Water Resources of the Hartford-New Britain Area, Connecticut

By R. V. CUSHMAN, D. TANSKI, *and* M. P. THOMAS

WATER RESOURCES OF INDUSTRIAL AREAS

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WATER RESOURCES OF THE HARTFORD-NEW BRITAIN AREA, CONNECTICUT

By R. V. CUSHMAN, D. TANSKI, and M. P. THOMAS

ABSTRACT

The Hartford-New Britain area includes the metropolitan areas of Hartford and New Britain and parts of several adjoining towns. Water used in the area is withdrawn from the principal streams and aquifers at an average rate of 463.5 mgd (million gallons per day). Sufficient water is available from these sources to meet present requirements and those for many years to come, although local shortages may develop in some areas as the result of problems of distribution and treatment. About 98 percent of all water used in 1957 was from surface sources. More than 425 mgd was required by industry, and about 23 mgd was for domestic water supply. The Farmington River upstream from Collinsville is the chief source of water for public supply in the Hartford-New Britain area, whereas the Connecticut River is the chief source of water for industry. An average of about 40 mgd is withdrawn from the upper Farmington River for public supply, and about 404 mgd is withdrawn by industry from the Connecticut River for nonconsumptive use and returned directly to the stream.

The Connecticut River is the source of the largest quantity of water in the area. The flow of the stream at Thompsonville may be expected to equal or exceed about 2,000 mgd 95 percent of the time, and the flow should not be less than this amount for periods longer than 12 days. The flow below Thompsonville is increased by additions from the Scantic, Farmington, Park, and Hockanum Rivers and from numerous smaller tributary streams. The available streamflow data for the aforementioned rivers have been summarized graphically in the report.

The chemical quality of water in the Connecticut River is good, except for short periods when the iron concentration is high. In addition to the removal of iron some other treatment may be necessary if water from the Connecticut River is used for special purposes. The chemical quality of the tributary streams is good, except the quality of the Park River, which is poor. Thus the Connecticut River in the vicinity of Hartford offers an almost unlimited source of water of good chemical quality to the Hartford-New Britain area. The Connecticut River and many of its tributaries, however, are polluted to some degree, and the cost of treatment for pollution and of delivery of water to the area presents an economic problem in the further development of these sources.

The Hartford-New Britain area in the vicinity of Hartford has been plagued by floods since the time of its settlement. Most of the damage to property and loss of life in the Hartford area has been caused by flooding of the Connecticut and Park Rivers. Floods have occurred on the Connecticut River and its tributaries in every month of the year, but the most severe floods occur in the spring and fall. The most devastating flood on the Connecticut River occurred on March 21, 1936, when the stage at Hartford reached 37.0 feet above mean sea level. The maximum flood on the Park River occurred on August 19, 1955, when the stage reached 43.5 feet above mean sea level. Floods on the other tributaries have been frequent and some have been large, but damage has not been as great because the streams flow mostly through rural areas.

Small to moderate supplies of water suitable for domestic use and for small municipalities and industries are available from wells in the Hartford-New Britain area. Moderate supplies are obtainable from five definable sand-and-gravel aquifers and from widespread consolidated sedimentary rocks. Yields to individual wells range from 15 to 400 gpm (gallons per minute) for wells penetrating sand and gravel and from 1 to 578 gpm for wells penetrating consolidated sedimentary rocks. Sand and gravel deposits bordering the Connecticut River downstream from Rocky Hill afford the greatest potential for the development of large supplies of ground water. Small supplies ranging from 1 to 40 gpm are obtainable from glacial till and from consolidated crystalline rocks. The chemical character of the ground water ranges from good to fair but is satisfactory for most uses. Most water from sand and gravel is soft to moderately hard. Water from the consolidated rocks is moderately hard to hard, and some water requires treatment before use.

Emergency water supplies are available from streams and wells in the area in the event of a large-scale disaster, such as a nuclear explosion. Ground-water sources would be least likely to be contaminated by radioactive fallout, but streams with a large discharge, such as the Connecticut and Farmington Rivers, would purify themselves to a certain extent in a relatively short time. Records of 93 existing wells believed to be suitable as emergency sources of water are given in a table in the report and are located on a map for Civil Defense use. In addition to supplies from wells already in existence, small supplies might be developed quickly from driven wells in sand and gravel aquifers.

INTRODUCTION

This report is one of a series on the water resources and present water utilization in selected industrial areas of national importance. It is designed to provide information for national-defense planning in the Hartford-New Britain area and for present and future planning for the development of the area's water resources by business, industry, and municipalities. The report was prepared by R. V. Cushman, under the supervision of G. C. Taylor, Jr., district geologist, Ground Water Branch; Daniel Tanski, under the supervision of F. H. Pauszek, district chemist, Quality of Water Branch; and M. P. Thomas, under the supervision successively of B. L. Bigwood and John Horton, district engineers, Surface Water Branch. It was prepared under the general supervision of K. A. MacKichan, Chief, Hydrologic Studies Section, Branch of General Hydrology.

Most of the data summarized in this report were collected over a period of many years by the U.S. Geological Survey in cooperation with the Connecticut Water Resources Commission, the Greater Hart-

ford Flood Commission, the Hartford Department of Public Works, and the New Britain Board of Water Commissioners. Additional information and records were furnished by the Metropolitan Water Bureau of Hartford, Farmington River Power Co., Collins Co., Rockville Water & Aqueduct Co., Hartford Electric Light Co., and United Aircraft Corp., and by public water-supply agencies, well drillers, and many persons in private organizations.

The authors wish to acknowledge the courtesy and cooperation of Messrs. W. S. Wise, director, Connecticut Water Resources Commission; W. J. Scott, director, Bureau of Sanitary Engineering, Connecticut Department of Health; G. W. Wood, chief engineer, New Britain Water Department; W. A. D. Wurts, manager, and W. A. Gentner, chief engineer, Hartford Metropolitan Water Bureau; and E. S. McCormick, superintendent, Kensington Fire District Water Department.

This report summarizes and evaluates the available information on the water resources and present water use in the Hartford-New Britain area and contains data useful to both defense and nondefense industries and to municipalities for the preliminary planning of new works or the expansion of existing facilities. Industrial expansion and the normal growth of municipalities and suburban communities in the area require adequate and continuing appraisals of water resources to insure sound management of existing supplies. This report describes the quantity, quality, and physical characteristics of the surface water at certain sites within the area. It describes the water-bearing characteristics of aquifers and gives data on the chemical quality of ground waters in the area. Chemical quality and other data on public water supplies are also given. It is not within the scope of this report to answer all questions or to solve all problems relating to water supplies in any specific area. Each individual problem may require its own detailed investigation and design study. Nor has an attempt been made to present a complete record of the hydrology of the area.

DESCRIPTION OF THE AREA

The Hartford-New Britain area, as considered in this report, includes the metropolitan area of Hartford and New Britain and a few small adjoining areas, all within Hartford County (fig. 1). It includes the towns of Bloomfield, Cromwell, East Hartford, Hartford, New Britain, Newington, Rocky Hill, West Hartford and Wethersfield and parts of the towns of Berlin, Farmington, Glastonbury, South Windsor, and Windsor. The area encompasses about 208 square miles and lies entirely within the Connecticut River lowland. Generally the lowland is a broad plain at an altitude of 40 to 120

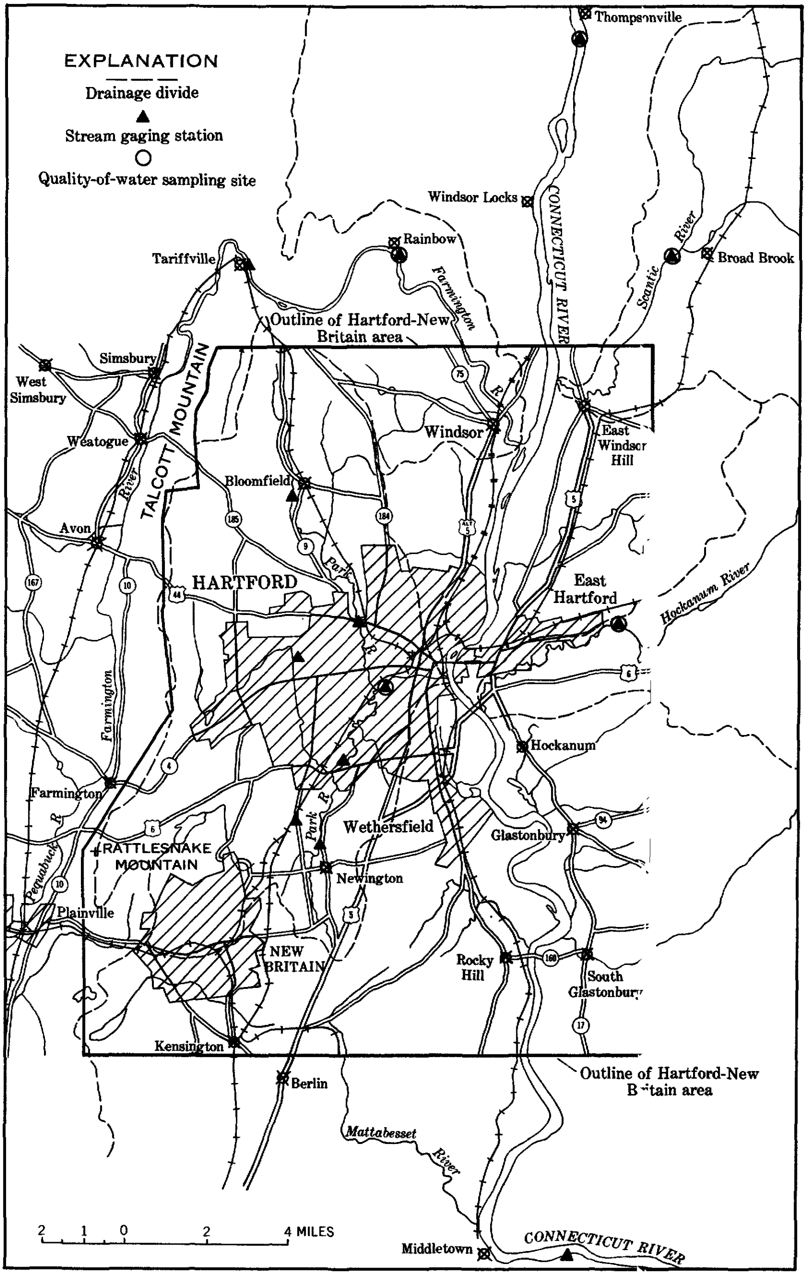

Figure 1.—Map showing area included in the Hartford-New Britain area, locations of stream-gaging stations, water-sampling sites, and outlines of drainage basins.

feet above sea level underlain by soft sedimentary rocks. West of the Connecticut River and south of Hartford, however, the plain is dotted by numerous low hills and ridges that rise to altitudes of 250 to 350 feet. The low hills are formed by differential erosion of the underlying sedimentary bedrock, whereas the broad plain is formed by beds of sand, silt, and clay that are the bottom deposits of an extensive glacial lake. The western border of the lowland and the Hartford-New Britain area is a series of discontinuous high ridges underlain by resistant basalt.

The entire area is drained by the Connecticut River, which flows southward in a meandering channel that is carved into the soft sediments of the plain. Within this area the river has a fall of about 5 feet and is tidal. Its principal tributaries are the Scantic, Farmington, Park, and Hockanum Rivers.

IMPORTANCE OF THE AREA

The Hartford-New Britain area includes two of the six largest cities in Connecticut and long has been a center of manufacturing operations. It has the greatest concentration of population of any area in Connecticut; the estimated population in July 1, 1959, was 466,000. It is probably the most important industrial area in the State. In 1958 there were 650 primary manufacturing establishments in the area, about three-fourths of which were in the Hartford metropolitan area. The chief manufacturing industries, in order of importance, are transportation equipment (including aircraft), machinery, fabricated metals, primary metals, and instruments. Hartford is known nationally as "the insurance city" because the home offices of 44 insurance companies are located there.

Although the area is known for its manufacturing, it is also the heart of the most intensively developed agricultural area in the State. There are two general categories of agricultural products: (1) fresh fruits and vegetables for nearby metropolitan markets and (2) tobacco and potatoes for markets throughout the region and the Nation. The soil and climate of the area are especially suited for the growing of fine cigar tobacco.

SOURCES AND SIGNIFICANCE OF WATER

Streamflow in the Hartford-New Britain area is plentiful, and ground water is present in many places in small to moderate quantities; yet water supplies are not readily available in certain parts of the area because of such diverse reasons as prior appropriation of water, lack of storage facilities to retain surplus water, and pollution of available streams. For example, the Connecticut River, the largest single source of water in the area, is not used at present as a source of potable water because of the poor sanitary quality of the water. Consequently, a large part of the potable water is imported from the upper Farmington River basin, which is beyond the Hartford-New Britain area as defined in this report.

The principal sources of water in the area are the Connecticut, Farmington, Scantic, Park, and Hockanum Rivers and ground-water. The first two rivers are capable of supplying the entire needs of the area for many years to come, although treatment is necessary for some uses. The Scantic, Park, and Hockanum Rivers are sources of lesser importance. Ground water occurs in almost all the rocks of the area. The largest supplies have been obtained from wells in water-bearing sand and gravel and in sedimentary bedrock. These aquifers probably receive some of their recharge from streams during periods of high flow or when heavy ground-water pumping has lowered the water table below the adjacent river level. The characteristics and potentialities of each source are considered in the report.

SIGNIFICANCE OF WATER QUALITY

All natural waters contain dissolved mineral matter leached directly from the soil and rocks. Other dissolved materials, both mineral and organic, are introduced by inflow of sewage and industrial wastes.

Because the utility of water is in part dependent on its quality, standards have been established for industry, irrigation, and domestic use. Process water generally should be soft, clear, odorless, free from iron and manganese, and low in dissolved solids. Suggested water-quality tolerances for many industrial processes are shown in tables 1 and 2.

The allowable mineral content for boiler-feed water is dependent upon the steam pressure. Quality tolerances for boiler-feed water are stringent, especially for water used in high-pressure boilers. As indicated in table 2, an increase in pressure requires a decrease in the permissible limit of the constituents present in water. For example, at pressure ranging from 250 to 400 pounds per square inch, the hardness limit is 10 ppm (parts per million) or less, whereas at pressure ranging from 0 to 150 pounds per square inch a hardness of 80 ppm is permissible.

Water used for cooling purposes should be free of slime and scale-forming materials and should be noncorrosive. Temperature also is an important consideration. Generally, ground water is an excellent source of water for cooling purposes, because its temperature is uniform throughout the year. Industries that require a large water supply, however, will often use surface water for cooling purposes if the quality is suitable.

Surface water and ground water used for irrigation must meet certain requirements, especially with respect to dissolved solids, per-

TABLE 1.—*Suggested water-quality tolerances*

[After Moore (1940). Allowable limits in parts per million. Iron as Fe: limit applies to both iron alone and the sum of iron and manganese. Other requirements: P indicates that potable water, conforming to U.S. Public Health standards, is necessary]

Industry or use	Turbidity	Color (units)	Hardness as $CaCO_3$	Iron as Fe	Manganese as Mn	Total solids	Alkalinity as $CaCO_3$	Odor, taste	Hydrogen sulfide	Other requirements
Air conditioning				0.5	0.5			Low	1	No corrosiveness or formation of slime.
Baking	10	10		.2	.2			Low	.2	P.
Boilerfeed										See table 2.
Brewing:										
Light beer	10			.1	.1	500	75	Low	.2	P; NaCl, <275 ppm; pH, 6.5–7.0.
Dark beer	10			.1	.1	1,000	150	Low	.2	P; NaCl <275 ppm; pH, 7.0 or more.
Canning:										
Legumes	10		25–75	.2	.2			Low	1	P.
General	10			.2	.2			Low	1	P.
Carbonated beverages	2	10	250	.2	.2	850	50–100	Low	.2	Iron alone, 0.2 ppm; P; organic color plus oxygen consumed, <10 ppm.
Confectionery				.2	.2	100		Low	.2	P; pH, >7.0 for hard candy.
Cooling	50		50	.5	.5				5	No corrosiveness or formation of slime.
Food processing (general)	10			.2	.2			Low		P.
Ice making	5			.2	.2			Low		P; SiO_2 <10 ppm.
Laundering		5	50	.2	.2					
Plastics (clear, uncolored)	2	2		.02	.02	200				
Paper and pulp:										
Groundwood	50	20	180	1.0	.5					No grit or corrosiveness.
Kraft pulp	25	15	100	.2	.1	300				
Soda and sulfite pulp	15	10	100	.1	.05	200				
High-grade light papers	5	5	50	.1	.05	200				
Rayon (viscose):										
Pulp production	5	5	8	.05	.03	100	[1] 50			Al_2O_3, < 8 ppm; SiO_2, <5 ppm; Cu, <5 ppm; pH, 7.8–8.3.
Manufacture	.3		55		.0					Iron alone, 0.0 ppm.
Tanning	20	10–100	50–135	.2	.2		[1] 135			
Textiles:										
General	5	20			.25					Iron alone, 0.25 ppm.
Dyeing	5	5–20		.25	.25	200				Constant composition; residual alumina, <0.5 ppm.
Wool scouring		70		1.0	1.0					
Cotton bandages	5	5		.2	.2			Low		

[1] Includes 8 ppm hydroxide.

TABLE 2.—*Suggested water-quality tolerance for boiler-feed water*

[After Moore (1940)]

	Allowable limits for pressure (psi) indicated			
	0–150	150–250	250–400	>400
Turbidity	20	10	5	1
Color units	80	40	5	2
Oxygen consumed ppm	15	10	4	3
Dissolved oxygen [1] do	1.4	.14	.0	.0
Hydrogen sulfide (H_2S) do	[2] 5	[2] 3	0	0
Total hardness as $CaCO_3$ do	80	40	10	2
Sulfate-carbonate ratio of ASME (Na_2SO_4:Na_2CO_3)	1:1	2:1	3:1	3:1
Aluminum oxide (Al_2O_3) ppm	5	.5	.05	.01
Silica (SiO_2) do	40	20	5	1
Bicarbonate (HCO_3)[1] do	50	30	5	0
Carbonate (CO_3) do	200	100	40	20
Hydroxide (OH) do	50	40	30	15
Total solids [3] do	500–3,000	500–2,500	100–1,500	50
pH (minimum value)	8.0	8.4	9.0	9.6

[1] Limits applicable only to feed water entering boiler, not to original water supply.
[2] Except when odor in live steam would be objectionable.
[3] Depends on design of boiler.

cent sodium, and boron concentration. These requirements are less stringent in the Eastern States, owing to abundant rainfall. Basically, water that is low in mineral content and contains no toxic substances is suitable for irrigation. A water with a specific conductance (a measure of solute content) of 2,000 micromhos per centimeter or less will generally have a negligible effect on crop yields. As the specific conductance increases, however, the yields of many crops are reduced. Class limits of specific conductance and their relationship to crop response (Wilcox, 1955, p. 14), are as follows:

Specific conductance (micromhos per cm)	*Effect on crop yield*
0–2,000	Mostly negligible.
2,000–4,000	Yields of more sensitive crops restricted.
4,000–8,000	Yields of many crops restricted.
8,000–16,000	Only salt-tolerant crops have satisfactory yields.
>16,000	Only a few crops, which are very salt tolerant, have satisfactory yields.

General chemical standards of water for domestic use have been established by the U.S. Public Health Service (1946), which set these standards for water supplies used on interstate carriers. These requirements have been accepted by the American Water Works Association and most State departments of public health. They are as follows:

	Mandatory limits (ppm)		*Mandatory limits (ppm)*
Lead (Pb)	0.1	Selenium (Se)	0.05
Fluoride (F)	1.5	Hexavalent chromium (Cr)	.05
Arsenic (As)	.05	Nitrate (NO_3)	[1].45

	Recommended limits (ppm)		*Recommended limits (ppm)*
Copper (Cu)	3.0	Sulfate (SO_4)	250
Iron and Manganese (Fe and Mn)	.3	Phenolic compounds (as C_6H_5OH)	.001
Magnesium (Mg)	125	Total solids:	
Zinc (Zn)	15	Desirable	500
Chloride (Cl)	250	Permitted	1,000

[1] Established by National Research Council.

POLLUTION

Pollution may affect the quality of water in many ways. It may cause water to become turbid, colored, odorous, toxic, mineralized, or bacteriologically contaminated. Principal sources of pollution are domestic sewage and waste effluent from industries.

In the Hartford area, pollution is a problem in the Connecticut, Park, Hockanum, and Scantic Rivers. Water from these streams, although polluted, may be suitable for limited industrial and agricultural uses. In contrast, water from most of the Farmington River is suitable for all purposes except untreated public water supplies, recreational bathing, and some agricultural uses.

The New England Interstate Water Pollution Control Commission has established water-quality standards for the classification of streams. They have adopted the plan, shown in table 3, whereby a stream is classified according to a description of the type of use for which the water is best suited. When the classification of a stream is approved, a pollution-abatement program is established to meet the requirements of the stream's classification. Continuing studies include sewage and industrial-waste surveys by the pollution-control agencies of the member States.

TABLE 3.—*Classification of surface waters according to suitability of use*

[New England Interstate Water Pollution Control Comm. Tentative plan for classification of waters as revised and accepted Dec. 8, 1950]

Impurities	Class A	Class B	Class C	Class D
Suitability[1]				
	Any water use. Character uniformly excellent.	Bathing and recreation; irrigation and agricultural uses; good fish habitat; good aesthetic value. Acceptable for public water supply with filtration and disinfection.	Recreational boating; irrigation of crops not used for consumption without cooking; habitat for wildlife and common food and game fishes indigenous to the region.	Transportation of sewage and industrial wastes without nuisance; navigation, power, generation, and other industrial uses.
Standards of quality				
Dissolved oxygen	Not less than 75 percent saturation.	Not less than 75 percent saturation.	Not less than 5 ppm	Present at all times.
Oil and grease	None	No appreciable amount	Not objectionable	Not objectionable.
Odor, scum, floating solids, or debris.	do	None	None	Do.
Sludge deposits	do	do	do	Do.
Color and turbidity	do	Not objectionable	Not objectionable	Do.

Phenols or other taste producing substances.	do	None	None	
Substances potentially toxic.	do	do	Not in toxic concentrations or combinations.	Not in toxic concentrations or combinations.
Free acids or alkalies	do	do	None	Not in objectionable amounts.
Coliform bacteria	Within limits approved by Connecticut State Department of Health for uses involved.[2]	Bacterial content of bathing waters shall meet limits approved by Connecticut State Department of Health, and acceptability will depend on sanitary survey.		

[1] Waters falling below these descriptions are considered to be unsatisfactory and are designated Class E waters. These standards do not apply to water whose conditions are brought about by natural causes. For purpose of distinction as to use, waters used or proposed for public water supply shall be so designated.

[2] Sea water used for the taking of market shellfish shall not have a median coliform content in excess of 70 per 100 ml.

WATER RESOURCES OF THE AREA

RECORDS AVAILABLE

Runoff has been measured at 20 gaging stations on streams within, bordering, or flowing into the report area; 13 of the stations are within or are just beyond the report area. All 20 stations are given on figure 2, which consists of bar graphs indicating years of operation; the general location of the 13 stations in or near the report area is shown on the outline map (fig. 1). Continuity of the available streamflow records ranges from a few months for four stations established in the Park River basin in the spring of 1958 to 45 years for the station on West Branch Farmington River at New Boston, Mass.

In this report, analyses are given of only the following streamflow records: Connecticut River at Thompsonville, Scantic River at Broad Brook, Burlington Brook near Burlington, Farmington River at Rainbow (Tariffville), South Branch Park River at Hartford, North Branch Park River at Hartford, Park River at Hartford, Hockanum River near East Hartford, and Connecticut River near Middletown. These eight streams were selected as being typical of the area, and their records were analyzed to furnish ready information for the economic selection, design, or operation of needed surface supplies in the area. A summary of the data is given in table 4.

Several hundred wells were inventoried in the report area to obtain geohydrologic information for use in a forthcoming Geological Survey report on ground water in north-central Connecticut. A number of these wells selected for use in this report are listed in table 17, and their locations are shown on plate 2. For convenience, only the number of the well within a town is included on plate 2; the symbol for the town has been omitted because it is obvious from the map. Periodic measurements of water level were made in three observation wells in the report area (wells EH 21, RH 44, and SW 64 in table 17). Except for one break, the records for wells EH 21 and SW 64 are continuous from 1934 to the present, whereas measurements for well RH 44 have been maintained only since 1954. In addition, single measurements of water level were made in a large number of wells.

Measurements of quality of water and temperature were recorded daily for Connecticut River at Thompsonville (site 1, fig. 2) from October 1955 to September 1956 and for Farmington River near Rainbow (site 11, fig. 2) from October 1957 to September 1958. Measurements of sediment load were recorded daily for Scantic River at Broad Brook (site 2, fig. 2) from December 1953 to September 1958. Periodic samples for water quality were also obtained for Scantic River at Broad Brook and for Burlington Brook near Burlington, Park River at Hartford (site 18, fig. 2), Hockanum River at Shenipsit Lake, and Hockanum River near East Hartford (site 19, fig. 2).

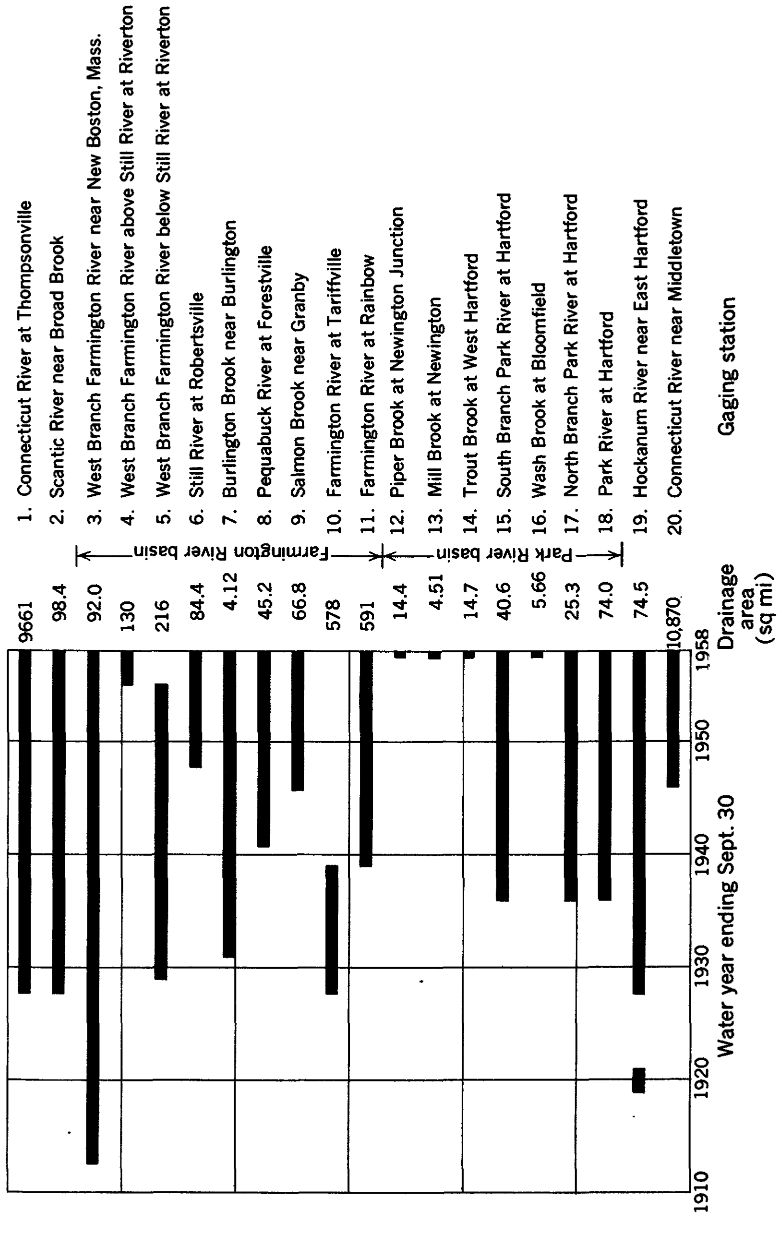

FIGURE 2.—Duration of records at gaging stations in the Hartford-New Britain area and vicinity.

TABLE 4.—*Summary of streamflow data, Hartford-New Britain area*

Site (See figs. 1, 2)	Stream	Gage location	Drainage area (sq mi)	Elevation of gage (ft above mean sea level)	Average flow: Period of record	Average flow: Quantity (mgd)	Average flow: Number of years	Maximum flow: Quantity (cfs)	Maximum flow: Gage height (feet)	Maximum flow: Date	Minimum daily flow: Quantity (mgd)	Minimum daily flow: Date
1	Connecticut River	Thompsonville	9,661	38.48	1928–58	10,690	30	282,000	16.6	Mar. 20, 1936	685	Aug. 28, 1949. Sept. 27, 1953.
								236,000	14.40	Sept. 22, 23, 1938		
								190,000	12.1	Nov. 6, 1927		
								174,000	10.93	Aug. 19, 1955		
2	Scantic River	Broad Brook	98.4	26.23	1928–58	91.8	30	13,300	19.9	Aug. 19, 1955	10.3	Aug. 13, 1954.
								7,360	16.08	Sept. 21, 1938		
								1,820	10.17	Mar. 13, 1936		
								1,810	10.15	Jan. 26, 1938		
7	Burlington Brook	Burlington	4.12	714.00	1931–58	5.30	27	1,690	9.22	Aug. 19, 1955	.3	July 18, 1957.
								676	7.24	Sept. 21, 1938		
								591	6.87	Dec. 31, 1949		
								533	6.58	Mar. 12, 1936		
								505	6.42	Jan. 25, 1938		
10	Farmington River	Tariffville	578	130.21	1928–39	701	30	69,200	23.5	Aug. 19, 1955	(1)	Mar. 5, 1944. Oct. 28, 1945. Nov. 11, 1945. Feb. 22, 1947.
11	do	Rainbow	591	35.36	1939–58			34,700	16.35	Oct. 16, 1955	3.3	
								29,900	14.0	Sept. 22, 1938		
								26,900	13.40	Mar. 19 1936		
								26,500	13.83	Jan. 1, 1949		
								24,500		Nov. 5, 1927		
	Connecticut River	Hartford	10,480	−0.55	1639–1958			313,000	37.6	Mar. 20, 21, 1936		
								251,000	35.42	Sept. 22, 23, 1938		
									30.6	Aug. 20, 1955		
									29.8	May 1, 1854		
									29.0	Nov. 6, 1927		
									28.7	Apr. 21, 1862		
									27.5	Mar. 20, 1801		
									27.2	Mar. 29, 1843		

15	South Branch Park River.	do	40.6	31.07	1936-58	46.9	22	5,000	19.65	Aug. 19, 1955	4.5	Sept. 2, 1957.
								3,600	13.6	Sept. 21, 1938		
								2,860	12.15	Jan. 25, 1938		
								2,800		Oct. 16, 1955		
								2,500		Mar. 12, 1936		
17	North Branch Park River.	do	25.3	34.20	1936-58	24.7	22	10,000	18.8	Aug. 19, 1955	.3	Sept. 24, 1943.
								3,680	12.4	Oct. 16, 1955		
								3,000	11.81	Jan. 25, 1938		
								2,800	11.2	Mar. 12, 1936		
								2,170	10.07	Sept. 21, 1938		
18	Park River	do	74.0	27.13	1936-58	78.2	22	14,000	16.36	Aug. 19, 1955	7.1	Oct. 6, 1941. Aug. 18, 1957.
								6,420	10.6	Oct. 16, 1955		
								5,650	9.16	Jan. 25, 1938		
								5,400	9.0	Mar. 12, 1936		
								5,320	8.93	Sept. 21, 1938		
19	Hockanum River	East Hartford	74.5	54.5	1919-21, 1928-58	75.6	32	5,160	13.78	Sept. 21, 1938	.8	Sept. 2, 1920.
								2,740	10.46	Aug. 19, 1955		
								2,140	8.79	Jan. 25, 1938		
								1,920	8.29	Mar. 5, 1934		
								1,810	8.06	Mar. 12, 1936		
20	Connecticut River	Near Middletown	10,870	0	1929-58	11,850	30	267,000	28.2	Mar. 21, 1936		
								239,000	25.75	Sept. 22, 24, 1938		
								[2] 210,000	23.4	May 1, 1854		
								177,000	20.44	Aug. 20, 1955		

[1] Minimum daily flow at Tariffville, 1928-30, was 113 mgd on Sept. 22, 1930.
[2] Discharge estimated from current rating.

