DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

WATER-SUPPLY PAPER 374

GROUND WATER

IN THE

HARTFORD, STAMFORD, SALISBURY, WILLIMANTIC AND SAYBROOK AREAS, CONNECTICUT

BY

HERBERT E. GREGORY AND ARTHUR J. ELLIS

Prepared in cooperation with the
Connecticut State Geological and Natural History Survey

WASHINGTON
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By Herbert E. Gregory and Arthur J. Ellis.

INTRODUCTION.

THE PROBLEM.

The census of 1910 reported the population of Connecticut as 1,114,756. The area of the State is 5,004 square miles. The average density of population is therefore about 220 per square mile, but the distribution of population is markedly uneven. More than 53 per cent of the inhabitants are gathered into 19 cities, each containing over 10,000 souls. The cities are rapidly increasing in population, but parts of the State—about 24 per cent of the towns—are more sparsely settled to-day than in 1860. Broadly speaking, the people of Connecticut are engaged in two occupations—manufacturing and mixed agriculture. Manufacturing is increasing at a rapid rate; agriculture at a slower rate, but with a distinct tendency toward specialization. There is in addition a tendency to utilize the scenery of the State—a tendency resulting in the development of country estates and shore homes.

With an annual rainfall of 45 inches, Connecticut has in the aggregate large supplies of both surface and ground water, but the rainfall is sometimes deficient through periods of several weeks or months. Consequently farmers must endure periods of drought, manufacturers must provide against fluctuating water power, and the inhabitants of congested districts must arrange for adequate municipal supplies. With increase in population and diversification of interests conflicts between water-power users and domestic consumers, as well as between towns, for the right to make use of a particular stream or area have already arisen. Demands are also being made by prospective users of the waters for irrigation and drainage. The question of quality of water also takes on new meaning with the effort to improve the healthfulness of the State and to reclaim the waters now polluted by factory waste and sewage. The necessity for obtaining small but unfailing supplies of potable water for the farm and for the village home furnishes an additional problem, for the condition of many private supplies in Connecticut is deplorable.

To meet the present situation and to provide for the future, State-wide regulations should be adopted. Obviously the first step in the solution of the Connecticut water problem is to make a comprehensive study of both surface and ground waters to obtain answers to the following questions: How much water is stored in the gravels and sands and bedrock of the State? How much does the amount fluctuate with the seasons? What is the quality of the water? How may it best be recovered in large amounts? In small amounts? What is the expense of procuring it? How much water may the streams of the State be relied upon to furnish? How much is the stream water polluted? How may the pollution be remedied? To what use should each stream be devoted? What is the equitable distribution of ground and surface waters among the conflicting claimants—industries and communities?

HISTORY OF THE INVESTIGATION.

The study of the water resources of Connecticut was begun in 1903 by the senior author of the present paper, under the auspices of the United States Geological Survey. A preliminary report was issued in 1904.[1] A discussion of the fundamental problems relating to the State as a whole, published in 1909,[2] meets in a broad way the requirements of the scientist and the engineer, but it is not designed to furnish a solution for local problems and is not sufficiently detailed to furnish data for use in a quantitative study of ultimate supply and its utilization. It was recognized that conditions in the State are so varied that each section of the State has its individual problem, and that in order to obtain data of direct practical value the conditions surrounding each town, and, where feasible, each farm and each village, should be investigated.

Realizing the importance of such studies to Connecticut, the State joined forces with the Federal Government in order to carry on this work. In 1911 a cooperative agreement was entered into by the United States Geological Survey and the Connecticut Geological and Natural History Survey for the purpose of obtaining information concerning the quantity and quality of waters available for municipal and private uses. The investigation was to be conducted through a period of two or more years, the cost to be shared equally by the parties to the agreement. Herbert E. Gregory, geologist, of the United States Geological Survey, was placed in charge of the investigation and Arthur J. Ellis, a junior geologist of the Federal Survey, was assigned to field work on ground waters. The present report

[1] Gregory, H. E. [notes on the wells, springs, and general water resources of], Connecticut: U. S. Geol. Survey Water-Supply Paper 102, pp. 127-168, 1904.

[2] Gregory, H. E., and Ellis, E. E., Underground water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, 1909.

is the first of a series of papers which are so planned as to cover eventually all the towns of the State. As the funds available were meager it appeared wise to devote most of the time to a study of ground waters, leaving studies of stream flow to be taken up later. Certain stream measurements obtained by the United States Geological Survey and by corporations and individuals are available for use when the surface water problem is seriously attacked.

The field work on which the present report is based was done by the junior author during the seasons of 1911 and 1912. The work consisted in gathering information concerning municipal water supplies; measuring the dug wells used in rural districts and obtaining other data in regard to them; obtaining data concerning drilled wells, driven wells, and springs; collecting and analyzing samples of water from wells, springs, and brooks; studying the character and relations of bedrock and of surficial deposits with reference to their influence upon the ground-water supply. An effort was made to obtain records of all drilled wells in the areas under consideration, and as many dug wells were examined as was deemed necessary to determine the position of the water table throughout the areas.

The junior author is responsible also for the maps and for the larger part of the manuscript. The senior author's contribution includes formulation of plans, field and office conferences, and outlining and in part preparing the manuscript for publication.

ACKNOWLEDGMENTS.

The data relating to drilled wells were collected through the hearty cooperation of the well drillers in Connecticut. Other information that was of value in the preparation of this report was obtained from clerks of towns and from engineers of cities and of water companies, and services were rendered by Messrs. E. M. Hobby, Henry C. Cowles, Hadley G. Gray, G. L. Ladd, and Frank Palm in the collection of data in regard to changes of the water level in wells. The assistance thus received is acknowledged with thanks.

Free use has been made of the technical literature dealing with water supplies and credit is given for specific facts taken from these sources, but the report contains also material gathered from the reports of previous investigations, some of which can not be rightly attributed to any one author.

AREAS SELECTED FOR STUDY.

The areas with which this report is concerned represent the typical geologic conditions of Connecticut. (See fig. 1.) The Hartford area includes the towns of Hartford, West Hartford, Newington, Wethersfield, East Hartford, Manchester, Windsor, East Windsor,

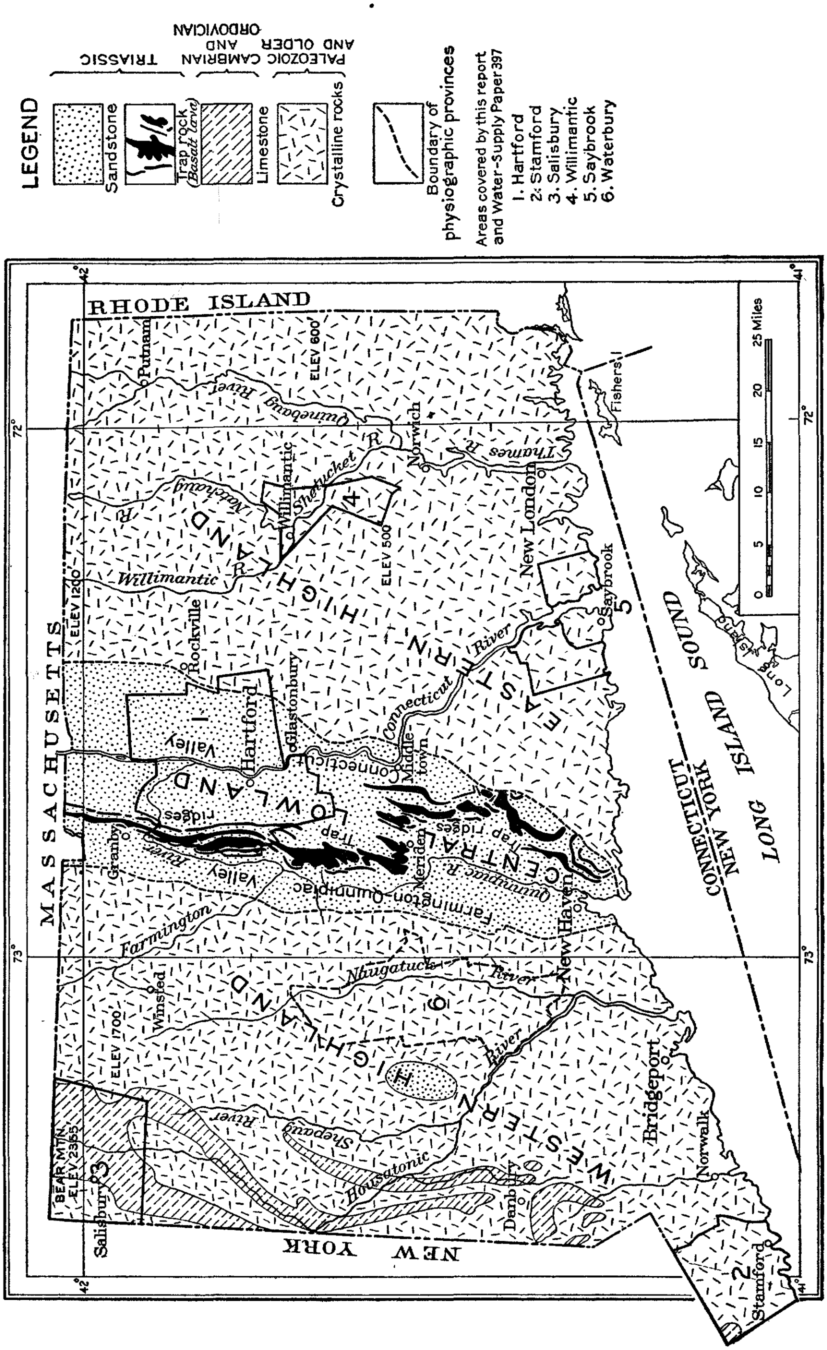


FIGURE 1.—Map of Connecticut showing physiographic provinces, geologic formations, and areas covered by this report.

South Windsor, and Bloomfield. It lies in the Connecticut River valley and is underlain by Triassic sediments and lavas.

The Stamford area includes the towns of Stamford and Greenwich. It lies in the southwest corner of the State and is underlain by crystalline rocks.

The Salisbury area is in the northwest corner of the State and includes the towns of Salisbury, Canaan, and North Canaan. The lowlands in this area are underlain by limestone.

The towns of Windham and Franklin are designated in this report as the Willimantic area. They are situated in the eastern highlands and are underlain by metamorphic rocks of various types, on which a highly varied topography has been developed.

Saybrook, Essex, Westbrook, and Old Lyme, which comprise the Saybrook area, are at the mouth of Connecticut River, where the land is low and comparatively flat and where the presence of salt water is a feature of ground-water problems.

RELIABILITY OF DATA.

The principal well data are given in tables appended to the detailed reports on the several towns. The depth and diameter of the dug wells and the amount of water in them were determined by measurement. The information presented as to depth to rock and the consumption of water is in general based on data supplied by local residents. The elevations of the wells and springs were determined by means of a hand level, the base used for each determination being the assumed height of some point through which a mapped contour line would pass. The error may be as much as 10 or 15 feet in the most hilly sections but is doubtless usually less than 5 feet. The limitations of the accuracy of the mapping of underground surfaces must also be taken into account. The estimated yields of drilled wells are based on tests made by the drillers when the wells were completed; for some of the dug wells the yield was computed from observation of the length of time taken to pump the well dry, the known rate of pumping, and the dimensions of the well; for others the yield was estimated from the lowering of the water in a given length of time by pumping at a known rate. For wells from which nearly all the water available was being consumed the yield was computed from the amount used each day. Information concerning the yield of a few improved springs was obtained by actual measurements of the overflow; the yield of others was computed from measurements of the velocity and cross section of the streams issuing from them; for still others the figures given represent the yield as estimated by the owners.

The quantity of ground water available at any particular time depends on the character of the weather previous to that time. For the year 1911 the precipitation in Connecticut was somewhat less than the average; from January 1 until August 23 it was about 6 inches below normal. The fall of 1910 was dry, and many dug wells failed during the following winter. The drought was broken during the last part of the winter, and when the field work was begun in June the supply of water in dug wells was sufficient for domestic uses although not abundant. Practically no rain fell from the beginning of the summer until August 24, and by that time the water in dug wells was generally low and many wells had again failed. From August 24 to September 1, inclusive, it rained practically without ceasing. No wells were measured after it began to rain until September 5, so that four days were allowed for the wells to recover from flooding. However, the measurements made after September 5 showed a large average increase in the depth of water. From that time until the end of the year there were occasional rains and all wells yielded water.

During 1912 the rainfall was about normal up to the early part of July, so that in May, when field work was begun, wells were generally in satisfactory condition, and although the precipitation during the last part of the year was somewhat below normal, the number of wells that failed was considerably less than in 1911.

OCCURRENCE OF GROUND WATER.

ORIGIN.

The ground water of Connecticut is derived from the precipitation within the State and near its borders. Owing to the ruggedness of the surface of the bedrock and the thinness of the overlying drift, which together prevent extensive underground circulation, the ground water at any particular place comes from near-by sources.

The precipitation is evenly distributed over the State and is nearly uniform throughout the year, as shown in the following tables:

Average precipitation at 10 stations in Connecticut, 1893–1903.[a]

Month.	Inches.	Month.	Inches.
January	4.28	November	4.48
February	3.94	December	3.44
March	4.23		
April	3.53		46.98
May	4.03		
June	2.95	Average for season:	
July	4.42	Winter	11.66
August	4.30	Spring	11.79
September	3.34	Summer	11.67
October	4.40	Fall	11.82

[a] Gregory, H. E., and Ellis, E. E., Underground water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, p. 24, 1909.

Geographic distribution of precipitation.[a]

Locality.	Average annual precipitation.	Years included.
	Inches.	
New Haven	45.89	[b] 1804–1908
Middletown	49.25	[c] 1859–1901
Hartford	44.30	[d] 1847–1908
Storrs	47.16	1897–1906
North Grosvenordale	45.00	[e] 1891–1908
Cream Hill	48.06	1897–1908

[a] Summaries of climatological data by sections: U. S. Weather Bureau Bull. W, vol. 2, sec. 105, p. 10, 1912.
[b] Except 1805, 1822 to 1826, 1828 to 1864, 1868 to 1872. Continuous record for 36 years, 1873 to 1908, inclusive, gives mean annual rainfall of 46.97 inches.
[c] Except 1860, 1863, 1883, 1884, 1892, 1898, 1899.
[d] Except 1853 to 1866, inclusive.
[e] Except 1898 and 1899.

The following table shows the monthly precipitation in Connecticut during 1911 and 1912 compared with the average monthly precipitation in the State:

Average monthly precipitation (in inches) in Connecticut, 1893–1903, 1911, and 1912.

Month.	Average of 10 stations, 1893–1903.	Average of 20 stations, 1911.	Average of 20 stations, 1912.
January	4.28	3.09	2.41
February	3.94	2.70	2.67
March	4.23	3.76	7.48
April	3.53	4.73	4.30
May	4.03	1.36	4.95
June	2.95	2.36	0.75
July	4.42	3.01	2.94
August	4.30	5.87	3.86
September	3.34	2.94	2.69
October	4.40	6.34	2.33
November	4.48	5.09	3.85
December	3.44	3.28	5.19
	47.34	44.53	43.42
January	4.28	3.09	2.41
January and February	8.22	5.79	5.08
January to March, inclusive	12.45	9.55	12.56
January to April, inclusive	15.98	14.28	16.86
January to May, inclusive	20.01	15.64	21.81
January to June, inclusive	22.96	18.00	22.56
January to July, inclusive	27.38	21.01	25.50
January to August, inclusive	31.68	26.88	29.36
January to September, inclusive	35.02	29.82	32.05
January to October, inclusive	39.42	36.16	34.38
January to November, inclusive	43.90	41.25	38.23
January to December, inclusive	47.34	44.53	43.42

WATER IN THE GLACIAL DRIFT.

CIRCULATION.

The chief water-bearing formations of Connecticut are the unconsolidated materials that cover the bedrock. These materials were derived from the great ice sheets which in the Pleistocene epoch extended over the State. They are of two general types: The unstratified drift, also called "till" (Pl. I, *A*), consists of heterogeneous mixtures of all the rock débris deposited directly by the ice;

the stratified drift consists of glacial materials that were rehandled by water and is therefore assorted into layers of different degrees of coarseness (Pl. II, *A*).

The unconsolidated surface materials absorb rain water at a rate and to an extent depending chiefly on their porosity. The most porous beds are composed of gravel and sand, the least porous of compact clays. The unstratified drift, which covers most of the State, is a mixture of bowlders, gravel, sand, and clay and has a porosity depending upon the relative amounts of these materials. Much of the unstratified drift of Connecticut is of the "stony" or "bowldery" type, containing little or no clay and possessing a degree of porosity equal to that attained by coarse varieties of stratified drift. The less porous types of unstratified drift may be represented by the following average of the analyses of 16 samples collected from 12 drumlins in the Boston Basin.[1] These analyses were made after removing all stones 2 inches or more in diameter, or about 10 per cent of the original material.

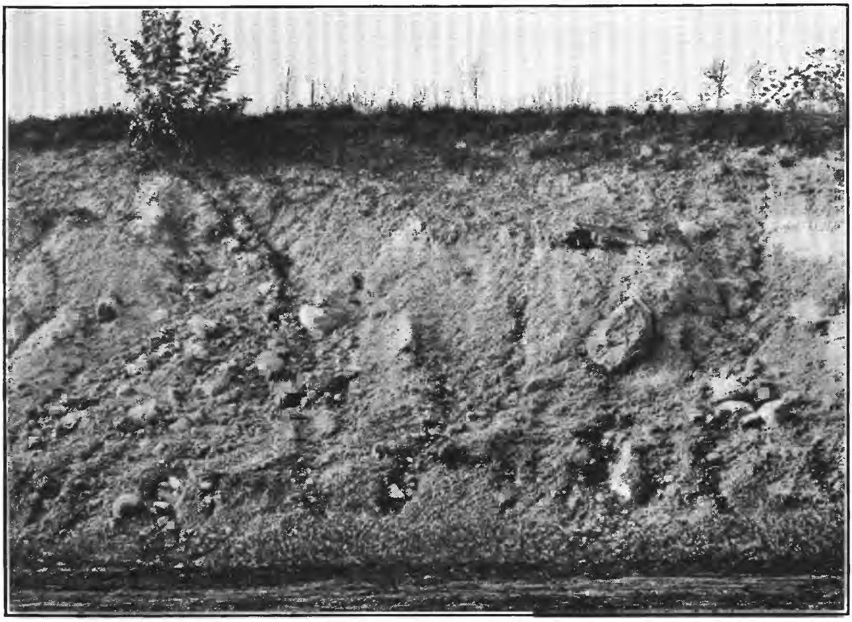
Composition of unstratified drift in Boston Basin.

	Per cent.
Gravel	24.90
Sand	19.51
Rock flour	43.66
Clay (three-fourths rock flour)	11.67
	99.94

Other factors influencing the amount of water absorbed are the growth of vegetation, the topography, the occurrence and duration of frost in the ground, and the atmospheric conditions that determine evaporation and rates of precipitation.

The water absorbed by the soil descends and saturates the lower part of the glacial drift, which serves as a reservoir for the storage of this water. The efficiency of the drift in this respect depends largely on the rate of underground drainage, the three principal factors of which are porosity, the arrangement of layers having different porosities, and the topography of the bedrock on which the water-bearing bed rests. The most porous beds, as, for example, the dune sands of the Connecticut River valley (Pl. I, *B*), absorb water most rapidly, but they also allow the water to circulate most freely and are therefore most rapidly drained. Impervious materials, such as clays (Pl. II, *B*), occurring among porous deposits bear a relation to underground drainage similar to that between dams or other obstructions and surface drainage—they divert or impound the percolating waters and in many places produce springs and swamps. Except where the drift is thick, the topography of the bedrock below the

[1] Crosby, W. O., Composition of till or bowlder clay: Boston Soc. Nat. Hist. Proc., vol. 25, p. 124, 1890.



A. SECTION OF TILL, WINDHAM, CONN.

B. SECTION OF SAND DUNE, SOUTH WINDSOR, CONN.

A. STRATIFIED DRIFT (GRAVEL), STAMFORD, CONN.

B. STRATIFIED DRIFT (CLAY), HARTFORD, CONN.

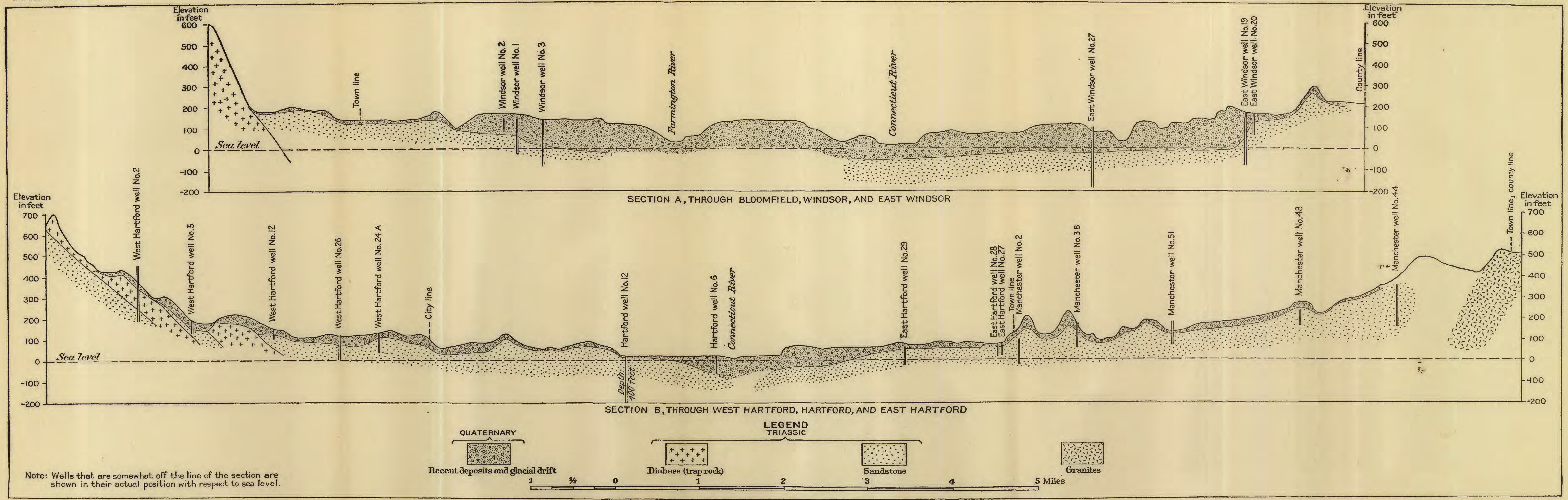
water-bearing beds is related to underground drainage as the topography of the land is related to surface drainage. Over most of Connecticut the drift is thin and the topography of the bedrock surface closely conforms to the present topography of the land surface, except that it is more rugged and has greater relief. The bedrock crops out on many of the hilltops and steep slopes but lies far below the surface in the valleys (Pl. III). Because of the similarity between the forms of the rock surface and the surface of the ground, the direction of underground drainage corresponds very closely to the direction of surface drainage. The ground water, like the surface water, flows most rapidly on steep slopes, but because of the resistance offered by the soil particles it moves much more slowly than the surface water and is generally replenished by rainfall before the supply contributed by previous rain has been drained away. Most of the ground water finds its way to the surface through springs and seepage areas, by capillary rise and evaporation, and by transpiration of trees and other plants; the amount drawn from wells is comparatively small.

THE WATER TABLE.

The water table is the plane below which the ground is saturated with water. Its surface conforms somewhat to that of the land but is less rugged. It is generally nearest the land surface in the valleys; on the hilltops it may lie at depths of 30 to 40 feet. The surfaces of streams, ponds, and lakes are generally continuous with the water table and may be regarded as forming parts of it. In bogs, marshes, and other places where the ground is saturated to the surface, the water table and the surface of the ground coincide. Where the water table is not exposed, its position is indicated by the surface of the water in wells. The position of the water table depends also on the character of the drift. Except in very low places it is, in general, nearer the surface in areas where the drift consists of clay or compact till and farther below the surface in areas where the drift is gravel and sand, because clay and till are less porous than gravel and sand and do not drain so rapidly.

The accompanying maps, Plates IX to XIII (in pocket), represent the average position of the water table. Where dense rocks appear at or very near the surface there is no water table; the rock masses rise above the ground water like islands in a lake, and the position of the water table immediately surrounding them is indeterminate. Figure 2 illustrates the relative position of the water table in various kinds of drift and under different topographic conditions.

The water table is constantly changing its position with respect to the surface of the ground, rising rapidly after a heavy rain, then



SECTIONS THROUGH CONNECTICUT RIVER VALLEY NEAR HARTFORD, SHOWING RELATION OF ROCK SURFACE TO LAND SURFACE.

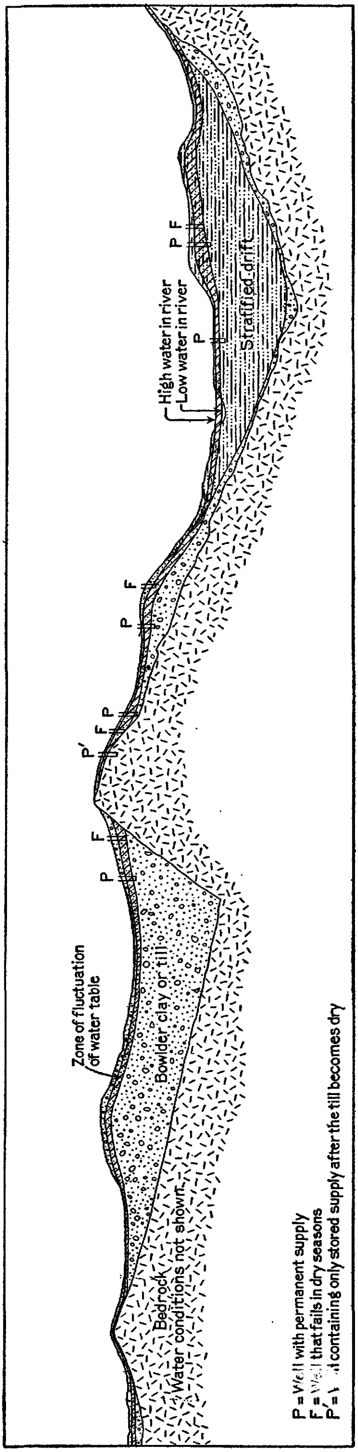


FIGURE 2.—Diagrammatic section illustrating position and fluctuation of the water table under various conditions.

gradually descending as the water is drained away. These changes may be observed by making successive measurements of the depth to water in wells. The zone through which the water table fluctuates is called in this report the zone of fluctuation.

In elevated positions, where the drift is thin, the water table may descend during a period of drought until it touches the rock surface and the water is all drained away; but in the vicinity of perennial streams or permanent bodies of water the change may not exceed a few inches during the year. The zone of fluctuation is therefore narrowest in the valleys and widest on the hills, where it may include the entire distance from the highest water level to the bedrock surface. Figure 3 shows the fluctuation of the water table as determined from measurements of wells in four towns in Connecticut. Other data concerning these wells appear in the tables on pages 71, 108, 132, 141.

QUANTITY OF WATER.

A rough conception of the annual supply of ground water may be obtained by analyzing the relations between rainfall and stream flow. Measurements of the rainfall give the total amount of water which falls on a drainage basin, but only a part of this is contributed to the underground supply, the rest being in part returned to the atmosphere and in part discharged by surface streams. The total run-off from a drainage basin, as determined by stream measurements, includes both the surface drainage—that is, the

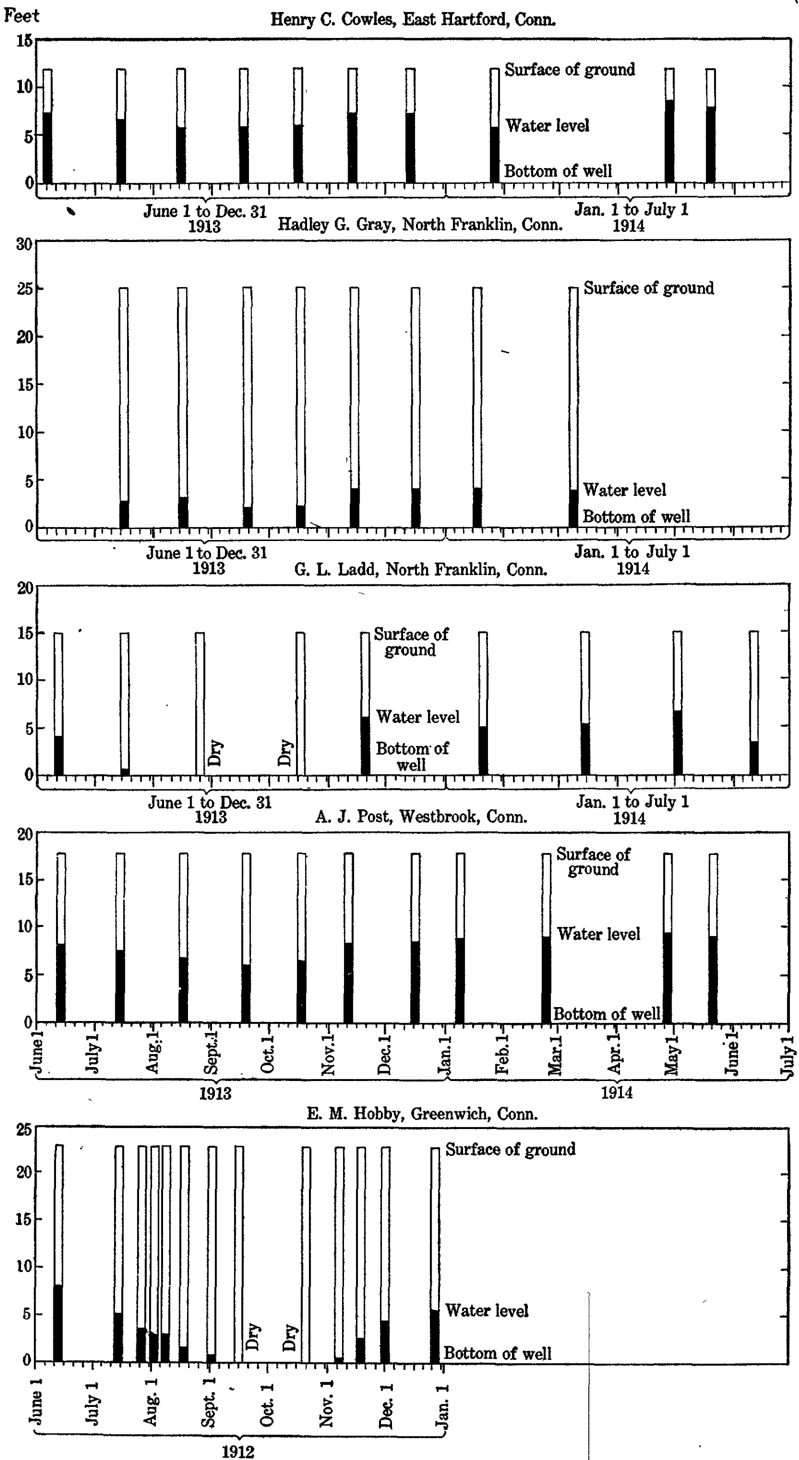


FIGURE 3.—Diagrams showing fluctuation of the water table in wells.

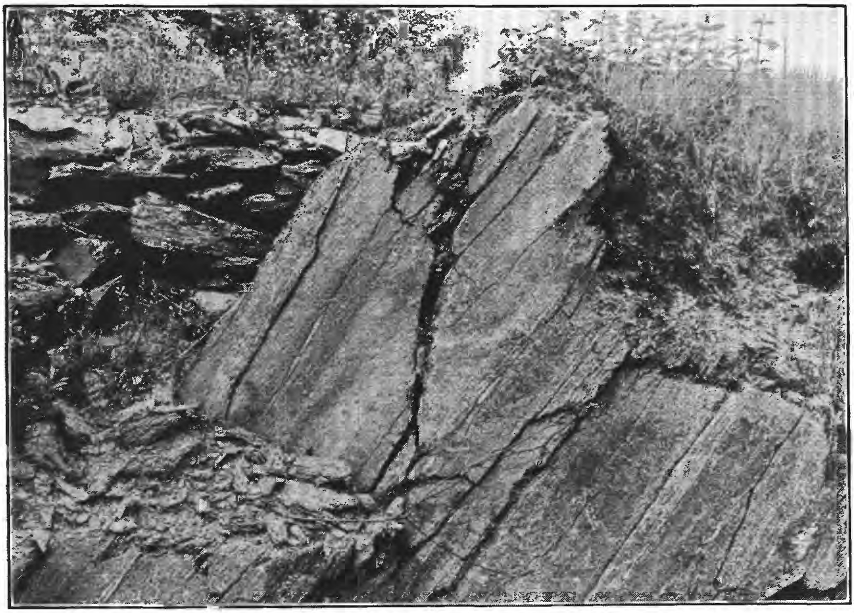
water which has never formed part of the underground supply—and the underground drainage—the water that has passed into the surface streams from the water bed. The water which is returned to the atmosphere by evaporation and transpiration is in part surface water and in part ground water. A rough index of its quantity is obtained by subtracting the total annual run-off from the total annual precipitation. The annual rainfall in Housatonic River basin above Gaylordsville, Conn. (area, 1,020 square miles), is 47.86 inches and the annual run-off is 29.43 inches. The loss—18.43 inches—is attributed to evaporation, plant growth, and other causes. Similarly, in the basin of Connecticut River above Orford (area, 3,300 square miles) the annual precipitation is 36.76 inches and the annual run-off is 21.66 inches, the loss being 15.10 inches. These and other data compiled by J. C. Hoyt[1] indicate that in the northeastern United States between 30 and 40 per cent of the rainfall is returned to the atmosphere. It is not possible to determine from the data at hand what part of this water is derived from the underground supply. All perennial streams lie below the water table and are maintained during dry seasons by infiltration from the saturated part of the drift. During a rainy season and for some time thereafter the streams carry more or less water that has not been drawn from the ground water. During the succeeding dry season this surface water is discharged, and the streams finally reach a stage at which the run-off is derived almost entirely from the ground water. At low stages the discharge of ground water is not much less than the amount carried by the streams and it increases immediately after rains, owing to the contribution from intermittent springs and seepage areas and to a general acceleration of underground circulation by hydrostatic pressure. In addition to the ground water discharged by streams large quantities of water are stored in drift-filled rock basins below the valley floors, as, for example, in the valley of Connecticut River near Hartford, where saturated deposits consisting largely of sand extend nearly 100 feet below the river bed. The quantity of water in such basins depends on the size of the basins and the porosity of the valley fill; but if the water is withdrawn the basins must be replenished by water usually carried in the streams; therefore, strictly speaking, these supplies are not available in addition to the amounts carried by the streams.

WATER IN CRYSTALLINE ROCKS AND TRAPS.

CIRCULATION.

More than two-thirds of the area of Connecticut is underlain by crystalline rocks whose ages have not been precisely determined, and in the remaining third of the State various Triassic lava sheets,

[1] Hoyt, J. C., Comparison between rainfall and run-off in northeastern United States: Am. Soc. Civil Eng. Trans., vol. 59, p. 470, 1907.



A. CRYSTALLINE ROCK SHOWING FISSURES, STAMFORD, CONN.

B. TRAP ROCK SHOWING FISSURES, HARTFORD, CONN.

A. SANDSTONE SHOWING FISSURES, HARTFORD, CONN.

B. LIMESTONE SHOWING SOLUTION CHANNELS AT THE SURFACE ALONG JOINT CRACKS, SALISBURY, CONN.

popularly called "trap rocks," are interbedded with sedimentary formations. As a result of the work of dynamic agencies the crystalline and sedimentary rocks are intensely fractured, cracks being visible wherever the rocks are exposed (Pls. IV, *A* and *B*, and V, *A*). All the crystalline rocks and traps have a very low porosity—less than 1 per cent—and for this reason the circulation of water in them is confined practically to the cracks. Water enters the openings from the overlying drift and passes in the direction of least resistance, down some sloping planes and up others, through vertical cracks, and horizontally through level ones, until it becomes imprisoned in cracks with no outlets or until it reappears at the surface as springs or seepage.

In general, the thickness of the zone of active circulation is nearly equal to the relief of the land surface; that is, openings below the level of the valleys are generally filled with water that is not in motion until wells reach these depths and start circulation by drawing water to the surface. In places, however, these deeper-lying waters are forced by hydrostatic pressure along fault planes or major joints and reach the surface as artesian springs or as artesian wells (figs. 4, 5, and 6).

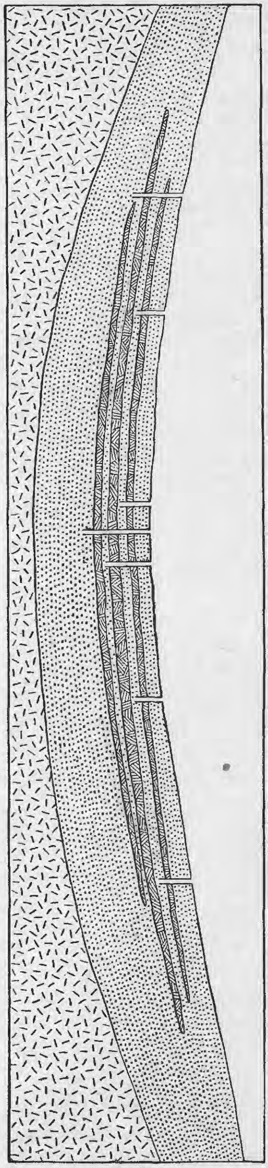


FIGURE 4.—Section of the Connecticut Triassic area as a synclinal basin, showing conditions favorable for artesian wells.

QUANTITY OF WATER.

The quantity of water in crystalline rocks and traps depends chiefly on the number and size of the cracks. Most of the openings are too narrow, even at the surface, to allow much water to pass, but they are generally connected, either directly or indirectly, with larger fissures into which they drain, and it is the ramifying systems of minor cracks which to large degree regulate the supplies derived from rock borings. The openings in these rocks do not extend to great depths, and their size rapidly diminishes from the surface downward. Nearly all the cracks pinch out entirely within a few hundred feet of the surface, and water-bearing fissures at greater depths are rare. As compared with the more porous drift, the crystalline rocks and traps contain little water, the average yield of wells in the crystalline rocks of Connecticut being about 15 gallons a minute. Figure 8 (p. 25) shows the percentage of the wells examined which yield various specified quantities.

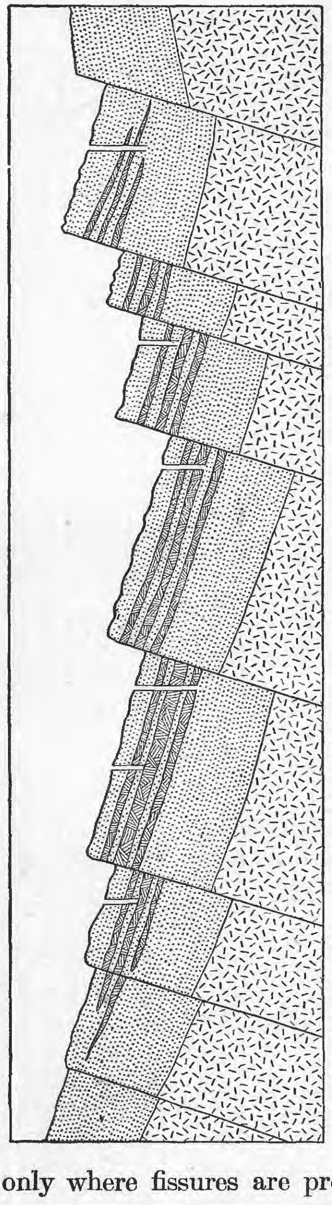


FIGURE 5.—Section of the Connecticut Triassic area as a simple faulted monocline, showing conditions favorable for several small artesian basins.

WATER IN LIMESTONES AND TRIASSIC SEDIMENTS.

CIRCULATION.

The most abundant sedimentary rocks of Connecticut are Triassic sandstones and shales, which occur in the valleys of Connecticut and Pomperaug rivers, and Cambrian and Ordovician limestone (Stockbridge), which occurs in discontinuous patches along the west border of the State from the northwest corner of Greenwich to the Massachusetts boundary. All these sedimentary rocks have been metamorphosed to greater or less degree, and their present texture and structure are such that the circulation of water in them is essentially like that in crystalline rocks.

The average porosity of this sandstone is 20 per cent or more, and its absorptive capacity is about 2 quarts of water per cubic foot, which equals 7 per cent,[1] but most of the water in its pores is not directly available because of the high resistance of the sandstone to circulation. The sandstone is of economic importance as a source of ground water only where fissures are present in which the water may be stored.

[1] Gregory, H. E., and Ellis, E. E., Underground water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, p. 105, 1909.

Fissures are, however, very numerous in the sandstones, and consequently these rocks are an important source of ground water supplies (Pl. V, *A*). The fissures are joints and fault cracks produced by crustal movements and in some places widened by weathering and erosion. The widest fissures are several inches across; the narrowest are mere incipient cracks. They extend from the surface to depths of 300 or 400 feet, and they generally grow narrower from the surface downward. The water in the sandstone, being derived chiefly from the drift at the surface, circulates through the fissures and reappears at the surface at lower elevations as springs issuing from the rock.

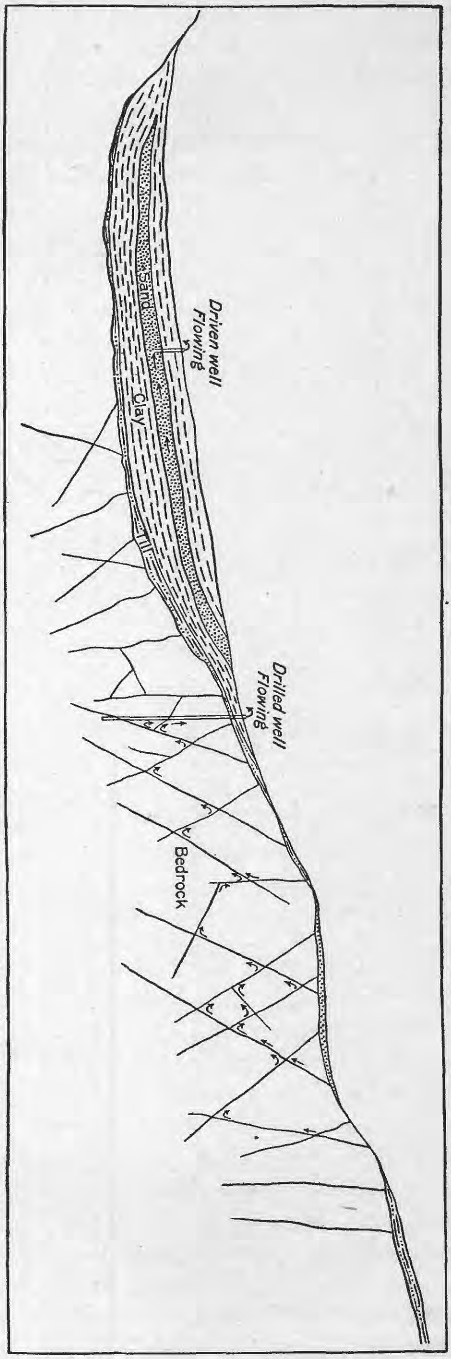


FIGURE 6.—Section of till-covered rock slope and stratum of sand interbedded with clay, showing conditions favorable for artesian flows.

