DEPARTMENT OF THE INTERIOR
Hubert Work, Secretary

U. S. GEOLOGICAL SURVEY
George Otis Smith, Director

WATER-SUPPLY PAPER 540

GROUND WATER IN THE NEW HAVEN AREA, CONNECTICUT

BY

JOHN S. BROWN

Prepared in cooperation with the
CONNECTICUT STATE GEOLOGICAL AND NATURAL HISTORY SURVEY

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GROUND WATER IN THE NEW HAVEN AREA, CONNECTICUT

By John S. Brown

INTRODUCTION

HISTORY OF GROUND-WATER INVESTIGATIONS IN CONNECTICUT

A study of the water resources of Connecticut was begun by the United States Geological Survey in 1903. Preliminary reports on the ground water of the State were published in 1904[1] and 1905,[2] and a more comprehensive report was published in 1909.[3] In 1911 the United States Geological Survey and the Connecticut Geological and Natural History Survey entered into a cooperative agreement under which investigations of the water resources of the State have been continued, the expenses generally being shared equally by the two surveys. This work has been done under the direction of H. E. Gregory and H. H. Robinson, former superintendents of the State survey, and O. E. Meinzer, geologist in charge of the division of ground water in the Federal survey. The results of the investigations have been published in the following reports, which treat in detail of the ground-water conditions and problems of selected areas in different parts of the State. (See pl. 1.)

Gregory, H. E., and Ellis, A. J., Ground water in the Hartford, Stamford, Salisbury, Willimantic, and Saybrook areas, Connecticut: U. S. Geol. Survey Water-Supply Paper 374, 1916.

Ellis, A. J., Ground water in the Waterbury area, Connecticut: U. S. Geol. Survey Water-Supply Paper 397, 1916.

Waring, G. A., Ground water in the Meriden area, Connecticut: U. S. Geol. Survey Water-Supply Paper 449, 1920.

Palmer, H. S., Ground water in the Norwalk, Suffield, and Glastonbury area, Connecticut: U. S. Geol. Survey Water-Supply Paper 470, 1920.

Palmer, H. S., Ground water in the Southington-Granby area, Connecticut: U. S. Geol. Survey Water-Supply Paper 466, 1921.

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

[2] Pynchon, W. H. C., Drilled wells of the Triassic area of the Connecticut Valley: U. S. Geol. Survey Water-Supply Paper 110, pp. 65–94, 1905. Fuller, M. L., Triassic rocks of the Connecticut Valley as a source of water supply: U. S. Geol. Survey Water-Supply Paper 110, pp. 95–112, 1905. Gregory, H. E., Underground waters of eastern United States—Connecticut: U. S. Geol. Survey Water-Supply Paper 114, pp. 76–81, 1905.

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

The present report, similar in character to those already published, is based on field work done in 1919 and comprises the results of a systematic survey of the municipal, industrial, and domestic supplies of water derived from wells within the region covered. The survey included measurements of the depth of wells and the depth to the water table, measurements or estimates of the yield of wells and the quantity of water used, and the collection of other pertinent data. The geology of the region was studied with reference to the occurrence of ground water, and a geologic map of the area was made.

In connection with this investigation the writer also made a special study of the quality of ground water near the sea. The water of many wells near the sea is brackish, owing to contamination by sea water, and is unfit for domestic or industrial uses. Samples of water from many places on the coast were collected and compared. The results of this special study were originally intended for publication in the present report, but the quantity and broad significance of the data gathered justified the publication of a separate report on coastal ground water.[4]

ACKNOWLEDGMENTS

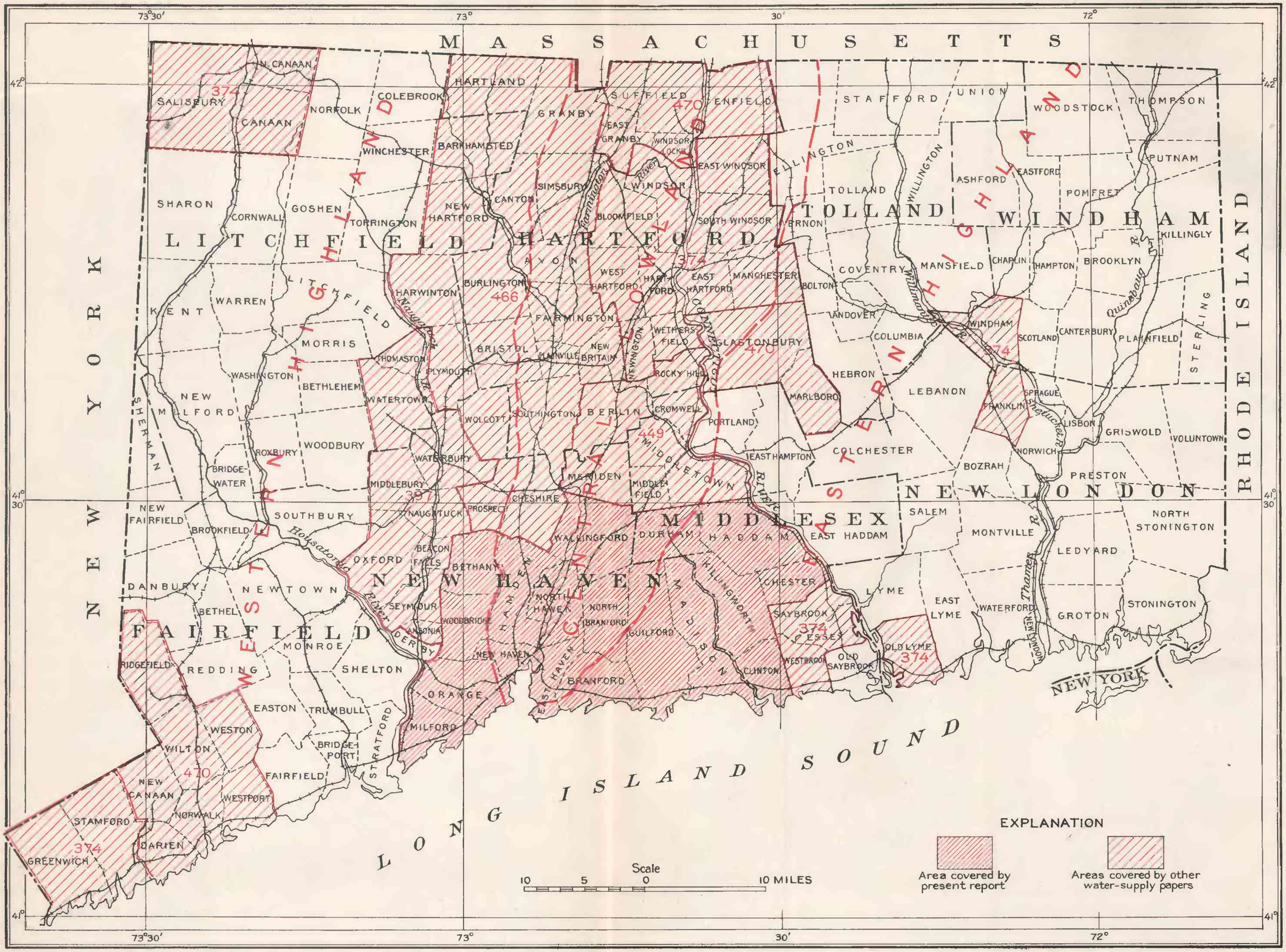
The writer is indebted to many persons who contributed information and assistance in the field, particularly well drillers who furnished information in regard to wells and factory officials who gave assistance in the collection of samples of water. Acknowledgment is due to Mr. Harold T. Stearns, who made the survey of the town of North Haven. In preparing this report free use has been made of unpublished material in the possession of the Connecticut Geological and Natural History Survey, including maps and notebooks of O. E. Hovey, W. M. Davis, J. B. Woodworth, Freeman Ward, H. E. Gregory, D. F. Hewett, L. H. Davison, W. L. Barrows, R. S. Tarr, Kirk Bryan, and C. R. Longwell; also of student reports in the possession of the department of geology of Yale University. These records have been used chiefly for the verification of data obtained by independent field work. H. H. Robinson, late superintendent of the State Survey, contributed valuable editorial criticism.

GENERAL DESCRIPTION OF THE NEW HAVEN AREA

LOCATION AND AREA

The area described in this report is not a political entity but is designated "the New Haven area" only for convenience, New Haven being its largest city and chief commercial center. It lies in the southern part of Connecticut, bordering Long Island Sound, in New Haven and Middlesex Counties. (See pl. 1.) The area is about 30

[4] Brown, J. S., A study of coastal ground water, with special reference to Connecticut: U. S. Geol. Survey Water-Supply Paper 537, 1925.



MAP OF CONNECTICUT SHOWING THE NEW HAVEN AREA AND OTHER AREAS COVERED BY WATER-SUPPLY PAPERS OF THE U. S. GEOLOGICAL SURVEY miles in length and 18 miles in width and contains 488 square miles. It includes the 18 towns[5] listed in the table below.

POPULATION AND ITS DISTRIBUTION

The total population of the New Haven area in 1920 was about 235,000. Statistics for each town are given in the table below.

Density of population of towns in the New Haven area in 1920

Town	Area (square miles) [a]	Population	Inhabitants per square mile	Town	Area (square miles) [a]	Population	Inhabitants per square mile
Killingworth	37.2	531	15	Chester	16.2	1,675	104
Bethany	19.9	411	21	Hamden	32.9	8,611	262
Haddam	[b] 36.0	[b] 1,361	38	Branford	23.8	6,627	278
Durham	24.1	959	40	East Haven	12.6	3,520	279
North Branford	25.8	1,110	43	Wallingford	37.4	12,010	321
Madison	40.5	1,857	46	Milford	25.4	10,193	401
Woodbridge	19.9	1,170	59	Orange	28.7	16,614	579
Guilford	47.2	2,803	59	New Haven	22.3	162,537	7,280
Clinton	16.4	1,217	74				
North Haven	21.8	1,968	90		488.1	235,174	482

[a] From Connecticut State Register and Manual.
[b] The part of the town of Haddam that lies east of Connecticut River is not included here, and the population of the rest of the town is estimated on the basis of the percentage of land west of the river.

For the area as a whole the average density of population in 1920 was 482 inhabitants to the square mile; but as more than two-thirds of the population was in the city of New Haven, which had 162,537 inhabitants, the average density of population in the rest of the area was only 156. Any estimate of the average density of population of the area as a whole, however, has little significance, because the population is very unevenly distributed.

For many years the population of the cities and boroughs and of some of the villages has increased rapidly, while that of the agricultural districts has decreased. New Haven and Killingworth are examples of the extremes of these contrasting trends. In 1830 the population of New Haven was 10,678 and that of Killingworth was 2,484; in 1920 the population of New Haven had increased to 162,537, whereas that of Killingworth had decreased to 531.

The rapid increase of population in the urban communities is due chiefly to the growth of manufacturing, which has characterized this region in common with much of the rest of New England. The development of trade and transportation has also played a particularly important part in the growth of New Haven, and its effects have extended to the surrounding territory.

[5] The name "town" is applied in Connecticut to each of the 168 minor subdivisions of the counties. It is equivalent to the "township" of the Western States, except that the boundaries of the towns are irregular and their areas unequal. A "city" or "borough" is an incorporated community within a town and may have the same name as the town. A "village" is unincorporated. For example, the town of Wallingford includes the borough of Wallingford and the two small villages of Yalesville and Tracy.

Another cause of the increase of population, one which affects also its distribution, is the establishment of summer resorts along the shore and, to a less extent, the building of summer homes in many localities in the interior. Cottages dot the shore at almost every accessible place, and in summer the resorts teem with thousands of visitors. The greater part of the summer population is transient, but the commercial activities it fosters support a considerable number of permanent residents in the favored areas. These activities account, in part at least, for the greater density of population along the shore in all the towns bordering Long Island Sound. There are fewer summer-residence sections in the interior, but the valley of Connecticut River in Haddam and Chester contains many attractive estates owned by wealthy nonresidents, who occupy them only in summer. Similar fashionable residence sections are found in Woodbridge, East Haven, and elsewhere.

New Haven owes its preeminent position chiefly to the facts that it possesses the best natural harbor on a long stretch of the coast and that behind the city there is a large and comparatively level lowland, which affords an easy route for railroads leading into the interior. The topography and soil of this lowland are favorable for cultivation and attracted the early settlers. New Haven's rank as a port has declined with the great increase in the size of ocean-going vessels, which now are too large to use its harbor, but a large volume of coastwise traffic is still handled, and the flow of traffic by sea and land has become so fixed by time that it is not likely to be entirely diverted from this city.

In the purely agricultural sections the density of population is governed mainly by the character of the soil and the topography. Level areas and smooth slopes free from stones have long been cleared and under cultivation. As the level lands occur for the most part as narrow terraces along river valleys or as small plains near the shore there is generally a concentration of population in these localities. The rounded divides and hilltops are cultivated to some extent, but a very large part of the more rugged country remains as woodland, and the less desirable land in those rural regions where the population is decreasing is being gradually abandoned.

INDUSTRIES

Manufacturing is the chief industry in the New Haven area, and New Haven is the leading manufacturing center, but some manufacturing is carried on in nearly all the smaller towns. A full list of the things manufactured would be very long; textiles, woodwork, paperware, silverware, wire, brass fittings, clocks, musical instruments, firearms, and munitions are some of the characteristic products. Many of the smaller towns specialize in a single product—

for instance, Wallingford manufactures silverware; Chester, ivory goods; and Higganum, farm machinery. Usually one plant has been the parent, and as it prospered others have grown up around it.

Agriculture is the principal industry outside the larger centers of population. Corn, oats, rye, and hay are staple crops, but near the towns many small farms produce fruits and vegetables for the local markets. Dairying is an important industry over nearly all the area.

Much land in the New Haven area which is too rough or stony for farming remains as woodland, and although it has been cut over frequently it still supplies considerable amounts of firewood, lumber, and charcoal. The brick kilns consume much cordwood. (See pl. 2, *A*.)

Along the coast fishing and oyster growing (see pl. 2, *B*) furnish a livelihood to a considerable number of people.

Quarrying is an important minor industry. Trap rock is quarried in great quantities by open-cut steam-shovel methods for use principally as crushed stone in road building. (See pl. 3.) Granite is quarried for rough masonry, for sea walls, and to a small extent for monuments. Sandstone was once much used for foundations and retaining walls but has been displaced to a great extent by concrete. Good sand and gravel for concrete are found at many places and are dug extensively.

There are several large brick plants in North Haven, the brick clay for which is obtained in the Quinnipiac Valley.[6]

GEOLOGY

ROCK FORMATIONS

The rocks of the New Haven area may be grouped into four main classes—crystalline rocks, Triassic sandstone, trap rock, and glacial drift. The first three classes comprise all the hard rocks of the region and are commonly referred to as bedrock. Their distribution in the New Haven area is shown in Plate 4. Throughout the area glacial drift overlies the bedrock, which crops out only in small exposures. (See pl. 5.)