CONNECTICUT RIVER

The Connecticut River, the largest river system in New England, has its source in the Connecticut Lakes country in northern New Hampshire. It flows southward separating the States of Vermont and New Hampshire, crosses western Massachusetts and central Connecticut, and enters Long Island Sound at Saybrook, Conn. It is 407 miles long and drains an area of 11,260 square miles, of which 10,480 square miles is above Hartford. The river enters the Hartford-New Britain area just above two of its larger tributaries (the Scantic and Farmington Rivers) flows southward across the east-central part of the area, and leaves the area below Rocky Hill. (See fig. 1.) The length of the river within the area is 28.5 miles.

This river is of great economic importance to the people within the area and to the State of Connecticut. It supplies water for industry and irrigation, provides a medium for the disposal of sewage and industrial waste, and is navigable by commercial vessels in the reach below Hartford, where a 15-foot channel is maintained. The estimated average withdrawal from the Connecticut River for industry and irrigation in the vicinity of Hartford is 404 mgd (million gallons per day).

A list of storage reservoirs on the Connecticut River and its tributaries above Middletown is given in table 5. Through the years these reservoirs have caused marked changes in the natural-flow regimen

TABLE 5.—*Usable storage, in million cubic feet, in Connecticut River basin above Middletown*

Reservoir	River	Date of completion	Usable storage		
			Power	Water supply	Flood control
Second Connecticut Lake	Connecticut		506		
First Connecticut Lake	do		3,330		
Lake Francis	do	Mar. 1940	4,326		
Moore Reservoir	do	Apr. 1956	4,970		
Comerford Station Pond	do	1930	1,279		
Union Village Reservoir	Ompompanoosuc	1949			1,660
Lakes and ponds in Mascoma River Basin	Mascoma		1,060		
Sunapee Lake	Sugar		862		
Surry Mountain Reservoirs	Ashuelot	1942			1,420
Birch Hill Reservoir	Millers	1941			2,180
Tully Reservoir	Tully	1948			958
Somerset and Harriman Reservoirs	Deerfield		7,560		
Quabbin Reservoir	Swift	Aug. 1939		55,700	
Ludlow (Springfield) Reservoir	Chicopee	1875		201	
Watershops Pond	Mill (Springfield)	1875	71		
Knightville Reservoir	Westfield	1941			2,130
Borden Brook and Cobble Mountain Reservoirs.	Little		[1] 3,394		
Otis Reservoir	Farmington	1865	780		
Barkhamsted Reservoir	do	1939		4,250	
East Branch Compensating Reservoir	do	1919	400		
Nepaug Reservoir	do	1918		1,280	
Whigville Reservoir	Pequabuck	1908		9	
Shenipsit Lake	Hockanum	1871	[1] 250		
Unspecified (storage in small ponds and reservoirs).			3,000		
Total			35,182	61,440	8,348

[1] Also used for municipal water supply.

in the Hartford-New Britain area. Flood runoff has been modified to a considerable degree. Controlled release of storage undoubtedly has progressively increased low-water discharge during hours of peak power demand, and the distribution of discharge over a month has likewise been altered. The records of flow and analytical data derived therefrom reflect these changes. For example, diversion from Quabbin Reservoir for municipal supply of the Boston metropolitan area is reflected in the reduced discharge of Connecticut River at Thompsonville. Such diversions are of minor practical significance, in view of the relatively large average discharge of the river, and may be offset by release of surplus storage at times when natural flow might be deficient.

DURATION AND FREQUENCY OF FLOWS

The flow of the Connecticut River is gaged in Connecticut at Thompsonville and near Middletown (fig. 2, table 4). Owing to large tidal effects at low and moderate stages, the gage-height record for Middletown cannot be converted directly into discharge. It has been necessary, therefore, to develop a synthetic calendar-week average-flow record for this location, based upon the summation of weekly flows at gages on Connecticut River at Thompsonville and on the following tributaries: Scantic River at Broad Brook, Hockanum River near East Hartford, Farmington River at Rainbow, and Park River at Hartford. The record has been adjusted for flow from the ungaged area. The flow characteristics of Connecticut River at Thompsonville near Middletown are shown by the flow-duration curves (figs. 3 and 4), which indicate the percentage of time during which a specific discharge was equaled or exceeded during the period of record. Also shown for comparison are curves for both maximum and minimum percentages of time during which specific daily discharges were equaled or exceeded in any year. For example, the daily flow for the period of record 1929–58 at Thompsonville has been equal to or greater than 2,500 mgd (3,870 cfs) for an average of 90 percent of the time, the minimum in a single year having been 76 percent and the maximum 98 percent of the time. The weekly flow at Middletown for the period of record 1929–58 has been equal to or greater than 5,200 mgd (8,040 cfs) for an average of 70 percent of the time, the minimum in a single year having been 45 percent and the maximum 91.5 percent of the time. These curves could be used to predict the distribution of future flows, if the water is stored and released in the same manner as during the period of record and if diversions and hydrologic conditions during the period are typical.

Flow-duration curves do not show whether the days of insufficient flow will be consecutive or how frequently shortages will occur.

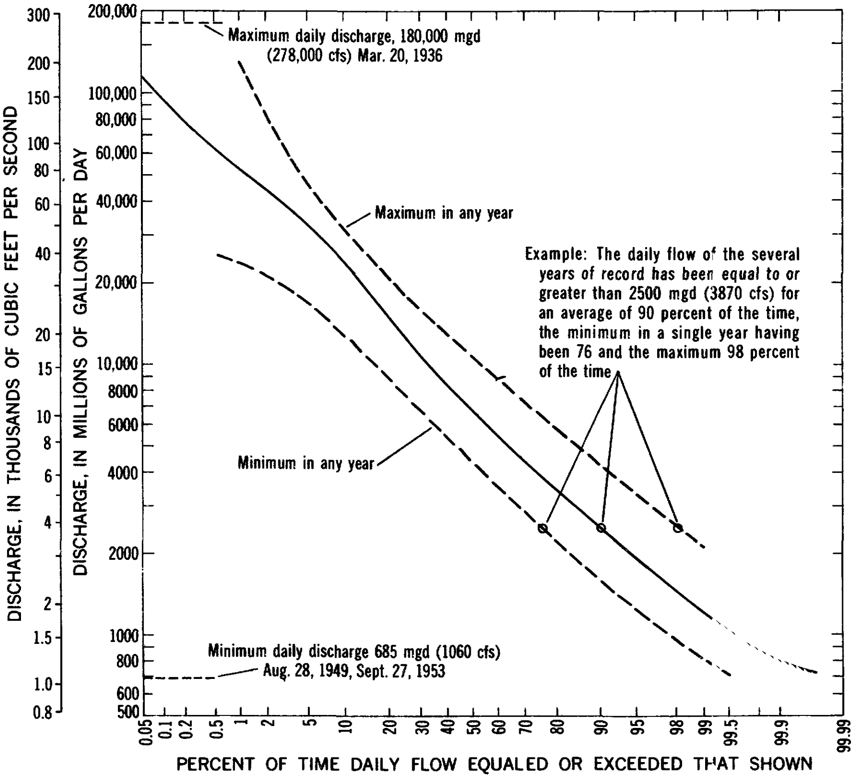

FIGURE 3.—Duration curve of daily flow, Connecticut River at Thompsonville, 1928–58.

Therefore, low-flow frequency curves are presented in figure 5 to show the average interval at which specific low flows may be expected to recur during the year under hydrologic conditions and pattern of regulation similar to those during the 29-year period April 1929 to March 1958. Curves for Thompsonville show the average flow for 1, 7, and 30 consecutive days, and the curve for Middletown shows the average flow for a calendar week. The maximum period during which the flow at Thompsonville was less than a specified discharge appears in figure 6. It shows, for example, that during the 29-year period 1929–57 the flow of Connecticut River at Thompsonville was less than 3,000 mgd (4,640 cfs) for not more than 40 consecutive days. Temporary retention of water in reservoirs and ponds upstream along the river, especially during drought periods of late summer, causes the flow to reach very low stages for short periods. A minimum daily flow of 685 mgd (1,060 cfs) occurred at Thompsonville on August 28, 1949, and on September 27, 1953.

Tidal effect in the Connecticut River is observed as far upstream as Windsor Locks during periods of low flow, and the mean tidal

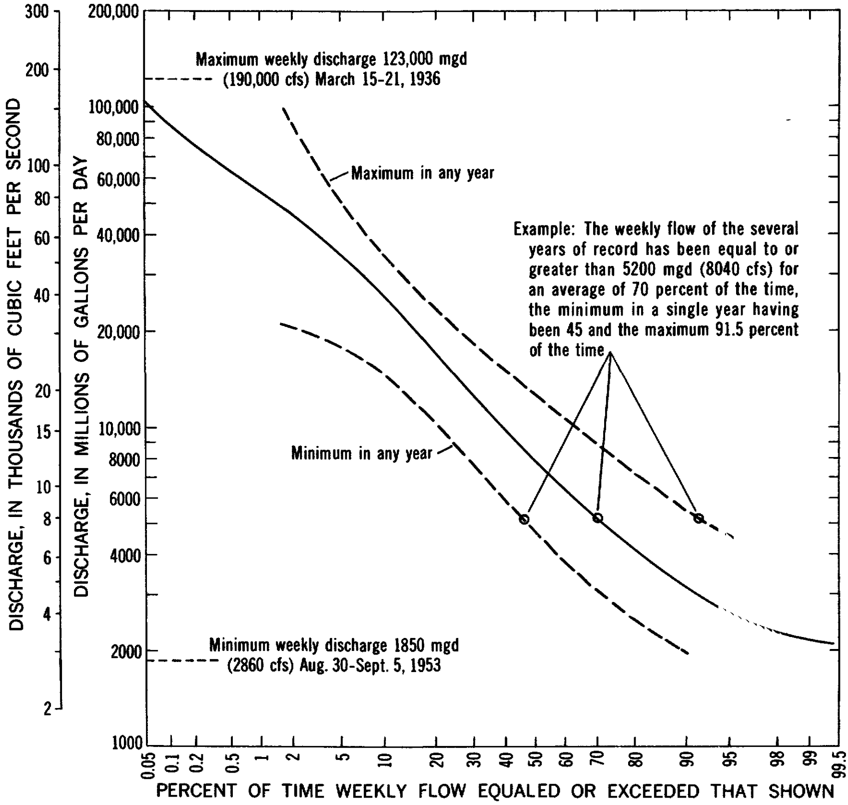

FIGURE 4.—Duration curve of weekly flow, Connecticut River near Middletown, 1929–58.

range at Hartford is 1.70 feet. So far as is known, salt water has not penetrated upstream beyond East Haddam, which is 19 miles below the Hartford-New Britain area.

FLOOD FLOWS

Floods have occurred on the Connecticut River in every month of the year, but they occur most frequently in the spring. They often occur on the tributaries within a few hours or a day after heavy precipitation, and some tributaries may have serious flooding without causing an appreciable rise on the main stem. Because the lowlands are settled densely, major floods have caused large property losses. Since 1943 the river in the Hartford-East Hartford area has been controlled by dikes. The crest of the Hartford dike is about 46 feet above mean sea level, 9 feet above the maximum flood stage ever experienced in this area. The East Hartford dike is about 3 feet lower. The large floods on the Connecticut River in 1927, 1936, and 1938 occurred prior to the construction of these dikes and caused

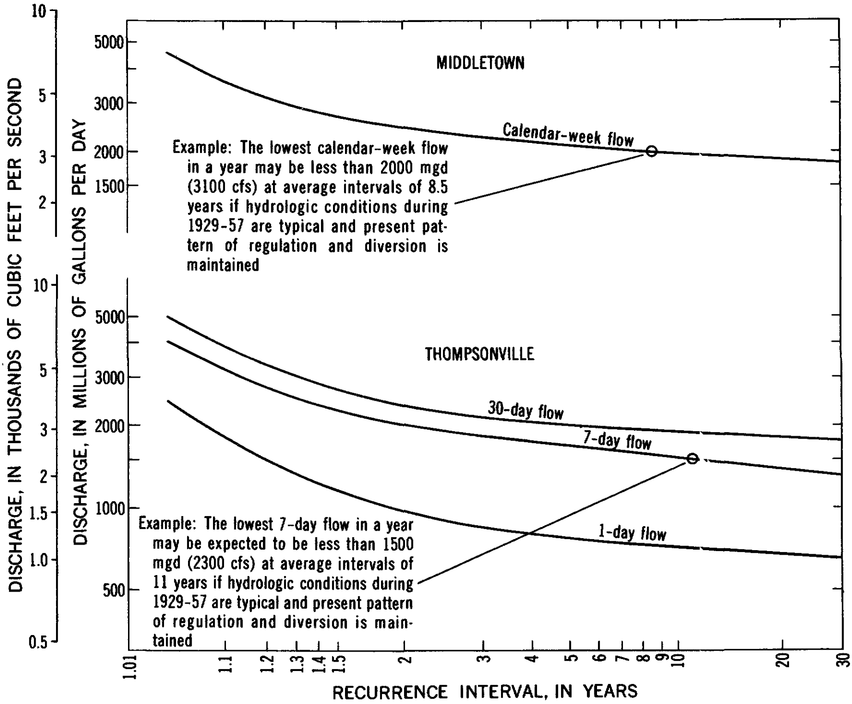

Figure 5.—Magnitude and frequency of annual low flows, Connecticut River at Thompsonville and near Middletown, 1929–57.

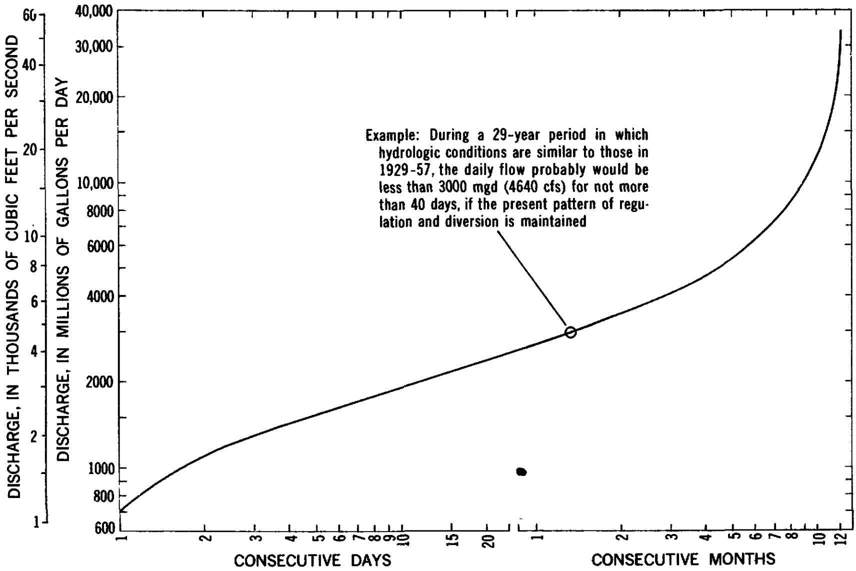

Figure 6.—Maximum period of deficient discharge, Connecticut River at Thompsonville, Conn., 1929–57.

damages totaling nearly $150 million. The maximum flood ever experienced in historic times (since 1639) on the Connecticut River was probably the flood of March 21, 1936, when the stage at Hartford reached 37.0 feet above mean sea level. The maximum discharge for this flood at Hartford was 313,000 cfs. The second highest flood in the same period occurred September 22, 1938, when the stage at Hartford rose to 34.9 feet above mean sea level. The maximum discharge for this flood was 251,000 cfs.

Through appraisal of the probable magnitude and frequency of floods heights, the risk to life and property can be evaluated for any selected severity of flooding. The flood-frequency curve for Connecticut River at Hartford appears in figure 7. It shows the average interval, in years, between floods that equal or exceed a given stage. For example, Connecticut River at Hartford may be expected to reach or exceed a stage of 25 feet at average intervals of 8.0 years. This does not mean that a flood reaching a stage of 25 feet will occur every 8.0 years but that about 10 such floods will occur within a period of 80 years.

Records of flood stages at Hartford are continuous from 1843 to 1958 and are intermittent from 1639 to 1842 (Kinnison and others, 1938). Table 4 gives the major floods on Connecticut River at Thompsonville, Hartford, and Middletown. Plate 1 shows the area along the Connecticut River which was inundated by the flood of March 20, 1936, exclusive of the parts of Hartford and East Hartford now protected by dikes and floodwalls. Figure 8 shows profiles of the Connecticut River observed during the floods of March 20, 1936, September 22, 1938, and August 19–20, 1955, in the reach between the gages at Thompsonville and near Middletown.

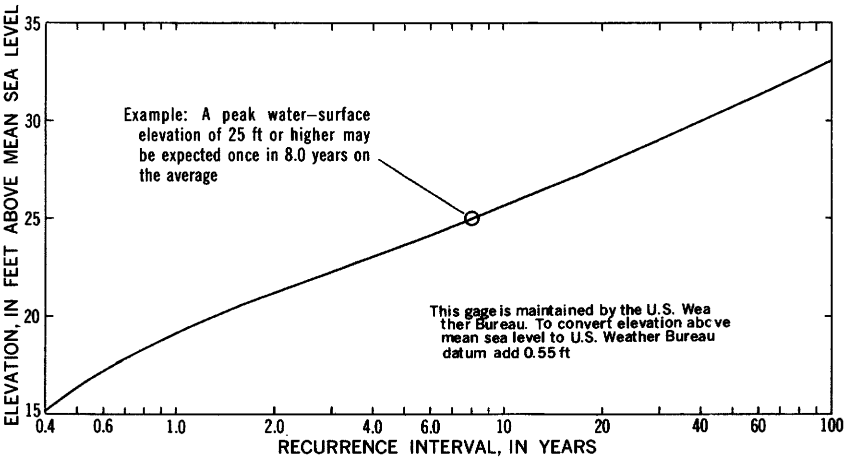

FIGURE 7.—Magnitude and frequency of floods, Connecticut River at Hartford, 1843–1958.

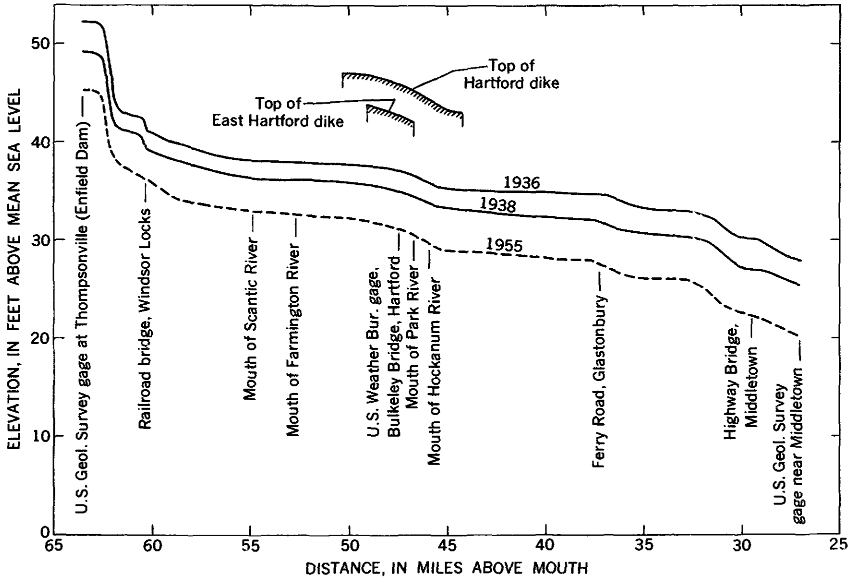

FIGURE 8.—Profiles of floods of 1936, 1938, and 1955 on the Connecticut River between Thompsonville and Middletown.

CHEMICAL QUALITY

The chemical quality of water of the Connecticut River at Thompsonville is good, except for periods of high iron concentration (fig. 9). Water from the river can be used for many industrial purposes because of its low mineral content. Treatment may be necessary to satisfy the water-quality tolerances of certain industrial processes.

The chemical character of the water of Connecticut River at Thompsonville reflects the geology of the drainage area and is modified by variations in streamflow. Ground-water inflow from the unconsolidated sand and gravel contributes only moderate quantities of dissolved solids to the Connecticut River, even during low flow. Increased streamflow, including overland runoff, further dilutes the low concentration of dissolved solids, and the end product is a soft water of low mineral content suitable for many purposes.

A summary of the concentration of chemical constituents at this location appears in table 6. Minimum, average, and maximum concentrations are shown for each constituent as observed during the year of record October 1955 to September 1956. Iron concentration was high during most of the period, as indicated in figure 9. Average iron concentration during the year of record was 0.39 ppm, and the highest determined was 1.4 ppm during the latter part of March. The higher concentrations of iron are due, in part, to the inflow of industrial wastes.

TABLE 6.—*Summary of chemical analyses, Connecticut River at Thompsonville, October 1955 to September 1956*

Constituent	Concentration (ppm)		
	Minimum	Average	Maximum
Silica (SiO_2)	1.8	5.8	8.5
Iron (Fe)	.15	.39	1.4
Calcium (Ca)	6.2	11	15
Magnesium (Mg)	1.3	1.9	3.3
Sodium (Na)	2.7	4.9	8.0
Potassium (K)	.9	1.4	1.9
Bicarbonate (HCO_3)	17	23	51
Sulfate (SO_4)	7.5	17	18
Chloride (Cl)	2.9	6.3	11
Fluoride (F)	.0	.1	.2
Nitrate (NO_3)	.1	2.2	3.8
Dissolved solids	46	67	91
Total hardness as $CaCO_3$ [1]	24	34	53
Color units	5	8	15

[1] Includes hardness of all polyvalent cations reported.

Low concentrations of calcium and magnesium were responsible for the softness of water from the Connecticut River. Although variations in hardness occurred throughout the year, the average hardness was only 34 ppm and the maximum was 53 ppm (fig. 9). Waters having a hardness of 60 ppm or less are generally regarded as soft.

The concentration of dissolved solids was modified by variations in streamflow. During periods of low flow, the concentration of dissolved solids increased, whereas during periods of high flow, it was reduced by dilution. The decrease, however, was small and continued to remain rather uniform at higher discharges. (See fig. 10.)

TEMPERATURE

Water temperature is significant if the water is to be used for cooling, and it may be an important consideration in the location of an industrial plant. Daily water-temperature measurements of Connecticut River at Thompsonville were taken for the period October 1955 to September 1956 and the results are given in figure 11. The maximum daily water temperature observed was 82°F on August 17 and 19, 1956; the minimum was 33°F on several days in December 1955, and the average for the year of record was 52°F. Thirty percent of the time the temperature of Connecticut River at Thompsonville equaled or exceeded 64°F (fig. 12).

SCANTIC RIVER

The Scantic River is the first major tributary of the Connecticut River in Connecticut and also within the Hartford-New Britain area. The river is 28 miles long and drains an area of 114 square

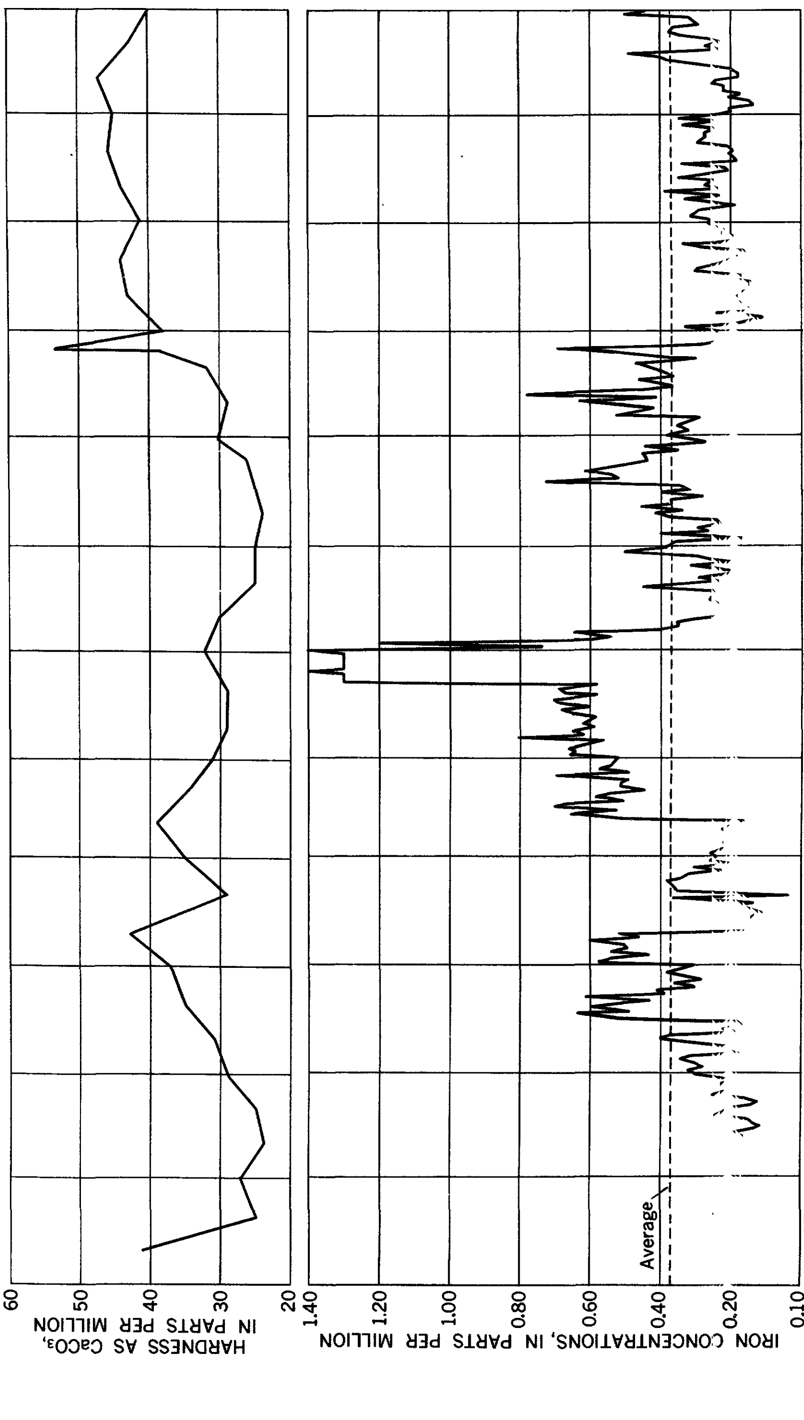

FIGURE 9.—Daily concentration of iron, November 1955 to September 1956, and hardness as $CaCO_3$, October 1955 to September 1956, of Connecticut River at Thompsonville.

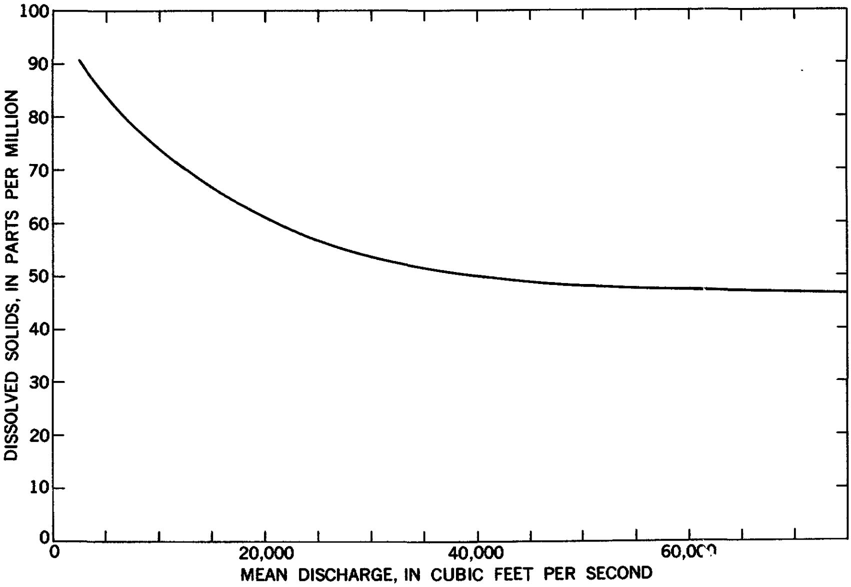

FIGURE 10.—Relation of dissolved solids to discharge, Connecticut River at Thompsonville, October 1955 to September 1956.

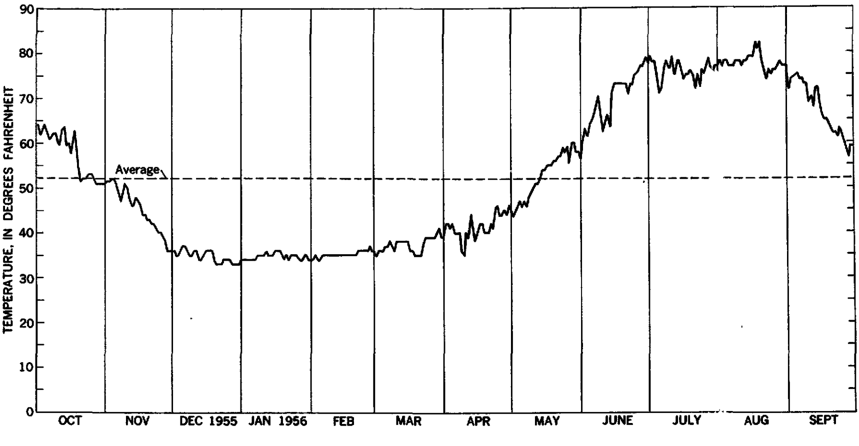

FIGURE 11.—Temperature of Connecticut River at Thompsonville, October 1955 to September 1956.

miles. It rises in the eastern highlands of south-central Massachusetts but through most of its course meanders through the relatively level eastern flood plain of the Connecticut River. Most of its tributaries are short, swift brooks, also flowing from the eastern highlands. It enters the Connecticut River from the east, 7½ miles above Hartford and just within the Hartford-New Britain area.