Shale does not occur in Connecticut as uninterrupted beds of wide extent, but in many localities it forms lenses in the sandstone. In general the shale is less porous than the sandstone, and in many places it is entirely impervious. It is important in intercepting and directing the circulation of water in the sandstone, and wells sunk through sandstone usually find water immediately above shale beds. Some of the sandy varieties of shale are, however, more porous than the sandstone, and all the shale is traversed by fissures through which water circulates as in the sandstone.

QUANTITY OF WATER.

The quantity of water contained in the pores of the sandstones and sandy shales is great, but owing to the minuteness of the pores the quantity recoverable by wells is small. This is illustrated by the well at the Hartford Sanatorium, which was drilled because, owing to the altitude of the institution, city water was not available except by pumping. It was sunk to a depth of 974 feet in an effort to obtain a yield of 50 gallons a minute, the minimum amount required. The following table shows the increase in yield as the well was sunk. (See fig. 7.)

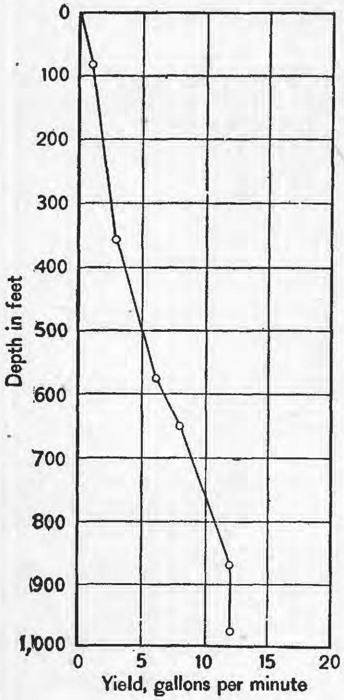


FIGURE 7.—Diagram illustrating increase of yield with depth in well at Hartford Sanatorium.

Yield of Hartford Sanatorium well at several specified depths.

Depth.	Yield.
Feet.	*Gallons per minute.*
85	1
360	3
575	6
650	8
872	12
974	12

Log of Hartford Sanatorium well.

	Feet.
Till	10
Trap	565
Red sandstone	230
Trap	169
	974

In places drills have penetrated to depths of 200 feet or more without encountering water-bearing fissures, and in many of these wells the seepage from the sandstone was so slight that it was necessary to add water from the surface to keep the drill holes wet. No successful wells have been reported in which the water did not come from fissures in the rocks; a considerable number of unsuccessful wells have been sunk in the sandstones which did not encounter water-bearing cracks, and the conclusion is that the porosity of the sandstone, though sufficient for the storage of large quantities of water, is not great enough to afford satisfactory yields by direct seepage into wells. Owing to the ramifying system of joints, however, most of the wells drilled into the sandstone obtain sufficient water for domestic needs. Figure 8 shows the percentage of the wells examined yielding various specified amounts.

The limestone differs from the sandstone in its relation to percolating water only in being much less porous and in being locally traversed by joints and solution channels formed by water (Pl. V, *B*). Water enters these passages, joints, or cracks from the saturated overlying material, circulates through them, and eventually issues as springs or seeps back into drift at lower levels. The limestone is so compact that it contains only small quantities of water, and the solution channels by which it is traversed in some places serve as drains through the rock itself and afford a rapid escape for water along their courses; consequently above the valley levels the limestone may become dry very early in a period of drought.

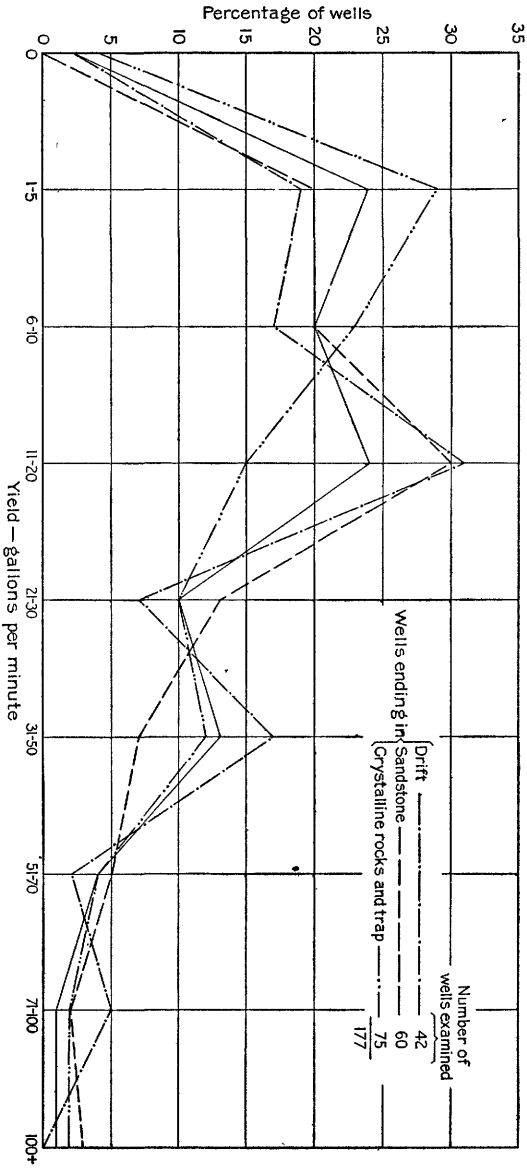


FIGURE 8.—Curves illustrating yields of drilled wells. The solid line shows the percentage yield of the total number of wells examined.

GROUND WATER FOR MUNICIPAL USE.

PROBLEMS INVOLVED.

The problems to be considered in planning the use of ground water for a new or enlarged public water system relate to the quantity of water available, the quality of the water, the methods of obtaining it, and the cost of establishing and maintaining the works. These problems are largely interdependent, and their relative importance depends on the proposed uses of the water and the conditions under which it is to be supplied.

QUANTITY REQUIRED.

In a town having an established water system the per capita consumption is known and the quantity of water required for extending the system can be estimated with a fair degree of accuracy. In a small town or community in which a public supply is designed to replace private wells an estimate of the amount of water required should be based on a comparative study of the consumption in towns of similar characteristics. Plans for cities or for smaller communities involve consideration of future needs based on the probable rate of increase in population and the circumstances affecting it, and also on the estimated rate and amount of development of industrial enterprises. In a State such as Connecticut, where the significance of past conditions and present trends of population and industries are fairly well understood, an average town of less than 10,000 inhabitants may plan for a 20-year service on the basis of the present population. Estimates of the future needs for larger cities are much less likely to be reliable, and so far as practicable future requirements should be provided by maintaining a system capable of extension at reasonable cost as the need arises. The data available for the larger cities of Connecticut are sufficient to serve as a guide in planning 10 years in advance of present needs on the basis of an estimated consumption of 100 gallons per capita per day.

The factors that determine the quantity of water required are as follows:

1. Number of inhabitants.
2. Nature of the local industries.
3. Wealth and habits of the people.
4. Extent to which water is used in fountains and in lawn and street sprinkling.
5. Climate, as affecting the use and waste of water to prevent freezing.
6. Leakage.
7. Basis of revenue (meter or flat rate).
8. Quality, quantity, and pressure, as tending to encourage or discourage liberal use and great wastefulness.
9. The popularity of a new or improved supply.

The consumption of water is usually stated in gallons per capita per day, but it is not sufficient to take into account only this average daily rate of consumption, for the demand varies during the year and during the day and the supply must be adequate for temporary heavy drafts. The following table shows the average daily consumption in Hartford, Conn., for each month during 1912 and during the period from 1903 to 1912, inclusive:

Average daily consumption of water during each month in Hartford, Conn.[a]

Month.	1912	Average for 10 years, 1903-1912.	Month.	1912	Average for 10 years, 1903-1912.
	Gallons.	*Gallons.*		*Gallons.*	*Gallons.*
January	8,317,000	6,717,000	July	9,245,000	7,642,000
February	8,730,000	6,959,000	August	8,694,000	7,315,000
March	8,625,000	6,896,000	September	8,675,000	7,411,000
April	8,445,000	7,044,000	October	8,674,000	7,191,000
May	8,800,000	7,380,000	November	8,283,000	6,978,000
June	9,128,000	7,648,000	December	8,142,000	6,775,000

[a] Board of Water Commissioners, Hartford, Conn., Fifty-ninth Ann. Rept. (year ending Mar. 1, 1913), p. 190.

The following table illustrates the variation in the rate of consumption during the day:

Consumption of Mystic water supply in Boston in August, 1893, in gallons per capita per day.[1]

1 to 4 a. m.	40.8	4 to 7 p. m.	79.5
4 to 7 a. m.	58.6	7 to 10 p. m.	61.9
7 to 10 a. m.	103.8	10 p. m. to 1 a. m.	52.9
10 a. m. to 1 p. m.	93.0		
1 to 4 p. m.	98.2	Average	73.6

"The large consumption from 1 to 4 a. m. must have been mostly waste."

To meet these daily peak loads and to insure against emergencies that might arise from fire or disability of pumps, a ground-water system should be equipped with a surface reservoir or a standpipe unless the capacity of the pumps and wells is much greater than the normal consumption.

QUALITY OF WATER.

Most surface waters may be polluted, and pollution of some is practically inevitable. The mineral content of surface waters in Connecticut, however, is seldom such as to render them unfit for general use. Ground waters, especially those drawn from bedrock, may require the removal of iron before they are suitable for use. Therefore the installation of purifying equipment may be necessary, whether the supply comes from the surface or from under ground.

METHODS OF OBTAINING WATER.

PRINCIPAL SOURCES.

The possible sources of water for municipal supplies are streams, springs, deep wells, filtration galleries, and shallow wells. The extent to which each of these sources is employed in New England is shown in the following table:

[1] Turneaure, F. E., and Russell, H. L., Public water supplies, p. 29, 1908.

Sources of public water supplies in New England.[a]

State.	Number of public supplies derived from—										
	Surface water.	Surface water and springs.	Surface water and shallow wells.	Springs.	Shallow wells.		Shallow wells and springs.	Galleries.	Shallow wells and galleries.	Deep and artesian wells.	Total.
					Dug.	Driven.					
Maine	53	2	0	12	1	0	0	0	0	2	70
New Hampshire	37	2	0	17	1	2	0	0	0	2	61
Vermont	21	3	0	13	0	0	0	0	0	0	37
Massachusetts	67	2	3	23	20	14	3	6	4	1	143
Rhode Island	12	0	0	0	1	0	0	0	0	0	13
Connecticut	48	9	0	8	0	0	0	0	0	2	67
Total	238	18	3	73	23	16	3	6	4	7	391

[a] Compiled from Baker, M. N., Manual of American waterworks, 1897.

NOTE.—Surface water includes supplies from streams, lakes, and impounding reservoirs.

STREAMS.

Streams afford the simplest means of obtaining water for municipal use. If the minimum daily discharge of the stream available exceeds the maximum daily consumption by an amount sufficient to provide for an emergency draft, the water may be diverted directly into the street mains. If, however, the daily discharge, as determined by measurements extending through a number of years, is not sufficient to meet the daily consumption, storage must be provided. As large streams are generally utilized in disposing of sewage, it is customary to go to the smaller ones for water supplies; hence the most common type of development involves the construction of reservoirs. A useful rule for estimating the storage required is that the amount stored shall be about the same percentage of the total yearly consumption as the total yearly consumption is of the total yield of the drainage basin.[1]

In the highland areas of Connecticut practically all the available ground water of the drift and considerable from crevices in the bedrock returns to the surface along the stream courses. For this reason the most effective method of obtaining this ground water is by constructing a dam in the stream into which it is discharged, and thus forcing it to the surface; and since in many places a reservoir site can be selected from which water can be delivered by gravity, the cost of pumping may be eliminated.

SPRINGS.

Springs may be grouped into two classes, the first including those which serve as outlets for ground water that has reached horizons far

[a] International Library of Technology, vol. 36, Water supply, p. 1322.

below the earth's surface, and the second including those whose water has passed to slight depths only.

Most of the Connecticut springs belong to the second class. In fact, nearly all perennial streams owe their persistence through dry seasons to such springs. Springs of this kind are generally small. They vary in yield with the amount and character of local precipitation and in permanency with the seasonal distribution of rainfall, the extent of their individual collecting areas, and the nature of the soil and vegetation. Most of the small, so-called surface supplies in the State are supported to a large extent by springs of this type, but because of their liability to fail in dry seasons and their average low yield, these springs are not adapted to use as public supplies unless they occur in large numbers and in localities where the surplus yield during wet seasons may be stored for use in droughts. A sufficient number of springs occurring in a favorable locality would produce either a lake or a stream. The accumulated waters from such groups of springs would possess the qualities of surface waters and would properly be classed with them.

Most deep-seated springs are independent of seasonal changes and are free from surface pollution. Their waters may, however, contain sufficient mineral matter to render them undesirable for municipal supplies but valuable medicinally. Springs of this type in Connecticut furnish waters of high purity and are highly exploited for special domestic use. Their commercial value as bottled waters as well as their small number will doubtless continue to prevent their use as sources of municipal supply.

WELLS DRILLED INTO ROCK.

The often expressed idea that a well of water or even a flowing well may be obtained anywhere by drilling deep enough is based on an erroneous conception of the occurrence of ground water. Some areas, as, for example, parts of Texas and South Dakota, are extensively underlain by porous water-bearing rocks capable of furnishing large and continuous supplies, and in such areas it is usually possible, after a few wells have been drilled, to predict with considerable accuracy the depth at which water will be found and the amount that will be obtained. In areas underlain by such materials as comprise the rock floor of Connecticut, however, large quantities of water are seldom obtained by drilling into bedrock, and moreover the yields of new wells can not be predicted from the records of existing rock wells because the supplies are obtained from discontinuous and irregular fissures which vary in size, distribution, and water content.

Wells that overflow at the surface are not common in Connecticut, but flows have been obtained both by drilling into bedrock and by driving "points" to shallow depths in the drift. Such flows are generally under low head and may cease within a few days or even within a few hours.

In drilled wells the flow is due to conditions illustrated in figures 2, 4, 5, and 6. If an impervious stratum of clay or till covers a sloping rock surface it may confine the water in the rock crevices and generate hydrostatic pressure that forces the water to the surface when a well penetrates the impervious stratum. In some shallow wells the conditions are similar. A sloping stratum of sand or gravel confined between beds of clay may contain water under sufficient pressure to force the water to flow at the surface when the upper impervious layer is penetrated by a driven point.

As conditions favor flowing wells in but few places in Connecticut, ground water must generally be recovered by pumping. Moreover, in most drilled wells the water does not rise to a level within the suction limit, and a gang of drilled wells can therefore generally not be pumped by means of a suction main. A lift pump is usually required in each well except where air lifts can be used to advantage. On account of the small yields, high costs, and great uncertainty in regard to every phase of the development, drilled wells are hardly to be considered for supplying water to large municipalities. For a village in which the consumption does not exceed 50,000 gallons a day and surface water is not readily available, a satisfactory supply may be obtained by drilling one or more wells into rock.

DUG WELLS.

Dug wells draw their water from the glacial drift. They are best adapted to areas where the drift is not very porous and yields water only slowly, whereas driven wells are best adapted to areas in the valleys where deposits of porous stratified drift supply water more freely. The yield from a dug well depends on the porosity of the drift, the dimensions of the well, and the depth to which the well is sunk below the water table. To obtain permanent supplies these wells must pass below the lowest position of the water table. Dug wells are not adapted for furnishing public supplies unless the quantity of water required is small, and even then such a supply would hardly justify the installation of the necessary pumps and pipe lines, because the cost would be great for each unit of water developed.

INFILTRATION GALLERIES.

Underground galleries or tunnels are usually constructed for the purpose of filtering stream waters. Under favorable conditions they may be used to recover ground water, but in general wherever the deposits are porous enough to yield much water to infiltration galleries, the supplies can be obtained more economically and satisfactorily by means of driven wells. Infiltration galleries are expensive to construct, and their efficiency is subject to decreases which are not easily remedied.

DRIVEN WELLS.

GENERAL CONDITIONS.

The larger stream valleys, as, for example, the valley of Connecticut River near Hartford and that of Willimantic River between Willimantic and Norwich, contain deposits of coarse sediments that are capable of yielding sufficient water for city and village supplies. Even the less extensive deposits, such as are found in the valley of Noroton River, would yield enough water for the smaller villages conveniently situated. The most economical method of utilizing the water from these deposits is probably by means of driven wells with perforated iron casings, 6 or 8 inches in diameter, as described on page 40. A project involving the use of driven wells differs from one in which drilled rock walls are to be used in that reliable information regarding the quantity and quality of water available can be obtained at moderate cost. The thickness and extent of the water-bearing formation can be determined by rough surveys, and pumping tests by means of drive points will establish the feasibility of the project. It does not seem probable that the largest cities of the State could be adequately served by ground-water supplies, but it is certain that many communities requiring water in moderate quantity could economically obtain it from this source, and the large cities could probably supplement their supplies. The use of driven wells is illustrated by the plants at Brookline, Mass., Brooklyn, N. Y., and Plainfield, N. J.

PLANT AT BROOKLINE, MASS.

The municipal pumping plant at Brookline, Mass., has been described by the superintendent, Mr. F. F. Forbes, as follows: [1]

The material for this paper was gathered from work which was done under my direction in Brookline, two and four years ago, to increase the water supply of this town.

The work consisted in laying a suction main made up as follows: 2,054 feet of 24-inch pipe, 2,093 feet of 20-inch pipe, 531 feet of 16-inch pipe, 1,427 feet of 10-inch pipe, and 155 feet of 8-inch pipe, a total of 6,260 feet, and driving 201 2½-inch wells, and connecting 160 wells. The other 41 wells were failures.

The plant was designed to deliver water at the rate of 5,000,000 gallons per day for as many hours each day as might be necessary to supply the town. A slight study for such a plant will convince one that it is very important that the pipes and connections should be air-tight and so put together that they will remain in this state even if some small settling should take place in the suction main, for not only does it cost money to pump air from which no benefit is received, but its presence in the conducting pipes lessens the amount of water they will carry, also decreases the quantity

[1] Forbes, F. F., Driven wells at Brookline, Mass.: New England Waterworks Assoc. Jour., vol. 11, No. 3, p. 195, Mar., 1897.

which can be taken from the ground by partially destroying the vacuum, and also causes the pumps to perform badly unless the air is removed before it reaches them.

It is not an easy matter to lay a long line of pipe, drive and connect numerous wells, and leave no place through which the air can flow. Not only must the material used be without defects, but the work must be most faithfully done—the latter being by far the most difficult part. It is with much satisfaction that I can speak of the results obtained in Brookline. The plant has now been in use nearly two years without giving the least trouble from air leaks, or, in fact, from any other causes.

A description of the principal details of construction is as follows: The 24-inch suction main is connected directly to the pumps without an air separator or sand receiver. The top of this main is laid from 6 to 8 feet below the surface of the ground, and about 5 feet below the usual level of Charles River during the summer months. The main was laid at this depth for two reasons—first, that more water might be drawn from the ground, and second, that the main might be in the most favorable position not to be affected by expansion or contraction due to changes of temperature. The main has a slight pitch from the pump, the farther end being about 6 inches lower. This construction is necessary to allow any air which may be in the pipes to flow toward the station and not pocket at any point on the line.

This suction main is composed of ordinary cast-iron bell and spigot pipes, laid in the usual way with lead joints. Extra pains were taken, however, in calking these joints. During the laying of this main and the connecting of the wells it was necessary to keep a 6-inch rotary pump running day and night to free the trench from water. The bottom of the trench was a rather fine sand, and the pipe was supported on a blocking reaching to a timber platform, placed about 8 inches below the bottom of the pipes, to allow room to calk the joints.

Short cast-iron Y branches of special design were placed in the main for each well. The 2½-inch outlets of these Y branches were drilled and tapped to a templet at the foundry before tarring, under the watch of an inspector.

The wells were connected to these Y branches by two lead connections 2½ inches in diameter and of a weight of 11 pounds per foot. A gate with companion flanges was placed between these lead connections, the flanges forming the union joint between the wells and suction main. The soldering nipples used with the lead connections were made to order and of the best steam metal. They were delivered untinned in order that any defect in them could be easily found. Special care was taken to solder these nipples to the lead connections. A wiped joint was not considered to be always air-tight, and of this size rather difficult to make, and we finally decided to sweat the nipples in, as this process is sometimes called. The necessary heat was obtained from cast-iron plugs heated in a portable forge which fitted loosely into the nipples. The well pipes were screwed together with special wrought-iron couplings until the ends butted, and special cement was used on the threads. The wells were from 35 to 95 feet deep. Two and one-half inch tees of a special pattern were placed on the wells at a proper grade to allow them to be connected by means of the lead connections to the suction main. The piping of the wells was carried to the height of about 1 foot above the surface of the ground and capped with a special cap. The wells have open ends, no strainers of any kind being used. In the bottom pieces there are five rows of holes with nine holes in a row, spaced 2½ inches apart from centers, and bushed with three-eighths inch brass pipe.

As before stated, we have had no air leaks so far, and as the suction pipe is laid with lead joints, and the connection between this pipe and the wells with lead pipe, thus making the whole construction flexible, we can see no reason why air leaks should ever occur.

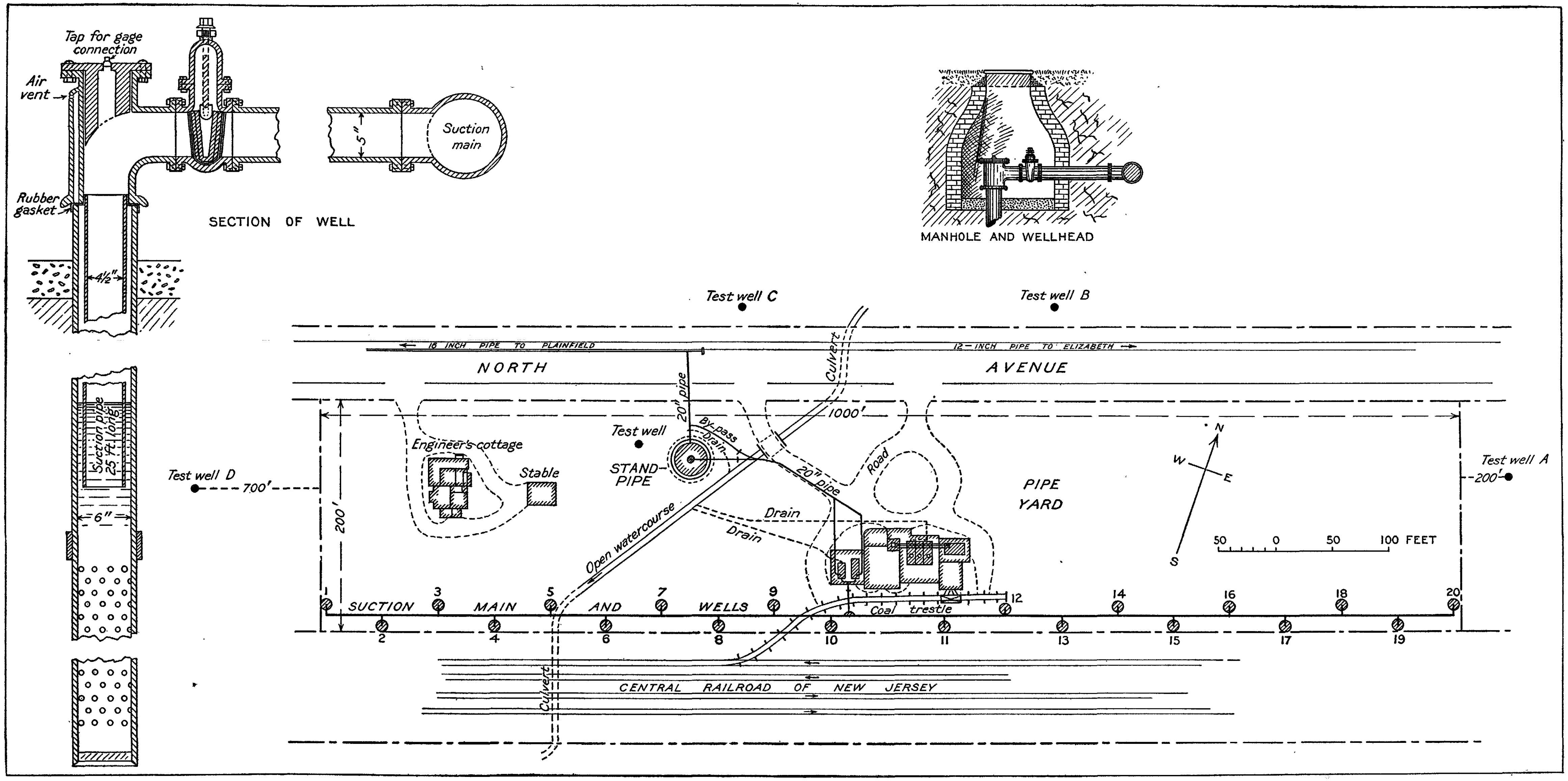
The details of the cost of construction of the work done two years ago, which included laying all of the 20, 16, 10, and 8 inch pipe and driving 159 wells, are as follows:

The cost of driving and connecting 118 good wells and driving and pulling up 41 poor wells:

Labor, driving wells	$1,561.00
Labor, connecting wells	210.00
Labor, pumping out wells	369.00
Well pipes, not including the bottom piece	572.06
Bottom pieces	196.23
Preparing the bottom pieces	118.00
Gate tops for the wells	360.37
Gates	660.80
2½-inch tees	94.40
Soldering nipples	250.16
Solder	23.00
Three-quarter inch rope	5.31
Oil	6.25
Red and white lead	23.59
Lead pipe	333.40
Making lead connections in the shop	52.50
2½-inch plugs	2.29
2½-inch couplings	155.40
Pulling up poor wells	80.00
Akron pipe for gate boxes	306.92
Cutting threads on pipe	206.72
Teaming	14.00
Miscellaneous	51.26
Total cost of wells	5,652.66
Number of feet of good wells driven	5,977
Number of feet of poor wells driven	1,741
Total	7,718
Average depth of the wells ... feet	50
Average number of feet driven per day with gang of four men	50
Cost of labor, driving wells, per foot	$0.21
Average cost of each good well, including driving and connecting and expense of driving and pulling the poor wells	47.90

Detail of the cost of laying the suction main:

Labor	$10,428.32
Lumber	1,118.55
Pipes	6,248.07
Gates	341.16
Lead	515.09
Pumping, the engineer	458.56
Pumping, coal	174.71
Unloading pipes	39.00
Inspecting pipes at foundry and at the cars	183.00
Rubber boots	210.00
Shovels	52.00
Carting men to and from work	947.30
Hauling the pipe from the cars	300.00
Miscellaneous expressing	79.30



PLAN OF PROPERTY AND DETAIL OF WELLS OF WATERWORKS AT PLAINFIELD, N. J., 1891.

Oil for the engine	$4.80
Jute packing	12.74
Miscellaneous	155.43
Total cost of laying the pipe	21,268.03

The amounts laid are as follows:

20-inch pipe	feet	2,023
16-inch pipe	do	551
10-inch pipe	do	1,420
8-inch pipe	do	155
		4,149

Total cost of laying the pipe	$21,268.03
Total cost of driving and connecting the wells	5,652.66
Total cost	26,920.69
Total cost of laying the pipe, driving and connecting wells, per foot of suction main	6.45

PLANT AT BROOKLYN, N. Y.

The city of Brooklyn, N. Y., obtains a large part of its water supply from gangs of driven wells situated at several places on Long Island. The wells first driven were of the closed-end type, but those sunk later are of the open-end type. The wells are arranged in two rows, one on each side of the suction main, the wells in some gangs being in files and in others staggered. One of the new plants is described as follows: [1]

The main suctions are about 2,340 feet long, with a fall of 12 inches from center to each end. The 62 wells are staggered along the main suction pipe, 12 feet from it and 75 feet apart on each side. Their average depth is 45 feet, a stratum of fine sharp sand being met with at that depth. The outside casing is 4½ inches, with a 6-foot strainer, 2-foot sand pocket,[2] and 6-inch point. Suctions are 3 inches in diameter and 28 feet long. Lateral branches are 3½ inches, and each is provided with a gate. It is expected to get 6,000,000 gallons from this station. The contract price for the last 25,000,000 was $167,250 for sinking and connecting wells, the yield to be determined by a test lasting one year and taken as the lowest average for five consecutive days.

PLANT AT PLAINFIELD, N. J.

The system of driven wells supplying the city of Plainfield, N. J., is described by L. L. Tribus [3] as follows:

The region itself is a comparatively level valley, some 7 miles long and from three-fourths to 2 miles wide, is fairly well wooded, and slopes gently to the westward. It is divided by a small stream running to the southwest, having several short tributaries; together they furnish excellent surface drainage for the city.

[1] Turneaure, F. E., and Russell, H. L., Public water supplies, p. 308, 1909.

[2] A sand pocket is a drum or box inserted in the suction pipe to catch sand that is drawn up with the water. It is provided with handholes to facilitate cleaning.—A. J. E.

[3] Tribus, L. L., Am. Soc. Civil Eng. Trans., vol. 31, No. 700, pp. 371 et seq., 1894.

The soil consists mostly of sand, clay, and gravel strata, rock not being encountered except at considerable depths.

It has always been an easy matter to procure water in abundance for domestic use by driving pipe wells from 20 to 80 feet deep at each residence and attaching pumps directly thereto; and for fire supplies, sinking large brick curbs some 15 or 20 feet into the gravel gave an abundant flow. But obviously, with the increasing population and no sewerage system, individual wells became a source of danger to health, yet for nearly 20 years no definite result was accomplished, more than the mere organization of a private water company.

In 1890 active measures were taken and tests and examinations made, which finally resulted in the sinking of pipe wells on a plot of ground 1½ miles east of the center of the city in a soil where the upper clay stratum was some 30 feet or more in thickness, underlaid by a very coarse water-bearing gravel. This spot was selected for its freedom from probable contamination on ground slightly higher than the city, which at the same time was convenient.

Several test wells were sunk at various points previous to the observations of the writer, and pumping tests made with a low-lift pump of a number of the main wells then driven, under the care of Mr. Rudolph Hering, M. Am. Soc. C. E. The quantity of water obtained from 10 wells for periods of eight hours' daily consecutive pumping, during two weeks of observation, was at the rate of from 2,000,000 to 2,125,000 gallons in 24 hours.

An inspection of Plate V [VI in the present report] will show the final arrangement of the wells, test wells, pumping plant in general, and details of the well tubes. The construction of the cast heads is such as to transform each water tube into practically an open well, giving atmospheric pressure free play rather than forcing its action through the earth, as in systems where but a single tube is used. The most distant well is 500 feet from the pumps and shows in an interesting manner by the vacuum at the well head and increased vacuum at the pump the effect of long suction and friction in the main.

The 2-inch pipe test wells, marked "A," "B," "C," and "D" on Plate VI, were observed daily by the writer, while resident engineer, during several months. They each had a simple balanced float gage and scale, which indicated the rise and fall of water level. They were all very sensitive to draft on the main wells when pumping was going on, though the nearest was 200 feet from the line of wells.

Comparison of these observations under the different conditions and seasons showed, among other things, that in about 1,900 feet the underground water level fell to the westward about 3 feet, or at about the same rate as the average surface of the ground. This evidenced conclusively that the flow of water was toward the city with a head sufficient to prevent any back flow of contaminated waters from the city.

In summary, the plant consists of 20 wells, 6 inches in diameter, from 35 to 50 feet in depth each, ranged in a double row on a strip of land 25 feet wide and 1,000 feet long, having in each a 4½-inch open-end suction tube, connected with a wrought-iron main varying from 8 to 12 inches in diameter. This main is in two sections, each 500 feet, connecting 10 wells.

Two compound surface-condensing duplex-plunger pumps, Worthington make, one of 3,000,000 and one of 2,000,000 gallons daily capacity, and a boiler plant of sufficient power, with various essential small machines, are housed in a rough stone building, slate roofed.

The water, drawn, as before stated, direct from the wells, is pumped into a wrought-iron standpipe (situated near at hand) 25 feet in diameter and 140 feet high, through a 20-inch interior tube rising 5 feet above the top. Two lower openings on this rising main, with valves operated from the outside spiral staircase, afford opportunity for filling the standpipe at lesser head if required.

The object of this interior tube, which was almost unique when erected, is threefold: First, by its fountain action, enforcing complete aeration.

Second, complete circulation.

Third, to afford instant fire pressure, no matter what the elevation of water in the main tower. This is accomplished by opening a by-pass, not otherwise used, connecting the rising main and the distribution line, the city's supply being drawn regularly from the bottom of the standpipe with pressure due to level of water in main tower.

From the standpipe the Plainfield pipe system extends to the west, comprising some 30 miles of mains from 6 to 16 inches in diameter, having fire hydrants spaced about 11 and valves 6 per mile. * * *

After the tests made by Mr. Hering and the partial completion of the works, various other tests were made with the permanent pumping plant. It was found that the wells on the westerly line yielded more abundantly than the easterly ones, under equally good conditions, and gave a lower vacuum for the same quantity pumped. * * *

The tests were made with the large pumps, under both free discharge and full working head, singly and together, and drawing from the wells in groups of 5, 10, 15, and 20, using each combination of 5; also, by cutting off one by one until the smallest number that could be used was reached, then adding one by one in reverse order until the full series were again in use. Five wells were found to be the smallest number possible to use and run the pumps smoothly. Wells Nos. 6 to 10 gave the best results, while Nos. 16 to 20 furnished but little water. The best results were obtained for a full flow by using Nos. 1 to 15, inclusive. * * *

During the long-continued dry weather of 1891 the water level became so low that difficulty arose with the extreme suction lift obtained, from 20 to 28 feet, according to rate of pumping, a fall of some 6 or 7 feet since the earlier observations, so that in the summer of 1892 it was deemed best to lower the pumps, which was done to the depth of 8 feet 1 inch below the former positions.

For the sake of a constant observation and record, a 3-inch open tube was driven from the engine room into the water-bearing gravel, and a permanent float gage suspended in it, indicating by a balance pointed on a scale of feet placed conveniently in the room. Although some 80 feet from the nearest main well, therefore not showing the lowest level of the water at the wells when pumping, it does show the relative water level under the same conditions and the daily and monthly range. When pumping the average lowering of the gage is about 8 inches, with an almost immediate return after stopping the pump.

Rainfalls need to be exceptionally heavy to make any marked showing in the water level, and not much then inside of 24 hours. This seems to indicate that the water supply comes from a distance, but there is an insufficiency of data for determining this interesting point.

In these two years or more of operation the wells have furnished daily, without difficulty or signs of falling away, the full demand of from 200,000 gallons at the start to 1,700,000 gallons at the present time, apparently derived, as the early tests indicated, from the western 15 of the 20 wells driven. The water itself has been of uniformly excellent quality, both for domestic and manufacturing purposes—so far, therefore, a decided success as an underground water supply.

PRIVATE SPRINGS AND WELLS.

Many of the wells in Connecticut were dug long before modern principles of sanitation had become established, and having been so long regarded as admirable relics of earlier days they are, naturally enough, imitated now, even at the expense of sanitary and economic considerations; indeed, nearly 80 per cent of the wells in Connecticut are of the old dug type, stone lined and, if covered at all, provided with loose, leaky curbs.

Sanitary precautions are necessary not only in caring for dug wells but also in caring for springs and drilled wells. Springs are especially susceptible to pollution because the water issues at the surface and almost always on a slope where surface drainage can readily enter the pool. Springs should be equipped with concrete reservoirs and should be kept covered, and the water should be drawn from delivery pipes. Such equipment is not necessarily elaborate or expensive. It is important only to exclude surface drainage and prevent contamination either by persons or animals, and it should be borne in mind that contamination is possible whenever access to the stored water is possible. Drilled wells properly constructed by reliable drillers exclude surface water. If the well casings are properly set and the pump fittings are tight, such wells are in little danger of pollution.

The per capita consumption of water from private wells is much less than that from public systems, largely because of the general lack of convenience in well equipment, and consequently the quantity of water that will be required in any particular case will depend on the equipment to be installed. A pneumatic system or a tower system installed for the purpose of furnishing running water in the house and barns will require about ten times as much water as a plant consisting merely of a hoisting bucket or a small hand pump. The type of well to be used should also be taken into account. An ordinary dug well yielding continuously only 2 gallons a minute might, because of its storage capacity, meet a temporary draft of 50 or 100 gallons a minute, whereas a driven well, having no stored supply, could not meet a draft in excess of its maximum yield. Therefore the estimate of the quantity required should be based not alone on the total quantity of water used in a day but in part also on the greatest rate at which it is to be pumped from the well.

The water delivered by springs is, in general, of the same quality as the water to be obtained from shallow wells in their vicinity. Therefore the choice between utilizing a spring and sinking a well depends on the relative cost and the resulting convenience. Springs so situated that water may be delivered to buildings by gravity afford very desirable supplies, but springs which must be pumped to be of service give no better supplies than dug wells.

So far as their mineral quality is concerned, well waters are suitable for all ordinary domestic purposes. Dug wells generally yield satisfactory domestic supplies, but they should be carefully curbed, and, if they are open to the air, they should be cleaned out at regular intervals.

Where the unconsolidated material consists of sand or gravel, driven wells are likely to be most convenient, because they are especially adaptable to uses in gardens, pastures, barnyards, and other places where water is required for stock and plants and where dug wells would be objectionable. Two or three screen points driven at convenient places in a tobacco field may pay for themselves in a single season by obviating long trips for water.

The water from driven wells is similar in composition to that from dug wells, as it comes from the same source, and it is to some extent susceptible to pollution. The ground around the top of driven wells should be kept clean and dry.

Drilled wells commonly yield at least 2 or 3 gallons a minute, a quantity adequate for the needs of most households (fig. 8, p. 25), and ordinarily the water is suitable for domestic uses.

METHODS OF DEVELOPING GROUND-WATER SUPPLIES.

DRILLED WELLS.

Construction.[1]—Two general methods of well drilling are employed in obtaining water supplies—the percussion method and the abrasion method. In Connecticut the percussion method is most commonly used. It consists of lifting and dropping, by means of suitable apparatus, a heavy string of drill tools which punches or cuts a hole through the unconsolidated materials and breaks the solid rock into fragments small enough to be readily removed from the hole. When drilling in unconsolidated material iron pipe or well casing as large in diameter as the hole will admit, usually either 6 or 8 inches, is generally driven down as rapidly as the drill descends, each added length of casing being securely screwed to the preceding one to make a tight joint. If the well penetrates bedrock, the casing is driven a few feet into the rock to prevent infiltration of surface water. If the well ends in loose materials, the casing extends to the bottom of the hole and may be perforated or slit at the lower end to admit water more readily. The casing is allowed to extend several inches above the surface of the ground to prevent inflow of surface water, and a flange is fitted to the top, to which a pump is attached.

In drilling by the abrasion method hollow drill tools armed with some harder materials, such as diamonds or chilled shot, are rotated on the rock in such a way that a cylindrical core is cut out and brought to the surface in short pieces. The walls sunk by this method are finished in the same way as those made by percussion drilling.

Drillers differ in opinion as to the relative efficiency of these two methods, the points of contention being that the abrasion method is more expensive, and that the rotation of the drill tools tends to seal up the smaller veins, thereby affording a comparatively lower

[1] Bowman, Isaiah, Well-drilling methods: U. S. Geol. Survey Water-Supply Paper 257, 1911.

yield than is obtained by percussion drilling. There are no data at hand which bear conclusively on these questions, but the fact remains that both methods are used, the percussion method to a much larger extent, and good results are obtained by each.

Cost.—Owing to the competition among well drillers there is no uniform scale of prices for drilling wells. The minimum prices charged range from about $1 to $4 per foot, including the casing. Usually the minimum price is charged for the first 100 feet and an additional charge of about $1 per foot is made for each succeeding 100 feet or fraction thereof. Other factors which affect the prices are the character of the bedrocks and depth of the unconsolidated materials, the accessibility of fuel and water for the engines, and the distance from the well to suitable boarding places for the drillers.

No reliable driller will guarantee to obtain water within a given depth. Sometimes a driller offers to obtain a certain quantity of water for a stated sum, but as no driller can predict the depth or location of a successful rock well, such arrangements amount to little more than games of chance in which the advantage is largely with the driller.

Quality of water.—Drilled wells are usually protected against contamination, but neither the quantity nor the mineral quality of the water can be definitely ascertained before drilling, and consequently an expensive well may be drilled without striking a suitable supply.

Drilled wells that end in the drift at depths of 75 or 100 feet are just as likely to be free from pollution as wells that end in rock and they are less likely to contain undesirable amounts of mineral matter. Moreover, drilled wells that end in rock may be polluted, especially where the rock outcrops or lies a short distance below the surface, by the entrance of infected matter through open fissures. Many rock wells situated near the coast are contaminated by salt because some of the fissures intersected by the well connect with the ocean. The contamination is not so easily detected if the fissures contributing to the water supply come to the surface in barnyards or in the beds of polluted rivers. It is not necessarily fortunate if a well strikes a vein of "sulphur" water, because odors not easily distinguished from "sulphur" may be due to pollution. The origin of any odors, colors, or tastes should be investigated before a water is used. Even deep drilled wells may be contaminated in a thickly populated community unless the protective cover of clay is thick and the casing is tight and fits tightly into the drill hole.