CRYSTALLINE ROCKS

Crystalline rocks occupy a wide strip along the east side of the New Haven area, and a narrower strip along the west side. (See fig. 1.) On lithologic grounds the crystalline rocks of Connecticut have been classified into a large number of formations.[7]

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[6] Loughlin, G. F., The clays and clay industries of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 4, Hartford, 1905.

[7] Rice, W. N., and Gregory, H. E., Manual of the geology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 6, Hartford, 1906. Gregory, H. E., and Robinson, H. H., Preliminary geologic map of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 7, Hartford, 1907. Barrell, Joseph, and Loughlin, G. F., The lithology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 13, Hartford, 1910.

The formations that occur in the New Haven area are shown in Plate 4 and are briefly described below, except three formations that occupy very small tracts within the area—namely, the Monson granodiorite, in Haddam, and amphibolite and the Cheshire ("Poughquag") quartzite in Milford.

The Stony Creek granite gneiss consists chiefly of reddish feldspar in large crystals, which gives the rock a reddish color, with some quartz and a small amount of mica. The rock was originally a granite, but it has been altered slightly and has taken on the banded appearance characteristic of gneiss. It is used for both rough and ornamental building stone and for monuments. There are large quarries at Hoadly Point, Leete Island, and elsewhere.

The Mamacoke gneiss contains feldspar, quartz, and a large proportion of black mica (biotite); much of it contains also some hornblende. The mica and hornblende give the rock a dark-gray appearance. Most of the Mamacoke gneiss in the New Haven area is very plainly banded.

The Hebron gneiss contains feldspar and quartz, with a sufficient amount of biotite and other dark minerals to make it dark colored. It is well banded, and some of it is so cleavable as to be virtually a schist.

The Middletown gneiss consists of feldspar and quartz, with considerable amounts of hornblende and biotite and small quantities of other dark minerals. Fresh specimens are dark colored, but weathered rock near the surface is often brown or rusty. Some of the rock is granulitic, and much of it is cleavable. This rock was formerly quarried near Haddam, and the Haddam town hall, jail, and academy are built of it.

The Haddam granite gneiss is a fine-grained grayish rock that consists chiefly of white or gray feldspar and quartz, with a little biotite. Distinct gneissic banding shows in the specimen of this rock figured in Plate 6, *A*.

The Bolton schist is a silvery white rock that consists chiefly of quartz and muscovite, with scattered crystals of garnet, staurolite, and other minerals. It is highly cleavable.

The Branford granite gneiss contains much white feldspar, some quartz, and some biotite, and the resulting color is gray. The rock is fairly well banded.

In the "Milford chlorite schist" the only mineral visible to the unaided eye is chlorite, which gives it a dark-green color. Grains of quartz, magnetite, and other minerals are visible under the microscope. The rock is strongly foliated, almost slaty, in appearance.

The Orange phyllite consists chiefly of minute flakes of white sericite but contains impurities that give it a dark-gray color. The rock is very fissile and splits into thin plates, but it is usually jointed, so that these plates break into small flat polygonal fragments. It contains veins or lenses of quartz that weather out into prominence at the surface.

The Prospect porphyritic gneiss contains very large crystals of white feldspar, some of them more than an inch across, in a groundmass of quartz and biotite, which gives it a mosaic effect. It is indistinctly banded.

TRIASSIC SANDSTONE

The Triassic sandstone extends northward from New Haven Bay across the middle of the New Haven area, separating the crystalline rocks to the east and west. (See pl. 4.) The Triassic sandstone (pl. 6, *B*) is a sedimentary formation, the beds of which are similar at all localities in some respects but differ locally in other respects. All the beds are composed of fragments of the older crystalline rocks, described above, and have a characteristic red or brown color due to ferric oxide in the ferruginous clay that occurs in greater or less amount throughout the formation and that forms the cementing material in the coarser beds. The beds differ chiefly in texture. Some beds, especially near the margins of the area underlain by the Triassic, are conglomeratic and contain coarse pebbles of gneiss and schist an inch or even several inches in diameter. Other beds are more properly termed sandstone, being composed mainly of small grains of quartz and feldspar. Still other beds are shaly and consist mainly of red clay and small flakes of mica, with microscopic grains of quartz. Between these types are numerous gradations. Many beds of clay contain fossil mud cracks, rain prints, and rill marks, similar to those that form on dried mud flats at the present day. These and other facts indicate that the sandstone was deposited under arid climatic conditions. The total thickness of the Triassic sandstone is not definitely known but is probably several thousand feet. At the plant of the Winchester Repeating Arms Co., in New Haven, a drill penetrated 4,000 feet of sandstone without reaching the underlying crystalline rocks.

TRAP

"Trap" is a convenient and well-known name used for a dark-colored igneous rock which may occur either as a surface flow or in dikes and sills. It includes both basalt and the somewhat coarser-grained form known as diabase.[8]

The trap rock in the New Haven area is of Triassic age and occurs mainly in association with the Triassic sandstone. It is dark colored, very dense, and so fine grained that its crystals can seldom be distinguished by the unaided eye. It occurs as dikes or sills and as

[8] Barrell, Joseph, and Loughlin, G. F., Lithology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 13, p. 84, Hartford, 1910.

sheets interbedded with the Triassic sandstone. The dikes usually consist of diabase; West Rock is a typical example. The sheets are composed of basalt; Saltonstall Mountain is a good example of this form. Chemically and mineralogically the two rocks are nearly identical, and they differ only in texture. As the difference is not readily distinguishable by the eye they are grouped under the term trap.

GLACIAL DRIFT

Glacial drift is the detritus left by glaciers and their attendant streams of water. Such drift occurs over the entire New Haven area, forming a relatively thin mantle that at most places conceals the bedrock. Bedrock crops out here and there in small exposures where the drift either was not deposited or has since been eroded away. Some of the drift is unassorted, just as it was left by the ice, and is called till; some of it has been assorted by running water, producing stratification, and is known as stratified drift. The distribution of the two types of drift and of the observed exposures of bedrock is shown in Plate 5.

TILL

Till is a mixture of clay, rock flour, sand, gravel, and boulders—everything that the heavy ice sheet, moving southward, could tear loose or grind to pieces. Nearly everywhere the soil and weathered rock were removed by the ice, and the bedrock scoured down to a hard, resistant surface. Over this surface the till was deposited. Plate 7, *A*, shows the heterogeneous character of the till and its sharp contact with the underlying hard bedrock.

The character of till varies greatly, even within a few feet; some of it is bouldery, some gravelly, some clayey. Much of the till in any locality is derived from the underlying bedrock, but a great deal of it consists of fragments of different rocks, some of which were transported for long distances. Trap boulders are often found in places many miles from the probable parent ledge, and quartzite boulders are found that must have been transported 25 to 50 miles. Usually boulders are not so common in the till overlying Triassic sandstone as in that overlying the crystalline rocks, presumably because the sandstone was more easily ground up into fine material. Where the Triassic sandstone is shaly, the till may consist almost wholly of dense red clay; such till is found in the western part of Durham. At other places the till is nearly pure sand or gravel derived from the crystalline rocks; till of this nature is common in Haddam and Killingworth. Loose boulders are a conspicuous feature of most till-covered areas (pl. 7, *B*) and supply material for the stone walls so common in this area.

Till covers about 75 per cent of the New Haven area (see pl. 5), lying for the most part on slopes and ridges. Its thickness is extremely variable but seldom exceeds 20 or 30 feet and at many places may be only 2 or 3 feet. Where the till has been piled up in drumlins, however, it is much thicker and may possibly reach a maximum of about 100 feet. A dug well on a drumlin near Pond Point, Milford, penetrated 56 feet of till without reaching the base, and a thickness of 40 feet has been found in several wells in the area.

STRATIFIED DRIFT

The essential characteristic of the stratified drift is its arrangement in layers. Stratified drift consists principally of sand and gravel, sandy material predominating. It was assorted and deposited by running water along the courses of the streams that were fed by the melting glaciers. Near the coast some of it may have been assorted by the action of the waves. It is entirely unconsolidated, and the faces of excavations made in it usually slump badly in a short time. Plate 8 shows typical stratified drift in freshly opened gravel pits in Milford.

In the stratified drift at North Haven and elsewhere in the Quinnipiac Valley there are beds of fine laminated reddish clay, which were deposited in a lake that once occupied the valley.[9]

In valleys that have been cut in crystalline rocks, such as the Connecticut River valley, much of the stratified drift contains boulders a foot or two in diameter, or even larger. The boulders are usually found near the contact with bedrock or till, on which the stratified material was deposited, and are rather poorly stratified, indicating that they have not been moved far and that their presence has somewhat hindered the assortment of the material surrounding them.

The aggregate area covered by stratified drift is probably slightly less than 25 per cent of the region. It comprises chiefly small terraced plains in the valleys. The thickness of stratified drift, like that of till, is variable, depending on the shape of the channels that it fills and the configuration of the bedrock floor. At most places the stratified drift is less than 25 or 30 feet thick, but in several wells near New Haven and along the Quinnipiac Valley it is reported to be more than 100 feet, and in the well of the Acme Wire Co., Hamden, 223 feet, which is probably near the maximum for the region.

As the stratified drift was deposited by running water, its distribution indicates the courses of streams at the time the glacial ice was retreating. It is evident from a study of the map (pl. 5) that many of the streams of that time followed courses different from those of the present day. Some of the more pronounced changes are pointed out below.

[9] Ward, Freeman, The Quaternary geology of the New Haven region, Conn.: Connecticut Geol. and Nat. Hist. Survey Bull. 29, Hartford, 1920.

Menunketesuck River, in Clinton, formerly joined Indian River and flowed directly southward. These two streams deposited most of the stratified drift in Clinton.

In the southeastern part of Durham a narrow but continuous body of stratified drift along the road passing Mount Pisgah indicates that drainage from this region once flowed southeastward into the headwaters of Hammonasset River. Farther south, near Rockland, in the northern part of Madison, Hammonasset River left its present valley and flowed southward past Race Hill into East River, Guilford. The lower part of Hammonasset River followed a course somewhat to the west of its present channel, by way of Horse Pond and the village of Madison.

Drainage from the vicinity of Lake Quonnipaug, in Guilford, probably flowed at different times into East River and into Branford River, instead of following its present course through West River.

Farm River, in North Branford, probably at one time turned westward north of Totoket and flowed down Fivemile Brook into the Quinnipiac. As Farm River deposited the stratified drift that forms the plain at East Haven it is evident that at other times it discharged into Morris Cove and into Long Island Sound, just east of Lighthouse Point.

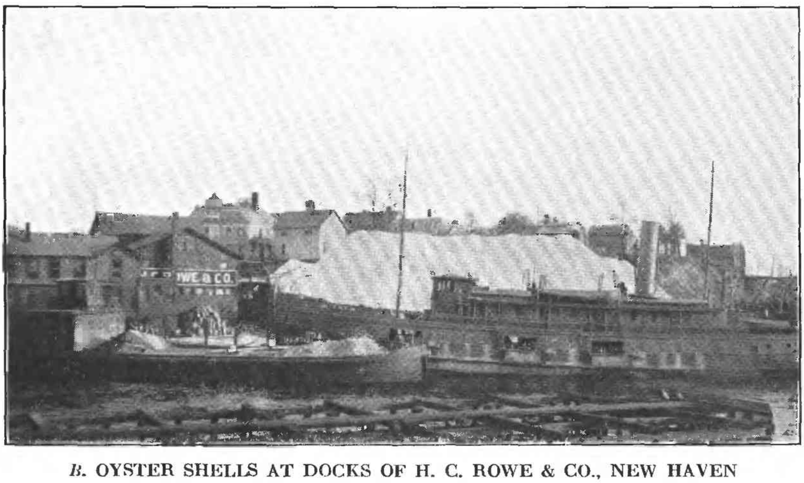
In Hamden, west of Mount Carmel, there are on the uplands irregular bodies of stratified drift that show little relation to the present valleys. These appear to have been deposited by temporary streams when the valley of Mill River, to the east, was filled by a great glacier. These temporary streams probably flowed southwestward through gaps in the trap ridges between Hamden and Bethany.

Complicated changes have occurred in the drainage of Bethany and Woodbridge. The headwaters of Hill Brook formerly flowed southward into West River, and the upper part of West River was tributary to Sargent River, which in turn flowed westward down Bladens River into the Housatonic. Farther down in its course Hill Brook was once connected with Hackanum Brook.

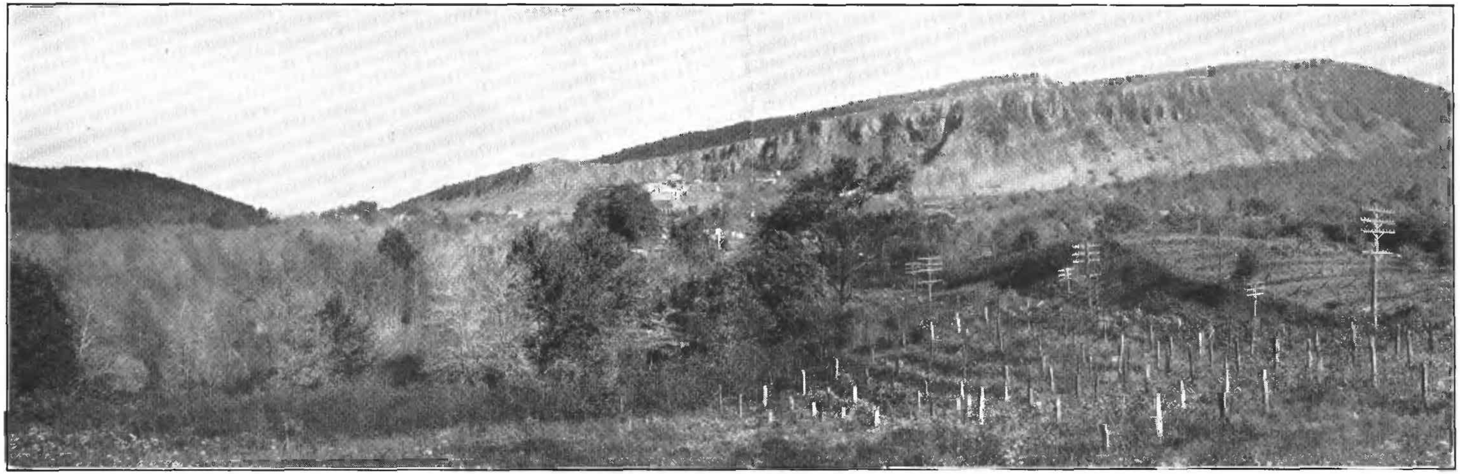
The upper Wepawaug River at the time of deposition of the stratified drift flowed southwestward out of Woodbridge into the Housatonic. The lower part of the Wepawaug also flowed southwestward, passing down Beaver Brook into the Housatonic, near Devon, and left a broad channel filled with stratified drift. Oyster River continued to the southwest and deposited the stratified drift in the vicinity of Merwin Point and Pond Point.