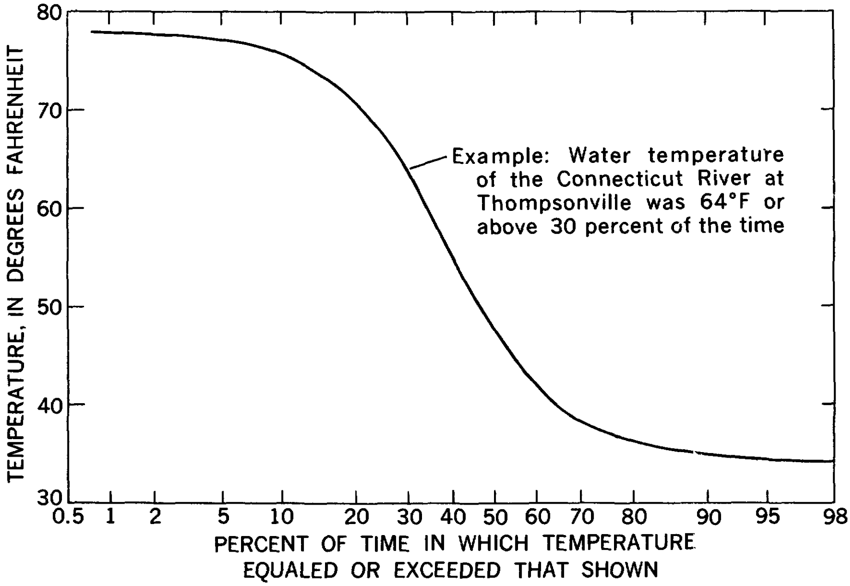

FIGURE 12.—Cumulative frequency curve of temperatures, Connecticut River at Thompsonville, October 1955 to September 1956.

DURATION AND FREQUENCY OF FLOWS

The Scantic River is gaged at Broad Brook (fig. 2, table 4). The flow characteristics of the Scantic River are shown by the flow-duration curve for the period of record (fig. 13) and by curves for both maximum and minimum percentages of time during which specific daily discharges were equaled or exceeded in any year.

The low-flow frequency curves presented in figure 14 show the average interval at which specific low flows may be expected to recur in the Scantic River under hydrologic conditions and pattern of regulation similar to those during the 29-year period 1929–57. Low-flow-frequency curves for the average flow during periods of 1, 7 and 30 consecutive days are shown in figure 14.

The curve in figure 15 shows the maximum period during which the flow at Broad Brook was less than a specified discharge. It shows, for example, that during a 29-year period in which hydrologic conditions are similar to those in 1929–57, the daily flow of Scantic River at Broad Brook probably would be less than 15 mgd (23 cfs) for not more than 30 consecutive days under the present pattern of regulation.

During dry periods streamflow is frequently inadequate to meet the minimum requirements of use. Additional flow may be provided during such periods by the use of reservoir storage. The draft-storage curve for the Scantic River in figure 16 shows the additional net

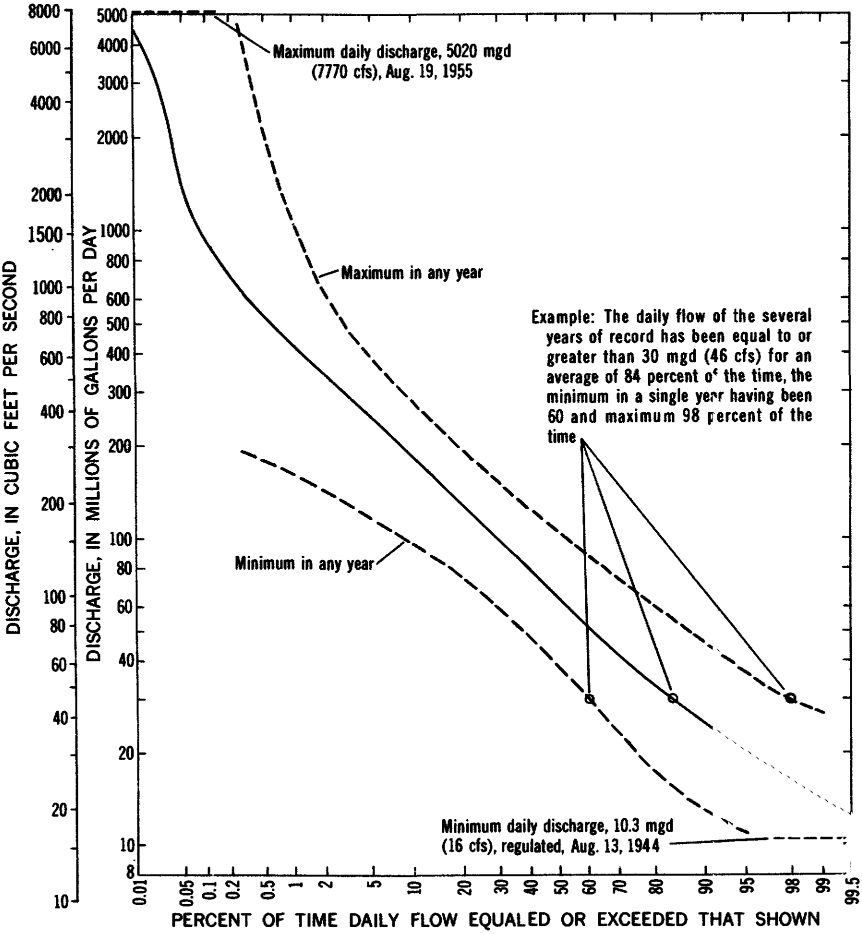

FIGURE 13.—Duration curve of daily flow, Scantic River at Broad Brook, 1929–58.

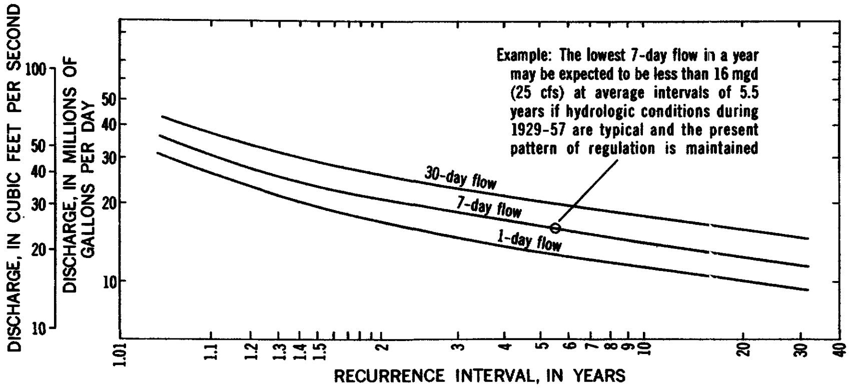

FIGURE 14.—Magnitude and frequency of annual low flows, Scantic River at Broad Brook, 1929–57.

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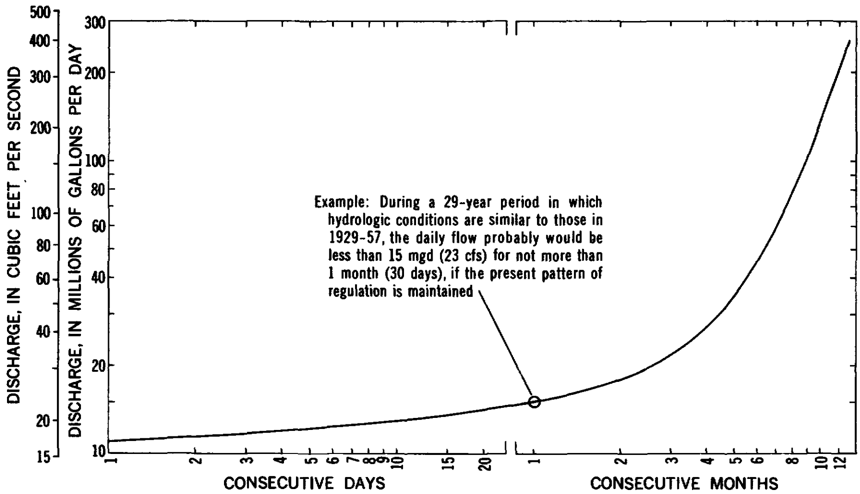

FIGURE 15.—Maximum period of deficient discharge, Scantic River at Broad Brook, 1929–57.

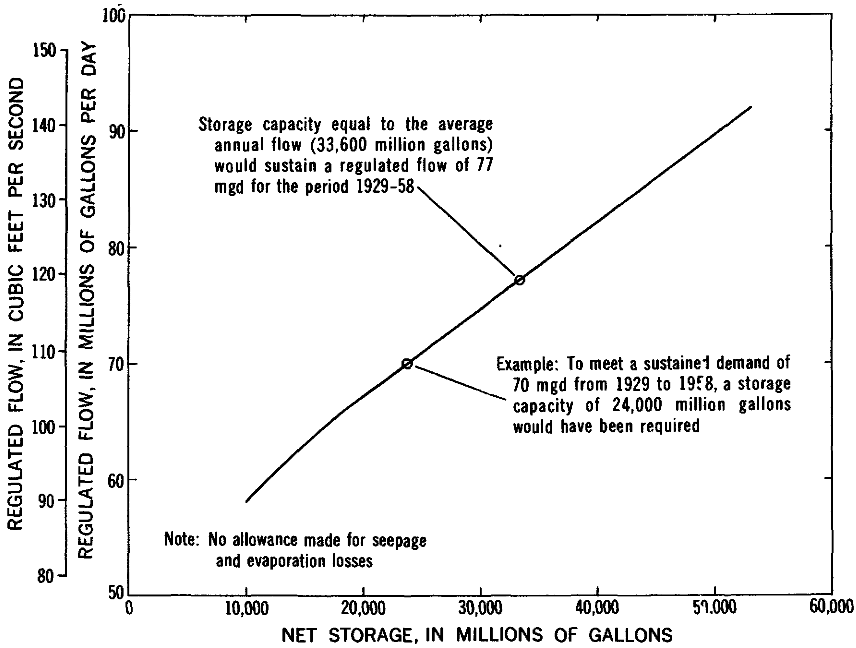

FIGURE 16.—Storage required to maintain flows, Scantic River at Broad Brook, 1929–58.

storage that would have been required to maintain specific outflow rates during the period 1929–58 if evaporation and seepage losses are considered to be part of the outflow. It shows, for example, that to meet a sustained demand of 70 mgd a net storage capacity of 24,000 million gallons would have been required.

FLOOD FLOWS

The Scantic River basin has been subject to at least three floods of extraordinary magnitude. The greatest flood known occurred on August 19, 1955, when the river reached an elevation of 46.1 feet above mean sea level at the Broad Brook gaging station and the flow was 13,300 cfs. On September 21, 1938, the river rose to 42.3 feet above mean sea level at the same place, and the flow was 7,360 cfs; however, the top 1.7 feet of this rise resulted from failures of dams upstream, which added about 2,200 cfs to the peak flow. The river is normally at an elevation of about 26 feet at this point. The greatest flood prior to the period of record occurred October 4, 1869. This flood was greater than any previously known by the oldest inhabitant and caused considerable damage throughout the area. Its height is unknown.

A flood-frequency curve showing the average interval, in years, between floods that equal or exceed a given elevation or discharge is shown in figure 17. Floods do not occur with any regularity, however, and the recurrence intervals shown are average values only. Table 4 gives major flood events that have occurred on the Scantic River since records began in August 1928.

CHEMICAL QUALITY

Based on total mineral content, the chemical quality of water from the Scantic River is good. Several analyses are available (table 7), and these show that the concentration of dissolved solids ranged from 52 to 138 ppm, and that the hardness ranged from 20 to 80 ppm. Although based on limited data, the aforementioned ranges probably reflect the influences of geology and streamflow. The minimum con-

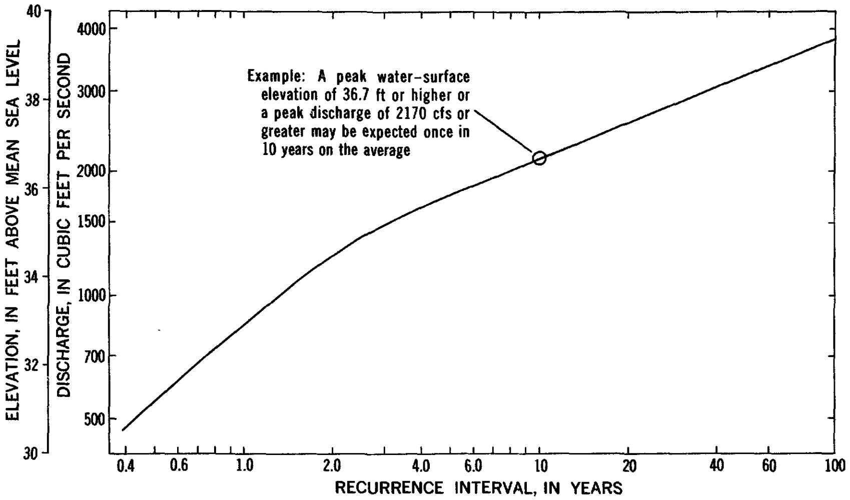

FIGURE 17.—Magnitude and frequency of floods, Scantic River at Broad Brook, 1929–58.

TABLE 7.—*Chemical analyses of periodic water samples, Scantic River at Broad Brook*

[Chemical constituents in parts per million. See fig. 1, and site 2, fig. 2 for locality]

Date of collection	Sept. 11, 1952	Oct. 10, 1952	Mar. 31, 1953	June 25, 1958
Instantaneous discharge mgd	23	34	724	48
Silica (SiO_2)	9.2	11	5.9	8.9
Iron (Fe)	.16	.14	.33	----------
Manganese (Mn)	.02	.00	.00	----------
Calcium (Ca)	23	22	6.0	18
Magnesium (Mg)	5.5	3.2	1.3	3.4
Sodium (Na)	8.3	11	2.2	5.4
Potassium (K)	1.3	1.9	.8	.8
Bicarbonate (HCO_3)	44	38	9	33
Carbonate (CO_3)	0	0	0	0
Sulfate (SO_4)	45	48	17	29
Chloride (Cl)	8.8	5.8	2.5	6.2
Fluoride (F)	.3	.1	.1	.1
Nitrate (NO_3)	4.3	1.9	1.1	7.1
Dissolved solids:				
Calculated	----------	----------	----------	----------
Residue on evaporation at 180° C	137	138	52	104
Hardness as $CaCO_3$	80	68	20	59
Noncarbonate hardness as $CaCO_3$	44	40	13	32
Alkalinity as $CaCO_3$	----------	----------	----------	----------
Specific conductance micromhos at 25° C	199	210	64.9	154
pH	7.1	7.1	6.2	6.6
Color units	5	10	33	9

centrations of dissolved solids and hardness occurred during a high flow of 724 mgd when dilution was most effective. The maximum concentrations occurred during a low flow of 23 mgd.

The maximum color of the stream occurred during a period of high flow and probably resulted from decayed organic matter. Iron was also present in objectionable quantities (0.33 ppm) during this period. High iron concentrations are often associated with waters of high color, because iron may combine with organic substances in solution. Objectionable amounts of iron and high color might affect the utility of water for some purposes, but proper treatment for their removal or reduction would make water from the Scantic River suitable for most purposes.

The concentrations of other dissolved chemical constituents found in Scantic River water were low and would have little or no effect on the utility of the water.

SEDIMENT

The lower Scantic River meanders through a gently rolling lowland underlain generally by fine-grained unconsolidated deposits. Erosion of the fine-grained material is rapid at times, and much of the eroded material is transported as suspended or bed material in the Scantic River. A sampling station has been operated on the Scantic River at Broad Brook since 1952 to determine the suspended-sediment load carried by the stream.

The sediment discharge of Scantic River at Broad Brook is less than 7 tons per day 50 percent of the time (table 8). During periods of rising stage and increased stream discharge, however, sediment

TABLE 8.—*Duration table of daily sediment load, Scantic River at Broad Brook, 1953–58*

Water year	Daily sediment load, equaled or exceeded the sediment load (tons per day) shown for the percent of time indicated					
	5	10	25	50	75	99
1953	108	58	17	7	5	3
1954	23	13	8	7	5	2
1955	54	29	11	7	6	3
1956	75	35	12	6	4	3
1957	17	9	6	5	5	2
1958	46	25	9	4	3	2

discharge increases rapidly for short periods (fig. 18). The increase in sediment load followed no particular pattern as to the time of year but was concurrent with the periods of intense and prolonged rainfall. The sediment load is generally lowest during the summer. During the hurricane floods of 1955, the maximum suspended load occurred on August 19 and was 6,670 tons per day. The total sediment load for the month of August 1955 was 12,100 tons, of which 10,900 tons passed the Broad Brook station during the 2-day period August 19–20, 1955. This was 70 percent of the total load for the water year 1955 (15,600 tons). In October 1955, because of additional floods, the monthly total was 4,070 tons, or 47 percent of the total annual load for the water year 1956 (fig. 19).

Records of sediment discharge prior to 1952 are not available for comparison, and the current record is insufficient for use in predicting a trend. Total annual sediment discharges for the period of record are given as follows:

Water year	Sediment load (tons per day)		
	Maximum	Minimum	Total
1953 [1]	708	0.2	7,470
1954	189	.2	2,460
1955	6,670	.2	15,600
1956	1,380	.4	8,660
1957	185	.2	2,120
1958	185	.3	3,820

[1] Nov. 25, 1952, to Sept. 30, 1953.

Generally the suspended sediment in the Scantic River consisted mostly of silt and clay (as much as 96 percent) and only small quantities of sand. This composition reflects the soil characteristics of the drainage basin. The composition, however, changed drastically during floods, such as the hurricane floods of August and October 1955. As stream velocity increased, erosion of the bed took place and the heavier particles of sand that had accumulated on the bed again became suspended and were transported downstream.. About 96 percent of the suspended sediment was sand during this period; the remainder was silt and clay.

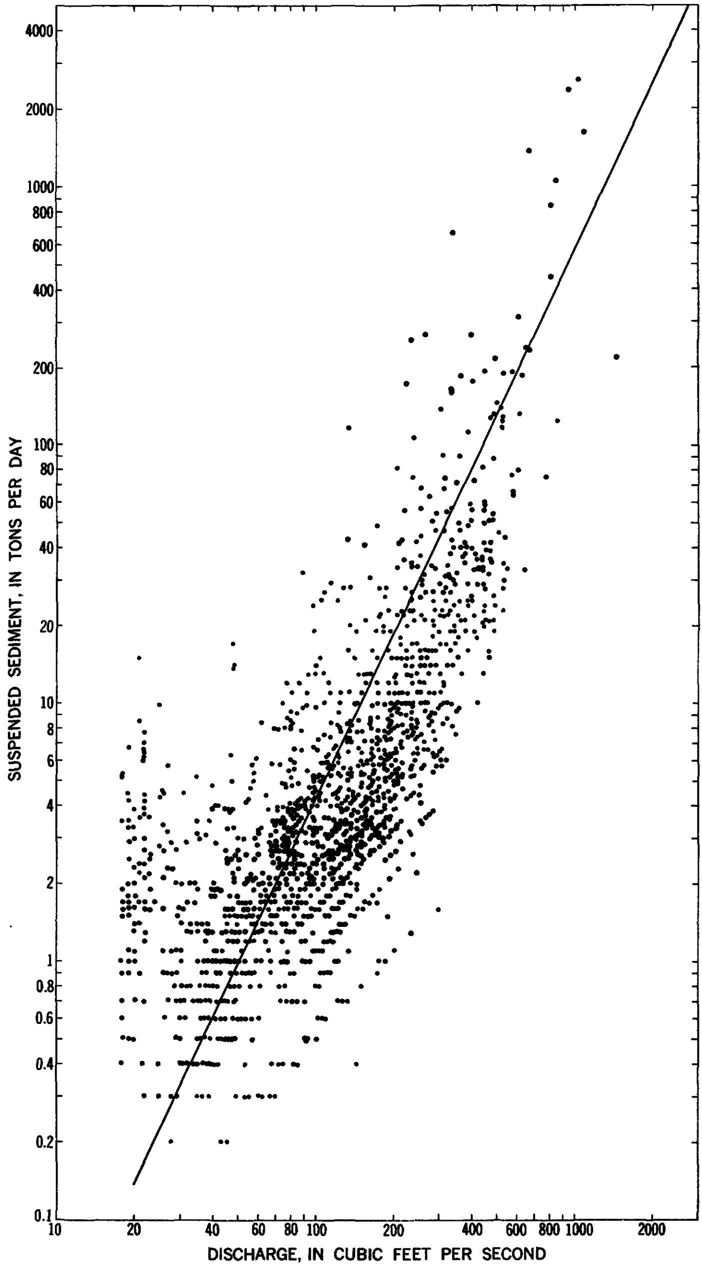

FIGURE 18.—Relation of suspended-sediment load to discharge, Scantic River at Broad Brook, water years 1953–58.

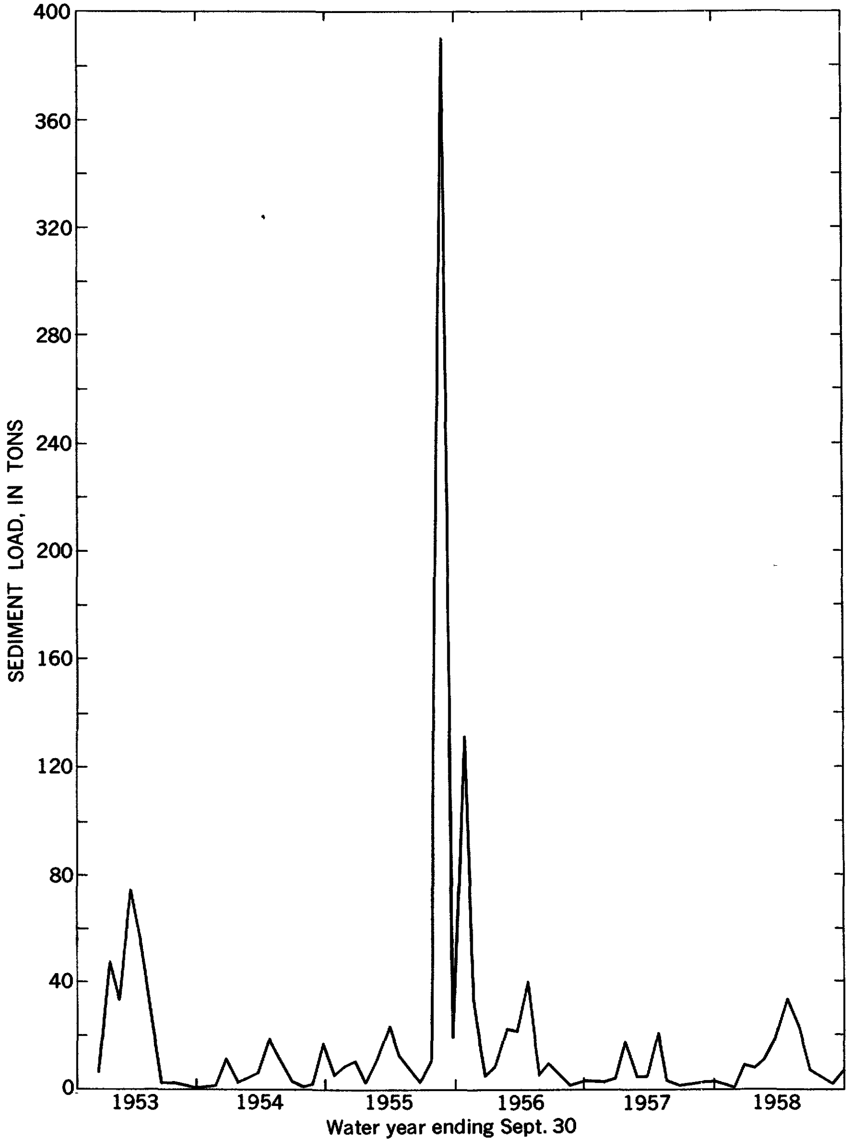

FIGURE 19.—Monthly sediment load, Scantic River at Broad Brook, water years 1953–58.

FARMINGTON RIVER

The Farmington River originates in the Berkshire Hills of western Massachusetts and empties into the Connecticut River 5 miles north of Hartford and 2 miles below the mouth of the Scantic River. It is the largest tributary entering the Connecticut River within Connecticut and has a drainage area of 609 square miles (fig. 1). Its tributaries are short and swift and flow in steep, narrow valleys. The main stream, which includes the East and West Branches, has relatively steep grades in its upper reach above Farmington, but between Farmington and Tariffville flat slopes and a meandering channel in a broad flood plain provide large overflow capacity which considerably alters the nature of floods downstream.

The East Branch Farmington River, draining 61.2 square miles, is completely controlled, as is the Nepaug River, draining 32.0 square miles. Both streams are the source of water supply for the Hartford metropolitan area and the diversion for this supply decreases the discharge of the lower Farmington River. The Charles A. Goodwin Dam, now (1959) under construction on the West Branch, will augment this supply by diverting a large part of the flow of the West Branch into Barkhamsted Reservoir on the East Branch. An average of about 45 mgd is presently diverted from the Farmington River basin to the Hartford metropolitan area for domestic and industrial uses. When the Charles A. Goodwin Dam is completed, an additional 122 square miles will be controlled by the Metropolitan District. Otis Reservoir on Fall River at Cold Spring, Mass., completely controls a drainage area of 17.2 square miles and is used for industrial storage.

The Corps of Engineers, U.S. Army, has proposed construction of three dams on the Farmington River to assist in the control of floods. One dam is to be constructed on the West Branch at Colebrook, just upstream from the new Hogback water-supply development of the Water Bureau of the Metropolitan District of Hartford; two dams are to be constructed on branches of the Still and Mad Rivers. At present, the dam on the Mad River above Winsted is the only one authorized for construction.

DURATION AND FREQUENCY OF FLOWS

The Farmington River has been gaged at Tariffville and at Rainbow (fig. 2, table 4). The minimum daily discharge at Tariffville was about 113 mgd (175 cfs) on September 22, 1930, and the regulated minimum daily discharge at Rainbow below the dam of the Farmington Power Co. was 3.3 mgd (5.1 cfs) on several days. The flow characteristics of Farmington River at Tariffville and Rainbow for the period of record are shown by the flow-duration curves on figure 20. Also shown for comparison are curves for both maximum and minimum percentages of time during which specific daily discharges were equaled or exceeded. Corresponding curves for the two stations differ for lower discharges because of the effect of storage and regulation at Rainbow Dam of the Farmington River Power Co. Low and moderate flows at the Rainbow gaging station are considerably affected by regulation from this power installation.

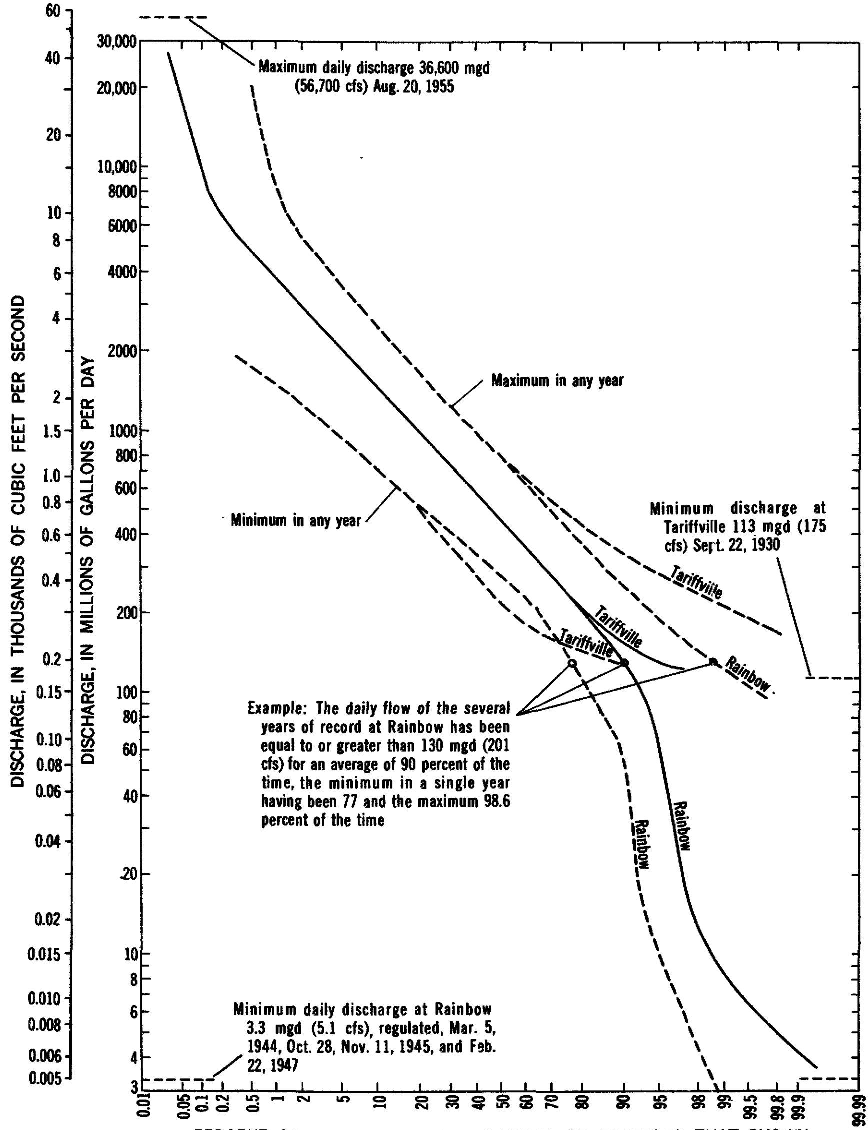

FIGURE 20.—Duration curve of daily flow, Farmington River at Tariffville (1929–39) and Rainbow (1940–58).

Low-flow frequency curves for the combined Tariffville-Rainbow record are shown in figure 21. The position of the curves beyond the 15-year recurrence interval is indefinite because of the uncertain frequency of occurrence of an extremely low flow. Such a flow in the summer of 1957 was due to an unusual combination of natural flow and natural and regulated flow. Curves are presented for the

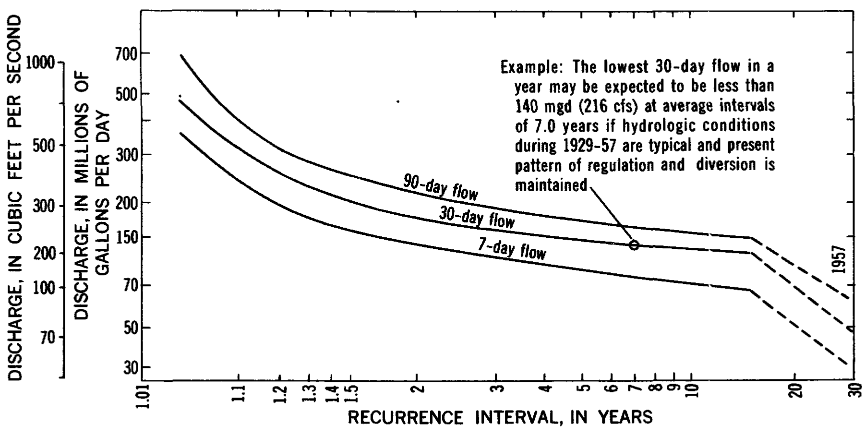

FIGURE 21.—Magnitude and frequency of annual low flows, Farmington River at Rainbow (Tariffville), 1929–57.

average flow during periods of 7, 30 and 90 consecutive days. Also curves showing the maximum period during which the flow at Tariffville and Rainbow was less than a specified discharge during the period of record appear in figure 22.