Improvements.—Drilled wells which end in the drift do not differ essentially from driven wells and they should be finished in the same manner (p. 40). The casing should be perforated or slit at the principal water-bearing horizons and for some distance above the lower end. By this method the yield may generally be materially increased.

Some wells which produce water of an undesirable mineral character may be improved by casing off the mineral water and drawing from a different water-bearing bed. This method is not likely to be generally successful in Connecticut, however, because at any one locality the quality of the ground water at one horizon does not differ greatly from that at another.

If the yield of a well is reduced by pumping from other wells in the vicinity, the pump cylinder should be lowered, and if this does not recover the yield, deepening the well may do so. But there is likely to be more or less permanent interference when a number of wells are drilled close together. A method of increasing yields of drilled wells which has not been sufficiently used to warrant recommending its general adoption consists of exploding a charge of nitroglycerin or dynamite at the bottom of the well, in order to open radiating fissures that may tap otherwise unavailable water veins. This method is used extensively in improving oil wells, and under favorable conditions it might be equally successful in water wells. The advisability of trying this method before abandoning dry holes ending in rock is suggested. It is not recommended for wells ending in drift.

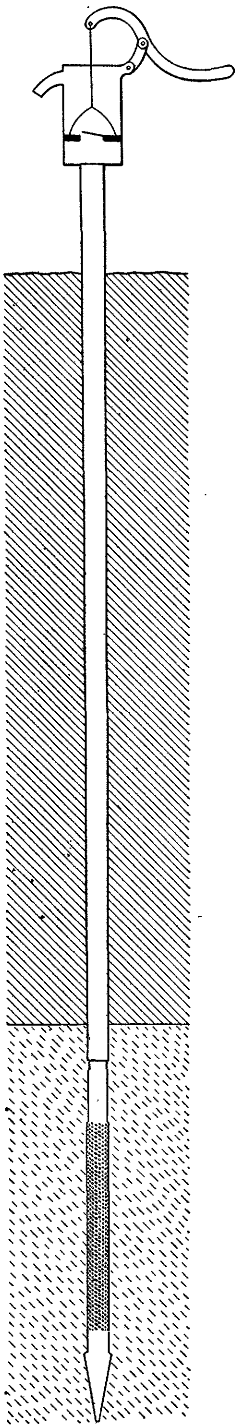


FIGURE 9.—Diagram of driven well.

DRIVEN WELLS.

Two general types of wells are classed as driven wells—the closed-end well and the open-end well. A closed-end well is constructed by driving into the ground with a sledge or drop hammer a "drive point" and strainer screwed to a piece of pipe. Other lengths of pipe are added and the driving is continued until the strainer penetrates the ground-water stratum (fig. 9). The diameter of the pipe and strainer may be 1 to 4 inches, and the length of the strainer is generally between 1½ and 4 feet.

The open-end well is constructed by driving a casing into the ground and at the same time removing the material from the interior by means of a sand bucket or sand pump or a jet of water. If the material penetrated is rather hard it may be necessary to remove it in advance of the casing by means of a heavy sand pump or combination jet and drill, or ordinary drilling may have to be done. A strainer may be attached previous to driving, or it may be adjusted after the casing is down by lowering it on the inside. Where the water-bearing deposits include coarse material and large quantities of water are sought, as for municipal or industrial supplies, the most satisfactory results will be obtained by perforating the casings where water is to be admitted with numerous circular holes at least one-fourth inch in diameter or by slits at least one-fourth inch wide. These perforations can be cut or drilled before the casing is inserted or they can be made by perforating tools after the casing is in place.[1]

After the casing is in place and the perforations have been made the well should be thoroughly cleaned out in order to remove the fine sediments and give the water free access to the well. This can best be done by first using a sand bucket or sand pump and then applying an air lift. If an air lift is not available, rapid pumping with a centrifugal or other pump can be substituted. Strong wells can often be developed by removing large quantities of sand and silt, and thus leaving a thick layer of clean gravel around the intake of the well.

The open-end well is adapted for harder ground and larger diameters than the closed-end well. The use of drive points is restricted to areas in which water can be obtained in rather fine gravel or sand at moderate depths, but open-end wells may be used in almost any unconsolidated deposits and they may be sunk to depths of several hundred feet. It is probable that in Connecticut either drive points or the usual drilled wells ending in the drift and having the casings perforated will be found satisfactory.

Driven wells are used to obtain both domestic and municipal supplies. It is seldom that more than one well is required to furnish the desired amount of water for domestic needs, but for public systems for large towns these wells are commonly driven in gangs, arranged in one or two rows along a suction main to which each well is connected by a lateral branch (Pl. VI, p. 34). The most economical system is one in which the suction main can be laid on the surface of the ground, but in some systems, either for the purpose of obtaining the maximum yield or because the water stands below the suction limit of the surface, it is necessary or desirable to lay the suction main in a trench.

[1] Bowman, Isaiah, Well-drilling methods: U. S. Geol. Survey Water-Supply Paper 257, pp. 67-69, 1911.

It is not possible to give universally applicable figures in regard to the requisite number of wells and their size and spacing, owing to the diversified conditions under which such plants are used. But in general the line of wells should be at right angles to the direction of underflow, and the distance between the wells from 15 to 100 feet, according to the size of the wells. The number and size of wells to be used will be determined by the quantity of water required, by the thickness and character of the water-bearing formation, and by the results of pumping tests to determine the permeability of the formation.

One of the principal difficulties encountered in the operation of driven wells is clogging. Infiltration of fine sand or incrusting of the strainer may reduce the yield of a well materially, and it is necessary, therefore, to keep the tube clean. It is usually advisable to subject a newly driven well to heavy pumping for the purpose of drawing out the fine material adjacent to the strainer. Coarse material will be left in its place, forming a natural screen, which will minimize the tendency to clogging, and the yield of the well will be increased by the consequent increase in the porosity of the material surrounding the screen.[1] When clogging is due to sand only, it is usually possible to remove the obstruction by forcing water into the wells under high pressure or by means of a steam jet, but when the sand is cemented it is necessary to withdraw the strainers and clean them or replace them by new ones.

The liability to pollution of supplies from driven wells depends on the depth from which the wells draw, the effectiveness of overlying clay beds in shutting out polluting matter, the amount of water that is drawn, and other conditions. Though the danger of pollution is less than in open dug wells, care should be exercised in selecting the sites and in protecting the surroundings. Supplies such as those required for large municipalities may be in danger of drawing polluted water from near-by streams, although small supplies drawn from the same wells might not be in danger of pollution.

INFILTRATION GALLERIES.

Infiltration galleries are trenches or tunnels with sides and roofs constructed usually of masonry or concrete and the floors made to admit water. Galleries may be built in the banks or beds of streams to intercept the underground water as it approaches the streams. The deposits in filled valleys are saturated below the level of permanent streams, and galleries in such deposits offer practicable means of obtaining water. The bottom of a gallery may profitably be made lower than the bed of the stream to insure maximum infiltra-

[1] Meinzer, O. E., Geology and underground waters of southern Minnesota: U. S. Geol. Survey Water-Supply Paper 256, p. 86, 1911.

tion. Water from the stream itself does not enter the gallery unless the draft on the gallery exceeds the infiltration from the landward side. A gallery is a modified form of dug well, from which it differs essentially only in capacity, and the same sanitary rules apply to both.

DUG WELLS.

The most common well is that made by digging a hole 2½ to 4 feet in diameter and deep enough to obtain a suitable quantity of water. The hole is then walled up from the bottom to the surface of the ground with loose irregular stones and bowlders picked up in the vicinity of the well. Brick laid in mortar and glazed tile have been used for some walls, but these materials, though much more desirable, are more expensive than the stone commonly used. The top of the well is commonly finished by fitting a square curbing of boards over the hole and adding a wheel or windlass for hoisting a bucket. On many wells, however, there are better equipments, ranging from screened well sheds to concrete seals with good pumps. Most dug wells end in the drift, but in areas where the drift is thin they may end at the rock surface or penetrate the rock a few feet, the rock being removed by blasting. The principal advantages of dug wells are the ease with which they may be cleaned and refitted with pumps and their large storage capacity; their chief disadvantages are their liability to pollution and their ready response to changes in the weather.

The following suggestions as to the sanitary construction of dug wells are extracted from the Virginia Health Bulletin, volume 1, No. 3, page 113, September, 1908:

THE ESSENTIALS OF A GOOD WELL.

The location of the well is of the greatest importance. It should be as far as possible from the house, barn, and privy. If possible, the surface of the ground about the well should be a little higher than the surrounding soil, so that any surface washings may be carried away from the top of the well. The ground about the top should be well sodded in grass. This not only adds to the attractiveness of the well but it takes care of a great deal of water that would otherwise have to stand in pools about the well. If the stock have to be watered from the well, there should be a pipe leading to a stock trough not less than 20 feet away, so that the stock need not come up to the well itself.

A well, to be safe, should be not less than 20 feet deep; that is to say, 20 feet from the surface of the ground to the top of the water. It should go well through the surface soil, preferably through a layer of clay. The lining should be of brick or stone laid in cement. Any lining that allows water to seep through it above the surface of the water may lead to pollution. The space between the casing and the surrounding soil should be filled with sand or earth.

The top of the well should be raised from the ground about a foot and set in cement or masonry coping that goes at least 3 feet below the surface of the ground. Over the top should be laid a solid, double tongue-and-groove flooring that is absolutely waterproof. This is essential. Most wells are polluted by material that falls in or is washed in from the top, and not by seepage through the soil.

On the well top there should be a good pump, carefully set so as to exclude leakage from around its base. If the pump can not be used, there should be an automatic tipping bucket. The well bucket should not be handled with the hands. Many wells have been infected by handling the bucket with soiled hands and then letting it back into the well, the filth being then washed off into the water.

Below the spout there should be a trough with a pipe leading some distance away, so that the waste water may be carried away from the well.

A well constructed in the manner described above will almost always furnish water that is perfectly safe, and the saving of sickness and trouble will many times overpay for the expense and care involved.

For convenience in discussion, dug wells may be divided, according to their relation to bedrock, into groups including, first, wells that penetrate bedrock; second, wells that just reach rock; and third, those that end in drift.

Wells that penetrate bedrock are sunk in localities in which the drift is thin. The thickness of the water bed in the vicinity of such wells may be less than the normal fluctuation of the water table and, consequently, in times of drought there may be no available water in the drift. But the rock basins generally act as reservoirs for the storage of water which has seeped in from the drift and these wells therefore usually carry small supplies through dry seasons. In cleaning rock wells, and sometimes in digging them, actual veins of water are encountered, and this has led some people to believe that the water is derived from sources deep in the bedrocks. Though such an origin is possible, most of these "veins" are shallow water-filled cracks formed naturally in the rock or produced by blasting. These cracks, radiating from the well, tap all along their courses the saturated zone of the overlying drift, and thus make it possible for the well to drain a much larger area than it otherwise could.

Wells that extend to the surface of the bedrock are usually found in areas of thicker drift than are those which penetrate the rock. Like the rock wells, they pass entirely through the saturated part of the drift, but they do not contain a stored supply and therefore fail if the water table sinks to the rock surface. Consequently in localities where the wells are of both types the supplies of the rock wells last longest in times of drought, although the others, drawing from a saturated deposit whose average thickness is greater, give a greater average yield.

Most of the wells that do not reach rock are found in areas of deep drift. These wells are sunk below the water level to a depth which at the time of digging is considered sufficient to insure the required quantity of water. Most of the wells that fail are of this kind. The failure may usually be attributed to one of the following causes:

(*a*) The well may be too shallow. To be reliable it should be sunk at least several feet below the lowest water level. This work can be most easily accomplished during dry seasons.

(*b*) The well, originally deep enough, may become "filled in" with sand and mud carried by inflowing water. In this manner the bottom of the well may be raised in wet seasons, when the water table stands high, to a level below which the water table sinks in dry seasons.

(*c*) There may be a permanent lowering of the water table, so that the bottom of the well lies within the zone of fluctuation. This may result from tiling, from a heavy draft on wells, or from lowering surface drainage either by removing dams or by deepening the channels of neighboring streams.

Wells that end in the sand or loose till should be cleaned about once a year; wells that end in the rock may need less

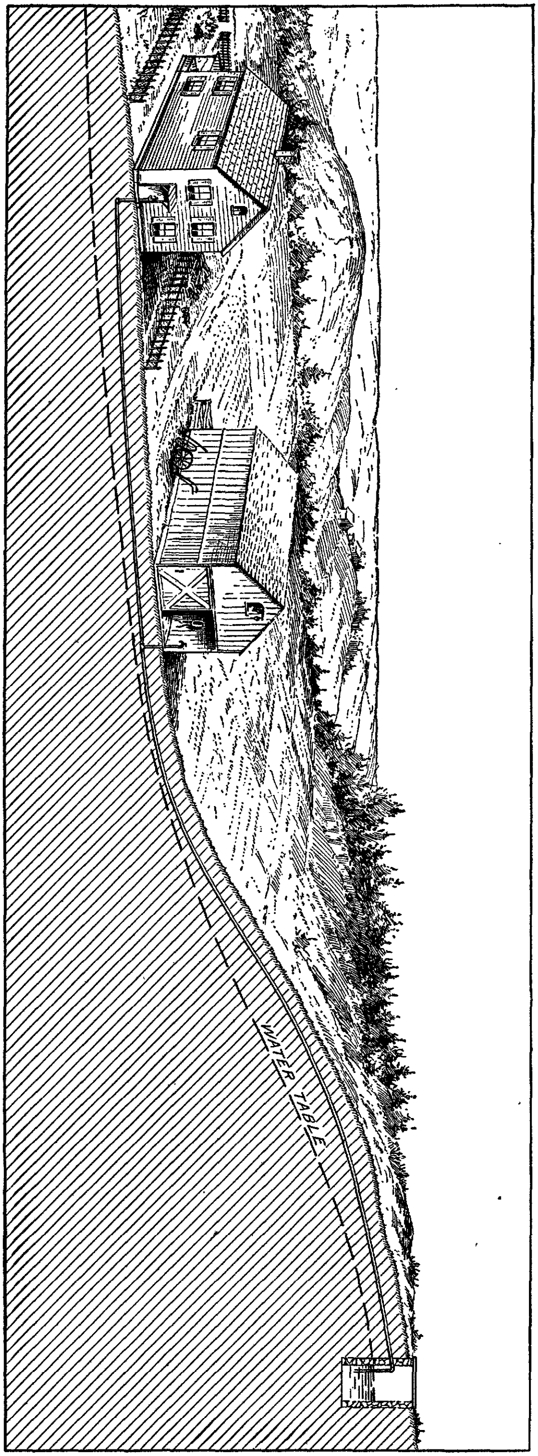


FIGURE 10.—Diagram of siphon well and domestic waterworks.

frequent attention. In any event cleaning should be the first remedy employed to restore the yield of a well. If this is not effective, then the well should be deepened, and if this is done when the water is lowest it will be easy to judge the necessary depth. Wells may be deepened without disturbing the old wall by sinking 18-inch or 24-inch tiling from the original bottom to the required depth. A method sometimes employed where the well ends in sand consists in driving a "point" (p. 40) into the bottom of the well to the necessary depth. If the strainer is more than 25 feet below the surface of the ground that is, below the suction limit—the pump cylinder may be attached at some point between the surface of the ground and the bottom of the dug well. In some wells, especially those that end in rock, the most feasible way to increase the supply is by drilling from the bottom of the old well. This method amounts practically to sinking a new well except that the cost of drilling to the depth of the old well is saved.

A use of the dug well which is popular in some parts of Connecticut is illustrated in figure 10, the well being sunk on a hillside above the house and barns so that water may be delivered to the buildings by gravity and under pressure. This is an excellent device wherever it can be used.

DESCRIPTIONS OF TOWNS.[1]

HARTFORD.

POPULATION AND INDUSTRIES.

Hartford is in the central part of the State, in Hartford County (fig. 1, p. 12). It is reached by the Highland division and the Springfield and Valley branches of the New York, New Haven & Hartford Railroad, and by the Central New England Railway; by steamboat from New York and Connecticut River towns during open season; by electric railways from Wethersfield, Rocky Hill, Middletown, Glastonbury, East Hartford, Burnside, Manchester, South Manchester, Talcottville, Rockville, East Windsor Hill, Springfield, Windsor, Poquonock, Suffield, West Hartford, Bloomfield, Farmington, Unionville, Newington, and New Britain. Post offices are maintained at Hartford and Parkville.

Hartford was settled in 1635. The Indian name was Suckiage. It was named Newtown, and changed to Hartford in 1637 by an act of the assembly. The city of Hartford was incorporated in May, 1784. The town and city were consolidated in April, 1896. The area is 17.29 square miles, or 11,065.6 acres.

[1] The name "town" applied to 168 minor subdivisions of the counties in Connecticut is equivalent to "township" of the Western States, except that the boundaries of the towns are irregular and their areas unequal. Cities, villages, and boroughs are incorporated communities within the several towns and may have the same name as the town.

The population of Hartford in 1910 was 98,915. In 1912 it was estimated to be 106,000. The population from 1756 to 1912 is shown in the following table:

Population of Hartford, 1756–1912.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1756	3,027			1850	13,555	59	
1774	5,031	66		1860	29,152	115	
1782	5,495	9		1870	37,743	26	
1790	4,090		[a] 25	1880	42,551	12	
1800	5,347	30		1890	53,230	25	
1810	6,003	12		1900	79,850	50	
1820	6,901	14		1910	98,915	23	
1830	9,789	41		1912	[b] 106,000	7	
1840	12,793	30					

[a] East Hartford was set off from Hartford in 1783.
[b] Population for 1912 estimated. Connecticut State Register and Manual, 1912, p. 404.

The principal industries are the manufacture of bicycles, blower systems, coil pipes, drop forgings, envelopes, fine tools, firearms, harnesses, knit goods, leather belting, machinery, metal castings, motor carriages, nails, organs, pins, plumbers' supplies, railroad equipment, rubber automobile tires, screws, silverware, typewriters, woven-wire mattresses, and printing and binding.

TOPOGRAPHY.

Hartford lies in the middle of Connecticut River valley, about midway between the Talcott Range on the west and the highlands on the east. The flood plain of Connecticut River occupies the northeast and southeast corners of the town, but elsewhere the topography is moderately hilly, in the south owing to outcrops of trap and, in the north, to drift and sandstone ridges. The average relief is about 50 feet. About one-sixth of the town is more than 100 feet above sea level and about one-third is less than 20 feet. The highest elevation—285 feet—is on Cedar Hill, which extends a short distance into the town from the south. (See Pl. IX, in pocket.)

A small part of the drainage reaches Connecticut River directly, but most of it is carried by Park River, which is formed by the union of Hog River and South Fork just west of the center of the town, the former occupying the north half and the latter the south half of a valley lying along the west boundary (Pl. IX). These streams are small, discharging at times not more than 0.5 second-foot.

WATER-BEARING FORMATIONS.

Bedrock.—The bedrocks underlying Hartford are Triassic sandstones and shales interbedded with trap rocks (Pl. VII). They come to the surface in only a few places in the city but generally lie only a short distance below. The trap rocks occur in three sheets, designated the lower, middle, and upper sheets. The middle sheet outcrops in Cedar Hill and the upper sheet outcrops along a line extending southward from Trinity College, but the lower sheet does not appear at the surface in Hartford. Sandstone is exposed in the bed of Park River and at other places in the town. From Connecticut River to the center of the city, a distance of about a mile, the rock surface rises nearly 100 feet, and the maximum relief of this buried surface within the limits of the town is about 360 feet, the lowest elevation being about 75 feet below sea level and the highest 285 feet above sea level.

Both the sandstones and the trap rocks are extensively fractured, and many of the cracks or "seams" contain water.

Till.—The higher hills in Hartford, such as Cedar Hill and the ridge marking the outcrop of the upper trap sheet, are covered with till, consisting of mixtures of sand, gravel, and bowlders, and a small amount of clay or rock powder. In general the till exceeds 10 feet in thickness only in a few rock depressions and on the east slope of Cedar Hill, where in some places its thickness is 20 feet or more. It is therefore unimportant as a water-bearing formation, although small quantities for domestic use might be obtained in the deeper deposits in outlying parts of the town.

Stratified drift.—Most of the material covering the rock in Hartford consists of stratified deposits of sand, clay, and gravel. (See Pl. IX.) The clays, which constitute the principal part of these deposits, occur in beds 20 to 100 feet thick along the valleys of South Fork, Hog River, and Park River, and in a belt about a mile wide along Connecticut River. The clays are regarded as having a high commercial value and are used for the manufacture of brick in the southwestern and in the northern parts of the city. West of the clay deposits the rock is covered principally with sand containing lenses of clay, ranging in thickness, according to the contour of the rock floor, from a mere film to 30 or 40 feet. The occurrence of ground water in areas of stratified deposits is discussed on page 15.

Alluvium.—Near the middle of the eastern boundary of Hartford Connecticut River closely approaches the rock wall, but north and south of this place the channel swings to the east and the rock valley is filled with drift and alluvium. In a number of test borings made through the valley fill near the northeast corner of the city by the Hartford water department, samples of the rock penetrated were taken at intervals of 5 feet, from which the following log was compiled. The first 35 feet of this section is alluvium, the underlying 40 feet of clay is believed to be a lacustrine deposit, and the last 5 feet is probably till.

CONTACT OF TRAP ROCK WITH UNDERLYING SANDSTONE, HARTFORD, CONN.

Log of test wells near northeast corner of Hartford.

	Depth in feet.
Fine silt, chiefly sand; some clay with very fine flakes of mica	5
Same as above but larger percentage of clay	10
Same, except larger percentage of sand	15
Do	20
Do	25
Do	30
One-half sand and one-half reddish clay; sand is about 30 per cent mica	35
Clay, reddish color	40
Do	45
Do	50
Do	65
Do	70
Do	75
Do	80
One-half reddish clay and one-half sand with a little mica	85
Very fine grained red sand (sandstone powder)	86

SURFACE-WATER SUPPLIES.

The surface waters in Hartford are not used for public supplies, principally because they are highly polluted. The only water available in considerable quantity is that of Connecticut River. Since 1867 this water has been used by the public system on only a few occasions when, as a result of drought, the quantity in the reservoir became inadequate. The last of these occasions was in the summer of 1900, when the water was distributed without filtration or germicidal treatment through certain sections of the city and a noticeable increase in sickness was attributed to its use. The reports of Dr. John L. Leal and James A. Newlands,[1] however, indicate that with proper germicidal treatment water of Connecticut River could be rendered suitable for municipal use in emergency.

The experiments made in this connection showed that when bleaching powder sufficient to furnish 1 part per million of available chlorine was used the removal of bacteria was always greater than 99.5 per cent and the colon bacillus was not found in the treated water. The cost of thus treating water is less than a dollar per million gallons.

GROUND-WATER SUPPLIES.

Owing to the fact that the municipal system reaches all parts of the city, ground water is little used in Hartford. In the central part of the city several wells have been drilled, most of which are being used, and they yield 8 to 102 gallons a minute and average

[1] Board of Water Commissioners, Hartford, Conn., Fifty-sixth Ann. Rept. (year ending Mar. 1, 1910), pp. 33–42.

47 gallons a minute. Considerable interference has been observed in these wells on account of their close proximity to each other. Five wells (Nos. 17, 18, 19, 20, 21 of Pl. IX, in pocket, and table on p. 51) were drilled about 75 feet apart at the offices of the Hartford Electric Light Co., but four of them have been abandoned because the combined yield was little more than the yield of the deepest one alone. The abandoned wells are respectively 200, 200, 201, and 228 feet deep. Their yields as reported by the driller were 120, 150, 150, and 200 gallons a minute, respectively. However, on their failure to deliver a combined yield of 100 gallons when in use the fifth well was drilled. This well is 620 feet deep and its yield is 100 gallons a minute. The water is now brought to the surface by means of an air lift. When this well was completed the other wells were so reduced in yield that they were abandoned.

A similar condition was observed in the wells of Long Bros. and Dillon & Douglass. The Long Bros. well was yielding 22 gallons a minute with the pump rods ending 153 feet below the surface until the Dillon & Douglass well, about 250 feet distant, was pumped, the pump cylinder being 235 feet below the surface. The yield of the Long Bros. well was thereupon reduced to only a few gallons a minute, but the original yield of 22 gallons was recovered by lowering the pump cylinder 38 feet.

The water obtained by means of wells drilled into bedrock is drawn from fissures or seams, many of which are small. The supply in one of these fissures is therefore not large and not readily replenished when drawn upon. (See description of well at Hartford Sanatorium, p. 24.) When more than one well taps such a fissure a heavy pumping from one well reduces the yield of the others.

The Hartford water department conducted a series of experiments with 2-inch driven wells to ascertain the possibility of obtaining water to supplement the present system in emergencies. Eighteen wells were driven, some of them in a sand bar in the bed of Connecticut River just above the Highland division railroad bridge and some of them in Riverside Park in a swale about 150 feet west of the river. The depths ranged from 4.5 to 48.5 feet. Steam pumps were operated day and night for testing the flows. The best yields, amounting to about 45 gallons a minute, were obtained at depths of about 15 feet.

The available information in regard to the drilled wells in Hartford is presented in the following table:

Drilled wells in Hartford.

Map No.	Owner.	Elevation above sea level.	Depth.	Yield per minute.	Depth to rock.
		Feet.	*Feet.*	*Gallons.*	*Feet.*
1	Keeny Park	70	200	42	40
2	Mrs. Louisa H. Sage	50	125	8	30
3	Hartford water department test hole	22.9	88		88
4	.....do	24.9	86		86
5	.....do	23	Between 80 and 90.		Between 80 and 90.
6	.....do	21.4			
7	.....do	22			
8	.....do	20.7			
9	.....do	22.8			
10	.....do	21.6			
11	Ætna Brewing Co.	30	400	102	8
12	P. Barry & Sons, Hartford Cold Storage Co	18	400	72	40
13	J. Pilgard	40	205	68	5
14	Dillon & Douglass	50			
15	Long Bros.	50			
16	Allyn House	35	318	50	28
17	Hartford Electric Light Co	40			
18	.....do	40			
19	.....do	40			
20	.....do	40			
21	.....do	40			
22	Retreat farm	130	180	20	49
23	Jos. Dart	130	74	22	58
24	Goodwin Park	55	251	(*a*)	29
25	Hartford Sanatorium	160 ?	974		

a Well flowing.

MUNICIPAL WATER SUPPLY.

The Hartford water department was organized in 1853 and the first reservoir of the present system was built in 1867. Others have been added from time to time, the total now being six, which have a combined capacity of 2,043,000,000 gallons and drain an area of 10½ square miles along the crest of the Talcott Range (Pl. VIII). The water is delivered by gravity. The mains also pass through West Hartford, supplying most of the homes in that town, and extend into Bloomfield and Wethersfield; altogether a population of about 121,644 receives the water. The total consumption for the year ending March 1, 1912, was 2,938,615,000 gallons; the daily consumption per consumer was 68.1 gallons. The average daily consumption during the month of July, 1911, was 8,450,000 gallons and the average depletion of the reservoir, determined by gage readings, was 8,850,000 gallons. The difference, 400,000 gallons, was attributed to evaporation.

The supply has become inadequate for the rapidly increasing population, and another reservoir, now being constructed on Nepaug River, is expected to increase the storage capacity of the system about 400 per cent, thus making it capable of serving a population of 400,000. The accompanying map (Pl. VIII) shows the newly acquired catchment area and details of the works.

QUALITY OF GROUND WATER.

Analyses of the water from six drilled wells in Hartford indicate that much of the water from the bedrock is high in mineral content and very hard. The wide range of composition is well shown by comparison of analyses 5 and 6, which represent, respectively, a soft water of low mineral content and a very hard water of high mineral content, especially high in sulphate. Analyses 2, 3, 4, and 6 represent waters too strongly mineralized to be suitable for boiler use in their raw state and almost too strong for economical softening.

Analyses of water from drilled wells in Hartford.

[Parts per million; R. B. Dole, analyst.]

Constituents.	1	2	3	4	5	6
Dissolved solids at 180° C.	474	916	1,098	1,249	57	1,534
Total hardness as $CaCO_3$	332	450	570	545	32	850
Silica (SiO_2)	18	....	15	15	....	16
Iron (Fe)	.30	.10	1.3	.12	.20	.5
Calcium (Ca)	96	157	190	196	....	286
Magnesium (Mg)	52	28	29	48	....	57
Carbonate radicle (CO_3)	.0	.0	.0	.0	.0	.0
Bicarbonate radicle (HCO_3)	335	136	340	252	31	144
Sulphate radicle (SO_4)	24	486	351	422	12	897
Chlorine (Cl)	40	38	139	213	2.3	20

1. Well of Mrs. Louisa H. Sage (Pl. IX, No. 2), 125 feet deep; sample collected June 17, 1915.
2. Well of Ætna Brewing Co. (Pl. IX, No. 11), 400 feet deep; sample collected June 17, 1915.
3. Well of Hartford Cold Storage Co. (Pl. IX, No. 12), 400 feet deep; sample collected June 7, 1915.
4. Well of Long Bros. (Pl. IX, No. 15), depth unknown; sample collected June 16, 1915.
5. Well at Allyn House (Pl. IX, No. 16), 318 feet deep; sample collected June 16, 1915.
6. Well at Retreat farm (Pl. IX, No. 22), 180 feet deep; sample collected June 24, 1915.

WEST HARTFORD

POPULATION AND INDUSTRIES.

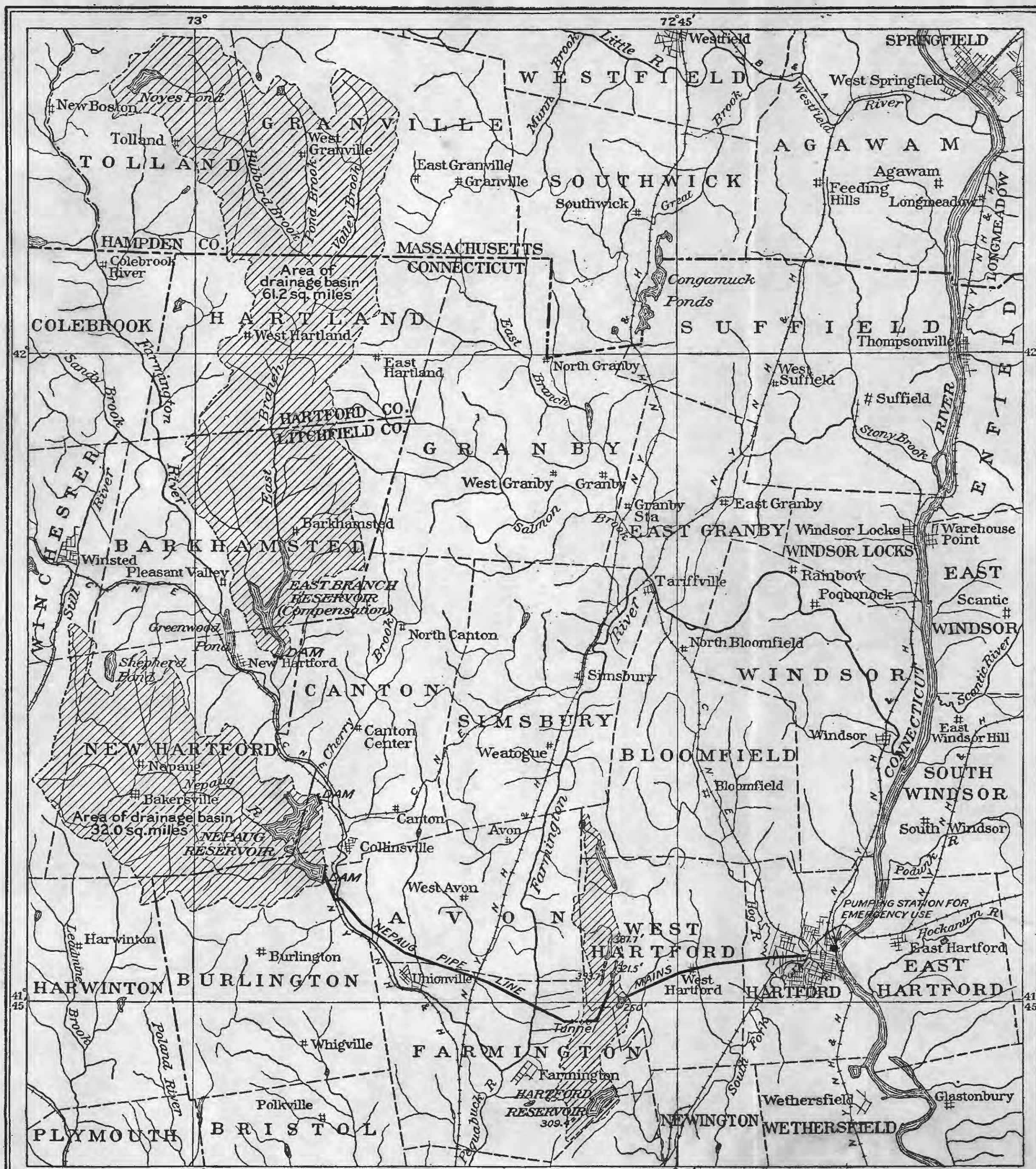
West Hartford (Pl. IX), in the central part of Hartford County, is reached by the Highland division of the New York, New Haven & Hartford Railroad, which has a station at Elmwood, and by electric railways from Hartford, Farmington, and Unionville. Post offices are maintained at West Hartford and Elmwood, and outlying sections of the town are covered to a large extent by rural free-delivery routes. The town comprises an area of 21 square miles. It was separated from Hartford and incorporated in 1854.

The census of 1910 gave the population as 4,808, or an increase of 51 per cent over the population in 1900. The changes in population since 1860 are shown in the following table:

Population of West Hartford, 1860–1910.

Year.	Population.	Per cent increase.	Year.	Population.	Per cent increase.
1860	1,296	....	1890	1,930	6
1870	1,533	18.7	1900	3,186	65
1880	1,828	19	1910	4,808	51

West Hartford is largely a residential town for Hartford business men. The principal industries are agriculture, in which dairying, tobacco growing, and market gardening are specialties; cultivation of flowers under glass; and manufacture of brick, motor coolers, and water heaters. From 10,000 to 12,000 tons of ice is stored annually for outside markets.



Base drawn from U.S.Geological Survey topographic atlas sheets

0 1 2 3 4 5 6 7 8 9 10 Miles

Number 309.4' at Hartford reservoir and others in same drainage basin indicate elevation of reservoirs above sea level

MAP SHOWING COLLECTING AREAS OF THE HARTFORD WATERWORKS.

TOPOGRAPHY.

The west boundary line lies along the crest of the Talcott Range and the highest altitude in the town is on this line near its north end, where it reaches an elevation of a little over 800 feet. The east slope of the range is moderately steep and the general level of the eastern part of the town is reached within a distance of 2 miles from the west boundary.

A second range of hills, much lower than those on the west border, extends through the middle of the town from north to south. These are slightly more than 100 feet in elevation and they are interrupted by several stream valleys. The lowest altitude is on the east boundary, where a branch of the South Fork crosses the line at an elevation of 35 feet above sea level.

The drainage finds its way into Connecticut River through Park River. Neither of these streams passes through West Hartford, but Park River is formed by the junction of Noyes River, which lies wholly within the town, and Hog River and South Fork, which pass across the northeast and southeast corners, respectively. Trout Brook receives all the drainage from the west half of the town and enters Noyes River about 1 mile north of West Hartford Center. The drainage of the east half is divided among Noyes River, South Fork, and Hog River. Noyes River joins South Fork in the southeast corner of the town.

WATER-BEARING FORMATIONS.

Bedrocks.—The indurated rocks consist of Triassic sandstones and trap sheets. The three trap sheets are separated by beds of sandstone, and dip eastward 10° to 15° at a fairly uniform rate. The trap rocks are more resistant than the sandstones and their outcrops are expressed in the topography by ranges of hills. Talcott Mountains consist of one outcrop of the lowest trap sheet and a repeated outcrop of the middle or main sheet. The upper sheet appears in the range of low hills extending through the middle of the town.

The trap rocks are exposed very generally in the hills in the west part of the town, but the sandstone is almost everywhere covered by drift. It appears in a small exposure in a creek bed just north of Elmwood, and is said to have been quarried at one time in the southwest corner of the town. Both the sandstones and the trap rocks contain numerous cracks which hold small quantities of water, as explained on pages 20 and 22.

Till.—Except for small areas of bare rocks in the ranges of hills, the rock throughout the town is covered with glacial drift, its maximum thickness being about 110 feet. Although the topography here is in general an expression of the bedrock contour and hills usually indicate a thinning of the drift in their vicinity, yet some of the prominent hills consist entirely of drift. A well sunk at the highest point on a hill in the northwest corner of the town at an elevation of 400 feet had not passed through the drift on reaching a depth of 85 feet.

Till, which is a mixture of clay, sand, gravel, and bowlders, covers the rock throughout the highest portions of the town, being prevalent at all elevations above 200 feet. The lower part of the till is generally saturated with water and constitutes the source of supply of many private wells.

Stratified drift.—East of the mountains, at elevations of less than about 200 feet above sea level, the surface deposits consist chiefly of lake beds and beach gravels. Between the mountains and the longitude of West Hartford Center the deposits consist chiefly of gravels, and from West Hartford Center eastward to the town line they are chiefly sands. The clay beds, which were formed in the center of the original lake basin, extend up the valley of South Fork into the southeast corner of the town. The gravel beds are generally too thin to be important as sources of ground water, and the clays are too fine grained to give satisfactory yields. The most favorable conditions for ground-water supplies in this town are afforded by the sandy deposits in the central and northeastern parts, where moderate quantities of water can generally be obtained by means of dug or driven wells.

SURFACE-WATER SUPPLIES.

The mountain streams in West Hartford are utilized in the public water supply of the city of Hartford. The streams on the lowlands are too small and sluggish to be useful for power development or public supplies.

All the streams on the lowlands, with the possible exception of Trout Creek, are badly polluted. Hog River, before it reaches Hartford, receives sewage from Bloomfield; South Fork receives sewage from Newington; and Noyes River receives most of the sewage from West Hartford.

GROUND-WATER SUPPLIES.

Dug wells.—Forty-five dug wells, 27 feet in average depth, were examined in West Hartford. Four of them are known to penetrate the rock to depths of 2 to 12 feet; two were said to just reach rock, and the rest end in drift, most of them in stratified drift. None of the wells that enter rock has failed, but one of the two that touch rock fails every summer. Most of the roads in West Hartford follow the tops of ridges and the houses are grouped along the roads. Consequently most wells are sunk in ridges where the water is farther below the surface than at the foot of slopes. Furthermore, there is evidence that in some localities the water table has become lower during the last 25 years, so that wells which formerly passed below the lowest position of the water table are now within the zone of fluctuation.

Some of these wells could be restored to their original efficiency by cleaning, an operation which seems to have decreased in popularity about as rapidly as the prospects for the extension of the municipal system have increased. Wells, especially those which are dug in sand, need cleaning about once a year; otherwise the infiltration of sand reduces the capacity to such an extent that the wells fail, first in dry seasons, and finally in all except very wet seasons.

Springs.—East of the outcrop of the upper trap sheet the rock troughs are not well defined at the surface and knowledge of the rock topography is unsatisfactory. Springs are common along the streams and many of them are perennial, indicating the presence of continuous supplies near by. A spring about three-eighths of a mile west and a little north of Elmwood, on the Beach farm, yields nearly 20 gallons a minute, or 30,000 gallons a day, of which about 9,000 gallons a day is used. The equipment includes a concrete reservoir and pumping plant. The spring is about one-fourth mile east of the outcrop of the upper trap sheet and near the base of the ridge produced by it. The surrounding slopes appear to be inadequate to afford so large a supply continuously, and it is probable, therefore, that the water delivered by this spring finds its way from the basin west of the ridge through a fissure in the trap. The spring is about 50 feet lower than the bottom of the basin west of the ridge. Other springs in this vicinity yield much less water, fluctuate in harmony with the rainfall, and doubtless get their supplies from the slopes on which they are situated.

Drilled wells.—Drilled wells, affording 2 to 20 gallons a minute, have proved satisfactory for domestic use in West Hartford. Of the 15 wells examined, 13 obtain their water from sandstone; one does not reach rock, but gets its water from a bed of till; and one ends in and draws its supply from trap. These wells are distributed over the entire town; some of them are on the trap hills, some of them in the sandstone troughs, and others in deep drift. Among them every geologic condition in West Hartford is encountered and their general success indicates that water may be obtained anywhere in the town. No very large quantities have been obtained in the traps. The wells which penetrate these rocks generally furnish less than 5 gallons a minute, unless they enter the sandstone, but for ordinary domestic needs 2 gallons a minute is ample, and for other purposes there is no reason to expect drilled wells to be successful. The largest yield yet obtained from trap rocks is 20 gallons a minute, which is by no means a large yield for an industrial or municipal supply. Moreover, this yield is obtained at a depth of 343 feet, which is about as deep as it is ordinarily feasible to drill, since at lower depths water-bearing fissures are less numerous and generally smaller.

Increase in use of ground water in West Hartford has been at least temporarily arrested by the extension of the Hartford water system, many of the citizens expecting city water to become more generally available and therefore hesitating to invest in well drilling.

SUGGESTED DEVELOPMENTS.

A rock trough lies between the outcrops of the two upper trap sheets and is especially well defined in the south half of the town, where it contains a small stream fed by a number of springs, some of which yield more than 10 gallons a minute (Pl. IX, in pocket). There are no wells in this basin, and its exact depth and water content are not determined. Several smaller troughs lie along the foot of the Talcott Range, all of which contain springs but no wells, as the wells are dug near the roads, which as a rule follow the tops of the ridges in this part of the town. In the largest basins the permanence of brooks and springs and the frequent marshy character of the ground indicate a thorough saturation of the mantle during most of the year, and the conditions indicate that the water table descends only a few feet below the surface even in the driest periods. Wells sunk in these places might be expected to afford sufficient water for domestic needs. At present the habitations are so distributed that the use of wells in this basin for domestic supplies would, as a rule, necessitate conveying the water considerable distances, and involve expenditures closely approaching the cost of drilled wells (p. 39).