Evidence that the shore was somewhat to the south of its present position and that the glacial streams extended farther in that direction is found on Charles Island, where stratified drift is found on the

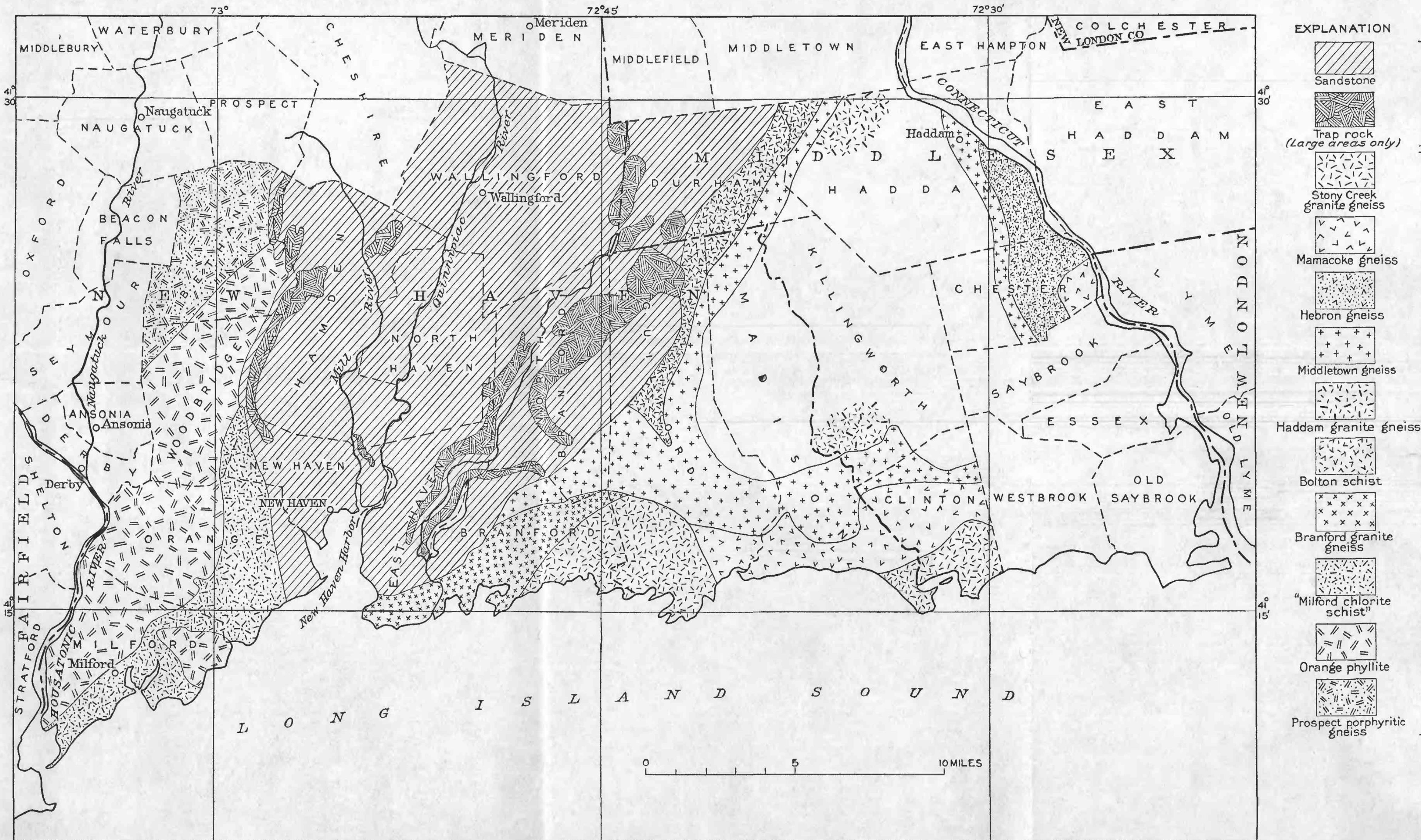
A. CORDWOOD ON A TYPICAL DEFORESTED HILLSIDE, BEACON FALLS



B. OYSTER SHELLS AT DOCKS OF H. C. ROWE & CO., NEW HAVEN



MAIN TRAP RIDGE AND QUARRY, CONNECTICUT TRAP ROCK CO., REED GAP, WALLINGFORD



MAP SHOWING GENERALIZED BEDROCK GEOLOGY OF THE NEW HAVEN AREA

After W. N. Rice, H. E. Gregory, H. H. Robinson, and others north and south sides and till is well exposed in a sea cliff on the west. If the stratified drift here had been laid down by waves it should encircle the island.

MUD OF NEW HAVEN HARBOR

Beneath New Haven Harbor and extending up some of the tributary salt marshes is a blanket of black, slimy mud. At least a part of this deposit is Recent, and it is receiving daily accretions of fine sand, clay, and sewage that settle in the quiet water of the harbor. The mud is very impervious and holds water like a cup in open pools or excavations. Well borings along the present water front at points where it has been extended beyond the original shore for several hundred feet by filling show that the mud is 20 or 30 feet thick, and thicknesses nearly as great were exposed by the excavations for bridge piers in the middle of the tidal channels of West River and Mill River. The deposit extends approximately to the high-tide shore line, where it thins to nothing. It doubtless extends beneath the bay as far south as the narrow opening below Fort Hale Park and Sandy Point. No similar deposit has been found elsewhere along the coast of the New Haven area, probably because there are no other large landlocked bays and because silt-supplying deposits such as the clays of Quinnipiac Valley are lacking elsewhere.

STRUCTURE

JOINTS

All the bedrock of the region is cut by many joints that divide it into irregular-shaped polygonal blocks that range in size from a few inches to many feet. Cleavage planes, common in schist, and bedding planes, characteristic of stratified rocks such as the Triassic sandstone, further assist in dividing the bedrock into blocks, and for the purposes of this paper they may be considered joints. Many joints near the surface become enlarged into open cracks by weathering and by the solvent action of percolating ground waters. Such joints in bedrock may be seen in nearly any quarry face or roadside cut. (See pl. 9.) The degree of enlargement in joints diminishes rapidly from the surface down, and at a depth of a few hundred feet they are generally closed very tightly. Because of the enormous pressure joints are probably absent at depths of a few thousand feet.

Joints may trend in any direction and may be inclined at any angle. The principal joints are usually more nearly vertical than horizontal. Many rocks are cut by several different systems of joints. In much of the trap there is an irregular columnar jointing, due probably to stresses set up during the cooling of the originally molten rock.

These joints cause the rock to weather out in long polygonal columns, such as those on the face of East Rock.

Joints have considerable influence upon the water supply because they afford channels for the circulation of ground water.

FAULTS

A fault is a break in the earth's crust along which the rocks on one side are displaced with respect to those on the other, thus differing from a joint, along which there is no displacement. The amount of displacement along fault planes may be a few inches or thousands of feet. Faults of small displacement, where it is possible to identify the beds on each side, can be seen in many of the quarries, railroad cuts, and other excavations in the Triassic sandstone.[10] The rock on both sides of a fault plane is usually more or less crushed or shattered, its appearance often being about the same as that of a rock having closely spaced joints.

Faults of great magnitude in the Triassic formations have had considerable influence upon the production of certain topographic forms that were developed by erosion. Probably the most extensive fault is that which bounds the eastern margin of the outcrop of Triassic sandstone in the New Haven area. Topographic features along this fault are described on page 15.

TILTING

Sedimentary rocks such as the Triassic sandstone are commonly deposited in nearly horizontal layers but may be tilted by later crustal movements. (See pl. 6, *B*.) Nearly all the Triassic sandstone and the interbedded trap sheets of the New Haven area have been tilted and now dip east or slightly south of east at angles of 10° to 30°.

The tilting of the Triassic rocks is mainly a result of faulting. The rocks are broken by a large number of parallel faults that trend generally north and south. The faulted strips were either depressed on their eastern edges or elevated on their western edges. A good idea of the present attitude of these rocks beneath the surface of the ground is given in Figure 1, taken from Barrell.[11]

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[10] For a discussion of faults in the Connecticut Triassic, with numerous illustrations, see Rice, W. N., and Gregory, H. E., Manual of the geology of Connecticut: Connecticut Geol. and Nat. Hist Survey Bull. 6, pp. 200–222, Hartford, 1906.

[11] Barrell, Joseph, Central Connecticut in the geologic past: Connecticut Geol. and Nat. Hist. Survey Bull. 23, p. 22, Hartford, 1915.

PHYSIOGRAPHY

MAJOR FEATURES

ALTITUDE AND RELIEF

The prevailing slope of the New Haven area is southward, and the altitude decreases rather uniformly from a maximum of 700 or 800 feet at the northern border to sea level at Long Island Sound. The region as a whole is rather rough, although the local relief in few places exceeds 400 or 500 feet and usually is only 100 or 200 feet. Almost all the level land occurs as small tracts in the larger valleys or as narrow plains along the coast.

PHYSIOGRAPHIC PROVINCES

The State of Connecticut contains three distinct physiographic provinces, commonly known as the Central Lowland, the Eastern Highland, and the Western Highland.[12] The Central Lowland extends from north to south across the middle of the State, terminating at New Haven. It passes directly through the middle of the New Haven area, which, therefore, resembles the State as a whole in that it contains a central lowland flanked by higher areas to the east and west. The distinction between the lowland and the highland, topographically, is one of altitude, the average altitude of the highlands being a few hundred feet greater than the average of the lowland. However, near the shore both lowland and highland reach accordant altitudes but little above sea level. Moreover, within the area of the lowland there are conspicuous hills and low mountains that rise to heights as great as the summits of the adjacent highlands. These are regarded as remnants of a once extensive level surface of former times.

It is generally agreed that after the Triassic sandstone was laid down, faulted, and tilted, erosion reduced the surface of Connecticut to a nearly level lowland—a peneplain—with a gentle slope to the south.[13] During or immediately after the period of peneplanation a part, perhaps all, of the State was covered by the sea. As the land was again uplifted the sea gradually withdrew, and the streams, eroding with renewed activity, produced the major features of the present topography.

Besides the difference in altitude, the lowland and highland areas are characterized by distinct geologic and physiographic features. The lowland is an area of Triassic rocks; the highlands are areas of

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[12] Gregory, H. E., Underground water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, pp. 12-17, 1909.

[13] Davis, W. M., The Triassic formation of Connecticut: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 2, pp. 1-192, 1898. Barrell, Joseph, Central Connecticut in the geologic past: Connecticut Geol. and Nat. Hist. Survey Bull. 23, Hartford, 1915; Piedmont terraces of the northern Appalachians: Am. Jour. Sci., 4th ser., vol. 49, pp. 227-258, 1920.

crystalline rocks. (See pl. 4.) The Triassic sandstone, being relatively soft, has been worn down much faster than the crystalline rocks; its valleys are comparatively wide and flat, its hills low and rounded. However, the Triassic trap, which is associated with the sandstone, is fully as resistant as the crystalline rocks, if not more so, and although the sandstone has been worn away the outcropping edges of the dikes and tilted sheets of trap have withstood erosion and form the prominent hills and mountains of the lowland, most of which are narrow ridges, trending generally north and south. (See fig. 1.) West Rock, Mount Carmel, Saltonstall Mountain, and Totoket Mountain are good examples. Where sheets of lava are interbedded with the Triassic sandstone the ridges of trap have very steep slopes on the west and more gentle slopes on the east, owing to

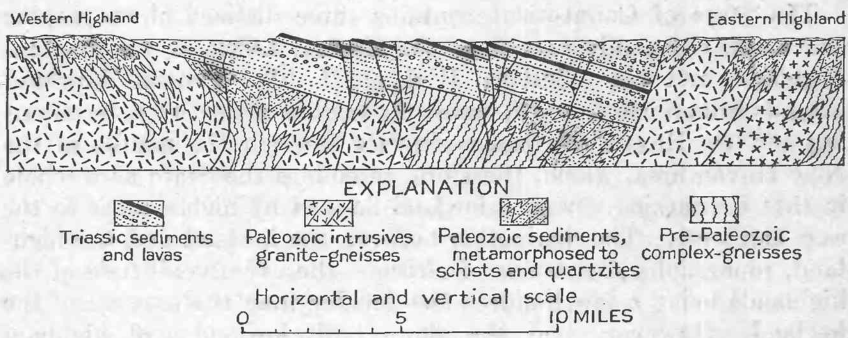


FIGURE 1.—Effect of faulting and tilting on the attitude of the Triassic rocks of Connecticut. (After Barrell)

the fact that the trap sheets dip eastward. The western slopes at many places form steep escarpments. Similar ridges occur in the sandstone at places where tilted beds of hard conglomerate crop out, the western slopes being abrupt, the eastern slopes gentle; but they are much less conspicuous than the trap ridges.

The highlands, developed on the crystalline rocks, are characterized by broad, rolling interstream areas and deep, narrow valleys. Ridges and bluffs occur in the highlands, following the line of outcrop of veins or hard layers of rock, but they are nowhere so bold or conspicuous as the trap ridges of the central lowland.

TOPOGRAPHIC FEATURES DUE TO FAULTING

Certain peculiar topographic features in the central lowland are the result of erosion along fault planes. Faults in the Triassic area cut across the trap ridges, breaking their continuity and causing them to be offset. Erosion has carved away the softer sandstone that intervened between the offset ends of faulted trap ridges, and the shattering of the rock due to faulting has enabled erosion to work more effectively along the fault planes. The several gaps in West Rock Ridge, one of which is shown in Plate 10, *A*, are examples, as are also Reed Gap (pl. 3) and the gap at Pistapaug Pond.

The eastern margin of the area of Triassic rocks is determined by a fault along which a peculiar succession of fault valleys has been developed by differential erosion. Prominent links in this chain of valleys are as follows: Beginning at the western limit of the borough of Branford, at the house of R. U. Plant, a small swampy valley, bordered on the west by a trap ridge, extends north by east. This is separated by only a low divide from the valley of the stream originating in Twin Lakes, which feeds Branford Reservoir; this valley trends northeast, and its physiographic prolongation is found in the upper valley of Branford River from North Branford nearly to North Guilford. Again a low divide intervenes. Then come the large, deep valley of Lake Quonnipaug and, continuing north by east, the valley of the brook that feeds into the lake. Beyond a low divide is the valley drained by the headwaters of the Coquinchaug. The line of the fault turns rather sharply to the northeast near the southern limit of Durham Center and passes beyond the New Haven area at the northeast corner of Durham.

This rift valley is utilized almost continuously from North Branford to Durham Center, more than halfway across the New Haven area, by the road that connects New Haven and Middletown. (See pl. 10, *B*.)

EFFECTS OF GLACIATION

The major features of the topography of the New Haven area have been inherited from past ages of geologic time, but the minor features were produced by glaciation and are comparatively young. When the glacial ice, hundreds of feet thick, moved southward over New England it scoured off the hills, tearing loose the soil and plucking out stones, which were deposited again in other places, forming the present blanket of till. As the ice sheet melted, the streams that flowed from it assorted this material along their courses into stratified drift. To some extent glaciation modified the original bedrock topography, but its chief effect was to impose upon the older topography minor features characteristic of the till and of the stratified drift.