During dry periods the flow of Farmington River may be inadequate to meet the minimum requirements, and additional flow may be provided from reservoir storage. The draft-storage curve for the combined Tariffville-Rainbow record (fig. 23) shows the additional net

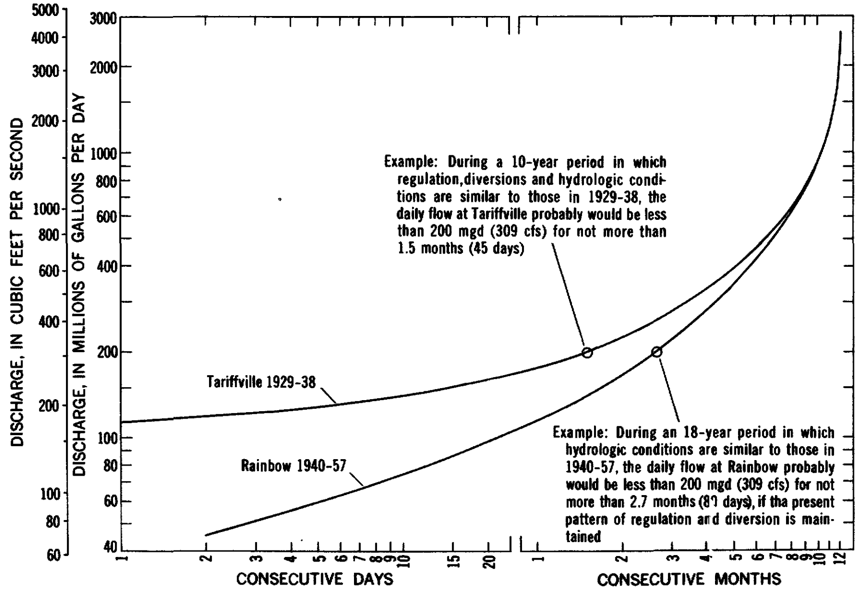

FIGURE 22.—Maximum period of deficient discharge, Farmington River at Tariffville (1929–38) and at Rainbow (1940–57).

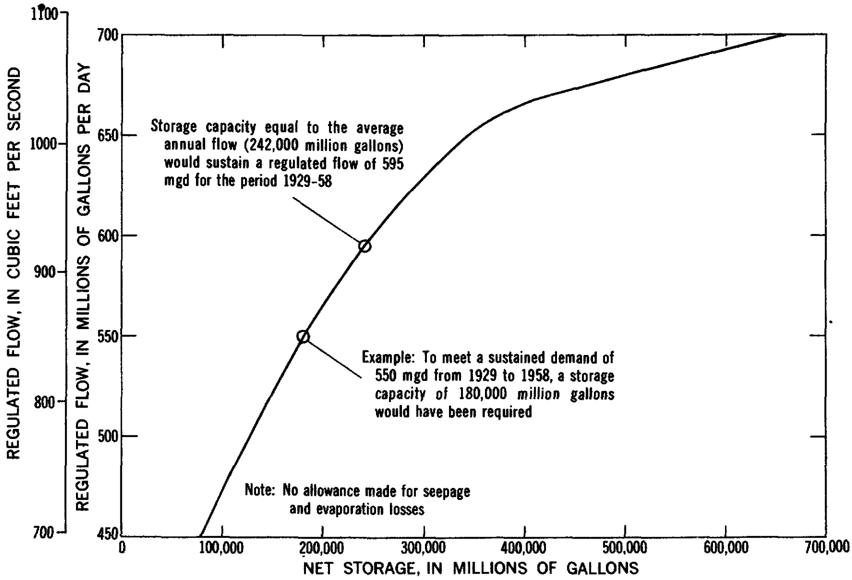

FIGURE 23.—Storage required to maintain flows, Farmington River at Rainbow (Tariffville), 1929–58.

storage that would have been required to maintain specific outflow rates during the period 1929–58, if evaporation and seepage losses are considered to be part of the outflow.

FLOOD FLOWS

Floods occur frequently in the Farmington River basin, particularly in the spring. Historic floods of great magnitude occurred in March 1639, March 1801, November 13, 1853, April 30, 1854, October 4, 1869, December 10, 1878 and March 1, 1896. During the period of record major floods occurred on November 4, 1927, March 18, 1936, September 21, 1938, January 1, 1949, August 19, 1955 and October 16–17, 1955. The flood of August 19, 1955, was the greatest and most devastating known to occur in the valley, and the flood of October 16, 1955, is perhaps the next greatest. At Rainbow, the flood of August 19, 1955, reached an elevation of 58.9 feet above mean sea level, 24 feet above the river bed, and the flow was 69,200 cfs. The peak elevation for the flood of October 16, 1955, was 51.7 feet, 17 feet above the riverbed; and the flow was 34,700 cfs, or half the August peak flow. A flood-frequency curve, based on the combined records at Tariffville and Rainbow, showing the average interval, in years, between floods that equal or exceed a given elevation or discharge, is presented in figure 28. The recurrence intervals are average values only, for floods do not occur with any regularity. Table 4 lists the major floods which have occurred on the Farmington River at Tariffville and Rainbow since records began in 1913.

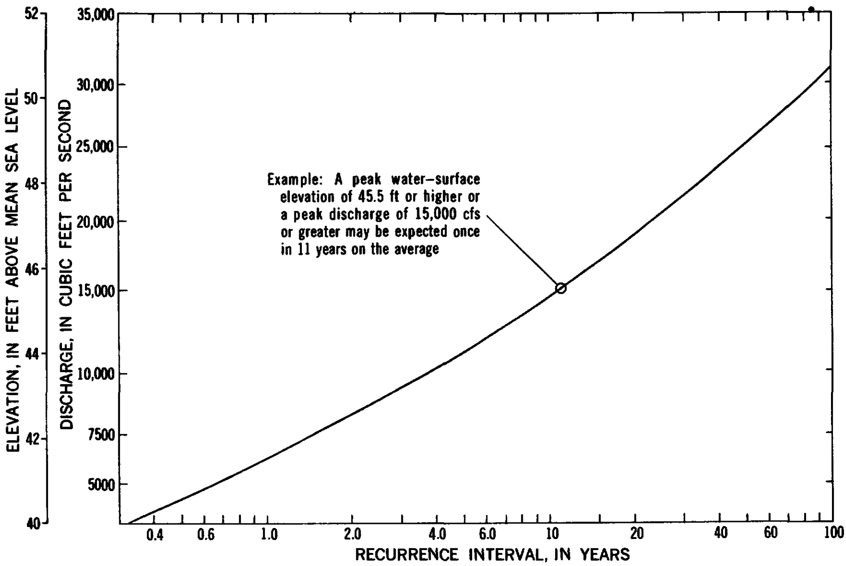

FIGURE 24.—Magnitude and frequency of floods, Farmington River at Rainbow (Tariffville), 1913–58.

CHEMICAL QUALITY

Generally, the chemical quality of water from the Farmington River at Rainbow is good. The rock formations underlying the drainage area contribute only moderate quantities of soluble mineral matter.

In the lower Farmington valley the principal bedrock is sandstone. This is overlain by unconsolidated drift consisting of gravel, sand, clay, and till. Only moderate quantities of material are dissolved from these deposits, as indicated by the ranges in the concentration of dissolved solids (43 to 80 ppm) and in hardness (20 to 60 ppm). (See table 9.)

TABLE 9.—*Summary of chemical analyses, Farmington River at Rainbow, October 1957 to September 1958*

Chemical constituent	Concentration (ppm)		
	Minimum	Average	Maximum
Silica (SiO_2)	5.1	8.4	12
Iron (Fe)	.10	.21	.44
Calcium (Ca)	5.6	9.1	12
Magnesium (Mg)	1.4	2.0	3.0
Sodium (Na)	2.6	4.5	6.1
Potassium (K)	.7	1.1	1.7
Bicarbonate (HCO_3)	10	27	56
Sulfate (SO_4)	9.6	14	24
Chloride (Cl)	3.4	5.2	6.6
Fluoride (F)	.0	.1	.3
Nitrate (NO_3)	.7	3.0	4.9
Dissolved solids	43	64	80
Hardness as $CaCO_3$	20	37	60
Color units	3	8	20

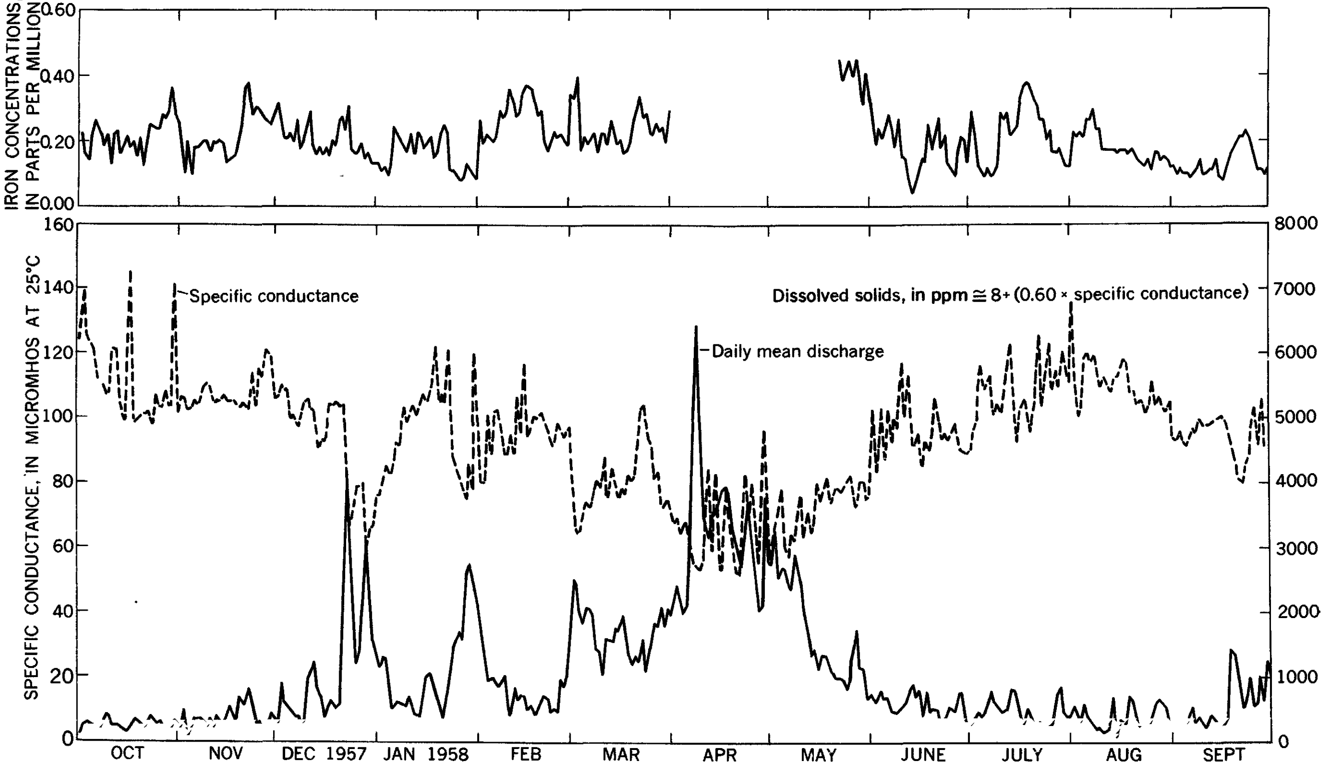

Figure 25.—Specific conductance, daily mean discharge, and daily concentration of iron, Farmington River at Rainbow, October 1957 to September 1958.

Variation in streamflow has a modifying effect on the concentration of dissolved solids in the Farmington River at Rainbow, as shown by the comparison of specific conductance and the daily mean discharge throughout the period October 1957 to September 1958 (fig. 25). Particularly noteworthy is the sharp decline in specific conductance caused by the increase in streamflow during the latter part of December and the low conductivity during the high-flow period in April.

Only slight variations in the concentrations of the individual dissolved constituents were noted for the period of October 1957 to September 1958 (table 9). The water contained mostly calcium and bicarbonate ions with lesser amounts of sulfate and chloride ions. Iron concentration was low and uniform, averaging 0.21 ppm for the period. The highest iron concentration determined was 0.44 ppm (fig. 25). The concentration of chloride, fluoride, and nitrate were low and would have little or no effect on the utility of the water.

TEMPERATURE

The temperature of water in the Farmington River at Rainbow followed a seasonal pattern. The minimum temperature was 32°F, February 17, 1958 and the maximum temperature, 82° F, July 2, 1958. Forty percent of the time the water temperature was 60°F or above (fig. 26).

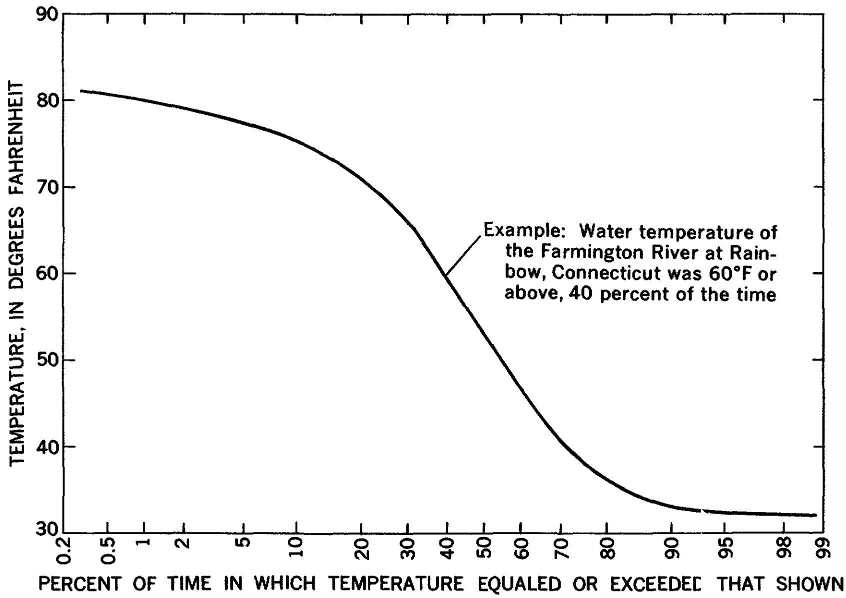

FIGURE 26.—Cumulative frequency curve of temperatures, Farmington River at Rainbow, October 1957 to September 1958.

In summary, the chemical quality of water of the Farmington River at Rainbow is good. The low concentration of dissolved solids makes the water suitable for domestic and most industrial uses, if one assumes that its sanitary quality is satisfactory. Very little, if any, treatment would be required.

BURLINGTON BROOK

Burlington Brook, a tributary to the Farmington River, 15 miles west of Hartford, is 6.7 miles long and has a drainage area of 9.81 square miles. Although not in the immediate area covered by the report, it is typical of the small streams of the western highlands. Burlington Brook has been considered as a source of water supply for the city of New Britain because its water is of good quality. It is a typical mountain stream, its valley having steep slopes, gorges, and waterfalls. Its dry-weather flow is sustained at a relatively high level; flood runoff is rapid and peaks are high and flashy.

DURATION AND FREQUENCY OF FLOWS

Burlington Brook has been gaged near Burlington (fig. 2, table 4). The flow characteristics of Burlington Brook are shown by the flow-duration curve, figure 27. Also shown for comparison are curves for both maximum and minimum percentages of time during which specific discharges were equaled or exceeded.

The low-flow frequency curves for Burlington Brook (fig. 28) show the average flow during periods of 1, 7 and 30 consecutive days.

A curve showing the maximum period during which the flow was less than a specified discharge is shown in figure 29.

The storage required to maintain flows for Burlington Brook is shown in figure 30.

FLOOD FLOWS

Floods on Burlington Brook generally cause little damage, because there is little of value near the brook except highway bridges. The flood of August 19, 1955, was by far the greatest experienced in recent years. At the gaging station the brook rose 9 feet and the flow reached 1,090 mgd (1,690 cfs). A flood-frequency curve (fig. 31) shows the average interval, in years, between floods that equal or exceed a given discharge. Table 4 describes the major floods that have occurred on Burlington Brook since records began in September 1931.

CHEMICAL QUALITY

The chemical quality of Burlington Brook is excellent. An analysis of a sample collected May 4, 1956, shows that the concentration of dissolved solids was 25 ppm and hardness was 10 ppm. Concentrations of the individual major constituents were as follows: Silica,

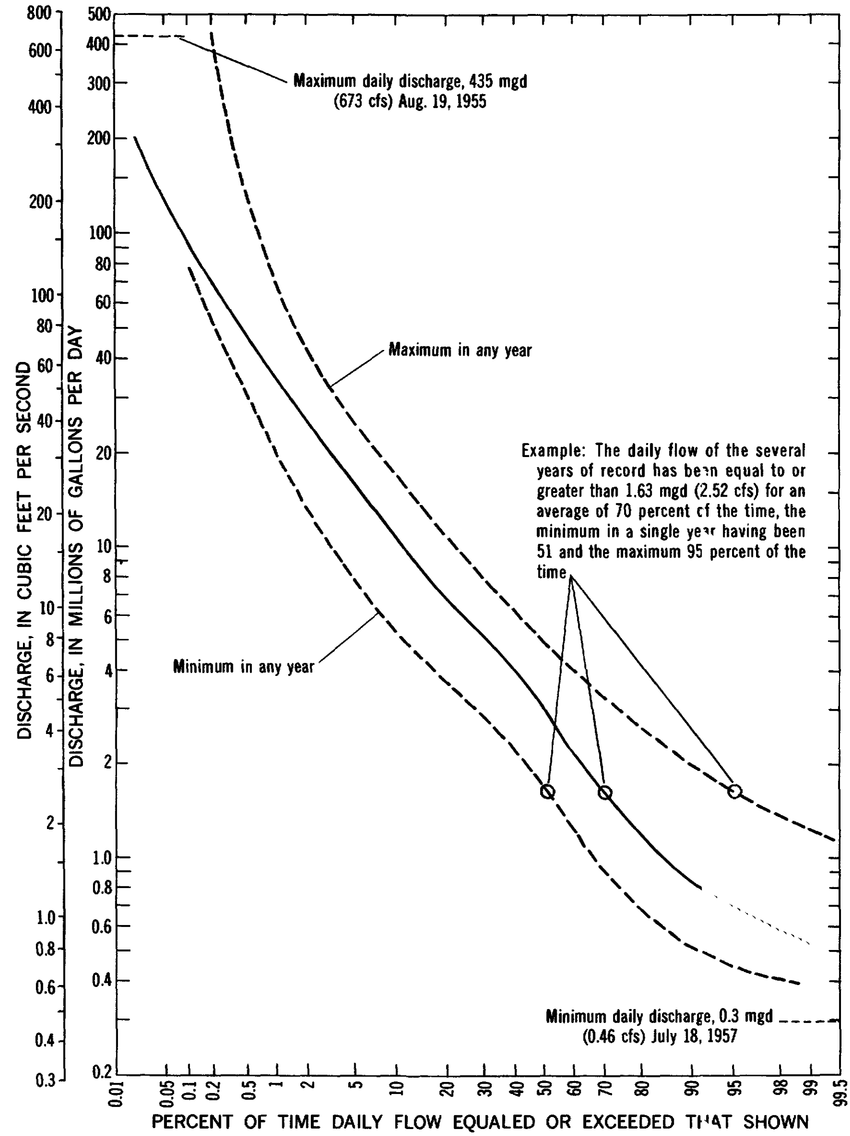

FIGURE 27.—Duration curve of daily flow, Burlington Brook near Burlington, 1932–58.

5.9 ppm; bicarbonate, 6 ppm; sulfate, 6.5 ppm. The concentration of each of the other constituents, including calcium and magnesium, was less than 2 ppm. These concentrations are very low and were present when stream discharge was about 24 cfs. During periods of lower discharge, concentrations probably would increase slightly. Even with slight increases in the dissolved-solids content, however, water from Burlington Brook would be satisfactory for most uses. Some treatment might be required if the water were corrosive.

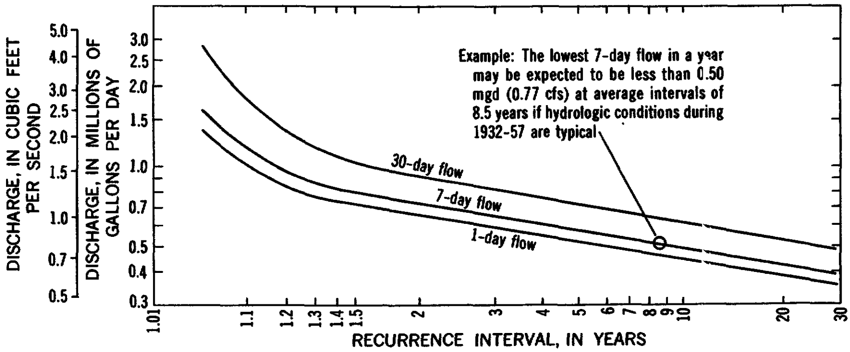

FIGURE 28.—Magnitude and frequency of annual low flows, Burlington Brook near Burlington, 1932–57.

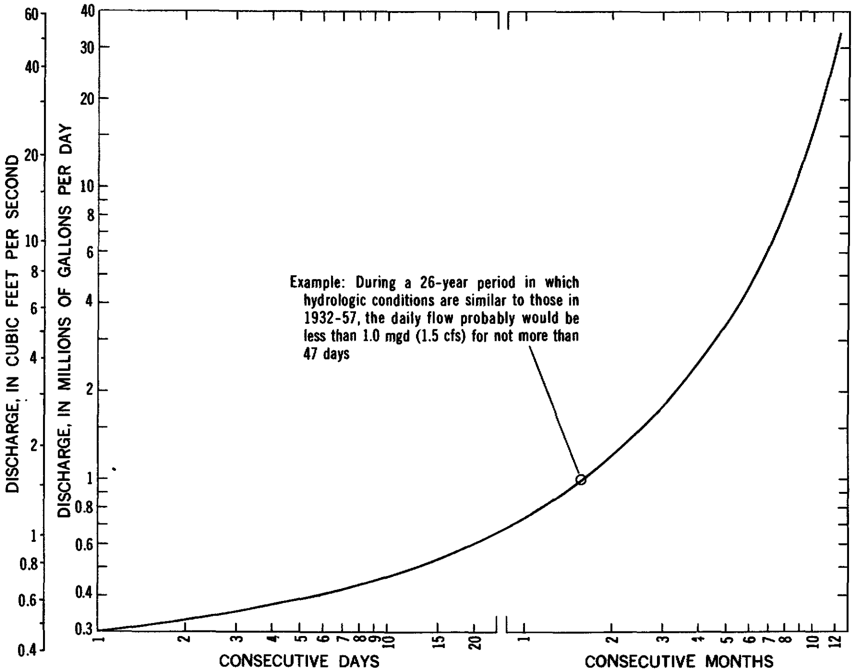

FIGURE 29.—Maximum period of deficient discharge, Burlington Brook near Burlington, 1932–57.

PARK RIVER

The Park River drainage basin is west of Hartford and has a total area of 78.7 square miles. It is formed by the confluence of the North and South Branches that have drainage areas of 27.4 and 46.8 square miles, respectively. The basin includes the greater part of the Hartford area west of the Connecticut River (see fig. 3). It extends from the Connecticut River at Hartford approximately 7 miles to Talcott Mountain on the west and approximately 16 miles from north to south. The western part of the area includes a number

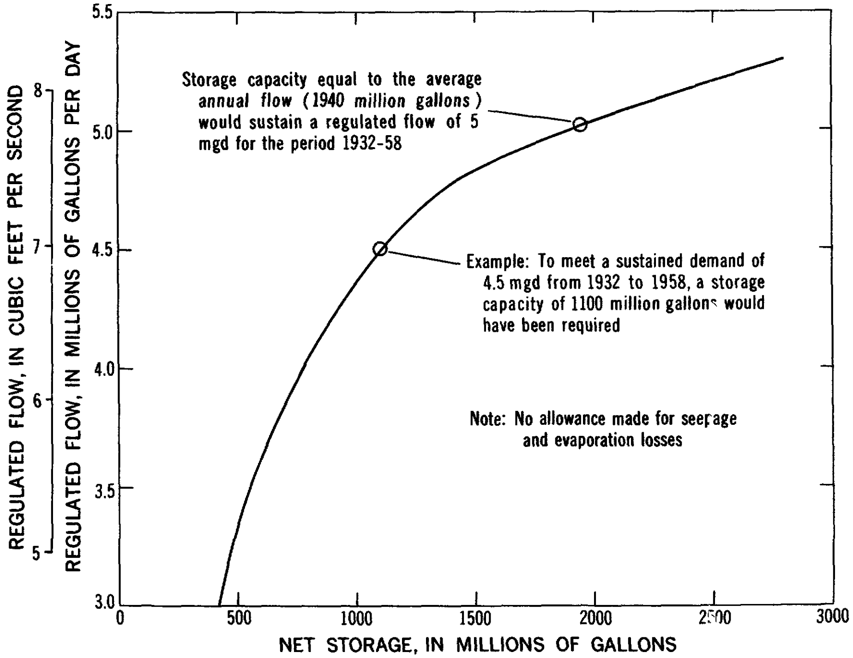

FIGURE 30.—Storage required to maintain flows, Burlington Brook near Burlington, 1932–58.

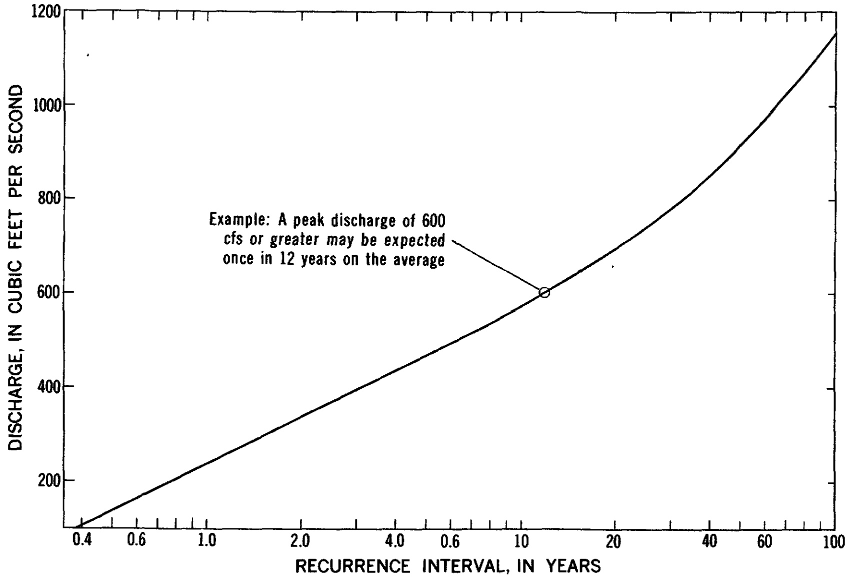

FIGURE 31.—Magnitude and frequency of floods, Burlington Brook near Burlington, 1928–58.

of ponds and reservoirs, six of which were once a part of the water supply of Hartford. Five of these are now held in reserve. The six reservoirs control the drainage from 11.0 square miles, and they are useful for storage of some flood runoff.

DURATION AND FREQUENCY OF FLOWS

Since October 1936, the North Branch Park River has been gaged at a point 3 miles upstream and the South Branch Park River at a point 3.3 miles upstream from where they merge to form the Park River. The Park River has also been gaged simultaneously at a point 0.2 mile below the confluence of the North and South Branches and 2.0 miles above its mouth (fig. 2, table 4).

Flow characteristics of the Park River are shown by the flow-duration curve for the period of record (fig. 32), and curves showing

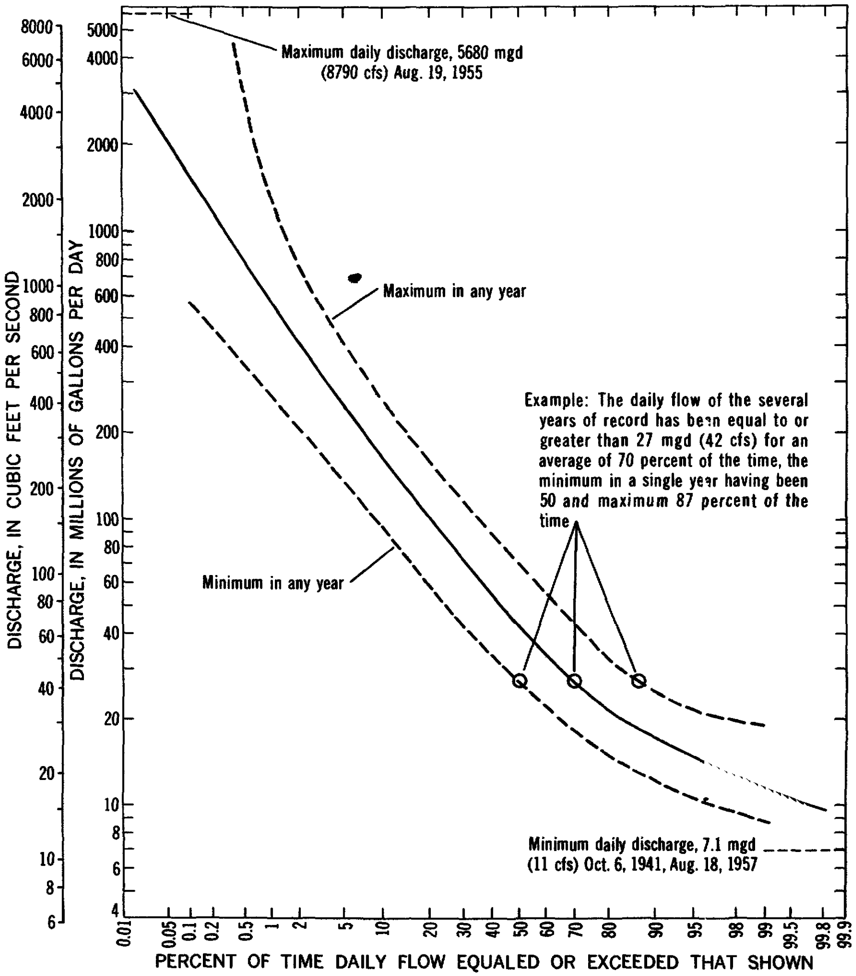

FIGURE 32.—Duration curve of daily flow, Park River at Hartford, 1937–58.

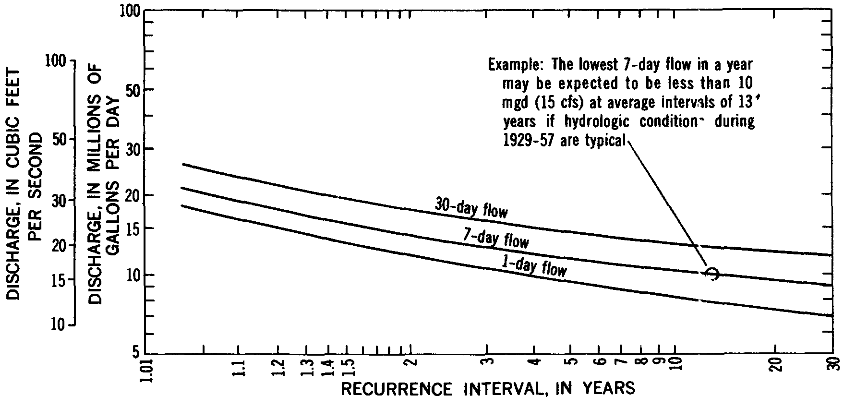

FIGURE 33.—Magnitude and frequency of annual low flows, Park River at Hartford, 1929–57.

both maximum and minimum percentages of time during which specific daily discharges were equaled or exceeded in any year. The maximum daily flow of 5,680 mgd (8,790 cfs), which occurred on August 19, 1955, does not include water lost to the basin by overflow into adjacent basins above the gage on the South Branch.

The low-flow frequency curves for the Park River are shown in figure 33.

Figure 34 shows the maximum period during which the flow of the Park River was less than a specified discharge. The draft-storage curve for the Park River is shown in figure 35.