In many localities, especially along the foot of the Talcott Range, the water for private use can best be obtained from springs. Springs so situated that the water may be delivered to buildings by gravity usually afford very economical supplies and are to be preferred to wells. Driven wells are recommended in areas of sand and gravel deposits (Pl. IX) because of their high efficiency and low cost, and where more water is required than may be obtained from a single well of this type, a gang of points connected at the surface to a common main may produce the required quantity. Driven wells are not likely to be satisfactory in localities where the water table is maintained at a low level by underground drainage; therefore care should be taken to determine as nearly as practicable the relation of the water table to the surface of the ground at the point where it is proposed to drive the well. The entire zone of fluctuation should lie within the suction limit—about 30 feet—otherwise points can be used only in combination with dug wells so that the pump cylinder may be lowered below the surface. In areas covered by till (Pl. IX) a sanitary dug well (p. 43) is best for moderate domestic use. Supplies from these sources are generally of good quality and adequate for domestic needs. Where the drift is so thin that water is not available throughout the year and where more water is required than may be obtained from dug wells, drilled wells may produce adequate quantities (p. 20). But drilled wells also furnish moderate supplies of good water in areas of stratified drift, and they are generally esteemed for their sanitary character.

Under an agreement with the city of Hartford the sections of West Hartford which petition for the privilege may obtain city water. At present families living along the main aqueduct are so supplied and many other parts of the town are reached by branch lines, the eastern half of the town being especially well supplied in this way. (See p. 51.) In sections not reached by the Hartford mains, water is obtained from private wells.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of West Hartford is presented in the following tables:

Dug wells in West Hartford.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.	Depth to rock.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*
4	Oulaudt	Slope	180	30	28	152			
8		Slope	185	20	16	169		5	
9		Slope	165	14	11	154		0	
10		Plain	150	30	10	140	4		
11		Plain	150	15	10	140	4		
15		Hill	160	22	18	142		40	
16		Hill	164	19	15	149		200	
20	John C. Delaney	Plain	130	16	15.8	114.2			16
22	F. Larenson	Hill	140	30	25	115			
24		Slope	160	40	37	123			
25		Flat	140			95	3	35	
28		Slope	140	30					
29	Henry farm	Slope	150	30	8	142			
31		Hill	125	30					
32	Mansfield	Slope	155	28	25	130	*a* 5		
33		Slope	155	30	10	145			
35	Hall	Hill	160	16	13	147		10	
36	do	Slope	130	20	16	114			
38	Griswold	Flat	100	12	5.5	94.5			
39	do	Hill	128	26	23	105		0	
40	Woodford	Slope	125	25	18.5	106.5		15	
41		Hill	130	17	14	116		0	
42		Hill	130	20	14	116			
43	M. A. Goodwin	Slope	200	30	26	174		2,400	
46		Valley	180	30	27	153	(*a*)	10	
47	Finneran	Slope	200	25	13	167	4	95	25
48	C. E. Carlson	Slope	250	45	42.5	207.5	(*a*)		45
50		Slope	160	12			10.5	320	
51		Slope	185	35	32	153	*a*.2	20	
52	Flint	Plain	178	40	30	148		0	
53	Mrs. Foot	Plain	170	27				0	20
54		Slope	180	25	22	158	8	20	
55		Slope	280	30			5		
56		Slope	185	30			(*a*)		
57	Newton	Hill	200	33.5	31.5	168.5	(*a*)		
60	do	Flat	180	15	12	168	(*a*)		
62		Slope	110	30			(*a*)		
63	Beach farm	Hill	160	18	14	146		0	16
65	do	Hill	170	40					
66		Hill	175	21	17.5	157.5			
70	Millard	Hill	180	30	25	155	.3	0	20
71		Slope	185	25			(*a*)		
73		Hill	145	25	17	128	.05	10	
74		Hill	140	25	20	120			
76	F. Steele	Hill	145	23					12
77	Walbridge	Hill	130	25	20	110	.08	10	
78		Slope	120	20	14	106		560	

a Well goes dry.

Drilled wells in West Hartford.

Map No.	Owner.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Drilled in year—	Cost.	Section.
		Feet.	*Feet.*	*Galls.*	*Galls.*	*Feet.*			
1	T. Slocum	400	83	5	60	(*a*)	1910	$181.00	Hardpan.
2	Morgan Braynard	450	265	15	800	107			Hardpan; sandstone.
3	W. B. Miller	195	168	6		44.5	1910	420.00	Gravel; hardpan; red trap.
5	Creamery	190	60	3		34			
12	Schoolhouse	150	52	12		31.8	1910	120.00	Red sandstone.
13	Arthur Allen	165	110	3	600	47	1911	275.00	Sandstone.
14	Judd	155	136		600				
17	Joseph Apter	165	108	4.2	800	50	1911	270.00	Do.
18	James Miller	170	113	10	1,160	70			
19	M. F. Greene	160	240	6	50	65.8	1909	313.50	
24a	St. Mary's Home	130	100	15		25			
26	M. F. Schwertsfeder.	120	118.5	15	120	50	1907	300.00	
37	C. W. Hall	130	50	3		16	1911	125.00	
61	W. J. McCartney	165	67	15		(?)	1904	142.80	Sand, clay, red sandstone, shale.
69	A. G. Wooley	175	175	45	50	10	1900		
75	Frank Steele	145	343	20	80	30	1906	709.00	
79	Coil Pipe Co	90	197			65	1899	485.00	
80		85	90						

a No rock.

Springs in West Hartford.

Map No.	Owner.	Elevation above sea level.	Yield per minute.	Amount used per day.	Improvements.
		Feet.	*Gallons.*	*Gallons.*	
6		210	10		
7		210	10		1-inch pipe.
21		90	6		
23	F. Larenson	105	4		
27	Henry farm	110	6		
30	Mansfield	115	2		Pumped to barn by wind.
34		120			Windmill.
44	M. A. Goodwin	220	2	0	
45	Bannon	280	2	1,200	Piped.
49	M. F. Schwatlow	250	9		Three-fourths inch pipe.
58		135	10		Tile, 24 inches by 3 feet.
59		175		2,400	
64		130	.5		
67	Beach farm	180		9,000	
68	....do	110	20	12,000	Pipe, 2 inches by 8 feet.
72		118	1		

QUALITY OF GROUND WATER.

The analyses in the following table indicate the composition of the water of three wells drilled into the rock at West Hartford. All are hard waters and those represented by analyses 2 and 3 are high in sulphate. According to tests [1] made by the Connecticut State Board of Health in 1898 the water from the well at Elmwood School (depth not given) contains 359 parts of total solids and has a total hardness of 125 parts per million, and that from the well at the South Kinder-

[1] Connecticut State Board of Health Rept. for 1898, pp. 292, 295.

garten (depth not given) contains 166 parts of total solids and has a total hardness of 80 parts per million.

Analyses of water from drilled wells in West Hartford.

[Parts per million; R. B. Dole, analyst.]

Constituents.	1	2	3
Dissolved solids at 180° C	253	500	630
Total hardness as $CaCO_3$	142	208	210
Silica (SiO_2)	....	....	18
Iron (Fe)	.10	1.1	.20
Calcium (Ca)	....	54	81
Magnesium (Mg)	....	25	34
Carbonate radicle (CO_3)	.0	6.4	.0
Bicarbonate radicle (HCO_3)	136	156	172
Sulphate radicle (SO_4)	12	220	305
Chlorine (Cl)	14	3.8	3.7

1. Well of H. C. Long; sample collected June 16, 1915.
2. Well of M. F. Schwertsfeder (Pl. IX, No. 26), 118.5 feet deep; sample collected June 24, 1915.
3. Well east of Whitlock Pipe Factory (Pl. IX, No. 80), 90 feet deep; sample collected June 17, 1915.

NEWINGTON.

POPULATION AND INDUSTRIES.

Newington is in the central part of Connecticut in Hartford County. It is reached by the Shore Line division of the New York, New Haven & Hartford Railroad (station Newington), by the Highland division of the same road (stations Newington and Clayton), and by electric railway from Hartford and New Britain. Post offices are maintained at Newington and Newington Junction, and mail is delivered by rural free delivery from New Britain. Newington was taken from Wethersfield and incorporated July 10, 1871. The area of the town is 14 square miles.

The population of Newington in 1910 was 1,689. The population from 1880 to 1910 is shown in the following table:

Population of Newington, 1880 to 1910.

Year.	Population.	Per cent increase.
1880	934	....
1890	953	2
1900	1,041	9
1910	1,689	62

The principal industry is agriculture.

TOPOGRAPHY.

The surface of Newington is in general flat and stands at an average elevation of about 100 feet. Cedar Mountain extends along the entire east border, reaching elevations of 350 feet in many places. The highest elevation is about 375 feet, near the northeast corner of the town. (See Pl. IX, in pocket.)

The principal stream in Newington is the South Fork of Park River, which, with its branches, drains practically the entire town. Two small tributaries of Mattabesset River rise in the extreme southeastern corner of the town and drain a small area, most of which is swampy. The general direction of the drainage is northward. All the streams are small, and their average fall is about 10 feet to the mile.

WATER-BEARING FORMATIONS.

Bedrocks.—The indurated rocks in Newington consist of Triassic sandstones and shales, and trap. The trap is exposed in Cedar Mountain. West of Cedar Mountain the bedrocks are sandstones and shales. All the rocks exposed in the central part of the town are sandstone. Shale appears at the surface at several places along the western border. The forces which produced the displacements along the eastern border of the town caused also a general shattering of the rocks throughout the area, and cracks of various widths appear in all the rock exposures and extend from the surface to depths of several hundred feet. Because of these cracks the rocks constitute a reservoir for the storage of underground water and form the source of supply of drilled wells that end in bedrock (p. 20).

Till.—Glacial till, a mixture of clay, sand, gravel, and bowlders covers the rock over the hills along the east border of the town and at many places in the central and western parts of the town. The till was deposited by the retreating ice sheet at the close of the glacial epoch. The most prominent characteristic of the till is the presence of large bowlders, and the distribution of the till is marked by the bowlders scattered over the ground or built into fences along the roads and through the fields. In some places the till is 30 or 40 feet thick, in other places it barely covers the rocks; its average thickness is about 15 feet. Till as a water-bearing formation is discussed on page 15.

Stratified drift.—Deposits of stratified sand and gravel extend along South Fork River and its branches and constitute the most important water-bearing formations in Newington. Many wells have been drilled in the vicinity of Newington Junction and Newington Center to depths ranging from 75 feet to 125 feet before reaching bedrock. These deposits are continuous with similar deposits, partly of lacustrine origin, found in Hartford and East Hartford and the towns northward.

GROUND-WATER SUPPLIES.

In Newington the depth of the water table below the surface of the ground, as determined by the measurement of 50 wells, ranges from 6 feet to 40 feet and averages 18 feet. The least fluctuation occurs in the areas of deep drift in the central portion of the town.

Fifty-two dug wells, ranging in depth from 8 to 42 feet and averaging 20 feet, were examined in Newington. The yield of wells as determined by measurements of four wells ranges from less than one-fourth gallon to 7 gallons a minute, the average being about 2 gallons. Thirteen of the wells examined are reported to go dry in periods of drought. Four of the wells penetrate rock but obtain their water from the overlying drift. The amount of water used, reported for 25 wells, ranges from 5 to 280 gallons a day and averages 46 gallons.

Thirteen of the drilled wells range in depth from 48 to 232 feet and average 116 feet; eight of these get their water in the bedrock. Their yields ranged from 4 gallons to 40 gallons a minute and averaged 17 gallons. The quantity of water used, as reported for four wells, ranged from 7 gallons to 1,000 gallons a day and averaged 376 gallons.

Data were obtained concerning five springs used by private families. Two of them are said to yield a gallon a minute, and one furnishes 8 gallons a minute. The quantities used from the five springs range from 10 to 2,400 gallons and average 517 gallons daily.

The distribution of the different kinds of drift is indicated on Plate IX, and the types of wells adapted for use in drift are discussed on page 38. The most satisfactory supplies in Newington are obtained from drilled wells. In the sandy area west of Cedar Mountain adequate supplies for domestic use are obtained from drilled wells ending in gravel or coarse sand about 100 feet below the surface. The water in most of these wells will rise within 30 feet of the surface.

PUBLIC WATER SUPPLY.

A cooperative company consisting of 20 members, of which Fred Hubbard is president and Newton Osborne secretary, controls a small system which furnishes water to the members only. Water from a spring on Cedar Mountain is discharged into a small reservoir, from which it is led to Newington Center through a 2-inch main. Each member is entitled to as much water as he desires and no check is kept on the quantity. This company was organized more than 30 years ago and the supply has been ample except during the droughts of the last three summers. The company has acquired a spring situated west of the foot of Cedar Mountain from which, in emergencies, water is pumped by a gasoline engine to the reservoir on the mountain.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of Newington is presented in the following tables:

Drilled wells in Newington.

Map No.	Owner.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Drilled in year—	Cost.	Section.
		Feet.	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*			
1	....	....	....	....	....	....	....	....	
4	Mrs. Geo. P. Brimley	135	100	6	1,000	6	1907	$388.00	Trap.
10	Pimm........	80	48	4	....	29	1899	....	Hardpan; brown sandstone.
13	Geo. Cooley........	....	124.5	18	....	....	1910	248.00	Clay; quicksand; gravel.
14	John F. Bergman.	....	130.5	18	....	....	1910	289.00	Quicksand; sand; gravel.
15	James Liquori....	100	106	18	....	....	1910	240.00	Do.
16	Edward Goodale.	80	93	18	....	....	1910	198.00	Clay; quicksand; coarse sand.
17	Carl Oscar Danielson.	....	83	18	....	....	1910	169.00	Quicksand; sand; gravel.
18	Newton Osborne.	95	159	18	....	42	1902	318.00	Hardpan; brown sandstone.
19	....	....	....	....	....	....	....	....	
21	W. H. Todd........	105	100	20	70	100	1899	200.00	Water, top of rock.
22	....	....	....	....	....	....	....	....	
30	Mrs. H. M. Robbins.	158	91	8	160	44	1901	180.00	Hardpan; brown sandstone.
39	Frank Rowley ...	135	73.5	15	....	31.5	1906	145.00	Red sandstone.
66	Chas. Luce........	150	165	25	160	18	1911	368.00	
71	Winter........	160	232	40	....	10	1910	437.00	Brown sandstone 183.5 feet; trap 32 feet.
73	....	....	....	....	....	....	....	....	
74	....	....	....	....	....	....	....	....	

Springs in Newington.

Map No.	Owner.	Elevation above sea level.	Yield per minute.	Amount used per day.	Improvements.
		Feet.	*Gallons.*	*Gallons.*	
3a	Cutler........	140	1	10	Tile 2 by 7 feet.
27	....	....	1	10	Reservoir 2 by 6 feet.
37	S. Symolon........	100	....	2,400	
40	Churchill........	....	....	50	
41	....	100	8	....	
55	Carlson........	100	....	60	Barrel reservoir.
62	....	70	1	60	
64	E. R. Barnard........	....	....	....	Pumped by wind.

Dug wells in Newington.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.	Depth to rock.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*
2		Slope	118	24	20	98	(a)	30	
3	Cutler	Slope	118	12	8	110	0.05		
5		Slope	115	30	26	89			
6		Plain	90	12.5	10	80			
7		Plain	90	16	12.5	77.5			
8		Plain	90	34	32.5	57.5	(a)	10	
9		Slope	110	16	13	97		15	
11		Plain	80	35	32	48		50	
12	Jeans	Hill	140	18	15	125			
20		Slope	100	17	10	90			
21a		Plain	105	18	15.5	89.5			
23	Calahan	Hill	280	22	19	261	.14		10
24		Hill	280	17.5	14.5	265.5	(a)	20	
25	Blinma	Hill	215	20			(a)	0	14
26	do.	Slope	195	8	6	189	.28	25	
28	Macnernay	Plain	135	28.7	27.7	107.3	(a)	25	
29	Miller	Plain	150	33					
31	Mrs. H. N. Robbins.	Plain	140	16	13	127		0	
32	Frank Stetzer	Plain	130	15.5	12	118		280	
33	Blair	Plain	115	10	8	107			
34		Hill	125	26	12	113	(a)		
35	S. Symolon	Flat	115	10	8	107		10	
36		Flat	100	11	7	93			
38	Barrows	Plain	110	17	16	94			
42		Slope	128	14	12	116	(a)	60	
43	Hall	Hill	125	18	13	112			
44		Plain	135	27	25.5	109.5		8	
45		Hill	230	22	18.5	211.5		40	6
46		Hill	240	24	22	218	(a)	5	
47		Slope	245	24	17	228		15	
48		Slope	175	32	27.5	147.5	7		
49	A. F. Pipkin	Slope	160	30	27	133			
50	Chas. Jocklin	Flat	130	12	9	123	(a)		
51	E. R. Barnard	Plain	160	31	27	133		12	
52	do.	Flat	146	11	8	138		240	
53	Carl Landell	Hill	170	27	24	146	(a)	160	
54	John Bentson	Flat	150	10	6	144			10
56		Hill	120	12	7	113			
57		Slope	115	15	12	103			
58	John Youhnat	Hill	130	24	22	108		30	
59	August Eckert	Hill	150	42	40	110	(a)	10	
60		Slope	160	13	11.5	148.5		20	
61		Slope	150	19	14.5	135.5		30	
63	E. R. Barnard	Hill	140	39.5	37.5	102.5		0	
65	U. Skomars	Flat	130	24	22	108			
67	Chas. Luce	Slope	155	27	24	131		0	
68		Plain	155	32	23	132			
69	S. B. Bingquist	Hill	160	21	17	143		8	
70	J. A. Johnson	Hill	150	40	30	120		10	
72		Plain	150	30	28	122	(a)	0	
75		Plain	130	19	12	118		10	
76		Slope	95	28	21	74		15	

[a] Well goes dry.

QUALITY OF GROUND WATER.

Only one ground water from Newington was analyzed, and the results are given in the following table. This is a highly mineralized water, very hard, containing much sulphate. According to a test[1] made by the Connecticut State Board of Health in 1898 the well (depth not given) at Center School yields better water, as its content of total solids is 156 parts and its total hardness 86 parts per million.

[1] Connecticut State Board of Health Rept. for 1898, p. 291.

Analysis of water from the drilled well of Joseph Belden (No. 81, Pl. IX), collected June 17, 1915.

[R. B. Dole, analyst.]

	Parts per million.
Total solids at 180° C	1,150
Total hardness as $CaCO_3$	580
Silica (SiO_2)	16
Iron (Fe)	Tr.
Calcium (Ca)	187
Magnesium (Mg)	67
Carbonate radicle (CO_3)	Tr.
Bicarbonate radicle (HCO_3)	116
Sulphate radicle (SO_4)	705
Chlorine (Cl)	5.3

WETHERSFIELD.

POPULATION AND INDUSTRIES.

Wethersfield, in the central part of the State in Hartford County, is reached by the Valley branch of the New York, New Haven & Hartford Railroad (stations at Wethersfield and South Wethersfield) and by electric railway from Hartford. There are post offices at Wethersfield and South Wethersfield. The town was settled in 1635 and named in 1637. Its area is 14 square miles.

The population of Wethersfield in 1910 was 3,148. The following table shows the population of the town from 1756 to 1910:

Population of Wethersfield, 1756 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1756	2,483			1840	3,824		1
1774	3,489	40		1850	2,523		34
1782	3,733	7		1860	2,705	7	
1790	3,806	2		1870	2,693		.5
1800	3,992	5		1880	2,173		19
1810	3,961		1	1890	2,271	4	
1820	3,825		3	1900	2,637	16	
1830	3,853	1		1910	3,148	19	

The principal industries are agriculture and the manufacture of tools and mattresses. Shoes are made at the State prison, which is situated here.

TOPOGRAPHY.

The land slopes from the top of Cedar Mountain on the west border eastward to Connecticut River. The highest elevation on the west border is about 325 feet. The land along Connecticut River is less than 20 feet above sea level. Cedar Mountain is formed by an outcrop of Triassic trap brought into position by faulting. The rocks dip eastward and underlie Connecticut River at a depth of about 75 feet. In this part of its course the Connecticut meanders over a broad flood plain, of which about 4 square miles lies within the town of Wethersfield.

All the drainage in Wethersfield reaches the Connecticut through small brooks. In the south part of the town there are considerable areas of swamp land, but the north half is well drained. Goff Brook, which is the only named stream in the town, rises in a small lake in the southwest corner and enters the Connecticut near Rocky Hill.

WATER-BEARING FORMATIONS.

Bedrocks.—Triassic sandstones and shales underlie all of Wethersfield except the extreme western part, where the trap rock comes to the surface Owing to the great amount of faulting to which this region has been subjected, the rocks are intensely fractured and afford storage for ground water. The fracturing, however, is confined to the upper part of the rock zone, and therefore water can not be obtained at very great depths (p. 20).

Till.—The higher elevations in Wethersfield are covered by till, a glacial deposit consisting of a mixture of clay, sand, gravel, and bowlders. The till is 30 to 40 feet thick in some places, but in many others barely covers the rock surface; its average thickness is about 15 feet. (See Pl. IX, in pocket.)

Stratified drift.—The bedrock in the central part of the town is covered with a thin deposit of stratified drift consisting chiefly of sand. The stratified sands found in Wethersfield are parts of the lake deposits, which are more prominent to the north (p. 48). The occurrence of water in stratified drift is discussed on page 15.

Alluvium.—The surface of the flood plain is alluvium. The character of the deposits underlying the alluvium has not been determined in Wethersfield, but they are doubtless similar to the deposits that occupy the same topographic position in Hartford (p. 48).

GROUND-WATER SUPPLIES.

Fifty dug wells, ranging in depth from 9 to 33 feet and averaging about 20 feet, were examined in Wethersfield. The average depth to water was 16 feet, the extremes being 1 foot and 27 feet. Nearly all of the wells in Wethersfield end in till. Four of those examined penetrate rock and nine have recently failed. The daily consumption of water was reported for 22 wells, the average being 23 gallons. Driven points have been used to a small extent in Wethersfield, generally in combination with dug wells. Two of these wells were examined in which the points were driven to depths of 33 and 45 feet, respectively. From one of these 200 gallons per day is used.

Ten drilled wells range in depth from 40 to 200 feet and average 100 feet, and yield 3 to 60 gallons per minute. The daily consumption reported for eight wells ranged from 6 to 3,200 gallons, excluding one well which is not used, and averaged 475 gallons.

Five springs yielding from one-half gallon to 1 gallon per minute were observed. All were gravity springs and three of them were intermittent.

PUBLIC WATER SUPPLY.

Wethersfield is supplied with water from the mains of the Hartford waterworks department (see p. 51), the service being metered and controlled by the Wethersfield fire district.

RECORDS OF WELLS AND SPRINGS.

Information concerning various important features of the wells and springs of Wethersfield is presented in the following tables:

Dug wells in Wethersfield.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.	Depth to rock.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*
2	Mrs. Fois	Slope	145	23	20	125	(a)	0	
5	Standly Viscus	Plain	50	14.5	13	37		3	
8	W. A. Leaver	Slope	60	22	13	47	6		
10		Plain	50	11	10	40			
11		Plain	60	11	8	52	12		
12	R. R. Duncan	Hill	110	30	26	84		40	
14	Goodrich	Plain	85	11	7	78			
20		Plain	215	15	13	202	3	4	
22		Slope	225	23			(a)		
23	Cowles	Hill	223	25	24.5	198.5			22.5
24	Michael Desmond	Slope	205	29	24	81		30	
25	H. E. Wells	Hill	190	28	26	164			
26	C. W. Rhodes	Hill	190	21	20	170	(a)	15	
29	O. A. Raymond	Slope	155	18	13	142		35	
30	George L. Wells	Slope	135	14	12	123		120	
32	Clark	Flat	90	17	15	75		5	
33		Slope	120	16	12	108		15	
35		Hill	116	29	22	94		15	
36	Dix	Hill	150	17	14.5	135.5		5	
39	John A. Isaacson	Slope	110	23	19.5	90.5		40	
40	do	Plain	107	9	6.5	100.5			
41	Antone Gassner	Flat	100	24	17	83		10	
42	Eugene Grover	Flat	100	13	9	91	5	12	
43		Slope	115	23	17	98			
44		Slope	130	22	20	110			
45	Churchill Bros.	Hill	195	21	13	182			
46	C. E. Clark	Hill	210	22	20	190		10	
47	John Olson	Flat	180	24	20	160			
48	J. W. Thomas	Slope	217	25	21	196	(a)		
49	Mrs. Harris	Hill	220	33	27	193		15	
50	K. Kilby	Flat	208	10	8	200		8	
51	H. W. Whaples	Slope	220	33	19	201			
52	Henry Carter	Plain	200	27	26.8	174.2		0	26
54		Hill	200	33			(a)		31
55		Slope	155	30	23	132			
56		Slope	185	23	20	165		6	13
57		Flat	182	15.5	14	168	(a)		
58		Flat	145	11	10	135	(a)	0	
59		Slope	110	24	15.5	194.5			
60		Flat	100	15	14.5	85.5		2	
61	S. E. Wallbeoff	Plain	175	23.5	19	156		75	
62	E. J. Flannagan	Slope	135	23	22.5	112.5	(a)	5	
63	Rev. Waters	Plain	125	14	12.5	112.5			
65	George Baxter	Slope	45	23	10	35			
66		Plain	40	25	23.5	16.5			
67		Plain	45	23	10	35			
68	O. J. Sweeney	Plain	45	22	19	26	(a)		
69		Flat	30	26	1.5	28.5	65		
70	R. G. Fox	Plain	32	15	13	19		40	
71		Plain	35	13.5	11	24			

a Well goes dry.

Drilled wells in Wethersfield.

Map No.	Owner.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Drilled in year—	Cost.	Section.
		Feet.	*Feet.*	*Galls.*	*Galls.*	*Feet.*			
1	A. Mannel	150	44	10	15	15	1908	$100.00	Sand; hardpan; brown sandstone.
7	Goodrich	170	200	5	30	21	1907		Hardpan; brown sandstone.
9	do	170	116	25	0	7	1909	251.00	Hardpan; black shale.
13	R. R. Wolcott	100	60			10	1896		Clay. Water flows.
16	A. G. Hubbard	78	56	60	50	None.	1909	114.00	Brown sandstone.
18	Frank Nowak	73	124	3	8	62	1911	248.00	Clay; gravel.
28	H. W. Wells	195	135	15	15	5	1910	530.00	Trap.
34	F. A. Griswold	117	40	Good.	3,200		1907		
37	John Turner	24	117		6		1905	234.00	
38	J. C. Warner	38	117				1909		

Springs in Wethersfield.

Map No.	Owner.	Elevation above sea level.	Yield per minute.	Improvements.
		Feet.	*Gallons.*	
3	Side of road	135	1	
4		50	1	Keg sunk.
17		76		Hydraulic ram.
19	Mrs. Wallwork	115	1	Keg sunk.
21			½	2 by 2 foot box.
27		175	1	
31	Edward A. Isaacson	95		
53		205		

QUALITY OF GROUND WATER.

An analysis of water from the 200-foot drilled well of Mrs. Goodrich (No. 7, Pl. IX) is given in the accompanying table. It represents a moderately mineralized, fairly hard calcium carbonate or limestone water. According to tests [1] made by the Connecticut State Board of Health the well at the high school (depth not given) yields a water containing 232 parts of total solids and having a total hardness of 120 parts per million, or water similar in composition to that from the Goodrich well, whereas the well water at the second district school contains 140 parts of total solids and has a total hardness of 60 parts per million.

[1] Connecticut State Board of Health Rept. for 1898, pp. 294, 296.

Analysis of water from the 200-foot drilled well of Mrs. Goodrich (No. 7, Pl. IX), collected June 17, 1915.

[R. B. Dole, analyst.]

	Parts per million.
Total solids at 180° C	337
Total hardness as $CaCO_3$	99
Iron (Fe)	.25
Carbonate radicle (CO_3)	5.8
Bicarbonate radicle (HCO_3)	220
Sulphate radicle (SO_4)	41
Chlorine (Cl)	23

EAST HARTFORD.

POPULATION AND INDUSTRIES.

East Hartford is in the central part of Connecticut, in Hartford County. It is reached by the Highland division of the New York, New Haven & Hartford Railroad (stations at East Hartford and Burnside) and by the Springfield branch of the same road (stations at East Hartford and Burnhams); by electric railways from Hartford, Springfield, Glastonbury, Manchester, South Manchester, and Rockville. Post offices: Burnside, Hockanum, East Hartford, and Silver Lane. East Hartford was separated from Hartford and incorporated in October, 1783. The area of the town is 18 square miles.

The census of 1910 reported the population as 8,138. The population from 1790 to 1910 is shown in the following table:

Population of East Hartford, 1790 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1790	3,016			1860	2,951	18	
1800	3,057	1		1870	3,007	2	
1810	3,240	6		1880	3,500	16	
1820	3,373	4		1890	4,455	27	
1830	2,237		33	1900	6,406	45	
1840	2,389	6		1910	8,138	27	
1850	2,497	4					

The principal industries are agriculture (in which tobacco growing is a specialty) and the manufacture of paper. The repair shops of the Highland division of the New York, New Haven & Hartford Railroad are situated here.

TOPOGRAPHY.

The flood plain of Connecticut River is about half a mile wide. Its east edge is marked by an abrupt rise of 35 feet to the broad terrace that extends eastward about 2 miles to the low hills formed by the outcrop of bedrock along the eastern boundary of the town. More than half the town is less than 60 feet above sea level, and not over one-fifth of it exceeds 100 feet. The highest elevation—250 feet—is in Laurel Park, just east of Burnside.

Connecticut River receives all the drainage from East Hartford. Hockanum River, a tributary of the Connecticut, occupies a narrow valley through the middle of the town, and Boyles Brook and Pewterpot Brook drain the remainder. All these streams are small and occupy narrow valleys which have been cut through the terrace.

About one-fourth of the town is under cultivation, and about one-fourth, adjacent to the river, is flood plain; the remaining half is wooded. The terrace lands, constituting about two-thirds of the town, support valuable tobacco fields.

WATER-BEARING FORMATIONS.

Bedrock.—Triassic sandstones come to the surface along the east border of the town. The highest elevation of the rock surface is nearly 250 feet in Laurel Park, just east of Burnside. From this point it slopes downward in all directions but most rapidly westward to about 75 feet below sea level at Connecticut River. The rock is coarse and conglomeratic, is intensely fractured, and owing to texture and structure it contains water which is recoverable by means of drilled wells (p. 20). (See Pl. IX.)

Till.—Unstratified mixtures of clay, sand, gravel, and bowlders deposited by the last retreating glacier cover the bedrock on the hills in Laurel Park. Till is not present at the surface in East Hartford, where the elevation is less than 150 feet, but it forms a comparatively thin layer between the rock surface and the overlying beds of stratified drift throughout the lower parts of the town.

Stratified drift.—The sediments deposited in the Connecticut Valley were in large part assorted and the coarse materials were laid down along the sides and the fine clays in the center of the valley, with materials of medium grade, as sands and fine gravels, in intermediate positions. The zone of gravel deposits barely reaches into East Hartford and sections of gravel are exposed in only a few places in the southeast corner of the town and on the hillsides in Laurel Park. Sand, however, is the predominating surface material. It occurs generally over the terrace lands ranging in thickness from a few inches to 100 feet. The occurrence of water in stratified deposits is discussed on page 15.

Alluvium.—In the flood-plain belt along the river alluvium overlies the stratified drift and in the northwest corner of the town it is about 40 feet thick. It consists principally of fine reddish sand, with a large admixture of mica and some clay. Alluvium extends from the river to the edge of the terrace and follows up the valley of Hockanum River to the wall of the rock valley at Burnside.

SURFACE-WATER SUPPLIES.

The paper mills at Burnside use water power when it is available, but it is generally necessary to employ steam or electric power during the summer months.

Hockanum River receives sewage from towns situated all along its course and large amounts of waste from textile and paper mills. The smaller streams are much polluted from the residential and rural sections of the town.

GROUND-WATER SUPPLIES.

Thirty-one shallow wells, ranging in depth from 8 to 28 feet, and averaging 16 feet, were measured in East Hartford. The depth from the surface of the ground to the surface of the water in these wells ranges from 2 to 23 feet, and averages 13 feet. The yield was determined approximately in two wells and found to be 3 and 4 gallons a minute, respectively. The amount of water used from 12 of the wells was reported as ranging from 5 to 240 gallons a day, and averaging 78 gallons. Five wells not included in this average are not used at all. Six of the wells examined fail during periods of drought.

Measurements of 30 wells on the terrace indicate that the average depth of the water table is about 13 feet. On the flood plain the average depth to water is less than 5 feet, as is indicated by the presence of moisture at the surface throughout the greater part of the year. The fluctuation of the water table averages about 8 feet on the terrace, but on the flood plain it is about 2 feet, not including the distance to which water rises above the surface of the ground in times of flood.

Eleven drilled wells, ranging in depth from 50 to 525 feet and averaging 173 feet, were examined in East Hartford (p. 71). Seven of the wells penetrate and draw their supplies from the sandstone. The yields of six wells range from 4 to 265 gallons a minute, and average 50 gallons. The quantity of water used was reported for two wells as 159,000 gallons and 60 gallons a day, respectively. The cost of construction, as reported for five wells, ranged from $105 to $247.50, and averaged $180.50.

A spring belonging to W. K. Ackley was reported to yield a gallon a minute. The water is pumped by wind to a 40-foot tank, and the consumption amounts to 240 gallons a day. The altitude of the spring is 22 feet above sea level.

The deep deposits of sand forming the terrace store large quantities of ground water. The general direction of the underflow is westward, and the amount of the fluctuation of the water table increases westward to the edge of the terrace. Conditions here are favorable for the construction and operation of driven wells, and wells of this type are recommended to those who desire to obtain water supplies on the terrace. It is probable that supplies sufficient to form important additions to municipal systems are available by this means in this locality.

PUBLIC WATER SUPPLY.

East Hartford is a borough but is governed as a fire district and the water system is owned by the district. The water is obtained in the hills of Glastonbury from brooks that feed two reservoirs having capacities of 1,700,000 gallons and 1,500,000 gallons, respectively, and from these the water is distributed by gravity. The collecting basin comprises about 7 square miles, and is well protected against contamination. This system now supplies most of East Hartford and parts of Glastonbury and South Windsor, or a total population of about 8,000. The daily consumption is about 1,100,000 gallons, or 137 gallons per capita. This supply has been adequate and of excellent quality, but owing to the rapidly growing population and the increasing demand for water the district is prepared to enlarge the supply by the acquisition of other brooks in Glastonbury.

RECORDS OF WELLS.

Information concerning the wells of East Hartford is given in the following table:

Dug wells in East Hartford.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*
1		Plain	45	12	9	36	(a)	0
2	Ruff	Slope	40	11	8	32		0
3	S. E. Roberts	Flat	40	14	12	28		
4	C. F. Roberts	Hill	45	10	6.5	38.5		0
5		Slope	100	23	20	80		80
6	Edward Rouff	Flat	115	20	15	100		0
7	Mary S. Hurlburt	Slope	130	18	14	116	3	100
8	Mulchy	Hill	170	25	22	148	4	160
9	Schoolhouse	Hill	180	23	21	159		
10		Flat	100	16	14	86		
11	R. L. Hoffman	Flat	160	10	8	152		
12	U. S. Bailey	Flat	145	10	8	137		5
13	Teat	Flat	140	11	9	131		120
14		Plain	130	15	14	116	(a)	
16	Hart	Slope	115	19.5	17	98	(a)	120
17	Lange	Plain	107	17	13	94		
19	J. V. Ran	Flat	90	19	16.5	83.5		
21	Charles Ott	Hill	100	14	12	88		25
25		Hill	110	13	10.5	99.5		
30		Flat	60	12	10	50		15
31	Frederick Hayes	Slope	90	8	7	83		6
32	C. H. Stump	Hill	105	17.5	15	90		50
33	E. A. Williams	Hill	110	28	25	85		
34		Plain	65	27			(a)	240
35	Hyram Colburn	Plain	75	12	10	65		20
36	H. L. Cowles	Plain	65	8	6	59	(a)	
37	Andy Bidwell	Plain	65	14	13.5	41.5	(a)	
38		Plain						
39	L. Burnham	Slope	30	16.5	15	15		
41	Hamilton Forbes	Slope	80	10	6	74		
42		Hill	100	22	21	79		0

[a] Well goes dry.

Drilled wells in East Hartford.

Map No.	Owner.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Drilled in year—	Cost.
		Feet.	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*		
15	Herbert Kennedy	120	88	8	60	[a] 70	1906	
18	J. W. Crowell	120	150					
20	Mrs. John Hart	110	125	10		25	1900	$245.00
22	Jacob Ott	120	75	Good.		25	1900	127.00
23	Gustave Banzener	125	71	Good.		22	1900	177.50
24	N. Schug	120	82	4		20	1902	247.50
26	Laurel Park	150						
27	Mrs. Levi	65	50			8		[b] 105.00
28	Mrs. John Hansen	65	60	5		10		
29	Eagle Paper Mills Co	50	280	10			1886	
44	East Hartford Manufacturing Co	38	525				1825	
45	do.[c]	38	395	265	159,000		1855	

[a] Section: Sand; clay; hardpan; brown sandstone.
[b] Drilling only; 18 feet dug.
[c] Well in sandstone; steam pump.

QUALITY OF GROUND WATER.

The 150-foot drilled well of J. W. Crowell (No. 18, Pl. IX) yields a hard, moderately mineralized calcium sulphate water, as the following analysis shows. According to tests [1] made in 1898 by the Connecticut State Board of Health the waters of six school wells (depths not given) in East Hartford range in total solids from 24 to 355 parts, in chlorine from 2 to 72 parts, and in total hardness from 9 to 112 parts per million. These figures illustrate well the variability in composition that may be expected because of local differences in the character of the water-bearing beds.

Analysis of water from the 150-foot drilled well of J. W. Crowell (No. 18, Pl. IX), collected June 16, 1915.

[R. B. Dole, analyst.]

	Parts per million.
Total solids at 180° C	472
Total hardness as $CaCO_3$	236
Iron (Fe)	.30
Carbonate radicle (CO_3)	.0
Bicarbonate radicle (HCO_3)	98
Sulphate radicle (SO_4)	218
Chlorine (Cl)	24

MANCHESTER.

POPULATION AND INDUSTRIES.

Manchester is in the central part of the State, in Hartford County. It is reached by the Highland division of the New York, New Haven & Hartford Railroad (stations at Buckland and Manchester) and by electric railway from Hartford and Rockville; the South Manchester Railroad connects Manchester and South Manchester, and the electric railway from Manchester Green connects with all passenger trains at

[1] Connecticut State Board of Health Rept. for 1898, pp. 291–296.

Manchester; stage from South Windsor to Buckland. Post offices are maintained at Manchester, South Manchester, Buckland, Manchester Green, and Highland Park.

Manchester was separated from East Hartford and incorporated in May, 1823. The area of the town is 21 square miles.

The population of Manchester in 1910 was 13,641. The population from 1830 to 1910 is shown in the following table:

Population of Manchester, 1830–1910.

Year.	Population.	Per cent increase.	Year.	Population.	Per cent increase.
1830	1,576		1880	6,462	53
1840	1,695	8	1890	8,222	27
1850	2,546	50	1900	10,601	29
1860	3,294	29	1910	13,641	29
1870	4,223	28			

The principal industries are agriculture and the manufacture of silk, cotton, and woolen goods, paper, electric appliances, and needles.

TOPOGRAPHY.

Manchester is hilly throughout and practically all the hills are rock. The highest elevation is in the southwest corner of the town, where a group of rocky knobs reaches an elevation of 750 feet above sea level. Two-thirds of the town is more than 200 feet and about half of it is more than 300 feet above sea level. The lowest elevation is 75 feet, where the Hockanum River crosses the east boundary. The terrace lands, which comprise large parts of East Hartford and South Windsor, extend into Manchester and occupy most of the northwest quarter of the town. (See Pl. IX, in pocket.)

About nine-tenths of the drainage of Manchester is received by Hockanum River, which passes through Buckland and Manchester and drains the north half of the town. South Branch, the principal tributary of the Hockanum, passes through South Manchester and drains the south half of the town. The headwaters of Pewterpot Brook and of Salmon Brook reach into the southwest corner of the town and receive a small part of the drainage. The fall of Hockanum River is about 20 feet to the mile, and that of South Branch 60 to 100 feet to the mile east of South Manchester and about 30 feet to the mile from this point west to its junction with the main stream.

WATER-BEARING FORMATIONS.

Bedrocks.—From Manchester Green westward Triassic sandstones comprise the rock floor, but eastward the bedrocks are granite gneisses. The dividing line between these formations is a fault extending due north and south through the town. The rock surface is rugged and has a maximum relief of more than 300 feet. Joints or cracks in the rocks are apparent in all exposures, and they afford storage for ground water as explained on page 20.

Till.—On the highlands of Manchester the rock is covered with till or bowlder clay (p. 15), which is in places more than 30 feet thick and is of general occurrence at elevations exceeding 200 feet. It probably occurs also in contact with the rock surface at lower elevations where the surface material is stratified drift. Till varies widely in porosity, and consequently in water-bearing capacity.

Stratified drift.—The occurrence of gravel deposits in a belt nearly 2 miles wide extending from north to south through the middle of Manchester, and of sand covering the rock in the northwest quarter of the town, suggests the conclusion that the stratified drift is deepest beyond the borders of the town. The deposits of sand and gravel are important water bearers, the porosity being high and the storage capacity consequently large. The occurrence of water in glacial drift is discussed on page 15.

SURFACE-WATER SUPPLIES.

Water power has been developed at Buckland, Manchester, and South Manchester, but the supply is not adequate during dry seasons and some of the plants have been abandoned. Mills are frequently obliged to run slack or to employ steam power. Reservoirs for municipal supplies have been located at South Manchester, on Porter Brook near the east border of the town, and at the headwaters of Hop Brook. With few exceptions these reservoirs have furnished adequate supplies.

Large quantities of sewage and wastes from textile mills are discharged into the streams. Wastes from some of the mills in South Manchester are discharged on filter beds which remove a part of the pollution, but much of the polluting matter in solution is carried through and enters the streams. The reservoirs that supply the town are above the sources of pollution and are protected against contamination.

GROUND-WATER SUPPLIES.

Sixty-four wells ranging in depth from 3 to 56 feet and averaging 21 feet were examined in Manchester. The range in depth to water was from 1 foot to 35 feet and the average was 11 feet. Most of these wells end in till and eight of them penetrate rock. They yield in general sufficient water for domestic needs, but 10 wells have recently been dry. The consumption of water, as reported from 28 wells, and not including 9 wells which are not used, ranges from 5 to 120 gallons per day and averages about 23 gallons.