The chief action of the ice sheets on the bedrock was to scour and polish the rock surface, especially on the hilltops and the sides of the valleys, where the harder portions of the rock stand up in relief and the softer parts are etched away. Smooth, rounded contours and polished surfaces are common on the rocks of the region, particularly on the gneiss of Guilford. Boulders embedded in the ice also scoured the underlying rocks, producing many scratches, or "striae." (See pl. 11, *B*.) These striae, most of which trend nearly south, show the direction of ice movement.[14]

The topography of till-covered areas is difficult to describe briefly, for it is not easily reduced to type forms. As the till was deposited both on ridges and in hollows in a mantle of very uneven thickness, the resultant surface is very irregular, containing many little undrained depressions. Small swamps and marshes may occur even on hillsides, as the till is rather impervious. A type form of till deposit that is fairly common in the New Haven area is the drumlin. This is an elongate oval hill, composed of till that was heaped up into a great mound by the overriding ice. (See pl. 11, *A*.) Many of the drumlins occur in groups, as at Pond Point, Milford. The Sugar Loaf Hills, in Guilford, and Cranberry Hill, Walnut Hill, and High Hill, in Madison, are other examples of drumlins.

The stratified drift is usually confined to valleys, because it was deposited by streams, although not all the streams of glacial time followed the courses of the present-day streams. Most of the valleys in which stratified drift was deposited were filled to a fairly uniform height, the deposit sloping gradually downward with the grade of the stream. The sand plains common in all the principal valleys originated in this way. The most extensive deposit is that in the Quinnipiac Valley, which extends entirely across the area from north to south. Near the shore it merges with the plains of Mill River and West River, and on this composite plain is built the city of New Haven.

Most of the original sand plains have been trenched by the streams, leaving only terraced remnants on the sides of the valleys. The terraces are usually bounded by bluffs that stand 5 to 50 feet above the present river flood plains. These terrace bluffs are a conspicuous feature of nearly every large valley and separate the tillable land of the terrace from the usually swampy land of the flood plain. (See pl. 12.) As a rule there is only one prominent terrace in each valley, although several more or less imperfect terraces occur along Connecticut and Housatonic Rivers, as well as along some of the smaller streams. The terrace bluffs are the favorite sites for sand or gravel pits, for here the material can be easily dug and hauled away. (See pl. 8.)

Kettle holes, found only on the sand plains, are small, more or less circular depressions, which have no outlets. They are supposed to have been formed by the melting of blocks of ice that had become embedded in the stratified drift at the time it was being deposited. They are very numerous in Farm River Valley, in North Branford, and in Mill River Valley near Mount Carmel, in Hamden. Some of

[14] See map showing direction of striae in Manual of the geology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 6, Hartford, 1906.

these are large enough to be shown by depression contours on the topographic map (pl. 5). Many kettle holes are occupied permanently or intermittently by water and add to the great number of small lakes and ponds in the region.

The surface materials deposited by the retreating ice sheet caused considerable disarrangement of the drainage of the region because many valleys were piled full of drift, and hills of drift were left where hollows formerly existed. This is the reason why many of the small streams, particularly in the till-covered country, now have erratic courses contrary to the prevailing direction of the drainage.

SHORE FEATURES

LATE HISTORY OF THE CONNECTICUT COAST

The Connecticut coast, possibly during and certainly since the glaciation of the Pleistocene epoch, has undergone a marked subsidence, which has produced what is called a drowned coast. Valleys have been invaded by the sea and made into bays and estuaries; ridges have become peninsulas; hills have been surrounded, forming islands. As a result the coast has a very irregular outline. Wave action has to some extent straightened the coast line by wearing away the headlands and building beaches between projecting points and across bays. Streams have aided by filling up bays and estuaries with sediment. These processes have modified the original drowned coast to a considerable extent, especially in the areas of soft, easily eroded drift in Clinton, Madison, Orange, and Milford. But where much bedrock is exposed, as in Guilford and Branford, the originally crooked shore line has been less modified. At no place have the modifications gone far enough to obliterate the prominent physiographic features due to drowning, such as tidal marshes and estuarine river channels. Some of the characteristic features of the coast in the New Haven area are described below.

BEACHES, BARS, AND SPITS

Beaches assume many different forms along the coast of the New Haven area, the form depending on local conditions. In stratified drift and till they are comparatively straight or gracefully curving and are usually backed by wave-cut terraces and sea cliffs. (See pl. 13, *A*.) Such beaches are typical of the coast in Clinton, Madison, Orange, and Milford. A bay-head beach is one built across the head of a small bay, making it rounded or U-shaped. Bay-head beaches are common where the coast is rocky, as in Guilford and Branford. Joshua Cove and Little Harbor, in Guilford, illustrate the type particularly well. A bar beach or barrier beach, consists of a ridge of sand behind which there is generally a lagoon or marsh. Many such beaches connect rocky points and thus tend to smooth out the irregularities of the coast line. Good examples are found from South End to Lighthouse Point in East Haven. As a rule, in the New Haven area, small openings exist in the bar or barrier beaches, affording an outlet for fresh water at low tide and an inlet for salt water at high tide.

Spits tend to grow from a point in the direction of the prevailing shore currents. A spit may finally become connected with an opposing point, thus sealing off the landward area, which usually becomes a marsh; the spit has then become a barrier beach. Hogshead Point, in Madison, and Milford Point, in Milford, are good examples of spits.

An unusual shore feature is the bar that connects an island with the mainland, sometimes called a tombolo. Two excellent examples are the tombolo connecting Charles Island with the mainland, in Milford (pl. 13, *B*), and the smaller one at Double Beach, in Branford.

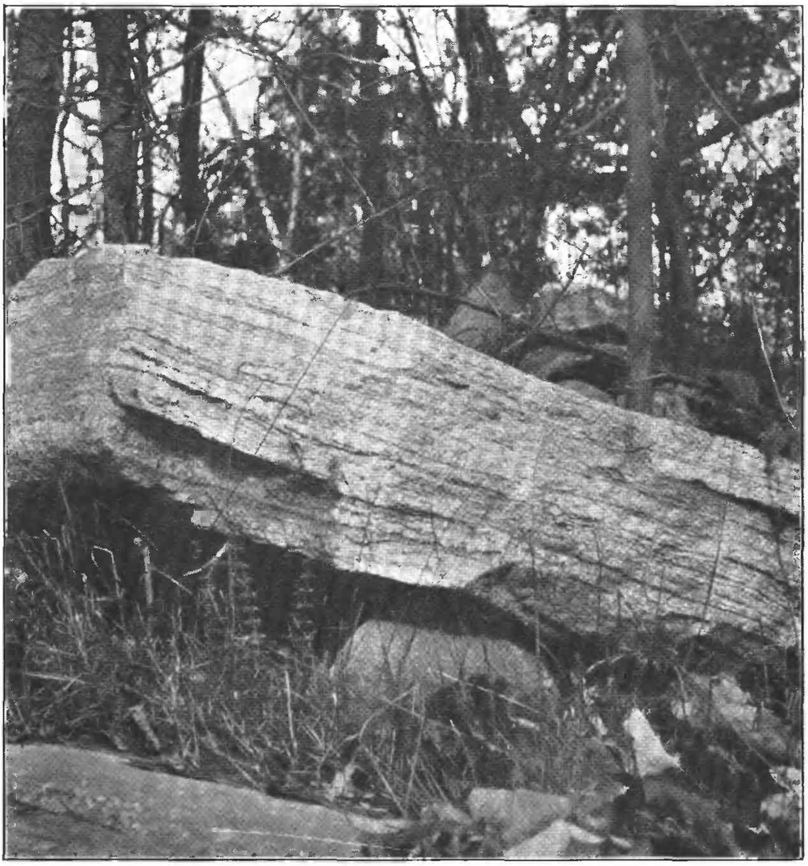
TIDAL MARSHES

Tidal marshes are described by Shaler[15] as "wide savannas which are covered by the sea but for an hour or two a day, during the time of high tide, and which support a growth of low-grade flowering plants, mostly of grasslike form." Most of the tidal marshes are situated in drowned valleys that have been partly sealed off from the sea by barrier beaches and have become filled with sediment and decaying vegetation. Marshes of this general type are very extensive along the New Haven coast and are commonly called salt meadows. Many of them are covered only occasionally by unusually high tides, and in some places the tidal water is sealed off from the marshes by tide gates; the grass on such meadows is cut for hay or stable bedding. For the most part, however, the tidal marshes are waste land, except at New Haven, where large areas have been filled in for building sites, or protected by tide gates for sanitary reasons.

ISLANDS

Most of the islands off the coast of the New Haven area lie between New Haven and Guilford, particularly in the towns of Branford and Guilford. Nearly all of them are composed chiefly of bedrock, generally with a thin covering of till. Charles Island, off the Milford shore, is an exception, for it appears to consist entirely of till and stratified drift, which is being rapidly worn away. When the land first sank to its present level there were probably numerous islands composed of till and stratified drift, but they have been destroyed by wave action, leaving only the more durable rock masses to mark the former seaward extension of the land.

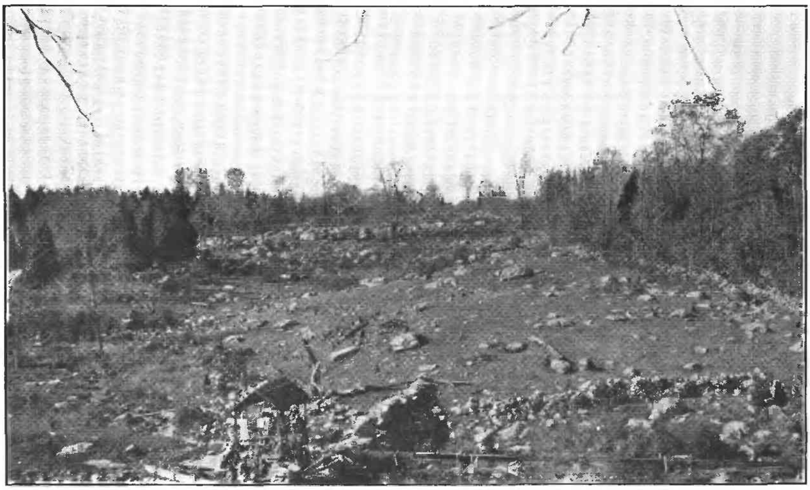
[15] Shaler, N. S., Beaches and tidal marshes of the Atlantic coast: Nat. Geog. Mon., vol. 1, p. 158, 1895.



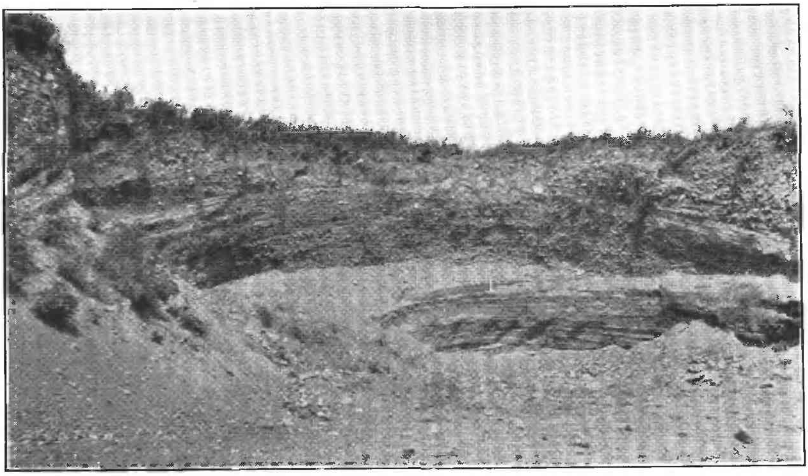
A. BANDING IN GNEISS NEAR TURKEY HILL, HADDAM

B. SANDSTONE IN QUARRY FACE, NEW HAVEN

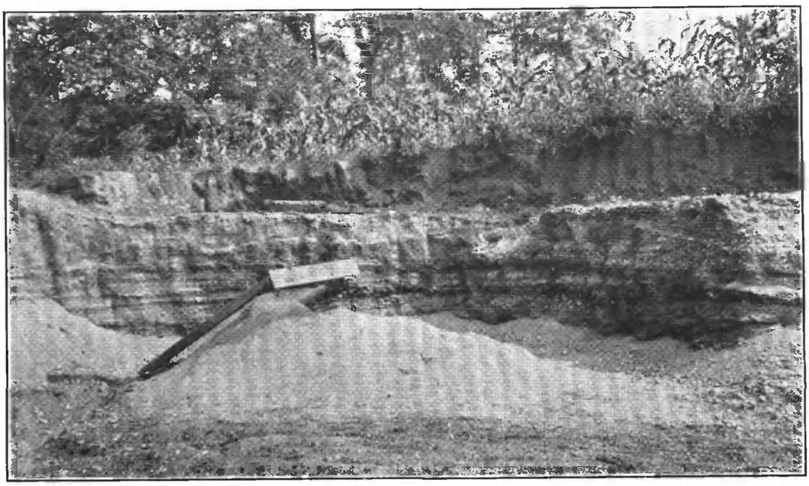
A. TILL OVERLYING BEDROCK ("MILFORD CHLORITE SCHIST"), DERBY AVENUE NEAR MALTBY LAKES, ORANGE