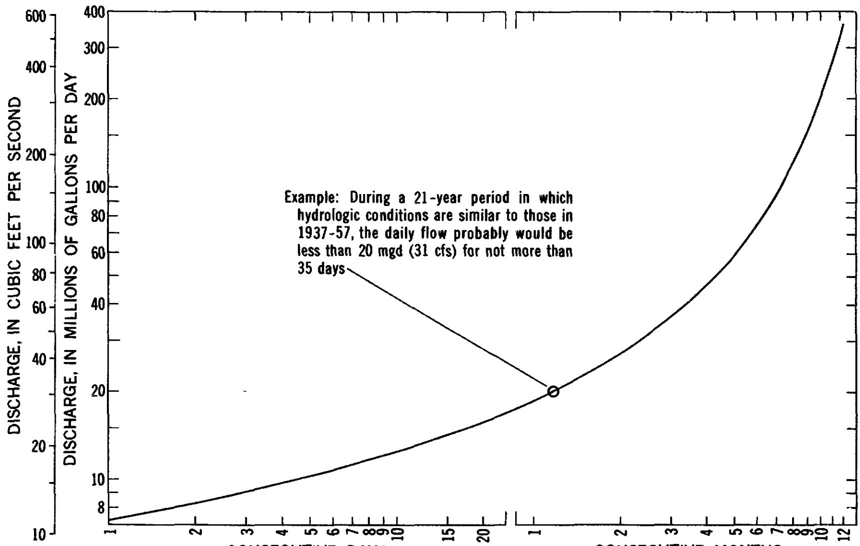

FIGURE 34.—Maximum period of deficient discharge, Park River at Hartford, 1937–57.

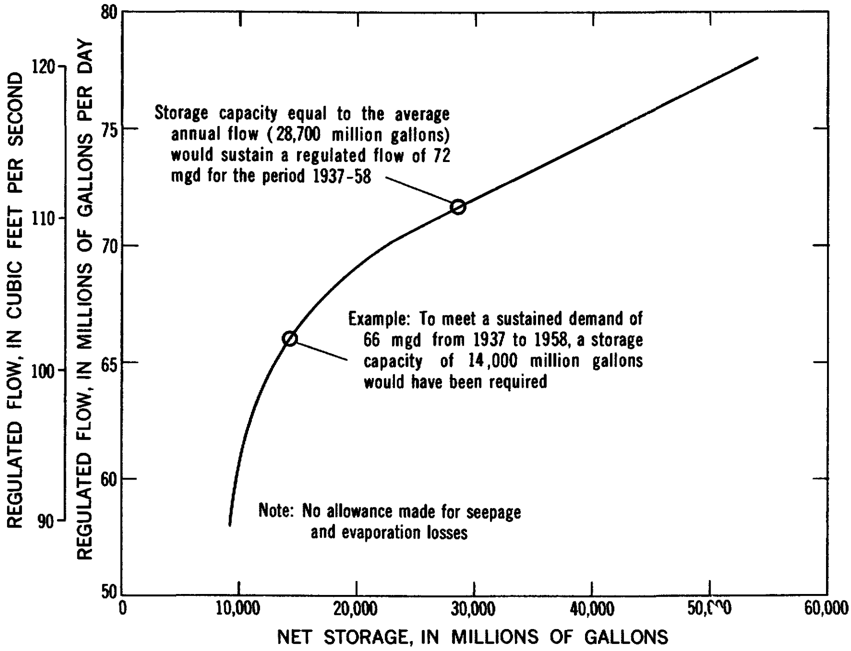

FIGURE 35.—Storage required to maintain flows, Park River at Hartford, 1937–58.

Similar flow-duration curves, low-flow frequency curves curves for the maximum period of deficient discharge, and storage-requirement curves for the North Branch and South Branch Park River are given in figures 36–43.

FLOOD FLOWS

The flood of August 19, 1955, was the outstanding flood of the Park River basin in the history of the Hartford area; flood losses exceeded $7 million in the drainage basin. At the gage on the South Branch, the flood reached an elevation of 50.7 feet above mean sea level, 20 feet above the river bottom; the peak flow of 5,000 cfs recorded at the gage does not include an undetermined amount that overflowed across low divides into the Mattabesset and Quinnipiac River basins. At the gage on the North Branch, the flood reached an elevation of 53.0 feet above mean sea level, 18 feet above the river bottom, and a peak flow of 10,000 cfs. At the Park River gage the flood reached an elevation of 43.5 feet above mean sea level, 14.9 feet above the dam crest which is the control; the flow recorded was 14,000 cfs, which does not include overflow lost from the South Branch. The area inundated by the flood is shown in plate 1. Flood-frequency curves for the gage sites (figs. 44–46) show the average interval, in years, between floods that equal or exceed a given elevation or discharge. Major floods which have occurred in the Park River basin since the gaging stations were established are given in table 4.

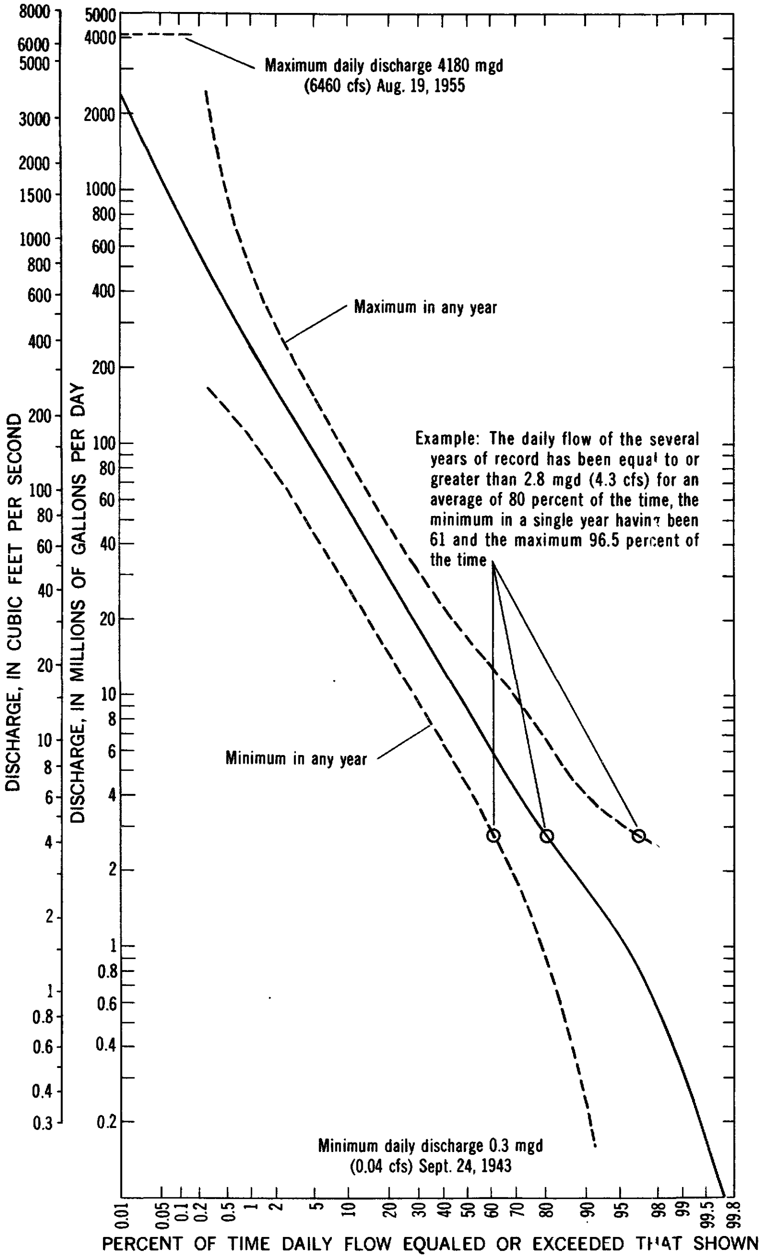

FIGURE 36.—Duration curve of daily flow, North Branch Park River at Hartford, 1937–58.

About 5,600 feet at the lowest end of the Park River channel, from a point in Bushnell Park near the State Capitol Building to the Connecticut River, is enclosed in a double-barreled reinforced con-

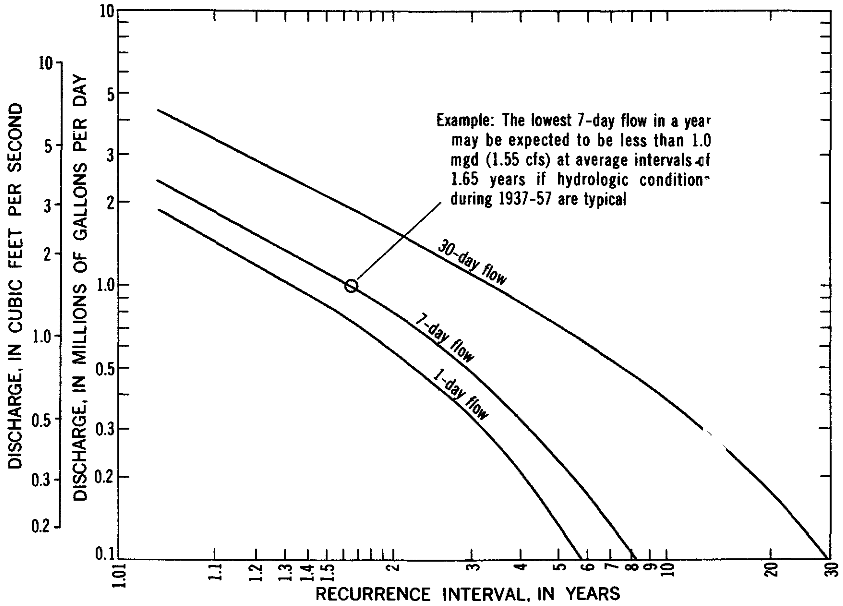

FIGURE 37.—Magnitude and frequency of annual low flows, North Branch Park River at Hartford, 1929–57.

crete pressure conduit completed in 1944. The low-lying built-up areas of the city behind the dikes are thus protected from backwater caused by floods in the Connecticut River and from floods caused by runoff in the Park River basin. The conduit was designed to carry 18,000 cfs when the Connecticut River at an elevation of 26.0 feet above mean sea level and was ample to accommodate the peak flow of 14,000 cfs in August 1955. A work plan has been prepared by the State Commissioner of Agriculture and the U.S. Soil Conservation Service for the construction of four structures to retain floodwaters on the North Branch Park River, each designed to control effectively about 12 inches of runoff from 8.3 square miles, or 30 percent of the total drainage area. A similar plan is being prepared to construct five such structures on the South Branch Park River, each designed to control effectively about 12 inches of runoff from about half the total drainage area. In addition, the Greater Hartford Flood Commission has proposed that the Park River conduit be extended upstream beyond the confluence of the North and South Branches to protect other low-lying areas affected by the flood of August 1955. This project and the proposed construction of the nine floodwater-retarding basins on the two upper branches constitute the present plans of the commission to control floods in the Park River basin. The basin is becoming urbanized at a rapid rate and may require more structures in the future to control the flow.

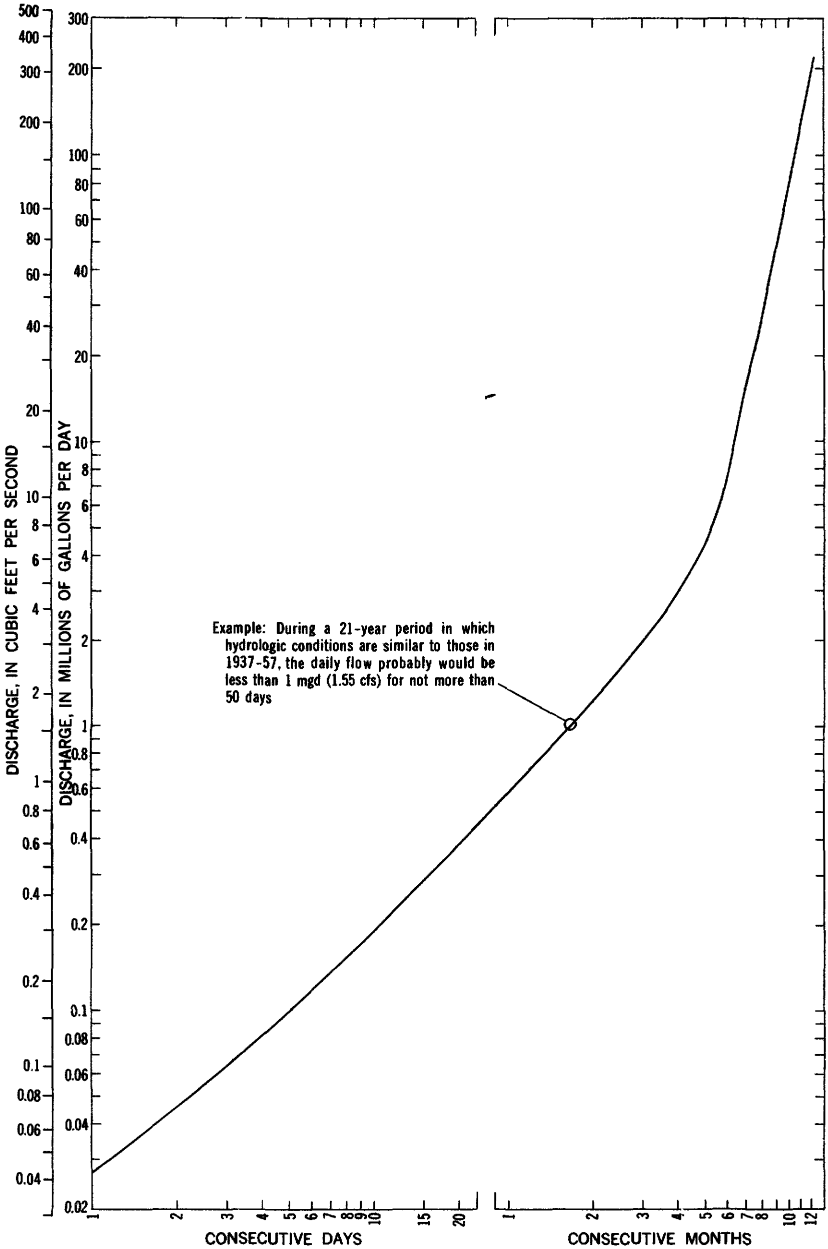

FIGURE 38.—Maximum period of deficient discharge, North Branch Park River at Hartford, 1937–57.

CHEMICAL QUALITY

The chemical quality of the Park River is fair. Treatment of the water would be necessary for some industrial processes. Chemical analyses indicate that the Park River contains a much higher con-

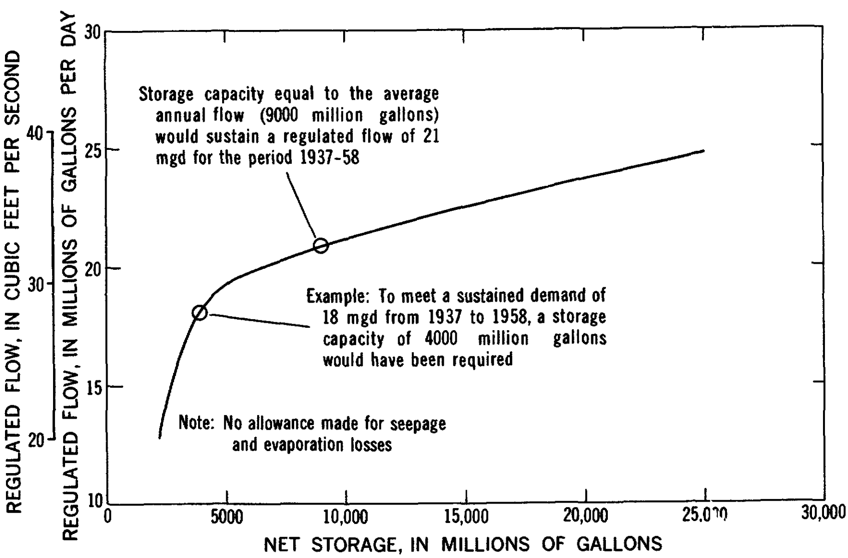

FIGURE 39.—Storage required to maintain flows, North Branch Park River at Hartford, 1937–58.

centration of dissolved solids than other streams in the area—as high as 199 ppm (table 10). Ground water in the Park River area contains more dissolved solids than the surface water, and thus ground-water discharge into the river contributes to the dissolved-solids content of the river, especially during periods of low flow. Industrial pollution of the Park River also increases the dissolved-solids content.

TABLE 10.—*Chemical analyses of periodic water samples, Park River at Hartford, Hockanum River at Shenipsit Lake, and Hockanum River near East Hartford*

[Analyses given in parts per million]

	Park River at Hartford		Hockanum River at Shenipsit Lake	Hockanum River near East Hartford		
Date of collection	Sept. 18, 1953	Apr. 19, 1954	Apr. 21, 1954	Apr. 21, 1954	Oct. 5, 1954	Apr. 27, 1955
Discharge cfs	36	265		240	50	400
Silica (SiO_2)	7.7	8.0	5.9	7.8	8.5	9.8
Iron (Fe)	.27	.66	.05	.47	.49	.17
Calcium (Ca)	28	16	3.8	11	14	11
Magnesium (Mg)	5.7	5.1	1.7	2.2	2.3	2.4
Sodium (Na)	25	6.3	2.2	5.9	8.0	6.0
Potassium (K)	2.8	1.7	.6	1.3	1.7	1.2
Bicarbonate (HCO_3)	94	45	6.7	21	30	22
Sulfate (SO_4)	69	28	11	22	16	19
Chloride (Cl)	7.7	6.0	3.0	6.0	9.0	6.8
Fluoride (F)	.5	.0	.2	.1	.1	.1
Nitrate (NO_3)	1.7	2.7	.8	4.5	8.0	6.4
Dissolved solids (residue on evaporation at 180°C)	199	131	38	86	93	74
Hardness as $CaCO_3$	97	62	17	37	45	20
Color units	25	15	15	25	15	25
pH	7.7	6.6	5.9	6.1	7.5	6.5
Specific conductance micromhos at 25°C	322	166	43.1	118	146	119

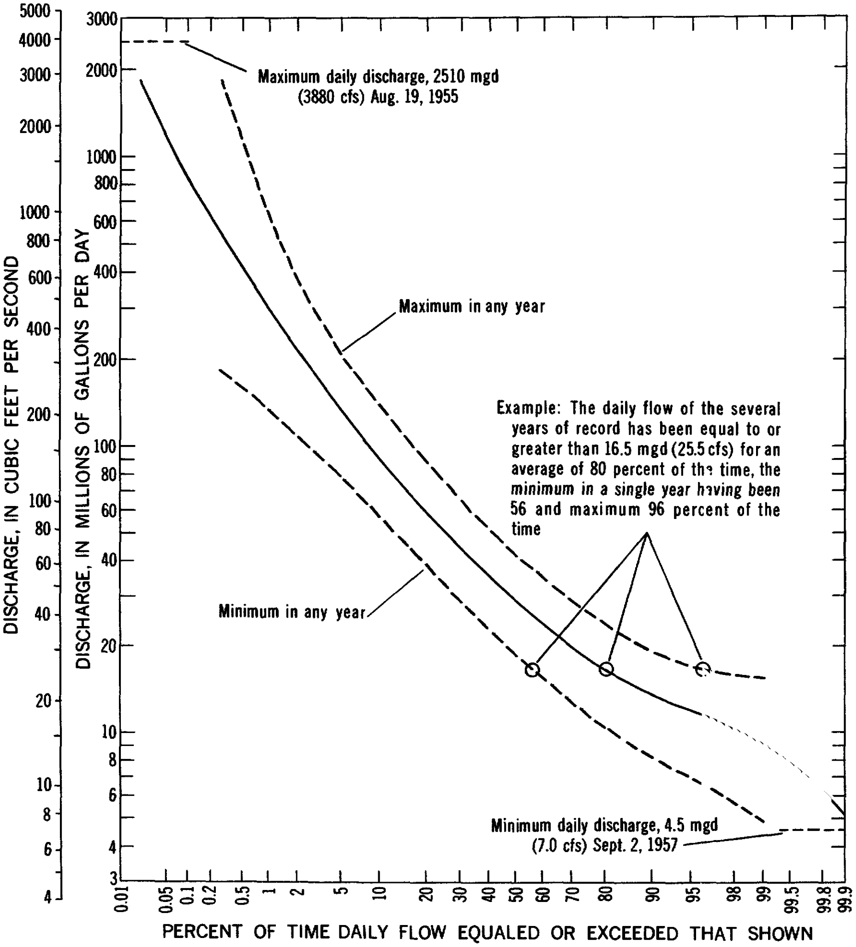

FIGURE 40.—Duration curve of daily flow, South Branch Park River at Hartford, 1937–58.

Excessive iron, objectionable color, and a moderate hardness affect the utility of the water from the Park River, insofar as chemical quality is concerned. As much as 0.66 ppm of iron was determined in a water sample collected April 19, 1954. The Park River also contains considerable color. Two water samples had 15 and 25 units of color. Highly colored water is objectionable from an aesthetic viewpoint; it may cause staining, and it also may be undesirable for use as a process water. Water from Park River is moderately hard; in two water analyses hardness as $CaCO_3$ was 62 and 97 ppm.

HOCKANUM RIVER

The Hockanum River is 26.3 miles long and drains an area of 82.2 square miles. It rises in the eastern highlands where its tributaries are short and steep, passes through Shenipsit Lake (a large natural

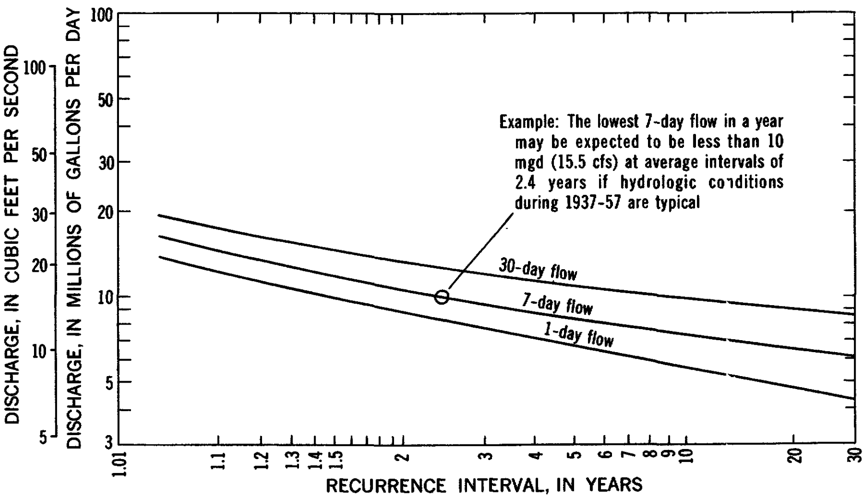

FIGURE 41.—Magnitude and frequency of annual low flows, South Branch Park River at Hartford, 1929–57.

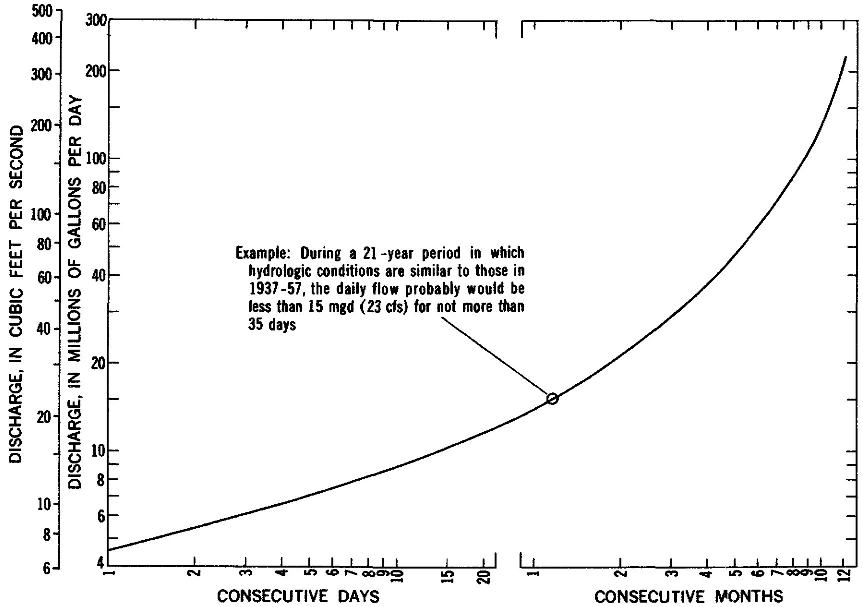

FIGURE 42.—Maximum period of deficient discharge, South Branch Park River at Hartford, 1937–57.

body of water whose storage capacity has been increased by a stone dam at its outlet), flows over several dams at water-power developments, and thence continues through the eastern flood plain to the Connecticut River at East Hartford. It is used extensively for generation of power and for process water. Shenipsit Lake is operated by the city of Rockville for water supply and by the power users downstream to maintain flow during low-flow periods.

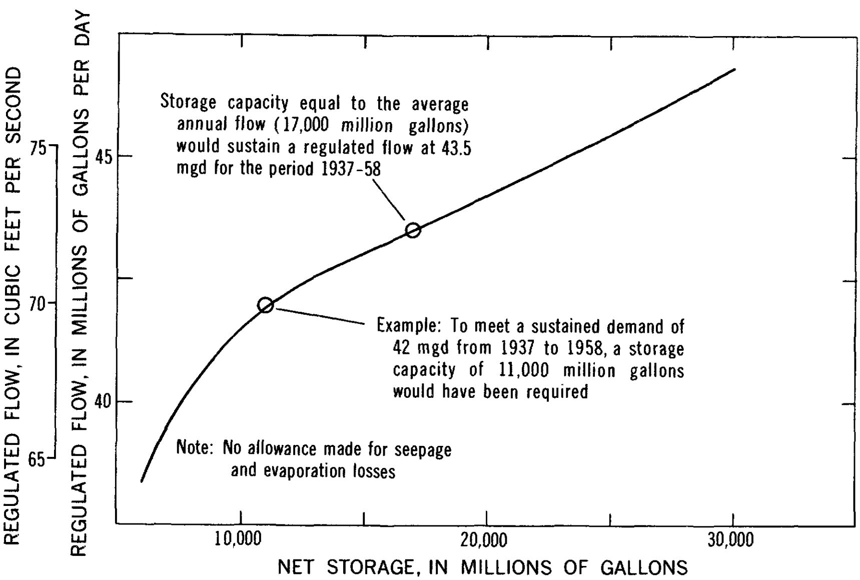

Figure 43.—Storage required to maintain flows, South Branch Park River at Hartford, 1937–58.

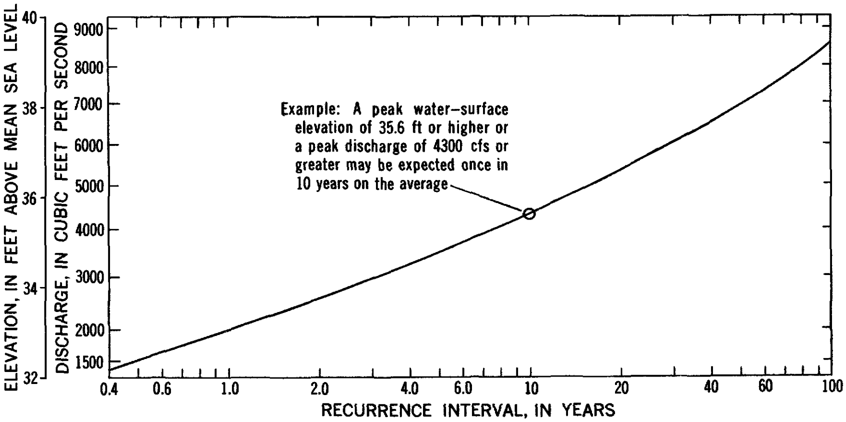

Figure 44.—Magnitude and frequency of floods, Park River at Hartford, 1928–58.

DURATION AND FREQUENCY OF FLOWS

The Hockanum River was gaged between September 1919 and September 1921 and has been gaged since July 1928 at a site 4.3 miles upstream from its mouth (fig. 2, table 4). Its flow characteristics are shown by the flow-duration curve for the period of record on figure 47. Also shown, for comparison, are curves for both maximum and minimum percent of time specific daily discharges were equaled or exceeded. There is almost no flow at times as a result of regulation at dams upstream.

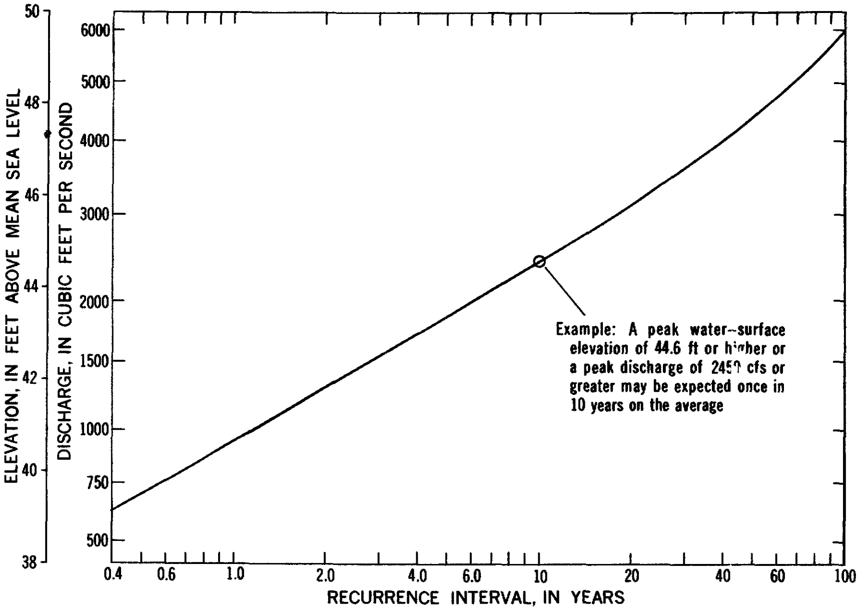

FIGURE 45.—Magnitude and frequency of floods, North Branch Park River at Hartford, 1928–58.

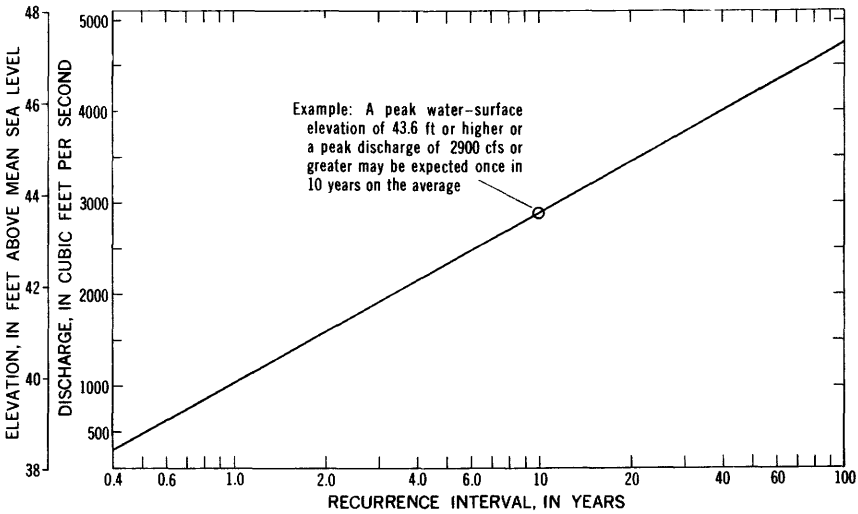

FIGURE 46.—Magnitude and frequency of floods, South Branch Park River at Hartford, 1928–58.