The depth of 27 drilled wells ranges from 45 to 500 feet and averages about 152 feet. The yield ranges from 3 to 150 gallons a minute. Satisfactory domestic supplies are obtained from drilled wells. Two wells drilled at the Porter reservoir for use in the municipal system were about 200 feet deep and yielded 50 gallons per minute, but they were abandoned because they did not flow and the yield was considered too small to warrant pumping for municipal distribution. Furthermore, when the wells were pumped several important springs which contributed to the reservoir were cut off and it became evident that no additional supply was obtained by pumping these wells.

On the slopes in Manchester are numerous springs, some of which are permanent and furnish sufficient water for domestic supplies. Ten springs were examined ranging in yield from 1.5 to 15 gallons a minute and averaging about 6 gallons. None of these are used on account of their inconvenient situation.

PUBLIC WATER SUPPLIES.

The Manchester Water Co. supplies the village of Manchester at a flat rate from a reservoir near Lydallville, holding between 4,000,000 and 5,000,000 gallons, and the Cheney Bros. Water Co. supplies South Manchester from two reservoirs on Porter Brook near the east border of the town. The reservoirs of the latter company receive drainage from an area of about 1½ square miles and have a total storage capacity of about 161,000,000 gallons. The population supplied is 9,000. The system is partly metered.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells of Manchester is presented in the following tables:

Dug wells in Manchester.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.	Depth to rock.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*
3a	Z. F. Hills	Plain	120	19	17	103			
4		Plain	150	16	14	136			
7		Hill	175	22	21.8	153.2		0	
8	Gillman	Plain	155	35			(a)	0	32
9		Plain	154	26	22	132		15	13
13	Mrs. E. E. Gillman	Plain	150	27	26	124		30	
17	Slater	Slope	245	12	10	235		12	
18	C. T. Tack	Slope	220	b 7	5	215			
19	M. Doyle	Slope	230	b 3	1	229	5	25	
20	W. McNall	Slope	220	b 9	7	211	5	50	9
21		Plain	200	16	14	186			
22	H. W. Wetherell	Hill	225	36	35	195		10	
23		Hill	190	30	29.8	160.2		0	
24		Hill	183	34					

a Well goes dry. b Well dug in spring.

Dug wells in Manchester—Continued.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.	Depth to rock.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*
25		Plain	185	20	18	167		0	
26		Plain	200	22	20	180			
28		Slope	235	26	25	210		10	
29	V. Johnson	Plain	235	14	11	224			
30		Flat	295	16	15	280			
31	Risley	(a)	425	21	17	408		60	
32	W. L. Fish	(a)	420	12	11.9	408.1		0	12
34	L. McKee	(a)	430	22	18.5	411.5			
35	do	Flat	380	20	18	362		10	
36	Joseph Hansen	Slope	390	22	19	371	2.5		
37			385	8	5	380			
42		Plain	310	22	20	290	(b)	5	
43		Plain	300	13	11.5	288.5	(b)	0	
44		Slope	285	25	23	262		0	
45	R. Hastings		260	24	22.5	237.5			
46	G. Henson	Slope	260	14	13.5	146.5			
50		Plain	225	29	28	197			
53	F. Tiechert	Plain	180	27	26.5	153.5	(b)	5	27
54		Plain	150	28	27.8	122.2		0	
56	Cushman	Plain	145	14	13.5	131.5			
57		Plain	145						
59	Leritz	Plain	155	25	24	131		20	
60	Hill Bros	Plain	130	25	22	108			
61	Ralph Noyes	Slope	140	22	19	121		80	
62	J. A. Roberts	Hill	160	c 61					
63	F. N. Buckland	Slope	170	18	15	155			
64	do	Slope	170	17			(b)		
65	Ruddell	Plain	150	14	13	137	(b)		14
66		Plain	180	29	26	154			
70	Schoolhouse	Slope	230	16	11	219			
71		Slope	245	25	18	227			
72		Plain	295	29	25	270		8	
73		Slope	265	17	16	249			
74	M. Schildge	Slope	385	24	21.5	363.5		10	
76	Fred Browsky	Plain	265	21.5	20	245		25	
77	Mrs. Weidman	Plain	260	19	16	244	1.5	15	
78	Barber	Slope	290	27	24	266		7	
79	Wm. Keish	Plain	275	20	17	158			
81	John Bissel	Plain	290	36	32	258		20	
84	E. T. Carrier	Hill	225	32	31.8	193.2	4	30	
87		Hill	290	31	29	261		35	
88	H. F. Case	Slope	300	32	27	273		0	
91	Katherine Calhoun	Slope	280	17	15.5	264.5	(b)	5	17
92	John Porterfield	Slope	280	30	28	252.5		8	
93		Slope	420	17	15.2	404.5			
94	Ida Wear	Slope	418	13	11.5	406.5		5	
96	D. J. Findley	Flat	460	15	13	447		8	9
98		Hill d	750	23	21.5	728.5			
99	Joseph Sipper	Slope	700	20	19	681		20	
100	J. Barthleim	Hill	710	15	13	697		5	
101	Matuchak	Hill d	740	18	17.2	722.8	(b)		

a Located in Bolton.
b Well goes dry.
c Dug 45 feet; point driven 16 feet.
d Well dug in spring.

Drilled wells in Manchester.

Map No.	Owner.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Diameter.	Drilled in year—	Cost.
		Feet.	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*	*Inches.*		
3	H. J. Wickham	100	125	5	400	16		1906	$312.50
5	Clint Williams	155	67	Good.		5			74.00
6	....do	155	30	Good.		28			60.00
10	Edward Hayes	150	[a] 207	12	450	43			[b] 1,050.00
11	Mrs. Bean	15	102		50				229.00
12	Burr	150	225	Good.				1905	
14	Sumatra Tobacco Co.	150	250						625.00
38	E. S. Ela	400	271					1906	
39	Fred Pitkin	355	200	20	800	4		1901	
40	Wadsworth	315	60			20			
41	W. Pitkin	310	60			20			
47	A. C. Knofla	270	64	3	20				
48	Corbin	255	71	60	15	20		1904	
49	Frish	230	70						
51	Jos. Bier	180	[c] 108	10	12	55		1906	216.00
52	Stone	177	131	5				1908	262.00
55	M. Hayes	118	175			20		1901	
58	Daniels	145	[d] 117						
68	Charles Stimburg	190	[e] 188	Good.		38		1909	264.00
69	Charles Pukosky	200	[e] 105	25	20	16		1908	210.00
80	W. B. Porter	280	[c] 104	Good.	40	54		1910	208.00
82	F. Wittkopski	280	99		25	22		1911	198.00
83	Joseph Hager		150		20			1908	300.00
85	E. T. Carrier	240	[f] 45	4				1899	
86	Renney	280	137						
102	Cheney Bros		450	[g] 150	([h])	10	8	1903	
103	....do	180	500	[i] 150	([j])	50	8	1911	
3B	Mrs. Chapman	120		[k] 3	([j])		6		

[a] Through sandstone and black slate.
[b] Cost of whole system.
[c] Through sandstone.
[d] Drill passed through 11 feet of rock; bottom of well is gravel.
[e] Through red sandstone.
[f] Through sand and clay.
[g] Flowing; mineral content 1,000 grains per gallon.
[h] Total yield.
[i] At depth of 80 feet.
[j] Not used.
[k] Flowing.

Springs in Manchester.

Map No.	Owner.	Elevation above sea level.	Yield per minute.	Improvements.
		Feet.	*Gallons.*	
1	H. J. Wickham	120	8	
2	....do	120	8	
15	Sumatra Tobacco Co	160	15	Piped to several houses.
16		160	15	
27		220	2.5	
33	W. L. Fish	[a] 405	3	
75	Frank Schildge	340	Small.	
89	Case Bros		1.5	
90	....do		4	
95	D. C. Finley	500	2	Piped to barn.
97		500	1.5	

[a] Spring located in Bolton.

QUALITY OF GROUND WATER.

The four analyses of water from drilled wells in Manchester reported in the following table indicate considerable difference in mineral content, doubtless due to local differences in the character of the water-bearing beds. Two of the wells yield soft water of low mineral content and two yield hard water high in sulphate. All contain little chlorine.

Analyses of water of drilled wells at Manchester.

[Parts per million; R. B. Dole, analyst.]

Constituents.	1	2	3	4
Total solids at 180° C.	258	[a] 99	99	455
Total hardness as $CaCO_3$	160	55	26	255
Silica (SiO_2)	......	12	......	15
Iron (Fe)	.25	Tr.	.7	.10
Calcium (Ca)	......	24	......	......
Magnesium (Mg)	......	2	......	......
Carbonate radicle (CO_3)	.0	.0	.0	.0
Bicarbonate radicle (HCO_3)	94	58	26	74
Sulphate radicle (SO_4)	106	20	5.3	239
Chlorine (Cl)	4.9	2.4	4.2	2.1

[a] Much organic matter.

1. Well of Mrs. Chapman (Pl. IX, No. 3B); sample collected June 16, 1915.
2. Well of H. J. Wickham (Pl. IX, No. 3), 125 feet deep; sample collected June 16, 1915.
3. Well of F. Whitkofski (Pl. IX, No. 82), 99 feet deep; sample collected June 16, 1915.
4. Well of Joseph Hager (Pl. IX, No. 83), 150 feet deep; sample collected June 16, 1915.

SOUTH WINDSOR.

POPULATION AND INDUSTRIES.

South Windsor, in the central part of Connecticut, in Hartford County (Pl. IX), is reached by the Highland division and the Springfield branch of the New York, New Haven & Hartford Railroad (station at South Windsor, East Windsor Hill, Rye Street, and Burnhams), and by electric railway from Hartford and Springfield to South Windsor and East Windsor Hill. The village of Wapping is reached by stage from Buckland station in Manchester. Post offices are maintained at South Windsor, East Windsor Hill, Wapping, Rockville R. D. No. 3, Burnside R. D. No. 1, and Broad Brook R. D. No. 1. South Windsor was incorporated in May, 1845; previous to this date the town was included in East Windsor. The area of the town is 30 square miles.

The population of South Windsor in 1910 was 2,251. The population from 1850 to 1910 is shown in the following table:

Population of South Windsor, 1850 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1850	1,638	....	....	1890	1,736	....	9
1860	1,789	9	....	1900	2,014	16	....
1870	1,688	....	6	1910	2,251	12	....
1880	1,902	13	....				

The principal industry is agriculture, especially tobacco growing About one-third of the town is under cultivation, and about 10 square miles is in woodland.

TOPOGRAPHY.

The west half of South Windsor, between the longitude of Wapping and Connecticut River, is a low flood plain, lying in general less than 50 feet above sea level. This flood plain is a little more than a mile wide at the southwest corner of the town and gradually narrows to less than a half mile in the northwest corner. A terrace, 3 miles wide, extends eastward from the flood plain. South of Podunk River the surface of this terrace is somewhat hilly, owing to elevations of the rock surface, which reaches a height near Vintons Mills of 275 feet; but from Podunk River north to the latitude of East Windsor Hill the surface is flat and stands at an elevation of about 85 feet. Between Podunk River and Stoughtons Brook the terrace is divided into two benches. The upper one is continuous with the plain in the north end of the town and the lower one, about a half mile wide, stands 50 feet above sea level.

East of the terraced lands the town is hilly. The highest elevation, 390 feet, is in the northwest corner. The average stream gradient in the hilly section is about 60 feet to the mile; in the western half of the town it is about 20 feet to the mile.

The drainage of South Windsor reaches Connecticut River through Podunk River, Stoughtons Brook, and Scantic River. A comparatively small area along the east border is drained by the headwaters of Hockanum River. These streams are all small and the only power developed within the town is at Vinton Mills, where a small sawmill is operated intermittently.

The flood plains along the Connecticut produce hay where the ground is not swampy.

WATER-BEARING FORMATIONS.

Bedrocks.—The bedrocks which come to the surface in many parts of South Windsor are brown sandstones of Triassic age. These rocks underlie the whole of South Windsor but are covered in the eastern part of the town by a heavy mantle of glacial drift. Subsequent to their deposition the sandstones throughout this region were faulted and fractured on a large scale, and as a result the rocks at the present time are cut in every direction by joints which hold ground water (p. 20).

Till.—On the hills along the east border of the town the bedrock is covered with till or hardpan—a mixture of clay, sand, and gravel containing bowlders, some of which are 2 or 3 feet in diameter. Till immediately overlies the rock surface throughout the town, but in the eastern part it is covered by stratified deposits.

Stratified drift.—Thin deposits of gravel are found in South Windsor at elevations between 100 and 200 feet above sea level. Below elevations of 100 feet the rock is covered with sand containing lenses of clay. The occurrence of ground water in glacial deposits is discussed on page 15.

Alluvium.—The flood-plain area marks the distribution of alluvium. This deposit is about one-half mile wide except near the mouth of Scantic River, where it extends eastward into the Scantic River valley, beyond the border of the town. The alluvium consists chiefly of sand, but small amounts of clay and organic matter are also present.

GROUND-WATER SUPPLIES.

Sixty-four dug wells, ranging in depth from 8 to 30 feet and averaging about 17 feet, were measured. The depth to water ranges from 7 to 28 feet and averages about 12 feet. Most of these wells are situated in stratified deposits and two of them penetrate rock. Thirteen of the wells have recently been dry. The daily consumption, as reported for 22 wells, ranges from 6 to 4,480 gallons. Driven points are being successfully used in South Windsor. The yield, as determined by measurements of three wells, is about 10 gallons per minute. The depths of seven wells range from 16 to 28 feet and average 22 feet.

The average depth of 13 drilled wells is 123 feet, the extremes being 38 feet and 206 feet. Their yields range from 2 to 30 gallons a minute and average 16 gallons. The consumption as reported for seven wells ranges from 10 to 100 gallons a day.

Seven springs were examined yielding from 1 to 12 gallons a minute and averaging 4 gallons. Four of these are used for domestic supplies, in which the consumption ranges from 60 to 500 gallons a day. All are gravity springs, but they do not respond too readily to changes in the weather. The springs now in use have not been known to fail.

In many places in the eastern part of the town the best supplies both for private and public uses are to be obtained from springs. Springs so situated that the water may be delivered to buildings through pipes by gravity usually afford the most economical supplies and should be preferred to wells. Driven wells are recommended in the areas of stratified drift in the western part of the town (Pl. IX) because of their high efficiency and low cost, and where larger supplies are required than may be obtained from a single well of this type a gang of points connected at the surface to a common main is likely to produce the required amount (p. 40). Infiltration galleries (p. 42) situated at the base of the terrace should afford large supplies, and this method of development, as well as the use of driven wells, should receive consideration in connection with the proposed public supplies.

In areas covered by till (Pl. IX) the best type of well for moderate domestic service is a sanitary dug well (p. 43). Water from these sources is generally good and is adequate for domestic needs. Where the drift is so thin that water is not available throughout the year and where larger supplies are required than may be obtained from dug wells drilled wells may produce adequate quantities of water (p. 38); indeed, drilled wells may yield domestic supplies in any part of the town.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of South Windsor is presented in the following tables:

Dug wells in South Windsor.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*
1	E. A. Sawyer	Hill	75	16	12	63		20
2		Hill	70	20	17.5	52.5		
3		Plain	90	11	7	83	(a)	
5	Edward Risley	Plain	110	10	8.5	101.5	(a)	20
6		Plain	110	10	8	102		
8	John Bryan	Hill	320	28				
9	E. Belknap	Slope	280	15	14	266		
13	Frank Dart	Slope	315	14	12	303	(a)	
14		Plain	280	30	28	252	(a)	
15	Hyram Skinner	Plain	280	18	17	263		0
16	Groves	Hill	285	17	16	269		
17		Slope	210	21	20.5	189.5		
19	Fred A. Pierce	Plain	190	24	23.5	146.5		
20	E. H. Nevers	Flat	185	21	18.5	167.5		
21	W. Green	Plain	190	18	17	173		40
22		Plain	192	24	22	170		
24	J. M. Preston	Slope	140	18	16	124		25
25	M. D. Sullivan	Slope	120	15	12	108		
27	Aug. Stubenrough	Slope	160	14	12	148		
31	Frank H. Pierce	Plain	90	11	9.5	80.5	3.7	70
32		Plain	95	11	7	88		15
33	G. W. Hayes	Plain	90	19	18	72		0
36	Arthur M. Hayes	Plain	90	10	8.5	81.5		15
37	W. T. Walker	Plain	90	24.5	23.5	66.5	(a)	6
38	L. P. Brown	Slope	135	28	27	108	(a)	
39	G. S. Thresher	Hill	98	24			(a).05	
44	R. F. Southergill	Hill	75	16	14	61		15
47	M. J. Meade	Plain	45	14	12	33	4	80
48	Kinary	Plain	40	13	12.5	27.5		0
50		Plain	45	15	14	31		
52		Slope	20	15	13.5	6.5		15
53	Leo Burnham	Plain	40	16	15	25		
56	H. W. Chandler	Plain	70	17	15	55		600
57	James Bradley	Plain	72	15	13	61		
58	J. E. Lathrop	Plain	70	15	12.5	77.5		4,480
59	do.	Plain	75	12	11	64	(a)	12
60	Elmore	Plain	65	18	17	48		
61		Plain	73	19	17.5	55.5		
62	Harry Holland	Hill	115	18	17.8	97.2	(a)	
63	J. L. Hayes	Slope	120	[b]12	10	110		
64	L. A. Miner	Hill	130	24	21	109	3	10
65		Slope	130	13	12.8	117.2	(a)	
66	G. E. W. Naples	Plain	110	16	14.5	95.2	(a)	10
68		Plain	75	15	11	64		
69		Plain	80	13	12	68		
70	Schoolhouse	Plain	80	14	13.8	66.2		
71	Geo. A. Smith	Plain	80	19	17	63		0
72	do.	Plain	80	22	18.5	61.5		
74	Johnson	Plain	115	20	18.5	96.5		
75	do.	Plain	115	20	18.5	96.5		
76		Plain	118	11.5	11	107		
77	Burgess	Plain	125	16	14	111		
78	C. P. Clark	Plain	110	19	18	92		
81	Schoolhouse	Slope	140	13	12	128		0
82	Henry Cady	Slope	160	14	11	149		15
83		Slope	150	8	7.8	142.2		0
84		Hill	220	12				0
85	Stroka	Slope	155	13	12.5	142.5	(a)	10
87		Slope	185	18	15.5	169.5		0
92	P. L. Burgess	Slope	260	17	14	246		
93	C. L. Whitmore	Hill	270	19	18.2	251.8		
96	C. T. Tack	Hill	268	14	13	255		15
97	K. Mikolite	Slope	200	14	8	192		20
98	Frank Rogers	Hill	335	[c]22	19.5	315.5		10

[a] Well goes dry. [b] Depth to rock, 12 feet. [c] Depth to rock, 16 feet.

Driven wells in South Windsor.

Map No.	Owner.	Elevation above sea level.	Depth.	Depth to water.	Yield per minute.
		Feet.	*Feet.*	*Feet.*	*Gallons.*
34	G. W. Hayes		28	16	[a] 10
35	do		28	16	[a] 10
40					
41					
42					
43					
45					
46	E. D. Farnum	50	27		10
49		45	18		Good.
51		45	20		Good.
54	Mrs. Ray		16		[b] Good.
55	Geo. H. Andrews	65	18		Good.

[a] 30 to 40 gallons used per day. [b] 40 gallons used per day.

Drilled wells in South Windsor.

Map No.	Owner.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Drilled in year—	Cost.
		Feet.	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*		
11	J. S. Brown	315	137		100			
12	Frank Dart	335	162	13	60	47	1911	
18	J. W. Graham	220	[a] 161	30	85	3.5		
23	Nickols	135			30			
28	Johnson	150	[b] 118	5	84			
67	E. E. Clark	130			40		1908	
79	L. J. Grant	120	160	20			1911	
80	Wapping M. E. parsonage	120	110			68	1911	
86	C. Grant	170	100				1908	
88	Wm. Clark	170	[c] 96	15		30	1907	$240.00
89	Will Felt	215	110	2			1901	
90	Simler	130	102	25				
94	P. Jennings	250	100	15	10		1909	
95	Mrs. W. C. Thompson	200	38	20		8	1899	50.00
99	Levi Felt	350	206		0			

[a] Red sandstone. [b] 30 feet of sand, then hardpan to rock. [c] Sand, gravel, and rock.

Springs in South Windsor.

Map No.	Owner.	Elevation above sea level.	Yield per minute.	Amount used per day.	Improvements.
		Feet.	*Gallons.*	*Gallons.*	
4	Michael McGrath	95	1.5	70	Hydraulic ram.
7	O'Connor & Havlin tobacco farm	138	10	100	Wind and gasoline engine.
10	Budy	315	1.5		Wind. Piped to house and barn.
26		90	2.5		
29		130	1		
30		100		60	Hydraulic ram.
73	Geo. A. Smith	100	2		Do.
91	Wapping creamery	200	12	500	

EAST WINDSOR.

POPULATION AND INDUSTRIES.

East Windsor (Pl. IX) is in central Connecticut in Hartford County. It is reached by the Highland division and the Springfield branch of the New York, New Haven & Hartford Railroad, with stations at Osborn, Broad Brook, and Melrose, and by the main line of the same road, with station at Warehouse Point; by electric railways from Hartford, Springfield, and Rockville. Post offices: East Windsor, Windsorville, Melrose, Broad Brook, and Warehouse Point.

East Windsor was taken from Windsor and incorporated in May, 1768. The area of the town is 27 square miles. The population in 1910 was 3,362.

The following table shows the population of the town from 1774 to 1910:

Population of East Windsor, 1774 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1774	2,999			1850	2,633		a 27
1782	3,237	8		1860	2,580		2
1790	2,600		20	1870	2,882	12	
1800	2,766	6		1880	3,019	4	
1810	3,081	11		1890	2,890		4
1820	3,400	10		1900	3,158	9	
1830	3,536	4		1910	3,362	6	
1840	3,600	2					

a South Windsor was set off from East Windsor in 1845.

About one-fourth of East Windsor is wooded and two-thirds of the town is under cultivation. Approximately 1,200 persons are engaged in agriculture. The manufacture of woolen and silk goods also forms an important industry. Rye gin is made on a large scale at Warehouse Point.

Water power is used at Broad Brook and at Windsorville, both of which are situated on tributaries of Scantic River.

TOPOGRAPHY.

Along the east border of East Windsor irregularities in rock surface produce hills ranging in height from 200 to 300 feet. The area characterized by this topography is about a mile wide and extends along the entire east border. Between this area and Connecticut River is a plain which is about 100 feet in general elevation and which is dissected nearly to sea level by Scantic River and its tributaries. The valleys of these streams are narrow and the areas between them are poorly drained. This plain is probably a part of the bed of a lake which formerly occupied much of the Connecticut Valley north of Rocky Hill.

The principal stream, Scantic River, enters the town about a mile west of Melrose and flows diagonally across to the southwest corner, where it joins the Connecticut. Its principal tributaries are Broad Brook and Ketch Brook, which drain the east half of the town. The west half is drained by Priors Creek and several short brooks which empty into the Connecticut. (See Pl. IX, in pocket.)

WATER-BEARING FORMATIONS.

Bedrocks.—Bedrocks—all Triassic sandstones—appear at the surface in the hills just east of Warehouse Point, at numerous places along Scantic River and its tributaries, and in the hills along the east border of the town. Numerous joints, many of which are water bearing, traverse the rock in all directions and constitute the source of the ground water obtained from rock borings, as explained on page 23.

Till.—The bedrock in the eastern part of the town is covered with till—a glacial deposit consisting of mixtures of bowlders, gravel, and sand, with small amounts of clay—which ranges in thickness from a mere film on the hilltops to 25 or 30 feet in the valleys. Wells drilled through the stratified drift in the eastern part of the town have all encountered till immediately overlying the bedrock. It is believed, therefore, that till lies between the stratified drift and the rock surface. The occurrence of water in till is discussed on page 15.

Stratified drift.—The till-covered areas are surrounded by stratified deposits consisting of coarse sand and gravel, and gravel deposits are found along the east border of East Windsor overlying the till at elevations of less than 225 feet. On the plains in the eastern part of the town the surface material is principally sand containing lenses of clay and ranging in depth from a few feet to about 100 feet (p. 15).

Alluvium.—Immediately along Connecticut River the surface material is alluvium, but the deposit is only a few yards wide. The alluvium also extends up the valley of Scantic River from its mouth through East Windsor and Enfield.

GROUND-WATER SUPPLIES.

The depth of dug wells in East Windsor, as determined by measurement of 31 wells, ranges from 10 to 65 feet and averages 17 feet. Depth to water ranges from 2 to 58 feet and averages 14 feet. Most of these wells end in stratified deposits and yield adequate supplies. Only two wells have recently been dry. The daily consumption of water reported for 15 wells ranges from 15 to 100 gallons. Four of the wells examined are not used.

Twenty-seven drilled wells, ranging in depth from 86 to 386 feet and averaging about 166 feet, and yielding 2.5 to 85 gallons a minute, were examined. Twenty-six of these wells penetrate rock. The daily consumption, as reported for 14 wells, ranged from 10 to 25,000 gallons.

Small springs are common along the streams but are generally intermittent and are so situated as to be unimportant as sources of water for domestic use. A few permanent springs on the slopes in the central and western part of the town are capable of development. One of these yields about 6 gallons per minute and is subject to slight variation throughout the year.

In the western part of the town, where the surface deposits consist largely of sand, one of the most suitable types of wells is the driven well described on page 40. Wells of this kind are especially desirable for tobacco irrigation, as they may be sunk at convenient spots in the fields and may be constructed in a few hours and at a very moderate cost. Such wells would be very useful in fields to which water must now be hauled from distant wells.

PUBLIC WATER SUPPLY.

A private company supplies water to Broad Brook, principally for fire protection but to some extent for domestic use. One reservoir, about 5,000,000 gallons in capacity, is situated about 1½ miles southeast of the village. The revenue is collected at a flat rate. A reservoir might be constructed 2 miles east of the city near the head of the tributary that joins Broad Brook just north of the city, but the quantity of water carried by this stream should be determined before any development is undertaken. The available head is about 75 feet and the catchment area is about 3 square miles. Wells might also be sunk by driving perforated well casings into the stratified deposits near Scantic River to a depth of about 100 feet or to bedrock.

RECORDS OF WELLS.

The available information relating to the wells in East Windsor is set forth in the following tables:

Dug wells in East Windsor.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.	Depth to rock.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*
1	W. A. Lord	Hill	130	18	17	113		0	18
2	John Winker	Plain	100	18	13	87			
4	Martin Cuscovitch	Plain	115	12	8	107		20	
5	M. Bagg	Plain	120	10	6	114		20	
6	C. C. Parker	Plain	110	14	9	101		25	
7	Fred Schlichting	Plain	115	15					
10		Plain	145	15	14	131			
12	Wm. Hill	Plain	120	18	15.5	104.5	5	35	
13	Richard Carroll	Hill	196	65	58	138			
23	Herman Krah	Hill	130						
24	I. H. Stiles	Slope	130	13	12	118			
25	H. A. Hunt	Plain	105	13	10	95		20	
26	Barton Wells	Plain	100	11	9	91			
28	Thomas Porter	Plain	107	14	12	95			
29		Plain	100	13	7	93		20	
30	Allen	Flat	100	14	2	98			
31		Plain	107	18	16.5	90.5			
32	E. P. Carter	Hill	130	14	11	129		30	
34		Plain	55	12	9	46			
35	J. O. Walker	Slope	60	18	16.5	43.5	(a)	20	
36		Plain	65	15	13.5	41.5		40	
37		Hill	80	12	10.5	69.5		0	
38	W. P. Bissel	Hill	106	25	14	92		20	
39		Hill	100	12	6	94			
40	Town farm	Slope	110	11	8	102		100	
41	J. F. Strong	Hill	105	27	25.5	79.5	2.5	15	
45	H. J. Allen	Hill	140	21	13	127		25	
47	W. H. Tallcott	Hill	80	12	10	70	(a)	15	
48	John Sheridan	Slope	95	25	23.5	71.5		0	
56		Flat	90	17	15	75			
58	Barnard	Plain	85	22	19	66			
59	H. M. Doane	Slope	220	22	18.5	201.5	10	30	22

a Well goes dry.

Drilled wells in East Windsor.

Map No.	Owner.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Drilled in year—	Cost.	Section.
		Feet.	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*			
3	H. W. Allen	105	222	30	50	120	1906	$444.00	Sand; clay; brown sandstone.
8	E. M. Granger	150	270	22	60	100	1900	540.00	Sand; clay; hardpan.
9	A. H. Grant	150	100	15	75	50	1902	....	
11	Francis Dowdy Distilling Co.	125	310	85	....	40	1900	620.00	Sand; gravel; hardpan.
14	Michael Sullivan	230	150	75	100	60	1905	300.00	Sand; hardpan.
15	Ertel	148	109	40	....	56	1910	218.00	Do.
16	F. A. Curtis	150	102	40	25	60	1907	204.00	Do.
17	Frank Dowd	150	100	48	....	73	1911	200.00	Do.
18	Wm. Morris	178	138	40	....	86	1910	276.00	Do.
19	R. C. Lasbury	180	257	34	80	135	1910	514.00	Do.
20	.....do	175	109	12	....	45	1911	218.00	Sand; quicksand; bowlders.
21	J. P. Norton	180	86	32	....	70	1900	360.00	Sand; quicksand; hardpan.
22	Miskill	170	154	18	....	48	1911	340.00	Sand; hardpan.
27	Robert Bartlett	200	386	2.5	40	21	1910	772.00	Sand; clay; hardpan.
33	E. Newberry	145	143	5	60	15	1909	321.75	
42	Farnham	145	298	50	25,000	168	1910	596.00	Sand; hardpan.
43	Fred Ellsworth	145	160	Small.	....	....	1885	....	
44	Albert Ellsworth	135	246	30	1,285	166	1911	492.00	Sand; clay; hardpan.
49	John Sheridan	200	102	6	20	10	1910	204.00	Sand; hardpan.
50	Joseph Titus	200	155	10	10	23	1911	310.00	Do.
51	John Leentie	200	210	16	....	80	1911	420.00	Sand; clay; hardpan.
52	Michael Dunn	195	90	6	....	38	1903	190.00	Sand; hardpan.
53	Wm. Stasowitz	200	87	25	....	23	1910	174.00	Do.
54	Andrew Hoffman	210	86	10	30	40	1903	172.00	Do.
55	Jacob Gilson	215	114	3	....	32	1911	228.00	Do.
57	Geo. Barnard	220	211	10.5	30	9	1911	422.00	Do.
60	Howard Hamilton	225	86	60	....	76	1910	172.00	Do.

QUALITY OF GROUND WATER.

The deeper of the two wells analyses of whose waters are given in the accompanying table yields a highly mineralized sulphate water. Data at other places in Connecticut, however, do not corroborate the conclusion that the shallower rock water is uniformly better than the deeper, and possibly the results of analyses of other rock waters in East Windsor would indicate opposite conditions.

Analyses of water of drilled wells in East Windsor.

[Parts per million; R. B. Dole, analyst.]

Constituents.	1	2
Total solids at 180° C	202	849
Total hardness as $CaCO_3$	142	133
Silica (SiO_2)	....	10
Iron (Fe)	Tr.	.15
Calcium (Ca)	....	54
Magnesium (Mg)	....	1.5
Carbonate radicle (CO_3)	.0	.0
Bicarbonate radicle (HCO_3)	182	86
Sulphate radicle (SO_4)	11	344
Chlorine (Cl)	6.9	29

1. Well of E. Newberry (Pl. IX, No. 33), 143 feet deep; sample collected June 18, 1915.
2. Well of Robert Bartlett (Pl. IX, No. 27), 386 feet deep; sample collected June 18, 1915.

WINDSOR.

POPULATION AND INDUSTRIES.

Windsor, in the central part of the State, in Hartford County, is reached by the Hartford division of the New York, New Haven & Hartford Railroad, with station at Windsor and flag stations at Wilsons and Haydens; by electric railway from Hartford to Rainbow and from Springfield. Post offices are maintained at Windsor, Poquonock, Rainbow, and Wilson.

Windsor was settled in 1635 and named in 1637. The area of the town is 31 square miles.

The population of the town in 1910 was 4,178. The following table shows the status of population from 1756 to 1910:

Population of Windsor, 1756 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1756	4,220			1840	2,283		29
1774	2,125		[a] 49	1850	3,294	44	
1782	2,382	12		1860	3,865	14	
1790	2,714	14		1870	2,783		28
1800	2,773	2		1880	3,058	10	
1810	2,868	3		1890	2,954		3
1820	3,008	5		1900	3,614	22	
1830	3,220	7		1910	4,178	16	

[a] East Windsor was set off from Windsor in 1768.

About one-third of Windsor is under cultivation. The principal industry is agriculture, the main crop grown being tobacco.

Nearly one-half of the area included in the town is wooded.

Water power is developed at Rainbow and Poquonock, both of which are situated on Farmington River.

TOPOGRAPHY.

Windsor lies entirely within the area once leveled by glacial lake deposits, and the present topography has been produced by the dissection of the lake plain. The highest elevation in the town—270 feet above sea level—is on the boundary near the northwest corner. At no other place does the elevation exceed 220 feet. The flood plain of Connecticut River, which is less than 20 feet above sea level, is about a mile wide near the mouth of Farmington River, but narrows both northward and southward from this locality, covering an area of about 3 square miles. The average elevation of the town is about 150 feet, and about four-fifths of its area lies between 100 and 200 feet above sea level. (See Pl. IX, in pocket.)

Farmington River has cut a narrow, steep-walled valley across the town and its tributaries are short and straight, leaving considerable areas between them without adequate drainage. Small lakes and ponds are found on these areas after rains, and in two or three shallow basins between Poquonock and North Bloomfield water stands throughout the year. Previous to the ice invasion Farmington River probably flowed due south from Farmington through Southington and Cheshire to the sound at New Haven. Its valley was dammed by glacial deposits at Southington, and the stream was deflected northward along the Talcott Mountains to Tariffville, where it found a passage through the range and then meandered across the lake plain in Windsor to Connecticut River. The total fall of the river within the limits of Windsor is 100 feet.

WATER-BEARING FORMATIONS.

Bedrock.—Triassic sandstones and shales underlie the town and are exposed at several places along Farmington River and in some of the gullies tributary to it. Trap rocks do not outcrop in Windsor but appear at the surface near the town line in East Granby and, overlain by sandstone, extend eastward through Windsor. Both the sandstones and the trap have been intensely fractured. Numerous cracks, cutting the rocks in all directions, dipping at all angles, and ranging from microscopic size to widths of several inches, afford storage for ground water. The occurrence of water under these conditions is discussed on page 20.

Till.—The till consists of unstratified glacial débris deposited by the melting ice. The material is principally sand, but contains a small amount of clay and a large amount of gravel and bowlders. Till covers the rock in the north part of the town and in patches along Farmington River and southward to Wilson. The thickness of the till is variable, owing to the unevenness of the rock surface. In the deepest portions it is about 50 feet thick, but the average thickness is probably not more than 20 feet.

Stratified drift.—Stratified drift occurs quite generally in Windsor. It consists chiefly of sand in the north parts of the town, but contains beds of clay in the extreme southern part. These deposits correspond in geologic position to the terraced deposits on the east side of Connecticut River in South Windsor (p. 15).

GROUND-WATER SUPPLIES.

Twenty-four shallow wells, ranging in depth from 8 to 36 feet and averaging 16 feet, were examined. One of these, a driven point, 10 feet deep and $1\frac{3}{4}$ inches in diameter, yielded a good supply of water; the others were dug wells of the usual diameter, about $2\frac{1}{2}$ feet. The approximate yield of three of the wells was determined as 3.5 gallons, 4 gallons, and 8 gallons a minute, respectively. One well which yielded a very small quantity at the time it was examined was said to fail in dry weather. The quantity of water used was reported for 12 wells, the range being 15 to 60 gallons and the average 26 gallons a day. All the wells examined end in the drift.

The depth of drilled wells in Windsor, as estimated by examination of 10 wells, 7 of which end in bedrock, ranges from 44 to 337 feet and averages 147 feet. The yields were reported for 5 wells and range from 4 to 35 gallons, averaging 15 gallons a minute. The consumption, as determined for 6 wells, ranges from 20 to 45 gallons a day and averages 35 gallons.

Measurements of 23 wells indicate that the water table lies 3 to 34 feet below the surface of the ground in Windsor, the average depth being 12 feet. Owing to the incomplete drainage, however, water stands at the surface of the ground at many places between the stream courses during the greater part of the year, and in and near such places adequate water supplies are readily obtainable. The wide distribution of sand deposits in Windsor favors development by means of driven wells, which would meet a special need for the cultivation of tobacco, the growing of which is confined to the sand plains.

RECORDS OF WELLS AND SPRINGS.

Information concerning the wells and springs examined in Windsor is presented in the following tables:

Dug wells in Windsor.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*
4		Plain	120	13	10	110		
5	Scheely	Plain	90	18	13	77	8	15
6		Valley	100	10	7	93		
7	W. H. Dickinson	Slope	120	20	16	104		20
9	L. J. Daniels	Slope	92	13	9	83	(a)	
11		Plain	76	9	6	70		
12	Henry M. Scott	Plain	130	12	9	121		30
13		Slope	140	27	13	127		20
14	E. Delebrand	Plain	145	15	12	133		25
15		Slope	125	8	3	122		
17	Wm. Cook	Plain	130	9	7.5	122.5	4	20
18	W. A. Graham	Plain	110	8	5.5	104.5		18
19	do	Plain	110	8.5	6.5	103.5		
20	Joe Twalcunis	Slope	140	15	14	126		
21	Mrs. Rood	Plain	90	17	15	75		15
23	John King	Plain	100	20	17	83		40
24	Hensen	Plain	100	13	9	91		20
25		Plain	104	9	6	98		
28	Mrs. Moore	Slope	90	36	33.5			0
31		Slope	83	32	31.8	51.2		
34	D. W. Bayley	Slope	35	10	7	28		60
35	A. Christensen	Flat	30	18	17	13		0
36	Seth Marsh	Hill	55	20	14	41	3.5	30

a Well goes dry.

Drilled wells in Windsor.

Map No.	Owner	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Drilled in year.	Cost.
		Feet.	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*		
1	Jacob Lang	140	167	8	45	80	1907	
2	Clark Bros.	140	62.5	Good.			1909	
3	W. L. Wolfe	140	219					
10	J. H. Smith	100	*a* 167	Good.		70	1906	$334
22	John C. King	100	*a* 337	4		97	1910	
26	Albert Arnurius	85	*a* 82	35	25	31.5	1908	
27	Mrs. O. B. Moore	85	*a* 111	25	25	31	1900	
29	Mrs. Henry Fox	80	*a* 143	5	25	37	1909	
30	F. V. Mills	85	135		40	35	1906	
32	Bert Philips	80	44	Good.	20		1898	

a Sandstone.

Springs in Windsor.

Map No.	Owner.	Elevation above sea level.	Depth.	Yield per minute.
		Feet.	*Feet.*	*Gallons.*
8	Merwin	140		3
33	N. Christenson	25		1.5

QUALITY OF GROUND WATER.

The four analyses of water from drilled wells represent supplies moderate in mineral content but rather hard. They are all of the calcium carbonate type and low in sulphate and chlorine.

Analyses of water from drilled wells in Windsor.

[Parts per million; R. B. Dole, analyst.]

Constituents.	1	2	3	4
Total solids at 180° C.	358	172	218	195
Total hardness as $CaCO_3$	190	84	155	112
Iron (Fe)	.10	.30	Tr.	Tr.
Carbonate radicle (CO_3)	Tr.	2.8	4.8	Tr.
Bicarbonate radicle (HCO_3)	273	137	240	202
Sulphate (SO_4)	24	27	11	4.3
Chlorine (Cl)	32	4.4	2.1	6.4

1. Well of F. V. Mills (Pl. IX, No. 30), 135 feet deep; sample collected June 17, 1915.
2. Well of J. H. Smith (Pl. IX, No. 10), 167 feet deep; sample collected June 18, 1915.
3. Well of Albert Arnurius (Pl. IX, No. 26), 82 feet deep; sample collected June 17, 1915.
4. Well of Mrs. O. B. Moore (Pl. IX, No. 27), 111 feet deep; sample collected June 17, 1915.

BLOOMFIELD.

POPULATION AND INDUSTRIES.

Bloomfield, situated in the central part of Connecticut, in Hartford County, is reached by the Central New England Railway (stations at Cottage Grove, Bloomfield, and North Bloomfield), and by electric railway from Hartford. The post office is Bloomfield. Rural free delivery serves outlying parts of the town.

The town was incorporated in May, 1835. It has an area of 28 square miles.

The population of Bloomfield in 1910 was 1,821. The population from 1840 to 1910 is shown in the following table:

Population of Bloomfield, 1840–1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1840	986			1880	1,346		9
1850	1,412	43		1890	1,308		3
1860	1,401		0.8	1900	1,513	15	
1870	1,473	5		1910	1,821	20	

The principal industries in Bloomfield are dairying and agriculture. Tobacco is grown on a large scale.

TOPOGRAPHY.

The west border of Bloomfield lies along the crest of the Talcott Mountain range. The elevations along this border are 500 to 800 feet above sea level. The land slopes steeply eastward and the level of the plains is reached within a distance of about 2 miles. The eastern two-thirds of the town stands about 150 feet above sea level and constitutes part of the lake plains which extend along both sides of Connecticut River above Hartford.

Hog River is formed by the confluence of Wash Brook and other smaller brooks near Cottage Grove. Its headwaters receive the drainage from all parts of the town. The average fall of Wash Brook is about 6 feet to the mile. A very small amount of drainage passes into Mill Brook which crosses the extreme northeast corner. The eastern part of the town is very flat and the streams have not established a complete drainage system. There remain therefore many undrained or poorly drained areas which are swampy throughout the greater part of the year. (See Pl. IX, in pocket.)

WATER-BEARING FORMATIONS.

Bedrocks.—The indurated rocks in Bloomfield consist of Triassic sandstones, shales, and traps. The outcrops of the three trap sheets produced the Talcott Mountains. Sandstones overlie the traps in the eastern part of the town but are covered by drift. A characteristic feature of the bedrocks is the extensive fracturing, as a result of which they constitute an important reservoir for the storage of water (p. 40).