B. BOULDERS ON A TILL-COVERED HILLSIDE, KILLINGWORTH

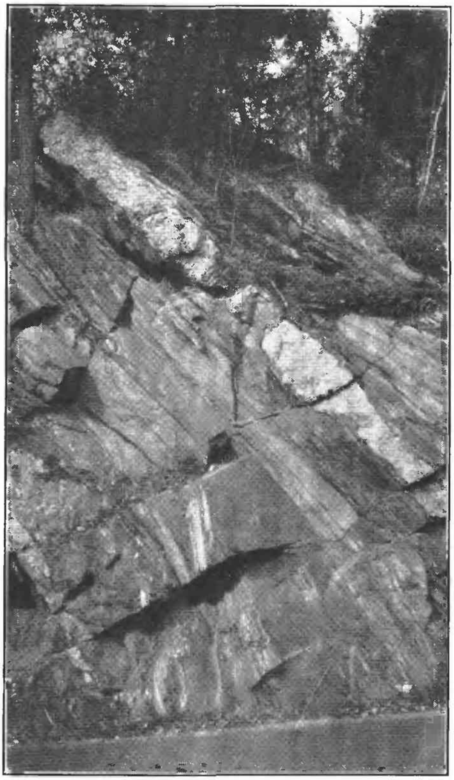


A



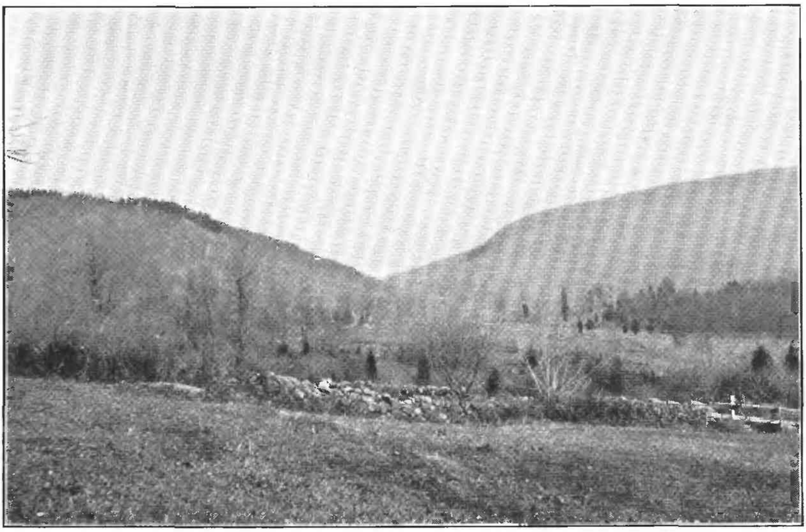
B

GRAVEL PITS IN STRATIFIED DRIFT, MILFORD



A. JOINTS IN GNEISS, ESSEX

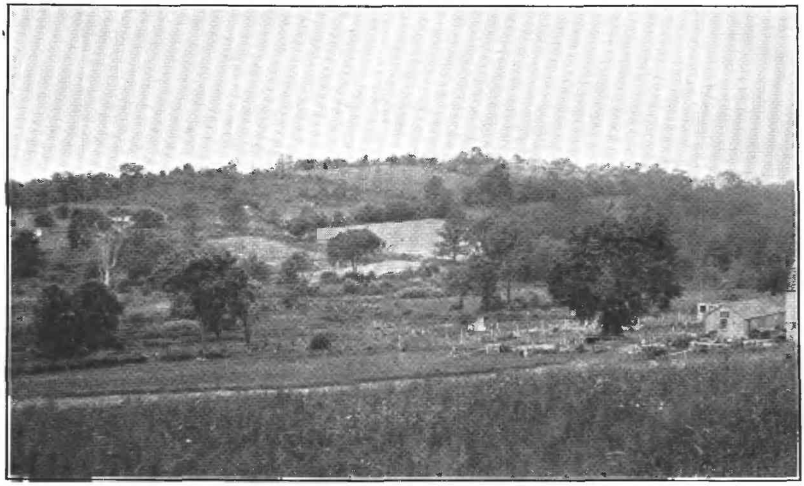
B. CLEAVAGE AND JOINTS IN SCHIST, GUILFORD



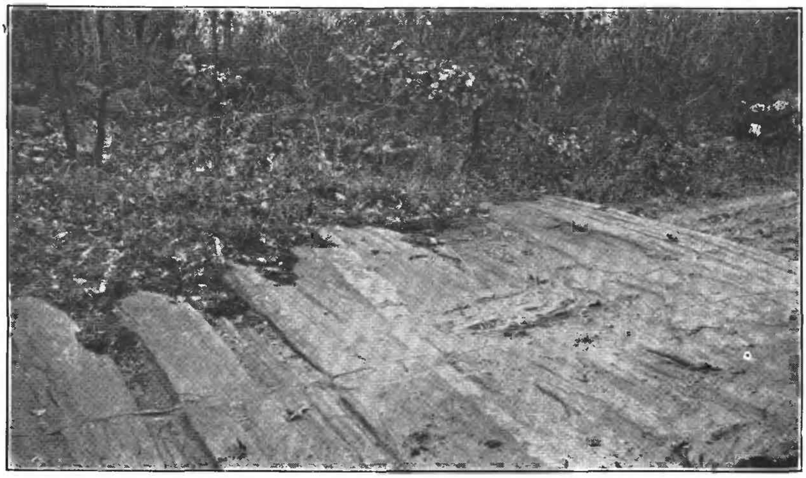
A. FAULT GAP AT NORTH END OF WEST ROCK RIDGE UTILIZED BY ROAD FROM BETHANY TO MOUNT CARMEL

B. FAULT VALLEY ALONG EASTERN MARGINAL CONTACT OF TRIASSIC AND CRYSTALLINE ROCKS, NORTH OF LAKE QUONNIPAUG

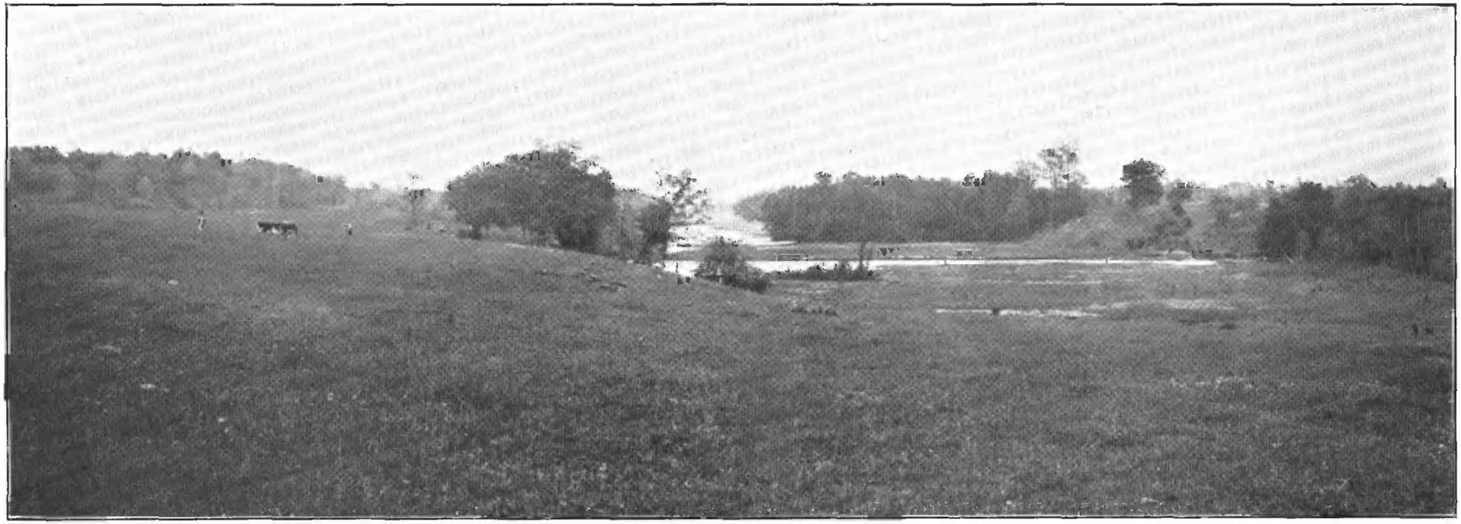
Trap rock to left of road, gneiss to right



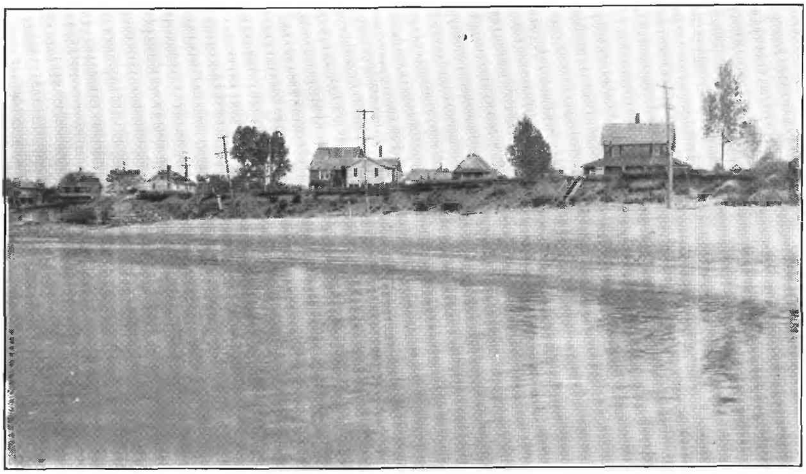
A. MARSH HILL, A TILL DRUMLIN IN ORANGE



B. GLACIAL STRIAE ON GRANITE GNEISS EAST OF LAKE QUONNIPAUG, GUILFORD



TERRACES AND FLOOD PLAIN OF EAST RIVER, NEAR NUT PLAINS, GUILFORD



A. BEACH AND SEA CLIFF IN STRATIFIED DRIFT, WEBSTER POINT, MADISON

B. BAR, OR TOMBOLO, TYING CHARLES ISLAND TO THE MAINLAND, MILFORD

PRECIPITATION

The average annual precipitation over Connecticut is about 45 inches, distributed rather uniformly throughout the year. The tables below give the available records of precipitation at New Haven and Wallingford since 1900. A climatologic station is maintained at New Haven by the United States Weather Bureau. Records made at Wallingford were supplied to the Weather Bureau by voluntary observers. The tables indicate a slightly greater average annual precipitation at Wallingford, in the interior, than at New Haven, on the shore. At New Haven, the greatest recorded precipitation in any one month was 10.64 inches, in October, 1913; the least was 0.17 inch, in September, 1914. At Wallingford the greatest precipitation in one month was 11.48 inches, in June, 1903; and the least was 0.12 inch, in March, 1915. These figures show that although the average precipitation over a number of years is almost equally distributed in the different seasons, there may nevertheless be many short periods of drought.

Precipitation, in inches, at New Haven, Conn., 1900–1918

[Altitude, 25 feet above sea level]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1900	3.00	6.39	4.21	1.95	3.30	1.79	2.28	.90	2.10	2.03	4.14	2.14	34.23
1901	1.38	.54	5.80	9.03	6.38	.25	4.40	6.92	5.70	2.95	1.61	7.65	52.61
1902	1.83	3.58	4.03	3.40	1.61	4.35	3.26	2.14	5.84	6.41	.79	6.49	43.73
1903	3.17	3.98	5.09	2.61	.31	7.41	2.17	6.96	2.20	2.94	1.85	2.53	41.22
1904	2.78	2.52	3.28	6.64	2.94	2.46	2.08	6.27	4.96	2.21	1.95	3.64	41.73
1905	4.14	2.06	2.96	3.42	1.18	5.87	2.86	7.20	5.07	2.21	1.53	4.83	43.33
1906	3.20	2.45	5.67	4.48	4.75	5.14	5.02	1.13	4.82	7.44	2.42	4.18	51.30
1907	3.56	2.91	2.59	3.00	4.42	3.18	1.10	1.21	7.67	4.85	6.97	4.73	46.19
1908	4.18	6.44	3.78	2.15	6.16	1.20	3.94	8.12	.88	1.58	.83	4.07	42.53
1909	3.38	6.98	4.20	6.66	2.19	3.47	1.42	3.49	3.93	1.76	1.51	4.70	43.69
1910	7.28	4.37	1.16	3.35	4.34	4.03	2.26	3.21	1.83	1.15	4.56	2.30	39.84
1911	3.20	3.45	4.48	4.31	.74	2.73	2.17	5.57	2.33	7.44	6.40	4.04	46.86
1912	3.08	2.91	9.15	4.56	6.34	.50	2.14	3.22	2.32	1.22	3.37	6.04	44.85
1913	3.64	3.77	5.33	5.39	2.30	2.77	1.69	3.40	2.52	10.64	2.74	4.28	48.47
1914	5.58	3.68	4.53	3.90	3.00	2.07	6.51	2.36	.17	3.81	3.28	4.87	43.76
1915	8.59	6.31	.25	1.86	2.72	2.94	3.90	7.48	1.35	3.30	1.90	5.78	46.38
1916	1.55	6.21	4.08	3.00	3.69	4.90	3.72	2.11	2.54	2.05	2.54	3.71	40.10
1917	3.34	2.16	6.21	3.00	3.45	3.36	3.35	2.53	2.23	4.68	1.08	3.90	39.29
1918	3.61	3.04	2.32	4.26	3.82	6.10	4.31	2.51	6.16	1.20	3.37	4.21	44.91
Mean	3.71	3.88	4.16	4.05	3.35	3.40	3.08	4.04	3.40	3.68	2.78	4.43	43.94

Precipitation, in inches, at Wallingford, Conn., 1900–1915

[Altitude, 100 feet above sea level]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1900	4.59	8.25	5.24	1.93	4.35	1.61	2.39	1.48	3.54	2.82	5.97	------	------
1901	1.93	.65	4.36	------	7.80	1.41	2.33	------	------	3.84	2.38	8.16	------
1902	2.07	6.40	7.39	------	1.53	4.44	------	------	7.53	6.95	1.64	8.60	------
1903	------	5.58	6.50	3.13	1.23	11.48	2.46	5.96	1.75	3.33	------	4.48	------
1904	4.91	------	------	------	2.91	1.33	2.31	5.18	6.05	1.18	2.28	4.33	------
1905	5.54	------	------	2.95	1.00	4.56	2.25	5.68	3.86	2.60	2.20	5.03	------
1906	4.15	3.15	6.40	3.95	4.58	3.97	4.36	2.52	3.92	6.95	1.95	3.77	49.67
1907	3.23	------	1.94	3.95	4.35	------	------	------	6.88	3.51	6.18	5.92	------
1908	------	------	------	------	------	------	------	------	------	------	------	------	------
1909	2.93	5.89	4.61	7.13	1.90	2.08	1.52	4.40	4.96	1.32	2.39	4.99	44.12
1910	7.62	4.56	.72	3.15	3.23	4.88	3.29	3.06	1.81	.91	4.24	1.92	39.39
1911	3.60	3.95	4.18	3.94	1.13	1.82	2.31	4.75	2.27	6.75	6.64	4.04	45.38
1912	2.58	3.02	9.82	4.45	5.63	.71	4.22	4.64	1.91	1.20	4.10	5.64	47.92
1913	3.23	3.37	4.99	5.12	1.44	2.13	------	2.37	------	10.06	2.70	3.72	------
1914	5.68	4.00	4.50	4.29	2.59	1.88	4.43	1.84	.36	3.34	3.46	------	------
1915	8.83	------	.12	2.22	2.56	3.46	3.35	6.27	2.15	2.01	2.08	7.05	------
Mean	4.35	4.44	4.69	3.85	3.28	3.27	2.93	4.01	3.62	3.78	3.44	5.20	46.86

GROUND WATER

OCCURRENCE AND CIRCULATION OF GROUND WATER

A short distance below the surface of the earth in regions of plentiful rainfall the voids of all the rocks are usually saturated with water, which is called ground water. In the glacial drift most of the ground water is stored in openings between the particles of till or grains of sand. In the bedrock it is stored mainly in joints. Ground water, like surface water, moves under the force of gravity from higher to lower levels, but as it circulates through small voids, it moves much more slowly than surface water. Ground water is returned to the surface in various ways; some of it emerges at springs, some by seepage in marshy areas, some by direct seepage into streams

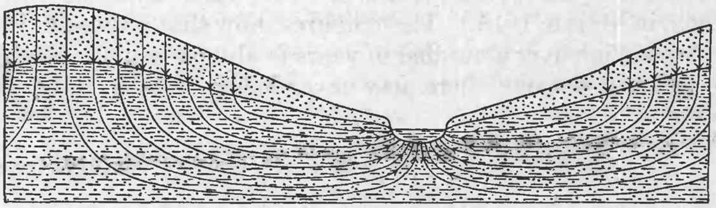


FIGURE 2.—Diagrammatic section illustrating seepage of ground water into streams. (After King)

(see fig. 2) and into the ocean. It is this slow seepage of ground water into streams in the New Haven area which maintains their flow throughout the year.