The low-flow frequency curves for the Hockanum River (fig. 48) show the average flow during periods of 1, 7 and 30 consecutive days and indicate the average interval at which a specific discharge may be expected to recur as the lowest flow in the year if hydrologic conditions and the pattern of regulation are similar to those during

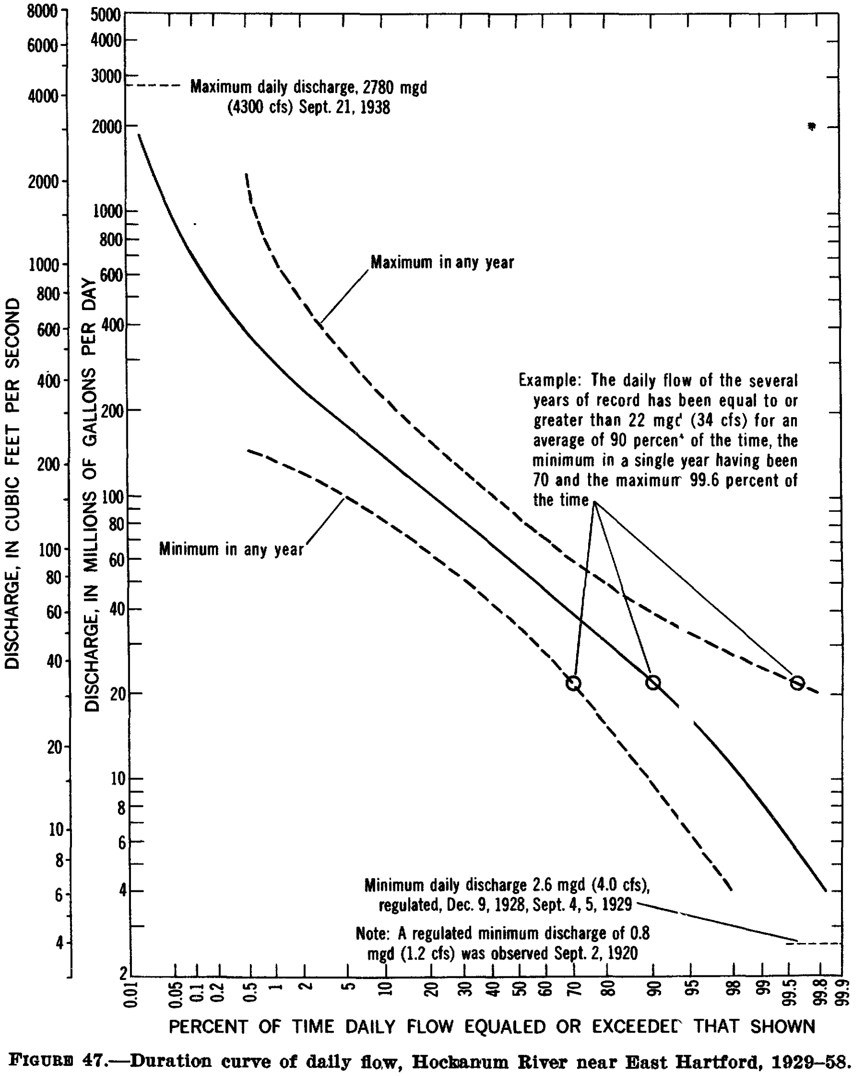

FIGURE 47.—Duration curve of daily flow, Hockanum River near East Hartford, 1929–58.

1929–57. A curve showing the maximum period during which the flow was less than a specified discharge is shown in figure 49.

The draft-storage curve for the Hockanum River is shown in figure 50.

FLOOD FLOWS

Floods on the Hockanum River are controlled to a considerable degree by storage in Shenipsit Lake and by the many small power dams along its course. On September 21, 1938, the greatest flood of record passed the gage with a peak elevation of 68.3 feet above mean sea level, 14 feet above the river bed, and a peak flow of 5,160 cfs.

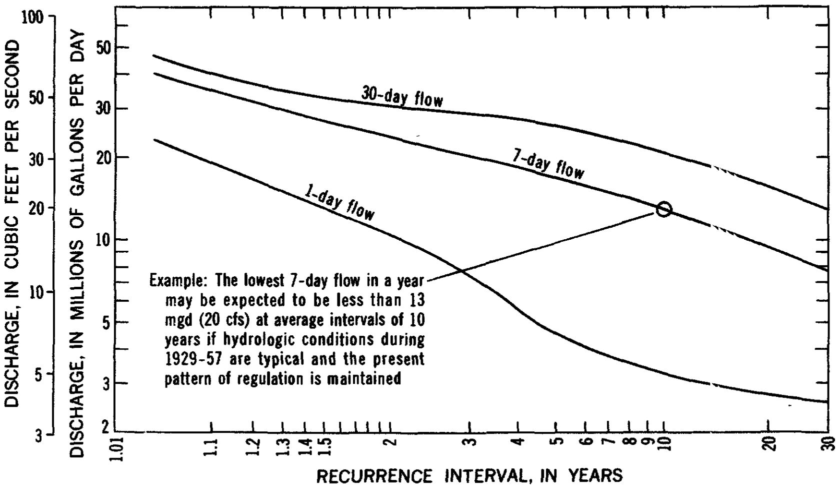

FIGURE 48.—Magnitude and frequency of annual low flows, Hockanum River near East Hartford, 1929–57.

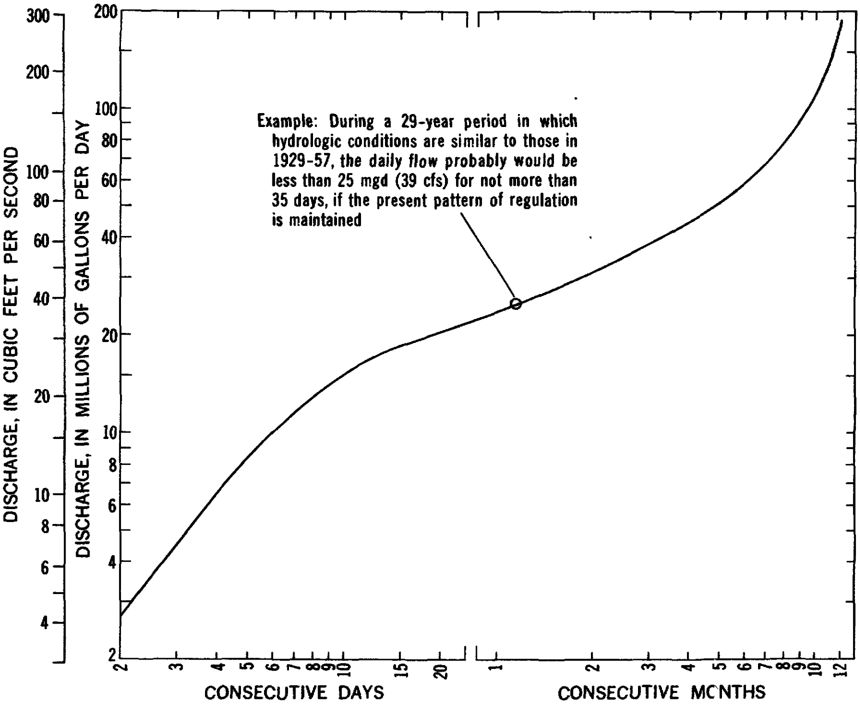

FIGURE 49.—Maximum period of deficient discharge, Hockanum River near East Hartford, 1929–57.

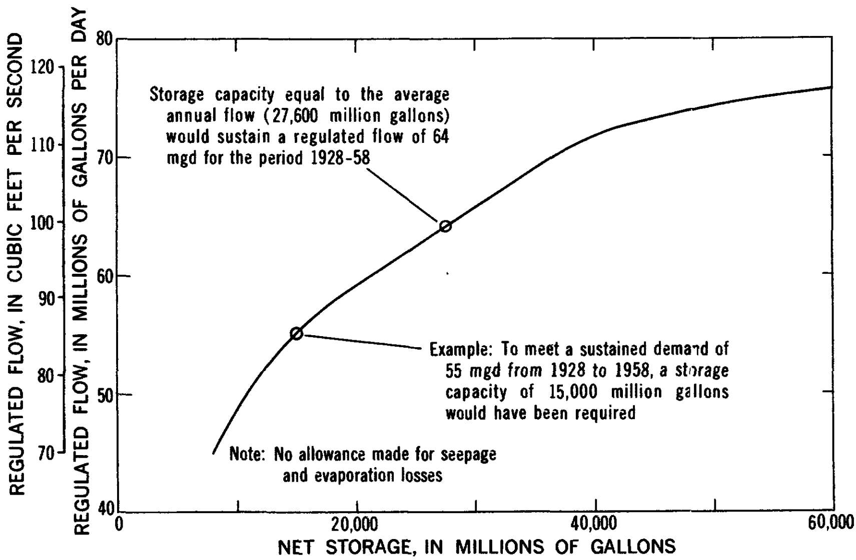

FIGURE 50.—Storage required to maintain flows, Hockanum River near East Hartford, 1928–58.

The peak flow over Shenipsit Lake Dam at this time was only about 800 cfs. On August 19, 1955, the river rose to an elevation of 65.0 feet above mean sea level and the discharge was 2,740 cfs. No flow from above Shenipsit Lake contributed to this peak. A flood-frequency curve showing the average interval, in years, between floods that equal or exceed a given elevation or discharge is shown in figure 51. A list of major floods on the Hockanum River which have occurred since the record began in July 1928 is shown in table 4.

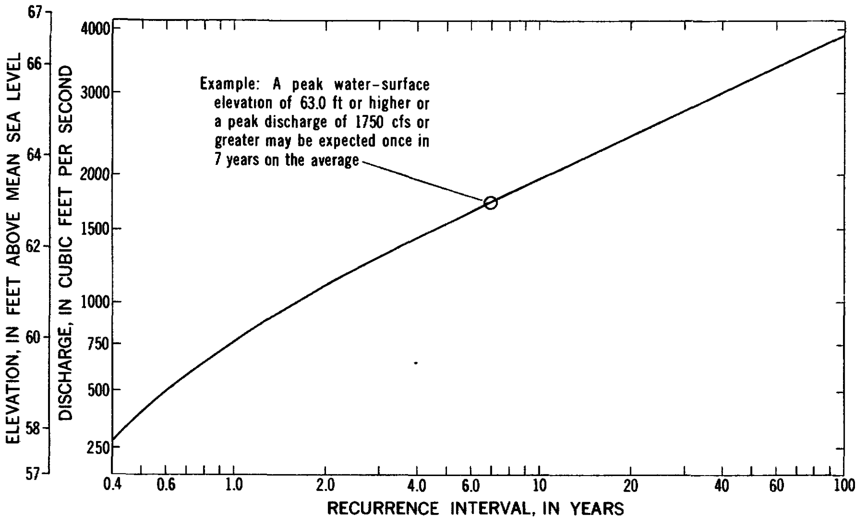

FIGURE 51.—Magnitude and frequency of floods, Hockanum River near East Hartford, 1920–21, 1928–58.

CHEMICAL QUALITY

Because the flow of Hockanum River is regulated by Shenipsit Lake and several small reservoirs, it would seem that the dissolved-solids content of Shenipsit Lake and the Hockanum River should be about equal, but this is not so. The dissolved-solids content of a sample of water taken from Shenipsit Lake on April 21, 1954, was 38 ppm, whereas chemical analyses of a sample from the Hockanum River near East Hartford taken the same day showed a dissolved-solids concentration of 86 ppm (table 10). The higher concentration of dissolved solids in the Hockanum River below Shenipsit Lake apparently is caused by discharge of industrial wastes.

Low concentrations of dissolved solids and low hardness were the predominant characteristics of chemical quality of the three water samples, whose analyses are given in table 8. Excessive iron and objectionable color, however, were present and would limit the use of the water. With proper treatment water from the Hockanum River can be made suitable for many uses.

GROUND WATER IN SAND-AND-GRAVEL AQUIFERS

Moderate supplies of ground water are contained in sand-and-gravel deposits in the Hartford-New Britain area. There are five principal sand-and-gravel aquifers (water-bearing formations) defined on the basis of the local geology. These are the glaciofluvial sand-and-gravel deposits of the Connecticut River lowland, the glaciofluvial sand-and-gravel deposits in the South Branch Park River basin, the glaciofluvial sand-and-gravel deposits forming the delta of the glacial Farmington River in Bloomfield, the fluvial sand in the Connecticut River lowland, and the buried fluvial sand-and-gravel deposits in the abandoned bedrock channels of an earlier Connecticut River. Areas underlain by all these deposits, except the buried fluvial deposits, and cross sections of the deposits are shown on plate 2. The location of the buried fluvial deposits is indicated by the bedrock contours in plate 2. The geology and hydrology of these deposits are not known completely, but it is believed that no additional extensive water-bearing sand-and-gravel deposits will be found. With few exceptions, the aforementioned deposits have no sharp boundaries, and in some places water is capable of seeping from one aquifer to another. In other places they are separated by impermeable lake deposits or by glacial till, and there is little movement of water from one aquifer to another.

FLUVIAL SAND OF THE CONNECTICUT RIVER LOWLAND

Of the five principal sand-and-gravel aquifers, the most important as potential sources of ground water are the fluvial sand in the Connecticut River lowland and the sand-and-gravel deposits forming the delta of the glacial Farmington River. The fluvial-sand deposits have the widest distribution of any of the sand-and-gravel aquifers. They are the surface deposits throughout the Connecticut River lowland north and east of Hartford below altitudes ranging from about 80 feet above sea level at the south to 150 at the north (pl. 2). In this area they most commonly overlie thick deposits of clay, although along the margin of their outcrop they may overlie till (unstratified and poorly sorted glacial deposits) or bedrock or may rest against and overlie glaciofluvial deposits. They consist rather uniformly of beds of well-sorted medium to fine buff-colored sand with thin beds of coarse sand and gravel.

The thickness of the fluvial sand in the Hartford area ranges from less than a foot to 40 feet, although it is less than 25 feet in most places. The sand is thinnest along the margin of the area of outcrop where it overlies glaciofluvial deposits, till, or bedrock or along the sloping banks of large streams, such as the Connecticut and Hockanum Rivers, which have cut through the sand and into the underlying clay. It is believed to attain its maximum thickness of about 40 feet in the northwestern part of the area, where it merges and interfingers with the deposits of the Farmington River delta.

The fluvial-sand deposits are highly permeable, owing to their well-sorted character. Although they seldom reach a thickness of more than 25 feet, they are generally saturated for fully three-fourths of their thickness because of the highly permeable nature of their exposed surface, the flatness of the land surface in the area of outcrop, and the relatively impermeable clay base on which they rest. The yield of wells tapping the sand ranges from 15 gpm (gallons per minute) to 100 gpm; the average properly constructed well yields about 60 to 70 gpm. The specific capacity of these wells averages 4.5 gpm per ft of drawdown. Thus, owing to its wide distribution, the fluvial sand is an important potential source of moderate supplies of ground water in the Hartford-New Britain area. A considerable number of shallow gravel-packed wells and gangs of driven well points supply water to industries and tobacco growers in the East Hartford-South Windsor area. The sand is well suited to development by either of these construction methods, owing to the ease with which it can be excavated or with which well points can be driven. Care is necessary in the construction and development of the larger capacity wells to insure that the finer sands are prevented from entering the well or clogging the screen.

The maximum yield of wells in the fluvial sand is limited by the saturated thickness of the aquifer. Since the depth to the water table averages 5 feet below the land surface and the average thickness of the sand is 25 feet, the average saturated thickness is only 20 feet. An aquifer of this saturated thickness is too small for large sustained yields, as it is soon dewatered. One industry, pumping from 12 shallow gravel-packed wells in the fluvial sand at an average rate of about 75 gpm, determined from tests that the wells should be spaced at least 300 feet apart in order to avoid excessive interference between pumped wells. It is common practice to space driven wells about 50 feet apart in a gang. The saturated sand is above the level of all but the smaller streams of the lowland, and thus only a minimum of induced infiltration can be counted on to sustain the yield of wells in the fluvial-sand deposits.

DELTA OF GLACIAL FARMINGTON RIVER

The sand-and-gravel deposits forming the delta of the glacial Farmington River are also an important source of moderate supplies of ground water. They are the surface deposits above an altitude of 150 feet in the northwestern part of the Hartford-New Britain area (pl. 2). They consist generally of buff-colored sand with some beds of gravel and silt. Generally they contain a larger percentage of gravel than the fluvial-sand deposits. The constituent materials are generally well sorted, the coarser grained materials occurring near the apex and near the surface of the delta, and the finer materials grading outward from these areas. Individual beds of gravel are continuous only for short distances, whereas beds of sand may be relatively continuous over long distances. These beds of sand and gravel are interfingered with beds of clay in outer parts of the delta. They commonly overlie clay but where the clay is absent may overlie till or bedrock.

The thickness of the deltaic sand-and-gravel deposits is irregular and depends upon their position with relation to the topography of the underlying bedrock or till surface. Their aggregate thickness generally is large, although individual beds of sand or gravel generally are less than 2 feet thick. The deposits reach a maximum reported thickness of 85 feet where they overlie the middle of a buried bedrock channel in the northeastern part of Bloomfield.

The surface of the deposits of deltaic sand and gravel is highly permeable and absorbs precipitation rapidly. There is very little direct runoff from the area of outcrop; most streams that drain the area originate as well-defined springs along the deltaic margin. The deposits are thick and extensive and provide a large volume of permeable material for the storage and transmission of ground water. The water table is usually less than 30 feet below the land surface, and the deposits therefore are saturated for much of their thickness. Little is known of the maximum yield to be obtained from these deposits in the Hartford-New Britain area, as they are tapped by only a few wells. Most of the area underlain by the deltaic sand and gravel is occupied by large farms, and thus, wells in the area are few in number. Maximum yields probably will be obtained near the apex of the delta. For example, two gravel-packed wells of the Hartman Tobacco Co. in this general area yield 200 gpm and 400 gpm (well W 122, table 17 and pl. 2) from thick beds of sand. The specific capacity of these wells is 9 and 12 gpm per ft of drawdown. These are the only large-capacity wells in deltaic sand and gravel for which records are available. In contrast to these wells, several test wells drilled for the Kaman Aircraft Corp. near the outer edges of the delta penetrated fine sand, silt, and clay which yielded only small supplies of water.

GLACIOFLUVIAL DEPOSITS OF THE CONNECTICUT RIVER LOWLAND

Of lesser importance as water-producing formations are the glaciofluvial sand-and-gravel deposits of the Connecticut River lowland and the South Branch Park River Basin and the buried sand-and-gravel deposits in bedrock channels. Within the Hartford-New Britain area the glaciofluvial deposits near the Connecticut River consist mostly of outwash deposited by melt-water streams in front of and over the terminus of a lobe of glacial ice that once occupied the Connecticut River lowland. They are the surface deposits in an area east of the Connecticut River in Glastonbury and, in places, are more than a mile wide, extending from the southern limits of the map area to the East Hartford town line. There is also a small area of glaciofluvial deposits west of the Connecticut River in southeastern Rocky Hill and northern Cromwell (pl. 2).

These deposits overlie till or bedrock and consist predominantly of red nearly horizontally bedded sand and silt with some gravel. In general, the deposits are coarsest in the vicinity of the bedrock sides of the valley, and it is these areas that are likely to be the most productive for water supplies. Where exposed in steep banks along the Connecticut River, the upper beds commonly consist of sand and gravel; and the lower beds of sand and silt, an arrangement which sometimes gives a false impression of the coarseness and permeability of the deposit as a whole. Almost no gravel is included in the glaciofluvial deposits north of the village of South Glastonbury. Because they are fine grained, they are likely to yield only small supplies of water.

The most productive water-bearing beds are in the vicinity of the Connecticut River, south of the center of Rocky Hill. In this area beds of sand and gravel, more than 60 feet thick, lie at and below river level and probably have direct hydraulic connection with the river. Two industrial wells tapping sand and gravel adjacent to the river yield more than 600,000 gpd. (See well RH 77 in table 17 and pl. 2.) The wells are situated on a broad terrace only 20 to 30 feet above river level. The water level in the wells is only slightly above river level and fluctuates with changes in the stage of the river. In addition, a collector well (well RH 78 in table 17 and pl. 2) obtains water from beds of outwash sand and gravel below the bottom of the river in this vicinity; the collector well is situated in the river and has been pumped at 6 million gpd at times of peak demand. The existence of sand-and-gravel beds at and below river level in this area has been proven in only the one locality, but similar beds probably occur beneath the bed of the Connecticut River between Rocky Hill and the southern limits of the map area and are potential sources of ground water.

Other productive water-bearing beds of glaciofluvial sand and gravel are present in the northern part of the small area of outwash between Rocky Hill and Cromwell. Sand and some gravel interfinger with finer material and form the main body of outwash in this area, which is 70 feet or more in depth. Several wells are screened in the coarser parts of the outwash and are reported to range in yield from 250 to 800 gpm. (See, for example, well RH 83 in table 17 and pl. 2.) The beds of coarse material are continuous for only short distances, and considerable test drilling would be necessary to locate the more productive beds. Potentially productive beds of sand and gravel probably occur in the body of outwash immediately east of the Connecticut River south of South Glastonbury. The most productive beds probably occur along the eastern edge of the outwash where it intersects the bedrock wall of the valley. Small or possibly moderate supplies of ground water (200 gpm or less per well) could be developed from the thicker beds of sand and gravel in this area, particularly from the deposits underlying the extensive flat-topped terrace immediately north of the Portland town line, if properly screened wells are used.

GLACIOFLUVIAL DEPOSITS IN SOUTH BRANCH PARK RIVER BASIN

The glaciofluvial sand-and-gravel deposits in the South Branch Park River basin are a potential source of moderate to small supplies of ground water. They consist mostly of outwash material that was deposited while the ice was wasting and compose an elongated mass of drift, a mile or more wide, extending from Berlin to Newington. The surface of this mass consists of flat-topped terraces on the east, where it intersects the side of the valley, and irregularly shaped knobs and depressions elsewhere.

The deposits in this area range in thickness from several feet to about 100 feet, depending on the configuration of the land surface and the bedrock surface. They consist largely of red sand and gravel with some silt and clay. Individual beds vary considerably in lateral extent, degree of sorting, and size of grain, and thus it is probable that considerable test drilling would be needed to locate the coarser, more productive beds.

Little is known of the maximum water-yielding capacity of the glaciofluvial deposits in the South Branch Park River basin because no large-capacity wells are known to obtain water from them. Most wells in the area are for domestic supply and were drilled through the glaciofluvial deposits to obtain water from the underlying bedrock.

The northern one-third of the area underlain by these deposits is within the urban area of Newington, and thus it is unlikely that the deposits here would be developed for water supply except in times of emergency. Several abandoned domestic wells along Cedar Street, however, are reported to have once obtained satisfactory supplies at a depth of about 100 feet from gravel immediately above the bedrock. The wells are along the axis of a north-south-trending buried bedrock channel at the western base of the basalt ridge in eastern Newington. Water-bearing beds of glaciofluvial sand and gravel may be present along the axis of this channel in a southerly direction from Cedar Street. Additional small to moderate supplies of ground water (200 gpm or less) are probably available from glaciofluvial sand and gravel in the southeastern part of the town of Newington and the northeastern part of the town of Berlin.

BURIED DEPOSITS IN BEDROCK CHANNELS

Moderate to small supplies of ground water are available from buried deposits of sand and gravel in an abandoned bedrock channel of an earlier Connecticut River. The location and trend of bedrock channels within the Hartford-New Britain area are delineated on the map of the configuration of the bedrock surface, plate 2, which has been constructed from logs of wells and test borings. Deposits of sand and gravel are known to be present only east of the Connecticut River in the bottom of the channel which extends southward from the northern limit of the map area into Glastonbury, although parts of the other channels shown may contain buried sand-and-gravel deposits.

The buried sand and gravel in the Hartford-New Britain area are probably glacial-outwash deposits. They were laid down in the bottom of the deep channel carved by river erosion and glacial scouring action in the relatively soft sedimentary bedrock. The exact composition and extent of these deposits are not known, as the records of most wells lack detail and as only a few samples were available for examination; however, these buried deposits, according to the records, are discontinuous and highly variable in composition and thickness, having been deposited in discontinuous channels rather than as sheets. In most places they consist of gravel and sand, but in a few places silt and fine sand also have been reported. The deposits commonly lie directly on the bedrock and are covered by a considerable thickness of fine-grained lacustrine sediments consisting of clay and silt. They seem to have a maximum thickness of about 20 feet, but a number of wells were reported to have penetrated no coarse material between the clay and the bedrock. The thickest deposits of buried sand and gravel were penetrated by wells in East Hartford, where the bedrock channel is deepest. A well at the First National Stores, Inc., warehouse (well EH 37 in table 17 and pl. 2) penetrated 21 feet of gravel and sand immediately above the bedrock. A well at the United Aircraft Corp. plant (well EH 19 in table 17 and pl. 2) penetrated 10 feet of sand and gravel, the base of which was 30 feet above the bedrock surface. The lowest altitude recorded in wells for the bottom of the bedrock channel in this area is 255 feet below sea level.

Only a small amount of information on the water-yielding capacity of the buried sand and gravel is available. The two wells just mentioned are the only large-capacity wells known to obtain water from the deposits, although several domestic and farm wells obtain smaller supplies from them. Well EH 37 yields 500 gpm and has a specific capacity of about 5.4 gpm per ft of drawdown. This is probably about the maximum yield that can be expected from the buried sand and gravel. Well EH 19 yields 250 gpm. The several domestic wells tapping buried sand and gravel yield 30 gpm or less. It is difficult to predict the yields of wells in these deposits. Two wells a few hundred feet apart may penetrate different types of sediments and different thicknesses of the deposits. Thus the yields of wells developed in the deposits are difficult to predict, because the rate of ground-water movement depends on the transmissibility of the sediments, which is largely a function of the grain-size and the thickness. To locate the buried sand-and-gravel deposits test wells should be drilled near the middle of the bedrock channels as indicated by the contours on plate 2. Neither the areal extent nor the recharge area for these deposits is known. If the recharge area is small or if the overlying blanket of fine-grained lacustrine sediment prevents significant recharge, the water in the aquifer may be depleted, or "mined out," in a short time by heavy pumping. Controlled pumping tests should be run on each large-capacity well developed in the buried sand and gravel before plans are made for long-term use.

CHEMICAL QUALITY

Generally the chemical character of ground water from the sand-and-gravel aquifers ranges from good to fair and is satisfactory for most uses. The concentration of dissolved solids is low to moderate, ranging from 51 to 285 ppm. (See tables 11 and 12.) The concentration of dissolved solids was highest in water from wells in the buried gravel. The range of hardness is 22 to 132 ppm and the average is 67 ppm. Water having a hardness of 60 ppm or less is generally regarded as soft and suitable for most purposes. Water exceeding 120 ppm is regarded as hard and usually must be softened for domestic or industrial use.

The low iron content is a significant feature of water from these aquifers. Of 26 wells sampled, only 2 had water with an iron concentration exceeding 0.3 ppm. The average was 0.14 ppm. Iron in excess of 0.3 ppm is objectionable for many industrial uses, and for some uses the maximum permissible concentration is less than 0.1 ppm. In the paper-and-pulp industry, for example, the suggested maximum concentration for high-grade light paper is 0.1 ppm of iron. Excessive iron is objectionable in water for domestic use also, as it causes staining of clothing, utensils, enamelware, and porcelain.

Manganese, even if present in small quantities, limits the use of the water. In the production of plastics, the suggested maximum is 0.02 ppm of manganese. Suggested maximum concentrations of manganese for other industrial uses are slightly higher, as shown in table 1. Manganese concentrations in water from wells tapping these aquifers were generally low, ranging from 0 to 0.13 ppm, with the exception of well EW 57. Water from this well contained 0.97 ppm of manganese. As this concentration of manganese is not typical of water from this formation, it is possible that this well was contaminated.

The concentration of nitrate in water from sand and gravel was generally low and would have little or no effect on the utility of the water. Water from three wells, however, had high concentrations of nitrate—as much as 86 ppm of nitrate was measured for well M 57. All three wells are in areas where considerable fertilizer is used in tobacco culture. Water from these wells is used for irrigation and meets all quality requirements for irrigation water. From a health standpoint, a nitrate content in excess of 44 ppm (as NO_3) should be regarded as unsafe for feeding infants (Maxcy, 1950, p. 271).

Chloride concentrations were low, ranging from 0.7 to 19 ppm and would not limit the utility of the water for most purposes Other dissolved chemical constituents were present in small quantities and, hence, would have little or no effect on the utility of the water.

The temperature of water from 26 wells ranged from 43° to 57°F. This range is caused by the annual variations in air temperature and differences in depth of wells. The majority of the measurements were taken during the spring.

GROUND WATER IN SEDIMENTARY BEDROCK

Small to moderate supplies of ground water may be obtained from the sedimentary bedrock in the Hartford-New Britain area. The sedimentary rocks are important aquifers, because they underlie all the area except the upland on the southeast, which is underlain by crystalline rocks, and the range of hills forming the western boundary of the area and several smaller hills and ridges south of Hartford, which are underlain by basalt. The sedimentary rocks consist predominantly of relatively thin-bedded, indurated arkose (sandstone), shale, and conglomerate. In general, shale predominates in the area west of the Connecticut River and arkose in the area east of the river. The thickness of the sedimentary bedrock is not known, as no wells have penetrated it completely. Geologic evidence suggests that the sedimentary rocks are as much as several thousand feet thick and increase in thickness eastward.

YIELD OF WELLS

The materials composing the sedimentary rocks are cemented and poorly sorted, resulting in low porosity and permeability. The storage and movement of water is mostly in openings along bedding planes and joints, and most wells obtain water from one or more of these openings. Because the joints are not evenly distributed and the size of openings along joints and bedding planes is variable, it is impossible to predict the depth and yield of a prospective well in sedimentary bedrock. However, these small openings are believed to be sufficiently interconnected to depths of several hundred feet so that a small supply can be obtained in most places. Reported yields of 388 wells drilled in sedimentary bedrock of the Hartford-New Britain area ranged from 1 to 578 gpm. (See, for example, wells Fl 32, Bl 92, and Bl 101 in table 17.) Most wells yield less than 300 gpm, and the average yield is 37 gpm. Thus, the sedimentary bedrock will yield sufficient water to meet the requirements of domestic supplies and of most small industries and municipalities. It should be noted that the average yield is weighted by the large number of wells that were drilled to supply water to modern suburban or rural homes. When the small supply required by these homes was obtained, drilling was stopped. In contrast, a much smaller number of wells were drilled for industrial and air-conditioning uses requiring large quantities of water; drilling at these sites was continued until either the desired yield was obtained or the funds allotted for the drilling were expended. It is probable that most wells in sedimentary bedrock would yield more water if they were drilled deeper and developed more fully. For example, 44 industrial and commercial wells tapping the sedimentary bedrock in the Hartford area have an average yield of 132 gpm.