Till.—Unstratified deposits of sand, gravel, bowlders, and small quantities of clay cover the rock on the hills along the west border of the town. These deposits vary in thickness according to the topography. On hilltops bedrock is exposed or barely covered, but on slopes the mantle is in some places 50 feet thick. The till extends eastward to the base of the hills. Its distribution is indicated by bowlder-strewn fields and stone fences and its thinness in general is indicated by the numerous outcrops of bedrocks. The quantity of water in the till is variable, depending on the rainfall, porosity of the material, and topographic position (p. 15).

Stratified drift.—The plains in the eastern part of the town are part of the bed of an ancient lake which once occupied a large area in the Connecticut Valley north of Rocky Hill. The deposits here consist principally of sand with lenses of gravel along the west margin. The sand deposits in the central and eastern parts of the town range in thickness from 10 to 125 feet. They contain fairly large quantities of water and are porous enough to yield adequate supplies for domestic use and the irrigation of tobacco fields (p. 15).

GROUND-WATER SUPPLIES.

In Bloomfield the depth of the water table below the surface of the ground, as determined by measurements of 44 wells, ranges from 5 to 30 feet and averages 13 feet. The fluctuation is greatest in the hills along the west border of the town, where extreme variations are common, owing to the rapid underflow on the steep slopes. In the east half of the town the stratified deposits are thick and the underflow is not rapid. At many places water stands on the surface throughout the year. In this section the fluctuation is very slight.

Forty-six dug and driven wells examined in Bloomfield range in depth from 7 to 43 feet and average 18 feet. Three of these are reported to pass entirely through the drift and to penetrate rock. The quantity of water used, as reported for 20 wells, ranges from 2 to 50 gallons a day and averages about 20 gallons.

Six of the driven wells in the northeast corner of the town range in depth from 10 to 25 feet, the average being 16 feet, and the points commonly used are 3 feet long and 1¼ inches in diameter. These wells obtain water in the stratified deposits and furnish supplies for domestic needs and for tobacco irrigation.

Thirteen of the drilled wells range in depth from 28 to 190 feet and average 98 feet. Eight of these wells draw water from bedrock. Ten wells were reported to yield 5 to 20 gallons a minute, the average being 13 gallons. The quantity of water used, as reported for four wells, ranged from 5 to 75 gallons a day, and the daily average per well was about 50 gallons. The wells cost $100 to $300; the average for five wells was $226.

Six springs examined in Bloomfield yielded one-half gallon to 11 gallons a minute and averaged 4½ gallons. Four of these furnish private supplies, the quantities used ranging from 20 to 400 gallons a day and averaging 153 gallons.

The small gravity springs found along the slopes of Talcott Mountains are both convenient and economical for use where arrangements can be made to deliver their water to houses and barns. In the hilly sections of the town, where springs are not available, suitable supplies can probably be obtained from dug wells equipped as described on page 43.

On the sand plains in the eastern part of the town driven wells are recommended for domestic use and for tobacco irrigation. In the areas where unstratified drift constitutes the rock cover driven wells can not be used to advantage, but dug wells will generally furnish insufficient water for domestic needs.

Drilled wells are not dependent on the character of the rock or drift and may be expected to furnish moderate quantities of water anywhere in the town.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of Bloomfield is presented in the following tables:

Drilled wells in Bloomfield.

Map No.	Owner.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Drilled in year—	Cost.
		Feet.	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*		
20	A. C. Case	210	60	6	0	7		
21	do	215	40	0	0	7		
22	do	218	[a] 96	14	5	6		
44	Henry Keeny	130	147		60		1899	
46	Alfred Marshall	135	136		50		1899	
50	Post office	125	[b] 40	10			1911	$100
51	W. L. Burnham	125	28	20	75	28	1897	
52	Mrs. G. K. Marvin	135	85	5		75	1911	
53	H. C. Cadwell	125	138	20		69	1911	
54	Jas. Francis	135	[c] 190	8		82	1909	380
55	Hutchinson	145	[c] 135	12		58		220
61	Carrol Davis	160						
72	Edw. McKune	110	[d] 110	20			1904	330
75	Geo. J. Maher	164	[c] 63	15		26	1899	100

[a] Trap; schist; trap. [b] Till; hardpan. [c] Hardpan; black shale. [d] Sand; quicksand.

Springs in Bloomfield.

Map No.	Owner.	Elevation above sea level.	Yield per minute.	Amount used per day.	Improvements.
		Feet.	*Gallons.*	*Gallons.*	
1	Adams	140		40	
3	W. Waugh	150	0.5	20	
25	A. Kelly	199	11	150	Compressed-air system; gas engine.
29	Connecticut Children's Aid	290	10		Piped to buildings.
35	Gillmartin	165	4	400	
47	W. C. Hubbard	130	.75		Piped to house.
57	W. C. Wade	140	.5		
67	P. C. Banfield	90			

Dug wells in Bloomfield.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.	Depth to rock.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*
4		Flat	185	32	30	155			
5		Flat	185	19			(a)		
6	Victor Brzenski	Hill	227	20	17.5		(a)		6
7	do	Hill	225	9	7.5	117.5			
8	Belzinski	Slope	200	20	15	185			
9	Howard Bloomer	Slope	225	16	9	216			
14		Flat	155	17	11	144			
15	L. M. Banning	Flat	158	20	16	142		20	
16		Slope	285	13	10	275			
17		Slope	275	11	9	266			
18	A. C. Case	Hill	210	9	5	205			
19	do	Hill	210	11	7	203		10	
23		Hill	145	21	14	131			
24	A. Kelly	Slope	195	25	15	180		0	15
26	Eugene Barnard	Slope	200	30				45	
27		Slope	190	10	8	182			
28	H. M. Myrick	Valley	200	25	24	176		20	
30	O. Johnson	Slope	185	17	15.5	169.5			
31		Slope	200	16	14	186	(a)	6	
32	Burnham	Slope	195	20	14	181	(a)		13
33		Slope	195	15	13	182		50	
34	F. W. Legeyt	Slope	200	14	13	187	(a)	20	
36		Hill	178	21	17	161			
37	W. J. Cooley	Slope	125	16	11	114		25	
38	C. H. Cooley	Slope	165	22	21	144	(a)	0	
39	Capin Bros	Hill	165	15	11	154			
40	Geo. Humphrey	Hill	127	14.5	12	115			
41	W. P. Francis	Hill	135	33	30.5	104.5			
42	C. F. Foster	Flat	115	10	8	107		12	
43	do	Flat	115	7	5	110		2	
45	Alfred Marshall	Flat	135	22	21.5	113.5	(a)	0	
48	W. C. Hubbard	Hill	120	18	14	106		5	
49	Eddy	Hill	120	18	14	106		5	
56		Flat	125	19	7.5	117.5		30	
58	Mohlolz	Flat	120	13	8.3	111.7		10	
59	O. Blasig	Flat	130	10	7	123		30	
60	Mills	Flat	160	16	13.5	146.5		10	
62	Louise Astermill	Flat	140	18	16.5	123.5		20	
65	A. A. Mills	Hill	145	43	15	130	4	15	
66	J. Burnham	Slope	125	11	8	117			
68	A. Christ	Flat	130	14.5	11.5	118.5			
69	A. M. Spenser	Flat	110	18	8.5	101.5		35	
70	G. R. Olin	Flat	100	20	19	81			
71		Flat	110	14	11	99			
73	Rathman	Flat	115	30	27	88		10	
74	Wm. Rockwell	Slope	150	13	10	140			

a Well goes dry.

Driven wells in Bloomfield.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Diameter.	Yield per minute.
			Feet.	*Feet.*	*Inches.*	*Gallons.*
2	Barns	Flat	180	25	1.5	2.5
10	Griffen-Newberger Tobacco Co	Flat	180	15		
11	do	Flat	180	15		
12	do	Flat	180	15		
13		Flat				
63		Flat	130	10		
64	Mix	Flat	120	13		

QUALITY OF GROUND WATER.

The water from the 63-foot well of George J. Maher was analyzed as indicated in the accompanying table and was found to be hard and rather high in its content of chlorine.

Analysis of water from the 63-foot drilled well of George J. Maher (Pl. IX, No. 75), collected June 17, 1915.

[R. B. Dole, analyst.]

	Parts per million.
Total solids at 180° C	722
Total hardness as $CaCO_3$	387
Silica (SiO_2)	10
Iron (Fe)	1.5
Calcium (Ca)	95
Magnesium (Mg)	26
Carbonate radicle (CO_3)	Tr.
Bicarbonate radicle (HCO_3)	75
Sulphate radicle (SO_4)	19
Chlorine (Cl)	245

STAMFORD.

POPULATION AND INDUSTRIES.

The town of Stamford is in the southwest part of Fairfield County, bordering Long Island Sound. It is reached by the New York division of the New York, New Haven & Hartford Railroad, which has stations at Stamford and Glenbrook; by the New Canaan branch of the same road, with stations at Glenbrook, Springdale, and Talmadge Hill; by steamboat from New York; by stage from Pound Ridge and Bedford in New York, Long Ridge, High Ridge, and North Stamford; and by trolley from Darien, Greenwich, Sound Beach, Springdale, Shippen Point, and Glenbrook. Post offices are maintained at Stamford, Glenbrook, and Springdale. Rural free delivery covers outlying parts of the town.

The area of Stamford is 38 square miles. It was settled in 1641 under New Haven jurisdiction, was named in 1642, and was incorporated under Connecticut in October, 1662.

The population of the town in 1910 was 28,836; of the city, 25,128. The population of the town from 1756 to 1910 is shown in the following table:

Population of town of Stamford, 1756 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1756	2,768			1840	3,516		
1774	3,563	22		1850	5,000	44	
1782	3,834	8		1860	7,185	44	
1790				1870	9,714	35	
1800	4,352			1880	11,297	16	
1810	4,440	2		1890	15,700	40	
1820	3,284		26	1900	18,839	20	
1830	3,707	13		1910	28,836	53	

The chief industries are agriculture and the manufacture of artificial leather, bronzes, camphor, carriages, cocoa, cod-liver oil, chocolate, drugs, dyestuffs, extracts, furs, hats, ink, insulated wire and cable supplies for rubber manufacturers, iron castings, japans and varnish, knit goods, locks, machinery, music boxes, Paris white, paints, pianos, pottery, shirtwaists, shoes, stoves, thread, and whiting.

TOPOGRAPHY.

The surface of the town is, in general, rugged. Elevations exceeding 100 feet are found within a quarter of a mile of the shore, and the hills increase in height northward, reaching an elevation of 570 feet on the north boundary in the northwest corner of the town. The topography of Stamford has been produced by the dissection of a plateau and the subsequent deposition of glacial drift over the surface. With the possible exception of a few drift mounds, the hills are remnants of an old highland gashed by innumerable stream valleys, which are lined with glacial deposits. (See Pl. X, in pocket.)

The principal rivers are the Rippowam, the Mianus, and the Noroton. The Mianus is the largest stream, but it lies near the boundary in the northwestern corner of the town and its drainage area in Stamford is comparatively small. In the vicinity of Riverbank the valley of this stream is constricted and the river falls 60 feet in less than a quarter of a mile, but north of Riverbank for a distance of 2 miles there is a flat, marshy valley floor, the remnant of a small glacial lake. Noroton River forms the east boundary of the town from 1½ miles above Springdale to the Sound, and it also drains only a small part of Stamford. Rippowam River passes through the town from north to south, and, with its tributaries, drains the greater part of it.

About one-fourth the area of Stamford, comprising most of the slopes, is forested. In the northern part of the town woods extend well into the valleys. The hilltops are generally bowlder-strewn grass lands. The plowed lands comprise less than one-quarter of the town, the small gardens and grain fields being separated by relatively large meadows.

WATER-BEARING FORMATIONS.

Bedrocks.—The indurated rocks of Stamford are crystalline schists and gneisses. They are exposed in many places and are encountered in all of the drilled wells, in many of the dug wells, and even in the excavations for buildings in the city. The rock surface is uneven and appears to correspond very closely to the topography of the present land surface. Almost all the hills reveal rock ledges on their slopes and crests, and in many places the rivers have rock beds. All these rocks are cut by joints that afford passage for water, which can frequently be seen trickling from them in the exposures along the roadsides. For further discussions of water in the bedrock see page 40.

Till.—Unstratified glacial deposits are found in all parts of the town except in some places along the shore, where beach sand has accumulated, and in narrow belts along the principal streams, where stratified drift is found. Unstratified deposits abound in bowlders, some of which are 2 feet in diameter, and over large tracts the bowlders lie at the surface so close together as to almost touch. Where the land is tilled they have been in large part cleared away and used in building fences. In a few places the mantle of till is 60 to 75 feet thick; in general it is thin, and the average thickness is probably not more than 20 feet. Rocks are exposed in practically all the hills and in most places the streams have rocky beds. Many of the domestic water supplies in the rural districts are obtained from the till.

Stratified drift.—The stratified drift occurs in a manner suggesting that it was deposited by glacial streams that occupied valleys practically identical with the valleys that contain the present streams. Kamelike deposits of stratified material are found in the northern part of the town, and stratified deposits form a conspicuous terrace in the southern part of the town, just north of the city of Stamford, on the east side of Mill River. The shore line is digitate, and the inner margins, as, for example, the shore of Wescott Cove, are sand beaches; the projections, however, such, for example, as Shipman Point, are covered with till. The gravel deposits in the northern part of the town and immediately north of the city should afford good supplies of water to driven wells, the conditions being especially favorable in the vicinity of Springdale and Glenbrook. For discussion of the occurrence of water in stratified deposits see page 15.

SURFACE-WATER SUPPLIES.

The topography of the north half of Stamford is favorable to the utilization of surface-water supplies. Streams and springs are numerous, and the slopes are steep and thinly covered with drift, affording suitable conditions for controlling the run-off. The reservoir of the Stamford water department is situated in the valley of Rippowam River at North Stamford. A small dam has been constructed on a short tributary of the Mianus in the northwest corner of the town to control a seldom-used emergency supply of 14,000,000 gallons for Greenwich.

Sites at which impounding reservoirs could be built are numerous in the northern part of Stamford. The best site is probably that in the valley of Mianus River in the vicinity of Riverbank.

No sewage enters the streams in the northern part of Stamford except that from the usual rural settlements, but owing to the rough topography and the steep slopes a large proportion of domestic and farm wastes is washed into the streams.

GROUND-WATER SUPPLIES.

Almost all the shallow wells in Stamford are sunk in glacial till and most of them either penetrate or closely approach bedrock. In the areas of deeper drift, as in the southeast part of the town, a bed of coarse gravel with some clay furnishes a good permanent supply wherever wells have penetrated it. Where the drift is thinner water is obtained chiefly from a zone of comparatively thin deposits just above the rock. The rough surface affords numerous small drainage slopes which are favorable for both dug wells and springs, and few wells fail in dry seasons.

In the deeper valleys, such as that of Noroton River, water is easily obtainable and is abundant, as these valleys generally contain deposits of sand and gravel. A well sunk by Mr. Waterbury, in Glenbrook, illustrates a practical method of procuring good supplies in such places. The well was made by driving a 6-inch well casing through 30 feet of sand to a bed of gravel. It was completed in a few hours and its yield was larger than could be determined by the methods commonly employed in pumping drilled wells. It is situated near Noroton River and ends at a level below the bed of the stream.

The range in depth of 139 shallow wells examined in this town lies only between 10 and 30 feet and the average depth is about 20 feet. The average yield, as computed from reports on 7 wells, is 3.7 gallons a minute, but the true average of all the wells would probably be less than 3 gallons a minute. Out of 35 wells, including none that were unused, the average daily consumption was found to be about 20 gallons to the well.

Of the wells examined 11 were said to have failed in dry seasons, and 24 were said never to have failed. No information was obtained on this point concerning the remaining 104 wells.

All the drilled wells in Stamford of which records were obtained end in crystalline rocks. With few exceptions, these wells yield water that is sufficient and suitable for domestic use. The number of drilled wells in the city of Stamford is relatively large, notwithstanding the fact that city water is abundant, because some people using large quantities of water consider it cheaper to obtain water from wells than from the public system. The higher parts of the city are not reached by the gravity system in use, and although pumping is resorted to in some places, drilled wells are commonly used instead. The average depth of 31 of the drilled wells in Stamford is 208 feet, the deepest being 454 feet and the shallowest 75 feet. The yields of 24 wells range from 3 to 75 gallons a minute and average 30 gallons.

The average daily consumption from 13 wells was found to be about 400 gallons.

Owing to favorable topographic conditions there are many springs along the streams and on the hillsides, but practically all fluctuate more or less with the seasons. The yield rarely exceeds 2 gallons a minute and the average is considerably less than 1 gallon. A number of such springs are utilized for domestic supplies and a few, such as Varuna Spring, furnish water that is sold. All the springs that were examined in Stamford are gravity springs situated on hillsides or at the foot of slopes and draw water from the drift.

PUBLIC WATER SUPPLIES.

Stamford is supplied with water chiefly from a reservoir in the basin of Rippowam River, near North Stamford, but reserve supplies are stored in Mead Pond and Trinity Lake, both in Pound Ridge, New York. The main reservoir has an area of 114 acres, an average depth of 13 feet, and a capacity of 512,000,000 gallons. The capacity of Mead Pond is 80,000,000 gallons, and that of Trinity Lake is 450,000,000 gallons. About 20,000 inhabitants are supplied with water from this system and the consumption amounts to 2,000,000 gallons a day, or 100 gallons per capita. The water is gathered from an area of 22 square miles and suffices to maintain an overflow at the dam during most of the year. In the summer of 1910 the water in the main reservoir was drawn to 4 feet below the crest of the dam, but even then more than three months' supply was in the reservoir when the rains came and filled it to overflowing.

Springdale is supplied from two drilled wells, one of which has a surface elevation of 140 feet, is 454 feet deep, and yields 50 gallons per minute. The following log of this well was furnished by the driller:

Log of drilled well at Springdale waterworks.

	Thickness.	Depth.
	Feet.	*Feet.*
Bowlder clay	16	16
Granite	84	100
"Hard glassy rock" (quartzite)	300	400
"Soft black micaceous rock"	54	454

To insure against emergencies occasioned by fires or disability of pumps the second well was drilled. This well, which was completed in November, 1911, has a surface elevation of 90 feet, is 510 feet deep, and yields 45 gallons a minute. About 300 people are supplied from the Springdale system, and the daily consumption is 15,000 gallons, or 50 gallons per capita.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of Stamford is presented in the following tables:

Dug wells in Stamford.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.	Depth to rock.	Section.	Wall.	Cover.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*			
3	George Webber	Slope	60	28	12	68		0		Till	Stone	Open.
6	George W. Northrop	Hill	75	26	13	62	Good.	50		Till, gravel[a]	Stone	Plank.
7	L. Brownfield	Hill	60	23	17	43				Till	Cement	
10	Kennedy	Slope	80	23	12	68		18		Till	Stone	
15	J. C. Woefel	Slope	100	23	20	80		0		Till	Stone	Open.
16		Flat	107	28.5	21	86		5		Till	Stone	Open.
18	W. A. Schaz	Slope	140	26	19	121	(b)			Till	Stone	Open.
19	McConnel	Hill	135	17	9	126		15	17	Till	Stone	Plank.
20		Hill	154	21	17	137	2			Till		
21	Jenkins	Hill	160	24	16	144	(b)			Till	Stone	Open.
22		Hill	200									Plank.
23	E. J. Louis	Slope	280	30			15			Till		Concrete.
25		Hill	270	28	13	257		0		Till	Stone	Open.
26	L. O. Murray	Slope	240	18	10	230		15		Till	Stone	Open.
28	W. L. Havery	Valley	230	17	2.5	227.5		10		Till	Stone	Open.
29		Hill	230	19	14	216				Till		Open.
30		Slope	233	17	15	218				Till	Stone	
31		Hill	370	16	13	357	(b)			Till	Stone	Open.
32	E. Weed	Hill	390	18	14.5	375.5				Till	Stone	Open.
34		Slope	325	26	18	307		50		Till	Stone	Plank.
36		Plain	300	18	13	287				Till	Stone	Open.
37		Plain	305	15	11	294	2	10		Till	Stone	Open.
40	George Jones	Slope	270	20	16	254		0		Till	Stone	Open.
41		Slope	385	20	15	370				Till		
42		Hill	240	22	15	225				Till	Stone	Open.
43	C. H. Crandall	Slope	450	24	17	433		15		Till	Stone	
44	W. H. Dann	Slope	425	18	13	412		10		Till	Stone	Open.
45		Hill	225	18	14	211				Gravel		
46		Slope	300	14	10	290				Till	Stone	Open.
47	S. Dann	Slope	375	19	14	361				Till	Stone	Open.
48	John Serrach	Slope	380	19	13	367				Till	Stone	Open.
49		Slope	360	23	16	344				Till	Stone	Open.
50	S. C. Brown	Plain	320	22	16	304				Till	Stone	Open.
51a	Town farm	Slope	287	20	14	273		0		Till	Stone	Plank.
53		Hill	335	26	18	317	(b)	12		Till	Stone	Open.
54		Slope	325	21	15	310		0		Till	Stone	Open.
55		Hill	270	23	14	256				Till	Stone	Open.
56		Slope	280	19	11	269				Till	Stone	Open.
57		Hill	260	21	9	251		8		Till	Stone	Open.
58		Hill	265	22	11	254		10		Till	Stone	Open.
59	George Heinze	Hill	275	27	15	260		0	17	Till, rock		Plank.

60	do.	Hill	275	38	15	260		150	30	Till, rock		
63	Garison	Hill	250	26	11	239				Till	Stone	Open.
64		Hill	240	33	13	227		12		Till	Stone	Open.
65	P. B. Glasby	Slope	220	16	8	112	2			Till		
66	do.	Plain	228	18	9	119				Till		
67		Slope	235	23	16	219				Till	Stone	Open.
68		Slope	210	10	4	206		0		Till	Stone	Open.
69	R. M. Gillespie	Plain	218	21	10	208				Till	Stone	Open.
70		Plain	190	20	8	182				Sand	Stone	Shed.
71		Slope	150	28	18	132		0		Gravel	Stone	Open.
72	J. J. Lacy	Slope	125	20	15	110				Gravel	Stone	Open.
•73	Gutzon Borglum	Flat	120									
75		Hill	140	18	12	128		0		Till	Stone	Open.
76		Hill	138	15	9	129		0		Till	Stone	Open.
77	H. E. Shockley	Hill	150	26	14	136				Till	Stone	Open.
78	W. Heinze	Hill	160	24	14	146	2	15		Till	Stone	Plank.
79	Frank Lockwood	Hill	175	23	18	157		0	6	Till, rock	Stone	Open.
86	Mrs. O'Toole	Hill	210	30	10	200			13	Till		
87	Dr. Milky	Hill	205	c 28	14	191		25		Till	Stone	Shed.
88		Hill	200	23	14	186	(b)	15		Till, rock	Stone	Open.
90	R. L. Case	Slope	135	25	8	127		40		Till	Stone	Plank.
91		Valley	90	16	9	81		0		Till	Stone	Plank.
94	A. E. Mitchell	Plain	145		10	135		0		Till	Stone	Plank.
95		Hill	60	26	15	45				Till	Stone	Lattice shed.
96		Flat	45	19	8	37		0		Till	Stone	Open.
97		Hill	62	17	13	49		0		Till	Stone	
98	G. W. Briggs	Slope	125	20	12	113		15		Till	Stone	Open.
99		Slope	65	20	14	51				Gravel	Stone	Open.
100		Slope	70	18	11	59				Sand, gravel	Stone	Open.
101	Mrs. A. L. Michael	Slope	175	15	10	165		0		Till		
102	O. D. Weed	Slope	200	21	15	185				Till	Stone	Open.
105	Norman Sherwood	Valley	140	15	8	132		15	12	Till, rock	Stone	Open.
106	C. Lockwood	Valley	155	19	13	142				Till	Stone	Open.
107		Slope	140	15	8	132		10		Till	Stone	Cpen.
108		Slope	143	14	6	137				Till	Stone	Open.
109		Slope	160	18	11	149				Till	Stone	Open.
110	S. Alvin Piza	Hill	90	26	18	72	(b)			Gravel	Stone	Plank.
111		Slope	65	18	12	53		10		Gravel, rock	Stone	Open.
112		Slope	90	20	13	77		0		Till	Stone	Open.
113		Slope	90	23	16	44				Till	Stone	Open.
115	George Marshall	Hill	185	20	14	171		10		Till	Stone	Open.
116	F. Reilly	Hill	190	17	11	179				Till		
117	John Connor	Hill	120	25	7	113				Till		

a Consists of—

	Feet.
Humic soil	1
Clay	6
Loam	3
Yellow clay	10
Hardpan	2
Gravel	4

b Well goes dry.

c Two feet of water at low mark.

Dug wells in Stamford—Continued.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Yield per minute.	Amount used per day.	Depth to rock.	Section.	Wall.	Cover.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*			
118	Town pest house	Valley	90	20	13	77		0		Till	Stone	Open.
120	A. T. Simcox	Slope	95	18	13	82				Sand, gravel.	Stone	Open.
121		Plain [a]	60	14	7	53				Till	Tile	Plank.
122		Hill	80	30	27	53	[b] 2	25		Till	Stone	Open.
124		Plain	250	21	12	238	1	10		Till, rock	Stone	Open.
125		Slope	328	28	11	317				Till	Stone	Open.
126		Valley	220	15	10	210		30		Till	Stone	Open.
127		Plain	240	12	7	233		7		Till, rock	Stone	Open.
128	F. Nolan	Plain	270	11	14	256				Till	Stone	Open.
129	E. Montaber	Slope	345	21	6	334		10		Till	Stone	Open.
130		Hill	420	12	19	411				Till		Open.
131		Hill	435	15	11	424		0		Till		
132		Slope	340	18	11	329				Gravel, rock.	Stone	Open.
133	Mrs. T. Cooper	Slope	340	26	11	329				Sand	Stone	Open.
134		Slope	345	18	12	333				Sand		Open.
135	E. Dutcher	Slope	347	14	11	336				Sand	Stone	Open.
136	C. Rivers	Plain	345	12	7	338				Till, rock	Stone	Open.
137		Hill	400	17	12	388				Till	Stone	Open.
138		Hill	420	23	17	403				Till	Stone	Open.
139		Slope [c]	438	15	11	427				Till	Stone	Open.
140		Hill	420	24	20	400				Till	Stone	Open.
141		Hill	425	19	15	410				Till		
142		Slope	410	24	19	391				Till	Stone	
143	Beecher	Hill	460	21	15	445	([b])			Till	Stone	Open.
144		Hill	260	20	15	245		10		Till	Stone	Open.
145	Tipmon	Plain	190	12	5	185				Alluvium	Stone	Open.
146	N. W. Smith	Slope	310	18	14	296				Till		Plank.
147		Slope	235	16	12	223				Till		
149		Plain	190	17	12	175				Till		Open.
150	B. F. June	Slope	190	12	8	182				Till		
151		Slope	175	18	11	164		7		Till	Stone, concrete.	Open.
152	J. Studwell	Plain [d]	160	13	5	155				Till	Stone	Open.
153		Hill	200	18	14	186				Till	Stone	Open.
154	Mrs. A. June	Plain	220	14	11	210				Till	Stone	Open.
155	A. Marshall	Slope	280	18	15	265			9	Till, rock	Stone	Open.
156	P. Horton	Slope	275	20	14	261				Till	Stone	Open.
157		Hill	217	16	13	204				Till	Stone	Open.
158		Hill	250	11	3	247		0		Till	Stone	Plank.
159	Church	Hill	230	10	2	228				Till	Stone	Open.
160	J. Ryle	Hill	230	18	8	222		0		Till		

161	Denbrook farm	Hill	235	16	4	231				Till	Stone	
162	High View farm	Hill	237	15	3	234				Till	Stone	Open.
163	Frank Weed	Slope	180	20	11	169				Till, rock	Stone	Open.
164		Slope	165	26	16	149		50		Till	Stone	
166	Mrs. Packer	Hill	335	43	6	329			10	Till, rock		Plank.
169		Slope	138	18	14	124		15	18	Till, rock		Plank.
170	J. Clason	Hill	220	23	15	205				Till	Stone	
171	C. Gildenmerster	Hill	220	18	11	209				Till	Stone	
172	Herbert G. Ogden	Slope	190	18	15	175				Till	Stone	
181	W. D. Baldwin	Shore	17	16	6	11				Till	Stone	Open.
183		Hill	155	30	9	146				Till		
185	Frank Lockwood	Valley	160	13	6	154		8		Till		Open.
186		Hill	200	21	15	185				Till		Open.
187	Mrs. Packer	Hill	290	17	2	288	(b)	0		Till	Stone	Plank.
188		Slope	160	16	11	149		15	9	Till, rock	Stone	Open.

a Edge of brook. b Well goes dry. c Slope fromout buildings toward well. d Swampy surroundings.

Drilled wells in Stamford.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Diameter.	Drilled in year—
			Feet.	*Feet.*	*Galls.*	*Galls.*	*Feet.*	*Inches.*	
1	E. B. Hoyt (residence).	Hill	90	200	45		60	8	1909
2	E. Y. Webber	Slope	60	150	35	500	40	8	1906
4		Slope	60						a 1911
5	George Webber	Slope	55	208	40	500	12	8	1904
8	Hartlett	Slope	80	80	2	50	18		1904
9	Powell	Slope	85	90	3	50	10		1907
11	Fred Berg	Hill	130	400	10		0		1910
12	McDougall	Valley	75	95	4	80	0		
13	Springdale Water Co.	Slope	100	454	48	12,000 to 15,000	16		
14	do	Hill	150	510	45		12		1911
24	W. M. Raymond	Slope	270	100	+ 7		b 45	6	
33	Advocate Co.	Flat	28	250	20	2,000	20		1896
38	W. W. Daschield	Hill	290	301		200			
39	do	Slope	270	90	c 6	0			1905
51	Town Farm	Slope	300	200	50		0		1897
52	Mrs. Towns	Hill	310	130	25	0	30		1900
62	Varuna Spring Water Co.	Slope	220	310	50			8	
74	Andrew Boyd	Hill	215	183	4		0		d 1909
80	J. N. Robbins	Hill	310	275	25	4,000	50		1909
81	Varian	Hill	310	150	20		40	6	1899
82	O'Flinn	Hill	290	275	12			6	
83	Rothchilds	Hill	290	183	70		60	6	1901
84	Robert Kerr	Hill	240	176					
85	J. C. Bickel	Hill	230	153	15	50			
89	Kans Bros	Slope	140	200		400			1910
92	A. E. Mitchell	Hill	160	300		100			
93	Mrs. Holbrook	Hill	160	412	5				
103	H. Palmer		200	300	3		0		1903
104	James Weed	Hill	195	155	10	75	0		1901
114	Stamford Sanatorium.	Valley	40	135	50	30,000	20		1897
119	Mrs. Gross	Slope	135	150	5		0		1896
123	E. P. Brown	Hill	290	132	4	40	20	6	1910
148	W. H. Childs	Hill	230	205	8	60	0		
165	Mrs. Gurtrude Hall	Hill	315	129	8	0	20	6	1911
168									a 1911
173	H. G. Ogden	Slope	190	310	10	60	8	8	
174	Dr. Morris	Ravine					0		a 1911
175	Mayer Ice Co	Valley	35	104	75				
176	Diamond Ice Co	Flat	25	90			50		
177	A. Lynch	Flat				e 0			
178	E. B. Hoyt (market)	Flat	30	140	40		40		
179	Mrs. Alexander	Shore	15	192		15,000	10		
180	W. D. Baldwin	Shore	17	250	f 7				
182	Crane	Hill	155	300	30		60		1902
184	Miss Smith	Hill	265	200	15		50	6	1897
189	C. Eckert	Slope	140	183	70	100	25		1902
190	Stamford Gas & Electric Co.	Shore	12	300		g 0	20		1911
191	do	Shore	12	250		g 0	20		1911
192	do	Shore	12	40		g 0	20		1911

a Incomplete when visited.
b Till.
c Well is now dry.
d Well cost $500.
e Water is foul.
f Salt water is obtained after one-half hour's pumping.
g Water is salty.

Springs in Stamford.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Yield per minute.	Improvements.
			Feet.	*Gallons.*	
17	Schofel & Miller	Slope	120	0.5	
27	A. Hatch	Slope	226	10	Concrete reservoir.
35	C. A. Bruce	Foot of slope	330	4	Piped to horse trough.
61	Varuna Spring Water Co.	Slope	230		
167	J. B. Strang	Foot of slope	230	1	

QUALITY OF GROUND WATER.

Analyses of water from three drilled wells in Stamford are given in the accompanying table. They represent moderately mineralized, moderately hard waters low in content of sulphate and chlorine.

Analyses of water of drilled wells in Stamford.

[Parts per million; R. B. Dole, analyst.]

Constituents.	1	2	3
Total solids at 180° C	127	250	138
Total hardness as $CaCO_3$	63	133	71
Silica (SiO_2)	12		
Iron (Fe)	Tr.	.10	Tr.
Carbonate radicle (CO_3)	.0	.0	.0
Bicarbonate radicle (HCO_3)	106	131	87
Sulphate radicle (SO_4)	14	36	23
Chlorine (Cl)	2.4	19	8.4

1. Well of Kans Bros. (Pl. X, No. 89), 200 feet deep; sample collected June 26, 1915.
2. Well of Mrs. Gross (Pl. X, No. 119), 150 feet deep; sample collected June 26, 1915.
3. Well of C. Eckert (Pl. X, No. 189), 183 feet deep; sample collected June 26, 1915.

GREENWICH.

POPULATION AND INDUSTRIES.

Greenwich is in the southwest corner of Connecticut, in Fairfield County. It is reached by the New York division of the New York, New Haven & Hartford Railroad (stations at Greenwich, Cos Cob, Riverside, and Sound Beach); by steamboat from New York daily during the summer and triweekly during the winter; by stage from Port Chester, N. Y., to the villages of Glenville and Pemberwick; and by trolley from Port Chester and Stamford. Post offices are maintained at Greenwich, Cos Cob, Glenville, Riverside, and Sound Beach.

Greenwich was settled by the Dutch in 1640 and was acquired by Connecticut from New York in 1662. The area of the town is 49 square miles.

The population of the town of Greenwich in 1910 was 16,463, of the borough, 3,886. The population of the town from 1756 to 1910 is shown in the following table:

Population of Greenwich, 1756 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1756	2,051			1840	3,921	4	
1774	2,776	37		1850	5,036	27	
1782	2,623		5	1860	6,522	30	
1790				1870	7,644	17	
1800	3,047			1880	7,892	3	
1810	3,533	16		1890	10,131	28	
1820	3,790	7		1900	12,172	20	
1830	3,801	3		1910	16,463	36	

The principal industries are agriculture and the manufacture of belting, woolens, hardware, etc. The town is a resort for New York City people during the summer, and there are many large country estates not essentially devoted to agriculture.

TOPOGRAPHY.

Greenwich is a highland town and its topography is characteristic of the highland areas. The land rises rapidly from the shore and reaches an elevation of 615 feet on the northwest boundary. In general, the topography is less rugged in Greenwich than in the adjoining town of Stamford; the divides are broader and the slopes gentler, but the relief is somewhat greater. In the southern half the average relief is about 100 feet; in the northern half about 250 feet.

The principal streams in Greenwich are Mianus River, Byram River, Greenwich Creek, and Horseneck Brook. Byram River, the largest, drains about half of the town. Greenwich Creek and Horseneck Brook receive most of the drainage from the eastern half. Mianus River enters the town about 2 miles above its mouth and receives very little drainage in Greenwich. The stream valleys are narrow, and there is an average fall of about 50 feet to the mile. The effect of glaciation is shown by five swampy areas, the remnants of small glacial lakes. (See Pl. X, in pocket.)

WATER-BEARING FORMATIONS.

Bedrocks.—Crystalline schists, gneisses, and granites constitute the larger part of the rock floor in Greenwich, but a small area in the northwest corner of the town is underlain by crystalline limestone. As a result of earth movements in past geologic time the bedrocks of this region have been thoroughly fractured throughout the upper zone. Irregular cracks extend from the surface to depths of several hundred feet and they constitute the only important source of water in these rocks. Cracks wide enough to allow a ready passage of water are, however, exceedingly rare at depths greater than about 300 feet, and it is therefore not usually advisable to sink wells deeper.

The bedrocks everywhere lie near the surface and are exposed in a great many places. Some varieties of gneiss weather very readily, and where these are exposed, as, for example, in the railroad cuts between the Stamford and Greenwich railroad stations, they form comparatively soft and shaly masses. Most of the rocks, however, have withstood weathering to such an extent that their appearance is not altered even in localities where they have been long exposed to attack of the atmosphere.

Till.—Till, which consists of mixtures of bowlders, sand, and clay, covers all the higher lands and is the predominating rock cover. It ranges in thickness up to about 80 feet, but the average is not more than 25 feet. On most of the hills the covering of till is thin and bedrock protrudes in many places, but some of the hills consist almost entirely of till.

Stratified drift.—Stratified drift, consisting of layers of sand and gravel without bowlders, lies at the surface along the principal stream courses, but it is generally thin, exceeding 30 feet in thickness at only a few places. This material is most conspicuous in the vicinity of Round Hill. Deposits of beach sand occur at a few places along the shore, but in general the till extends down to the water line. (See p. 15.)

SURFACE-WATER SUPPLIES.

The principal surface-water developments in Greenwich are on Putnam, Rockwood, and Converse lakes, the last two "lakes" being in fact artificial reservoirs formed by the construction of dams. Putnam and Rockwood lakes supply the Greenwich waterworks. Converse Lake is said also to have been intended for the municipal system, but it has been used for the public supply only in emergency. Putnam Lake is in the upper part of the basin of Horseneck Brook, at an elevation of about 282 feet above sea level. Rockwood Lake is at the head of Greenwich Creek near Stanwich, at an elevation of about 300 feet above sea level. Converse Lake is at the head of the east branch of Byram River near Banksville, its upper lobe extending a short distance into New York. There are a few power plants on Byram River and at North Mianus on Mianus River

GROUND-WATER SUPPLIES.

In the rural districts of Greenwich water is most commonly obtained from dug wells. Forty dug wells, ranging in depth from 11 to 36 feet and averaging 16 feet, were examined. Thirty-four of these wells end in till and five in sand; one ends at the rock surface, and seven penetrate rock. The depth to rock in eight wells ranges from 8 to 26 feet and averages 16 feet. The depth to water, as determined by measurements of 40 wells, ranges from 7 to 24 feet and averages 12 feet. The average yield, determined by measurement of five wells, is 3 gallons a minute, or about 4,500 gallons a day, the greatest yield being 4 gallons and the least 1.5 gallons. Reports of the quantity of water used from 24 wells show a maximum under 40 gallons a day and average about 20 gallons. Four of the wells examined are said to fall frequently.

Twenty-four drilled wells, ranging in depth from 70 to 1,000 feet and averaging 331 feet, were examined; excluding eight wells that are 500 feet or more in depth, the average depth is 233 feet. The position of bedrock in 21 wells ranges from the surface to 100 feet below, and, including 13 wells which start on rock, average depth to rock is 16 feet. The maximum yield reported was 60 gallons a minute, and the average, excluding two dry wells, is about 12.5 gallons.

The daily consumption reported for seven wells ranges from about 25 to 500 gallons and averages about 180 gallons a well.

The average annual fluctuation of the water level in the wells of Greenwich, as determined from observations of four wells during 1912, is 9 feet, the greatest fluctuation being 12 feet and the least 6 feet. Wells situated on low flats generally show the least fluctuation, those on hillsides near the tops of slopes show the greatest fluctuation (fig. 2, p. 18). The average depth to the water table as determined from measurements of 40 wells in the town is about 12 feet. These measurements were made in June, 1912, when the water level was approximately at its average position.

PUBLIC WATER SUPPLIES.

The borough of Greenwich obtains water from two reservoirs in the central part of the town, one, Putnam Lake, in the valley of Horseneck Brook, and the other, Rockwood Lake, at the headwaters of Greenwich Creek. Putnam Lake covers 105 acres and holds 570,000,000 gallons. Rockwood Lake covers 106½ acres and holds 460,000,000 gallons. A reservoir with a capacity of 14,000,000 gallons is situated on a small tributary of Mianus River in Stamford, but has been rarely utilized. A drought during the winter of 1910 necessitated drawing temporarily from Converse Lake, a private reservoir at the headwaters of the east branch of Byram River near Banksville. All the water distributed by this system is purified by mechanical filtration. The average daily consumption is 5,000,000 gallons in summer and 3,000,000 gallons in winter.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of Greenwich is presented in the following tables:

Dug wells in Greenwich.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.	Yield per minute.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Gallons.*
3		Hill	60	12	7	53		
5	George Clark	Slope	85	11	8	77		(a)
6	Mrs. S. E. Marshall	Hill	110	20	12	98		
7	Wm. Wenzel	Hill	140	17	12	128		
9	Chas. Perin et al	Valley	242	14	12	230		
10		Hill	280	28	25	255		
11		Slope	345	13	10	335		
12	W. Lockwood	Slope	350	15	11	339		
16	E. M. Hobby	Hill	485	23	15	470	10	a 4
17		Slope	400	18	16	384		
18		Slope	400	12	10	390		

a Well goes dry.