SOURCE OF GROUND WATER

All ground water in the New Haven area comes from the rain and snow that fall upon this area and upon the adjoining parts of drainage basins of the streams that flow through it. A large proportion of the precipitation, probably 25 to 50 per cent, becomes ground water, because the annual precipitation, which averages nearly 4 feet, is fairly evenly distributed throughout the year, evaporation is moderate, the relief of the region is not great, and much of the surface is wooded. Undoubtedly this percentage varies with the nature of the topography, the character of the underlying rock, and other conditions.

THE WATER TABLE

That surface below which the rocks in the earth's crust are saturated with ground water is called the water table, or the groundwater level; it is not a level surface but curves upward under hills and downward beneath valleys. Usually the depth to the water table is greater on hills and less in the valleys, because ground water is continually sinking and flowing away from the higher areas, while in lower areas it frequently is rising and being discharged. The principal body of surface water in any locality, such as the ocean, a lake, or a permanent stream, exerts an important influence on the water table. When the ground water is being discharged into the body of surface water the water table must stand somewhat higher in altitude than the surface water, the height increasing as distance from the controlling body of surface water increases. Figure 3, constructed from actual measurements of wells in Hamden, shows how the water table arches upward under the hills and how it is controlled by adjacent streams and lakes.

WATER IN THE STRATIFIED DRIFT

Although the postulation of a water table is useful in explaining the movements of ground water, its depth is seldom uniform over any considerable area and consequently can not be predicted with sufficient accuracy to be of much practical use except where the rocks are markedly and uniformly porous. In the New Haven area such conditions are found in the stratified drift. Wherever there are large bodies of stratified drift the ground water settles to a nearly uniform level, which is not much above that of the adjacent streams or other controlling bodies of surface water. Figure 4 and the corresponding table of well records show how the ground water in wells penetrating stratified drift stands at a nearly uniform level in the vicinity of lakes, rivers, and the Sound. The figures do not indicate a perfectly uniform water table, but the apparent irregularity is due in part to inability to determine accurately for many of the wells the altitude above sea level. Map C shows how the water table maintains a constant relation to its adjacent stream, becoming lower as the stream descends to lower levels.

Relation of water table in stratified drift to controlling surface-water features

[Measurements are given in feet; altitude is reckoned from mean sea level]

A. Wells in vicinity of Whitney Lake, Hamden; controlled by lake

[Altitude of lake surface, 25 feet]

No. on Figure 4	Owner	Estimated altitude	Depth	Depth to water	Altitude of water table
1	Thorpe	75	48	43	32
2	Mrs. Basset	70	32	26	44
3	C. E. Hayes	70	45	39	31
4	Whitney-Blake Co.	70	42	37	33
5	Winchester Co.	70	42	35	35
6	Neilson	35	12	7	28
7	Reeves	40	23	13	27
8	Silliman	50	24	17	31
9	Osborne	40	22½	14	26
10	E. H. Moulton	65	42	39	26
11	C. W. Brock	60	[a] 50	[a] 25	35
12		60	26	20	40

[a] Reported.

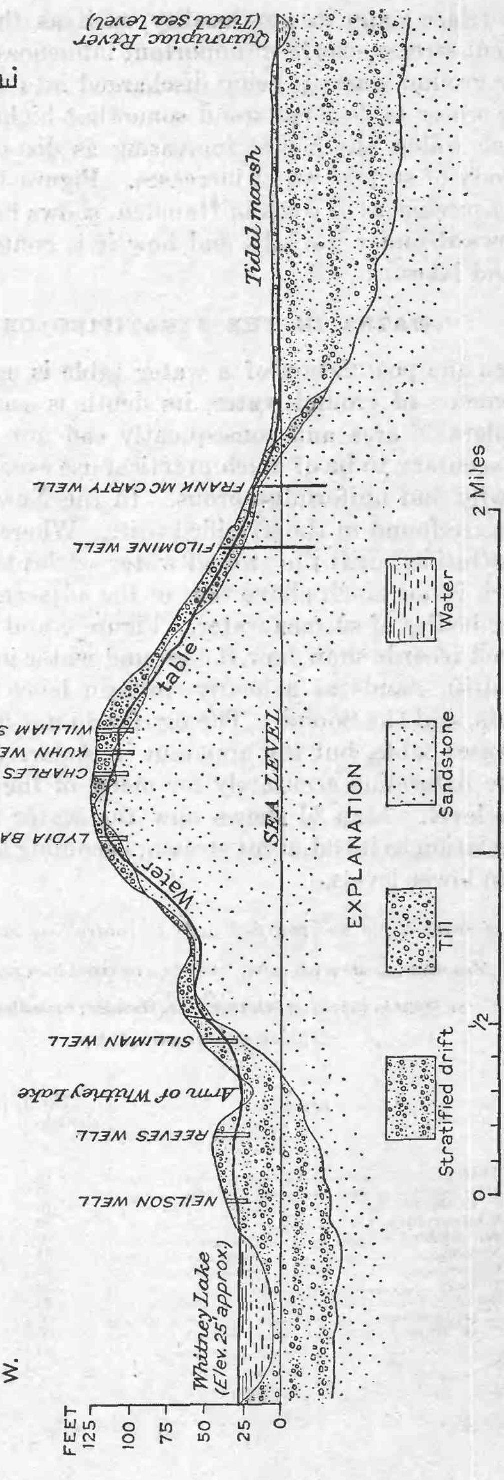


FIGURE 3.—Profile and section from Whitney Lake at trolley crossing south of Augerville east along road to Quinnipiac River, showing relation of water table to the surface

Relation of water table in stratified drift to controlling surface-water features—Continued

B. Wells at South End, East Haven; controlled by sea

No. on Figure 4	Owner	Estimated altitude	Depth	Depth to water	Altitude of water table
1	New Haven Normal School of Gymnastics	10	12	8	2
2	Max Praeger	20	25	(?)	(?)
3	William E. Jones	15	20	13	3
4	New Haven Normal School of Gymnastics	15	14	9	6
5	N. S. Quick	20	45	[a] 25	−5?
6		10	[a] 13	9	2
7	A. P. Luddington	10	9	7	3

C. Wells in valley of Farm River, North Branford; controlled by stream

No. on Figure 4	Owner	Estimated altitude	Depth	Depth to water	Altitude of water table	Adjacent level of Farm River
1		185	43	41	144	145
2		170	37	31	139	140
3	Vincenzo	160	24	20	140	140
4	Richtelli	170	36	33	137	138
5		160	24	18	142	138
6	Ceronne	140	13	8	132	130
7	J. J. Lund	160	38	32	128	127
8	George Bunnel [b]	140	17	11	129	120
9	Isabelle Bunnel	140	25	22	118	120
10	Thursman	135	37	33	102	105
11	George Harder	120	24	21	99	100
12	Reynolds	120	23	17	103	100
13	Butes	120	33	20	100	95

[a] Reported. [b] Well has rock bottom.

There are numerous localities in the stratified-drift areas where there is no extensive and permanent water table at a uniform level. This is especially true in the stratified drift that underlies narrow terraces along the deep valleys in crystalline rock, such as the valleys of Connecticut River in Haddam, Bladens River in Woodbridge, and Housatonic River in Milford and Orange. These patches of stratified drift lie high on the sides of the valleys, and wells starting in them reach bedrock long before they have gone to the river level. (See fig. 5.) Nearly all the wells along the road from Higganum to Chester near Connecticut River are of the types a and b shown in the section. The bedrock floor greatly influences the circulation of water, because the bedrock is much less pervious than the sand.

Another cause of irregularity in the occurrence of water in the stratified drift is the presence of beds of clay at some localities, particularly along the Quinnipiac Valley. Local beds of clay above the prevailing water table prevent downward seepage and cause water to accumulate above them, forming perched water tables (fig. 6); this water may overflow at the outcrops of the clay bed as springs (fig. 7, d). Such springs occur along the terrace bluffs in Wallingford and North Haven. Shallow wells that reach the clay bed may get some water from the perched water table above it (fig. 6, b), as illustrated by several wells at Tylerville. If dug through the clay and just into sand below,

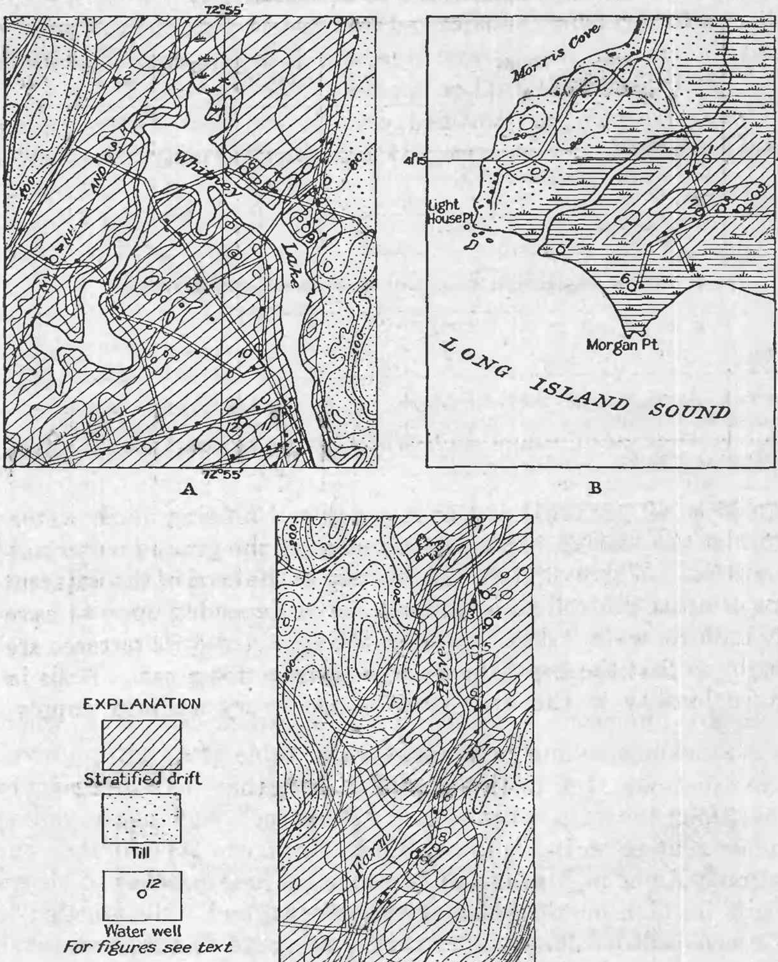


FIGURE 4.—Maps showing relation of water table in stratified drift to controlling surface-water features. A, Vicinity of Whitney Lake, Hamden (controlled by lake); B, South End, East Haven (controlled by sea); C, valley of Farm River, North Branford (controlled by stream). (Base from map of New Haven quadrangle, surveyed in 1890)

these wells are dry (fig. 6, a), but if sunk deeper into the sand a larger supply may be obtained than is available above the clay (fig. 6, c).

Wells in stratified drift usually yield a large supply of water and seldom go entirely dry. As a rule the water level does not fluctuate more than 2 or 3 feet throughout the year. Generally the water seeps in rather uniformly from the sides and from below, though most owners say that the greatest flow is from a certain direction, usually the side that corresponds to the uphill or upstream side of the well.

For many reasons the stratified drift is the best water-bearing material in the New Haven area. It has a high porosity (most sands average 30 to 40 per cent) and so is capable of holding much water. It occurs in the valleys, toward which most of the ground water naturally moves. Wherever it extends as deep as the level of the adjacent streams or other controlling features it can be depended upon to have a fairly uniform water table. None of the stratified-drift terraces are very high, so that the depth to water is usually not great. Wells in any given locality in the drift areas yield a very uniform supply.

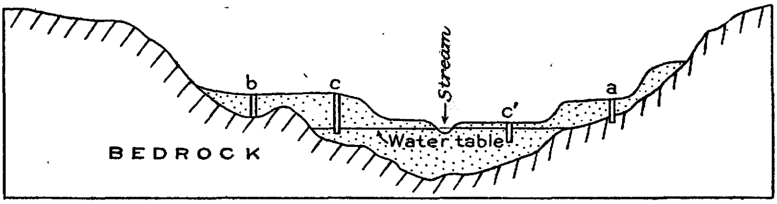


FIGURE 5.—Section of a valley filled with stratified drift, showing how some wells reach permanent water and others do not: Well a may be entirely dry, or may receive some water seeping down bedrock slope; b probably has a small supply of water trapped in bedrock depression; c and c' reach permanent water

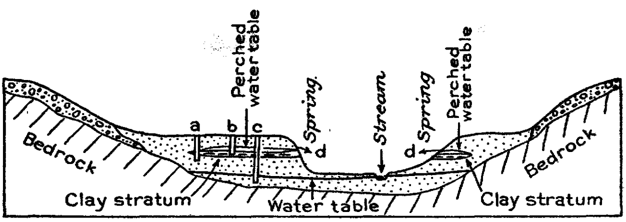


FIGURE 6.—Diagrams of wells showing effect of a clay bed in stratified drift: a, Penetrates entirely through the clay, and its water seeps out below; b, derives a small supply of water from perched water table above clay bed; c, derives large supply from permanent water table below clay bed; d, springs at outcrop of clay bed on terrace bluffs

Dug, driven, and drilled wells are all easily constructed in stratified drift. The water is good for domestic use and most industrial uses.

The accurate mapping of the principal bodies of stratified drift is therefore the most useful part of a study of ground-water supplies in this region. It is only in the stratified drift that enough ground water for industrial or municipal supplies can be obtained with certainty. Where the depth of the drift, the altitude of the water table, and the extent of the drainage basin are known very reliable forecasts can be made of the quantity, quality, and availability of the supply. One of the chief objects of the detailed descriptions of towns in this report is to point out the places where such supplies seem to be most easily obtainable. The conclusions are based chiefly on the study of supplies already developed.

WATER IN THE TILL

Although the porosity of till is probably equal to that of stratified drift, water circulates less freely through it because of its irregular structure and texture. Clay and rock flour at places fill the spaces between coarser particles of till and are distributed through it in irregular masses. Thus, some parts of till deposits are porous and conduct water freely, whereas others are very impervious and absorb and transmit but little water.

Although the till is a poorer conductor of ground water than stratified drift, it is commonly much better than the underlying bedrock. As the till generally occupies the slopes and hilltops and is as a rule not more than 25 or 30 feet thick, much of the water that enters it sinks to the bedrock and then travels in devious ways down the bedrock slope, emerging at springs or stream channels.

Those patches or channels in the till which offer freest circulation to the water tend to become the sites of currents—as the layman says, "veins"—of ground water. For this reason wells that strike a favorable channel of circulation receive an abundant supply of water. Other wells only a few feet away may penetrate impervious material and supply little or no water. The water level in adjacent wells at the same altitude bears little concordant relation. The depth to water in wells near the bottom of a slope may be greater than in wells higher up the slope.