The number of wells in sedimentary rocks that yield specified amounts is shown in figure 52. The curves are based on records of wells in the Hartford-New Britain area whose locations were selected largely for convenience of the owners. The lower curve is the cumulative frequency curve of yields of 388 wells penetrating sedimentary

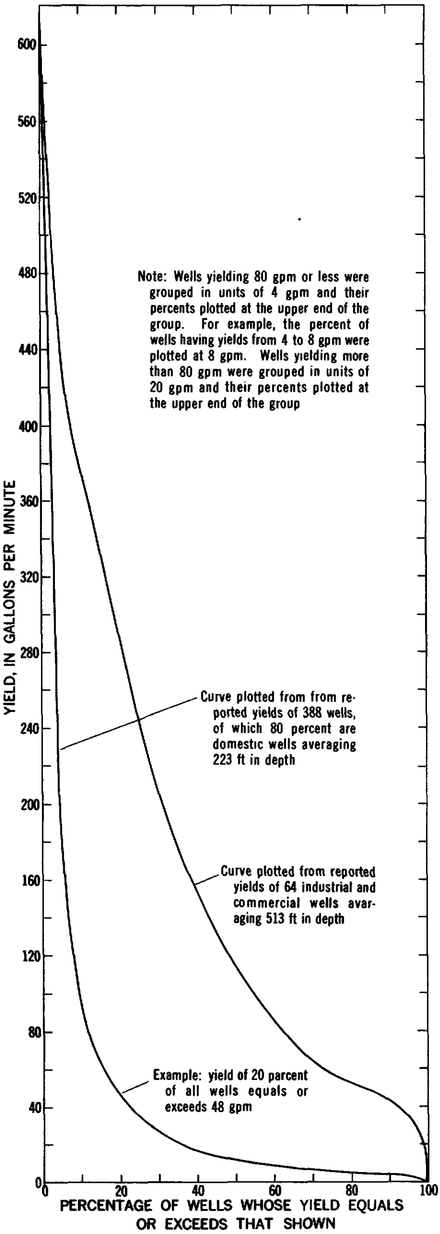

FIGURE 52.—Cumulative frequency curves of yield of wells in sedimentary bedrock.

bedrock that were drilled for industrial, commercial, municipal, and domestic uses. The upper curve represents yields of only 64 industrial and commercial wells, which are much deeper. The curves emphasize that in this type of rock larger yields are obtained from deeper wells. Thus the example shows that the yield of 20 percent of the 388 wells equals or exceeds 48 gpm, whereas the yield of 20 percent of the deeper 64 industrial and commercial wells equals or exceeds 290 gpm.

The maximum depth at which productive water-bearing zones are found in most wells in sedimentary bedrock is less than 450 feet, although a few wells may obtain water from greater depth. The average depth of the 388 wells is 223 feet, whereas the average depth of the 64 industrial and commercial wells is 513 feet. The depth at which maximum well yields may be obtained is difficult to predict. The relation between depth and yield of wells is not a simple one, and in a given well an increase in depth does not necessarily result in a proportional increase in yield. Available records indicate that unless a well shows an appreciable increase in yield between the depths of 400 to 500 feet, it generally is not worthwhile to drill deeper than 500 feet in sedimentary bedrock in the Hartford-New Britain area.

It seems apparent, however, that most large yields from sedimentary bedrock are obtained because a greater than average thickness of the aquifer is penetrated. The permeability of the rock generally is low; the specific capacity of the wells penetrating the rock is 1 gpm per ft or less of drawdown of water level. Thus large yields are seldom obtained without large drawdowns which result in higher pumping costs and greater interference between adjacent wells.

Observed static water levels measured in wells in the sedimentary bedrock at all times of the year range from 3.5 feet above the land surface to 70 feet below the land surface and average about 25 feet below it. Periodic water-level measurements in a few of these wells in areas where there is no disturbance from pumping show that the levels fluctuate according to the normal annual cycle of precipitation, high in the winter and early spring and low in the late summer and fall. The range in fluctuation from high to low averages about 7 feet.

CHEMICAL QUALITY

The chemical character of ground water from the sedimentary bedrock differs markedly from that of water in the sand-and-gravel aquifers. (See tables 11 and 12.) The significant difference is in the higher dissolved-solids content of the water, especially from wells H 11, H 14, and H 22 (table 12). The dissolved-solids content in water from H 11 was 1,890 ppm. The concentration of dissolved solids in water from wells H 14 and H 22 was not determined, but it would be expected to be at least as high as in water from H 11 because

TABLE 11.—*Partial chemical analyses, in parts per million, by the Connecticut State Department of Health of water from wells in the Hartford-New Britain area and vicinity*

Well	Depth (feet)	Date of analysis	Iron (Fe)	Total alkalinity (as $CaCO_3$)	Chloride (Cl)	Nitrate (NO_3)	Total hardness (as $CaCO_3$)	Remarks
Sand and gravel aquifers								
RH 77	94	Apr. 19, 1949		76	4.2	0.07	100	pH 8.0.
SW 65	20	1957		56	5.4	.80		
71	56	1957	<0.1	24	4.0	10.0	110	
W 127	81	Aug. 15, 1956	<.1	54	2.4	3.0	78	
Sedimentary bedrock								
B 25	257	May 13, 1958		100	6.4	2.4		
B 35	183	May 28, 1958		120	17.0	3.0		
B 363	400	Feb. 4, 1959	<0.1	120	5.6	.5	38	
Bl 101	180	Mar. 6, 1958	<.1	110	6.2	1.2	140	pH 7.7.
N 79	200	1957	.1	89	3.0	.02		
SW 106	500	1958	.3	59	110	.01	580	
Wf 87	404	July 13, 1936			17	.5	160	Total dissolved solids, 300 ppm.

of the high concentrations of individual constituents. Calcium and sulfate are the most predominant ions and indicate solutes from calcite and gypsum inclusions and from thin limestone beds in the sedimentary rocks. Because of the high concentrations of calcium and magnesium, the water is extremely hard. The hardness of water from well H 22 was 930 ppm. The noncarbonate hardness also is high, owing to the high sulfate content of the water. This makes the water undesirable for use in boilers and for some other industrial uses because of the formation of a hard scale.

Chemical analyses of water samples from other wells—namely, Bl 32, M 60, RH 78, and Wf 87—showed less dissolved material. The dissolved solids ranged from 145 to 300 ppm and consisted principally of calcium and bicarbonate. The water would be considered to be moderately hard to hard; the range of hardness was 78 to 160 ppm. Other dissolved mineral constituents added little to the mineral content of the water.

Occasionally, water from the sedimentary bedrock is reported to have a high concentration of chloride. This water has probably resulted from the solution of salt in cavities and lenses within the sedimentary bedrock.

Only two water samples were analyzed for iron. Iron concentrations in water samples from wells Bl 32 and M 60 were 0.24 and 0.08 ppm, respectively.

In summary, the chemical quality of water from the sedimentary bedrock showed a wide variation in dissolved solids which reflects the diverse mineral composition of the sedimentary bedrock. Treatment of the highly mineralized waters would improve the chemical quality and increase suitability for domestic or industrial use.

OTHER SOURCES OF SMALL GROUND-WATER SUPPLIES

Ground-water supplies adequate for the needs of rural homes and small commercial establishments can also be obtained from crystalline bedrock in the Hartford-New Britain area. The yields of wells in these rocks are usually inadequate for industrial and large commercial supplies. Other small but less reliable supplies are obtained from glacial till.

CRYSTALLINE BEDROCK

The crystalline bedrock is of two types: metamorphic rock consisting of gneiss and schist and igneous rock consisting of basalt. The outcrop pattern of each type is shown on plate 2. The gneiss and schist underlie and crop out only in a small upland section in the southeastern part of the Hartford-New Britain area. A major fault separates them from the sedimentary bedrock which crops out in the lowland. The gneiss and schist also underlie the sedimentary rocks at depth, but drilling to tap water in them usually is not economically feasible because of the great thickness of the sedimentary rocks. The metamorphic rocks are relatively massive and dense, but near the land surface they are broken by interconnected joints and other small fractures which store and transmit water. The joints are not evenly distributed, and there is a great variation in the size of openings. In general they are fewer in number and become smaller in size with depth. The zone of water-bearing fractures generally extends to a depth of about 200 feet or less, although a few wells obtain water from greater depths.

The yield of an individual well drilled into these rocks depends upon the number and size of openings penetrated by the well, and individual drilled wells show a wide range in yield. Reported yields of wells drilled in gneiss and schist in the Hartford-New Britain area and vicinity range from less than 1 gpm to 40 gpm and average 10.3 gpm (median, 7 gpm). (See well Gl 46 in table 17.) The specific capacity of these wells is generally less than 1 gpm per ft of drawdown, and thus the larger yields cannot be sustained without large drawdowns. These wells range in depth from 25 feet to 550 feet, the average depth being 145 feet (median depth 125 feet). The presence or absence of water is difficult to predict in advance of drilling, but most wells obtain some water at depths of less than 200 feet. The existing records indicate that unless a well shows an increase in yield between the depths of 150 to 200 feet, it generally is not worthwhile to drill deeper than 200 feet.

The basalt occurs as lava flows interlayered with the sedimentary bedrock. It underlies and forms the low mountains that are the western border of the Hartford-New Britain area (Talcott and Farmington Mountains) and that extend along the entire length of the area. It also underlies several smaller disconnected ridges in the area south

TABLE 12.—*Chemical analyses, in parts per million, of water from wells in the Hartford-New Britain area and vicinity*

[Analyses by U.S. Geological Survey unless otherwise indicated]

Well	Depth (feet)	Date of collection	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Lithium (Li)	Zinc (Zn)	Dissolved solids (residue on evaporation at 180° C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25° C)	pH
Sand and gravel aquifers																							
Bl 19	47	May 21, 1953	------	9.4	0.11	0.06	12	1.3	[1] 8.6		40	14	2.1	0.1	3.5	0.5	------	0.00	71	35	3	97	7.4
Bl 49	66	Mar. 30, 1954	55	16	.10	.01	20	13	16	1.0	135	27	1.9	.3	.4	.0	0.3	------	156	103	0	250	7.9
EH 37	258	May 18, 1953	57	9.3	.06	.13	30	5.6	[1] 56		125	87	18	.3	.2	.0	------	.01	285	98	0	442	8.1
EH 42	26	Mar. 26, 1954	47	9.4	.25	.02	25	6.6	9.4	8.2	15	50	7.9	.1	63	.0	.8	------	201	90	77	268	6.2
EW 6	198	May 27, 1953	50	16	.20	.10	30	5.7	[1] 55		187	57	3.9	.2	.3	.1	------	.00	262	98	0	404	7.8
EW 10	160	May 27, 1953	52	12	.09	.04	22	2.6	[1] 65		180	53	2.8	.2	.1	.1	------	.00	249	66	0	385	7.9
EW 49	85	May 27, 1953	50	9.9	.08	.00	21	4.3	[1] 29		142	12	2.4	.3	.9	.1	------	.00	163	70	0	261	7.7
EW 57	6	Apr. 4, 1954	48	12	.42	.97	28	6.8	5.9	.8	41	43	5.9	.0	33	.0	.0	------	167	98	64	237	7.0
EW 58	13	Mar. 30, 1954	43	6.5	.09	.05	18	2.4	13	11	12	46	9.9	.0	43	.0	1.0	------	138	55	45	210	6.5
EW 59	9	Mar. 30, 1954	49	7.8	.28	.02	7.4	2.5	2.1	4.8	3.8	32	1.9	.1	1.8	.0	.3	------	67	29	26	97	5.4
EW 60	10	Mar. 30, 1954	43	3.5	.15	.01	13	2.0	3.6	2.0	5.0	31	4.7	.1	9.5	.0	.1	------	79	41	37	118	6.0
Gl 103	52	May 26, 1954	------	9.4	.06	.00	7.6	1.6	2.8	1.5	17	18	2.2	.0	3.2	.0	.2	------	52	26	12	71	6.6
Gl 104	23	Mar. 26, 1954	50	14	.41	.01	10	2.3	11	3.4	15	20	18	.0	9.0	.0	.5	------	101	34	22	144	6.1
M 46	60	Apr. 5, 1954	49	13	.14	.00	15	3.0	5.0	1.0	33	27	3.8	.0	3.5	.0	.2	------	98	50	23	137	6.6
M 57	52	July 20, 1954	57	15	.02	.03	35	9.1	8.7	.6	16	57	4.0	.0	86	.0	.6	------	258	125	112	317	6.3
M 58	64	Apr. 5, 1954	48	17	.21	.01	33	2.7	6.3	.7	90	21	5.0	.1	12	7.9	------	------	144	95	21	212	7.9
P 66	146	May 18, 1953	50	11	.06	.00	22	2.0	3.8	.7	68	16	1.8	.0	1.4	.0	.1	.00	119	63	8	147	8.0
SW 68	9	May 20, 1953	49	9.6	.13	.08	16	5.1	[1] 14		26	50	9.0	.3	9.0	.0	------	.76	140	61	40	192	5.6
SW 69	30	May 20, 1953	51	12	.24	.06	8.2	3.0	[1] 4.1		15	19	5.0	.0	4.0	.0	------	.36	77	33	21	104	6.1
SW 71	56	July 20, 1954	51	15	.02	.00	42	6.6	9.1	.6	28	74	3.5	.0	62	.0	.5	------	259	132	109	324	6.7
SW 72	30	Mar. 27, 1954	49	8.6	.01	.00	15	4.3	6.7	4.0	3.0	46	8.2	.0	11	.0	.6	------	114	56	48	135	6.4
SW 73	30	Mar. 27, 1954	45	12	.18	.02	5.6	2.0	3.3	1.3	6.0	18	.7	.1	7.5	.0	.0	------	63	22	17	72	6.1
W 9	9	Mar. 30, 1954	43	4.0	.09	.02	4.6	1.1	3.8	1.3	3.4	18	3.2	.1	2.5	.0	.1	------	48	16	13	61	5.5
W 11	20	May 27, 1953	50	8.7	.03	.01	26	3.8	[1] 8.3		63	27	4.1	.1	16	.1	------	.07	147	81	29	212	7.0
WL 3	80	Apr. 15, 1954	49	9.2	.13	.00	25	6.4	8.0	1.5	60	47	3.4	.0	6.0	.0	.2	------	137	89	40	213	7.8
WL 4	32	Apr. 15, 1954	50	9.2	.12	.00	16	5.8	3.4	1.3	42	31	3.2	.0	5.5	.0	.2	------	104	64	29	147	7.3

Sedimentary bedrock																						
Bl 32	609	Mar. 26, 1954	52	17	0.24	0.00	20	6.8	12	1.1	80	26	3.9	0.0	12	0.0	0.2	...	145	78	12	201	7.8
H 11 [2]	640	June 10, 1942	59	...	...	...	...	...	...	...	...	...	14	...	.2	...	...	...	1,890	[3] 415	...	...	7.3
H 14 [2]	398	Mar. 3, 1938	...	...	...	...	233	43	[1] 121		86	836	40	...	.15	...	...	...	...	[3] 734	...	...	...
H 22 [2]	502	Mar. 3, 1938	...	...	...	...	285	53	[1] 129		121	1,029	28	...	.0	...	...	...	...	[3] 930	...	...	...
M 60	602	Nov. 4, 1954	55	14	.08	.08	27	10	[1] 2.3		80	31	5.6	.1	18	.1	.1	0.00	148	109	43	233	7.8
Crystalline bedrock																						
El 28	92	May 20, 1953	52	14	0.09	0.03	8.6	2.8	[1] 6.9		32	18	2.0	0.1	0.5	0.0	...	0.26	69	33	7	90	6.9
Gl 46	210	May 18, 1953	56	13	.06	.03	30	4.0	[1] 11		69	34	10	.0	12	.0	...	.26	157	91	35	248	6.9
Gl 76	353	Mar. 30, 1954	55	15	.39	.01	6.3	1.3	3.6	1.7	26	8.0	.9	.1	.8	.2	0.0	...	58	21	0	64	6.9
P 36	283	June 2, 1953	52	12	.06	.02	33	5.3	[1] 11		100	17	10	.0	16	.3	...	.00	167	104	22	262	7.7
V 8	150	May 20, 1953	52	23	.02	.12	20	2.6	[1] 1.7		56	10	4.5	.3	2.2	.0	...	1.1	107	61	15	161	7.4
V 47	57	May 20, 1953	54	11	1.1	.16	7.0	3.1	[1] 4.2		22	18	6.0	.1	2.4	.0	...	.17	63	30	12	106	6.3
Basalt																						
Bl 27	210	May 21, 1953	53	19	0.13	0.03	27	3.5	[1] 8.0		69	30	6.6	.3	4.0	0.0	...	1.3	154	82	25	202	7.2
Bl 31	96	May 27, 1953	49	11	.40	.03	28	15	[1] 7.8		112	27	6.8	.0	24	.0	...	.00	184	132	40	312	7.4
Cr 88	66	Apr. 3, 1954	...	19	.16	.00	21	5.4	7.8	3.0	64	26	7.1	.1	7.9	.0	.5	...	140	75	22	197	7.1
RH 79 [4]	200	Dec. 11, 1933	...	...	...	...	...	...	...	...	...	...	18	...	.03	...	...	...	260	[3] 220	...	...	...
Ground moraine																						
El 22	21	May 20, 1953	52	6.8	0.84	0.08	5.5	3.0	[1] 3.2		9.0	21	3.5	0.1	0.5	0.0	...	1.0	58	26	18	87	6.1
El 27	28	May 20, 1953	47	8.7	2.0	.02	4.2	2.8	[1] 1.5		20	7	1.5	.1	.5	.1	...	.53	44	22	6	53	6.5

[1] Calculated sodium plus potassium.
[2] Analysis by the Bridgeport Testing Laboratory.
[3] Includes hardness of all polyvalent cations.
[4] Analysis by the Connecticut State Department of Health.

of Hartford and in New Britain. Cedar Mountain in Wethersfield is an example of the latter. The basalt crops out extensively in these areas or is overlain by a thin cover of ground moraine. The lava flows dip eastward at a low angle, and as they are interlayered with the sedimentary bedrock they underlie the latter in some places and overlie it in others. They are also broken by a number of extensive cross faults in the southern part of the area, which have caused pronounced offsetting and discontinuity of the ridges in this region.

The occurrence of ground water and the yield of wells in basalt are about the same as in gneiss and schist.. The yield of wells in basalt in this area ranges from 1½ to 125 gpm and averages 13 gpm (median, 9½ gpm). (See, for example, wells Bl 27 and NB 13 in table 17.) The wells average 153 feet in depth and range from 60 feet to 500 feet. The basalt is much harder and more difficult to drill than most gneiss and schist but is developed extensively for domestic water supply in the western part of the area. Water supplies are commonly found along the contact of the basalt and the sedimentary bedrock, particularly along the contact at the base of the basalt. In some areas where the basalt is known to be relatively thin, it is worthwhile to drill through the basalt into the underlying sedimentary rock if little or no water is found in the basalt.

GLACIAL TILL

Glacial till (boulder clay) forms a discontinuous mantle over the bedrock in the Hartford-New Britain area and is the surface deposit in most areas that are above an altitude of 150 feet. It consists of an unsorted mixture of clay, sand, gravel, and boulders, the finer grained sizes predominating. The deposit generally has a low permeability and yields small and, in some areas, unreliable supplies to large-diameter dug wells. Generally yields are sufficient only for small domestic uses, but, owing to the widespread occurrence of the deposit, water can be obtained from till in many localities where water from other sources is not available.

CHEMICAL QUALITY

Water obtained from the crystalline bedrock generally is low in dissolved solids, ranging from 58 to 167 ppm (table 12). The water generally is soft. The hardness of water from wells Gl 46 and P 36, however, was 91 ppm and 104 ppm, respectively.

The iron concentration in water from crystalline rocks showed a wide range, from 0.02 to 1.1 ppm. Manganese concentrations also were low, from 0.01 to 0.16 ppm. Some industrial processes, however, require very low concentrations of iron and manganese, and for these processes treatment of the water would be necessary.

The highest concentration of zinc reported was 1.1 ppm; this concentration would have no effect on the utility of water for domestic or industrial use.

The average temperature of water from seven wells in the glacial till was 53°F.

The dissolved-solids content of water from basalt is slightly higher than that of water from crystalline rock. Chemical analyses of water from four wells in basalt showed that dissolved solids, principally calcium and bicarbonate ions, ranged in concentration from 154 to 260 ppm. The slightly higher concentration was apparent from the hardness of the water, which ranged from 75 to 220 ppm.

The concentration of nitrate was generally low, except for well Bl 31. The nitrate concentration of water from this well was 24 ppm, which would indicate contamination by fertilizer, sewage, or other organic matter. Concentrations of chloride were low, ranging from 6.6 to 18 ppm. These concentrations would have little or no effect on the utility of the water.

Analyses of water for iron content from three wells showed a range of 0.13 to 0.40 ppm. Concentrations of other dissolved constituents added little to the mineral content of the water.

The water from basalt is used mostly for domestic purposes, as yields are generally small. The quality of water is generally good; however, the water from some sources is hard, and the quality would be improved if the water were softened.

The chemical quality of water from till is good. The most significant feature of water from this material is the low concentration of dissolved solids. The highest concentration of dissolved solids reported was 58 ppm. The concentrations of calcium and magnesium were very low, and, consequently, water from these deposits was soft. The iron content of water was as high as 2.0 ppm (well El 27, table 12). The concentration of other dissolved constituents was low and would have little or no effect on the utility of the water.

PUBLIC WATER SUPPLIES

The Hartford-New Britain area is served chiefly by the Water Bureau of the Metropolitan District Commission and by the New Britain Water Department.

The water supply for the Metropolitan District obtained is principally from Nepaug and Barkhamsted Reservoirs having a total capacity of 41,300 million gallons. Hogback reservoir will provide an additional 6,500 million gallons upon completion (fig. 53). In addition, there are four small reservoirs in West Hartford now operated only for emergency supplies. In 1957 about 16,000 million gallons of water was distributed to 361,000 people at an average daily

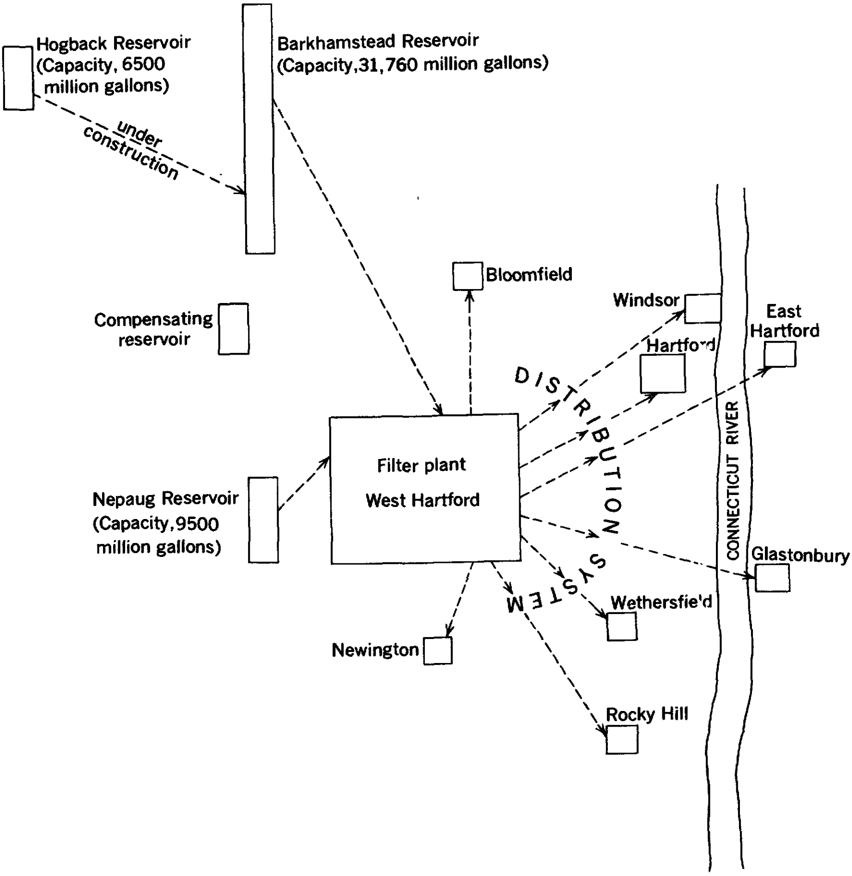

FIGURE 53.—Flow chart of water-supply system of Metropolitan District.

rate of 43.68 million gallons. This represents an increase of 3 mgd over the 1956 rate. On a per capita basis, 121 gallons per day was supplied in 1957, representing an increase of 5.2 percent over the 1956 rate. The percentage of water used for domestic, commercial, industrial and municipal purposes is shown in figure 54.

All water is filtered and chlorinated at West Hartford, with the exception of water from the Glastonbury Reservoir which is chlorinated only. The rated capacity of the West Hartford filter plant is 60 mgd. Other pertinent data relating to the supply system are given in table 13.

The chemical quality of water supplied to the consumer in the Metropolitan District is excellent. The water is very soft and low in dissolved solids. Iron is present in trace amounts but manganese is completely absent. Concentrations of the individual dissolved constituents are shown in table 14.

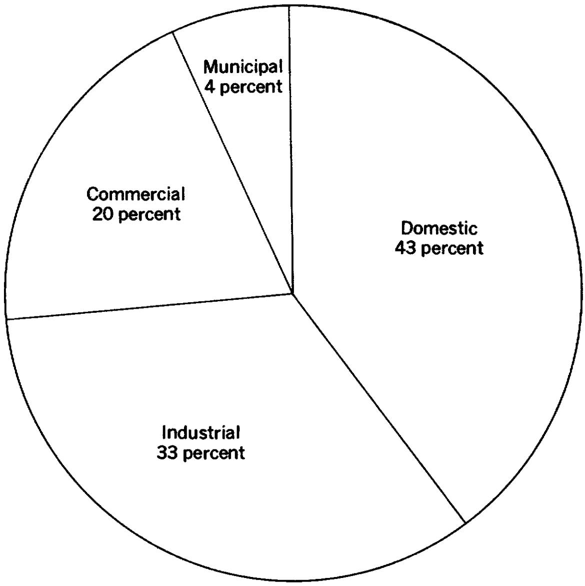

FIGURE 54.—Percentage of total use of water of the Metropolitan District for 1957.

Construction is nearing completion on the Charles A. Goodwin Dam on the West Branch Farmington River which will impound floodwaters in a reservoir having a capacity of 6,500 million gallons. This water will be conveyed by pipeline and tunnel to the Barkhamsted Reservoir (fig. 53). Additional plans of the Metropolitan District Commission include a second pipeline from Barkhamsted Reservoir to the West Hartford reservoir system and construction of a second filter plant in West Hartford.

The New Britain Water Department obtains water from three reservoirs having a total capacity of 1,460 million gallons, two well fields near Whigville and a single well on Patton Brook (table 13 and fig. 55). In 1957 the reservoirs supplied about 85 percent of all water delivered to the distribution system. The rate of water use was 8.809 mgd in 1957 as compared to 10.411 mgd in 1956. This decrease was an aftereffect of the summer-long drought of 1957. The New Britain Water Department reported a critical water shortage in 1957, and all unnecessary use of water was sharply curtailed. To alleviate the situation, arrangements were made to obtain 1 mgd from the Metropolitan District Commission.

The water is treated at a filtration plant at Shuttle Meadow Reservoir that has a rated capacity of 10 mgd. An expansion of capacity of 15 mgd is planned. Treatment consists of coagulation with alum, rapid sand filtration, and chlorination and fluoridation.

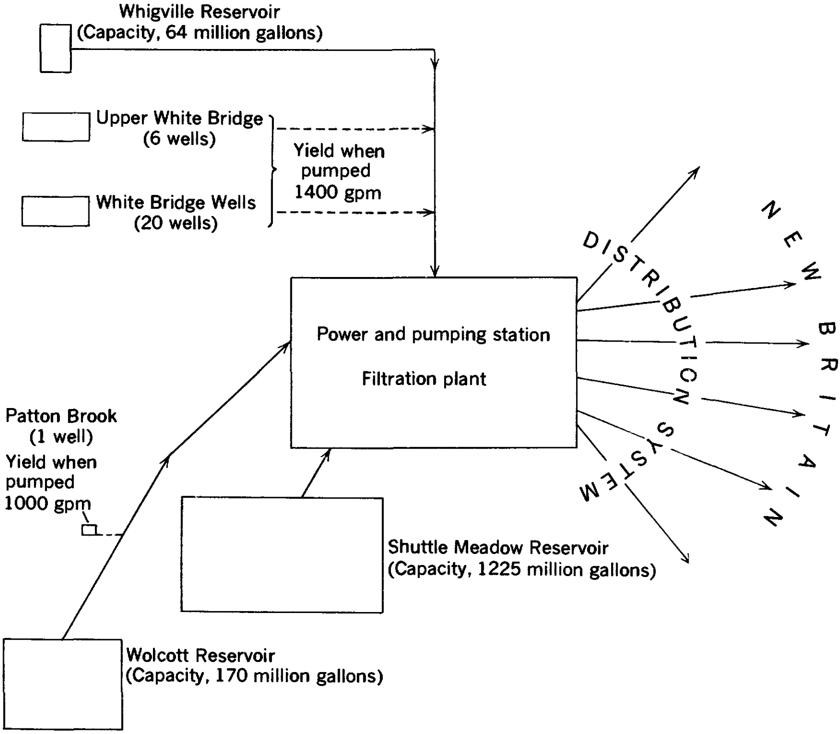

FIGURE 55.—Flow chart of water-supply system, New Britain.

Except for its greater alkalinity, the chemical quality of this water (table 15) is similar to the water supplied by the Metropolitan District (table 14).

Three smaller water districts—namely, Kensington, Worthington, and East Berlin Fire Districts—purchase treated water from the New Britain Water Department (about 205 million gallons in 1957).

USE OF WATER

The average daily use of water in the Hartford-New Britain area was estimated to be 463.5 mgd in 1957. More than 425 mgd, or 92 percent of the total water withdrawn, was required to satisfy the needs of industry, and about 5 percent was for domestic water supply (figure 56). About 98 percent of all water used was from surface sources, the remaining 2 percent being pumped from wells. In table 16 the average daily use of water in the area in 1957 is summarized by types of use and by source of supply. The data in the table, and in other presentations in this report, are given as average use in million gallons per day computed on an annual basis for 1957. This method of reporting may be somewhat misleading, unless it is noted that water use fluctuates greatly with the seasons. Maximum daily

TABLE 13.—*Public water supplies in the Hartford-New Britain area for the year ending December 31, 1957*

Name of water system	Source of water supply	Treatment	Rated capacity of treatment plant (mgd)	Raw-water storage (million gallons)	Average rate of water use (mgd)	Average daily water use in month of maximum water use (mgd)	Municipality served	Population supplied	Use of water by types of use (mgd)			
									Domestic	Commercial	Industrial	Municipal [1]
J. B. Williams Co.	Hubbard Brook and reservoir.	Chlorination		2	0.02		Glastonbury	410	0.02			
New Britain Water Department.	Shuttle Meadow, Wolcott, and Whigville Reservoirs; Upper White Bridge well field (5 wells), Lower White Bridge well field (20 wells), Patten Brook well (1 well).	Rapid sand filtration, chlorination, fluoridation.	10	1,460	8.76	11.530	New Britain	[2] 93,959	4.77	1.20	2.10	0.70
Water Bureau of the Metropolitan District Commission.	West Hartford, Barkhamsted, Nepaug, and Glastonbury Reservoirs.	Slow sand filtration, chlorination.	60	41,100	43.68	52.92	Bloomfield	7,600	.48	.35	.07	.01
							East Hartford	41,500	2.07	.80	8.35	.08
							Glastonbury	7,900	.41	.07	.04	.01
							Hartford	188,700	9.02	6.22	4.00	.68
							Newington	12,700	.72	.19	.24	.16
							Rocky Hill	5,600	.23	.05	.02	.45
							West Hartford	64,600	3.93	.77	1.59	.10
							Wethersfield	17,100	.98	.12	.02	.18
							Windsor	15,300	.79	.19	.27	.02
Total, Metropolitan District.								361,000				
Percent of total use									42.70	20.00	33.40	3.90

[1] Includes water lost through leakage.
[2] Includes 6,122 people served by Kensington and Plainville Water Companies who purchase treated water from New Britain Water Dept.