Dug wells in Greenwich—Continued.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.	Yield per minute.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Gallons.*
25		Slope	85	16	9	76		
27		Slope	30	13	12	18		
31	G. Kennedy Todd	Flat	13	12	9	7		
32		Flat	15	16	8	7		
34		Flat	20	14	10	10		
35		Flat	15	12	9	6		
37		Slope	340	33	27	313		(*a*)
38	E. C. Converse	Plain	408	18	11	397		
39	W. H. Erhart	Valley	410	12	7	403		
40	L. Timmons	Hill	440	36	19	421		
41	Mrs. John Clark	Slope	516	23	19	497	6	2
42		Hill	480	16	11	469		
43	W. O. Dove	Slope	460	30	16	444		2.5
44		Hill	320	21	17	303		
45		Valley	250	13.5	7.5	242.5		
47		Slope	260	15	9	251		
49	Schoolhouse	Hill	345	20	8	237		1.5
50		Hill	300	13	10	290		
51	R. A. Strong	Hill	380	12	8	372	9	(*a*)
53	W. T. Carrington	Hill	500	21	10.5	489.5		
54	Daniel Ryan	Slope	430	13	10	420		4
55	D. M. Griffin	Slope	430	15	11	419		
57	King Street School	Hill	325	32	8	317	12+	
58		Slope	160	15	8	152		
59	A. J. Peck	Slope	140	30	24(?)	116(?)		
61	Lown	Hill	240	25	22	218		
63		Hill	250	19	14	236		
64		Valley	270	15	7	263		
65		Plain	240	11	10.5	229.5		

Map No.	Owner.	Amount used per day.	Depth to rock.	Section.	Wall.	Cover
		Gallons.	*Feet.*			
3		10	8	Till and rock	Stone	Open.
5	George Clark	12	10	Till and rock	Stone	Plank.
6	Mrs. S. E. Marshall	15		Till	Stone	Lattice shed.
7	Wm. Wenzel	15	15	Till and rock	Stone	Open.
9	Chas. Perin and others	25	14	Till and rock	Stone	Open.
10				Till	Stone	Open.
11		0		Till	Stone	Plank.
12	W. Lockwood	25		Till	Stone	Plank.
16	E. M. Hobby	25		Till	Stone	Open.
17		15		Till	Stone	Open.
18		20		Till	Stone	Plank.
25		20		Till	Stone	Open.
27		0		Till	Stone	Open.
31	G. Kennedy Todd			Sand	Stone	
32		0		Till	Stone	Plank.
34		20		Till	Stone	Open.
35		10		Till	Stone	Plank.
37				Till	Stone	Open.
38	E. C. Converse	10		Till	Stone	Open.
39	W. H. Erhart	40		Till	Stone	Open.
40	L. Timmons	0		Till	Stone	Plank.
41	Mrs. John Clark	25	22	Sand and rock	Stone	Lattice shed.
42		20		Till	Stone	Open.
43	W. O. Dove	25		Till	Stone	Open.
44		0		Till	Stone	Open.
45				Sand	Stone	Open.
47				Sand	Stone	Plank.
49	Schoolhouse	2		Till	Stone	Plank.
50				Till	Stone	Open.
51	R. A. Strong	0	10	Till and rock	Stone	Plank.
53	W. T. Carrington	0		Till	Stone	Open.
54	Daniel Ryan	20		Till	Stone	Shed.
55	D. M. Griffin	30		Till	Stone	Open.
57	King Street School	8	25	Till and rock	Stone	Plank.
58		15		Till	Stone	Open.
59	A. J. Peck		26	Sand and rock	Stone	Plank.
61	Lown	20		Till	Stone	
63					Stone	Open.
64				Till	Stone	Plank.
65		15		Till	Stone	Plank.

a Well goes dry.

Drilled wells in Greenwich.

Map No.	Owner.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Drilled in year—
		Feet.	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*	
1	Mrs. Alexander	160	170	5	200		
2	H. O. Havemeyer	160	245	60			
4	North Mianus School	35	75	7	25	0	
8	Charles Perin and others	240	250	10		0	1912
13	Thomas Paten	360	*a* 104	2.5	100		
14	R. A. Elliott	500	300	36	500	62	
15	A. Barrett	520	150	3	300	10	1911
19	Booze	300	300	16		30	
20	H. C. Krothoff	230	1,000	30		0	1911
21	do	190	430	5		0	1912
22	Ely School	265	300	2		0	
23	do	258	300	8		0	
24	Greenwich Country Club	255	150	10		0	
26	Mrs. Judge McNowell	100	200	15	100	0	
28	Edward Sandreuter	80	203	6	50	0	1912
29	G. Kennedy Todd	12	70	4	0	0	
30	do	12	300	0	0	0	
33	Roberts	20	300	6		8	
36	Hotel	12	1,000	6?	0	10	
48	Griswold	325	405	22		90	
52	W. T. Carrington	500	800	30?		30	
56	Charles Purdy	425	200?	10		0	
60							
62	Lown	240	200	0		0	
67	A. P. Stokes	360	500	6		100	

a Diameter of well 6 inches.

Springs in Greenwich.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Yield per minute.	Amount used per day.	Improvements.
			Feet.	*Gallons.*	*Gallons.*	
46	De Craft	Slope	280	1.5	0	Concrete reservoir; shed.
66		Valley	235	8	30	Concrete cistern 8 by 12 feet; windmill.

QUALITY OF GROUND WATER.

No recent tests of water from drilled wells are available, but analyses of water from nine school wells, probably shallow, were made by the Connecticut State Board of Health in 1898.[1] According to those analyses the waters ranged in total solids from 52 to 109 parts, in total hardness from 15 to 44 parts, and in chlorine from 2 to 15 parts per million. If conditions here are similar to those around Hartford the waters of deep wells would be harder and would show a higher mineral content.

SALISBURY.

POPULATION AND INDUSTRIES.

Salisbury is in Litchfield County, in the northwest corner of the State. It is reached by the Central New England Railway, which

[1] Connecticut State Board of Health Rept. for 1898, pp. 291-296.

has stations at Chapinville, Salisbury, Lakeville, and Ore Hill and which connects with the Berkshire division of the New York, New Haven & Hartford Railroad at Canaan, on the east border of the town. The Harlem division of the New York Central & Hudson River Railroad runs along the west border and connects with the Central New England Railway at Millerton. Post offices are situated at Salisbury, Chapinville, Lakeville, Ore Hill, and Lime rock.

Salisbury was incorporated in October, 1741. Its area is 61 square miles.

The population in 1910 was 3,522. The following table shows the population of the town from 1756 to 1910, inclusive:

Population of the town of Salisbury, 1756 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1756	1,100			1840	2,562		0.7
1774	1,980	80		1850	3,103	21	
1782	2,225	12		1860	3,100		.1
1790				1870	3,303	6	
1800	2,266			1880	3,715	12	
1810	2,321	2		1890	3,420		8
1820	2,695	16		1900	3,489	2	
1830	2,580		4	1910	3,522	1	

The principal industries are agriculture, mining and smelting iron ore, and manufacture of car wheels and pocketknives. About 15,200 acres of land are under cultivation and about 200 people are engaged in farming.

TOPOGRAPHY.

The west half of Salisbury is mountainous, the principal peaks being Bear Mountain, Gridley Mountain, Mount Riga, Lions Head, and Indian Mountain. East of the mountains a narrow central valley extends from the Massachusetts line southward to Sharon. The east boundary of the town is formed by Housatonic River. Between the Housatonic and the central valley, Miles Mountain, Toms Mountain, Mount Prospect, Gallows Hill, Forge Hill, Red Rocks, and Sharon Mountain produce a rugged topography. The highest point in the State of Connecticut, 2,355 feet above sea level, is on Bear Mountain. The lowest land in the town, about 530 feet, is on the Housatonic in the southeastern corner of the town. About 22,800 acres, or a little less than half of the total area of the town, is mountainous. The central valley, which comprises nearly all the agricultural land of the town, is about a mile in average width in the southern half of the town but broadens to nearly 3 miles north of Mount Prospect. (See Pl. XI, in pocket.)

Nearly all the drainage reaches the Housatonic through Moore Brook, which occupies the central valley from Chapinville to Salisbury, where it joins Button Brook to form Salmon Creek, flows through a narrow pass at Limerock, and finally enters the Housatonic above Limerock station. The fall of Moore Brook between Chapinville and Salisbury is about 80 feet; of Salmon Creek from Salisbury to its mouth about 100 feet; and of Housatonic River between the Massachusetts line and the southern boundary of Salisbury, 130 feet. The following table shows the discharge of the Housatonic at Gaylordsville:

Monthly discharge of Housatonic River at Gaylordsville, Conn., for 1906–1909.[a]

[Drainage area, 1,020 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1906.						
January	3,170	938	1,800	1.76	2.03	
February	4,630	788	1,630	1.60	1.67	
March	10,000	1,120	2,910	2.85	3.29	
April	8,930	2,460	4,780	4.69	5.23	
May	5,060	1,090	2,110	2.07	2.39	
June	2,370	928	1,630	1.60	1.78	
July	2,120	421	984	.965	1.11	
August	1,310	347	818	.802	.92	
September	876	296	554	.543	.61	
October	2,220	296	861	.844	.97	
November	1,980	550	992	.973	1.09	
December	1,440	686	958	.939	1.08	
The year	10,000	296	1,670	1.64	22.17	
1907.						
January	3,970	1,060	2,080	2.04	2.35	B.
February	1,370	816	1,120	1.10	1.14	B.
March	5,330	714	2,430	2.38	2.74	B.
April	3,350	1,830	2,340	2.29	2.56	B.
May	3,550	1,430	2,010	1.97	2.27	B.
June	4,860	930	2,160	2.12	2.36	B.
July	1,560	620	921	.903	1.04	B.
August	651	328	493	.483	.56	B.
September	6,690	240	1,210	1.19	1.33	B.
October	16,100	1,320	3,700	3.63	4.18	B.
November	11,200	2,200	4,950	4.85	5.41	B.
December	5,690	1,260	3,120	3.06	3.53	B.
The year	16,100	240	2,210	2.17	29.47	
1908.						
January	6,430	1,160	2,820	2.76	3.18	B.
February	12,600	1,160	2,860	2.80	3.02	B.
March	4,750	1,620	3,180	3.12	3.60	B.
April	4,640	1,830	2,790	2.74	3.06	B.
May	4,860	930	2,510	2.46	2.84	B.
June	1,830	478	958	.939	1.05	B.
July	1,210	328	687	.674	.78	B.
August	1,110	305	592	.580	.67	B.
September	505	130	310	.304	.34	B.
October	505	147	313	.307	.35	B.
November	452	130	290	.284	.32	B.
December	682	147	411	.403	.46	B.
The year	12,600	130	1,480	1.45	19.67	

[a] Discharge for 1906 is taken from U. S. Geol. Survey Water-Supply Paper 201, p. 114, 1907; discharge for 1907–8 from Water-Supply Paper 241, p. 172, 1910; and discharge for 1909 from Water-Supply Paper 261, p. 170, 1911.

Monthly discharge of Housatonic River at Gaylordsville, Conn., for 1906–1909—Contd.

Month.	Discharge in second-feet.				Run-off (depth in inches on drainage area).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.		
1909.						
January	5,450	182	1,250	1.23	1.42	C.
February	10,400	....	3,270	3.21	3.34	B.
March	6,180	1,620	2,710	2.66	3.07	B.
April	8,940	2,520	3,970	3.89	4.34	B.
May	4,520	1,620	2,490	2.44	2.81	B.
June	2,360	561	1,260	1.24	1.38	B.
July	1,060	305	518	.508	.59	B.
August	1,760	220	668	.655	.76	B.
September	1,160	83	469	.460	.51	B.
October	890	114	445	.436	.50	B.
November	505	83	387	.379	.42	B.
December	2,050	220	632	.620	.71	B.
The year	10,400	83	1,510	1.48	19.85	

NOTE.—In the last column B indicates that the mean monthly flow is probably accurate within 10 per cent, C, within 15 per cent. Figures for 1906 are rated good. Minimum figures are low on account of storage of water at power plant above the station. Mean discharge estimated because of ice as follows: Jan. 16 to 31, 1909, 819 second-feet; Feb. 1 to 5, 1909, 650 second-feet; Dec. 24 to 31, 1909, 375 second-feet.

Natural lakes of glacial origin constitute a picturesque feature of Salisbury. They have remarkably clear water and clean shores and are popular summer resorts. South of Lakeville, Wononskopomuc Lake and Wononpakook Lake occupy the central valley; the former is nearly circular and almost a mile in diameter; the latter is about a quarter of a mile wide and a mile long. The elevation of Wononskopomuc Lake is about 760 feet; the elevation of Wononpakook Lake, about 735 feet. These two lakes are separated by a ridge of glacial material three-eighths of a mile wide. At Chapinville, in the northern part of the valley, there are two similar but somewhat larger lakes known as Twin Lakes, which are 735 feet above sea level and are separated by a strip of lowland only a few yards wide and connected by a small brook. The larger of the two is nearly circular and about a mile and a half in diameter; the other is half a mile wide and 2 miles long. Riga Lake and South Pond, near the top of Mount Riga, at an elevation of 1,700 feet, also owe their origin to glaciation. Riga Lake is about half a mile in diameter and is about twice as large as South Pond.

Salisbury consists so largely of mountainous, woody, or swampy land that only about 15,200 acres, or two-fifths of its area, is under cultivation and only about 200 persons are engaged in agriculture. All the mountainous parts are forested.

WATER-BEARING FORMATIONS.

Bedrocks.—The two principal rock formations in Salisbury are the Berkshire schist and the Stockbridge limestone.[1] The distribution

[1] See Gregory, H. E., and Robinson, H. H., Preliminary geological map of Connecticut: State Geol. and Nat. Hist. Survey Bull. 7, 1907.

of these rocks is indicated by the topography. The Berkshire schist is much more resistant to erosion than the limestone, and therefore forms the mountainous parts of the town. The limestone constitutes the bedrock in the valley, but it is believed to underlie the mountains of harder rocks also, particularly those along the west border. Pockets of iron ore occur in the limestone near its contact with the overlying schist, and the mining of these deposits is one of the principal industries. The only mine now in operation is at Ore Hill, but iron was formerly mined on a large scale at Salisbury.

The schist is a dense rock but is traversed by joints, some of which are water bearing. However, the topography throughout the area underlain by schist is such that surface water affords a more practicable source of supply than ground water, and for this reason no attempt has been made in this town to obtain water from these rocks. The limestone also is a dense crystalline rock, but in many places it is readily soluble, as is indicated by the solution cavities along the west shore of Lake Wononpakook. Percolating waters have widened many of the joints, thereby affording free underground drainage (Pl. V, *B*, p. 21). For this reason water is not stored long in the limestone above the base levels of underground drainage. Most of the wells that have been drilled into this rock have failed to obtain a permanent supply of water.

Till.—Till, which consists of mixtures of clay, sand, gravel, and bowlders, covers the rock in the mountainous districts and in the southern part of the central valley and is the most widely distributed surface deposit in Salisbury. Its thickness varies according to the topography. It is very thin immediately surrounding the rock outcrops and becomes thicker near the bottoms of the slopes. On the higher elevations the till was deposited by melting ice, but on the valley walls the material was squeezed against the rocks by advancing tongues of ice and remains as a plaster in some places 100 feet thick. On the valley floors it was heaped up by floods from the ice front and from the mountain sides. One hundred feet of till is exposed in the abandoned mine at Salisbury. The occurrence of water in till is discussed on page 15.

Stratified drift.—Deposits of stratified drift not more than 25 feet thick are found in small areas in the northern part of the central valley near Twin Lakes, and a few small deposits that consist of sand and gravel and show fluviatile cross-bedding are exposed in ravines along the mountain sides at elevations of about 100 feet. The elevated deposits of stratified drift are drained rapidly and are therefore not likely to afford good wells, but the low-lying beds of sand and gravel may be expected to furnish good supplies of water.

Alluvium.—Deposits of alluvium are found on the lowlands along Moore Brook and smaller deposits along Salmon Creek. The flood plains along the west side of the Housatonic between Falls village and Canaan are also covered by alluvium. These deposits are thin and are not important in determining the position of wells.

SURFACE-WATER SUPPLIES.

Water power is developed at the outlet of Wononskopomuc Lake and on Salmon Creek at Lime rock. A dam at the outlet of Twin Lakes at Chapinville furnishes power intermittently. Two impounding reservoirs at the headwaters of Burton Brook furnish the public water supply of Lakeville and Salisbury.

There is large opportunity for the utilization of surface water. The lakes are capable of furnishing an almost unlimited quantity of good water and some of them are so situated that pumping would not be necessary. At present, however, the lakes in the valley are not protected against contamination.

GROUND-WATER SUPPLIES.

Shallow dug wells ranging in depth from 8 to 27 feet and averaging 15 feet furnish most of the private domestic supplies in Salisbury. The depth to water ranges from 4 to 25 feet and averages 11 feet but fluctuates with the rainfall, the fluctuation as determined for three wells being 4, 5, and 6 feet, respectively. All except one of the wells examined obtained water from till and only two of them were reported to have failed. The yields, as determined in three wells, were 3, 3½, and 8 gallons, respectively. The quantity of water used from 27 wells ranges from 10 to 60 gallons and averages 27 gallons a day.

Drilled wells in Salisbury have not been generally successful, although this method of procuring water has not been fully tested. Ten wells, ranging in depth from 28 to 500 feet and penetrating bedrock, have been drilled. Two of these wells failed to obtain water in the limestone, and were therefore abandoned. Four others penetrated the crystalline rocks but were abandoned because the quantity obtained was not adequate, although eaeh of them furnished about 5 gallons a minute. The other four wells yielded 5, 12, 20, and 60 gallons a minute, and are at present drawn upon to the extent of about 30 gallons, 200 gallons, 500 gallons, and 5,000 gallons a day, respectively.

Springs are numerous on the hillsides in all parts of the town. Most of them yield very small quantities of water, but a great many of them are capable of furnishing supplies for households. Fourteen springs were examined whose yields range from a quarter of a gallon to 20 gallons per minute. Seven of these are used, the consumption ranging from 20 to 500 gallons per day and averaging 110 gallons.

All are gravity springs and fluctuate to some extent, but only two of those examined fail during dry weather.

PUBLIC WATER SUPPLY.

The public water system of Lakeville and Salisbury, operated by the Lakeville Water Co., takes its water from two reservoirs, with a total capacity of 18,000 gallons, at the head of Burton Brook. About 2,000 people are served from this system and the quantity has always been adequate.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of Salisbury is presented in the following tables:

Drilled wells in Salisbury.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.	Yield per minute.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Gallons.*
2	E. C. Eggleston		920	16?	10	910		
3	Edward Garrity		880	15	9	871	6	(a)
4			585	12	5	580		
5			580	12	5	575		8+
8			638	11	4.5	633.5		
9		Slope	800	14	12	788		
10	J. Conour	Slope	815		14	801		
11	John Lloyd	Slope	830	16	14	816		3
12		Slope	920	18	12.5	907.5		
13	P. F. Cleveland	Hill	900	15	10	890		
14		Hill	920	12.5	7	913		
16	C. H. Bissel	Hill	890	22	9	881		
17	E. E. Burch	Slope	880	14	7.5	872.5		
18	Mike Walsh	Slope	700	12	12	688	4	Dry.
22	F. B. White	Hill	860	23	21	839		
23		Plain	800	12	8	792		3.5
25	Hotchkiss School	Hill	820	10	7	813		
26	Henry Wells	Hill	940	16	11	929		
27		Valley	760	9	8	752		
28	Peter Garrity	Hill	920	25	12	908	5	
32	D. T. Warner	Hill	1,770	27	25	1,745		
34		Flat	700	13.5	11	689		
36		Flat	780	8	6	774		
37	J. King	Flat	770	24.5	21.5	748.5		
44		Slope	810	18	10	800		
45		Slope	720	11	10	710		
46		Slope	770	16	11	759		
47		Hill	860	23	14	846		
52		Hill	960	25.5	13	947		
53		Slope	800	21	17	783		
54		Hill	860	12	9	851		
55		Hill	860	13	13	847		
57		Hill	770	16	9	761		
58		Slope	680	16	12	768		
59		Flat	780		13	757		
61		Flat	680	12	9	671		
62		Flat	640	9	8	632		
63		Slope	680	10	8.5	671.5		
66		Flat	670	12	10	660		

Drilled wells in Salisbury—Continued.

Map No.	Owner.	Amount used per day.	Section.	Wall.	Cover.
		Gallons.			
2	E. C. Eggleston	50	Till		Plank.
3	Edward Garrity	50	Till	Stone	Open.
4		25	Till	Stone	Plank.
5		40	Alluvium	Stone	Plank.
8		30	Till	Stone	Plank.
9		0	Till	Stone	Open.
10	J. Conour	50	Till	Stone	Plank.
11	John Lloyd	30	Till	Stone	Plank.
12		20	Till	Stone	Open.
13	P. F. Cleveland	35	Till	Stone	Plank.
14			Till	Stone	Open.
16	C. H. Bissel	60	Till	Stone	Plank.
17	E. E. Burch	15	Till	Stone	Plank.
18	Mike Walsh	0	Till	Stone	Open.
22	F. B. White	30	Till	Stone	Plank.
23		10	Till		Plank.
25	Hotchkiss School	15	Till	Stone	Shed.
26	Henry Wells	0	Till		Plank.
27		10	Till	Stone	Open.
28	Peter Garrity	20	Till	Stone	Open.
32	D. T. Warner	10	Till	Stone	Plank.
34		10	Till	Stone	Open.
36		10	Till	Stone	Open.
37	J. King	15	Till	Stone	Plank.
44			Till		
45		0	Till	Stone	Open.
46			Till		
47		10	Till		Plank.
52		50	Till	Stone	Plank.
53			Till	Stone	Plank.
54			Till		Plank.
55		10	Till	Stone	Plank.
57		20	Till		Plank.
58			Till		
59			Till		Plank.
61		20	Till	Stone	Open.
62		15	Till	Stone	Shed.
63			Till	Stone	Open.
66		20	Till	Stone	Open.

[a] Well goes dry.

Drilled wells in Salisbury.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Section.	Pump.	Diameter.
			Feet.	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*			*Inches.*
19	Mike Walsh	Hill	735	34	0	0	(?)			
21	Joseph Parsons	Slope	845	250	[a] 12	200	22	([b])		5
24	W. R. Warner	Hill	920	60	0	0	40			4
38	J. F. Fisher	Flat	750	500	5	0	0	Limestone	None.	4
39	....do	Flat	538	500	5	0	0	Limestone	None.	
41	....do	Slope	950	200	4.5	0	0	Schist	None.	
42	....do	Slope	800	150	4	0	0	Schist	None.	
43	Beal	Flat	760	200	5	30	(?)			
51	Salisbury School	Slope	940	[c] 215	60	5,000	8			6
56	Bierce	Valley	750	28	20	500	8	Limestone		4

[a] Flows 1 gallon per minute; used only in summer.

[b] Log:

	Feet.
Till	18
Limestone	145
Schist	87

[c] Well drilled in 1901; cost $3.75 per foot.

Springs in Salisbury.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Yield per minute.	Amount used per day.	Temperature.	Improvements.
			Feet.	*Gallons.*	*Gallons.*	°*F.*	
6		Slope	650	0.25		59	Horse trough.
7		Slope	600	4.5		55	Do.
15		Slope	820	Slight.		57	Do.
20	Mike Walsh	Slope	870	1	20	55	
29		Slope	945	0.5	0	59	
30	D. T. Warner	Slope	1,200	1	30	57	
31	Pettee	Valley	1,090	[a] 20	50	48	
33		Slope	1,300	2	0	56	
35	Bushnell	Slope	920	2	50	58	
40	Henry Schoville	Swamp	760	20	500	50	
48		Slope	740	5		57	
49	Little	Flat	960	6	20	56	
60		Slope	770	7	100	56	Concrete reservoir.
64		Slope	775	[b] 0.5	0	57	
65		Slope	640	[b] 1	0	56	

[a] No variation in yield. [b] Well goes dry.

QUALITY OF GROUND WATER.

Two Salisbury waters, analyses of which are given below, are moderate in mineral content, distinctly hard, calcium carbonate in type, and low in their contents of sulphate and chlorine.

Analyses of water from drilled wells in Salisbury.

[Parts per million; R. B. Dole, analyst.]

Constituents.	1	2
Total solids at 180° C.	319	325
Total hardness as $CaCO_3$	160	245
Iron (Fe)	.7	Tr.
Carbonate radicle (CO_3)	Tr.	Tr.
Bicarbonate radicle (HCO_3)	360	313
Sulphate radicle (SO_4)	21	32
Chlorine (Cl)	1.1	5.4

1. Well of Joseph Parsons (Pl. XI, No. 21), 250 feet deep; sample collected June 25, 1915.
2. Well of Mr. Bierce (Pl. XI, No. 56), 28 feet deep; sample collected June 25, 1915.

NORTH CANAAN.

POPULATION AND INDUSTRIES.

North Canaan is in Litchfield County, in the northwest corner of Connecticut. It is reached by the Berkshire division of the New York, New Haven & Hartford Railroad (station at Canaan), by the Central New England Railway (stations at Canaan and East Canaan), and by daily stage from Southfield, Mass., via Mill River and Clayton, and by trolley from Sheffield, Mass. There are post offices at Canaan and East Canaan.

The town has an area of 19 square miles. It was separated from the town of Canaan and incorporated in May, 1858. The village of Canaan is in the town of North Canaan.

The population of North Canaan in 1910 was 2,171. The following table shows the population from 1870 to 1910, inclusive:

Population of North Canaan, 1870 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1870	1,695			1900	1,803	7	
1880	1,537		9	1910	2,171	20	
1890	1,683	10					

The principal industries are agriculture, the manufacture of pig iron and lime, and the quarrying of marble and quartzite.

TOPOGRAPHY.

The region east of the village of Canaan is mountainous. Rattlesnake Hill, which lies between Canaan and Sodom, 1,000 feet above sea level, or 340 feet above Housatonic River, is produced by outcrops of limestone and quartzite. The foothills of Ball Mountain, between Sodom and the east border of the town, attain an elevation along the east boundary of 1,300 feet. Canaan Mountain rises on the south side of Blackberry River to an elevation of 1,927 feet a short distance south of the south boundary. A low range of limestone hills extends along the west border of the town from the latitude of Canaan to the south line. The highest point in these hills is 800 feet above sea level. Between these hills and Canaan Mountain and between Rattlesnake Hill and Housatonic River there is a flat plain about a mile wide and 680 feet above sea level, which was formerly the bed of the Housatonic. (See Pl. XI, in pocket.)

The Housatonic forms the west boundary of North Canaan and receives as tributaries all the minor streams of the town. Konkapot River enters the town of Clayton, follows around the north foot of Rattlesnake Hill, crosses the State line, and enters the Housatonic west of Ashley Falls, Mass. Blackberry River, which drains nearly the entire town, flows across the town along the north foot of Canaan Mountain and enters the Housatonic west of Canaan. Whiting River flows southward through Canaan Valley to East Canaan, where it joins Blackberry River. A small amount of power is developed on Blackberry River at Canaan.

The woodlands in North Canaan are confined to the hilltops and comprise an area of only about 5 square miles. The remainder of the town is devoted to agriculture, about half being tilled land and the rest meadows.

WATER-BEARING FORMATIONS.

Bedrocks.—Most of the rock floor of North Canaan is composed of Stockbridge limestone, but an area in the northeast corner of the town, north of Blackberry River and east of Whiting River, is underlain by Becket gneiss. Canaan Mountain consists of Berkshire schist, and in Rattlesnake Hill and at the Central New England Railway bridge over Whiting River the Cheshire ("Poughquag") quartzite[1] comes to the surface. All of these rocks outcrop in many places and the limestone and quartzite are quarried. (See p. 20.)

Till.—Unstratified glacial deposits cover the rock on Canaan Mountain and Rattlesnake Hill and on the hills in the northeast quarter of the town. They range in thickness from a few inches surrounding the rock exposures to 25 or 30 feet. (See p. 15.)

Stratified drift.—In the lowlands along Housatonic and Blackberry rivers bedrock is covered with stratified sand and gravel. These deposits form a terrace bordering the hills near the mouth of Blackberry River and a much broader terrace extending from Canaan northward along the base of Rattlesnake Hill. Similar deposits occur along Squabble Brook north of Sodom. The stratified deposits range in thickness from a few feet to about 50 feet, the thickest deposits being just west of Canaan. The water-bearing capacity of these deposits is large, and by means of dug or driven wells water suitable for domestic use or for additions to public supplies is available.

Infiltration galleries (p. 42) in the stratified deposits in the central and west parts of the town would probably afford rather large quantities of water, and this method of utilization should receive consideration in connection with proposed public supplies.

GROUND-WATER SUPPLIES.

The average depth of 16 dug wells is 14 feet and the depth to water ranges from 5 to 19 feet and averages 11 feet. The fluctuation of the water table was reported for three wells to be 4, 7, and 8 feet, respectively. All the wells examined end in till and only two fail in dry weather. The quantity of water used daily, as reported for 10 wells, ranges from 10 to 40 gallons and averages 21 gallons.

A drilled well, 333 feet deep, in the village of Canaan (see No. 23, Pl. XI), at an elevation of 670 feet, was sunk at a cost of $1,800, for the purpose of obtaining a supplementary supply for the public waterworks. It yielded, however, only 17 gallons a minute, and as this quantity was considered inadequate it was abandoned, a larger supply being obtained by sinking a shallow well into the drift.

Springs are common on the hillsides, but all of them yield small quantities of water and most of them are intermittent. The average yield of the permanent springs is about a gallon a minute. The yield of the springs is, however, generally much greater than the amount used, which averages only about 35 gallons a day.

PUBLIC WATER SUPPLY.

The water supply for the village of Canaan is obtained from a 3,000,000-gallon reservoir on the north slope of Canaan Mountain.

[1] See Preliminary geological map of Connecticut: State Geol. and Nat. Hist. Survey Bull. 7, 1907.

The reservoir is fed by springs which have a combined yield of 55,000 gallons a day. All the water is used for domestic needs, and about 1,000 persons are supplied. The consumption in summer is 65,000 gallons a day. In dry summers, when the supply is inadequate, additional water is obtained from a dug well 12 feet square and 12 feet deep, lined with planking. The water in this well is usually 6 feet deep, but pumping at the rate of 110 gallons a minute lowers it nearly to the bottom.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of North Canaan is presented in the following tables:

Dug wells in North Canaan.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1			700	10	10	690	
2	H. R. Cadwell	Flat	720	*a* 17	16	704	7
3	R. D. Miller	Flat	715	11	10	705	
4	T. P. Couch	Flat	720	10	7	713	
6	E. P. Adsit	Slope	700	12	10	690	
7		Slope	880		9	871	
8		Flat	860	16	11	849	
11	E. Taylor	Hill	855	12	10	845	
12	Rogers	Flat	818	10	8	810	
13	Langdon	Flat	810	10	5	805	
14		Flat	822	14	8	814	
15	Thomas Morris	Flat	815	16			4
17		Flat	765	18(?)	15(?)	750(?)	
18		Slope	780	22	19	761	
19		Hill	815	19	12	803	
21	George Preny	Hill	850	23	19	831	8
22	Canaan Water Co	Flat	680	12	6	674	

Map No.	Owner.	Amount used per day.	Section.	Wall.	Cover.
		Gallons.			
1		30	Till	Stone	Open.
2	H. R. Cadwell	(*b*)	Till	Stone	Loose boards.
3	R. D. Miller	20	Till	Stone	Shed.
4	T. P. Couch		Till	Stone	Plank.
6	E. P. Adsit		Till	Stone	Plank.
7			Till	Stone	Open.
8		0	Till	Stone	Lattice shed.
11	E. Taylor	20	Till		
12	Rogers	25	Till		
13	Langdon	15	Till	Stone	Open.
14		10	Till	Stone	Open.
15	Thomas Morris	*c* 10	Till	Stone	Plank.
17		20	Till	Stone	Plank.
18		20	Till	Stone	Plank.
19		40	Till	Stone	Lattice shed.
21	George Preny	10	Till	Stone	Plank.
22	Canaan Water Co		Till	Plank	Shed.

a Tile at bottom, 2 feet. *b* Well goes dry. *c* Dry.

Springs in North Canaan.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Yield per minute.	Amount used per day.
			Feet.	*Gallons.*	*Gallons.*
5	....	Slope....	735	4	30
9	....	Slope....	980	0.25	20
10	....	Slope....	1,120	0.5	....
16	Thomas Morris........	Slope....	845	1	60
24	....	Slope....	755	1.5	....

CANAAN.

POPULATION AND INDUSTRIES.

Canaan, in Litchfield County, in the northwest corner of Connecticut, is reached by the Berkshire division of the New York, New Haven & Hartford Railroad, which has stations at Falls Village and Lime rock; by mail carrier from Cornwall Hollow through South Canaan and Huntsville daily, and also over Barrack Mountain by Lime rock station, part of Lime rock village, and Amesville daily. Post offices are maintained at Falls Village and during the summer at Pine Grove. The rural free delivery reaches outlying parts of the town.

Canaan was incorporated in October. 1739. The area of the town is 33 square miles.

The population in 1910 was 702. The population from 1756 tc 1910, inclusive, is shown in the following table. The chief industry is agriculture.

Population of Canaan, 1756 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1756	1,100	....	....	1840	2,166	....	6
1774	1,635	48	....	1850	2,627	21	....
1782	2,061	26	....	1860	2,834	8	....
1790	....	....	....	1870	1,257	....	[a] 55
1800	2,137	....	....	1880	1,157	....	8
1810	2,203	3	....	1890	970	....	16
1820	2,332	6	....	1900	820	....	16
1830	2,301	....	1	1910	702	....	14

[a] North Canaan was set off from Canaan in 1858.

TOPOGRAPHY.

The topography of Canaan is produced by faulting and by erosion. Canaan Mountain occupies the northeast corner of the town, and Barrack Mountain and Titus Mountain occupy the south half. Lowlands, which were at one time flood plains of Housatonic River, extend from Lime rock station northward to the town line and from Housatonic River eastward to South Canaan and the base of Canaan

Mountain. The general elevation of these lowlands is about 680 feet above sea level. The highest elevation in the town is Bradford Mountain, the principal peak on Canaan Mountain, which is 1,927 feet above sea level. The altitude of Barrack Mountain is 1,140 feet, of Cobble Hill 1,278 feet, and of two peaks which form the northern part of Titus Mountain 1,420 and 1,450 feet, respectively. (See Pl. XI, in pocket.)

Housatonic River forms the west boundary of Canaan and receives all the drainage from the town; its principal tributary is Hollenbeck River. The south branch or main stream of Hollenbeck River rises in the hills east of Huntsville, flows through a narrow valley between Cobble Hill and Beebe Hill, passes through South Canaan, and enters the Housatonic 1 mile north of Falls Village. The east branch of Hollenbeck River rises in Wangum Lake, near the top of Canaan Mountain, at an elevation of 1,410 feet, and flows between Cobble Hill and Canaan Mountain to its confluence with Hollenbeck River half a mile north of South Canaan. The north branch of this river rises near the town line at the foot of Canaan Mountain and flows due south till it joins Hollenbeck River. The lowlands between Canaan Mountain and Housatonic River are poorly drained and are marshy throughout the greater part of the year.

The mountainous parts of Canaan, comprising an area of about 25 square miles, are forested. The cultivated lands are confined to the valleys in the immediate vicinity of South Canaan.

WATER-BEARING FORMATIONS.

Bedrocks.—Berkshire schist and Becket gneiss [1] constitute the rock floor in the mountainous parts of the town. The Cheshire ("Poughquag") quartzite appears at the surface in Cobble Hill and at several places south of Hollenbeck River. All the lowland area is underlain by Stockbridge limestone. The steep slopes in the southern and western parts of the town afford numerous rock exposures, but the limestone appears at the surface only in the low hills adjacent to Housatonic River. The occurrence of water in rocks of this kind is discussed on page 20.

Till.—The rocks throughout the eastern and southern parts of the town at elevations of more than 700 feet above sea level are covered with mixtures of bowlders, sand, and clay, ranging in thickness from a few inches to 25 or 30 feet. (See p. 15.)

Stratified drift.—Stratified deposits of sand and gravel occur generally at elevations less than 700 feet. The thickest deposits are in the valley just west of Canaan Mountain and in the immediate vicinity of South Canaan, where they are in some places more than 30 feet deep.

[1] See Preliminary geological map of Connecticut: State Geol. and Nat. Hist. Survey Bull. 7, 1907.

These deposits afford an opportunity for obtaining ground-water supplies by means of dug and driven wells. (See p. 38.)

SURFACE-WATER SUPPLIES.

Opportunity for the development of power is afforded by the south and east branches of Hollenbeck River. Water supply of moderate size for public use may be obtained from Wangum Lake or by constructing impounding reservoirs at a number of points along the south slope of Canaan Mountain and along the south border of the town.

GROUND-WATER SUPPLIES.

The average depth of shallow wells is 16 feet and the maximum depth about 23 feet, but water is obtained within 10 feet of the surface on the lowlands north of South Canaan. The depths to water range from 5 to 20 feet and average about 12 feet. The fluctuation of the water table was observed in two wells to be 5 and 6 feet, respectively. The yield of one well was estimated at about 3 gallons a minute. The quantity of water used daily from two wells was reported as 10 and 15 gallons. Six of the wells examined end in till and two in alluvium. Two of the wells which end in till fail during dry weather.

There are four drilled wells in Canaan, ranging in depth from 42 to 90 feet and averaging about 62 feet. The yields obtained from three of these wells were 1½ gallons, 2 gallons, and 3 gallons, respectively.

Springs yielding from half a gallon a minute to 6 gallons a minute and averaging about 2 gallons a minute are numerous on the slopes throughout the town. All are gravity springs, and most of them are intermittent. Four of the springs examined are used for private supplies, the average consumption being about 47 gallons a day.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of Canaan is presented in the following tables:

Dug wells in Canaan.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.	Yield per minute.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Gallons.*
1	....	Flat.....	685	10	5	680	....	....
2	....	Slope....	720	20	20	700	....	Dry.
4	....	Slope....	715	23	19	696	....	....
7	H. Scoville........	Flat.....	875	14	6	869	6	3
10	....	Flat.....	690	10	10	680	....	....
11	....	Hill.....	935	22	18	917	....	....
17	D. Brinton........	Flat.....	680	....	11	669	....	....
18	W. J. Russell........	Flat.....	680	11	10	670	5	(a)

a Well goes dry.

Dug wells in Canaan—Continued.

Map No.	Owner.	Amount used per day.	Section.	Wall.	Cover.
		Gallons.			
1			Alluvium	Stone	Open.
2		0	Till	Stone	Plank.
4			Till		Plank.
7	H. Scoville	10	Alluvium	Stone	Plank.
10			Till	Stone	Plank.
11		0	Till	Stone	Open.
17	D. Brinton		Till	Stone	Plank.
18	W. J. Russell	15	Till	Stone	Plank.

Drilled wells in Canaan.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Section.	Diameter.	Quality of water.
			Feet.	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*		*Inches.*	
15	G. Schultis	Slope	600	90	1.5	0	0	Limestone		Rusty.
16	L. J. Morris	Hill	580	72	2		6	Limestone		
19	J. M. Benjamine.	Hill	585	42	3		8	Limestone	4	
20	do	Hill	585	43			19	Schist		

Springs in Canaan.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Yield per minute.	Amount used per day.	Temperature.
			Feet.	*Gallons.*	*Gallons.*	*° F.*
3		Slope	775	6	100	
5		Slope	800	0.5	40	55
6	M. C. Dean	Slope	930	1		54
8	Lucas	Slope	800	1	30	51
9	E. S. Parker	Valley	750	1	20	53
12		Valley	905	3		54
13		Slope	868	2.5		
14		Slope	740	2		54

WINDHAM.

POPULATION AND INDUSTRIES.

The town of Windham is in the southwestern corner of Windham County, in the east-central part of the State. It is reached by the Highland division of the New York, New Haven & Hartford Railroad (stations at Willimantic, North Windham, and South Windham) by the New London Northern Railroad (stations at Willimantic and South Windham); by electric railway from Baltic, Norwich, and New London; and by stage from Ashford, Warrenville, Mount Hope, and Mansfield Center. Post offices are maintained at Willimantic, Windham, North Windham, and South Windham, and outlying parts of the town are reached by rural free delivery.

Windham was incorporated in May, 1692. Its area is 26 square miles.

The population of the town of Windham in 1910 was 12,604; of the city of Willimantic, 11,230. The following table shows the population of the town from 1756 to 1910, inclusive.

Population of Windham, 1756 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1756	2,446			1840	3,382	20	
1774	3,528	44		1850	4,503	33	
1782	3,571	1		1860	4,711	5	
1790	2,765		23	1870	5,412	15	
1800	2,644		4	1880	8,264	53	
1810	2,416		9	1890	10,032	21	
1820	2,489	3		1900	10,137	1	
1830	2,812	13		1910	12,604	24	

Water power has been developed on a large scale at Willimantic by means of dams built across Willimantic River. Most of these structures are owned by the American Thread Co.

The principal industries in Windham are manufacturing and agriculture. The principal manufactured products are spool cotton, silk twist, silk and cotton fabrics, carriages, and silk-making, paper-making, and other machinery.

TOPOGRAPHY.

The average elevation of Windham is 400 feet above sea level. The highest elevation, 661 feet, is on Obwebetuck Hill; the lowest, 100 feet, is in the southeastern corner of the town. Blake Hill, Prospect Hill, and Obwebetuck Hill, between the Shetucket and the western boundary of the town, are produced by undulation of the rock surface. The hills in the eastern half of the town are also rock hills, but between Windham Center and Willimantic the topography is due to valley filling. (See Pl. XII, in pocket.)

The principal stream is Shetucket River, which is produced by the confluence of the Willimantic and Nachaug at Willimantic.

About one-half of the area of Windham is forested and about one-fourth is under cultivation, the rest of the town being occupied by the city of Willimantic. Most of the farm lands are situated on the plain that lies between Willimantic and Windham Center and extends southward along the river to the Franklin boundary.

WATER-BEARING FORMATIONS.

Bedrocks.—The rock floor of Windham consists of gneisses and schists of unknown age, which have been classified according to their lithologic characters. The western half of the town is underlain by rocks which in the publications of the Connecticut State Geological and Natural History Survey have been designated the Willimantic gneiss, and the eastern half by rocks which have been designated Scotland schist, Hebron gneiss, and Eastford granite gneiss.[1] These rocks are exposed in many places along the eastern, southern, and western borders, but in the central and northern parts of the town they are covered by glacial deposits. All these rocks contain joints, the largest of which extend to depths of 200 or 300 feet and yield small quantities of water (p. 20).

Till.—At elevations of more than 300 feet above sea level the rock is covered with unstratified drift, the average thickness of which is about 25 feet. (See p. 15.)

Stratified drift.—Stratified deposits consisting of gravel and some sand are found in most places where the surface is less than 300 feet above sea level. Some of the sections along the west side of Shetucket River near South Windham reveal thicknesses of 25 feet. These deposits constitute the most important water-bearing formation in Windham (p. 40).

GROUND-WATER SUPPLIES.

Seventeen dug wells in Windham range in depth from 12 to 26 feet and average about 15 feet. Depth to water ranges from 2 to 21 feet and averages about 13 feet. The fluctuation of the water table in one well was 10 feet, and one well yielded 5 gallons a minute. The quantity of water used, reported for four wells, ranged in amount from 20 to 40 gallons a day. Three other wells are not used at all. Only one of the wells examined in this town is known to fail in dry seasons.