Figure 7 shows the altitude and depth to water in wells on a drumlin south of Maltby Reservoir, Orange. Most of the wells do not reach bedrock; a few probably do, although the information obtained was rather unreliable. The depth to water in the wells, however, is given from actual measurements. It will be noticed that well 1, which, except for one other, is at the lowest altitude, shows the greatest depth to water, 22 feet. In well 8, near the summit of the hill, water is but 15 feet below the surface. The water levels are anything but uniform and bear little relation to the level of Maltby Lakes, the controlling surface feature.

The statements made above apply to the till in other localities. Two significant facts stand out as a result of many observations. Where the till is 10 feet or more in thickness it is nearly always possible to get enough water for domestic or farm use; where wells reach bedrock the greater part of the water usually seeps in along the bedrock surface.

Chief among the features that distinguish wells in till from those in stratified drift is the great fluctuation of the water level in till. In rainy seasons the wells are nearly full; in dry seasons they may fail completely. Fluctuations of 20 feet through the course of a year in wells 30 feet or more in depth are by no means uncommon. They are probably due largely to conditions like those shown in Figure 5. The water entering wells in the till may come from a "vein"; that

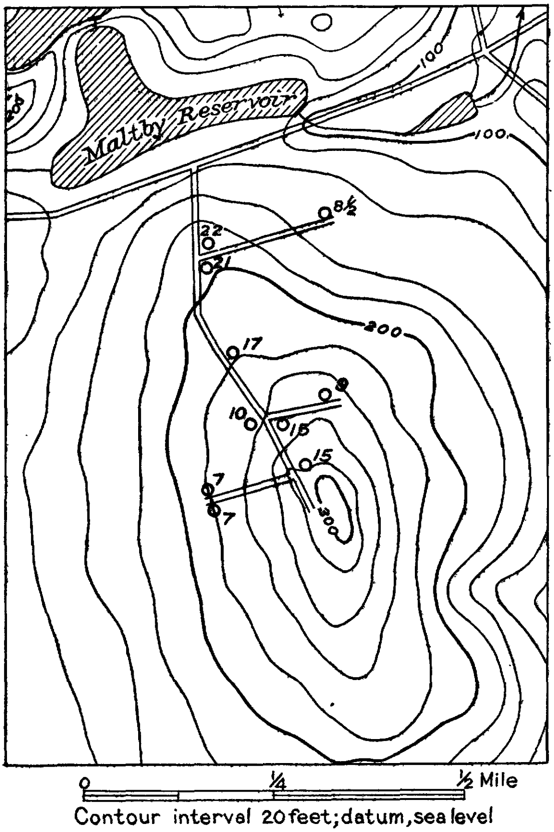


FIGURE. 7.—Sketch map showing irregularities of water table in till on a drumlin south of Maltby Reservoir, Orange. Figures beside wells show depth to water. (Base from map of New Haven quadrangle, surveyed in 1890)

is, a channel of underground drainage, such as a coarse, porous body of till. Sometimes two or three such "veins" are described by the owner as feeding his well. Almost invariably the water in these "veins" flows in from the higher side, indicating the general "downhill" trend of circulation. Frequently the water comes in at the bedrock surface, often in a distinct "vein." A few wells that reach bedrock are supplied from below through fissures in the bedrock. Rarely a well has no distinct source of supply, but receives a very slow seepage coming in uniformly from every side. The owner usually describes this process as "sweating in." Several such wells are reported on Clapboard Hill, Guilford.

Because till covers the larger part of the New Haven area, it is the source of water in many wells, particularly shallow wells for household and stock supply. Wells in till for industrial supply are almost unknown because the yield is too small. Large springs on till-covered areas, however, are used for small water systems, public and industrial, with some success. A spring in Wallingford supplies a pipe system for about 10 families at the little hamlet of Quinnipiac.

WATER IN BEDROCK

Ground water occurs in bedrock principally in small pores and in cracks, such as joints or bedding planes. The pore space of crystalline rocks is very small, often less than 1 per cent, and the pores are too small to permit active circulation, so that for practical purposes they are of no value. Trap rock is even more dense than the crystalline rocks. In all these rocks water circulates chiefly through openings such as joints and bedding planes.[16] (See pl. 6, *B*, and pl. 9.) The Triassic sandstone is more porous than the crystalline and igneous rocks but much denser than average sandstones because of its very close cementation. Samples from a Portland quarry show a porosity of only about 7 per cent.[17] Wells in the sandstone appear to draw water almost entirely from cracks.

As the circulation of water in bedrock is confined chiefly to open joints and other crevices of irregular distribution, it follows that the occurrence of water is very erratic. Some joints connected with numerous feeders carry a large volume of water. Others connected with few feeders or none at all may yield only the small quantity represented by their own actual capacity. Water-bearing openings are entirely absent at some places, and some wells 200 or 300 feet deep are perfectly dry. At great depth nearly all wells in bedrock are dry, because the fissures are no longer open enough to carry water. Ellis [18] recommends that wells be drilled not more than 250 feet deep in the crystalline rocks or the sandstone. The Winchester well at New Haven, 4,000 feet deep, was dry in the rock at the bottom, but there is abundant water in the overlying stratified drift or in the bedrock within 30 feet of the surface.

There is rarely any definite water table in the bedrock. Water may be within a few feet of the surface at one place and several hundred feet deep near by. Figure 8 is a sketch of the face of the

[16] Ellis, E. E., Ground water in the crystalline rocks of Connecticut: U. S. Geol. Survey Water-Supply Paper 232, pp. 54–103, 1909.

[17] Idem, p. 105.

[18] Idem, p. 94.

Fort Hale cliff, New Haven, during a rainy season when ground water was being discharged freely at the beach. The limit of noticeable escape of ground water on the surface of the cliff was about 7 feet above high-tide mark. Large areas around some joints were thoroughly wet with escaping water. Part of the surface was moist but showed no actual flow of water; the rest was perfectly dry down to the limit of the last tide.

FLUCTUATIONS OF THE WATER LEVEL

It is usually assumed, justifiably, that the surface of the water in a well corresponds with the level of saturation of the surrounding earth and therefore shows the height of the water table. Rains add to the body of ground water, thus causing the water table to rise, and continued discharge in periods of drought causes it to fall. This

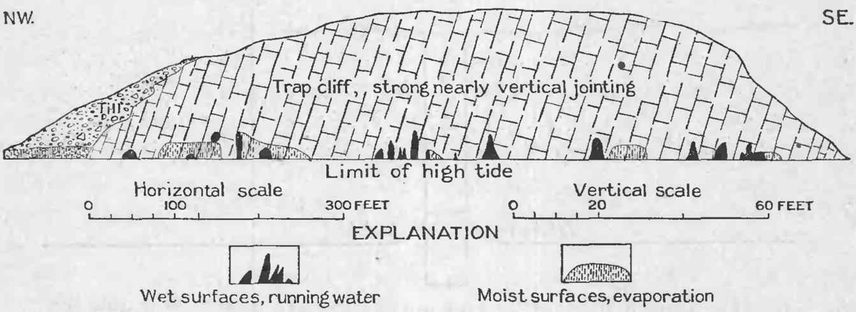


FIGURE 8.—Sketch of sea cliff in trap rock at Fort Hale Park, New Haven, showing escape of ground water at sea level. Sketch made Apr. 27, 1919. Note the great irregularity of water table, characteristic of circulation in bedrock

accounts in a great measure for the fluctuations of water level in wells. However, the water table does not rise uniformly after a rain. The greatest rise in a well on top of a hill may come very soon after a rain; but wells on the slopes or in the valleys may continue to rise for many days, owing to the slow movement of ground water toward them.

Slight fluctuations of the water level in wells are caused by changes in atmospheric pressure transmitted more directly to the water in the wells than to the body of ground water through the soil. For example, as the barometric pressure drops the water level in wells may rise, and the flow of springs may increase noticeably.[19]

Shallow wells frequently rise very rapidly after rains, sometimes filling 10 feet or more above the previous level, but this does not necessarily indicate an equally great rise of the water table. The downward movement of the water is often retarded by the air that is trapped in the pores of the soil between the water descending from

[19] See King, F. H., Principles and conditions of the movements of ground water: U. S. Geol. Survey Nineteenth Ann. Rept., pt. 2, p. 73, 1898.

the surface and the true water table. The result is that much water in the area near a shallow well that is not tightly cased may flow directly into the well without reaching the water table and may thus raise the water surface in the well above the level of the water table. Figure 9 illustrates the process.

DEPTH TO WATER

The tables below show the average depth to water in the different rock formations for the towns of the New Haven area and the average depth for the region as a whole.

The average depth to water in the area, regardless of formations, is 12 feet. This average is computed from more than 3,000 measurements. The average for different towns ranges from 8 feet in Branford to 17 feet in Hamden. Of course the depth to the water

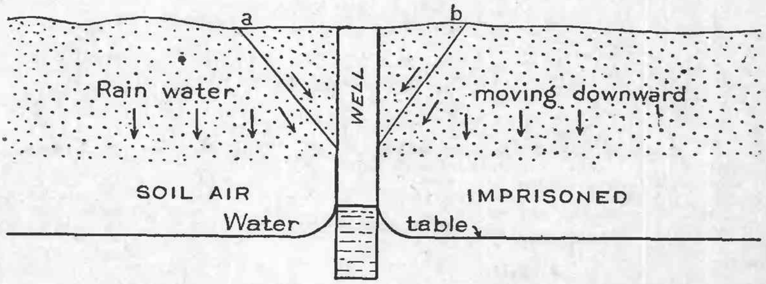


FIGURE 9.—*Diagram illustrating how a well may fill above the level of the water table after rains. Water from the area ab drains directly into the upper part of the well. If the well ends in material that is not very permeable considerable time may elapse before the excess water seeps out of the well*

table varies somewhat with the season, being greatest in the summer. The wells in Branford were observed in April, when the water table doubtless was high; during midsummer the average depth might be as much as 10 feet. Observations in Hamden were made in November and may be taken to indicate a fairly normal condition for the year. No observations were made in August and September, when the water table generally is unusually low. The averages for Orange and Milford, where observations were made in July, do not greatly exceed that for the region; the figures given may be taken as fairly representative of conditions throughout the year.

The average depth to the water table is one-third greater in stratified drift than in till. There are at least two principal causes for this difference—first, the average thickness of the stratified drift doubtless is greater than that of the till; second, the stratified drift occurs mainly in terraces that stand considerably above the adjacent controlling streams, whereas in till the water table is controlled more by the depth to the underlying bedrock, which is seldom great, than by the level of adjacent streams. In the large areas of stratified drift that have been deeply eroded and remain as high terraces, particularly in the towns of Hamden, North Branford, and Wallingford, the water table is unusually low and wells are necessarily deeper than elsewhere. This condition is accentuated in the Quinnipiac Valley in North Haven and parts of Wallingford, where the water table lies so deep and soil moisture sinks so rapidly into the porous sand that crops can not thrive. The natural flora consists mainly of dry grass, a few stunted pines, and plants of semiarid affinities, such as certain species of cacti. The land is sterile and of little use. In the area where the stratified drift is unusually deep there are almost no wells, and it is for this reason that the average depth to the water table in North Haven, as given above, is no greater.

Average depth to water in the New Haven area, from measurements in dug wells

Town	Till or bedrock [a]		Stratified drift [a]		All	
	Depth to water	Number of records	Depth to water	Number of records	Depth to water	Number of records
	Feet		*Feet*		*Feet*	
Clinton	10	75	12	128	11	203
Madison	10	135	11	164	10	299
Guilford	8	169	8	174	8	343
Branford	8	184	14	150	11	334
East Haven	8	18	13	48	12	66
New Haven	10	25	16	29	13	54
Orange	13	199	16	42	13	241
Milford	13	100	16	143	15	243
Woodbridge	10	66	15	44	13	110
Bethany	9	65	13	21	10	86
Hamden	10	57	21	98	17	155
North Haven	11	35	12	85	12	120
North Branford	12	60	18	57	14	117
Wallingford	13	88	19	84	16	172
Durham	12	28	13	39	13	67
Haddam	9	92	15	47	12	139
Chester	9	62	11	67	10	129
Killingworth	10	133	16	21	11	154
The area	10	1,591	14	1,441	12	3,032

[a] Wells wholly in bedrock are grouped with those in till; wells partly in bedrock with those in till or stratified drift, according to the surface material at the well.

Dug wells penetrating bedrock are rather uncommon, but records of 192, summarized below, indicate that the depth to the water table in bedrock averages 13 feet and generally shows no consistent variation from that in till or stratified drift. In Durham and Wallingford, where there are many wells on sandstone ridges and slopes, the depth to the water table in the sandstone is unusually great.

Average depth to water in bedrock[a] *in the New Haven area, from measurements in dug wells*

Town	Depth to water	Number of records	Town	Depth to water	Number of records
	Feet			*Feet*	
Clinton	12	9	Hamden	13	9
Madison	12	11	North Haven	9	11
Guilford	9	14	North Branford	15	4
Branford	11	24	Wallingford	19	32
East Haven	8	2	Durham	16	12
New Haven	10	15	Haddam	10	1
Orange	13	27	Chester	9	5
Milford	13	7	Killingworth	9	3
Woodbridge	11	4			
Bethany	9	2	The area	13	192

[a] Includes all wells wholly in bedrock, wells that penetrate at least 7 feet of bedrock, and wells in which at least one-third of the depth is in bedrock.

SPRINGS

Springs are common in nearly all parts of the New Haven area. They are all cold springs directly dependent on the rainfall for their supply. Many of them fluctuate perceptibly with the season; some dry up entirely in dry weather; others fluctuate but little throughout the year.

Springs are formed where the surface of the ground lies below the level of the water table. It follows that they are most common at the foot of hills and bluffs, the head of ravines, the sides of valleys, or other places where there is a drop of the land surface so steep that the water table can not adjust its curvature to the slope of the land. Usually there is a little depression associated with the outlet of a spring. This feature is both antecedent and consequent. The spring is most apt to be formed originally at a depression, and its running water tends to erode a channel.

Springs are most common in the till. The underlying bedrock is relatively impervious, and ground water circulates most freely along the contact of till and bedrock. The concentration of flow through till along channels of pervious material gives rise to springs wherever the bedrock surface or the channel of circulation comes out on a hillside. The thick patches of till act as reservoirs, absorbing much water and feeding it out slowly, thus maintaining the flow of perennial springs. Springs fed from patches or pockets of till are appropriately called pocket springs.[20] Springs due to small accidental depressions on hillsides have also been called dimple springs.[21] (See pl. 14, *A*.) Pockets of stratified drift on hillsides rarely, if ever, feed springs, because their water seeps away too rapidly.

In the valleys springs occur both in till and in stratified drift. In till they usually break out at the edges of low swamps or on the bor-

[20] Bryan, Kirk, Classification of springs: Jour. Geology, vol. 27, pp. 545-547, 1919.