TABLE 14.—*Analysis of finished water, Water Bureau of the Metropolitan District*

[Sample taken from the distribution system in East Hartford, April 3, 1954. Chemical constituents, in parts per million]

Silica (SiO_2)	13	Fluoride (F)	0.0
Iron (Fe)	.02	Nitrate (NO_3)	.4
Manganese (Mn)	.00	Dissolved solids	43
Calcium (Ca)	3.9	Hardness as $CaCO_3$:	
Magnesium (Mg)	1.2	Total	17
Sodium (Na)	3.2	Noncarbonate	9
Potassium (K)	.3		
Carbonate (CO_3)	0	Color units	3
Bicarbonate (HCO_3)	10	pH	6.5
Sulfate (SO_4)	13	Specific conductance micromhos at 25 °C	48.4
Chloride (Cl)	2.2	Temperature °F	51

TABLE 15.—*Analysis of finished water, New Britain Water Department*

[Sample taken from the distribution system at Shuttle Meadow treatment plant, July 11, 1951. Chemical constituents, in parts per million]

Silica (SiO_2)	8.2	Nitrate (NO_3)	0.2
Iron (Fe)	.01	Dissolved solids	52
Manganese (Mn)	.00	Hardness as $CaCO_3$:	
Calcium (Ca)	9.4	Total	29
Magnesium (Mg)	1.4	Noncarbonate	13
Sodium (Na)	3.2		
Potassium (K)	.3	Color units	2
Carbonate (CO_3)	2	pH	9.0
Bicarbonate (HCO_3)	16	Specific conductance micromhos at 25° C	85.1
Sulfate (SO_4)	14	Turbidity	.5
Chloride (Cl)	3.2	Temperature °F	72
Fluoride (F)	.4		

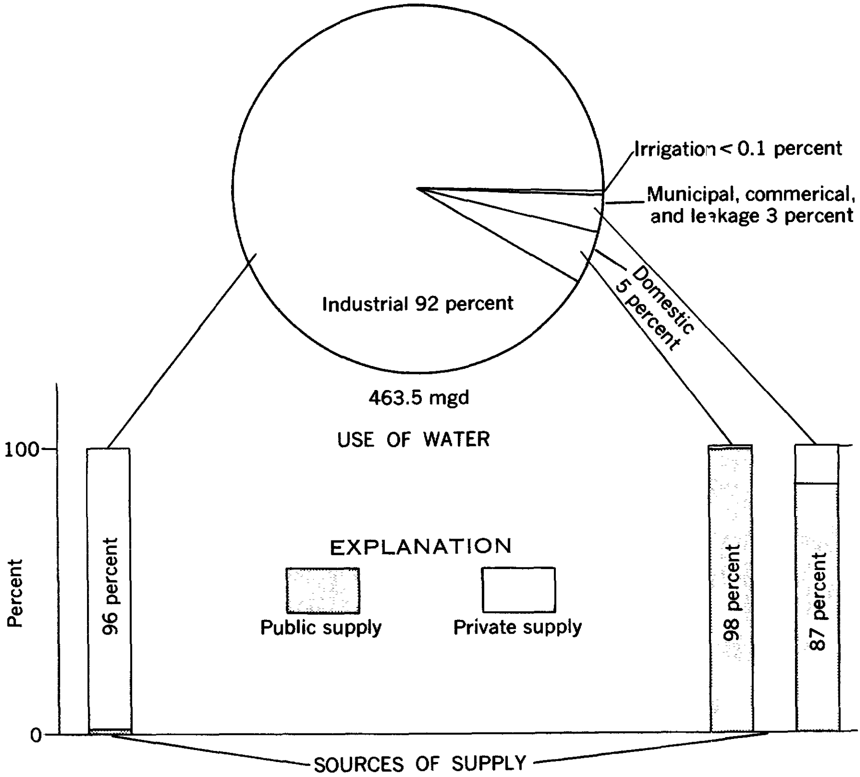

FIGURE 56.—Use of water in the Hartford-New Britain area, 1957.

use for almost all purposes occurs during the summer. For example, the use of water for cooling purposes by commercial and industrial establishments and for domestic use reaches a maximum during the summer, and the entire load of water use for air conditioning is concentrated during this same period. Therefore, the maximum and, perhaps, also the minimum daily use in the area is considerably more and considerably less, respectively, than the average daily use.

TABLE 16.—*Average use of water, in million gallons per day, in Hartford-New Britain area, 1957*

Use	Public supply (all from surface sources except as indicated)	Private supply			Total
		Surface water	Ground water	Total	
Domestic	[1] 23.3		[2] 0.4	0.4	23.7
Municipal and commercial	[3] 12.3		1.9	1.9	14.2
Industrial	16.8	[4] 403.8	4.7	408.5	425.3
Irrigation		.2	.1	.3	.3
Total	52.4	404.0	7.1	411.1	463.5

[1] Includes a small amount of water used for stock. Population served, 466,000.
[2] Population supplied, 10,631.
[3] Includes water for air conditioning and water lost through leakage.
[4] 403.5 mgd pumped from Connecticut River for power generation and cooling purposes by two plants.

Of the total water withdrawn by industry, it is estimated that 403.5 mgd, or 95 percent, was withdrawn from the Connecticut River for cooling purposes at a steam-powered electric-generating plant and a large engine-test laboratory. More than 90 percent of this water was returned immediately to the river, unchanged in quality but at a slightly higher temperature. The total withdrawal by these two plants was about one-third of the minimum flow of the river, whose low flow is regulated, and was a much smaller percentage of the average daily flow of about 10,690 million gallons at Thompsonville (table 4). Exclusive of the water used for cooling at these two plants, the use of water in 1957 by all other industries in the area totaled 21.8 mgd, or slightly less than the average daily amount used for domestic purposes. Exclusive of the water pumped from the Connecticut River by the two plants just mentioned, industry supplies itself with an average of only 5 mgd, most of which is pumped from wells; the rest of the water used is purchased from public water systems.

Industry in the Hartford-New Britain area uses water for cooling purposes and processing, for boiler feed, and for sanitary service needs. Exclusive of electric-power generation, the largest use in 1957 was in the production of aircraft engines. Other large uses are in the production of machinery, fabricated metals, and plastics. The use of water by industry in the area has increased in recent years because of new industries moving into the area, expansion of existing industries, and new water-using processes and methods. No data are available on the amount of increase for the entire area, but an indication of the increase is shown in data for the Hartford area contained in the annual reports of the Hartford Water Bureau. Figure 57 shows a steady increase in water supplied to industry for the period 1955–57 and an overall increase of 17 percent for the 3 years.

About 98 percent of the population of the area is served by public water-supply systems, which during 1957 provided water at an average rate of 23.3 mgd. The per capita use of water in the area for all purposes, except for generation of power and cooling purposes at the engine-test laboratory averaged 129 gpd in 1957. If only the domestic use of water is considered, the per capita use was 51 gpd. Most of the withdrawals were from surface sources; only 11 percent

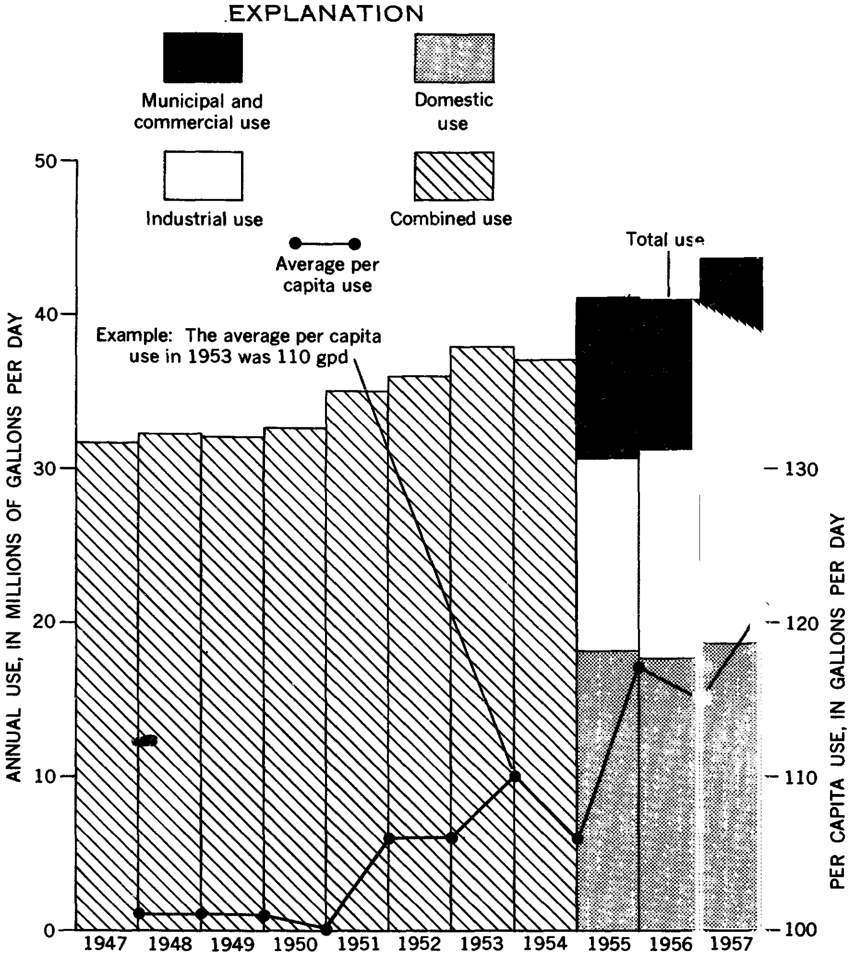

FIGURE 57.—Average annual use and per capita use of water supplied by the Metropolitan District, 1947–57. (From annual reports of the Water Bureau of the Metropolitan District.)

of the total was pumped from wells. A large part of the water supplied by public-supply agencies was obtained from reservoirs and wells beyond the Hartford-New Britain area. About 68 percent of the water furnished was for domestic, commercial, and industrial uses, and 32 percent was used by industry. Water from this latter source constitutes about 4 percent of all the water used by industry in the area. The water supply to commercial and industrial users for air-conditioning constitutes only a small percentage when averaged over the year, but it is a significant amount during the air-conditioning season. According to the Hartford Water Bureau, the peak air-conditioning load on its system is about 13 mgd.

There has been a steady increase in the use of water for public supply in the Hartford-New Britain area. The increase in water supplied by the Hartford Water Bureau in the period 1947–57 (fig. 57) probably is typical of the increase, as this agency serves about 77 percent of the population in the area. In the Hartford area water consumption has increased 38 percent since 1947 and the per capita use has increased from 101 to 121 gpd.

An estimated 10,600 persons live beyond the areas served by the public water-supply systems and obtain their water from privately owned sources, most of which are wells that tap bedrock aquifers. Pumpage is not metered, but on a per capita consumption of 40 gpd, the privately supplied use would be 0.4 mgd. Farms are few in the area, and therefore the daily use of water for livestock is probably small and is included with water for domestic use. Most farms are large and raise tobacco and vegetable crops. Sprinkler irrigation is practiced on many of these farms, and it is estimated that the average daily use of water for this purpose, based on use for the entire year, is 0.3 mgd. It should be noted that irrigation generally is practiced less than 60 days in the year, and thus the actual use during the irrigation season is much greater than 0.3 mgd.

EMERGENCY WATER SUPPLIES

One of the basic considerations in a well-integrated modern civil defense program is to make adequate provisions for safeguarding water supplies against contamination and destruction and to plan for emergency water supplies in the event that normal service is interrupted or ceased permanently.

If a nuclear explosion were to occur in the area, a wide variety of problems involving water would arise. Among the more serious of these problems are direct radioactive contamination of water sources, destruction of water plants and distribution systems, and interruption of water service through breakage of water and sewer mains. If one or more of these problems were to arise it would be necessary to supply the populace for an undetermined period of time from emergency sources that had not been seriously contaminated by radioactive fallout. Of the possible water sources in the area, ground water would be least likely to be contaminated immediately because it is not in direct contact with the atmosphere and the materials overlying the water table or the water-bearing formation would remove much of the fallout material by filtration and sorption. Wells drilled in bedrock would be least subject to contamination. Many wells within the Hartford-New Britain area which have fairly substantial yields could be designated as emergency well-water suppliers. Records of these wells are given in table 17 and their locations are shown on the map on plate 2. Wells yielding more than 30 gpm generally were selected, although wells yielding smaller amounts were selected in areas where only a few wells were available. Additional wells in fringe areas just beyond the area could also be used for this purpose. For example, wells in Burlington, owned by the water department of the city of New Britain produced an average of 2.6 mgd in 1957. These wells are connected by pipeline to the distribution system in New Britain.

Most of the wells given in table 17 are equipped with pumps driven by electric motors which would be inoperative in the event of a power failure. For this reason wells chosen for emergency water supplies should be equipped with auxiliary gasoline motors or other standby power facilities.

In addition to wells already in existence, small supplies of ground water might be developed quickly by means of driven wells in sand and gravel aquifers. These wells would be feasible as auxiliary supplies in areas where no wells or only a few wells are available. Driven wells are best suited to areas where the sand and gravel can be penetrated easily by a well point and where the water table is shallow. In the Hartford-New Britain area the most favorable areas of this type are those underlain by fluvial sand and by deltaic sand and gravel (pl. 2). The fluvial sand is widespread in the area and contains ground water at shallow depths. Driven wells could be installed quickly with portable well-driving equipment, and the wells could be fitted with hand-operated pumps. Such wells would be safe sources of water so long as the ground water received no contaminated recharge, and they would not depend on electric power.

Surface-water sources are exposed to the atmosphere at all times and are subject to immediate contamination from radioactive fallout. Surface sources in which the water is held in quiet storage, such as in reservoirs and ponds, might be rendered useless for some time. Flowing streams, however, tend to purify themselves to a certain extent and would be potential sources of water which might be made suitable by treatment. Larger streams, such as the Connecticut and Farmington Rivers, which drain large areas outside the Hartford-New Britain area, might purify themselves by flushing and other processes in a relatively short time. Therefore, they could be made potable after treatment and would be an important source of water for fire fighting and the washing down of streets and buildings.

POSSIBILITY OF FURTHER DEVELOPMENT

If all sources of water are considered, the potential water supply of the Hartford-New Britain area is adequate for many years to come. Surface water provides the greatest part of the water currently used in the area and also holds the greatest promise for additional development.

According to the report of the Connecticut Water Resources Study Commission (1957), it seems that present and projected public water-supply developments will furnish the area with an adequate supply of potable water at least until the year 2000. This water is of good chemical quality, although it does require some purification. This favorable situation exists largely because of careful planning by the Metropolitan District Commission of Hartford for the future. The Hartford charter empowers the Metropolitan District to furnish water to users within a 20-mile radius of Hartford after the local communities have developed their own sources of supply to the limits of their capabilities. The other communities in the Hartford-New Britain area, principally New Britain, may have to continue to depend upon Hartford to obtain additional water during periods of drought.

At the present rate of use the Connecticut River could furnish enough water to supply the area adequately most of the time. Although of less desirable quality than the potable water now used, the water could be made chemically satisfactory by proper treatment. Records for the period 1928–58 at Thompsonville indicate that a supply of about 2,000 mgd (3,090 cfs) can reasonably be expected 95 percent of the time. The longest period during which the average flow was less than this amount was 12 consecutive days. In addition, the entire flow of the Farmington River at Rainbow is not utilized except for power generation. Based on records at Rainbow, a supply of about 62 mgd, or 96 cfs, can be expected 95 percent of the time.

Small water supplies could be developed from the other small streams in the area but probably only at considerable expense for treatment and distribution of the water.

Potential supplies of ground water of good quality are available in modern quantities from coarse sand-and-gravel deposits. It is difficult to estimate the potential ground-water supply available in the Hartford-New Britain area, because of the many factors involved and the inadequacy of hydrologic data. The most important sources are the fluvial sand in the Connecticut River lowland and the sand

TABLE 17.—*Records of wells selected as possible emergency water supplies and wells for which quality-of-water and water-level data are available*

[All wells are possible emergency sources unless indicated otherwise. Locations of wells are shown on pl. 2]

Type of well: Col, collector; Drl, drilled; Drv, driven; Dug, dug.
Depth of well: All depths are below land-surface datum.
Use of water: Acc, air conditioning or cooling; Com, commercial; Dom, domestic; Farm, general farm purposes (may include stock watering and domestic use); Ind, industrial; Irr, irrigation; PWS, privately-owned community supply; Refrig, refrigeration; Un, unused.
Remarks: A, indicates that a chemical analysis is given in table 14. Ap, indicates that a partial chemical analysis is given in table 11.

Well	Owner	Location	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-yielding formation	Static water level: Feet below land surface	Static water level: Date of measurement	Yield (gpm)	Use	Remarks
Berlin											
B 25	Ferndale Dairy, Inc.		Drl	257	6		35	Aug. 4, 1931	60	Refrig	Water hard, Ap.
B 35	Pure Ice Co	8 Harding St	Drl	183	8	Sedimentary bedrock.	25		85	Com	Ap.
B 300	Surrey Restaurant	Berlin Turnpike	Drl	138	6	do	5	Aug. 12, 1955	50	Com	
B 363	Connecticut Light & Power Co.	do	Drl	400	6	do	37	May 2, 1950	20	Dom Acc	One other similar well at this location, Ap.
Bloomfield											
Bl 13	Hartman Tobacco Co.	Blue Hills Ave	Drl	590	8	Sedimentary bedrock.			35	Dom	
Bl 19 [1]	Nigro Pump Co	1500 Blue Hills Ave.	Drl	47	4	Sand	11	Oct. 16, 1948	20	Dom	A.
Bl 27 [1]	R. D. Shaw	615 Duncaster Rd.	Drl	210	6	Basalt	26		20	Dom	A.
Bl 31 [1]	E. E. Case	262 Duncaster Rd.	Drl	96	6	do	20		12	Farm	A.
Bl 32	Connecticut General Life Insurance Co.	900 Cottage Grove Rd.	Drl	609	10-8	Sedimentary bedrock.	20	Jan. 31, 1954	280	Acc	A. Nine other similar wells on this property.
Bl 43	S. N. Tychsen	Kenmore Rd	Drl	140	6	Basalt	20	Sept. 12, 1935	35	Dom	
Bl 49 [1]	R. E. Kohler	320 Woodland Ave.	Drl	66		Sand and gravel	28	Mar. 30, 1954		Dom	A.
Bl 92	Rundelane Homes	Juniper Rd	Drl	156	6	Basalt	14		30	PWS	
Bl 101 [2]	Hartford Electric Light Co.	Hoskins Rd	Drl	180	8	Sedimentary bedrock.	4	May 1, 1956	60	Com	Ap.
Bl 135	J. M. Ney Co	Maplewood Ave.	Drl	400	10	do	Flows	Mar. 17, 1956	200	Ind	

East Hartford											
EH 1	First National Stores, Inc.	Oakland Ave	Drl	35	8	Sand	4		90	Com	
EH 8	United Aircraft Corp.	400 Main St	Drl	28	16	do			96	Ind	Eleven other similar wells at this location.
EH 19	do	do	Drl	270	10–8	Sand and gravel			250	Ind	
EH 20	Boulevard Diner	473 Connecticut Blvd.	Drl	183	6	Sedimentary bedrock.			30	Acc	
EH 21 [3]	Burnside Ice Co	805 Tolland St	Dug	24	24	Sand	17	Sept. 27, 1958		Un	USGS observation well 1934–39, 1946–59.
EH 22	Burnside Co	87 Church St	Drl	447	6	Sedimentary bedrock.	Flows		265	Un	Water very hard (880 ppm).
EH 36	Burnside Theatre Co.	580 Burnside Ave	Drl	600	6	do	30	Apr. 7, 1949	140	Acc	
EH 37	First National Stores, Inc.	Oakland Ave	Drl	241	8	Sand and gravel	37	Apr. 28, 1948	500	Acc	A.
EH 42 [1]	Robert DiPietro	Forest St	Dug	26	36	Sand	8	Mar. 26, 1954	30	Irr	A.
EH 49	Silver Lane Pickle Co.	449 Silver Lane	Drl	22	12	do	5	Dec. 14, 1954	69	Com	
Glastonbury											
Gl 7	Pequot Spring Water Co.	Spring St. Extension.	Drl	540	6	Sedimentary bedrock.			30	Com	
Gl 46 [1]	Louis Scaglia	409 Matson Hill Rd.	Drl	210	6	Crystalline bedrock	15	1948	6	Dom	A.
Gl 109	Larson & Son	Nipsic Rd	Drl	110	6	Sedimentary bedrock.			50	PWS	
Gl 126	John Scaglia	do	Drl	42	8	Sand and gravel	10	Jan. 31, 1957	50	PWS	
Hartford											
H 2	State Theater	70 Village St	Drl	566	8	Sedimentary bedrock.			97	Acc	Two other wells at this location.
H 9	Cushman Chuck Co.	806 Windsor St	Drl	662	8	do			150	Ind	
H 11	Fuller Brush Co	3580 Main St	Drl	640	8	do			150	Un	A.
H 12	Sage-Allen & Co., Inc.	896 Main St	Drl	253	10	do			207	Un	

See footnotes at end of table.

TABLE 17.—*Records of wells selected as possible emergency water supplies and wells for which quality-of-water and water-level data are available*—Continued

[All wells are possible emergency sources unless indicated otherwise. Locations of wells are shown on pl. 2]

Well	Owner	Location	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-yielding formation	Static water level: Feet below land surface	Static water level: Date of measurement	Yield (gpm)	Use	Remarks
Hartford—Continued											
H 14	Bryant & Chapman Dairy.	255 Homestead Ave.	Drl	398	8	Sedimentary bedrock			40	Refrig	A.
H 15	Hartford Electric Light Co.	Ann St	Drl	620	12–10	do	13	Jan. 6, 1936	68	Acc	
H 22 [1]	Royal Typewriter Co.	150 New Park Ave.	Drl	502	8	do	27	Jan. 18, 1913	50	Un	A.
H 23	Bond Baking Co	1055 Broad St	Drl	308	8	do			50	Refrig	
H 24	Atlantic Screw Co	85 Charter Oak Ave.	Drl	240	6	do	12		35	Ind	
H 28	Rivoli Theater	1755 Park St	Drl	600	8	do			260	Acc	
H 29	Webster Theater	51 Webster St	Drl	500	8	do	12	June 2, 1937	106	Acc	
H 47	Billings & Spencer	1 Laurel St	Drl	733	6	do	19		110	Ind	
H 49	H. P. Hood & Sons	2120 Park St	Drl	366	6	do	9	Sept. 22, 1925	50	Refrig	
H 56	General Ice Cream Co.	51 Walnut St	Drl	445	8	do			60	Un	
H 57	E. E. Mucke & Sons, Inc.	2326 Main St	Drl	298	8	do	65	Oct. 26, 1937	40	Refrig	
H 73	Connecticut Milk Producers Association.	990 Wethersfield Ave.	Drl	600	8	do			55	Acc	
H 103	Kilian Steel Ball Corp.	100 Wellington St.	Drl	480	8	do	55	Sept. 1951	160	Ind	
H 104	Mount Sinai Hospital.	500 Blue Hills Ave.	Drl	240	10	do	9	Apr. 7, 1956	150	Acc	
New Britain											
NB 13	Stanley Works	Lake St	Drl	252	6	Basalt	Flows.	Nov. 15, 1938	125	Ind	Four other similar wells at this location.
NB 29	Rafael Department Store.	Main St	Drl	540	6	Sedimentary bedrock.			93	Acc	

NB 33	Fafnir Bearing Co	37 Booth St	Drl	500	8	do			50	Ind	
NB 34	Landers, Frary & Clark.	Center St	Drl	80	12	Sand and gravel	18	Sept. 7, 1955	100	Acc	One other well at this location.
NB 36	Moran Co	373 Main St	Drl	390		Sedimentary bedrock.			85	Acc	
NB 37	LeWitt	249 Main St	Drl	404	6	do			125	Acc	
NB 38	Moran Co	20 Lake St	Drl	320		do			125	Acc	
NB 39	Connecticut Oxygen Service Co.	Christian Lane	Drl	205	6	do	9	Mar. 12, 1957	40	Dom Com	
Newington											
N 74	Keeney Manufacturiug Co.	1170 Main St	Drl	330	8	Sedimentary bedrock.	74	July 14, 1955	144	Ind	Water high in mineral matter.
N 79	Moylan Dairy	Hartford Ave	Drl	200	8	do	32	July 19, 1955	200	Refrig	Ap.
N 87	Esso service station	Berlin Turnpike	Drl	160	6	do			30	Dom	
N 93	Hi View Motel	do	Drl	440	6	do	70	July 6, 1955	20	Dom	
Rocky Hill											
RH 44[3]	C. H. Yeager	1 Pratt St	Drl	150	6	Basalt	51	Nov. 1, 1954	10	Un	USGS observation well 1954–59.
RH 77	Hartford Rayon Co	Dividend Rd	Drl	94	16	Sand and gravel	29	1942	700	Ind	Ap.
RH 78	do	do	Col	82	192	do	1	1958	4,200	Ind	
RH 83	Gardner Nurseries, Inc.	Brook St	Drl	72	12	do	20	Jan. 27, 1958	800	Irr	
South Windsor											
SW 44	Warren Marks	Long Hill	Drl	212	6	Sand and gravel	70		20	Dom	
SW 58	G. Fox & Co	U.S. Route 5	Drl	800	6	do	40		100	Dom	
SW 59	John Schweir	Sullivan Ave	Drl	327	6	do			80	Dom Irr	
SW 60	Carbide & Carbon Chemical Corp.	U.S. Route 5	Drl	300	6	do	50		50	Com	
SW 61	H. G. Lorentz	Main St	Drl	193	6	do	20		40	Dom	
SW 34[3]	H. F. Church	do	Dug	13	4	Sand	11	Nov. 30, 1958		Un	USGS observation well 1934–39, 1948–59.
SW 65	J. E. Shepard Tobacco Co.	do	Drv	20	1½	do	11		20	Com	Gang of 8 similar wells spaced 50 ft apart. Ap.

See footnotes at end of table.

TABLE 17.—*Records of wells selected as possible emergency water supplies and wells for which quality-of-water and water-level data are available*—Continued

[All wells are possible emergency sources unless indicated otherwise. Locations of wells are shown on pl. 2]

Well	Owner	Location	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-yielding formation	Static water level: Feet below land surface	Static water level: Date of measurement	Yield (gpm)	Use	Remarks
South Windsor—Continued											
SW 66	Consolidated Cigar Co.	Main St	Drv	25	1½	Sand	15		25	Com	Gang of 8 similar wells spaced 50 ft apart.
SW 68 [1]	P. Bielski	Sullivan Ave	Dug	9	24	do	4	May 20, 1953		Dom	A.
SW 69 [1]	J. A. Dupont	Burnham St	Dug	30	24	do	5	May 20, 1953		Dom	A.
SW 71 [2]	Kupchunos Bros. Inc.	Graham Rd	Drl	56	12	Sand and gravel	21	Apr. 1950	450	Irr	A, Ap.
SW 72 [1]	P. Yonika	Strong Rd	Dug	30	72	Sand				Dom	A.
SW 73 [1]	H. L. Belknap	Barbour Hill Rd	Dug	30	30	Sand and gravel	6	Mar. 27, 1954		Dom	A.
SW 106	I. R. Stitch Associates.	Rye St	Drl	500	10–8	Sedimentary bedrock.	23	Mar. 15, 1957	350	PWS	Ap.
West Hartford											
WH 2	C. F. Morway	Fern Cliff	Drl	400	8	Basalt	14		50	Dom	
WH 82	F. B. Rentschler	Albany Ave	Drl	437	6	Sedimentary bedrock.	11	Sept. 26, 1930	100	Dom	
WH 89	G. E. Kohn	Ridgewood Rd	Drl	230	6	Basalt	17	Oct. 20, 1931	40	Un	
WH 90	A. C. Petersen Farms.	240 Park Rd	Drl	391	6	Sedimentary bedrock.	10	Aug. 21, 1924	20	Refrig	
WH 91	Camp Courant	Park St	Drl	394	6	do	Flows	May 14, 1954	54	Pool	Flows 5 gpm.
WH 92	West Hartford Diner.	980 Farmington Ave.	Drl	500	6	do			60	Acc	
WH 98	Rockledge Country Club.	289 South Main St.	Drl	500	6	Basalt	8	May 28, 1931	40	Acc	
WH 99	Elm Theatre	924 Quaker Lane	Drl	480	8	Sedimentary bedrock.	Flows		280	Acc	Flows 10 gpm.
WH 100	Abbott Ball Co	Railroad Ave	Drl	702	8	do	16	Aug. 1953	200	Ind	
WH 121	Pratt & Whitney Co., Inc.	Charter Oak Blvd.	Drl	455	8	do	20	Dec. 1946	300	Ind	Three other similar wells at this location.
WH 125	HoloKrome Screw Corp.	Brook St	Drl	500	8	do	4		160	Ind	
WH 126	Jacobs Manufacturing Co.	Jacobs Rd	Drl	400	8	do	8	Sept. 1947	130	Ind	

Wethersfield

Wf 87 [1]	Ballard Oil Co.	River Rd	Drl	404	8	Sedimentary bedrock.	5	1954		Un.	Ap.
Wf 89	Hartford Electric Light Co.	176 Cumberland Rd.	Drl	700	10-8	do			325	Acc.	Two other similar wells at this location.

Windsor

W 9 [1]	Mary Jorozko	Dudley Town Rd.	Dug	9	36	Sand	9	Sept. 24, 1948		Dom.	A.
W 122	Hartman Tobacco Co.	Blue Hills Ave.	Drl	50	10	do	8	Nov. 1949	400	Irr.	One other large-capacity well at this location.
W 127 [2]	Combustion Engineering Co.	Prospect Hill Rd.	Drl	81	8	Sand and gravel	3	Nov. 26, 1955	350	Ind.	Two other large-capacity wells at this location. Ap.

[1] Quality-of-water data only.
[2] Well beyond the Hartford-New Britain area and location is not shown on plate 2.
[3] Water-level data only.

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and gravel that make up the delta of the glacial Farmington River. The fluvial-sand deposits, together with the delta deposits, have the widest distribution of any of the aquifers and offer the best possibilities for the development of water supplies. The relatively high porosity of the surface sand and the flatness of the land surface in the area of outcrop makes possible the storage of large amounts of ground water. However, it is not likely that perennial yields much in excess of 100 gpm will be obtained from single wells in the fluvial sand, and most wells may be expected to yield less. There are at present (1959) no over-developed areas and in most of the area ground-water development could be increased many times without depletion of the supply. Development would be limited by the amount of recharge from precipitation, as there are no large streams crossing the sand deposits to provide water for induced infiltration. Similar conditions apply to the development of the potential supply in the delta deposits. Yields from single wells would be larger, however, owing to the more permeable nature of the deposit and the greater saturated thickness. Glaciofluvial sand-and-gravel deposits east of the Connecticut River and in the South Branch Park River basin are other promising sources of ground-water supplies. The occurrence of beds of highly permeable sand and gravel is uncertain, but where present these beds would furnish good yields. The sand-and-gravel deposits adjacent to the Connecticut River below Rocky Hill offer the best possibilities for development. Here, the large potential supply is in permeable deposits that are hydraulically connected to the river. The potential supply is limited only by the water-transmitting capacity of the sand and gravel, as the flow of the stream is very large. The chemical quality of the water developed by induced infiltration will be similar to that of the river water.

Moderate to small supplies also could be developed from buried sand and gravel in abandoned bedrock channels and from bedrock aquifers. Hydrologic data are inadequate to estimate the potential ground-water supply in buried sand and gravel. Where permeable deposits are present moderate yields may be developed, but the amount of development would depend upon the recharge from precipitation and the nature of the intake area. The quality of water from these deposits may be somewhat high in dissolved solids.

The bedrock aquifers are capable of further exploitation. Present withdrawals seem to be approaching the maximum perennial supply available in a few local centers of pumping, but moderate to small supplies are available in most other parts of the Hartford-New Britain area. Moderate yields will be obtained from sedimentary bedrock, but yields from crystalline bedrock and basalt will be considerably less.

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