The well of the Willimantic Bottling Co. (No. 22, Pl. XII), which is the only drilled well in Windham, is 178 feet deep, the lowest 163 feet being in rock. Its elevation is 270 feet above sea level. It is used only occasionally to supply drinking water, the quantity used being about 20 gallons a day.

Springs are common along the slopes west of Shetucket River and on the hillsides in the eastern part of the town. All are gravity springs, averaging in yield between 1 and 2 gallons a minute. At a few places in the vicinity of Windham Center small springs occur in groups and, being properly developed, yield very desirable supplies. The quantity of water used from one of these groups exceeds 1,200 gallons a day.

The stratified sands and gravels of Windham contain large quantities of ground water. Driven wells drawing from these deposits would probably yield sufficient water to meet the needs of the villages in this town, and it is possible that Willimantic could obtain

[1] See Preliminary geological map of Connecticut: State Geol. and Nat. Hist. Survey Bull. 7, 1907.

water in this manner should the present supply become inadequate. Infiltration galleries (p. 42) in the stratified deposits along Willimantic River would afford large quantities, and should receive consideration in connection with proposed public systems.

PUBLIC WATER SUPPLY.

The waterworks of Willimantic are owned by the city. The water is pumped from Willimantic River at a dam 2 miles north of the city to a reservoir that will hold 5,000,000 gallons. About 12,000 people are served with 600,000 to 900,000 gallons a day. Meters are exclusively used. The water is considered good, and no shortage has been reported.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of Windham is presented in the following tables:

Dug wells in Windham.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.	Yield per minute.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Gallons.*
1		Slope	275	20	14	261		
2		Slope	300	12	9	291		
3	A. Lewis	Plain	285	21	15	270		
4		Plain	265	26	19	246		
5		Plain	265	22	21	244		(*a*)
6		Slope	318	16	14	304		
7		Slope	300		14	286		
9	Brookman	Slope	365	15	14	351		
10		Plain	490	18	16	474		
11		Plain	310	16.5	15	295		
12	Thompson	Plain	300	18	16	284		5
13		Plain	350		2	348		
15		Slope	285		12	273		
16	Gould	Hill	325	16	13	312		
17		Plain	265	12	7	258		
19	Wilson	Slope	230	17	12	218	10	
20	W. E. Light	Hill	225	18	14	211		
24		Plain	280					

Map No.	Owner.	Amount used per day.	Depth to rock.	Section.	Wall.	Cover.
		Gallons.	*Feet.*			
1		20		Till	Stove	Plank.
2		0		Till	Stone	Open.
3	A. Lewis	0		Till	Stone	Open.
4				Till	Stone	Shed.
5		30		Gravel	Stone	Open.
6				Till	Stone	Open.
7				Till		Plank.
9	Brookman		15	Till	Stone	Plank.
10				Till	Stone	Open.
11				Till	Stone	Open.
12	Thompson	25		Till	Stone	Plank.
13		0		Till		None.
15				Till	Stone	Open.
16	Gould			Till	Stone	Open.
17				Till	Stone	Open.
19	Wilson	40		Till		Open.
20	W. E. Light			Sand and gravel.	Stone	Plank.
24						

a Well goes dry.

Springs in Windham.

Map No.	Owner.	Topographic position.	Yield per minute.	Amount used per day.	Temperature.	Improvements.
			Gallons.	*Gallons.*	°*F.*	
8		Slope			55	Horse trough.
14		Slope		0	55	
18		Valley	1	0	56	
21	Windham Aqueduct Co.	Slope		1,200+	55	14 families supplied.

QUALITY OF GROUND WATER.

The Willimantic Bottling Co.'s well yields moderately mineralized, rather hard water that would probably form hard scale in boilers because of its content of sulphate. It contains only a trace of iron.

Analysis of water of the 178-foot drilled well of the Willimantic Bottling Co. (Pl. XII, No. 22), collected June 15, 1915.

[R. B. Dole, analyst.]

	Parts per million.
Total solids at 180° C.	228
Total hardness as $CaCO_3$	103
Silica (SiO_2)	37
Iron (Fe)	Tr.
Calcium (Ca)	23
Carbonate radicle (CO_3)	4.5
Bicarbonate radicle (HCO_3)	75
Sulphate radicle (SO_4)	69
Chlorine (Cl)	5.4

FRANKLIN.

POPULATION AND INDUSTRIES.

Franklin is in the north-central part of New London County, in the east-central part of the State. It is reached by the New London Northern Railroad, which has stations at Franklin, North Franklin, and Yantic (just over the south line of the town), and by electric railway from Willimantic, Baltic, Norwich, and New London. Post offices are at Yantic and North Franklin. Rural free delivery reaches all parts of the town.

Franklin was taken from Norwich and incorporated in May, 1786. The area of the town is 20 square miles.

The population of Franklin in 1910 was 527. The population from 1800 to 1910, inclusive, is shown in the following table. The principal industry is agriculture.

Population of Franklin, 1800 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1800	1,210			1860	2,358	163	
1810	1,161		4	1870	731		69
1820	1,161			1880	686		6
1830	1,194	3		1890	585		15
1840	1,000		16	1900	546		6
1850	895		11	1910	527		3

TOPOGRAPHY.

The present topography has been produced by the dissection of a peneplain and the subsequent filling of the valleys with glacial deposits. The highest elevations in Franklin are the summits of the nine hills, including Prospect Hill, Avery Hill, Hearthstone Hill, and Blue Hill, which embrace nearly the entire area of the town. The hills have a uniform height of about 520 feet above sea level. The valleys have been filled to some extent with glacial drift, which forms flat valley floors standing about 180 feet above sea level.

The accumulations of drift in the valleys have interrupted drainage, and considerable areas are therefore swampy. Four brooks in the northern part of Franklin empty into a swamp just east of Avery Hill, and Beaver Brook, a tributary to Shetucket River, rises in this swamp. Similar areas lie along Susquetonscut Brook, a tributary to Yantic River. Beaver Brook and Susquetonscut Brook carry nearly all of the drainage in Franklin, but a small amount enters Shetucket River directly.

About half the area of Franklin is forested, including most of the slopes and considerable areas in the low swampy lands in the central and western parts of the town. The remaining half is nearly all under cultivation.

WATER-BEARING FORMATIONS.

Bedrocks.—The town of Franklin is underlain by crystalline rocks which in publications of the Connecticut State Geological and Natural History Survey have been designated the Scotland schist, the Hebron gneiss, the Canterbury granite gneiss, and the Pomfret phyllite.[1] These rocks are exposed in many places throughout the town (Pl. XII, in pocket). All are broken by joints, or cracks, the largest of which probably extend 200 or 300 feet below the surface and are capable of furnishing moderate supplies of water. (See p. 20.)

Till.—Unstratified deposits of bowlders, gravel, sand, and clay cover the rock in most places. The extent of these deposits is indicated by the distribution of bowlders on the surface of the ground. Their thickness ranges from a few inches to 30 feet and averages about 15 feet. The deepest deposits are at the bases of the slopes and the thinnest on the tops of the hills, where the rocks are barely covered. The occurrence of water in till is discussed on page 15.

Stratified drift.—Kamelike deposits of stratified drift are found in the valley in the central part of the town between Hearthstone Hill and Franklin and between Hearthstone and Pautipaug Hill. Although these deposits are small in extent and probably not very thick, they are nevertheless important sources of ground water for domestic use.

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[1] See Preliminary geological map of Connecticut: State Geol. and Nat. Hist. Survey Bull. 7, 1907.

GROUND-WATER SUPPLIES.

Dug wells in Franklin range in depth from 8 to 32 feet and average 18 feet. Depth to water ranges from 5 to 29 feet and averages about 15 feet. The fluctuation of the water table ranges from 5 to 20 feet and averages about 10 feet. Nearly all the wells end in till and most of them are situated on slopes where the drift is thin and the ground-water supply therefore small. About 30 per cent of the shallow wells in the town go dry. The quantity of water used, as reported for six wells, ranges from 10 to 40 gallons per day and averages about 30 gallons.

Two wells have been drilled to depths of 125 feet and 235 feet, respectively. One of these wells is not used because of the high iron content of its water. From the other well about 50 gallons per day is used. Neither well is suitable for domestic supply on account of the iron in the water. Both wells end in crystalline rocks, from which the iron is derived.

Gravity springs, many of which are intermittent, issue on the numerous slopes throughout the town and range in yield from very small amounts to about 6 gallons a minute. The largest springs are at low levels and the water which they furnish must therefore be carried or pumped.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of Franklin is presented in the following tables:

Dug wells in Franklin.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.	Yield per minute.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Gallons.*
1		Hill	310	(?)11	10	300		
2		Slope	275	13	10	265		
4		Hill	470	(?)16	15	455		
5		Hill	435	12	10	425		
6	M. F. Rodman	Plain	190		10	180		
7		Slope	150	8	7	143		
8	Mabry	Slope	185	32	29	158		
10		Slope	210	24	15	195	20	
11		Plain	200		11	189		
12	S. G. Hartshorn	Slope	185	15	5	180		2.5
15	T. O'Hearn	Plain	180	(?)25	23	157		
16		Slope	160	20	20	140	5	([a])
17		Plain	150	18	16	134	7	
18	F. S. Barber	Plain	175	20	16	159		
19		Plain	175	18	16	159		
20	John Howe	Slope	200	14	12	188		([a])
21	School	Slope	300	10				([a])
22		Slope	355	14	12	343		
23		Hill	480	13				([a])
25	G. L. Ladd	Hill	510	17	16.5	493.5	6	([a])
27	E. Mitchell	Hill	285	28	23	262		
28	Town hall	Hill	380	27	25	355		([a])
29		Slope	240		12	228		
31	M. H. Race	Hill	315		11	304		([a])
32		Slope	295		10	285		

[a] Well goes dry.

Dug wells in Franklin—Continued.

Map No.	Owner.	Amount used per day.	Depth to rock.	Section.	Wall.	Cover.
		Gallons.	*Feet.*			
1		35		Till		Plank.
2				Till	Stone	Plank.
4				Till		Plank.
5		0	11	Till	Stone	Open.
6	M. F. Rodman			Till	Stone	Open.
7				Till	Stone	Open.
8	Mabry			Till	Stone	Open.
10		0		Till	Stone	Open.
11		20		Till	Stone	Plank.
12	S. G. Hartshorn	60		Till	Stone	Shed.
15	T. O'Hearn			Till	Stone	Open.
16		0	20	Till	Stone	Open.
17		0		Till	Stone	Open.
18	F. S. Barber			Till	Stone	Open.
19				Till	Stone	Plank.
20	John Howe	10	14	Till	Stone	Plank.
21	School	0	10	Till	Stone	Plank.
22		20		Till	Stone	Open.
23		0	12	Till	Stone	Open.
25	G. L. Ladd	0	17	Till	Stone	Open.
27	E. Mitchell	40		Till	Stone	Open.
28	Town hall	0		Till	Stone	Plank.
29				Till	Stone	Plank.
31	M. H. Race			Till	Stone	Plank.
32		0		Till	Stone	Plank.

Drilled wells in Franklin.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Depth to rock.	Quality of water.	Drilled in year—
			Feet.	*Feet.*	*Gallons.*	*Gallons.*	*Feet.*		
3	Mrs. F. E. Johnson	Hill	460	125	26	50		Rusty	1911
24	Sherman Loomis	Hill	500	235		0	15	Rusty	1911

Springs in Franklin.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Yield per minute.	Amount used per day.	Temperature.
			Feet.	*Gallons.*	*Gallons.*	° *F.*
9		Slope	190	0.5	0	55
13		Slope	230	.2	0	55
14		Slope	230	.5	0	54
26		Slope	235	6	0	50
30	Woodward	Slope	260	1		

QUALITY OF GROUND WATER.

The shallow well of T. O'Hearn yields soft water of very low mineral content.

Analysis of water of the 25-foot (?) well of T. O'Hearn (Pl. XII, No. 15), collected June 15, 1915.

[R. B. Dole, analyst.]

	Parts per million.
Total solids at 180° C	46
Total hardness as $CaCO_3$	19
Iron (Fe)	.10
Carbonate radicle (CO_3)	.0
Bicarbonate radicle (HCO_3)	27
Sulphate radicle (SO_4)	3
Chlorine (Cl)	2.9

SAYBROOK.

POPULATION AND INDUSTRIES.

Saybrook is in the south-central part of Connecticut, in Middlesex County. It is reached by the Valley branch of the New York, New Haven & Hartford Railroad (station at Deep River), and by steamboats from Hartford and New York daily during the open season. The post office is at Deep River. The western part of the town receives mail by rural delivery from Deep River.

Saybrook was settled in 1635 and united with Connecticut in December, 1644. The area of the town is 15 square miles.

The population of Saybrook in 1910 was 1,907. The population from 1756 to 1910 is shown in the following table:

Population of Saybrook, 1756 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1756	1,931			1840	3,417		[a] 32
1774	2,687	39		1850	2,904		15
1782	2,738	2		1860	1,213		58
1790	3,233	18		1870	1,267	4	
1800	3,363	4		1880	1,362	8	
1810	3,996	19		1890	1,484	9	
1820	4,165	4		1900	1,634	10	
1830	5,018	20		1910	1,907	17	

[a] Westbrook was set off from Saybrook in 1840.

The principal industries are agriculture and the manufacture of piano keys, piano-player actions, ivory and bone goods, wire goods, button hooks, crochet needles, etc.

Four dams on Deep River, in the vicinity of Deep River, furnish power.

TOPOGRAPHY.

The lowest elevation in Saybrook is sea level along Connecticut River; the highest is about 460 feet, in the northwest corner of the town. The rock cover is generally thin and the present topography is due chiefly to undulations of the rock floor.

Connecticut River forms the east boundary of Saybrook and receives all the drainage from the town. Deep River rises in the northwest corner of the town and enters the Connecticut at Deep River. The total fall of this stream is 400 feet, or an average of about 50 feet to the mile.

Half the area of Saybrook, including most of the hills and steep slopes, is wooded. The farm lands occupy the central part of the town about Winthrop and areas near the Connecticut south of Deep River.

WATER-BEARING FORMATIONS.

Bedrocks.—The bedrocks, which Gregory has named Mamacoke, Middletown, and Haddam gneisses and Haddam granite gneiss,[1]

[1] See Preliminary geological map of Connecticut: State Geol. and Nat. Hist. Survey Bull. 7, 1907.

appear at the surface on the hillsides throughout the town (Pl. XIII, in pocket). Joints or cracks appear in all exposures and range in size from partings that are barely visible to openings an inch or more in width. The largest extend 200 or 300 feet below the surface, affording space for the storage of ground water (p. 20).

Till.—Glacial drift forms a mantle over the rock surface throughout the greater part of the town and consists of typical till or unstratified sand and clay containing numerous bowlders. It ranges in thickness from a few inches to about 30 feet and averages about 20 feet. Many domestic water supplies are obtained from dug wells which end in till. (See p. 15.)

Stratified drift.—In the vicinity of Deep River the drift includes patches of sand which were deposited by water around the hills. These deposits are not, however, large enough to be of much importance in determining the location of wells.

GROUND-WATER SUPPLIES.

The average depth of shallow wells is about 12 feet. Eighteen wells examined ranged in depth from 8 to 18 feet. The depth to water, as determined by the measurement of 22 wells, ranges from 5 to 17 feet and averages about 10 feet. The total fluctuation of the water table in three wells was 3, 5, and 7 feet, respectively. Nearly all the wells in Saybrook are situated in till and afford adequate supplies. Only one well was reported to go dry. The quantity of water used daily, as reported for six wells, ranges from 10 to 30 gallons and averages 20 gallons.

Springs are common along the streams and on the slopes in Saybrook, but they are generally small, few yielding more than half a gallon per minute, and all responding to changes in the weather.

PUBLIC WATER SUPPLY.

Part of Deep River is supplied with water from a reservoir of the Guilford Chester Water Co., near Chester. A flat rate is charged and the quantity of water delivered is not measured.

RECORDS OF WELLS AND SPRINGS.

The available information concerning the wells and springs of Saybrook is presented in the following tables:

Dug wells in Saybrook.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.	Yield per minute.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Gallons.*
1		Hill	160	14	14	146		
2		Plain	146	9	5	141		
3		Slope	200		11	189		
4		Valley	260	11	9	251		
5	L. T. Louis	Slope	300	13	13	287	5	
6		Plain	360	14	8	252		
7	Jacob Hemmig	Slope	390	12.5	10	380		
8		Slope	370	17	16	354		
9	J. M. Mook	Slope	290	9.5	8	282		4
10		Hill	290	10.5	9	28		
13		Slope	300	11	10	290		
14		Slope	300	9.5	8.5	291.5		
16		Slope	140	11	7	133		
17		Hill	140	9	6	134		
18		Hill	140	8	5	135		
20		Hill	140	10.5	6	134		[a]
22		Slope	20		8	12		
23		Slope	30	12	11.5	18.5	3	
24	R. C. Brockman	Hill	20	18.5	17	3		
25	E. E. Smith	Slope	40		15	25		
26	A. E. Lord	Slope	60		16	44		
27		Plain	155	12	10	145	7	

Map No.	Owner.	Amount used per day.	Section.	Wall.	Cover.
		Gallons.			
1		20	Till	Stone	Open.
2			Till	Stone	Open.
3			Till	Stone	
4			Till	Stone	Open.
5	L. T. Louis	0	Till	Stone	Open.
6		0	Till	Stone	Plank.
7	Jacob Hemmig	10	Till	Stone	Open.
8		0	Till	Stone	Open.
9	J. M. Mook		Till	Stone	Open.
10		15	Till	Stone	Open.
13			Till	Stone	Open.
14			Till	Stone	Open.
16		20	Till	Stone	Plank.
17			Till	Stone	Plank.
18			Till	Stone	Open.
20		0	Till	Stone	Open.
22			Till	Stone	Plank.
23			Till	Stone	Plank.
24	R. C. Brockman	30	Till	Stone	Open.
25	E. E. Smith		Till	Stone	Plank.
26	A. E. Lord		Till	Stone	Plank.
27		30	Till	Stone	Shed.

[a] Well goes dry.

Springs in Saybrook.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Yield per minute.	Amount used per day.
			Feet.	*Gallons.*	*Gallons.*
11		Slope	230		0
12		Slope	235		0
15		Slope	165	0.2	0
19		Valley	140		0
21		Slope	105	.5	0

ESSEX.

POPULATION AND INDUSTRIES.

Essex, in the south-central part of Connecticut, in Middlesex County, comprises an area of 13 square miles. It is reached by the Valley branch of the New York, New Haven & Hartford Railroad, by steamboat from Hartford and New York daily during the open season, and by the Shore Line Electric Railroad from Deep River and New Haven. Post offices are maintained at Essex, Centerbrook, and Ivoryton.

Essex was separated from Old Saybrook and incorporated in May, 1854.

The population of Essex in 1910 was 2,745. The population of the town from 1850 to 1910 is shown in the following table:

Population of Essex, 1850 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1850	950			1890	2,035	10	
1860	1,764	86		1900	2,530	24	
1870	1,669		5	1910	2,745	9	
1880	1,855	11					

The principal industries are agriculture, wood turning, and nickel plating, and the manufacture of augers and bits, bone and ivory goods, and piano keys and piano boards. Boat building, sail making, and the repair of vessels is carried on to some extent.

Water power developed along Falls River is used by manufacturing plants at Ivoryton and Centerbrook.

TOPOGRAPHY.

The topography of Essex is characterized by numerous hills about 200 feet high, rising above flat drift-filled valley floors. The highest elevation is 360 feet, in the northeast corner of the town, and the lowest elevation is sea level, along Connecticut River. The tidal flat along Connecticut River is about half a mile wide. Rock is exposed in all the hills, but in the valleys the drift is in some places more than 50 feet thick.

Connecticut River forms the east boundary of Essex and receives all the drainage from the town. Falls River enters the town at the southeast corner and flows through Ivoryton and Centerbrook to the Connecticut at Essex. The total fall within the town is about 100 feet, or about 20 feet to the mile.

The farm lands lie along Trout Brook and Falls River and comprise about one-fourth the area of the town. Woodlands comprising about 5 square miles occupy the borders of the town, including practically all the hills.

WATER-BEARING FORMATIONS.

Bedrocks.—The Mamacoke, Middletown, and Hebron gneisses and the Haddam granite gneiss of the Connecticut State Geological and Natural History Survey form the rock floor of Essex and appear at the surface on most of the hillsides throughout the town (Pl. XIII, in pocket). For description of water in bedrock see page 20.

Till.—Till, which consists of heterogeneous mixtures of bowlders, gravel, sand, and clay, is distributed over the rock surface throughout the western part of the town and at elevations above 40 feet in the eastern part. Its thickness ranges from a few inches to about 25 feet. The occurrence of water in the till is described on page 15.

Stratified drift.—Deposits of sand are found in the vicinity of Centerbrook and at elevations less than 40 feet surrounding the hills in the east part of the town. In the valley of the south branch of Falls River, south of Centerbrook, wells 20 feet deep end in stratified drift, and the total thickness of the deposit probably exceeds 50 feet. In the vicinity of Essex it is, however, less than 20 feet thick. The occurrence of water in deposits of this kind is discussed on page 15.

GROUND-WATER SUPPLIES.

The average depth of 16 wells measured in Essex is 15 feet, the extremes being 5 and 30 feet. Depth to water ranges from 2 to 24 feet and averages 12 feet. The total fluctuation of the water in two wells was 4 and 6 feet, respectively. Nearly all the wells in Essex end in till, but only two were said to fail. The quantity of water used, as reported for nine wells, ranges from 15 to 50 gallons per day, the average being 26 gallons.

Many small springs issue on the slopes throughout the town, but none of those observed is known to be permanent. All are gravity springs, deriving their water from very local sources, and few of them are so situated that they are of value for domestic supplies. A spring belonging to H. A. Pratt (No. 13, Pl. XIII) yielded half a gallon a minute. The altitude of the spring is 50 feet above sea level and the temperature of the water 55° F.

The drift-filled central valley of Essex is believed to contain principally stratified deposits of sand and gravel. The depth of the filling has not been determined, but it is probably more than 50 feet in the central part. The conditions are favorable for the storage of a large quantity of ground water, which could be most economically recovered by means of driven wells (p. 40).

PUBLIC WATER SUPPLY.

A small part of Essex is supplied with water from a reservoir of the Guilford Chester Water Co. near Chester. A flat rate is charged, and no record of consumption is kept.

RECORDS OF WELLS.

Information concerning the wells of Essex is presented in the following tables:

Dug wells in Essex.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	David Gannon	Hill	280	17	15	265	
2		Hill	120	116	15	105	
3	Alfred Wilcox	Valley	250	16	13	237	6
4		Plain	110		11	99	
5		Slope	105	19.5	14.5	90.5	
6		Slope	210	18	14.5	195.5	
7	Charles Lund	Hill	260	30.			
8		Flat	50	25	24	26	
9	C. C. Dibble	Slope	20	8	4.5	15.5	
10	E. A. Parker	Slope	23	12	10	13	
11		Slope	25	15	15	10	
12	H. A. Pratt	Slope	58	13	13+		
14	D. F. Doane	Flat	18	19	16	2	4
15		Plain	45	13	11	34	
16	Matt Brown	Hill	160	5	2	158	
17	W. I. Doane	Flat	33		9	24	
18	P. E. Post	Flat	30	13	12	18	
19	E. J. Pratt	Flat	15	11	9	6	
20	A. H. Pratt	Slope	40				

Map No.	Owner.	Amount used per day.	Depth to rock.	Section.	Wall.	Cover.
		Gallons.	*Feet.*			
1	David Gannon	20		Till	Stone	Open.
2			16	Till	Stone	Open.
3	Alfred Wilcox	[a] 50		Till	Stone	Open.
4				Till	Stone	
5				Till	Stone	Open.
6		30		Till		
7	Charles Lund	50		Till	Stone	Plank.
8				Till	Stone	Open.
9	C. C. Dibble	15		Till	Stone	Open.
10	E. A. Parker			Till	Stone	Open.
11		0		Till	Stone	Open.
12	H. A. Pratt	Dry.		Till	Stone	Open.
14	D. F. Doane	20		Sand	Stone	Shed.
15		25		Till	Stone	Open.
16	Matt Brown	10		Till	Board	Open.
17	W. I. Doane			Till	Stone	Plank.
18	P. E. Post	[a] 15		Till	Stone	Open.
19	E. J. Pratt			Till	Stone	Open.
20	A. H. Pratt			Till		Plank.

[a] Well goes dry.

WESTBROOK.

POPULATION AND INDUSTRIES.

Westbrook comprises an area of 19 square miles lying in the south-central part of Connecticut, near the mouth of Connecticut River, in Middlesex County. It is reached by the New London division of the New York, New Haven & Hartford Railroad and by electric railway from New Haven. There are post offices at Westbrook and Grove Beach.

Westbrook was separated from Saybrook and incorporated in May, 1840.

The population of Westbrook in 1910 was 951. The population from 1840 to 1910 is shown in the following table. The principal industries are agriculture and fishing.

Population of Westbrook, 1840 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1840	1,182			1880	878		11
1850	1,202	2		1890	874		.5
1860	974		19	1900	884	1	
1870	987	1		1910	951	8	

TOPOGRAPHY.

The surface of Westbrook slopes gradually toward the tidal flat, which is about three-quarters of a mile wide. The highest elevation is 350 feet.

Practically all the drainage in Westbrook enters the Sound at Menunketesuck Point through Patchogue and Menunketesuck rivers. The former drains the east half of the town and the latter the west half.

Woodlands comprise an area of about 12 square miles. The farm lands are situated principally in the vicinity of Westbrook, in the southeast corner of the town, and extend northward along Trout Brook.

WATER-BEARING FORMATIONS.

Bedrocks.—The southern half of Westbrook is underlain by rocks which have been designated in publications of the Connecticut State Geological and Natural History Survey Mamacoke gneiss, Stony Creek granite gneiss, and Lyme granite gneiss. The northern half is underlain by rocks which have been designated Middletown gneiss and Haddam granite gneiss.[1] There are a few exposures along the shore, but in

[1] See Preliminary geological map of Connecticut: State Geol. and Nat. Hist. Survey Bull. 7, 1907.

the northern part of the town outcrops are numerous. (See Pl. XIII, in pocket.) The occurrence of water in crystalline rocks is discussed on page 20.

Till.—Till, consisting of a heterogeneous mixture of bowlders, gravel, sand, and clay, occurs generally throughout the town. Its average thickness is about 20 feet and maximum thickness about 30 feet. The occurrence of water in till is described on page 15.

Stratified drift.—Isolated deposits of sand, 5 to 10 or 15 feet thick, occur along the west side of the valley of Trout Brook and at a few places in the northwestern part of the town. None of these deposits are extensive and they are not important as a source of ground water. Beach sand has accumulated along the shore of Westbrook Harbor, but till extends out to the water's edge at Chapman Point and on the west side of the town.

GROUND-WATER SUPPLIES.

The depth of dug wells in Westbrook, as determined by measurements of 29 wells, ranges from 9 to 29 feet and averages about 18 feet. The depth to water, measured in 31 wells, ranges from 5 to 25 feet and averages 14 feet. Four wells have shown fluctuations ranging from 3 to 6 feet. Three of the wells examined penetrate rock and three have failed during recent dry seasons. The daily consumption of water, as reported for 13 wells, ranges from 5 to 30 gallons, averaging 15 gallons. A number of wells have been dug south of Westbrook within a few rods of the shore and at elevations only a few feet above sea level. These wells range in depth from 15 to 25 feet and contain large supplies of fresh water.

In the southern part of the town are two drilled wells 40 and 135 feet deep, respectively. Both end in rock and produce good domestic supplies. One of these wells is within half a mile of the shore and ends at a point more than 100 feet below sea level. The other well is a little more than a mile from shore and extends 5 feet below sea level.

A few small springs issue on the slopes in the northern part of the town, but they are not suitably situated for use in domestic supplies. One spring (No. 33, Pl. XIII), located at an altitude of 140 feet, was found to yield 0.5 gallon of water a minute.

RECORDS OF WELLS.

The available information regarding the wells of Westbrook is set forth in the following tables:

Dug wells in Westbrook.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	Mrs. Heflin	Flat	18	13.5	12.5	5.5	
2	H. M. Platts	Flat	30	11	9	21	
3a		Flat	30	26	24.5	5.5	
4	A. H. Reynolds	Flat	25	22	22	3	
5		Flat	30		8	22	
6	Steinbach	Flat	50	14.5	12	38	
7	W. Z. Jones	Flat	50	21	19	31	
8		Hill	30	25	23.5	6.5	
9		Flat	38	20	19	19	
10		Flat	40	13.5	12	28	
11		Ravine	120	18	16	105	
12	John Hayden	Slope	140	23	21	119	
13		Plain	210	11	9	201	4
14		Slope	160	16.5	14	146	
15		Hill	205	18.5	15	190	
16	Robert Harvey	Hill	230	15	13	217	6
17	S. E. Stevens	Slope	175	9	5.5	169.5	
18		Slope	200	14.5	9.5	190.5	
19		Hill	175	22	15	160	
20		Hill	155		12	143	
21	H. C. Schmelre	Hill	150	16	13	147	
22		Hill	120	18.5	16.5	103.5	
23		Slope	55	19	18	37	
24		Hill	30	28.5	12.5	17.5	
25	E. A. Dean	Valley	15	13	12	3	
27		Shore	15	18	12	3	3
28		Shore	12	24	12	10	
29		Shore	13	18	12	6	4
30		Shore	15	20	13	2	
31	R. W. Wright	Flat	90	10.5	9	81	
32		Slope	100	14	12	88	

Map No.	Owner.	Amount used per day.	Depth to rock.	Section.	Wall.	Cover.
		Gallons.	*Feet.*			
1	Mrs. Heflin	10		Sand	Stone	Open.
2	H. M. Platts	0		Till	Stone	Open.
3		0		Till	Stone	Open.
4	A. H. Reynolds	5		Till	Stone	Open.
5						
6	Steinbach	30		Till	Stone	Plank.
7	W. Z. Jones	10		Till	Stone	Open.
8		25		Till	Stone	Open.
9		0	20	Till	Stone	Open.
10		15		Till	Stone	Open.
11				Till	Stone	Open.
12	John Hayden	*a* 0		Till	Stone	
13		*a* 10	11	Till	Stone	Open.
14		0		Till	Stone	Open.
15		0		Till	Stone	Open.
16	Robert Harvey	10		Till	Stone	Open.
17	S. E. Stevens	15		Till	Stone	Open.
18		0		Till	Stone	Open.
19		20		Till	Stone	Plank.
20						
21	H. C. Schmelre	0		Till	Stone	Plank.
22		10	15	Till	Stone	Open.
23		0		Till	Stone	Open.
24		20		Till	Stone	Open.
25	E. A. Dean			Till	Stone	Open.
27					Stone	Shed.
28					Stone	Plank.
29					Stone	
30					Stone	
31	R. W. Wright			Till	Stone	Open.
32		*a* 15		Till	Tile	Open.

a Well goes dry.

Drilled wells in Westbrook.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Amount used per day.	Depth to rock.	Quality of water.	Drilled in year—
			Feet.	*Feet.*	*Gallons.*	*Feet.*		
3	Wm. Johnson	Flat	35	40	30	10	Rusty	1908
26	John Veeser	Flat	25	135	25		Good	
34	R. H. Stannard	Slope						
35	Knough	Slope						

QUALITY OF GROUND WATER.

Both of the waters that were analyzed from drilled wells in Westbrook, though from different depths, are moderate in mineral content and fairly soft.

Analyses of water from drilled wells in Westbrook.

[Parts per million; R. B. Dole, analyst.]

Constituents.	1	2
Total solids at 180° C.	172	140
Total hardness as $CaCO_3$	57	64
Iron (Fe)	.25	.15
Carbonate radicle (CO_3)	.0	.0
Bicarbonate radicle (HCO_3)	12	74
Sulphate radicle (SO_4)	10	23
Chlorine (Cl)	34	13

1. Well of Wm. Johnson (Pl. XIII, No. 3), 40 feet deep; sample collected June 14, 1915.
2. Well of John Veeser (Pl. XIII, No. 26), 135 feet deep; sample collected June 14, 1915.

OLD LYME.

POPULATION AND INDUSTRIES.

Old Lyme is situated in the south-central part of Connecticut, at the mouth of Connecticut River, in New London County. It is reached by the New London division of the New York, New Haven & Hartford Railroad (stations at Lyme and Black Hall), by steamboat from Hartford and New York daily during the open season, and by stage from North Lyme. Post offices are maintained at Lyme, South Lyme, Black Hall, and Sound View.

Old Lyme was taken from Lyme and incorporated in May, 1855, as South Lyme. The name was changed to Old Lyme in 1857. The area of the town is 27 square miles.

The population in 1910 was 1,181. The following table shows the population from 1860 to 1910. The principal industry is agriculture:

Population of Old Lyme, 1860 to 1910.

Year.	Population.	Per cent increase.	Per cent decrease.	Year.	Population.	Per cent increase.	Per cent decrease.
1860	1,304			1890	1,319		5
1870	1,362	4		1900	1,180		11
1880	1,387	2		1910	1,181		

TOPOGRAPHY.

The south and west borders of Old Lyme are characterized by tidal flats, which reach a width of 2 miles in the southwest corner of the town. In the vicinity of Roger Lake, on the north border, a broad flat area, 50 feet above sea level, 2 miles long and 1½ miles wide, marks the position of an ancient lake. Hills produced by undulations of the rock floor and ranging in height from 100 to 260 feet occur throughout the other parts of the town. The highest point, 270 feet above sea level, is on the east border. (See Pl. XIII, in pocket.)

Connecticut River forms the western boundary and Long Island Sound the south boundary, and all the drainage enters these water bodies. The principal streams within the town are Lieutenant, Duck, and Blackhall rivers and Mill Creek, all tidal for 1 to 3 miles above their mouths. Roger Lake, 49 feet above sea level, lies partly in the town of Lyme and partly in Old Lyme; its outlet is a tributary to Lieutenant River.

The tidal flats lie along the south and west borders of the town and extend up Blackhall River to Black Hall and up Lieutenant River nearly to Laysville.

Woodlands along the west border of the town and in the central part, extending from Black Hall north to Rogers Lake, occupy about half the area of Old Lyme. The cultivated lands are situated in the valleys of Blackhall River and Lieutenant River.

WATER-BEARING FORMATIONS.

Bedrocks.—The bedrocks consist of the formations named by Gregory Mamacoke gneiss and Lyme granite gneiss.[1] The former is exposed in the hills in the eastern and southern parts of the town and the latter appears at the surface in the northwest quarter of the town. The occurrence of water in rocks of this type is discussed on page 20.

Till.—Unstratified deposits of sand, clay, and bowlders of glacial origin lie at the surface in the eastern half of the town and on the hills in the western half, except where bedrock is exposed. These deposits range in thickness from a few inches to about 30 feet and average about 20 feet. See page 15 for a discussion of the occurrence of water in this formation.

Stratified drift.—In the vicinity of Roger Lake and extending westward from the lake about 1½ miles and southward from the town line to Laysville, a distance of nearly 2 miles, is a deposit of stratified sand and gravel exceeding 15 feet in thickness. Small deposits of sand are found at several places in the valley of Blackhall River (Pl. XIII).

[1] See Preliminary geological map of Connecticut: State Geol. and Nat. Hist. Survey Bull. 7, 1907.

GROUND-WATER SUPPLIES.

Dug wells in Old Lyme range in depth from 8 to 35 feet and average about 15 feet. Depth to water, as determined by measurements of 40 wells, ranges from 5 to 34 feet and averages 12 feet. The average fluctuation of the water table, as determined by measurements of 4 wells, is about 4 feet. Three of the wells examined penetrate rock and 3 had recently been dry. Reports for 14 wells indicated an average daily consumption ranging from 10 to 35 gallons and averaging about 15 gallons. Eight of the wells examined are not used.

Six drilled wells in Old Lyme range in depth from 90 to 314 feet. The yields were not determined but are sufficient for domestic needs. From one of these wells 30 gallons a day is used and from another 2,000 gallons a day; the other four are seldom used.

The stratified deposits in the vicinity of Roger Lake are probably thick enough to store a large supply of ground water. A public water supply is needed now and the newly constructed electric railroad will increase this demand. The utilization of the ground waters in the vicinity of Roger Lake by means of driven wells should receive consideration. The lake itself lies too low to be available for use without pumping.

RECORDS OF WELLS.

Information concerning the wells of Old Lyme is set forth in the following tables:

Dug wells in Old Lyme.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.	Yield per minute.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Gallons.*
1	....	Flat	16	13	11	5	....	....
2	S. P. Monroe	Valley	35	9	5	30	....	....
3	B. L. Bramble	Slope	23	8	6	14	....	....
7	J. A. De Wolf	Flat	16	8	6	10	....	....
8	Black Hall School	Slope	14	13	11	3	....	....
9	....	Flat	15	12.5	11	4	....	....
10	....	Hill	18	14	12	6	....	....
11	Byron Maynard	Plain	24	12	8	16	....	....
12	.....do	Plain	30	14	14	16	3+	(a)
13	W. P. Howard	Hill	22	14	13	9	6	(a)
14	Henry Austin	Flat	18	12	10	8	....	....
15	H. H. Haines	Flat	18	17	16	2	5	4
16	....	Flat	19	10	9	10	....	(a)
17	....	Slope	60	11	9	51	....	....
18	W. L. Anderson	Slope	85	10.5	8	77	....	....
19	Mrs. C. Roberts	Slope	30	18	16	14	....	....
20	....	Flat	8	14	5	3	....	....
23	....	Hill	45	15	....	....	2+	....
24	....	Hill	45	15	14.7	30.3	....	....
25	Leonard	Slope	70	12	10	60	....	....
26	Brown	Hill	135	35	34	101	....	....
27	G. H. Reed	Hill	173	12	....	....	....	....
28	....	Slope	214	12	11	203	....	....
29	Matthew Rouland	Slope	50	10	8	42	....	....
30	E. J. Swaney	Slope	25	9	....	....	....	....
31	.....do	Slope	35	14	12	23	....	....
32	T. J. Dickey	Slope	32	13	12	20	....	....
33	....	Plain	50	12	9.5	40.5	....	....
34	Mrs. Georgeanna Maynard	Plain	50	10	8.2	41.8	....	....
35	....	Plain	48	11	9	39	....	....
36	....	Slope	60	17	15	45	....	....

a Well goes dry.

Dug wells in Old Lyme—Continued.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Depth to water.	Elevation of water table above sea.	Fluctuation of water table.	Yield per minute.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Gallons.*
38	Fred Harding	Slope	75	20	18	57		
39		Hill	110	28	21	89		
40		Slope	60	17	13	47		
41		Hill	43	32	30	13		
42		Plain	40	20	16	24		
43		Plain	50	12	10	40		
44		Slope	20	18.5	16.5	3.5		
45	E. P. Trowbridge	Slope	35	10	8	27		
46		Flat	18	13	11	7		
47		Slope	20	21	20	0		
48		Slope	60	22	18	42		
49	H. C. Pearson	Hill	208	20	16	192		

Map No.	Owner.	Amount used per day.	Depth to rock.	Section.	Wall.	Cover.
		Gallons.	*Feet.*			
1		60		Till	Stone	Plank.
2	S. P. Monroe			Till	Stone	Open.
3	B. L. Bramble			Till	Stone	Open.
7	J. A. De Wolf			Till	Stone	Plank.
8	Black Hall School			Till	Stone	Shed.
9				Sand	Stone	Open.
10				Till	Stone	Open.
11	Byron Maynard			Till		
12	do	0	14	Till	Stone	Shed.
13	W. P. Howard			Till	Stone	Open.
14	Henry Austin	30		Till, sand	Stone	Open.
15	H. H. Haines	25		Till	Stone	Open.
16		0		Sand	Stone	Open.
17		0		Till	Stone	Open.
18	W. L. Anderson	15		Till	Stone	Open.
19	Mrs. C. Roberts	10		Till	Stone	Open.
20		0		Sand	Stone	Shed.
23		0		Till	Stone	Open.
24				Till	Stone	Open.
25	Leonard			Till	Stone	Plank.
26	Brown	20		Till	Stone	Shed.
27	G. H. Reed			Till	Concrete	Open.
28		20		Till	Stone	Open.
29	Matthew Rouland	15		Till	Stone	Open.
30	E. J. Swaney	0		Till	Stone	Open.
31	do	15		Till	Stone	Plank.
32	T. J. Dickey			Till	Stone	Open.
33				Gravel	Stone	Open.
34	Mrs. Georgeanna Maynard	30		Gravel	Stone	Open.
35				Gravel	Stone	Plank.
36				Till	Stone	Open.
38	Fred Harding	20		Till	Stone	Open.
39		30		Till	Stone	Open.
40				Till	Stone	Open.
41		0		Till	Stone	Shed.
42				Till	Stone	Plank.
43				Sand, gravel	Stone	Open.
44				Till	Stone	Open.
45	E. P. Trowbridge	0		Till	Stone	Open.
46				Till	Stone	
47		20		Till	Stone	Open.
48				Till	Stone	Open.
49	H. C. Pearson	35	18	Till, rock	Stone	Open.

Drilled wells in Old Lyme.

Map No.	Owner.	Topographic position.	Elevation above sea level.	Depth.	Yield per minute.	Amount used per day.	Quality of water.	Drilled in year—
			Feet.	*Feet.*		*Gallons.*		
4	Mrs. Clara Noyes	Flat	20			0		1911
5	L. F. Lowry	Flat	25			30		1911
6	J. A. De Wolf	Flat	20	90	Low	0		
21	Mrs. Sill	Shore	12	101		0	Iron	
22	Hale	Shore	8	160		0		
37	H. L. Hoffman	Hill	82	314		2,000		1908

QUALITY OF GROUND WATER.

The subjoined analysis shows the composition of water from a dug well supplying the house system of Fred Harding (Pl. XIII, No. 38). The water is low in mineral content and fairly soft.

Analysis of water of dug well of Fred Harding, June 14, 1915.

[R. B. Dole, analyst.]

	Parts per million.
Total solids at 180° C	110
Total hardness as $CaCO_3$	35
Iron (Fe)	Tr.
Carbonate radicle (CO_3)	.0
Bicarbonate radicle (HCO_3)	40
Sulphate radicle (SO_4)	21
Chlorine (Cl)	9.5

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