[21] Idem, p. 536.

ders of streams. (See pl. 14, *B*.) In stratified drift they are nearly always at the foot of the terrace bluffs on the edges of wet, swampy flood plains or at the border of a stream channel, as Cold Spring, in Cold Spring Park, New Haven; here the foot of the terrace is also at the border of the stream. Springs also occur on terrace bluffs where layers of impervious clay crop out above the valley level (fig. 6, d, d′). Such springs have been called hardpan springs. They occur along the terrace bluffs of Wallingford and North Haven.

Most of the springs in the bedrock of the New Haven area issue from fractures. They occur commonly where bedrock is exposed at the base of slopes and derive their water from higher altitudes through series of connecting fractures. (See fig. 10.) In the region underlain

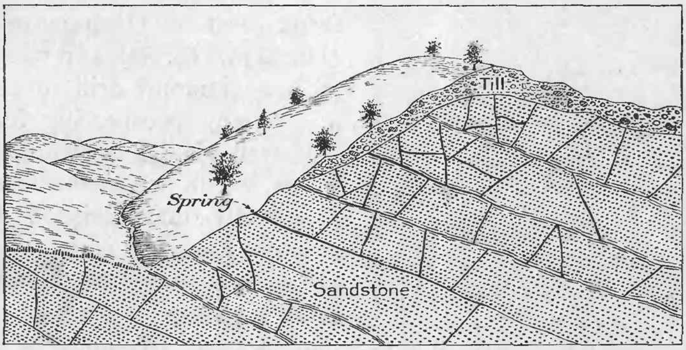


FIGURE 10.—Diagram showing occurrence of fracture springs near Mount Carmel, Hamden. (After Gregory)

by sandstone most of the springs come from the western base of scarps where hard sandstone is exposed. (See pl. 15, *A*.)

There are a few so-called boiling springs in the New Haven area, which have no definite relation to the topography. The water usually comes through fractures in bedrock and has a high pressure due to its entering the fractures at a level much higher than its point of discharge. Usually there is a little sand over the rock surface, and the water welling up under pressure agitates the sand and creates the impression of boiling. The springs of William Artger, in Durham (No. 5, Durham), Mr. Gates, in North Branford (No. 67, North Branford), and Donald Page, in Milford (No. 88, Milford), are examples.

There are no springs in the New Haven area that yield water of high mineral content. Water from several springs, however, is bottled and sold under different trade names for table use.

ARTESIAN CONDITIONS

In the New Haven area drilled wells are commonly called "artesian wells," but in only a few of these wells does the water rise appreciably above the level at which it was first struck. Of nearly 4,000 wells examined only 6 overflow at the surface, and the yield of these is small. The flows occur under two sets of conditions—at the foot of long dip slopes in the area underlain by Triassic sandstone and trap (fig. 11) or on slopes in the crystalline rock (fig. 12). In the Triassic area the water comes from sandstone or trap which crops out farther west at higher altitudes, and the impervious cover is usually a bed of Triassic shale. The most notable flowing well in the New Haven area is of this kind. It is on the Eick farm, west of Durham meadows (Durham, No. 82), and was drilled with a diamond drill in 1888 by a company prospecting for coal. The well yielded a strong flow of water, which has maintained itself practically undiminished to the present day. It is on very low ground at the foot of the long slope from the main trap ridge. A similar well in Branford is at the west edge of a large swamp, which is now drained, and at the east base of a small trap ridge. It yields a flow of 2 or 3 gallons a minute and is used to irrigate a truck garden. By a careful choice of location more flowing wells probably could be obtained in the Triassic rocks, but their small yield and the cheapness of water obtained in other ways render the expense of prospecting for them unjustifiable.

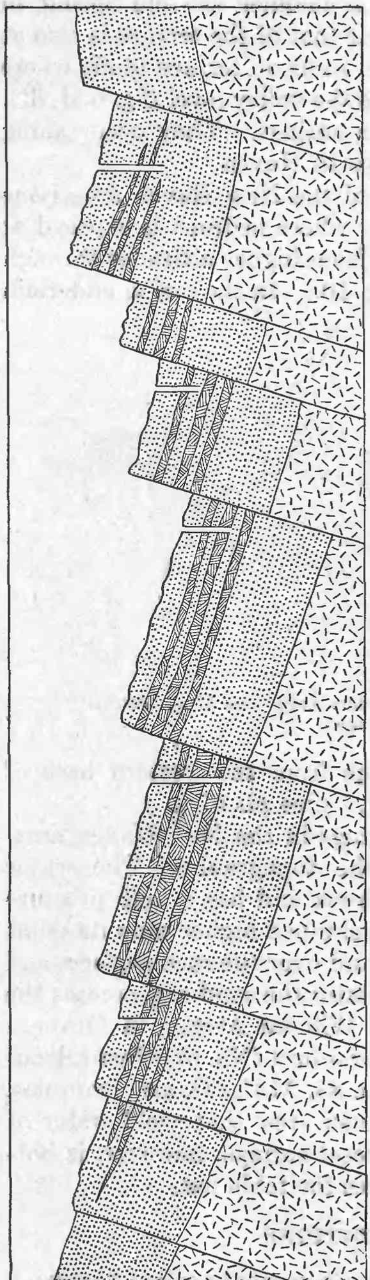


FIGURE 11.—Section of the Triassic area showing conditions favorable for small artesian basins

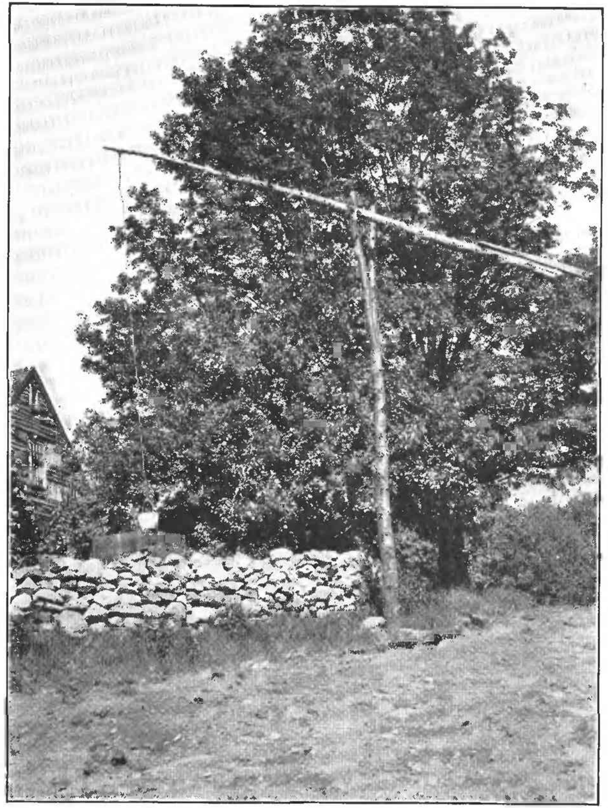
In the crystalline rocks (fig. 12) wells drilled on slopes occasionally flow. The water comes either from connecting fractures at a higher altitude or from a small reservoir in which it has been trapped by a cover of impervious till. The yield is usually small, and the location of flowing wells is not at all predictable.

A. SPRING DUE TO SMALL DEPRESSION ON TILL-COVERED HILLSIDE, YALESVILLE, WALLINGFORD

B. VALLEY SPRING IN TILL, W. H. FANNING FARM, ORANGE

Spring is at the edge of a low, swampy valley in till. Spring house at lower right

A. SPRING ISSUING FROM WEST BASE OF A SCARP IN SANDSTONE, FOXON, EAST HAVEN



B. OLD-FASHIONED WELL SWEEP, FARM OF PIERRE HOUPERT, CLINTON

QUALITY OF GROUND WATER

CHEMICAL CHARACTER

The chemical character of ground waters of the New Haven area is shown by the analyses on page 36. The mineral constituents reported in these analyses affect the value of water for may uses, as in steam boilers, laundry work, dyeing, and domestic uses. Analyses of mineral constituents do not, however, give much indication of the sanitary quality of the waters, which depends upon their freedom from disease-producing organisms and is likely to change much more rapidly than the mineral character.

Samples of ground water from 49 sources were collected in the course of the field work and were analyzed in the water resources

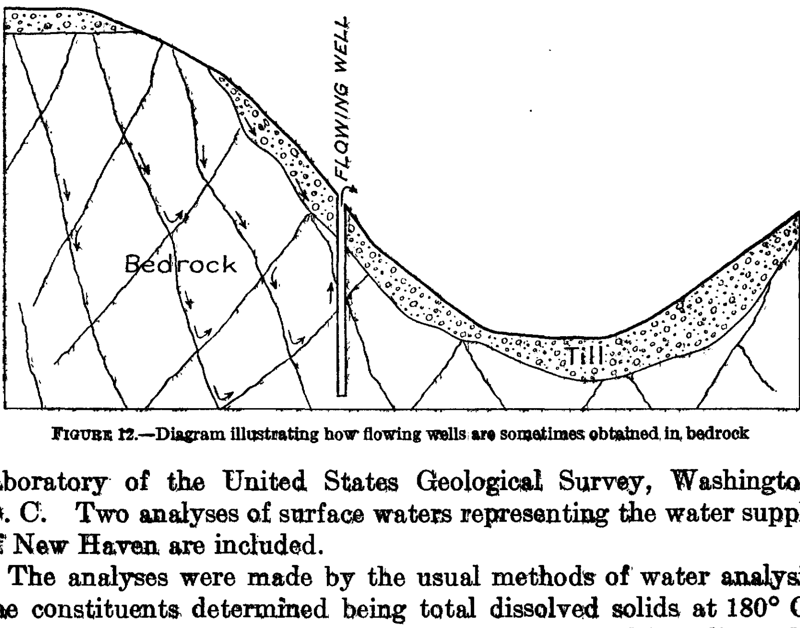


FIGURE 12.—Diagram illustrating how flowing wells are sometimes obtained in bedrock

laboratory of the United States Geological Survey, Washington, D. C. Two analyses of surface waters representing the water supply of New Haven are included.

The analyses were made by the usual methods of water analysis, the constituents determined being total dissolved solids at 180° C., silica (SiO_2), iron (Fe), calcium (Ca), magnesium (Mg), sodium plus potassium (Na+K), carbonate (CO_3), bicarbonate (HCO_3), sulphate (SO_4), chloride (Cl), and nitrate (NO_3). The quantities of dissolved constituents are reported in parts of the radicle determined in a million parts of water.

Total hardness was calculated as calcium carbonate by the use of the formula $T. H. = 2.5 Ca + 4.1 Mg$, in which T. H., Ca, and Mg represent parts per million of total hardness, calcium, and magnesium, respectively.

Analyses of water from the New Haven area

[Parts per million. Numbers of analyses correspond to those used in tables of well records, except those having prefix P, which refer to descriptions of pumping plants under the respective towns]

No.	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Carbonate radicle (CO_3)	Bicarbonate radicle (HCO_3)	Sulphate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Total dissolved solids at 180° C.	Total hardness (calculated)	Date of collection	Analyst[a]
Madison:														
219	7.8	0.49	12	4.9	14	0	37	18	4.8	30	118	50	July 6, 1922	F.
280	7.6	.26	11	3.0	7.7	0	29	16	10	4.4	82	40	do	F.
Guilford:														
148	12	.10	71	16	15	0	165	86	86	20	336	243	do	F.
149	11	.07	39	8.1	23	0	77	36	17	69	264	131	do	F.
150	17	.23	17	8.2	16	0	42	43	21	5.8	168	76	do	F.
151	21	.25	35	13	48	0	151	38	53	8.0	306	141	do	F.
224	26	.08	60	35	344	0	88	127	590	3.4	1,295	294	July 12, 1919	R.
280	12	.05	22	5.0	10	0	56	25	19	5.2	139	76	July 6, 1922	F.
Branford:														
35	99	.51	21	9.0	27	25	116	8.7	4.0	Trace	261	89	July 7, 1922	F.
45	23	.14	127	79	104	0	381	159	169	185	1,038	641	do	F.
New Haven:														
19	17	.08	18	5.1	6.4	0	26	43	7.8	.77	112	66	July 1, 1922	F.
75	26	.07	27	9.9	13	0	57	28	41	3.7	206	108	July 7, 1922	F.
79	74	.09	20	4.2	21	21	44	26	8.8	Trace	208	67	do	F.
P-17	33	.13	48	17	91	2.4	178	60	115	38	[b]493	190	July 9, 1919	R.
P-23	25	.10	20	15	[b]101	24	85	56	113	5.2	466	112	do	R.
P-24	34	.15	108	47	224	0	117	96	514	21	1,161	463	do	R.
P-27	28	.23	15	15	[b]77	7.2	59	93	75	3.3	374	99	do	R.
P-28	26	.16	56	17	117	2.4	114	132	145	31	653	210	do	R.
P-31	20	1.2	70	9.2	[b]108	2.4	198	232	26	2.1	609	213	do	R.
P-34	27	1.7	29	22	[b]164	12	178	74	193	3.8	649	163	July 16, 1919	R.
P-36	28	.06	52	39	[b]250	4.8	158	65	439	9.6	1,003	290	July 9, 1919	R.
P-43	28	.06	45	78	[b]496	11	121	139	885	1.8	1,803	432	do	R.
Orange:														
16	12	.23	34	4.6	9.1	0	87	26	9.0	18	169	104	July 3, 1922	F.
125	9.0	.06	63	7.9	9.4	0	121	75	14	14	277	190	do	F.
P-49	16	.08	47	32	357	0	24	221	574	8.4	1,340	249	July 9, 1919	R.
Milford:														
76	6.8	.53	5.8	2.3	5.0	0	14	13	5.8	.67	48	24	July 1, 1922	F.
145	17	.08	28	13	25	0	83	50	34	6.2	236	125	July 3, 1922	F.
159	8.0	.05	14	3.2	6.6	0	13	22	6.8	21	103	48	July 1, 1922	F.
Woodbridge:														
103	9.1	.10	6.7	1.8	3.6	0	15	11	4.4	.80	46	24	July 3, 1922	F.
107	8.1	.08	6.7	7.3	8.2	0	37	13	8.0	12	91	47	do	F.
118	11	.72	16	5.6	5.7	0	59	11	4.2	11	102	63	July 25, 1922	F.
Hamden:														
22	8.7	.19	37	3.6	3.4	0	111	14	3.0	.59	127	107	July 5, 1922	F.
93	12	.81	70	1.7	11	0	151	38	11	29	278	243	do	F.
183	13	.15	47	8.3	15	0	47	59	13	81	308	152	July 1, 1922	F.
184	9.0	.11	56	12	34	0	76	79	19	107	434	189	do	F.
189	6.2	.04	21	3.8	12	0	27	35	8.0	29	147	68	do	F.
208	15	.30	27	8.6	11	0	28	45	7.4	54	207	103	July 3, 1922	F.
P-5	18	.04	28	4.0	10	5.8	84	6.3	5.6	13	135	90	do	F.
North Branford:														
78	15	04	22	15	11	0	118	28	4.6	5.6	160	116	July 6, 1922	F.
134	10	.27	49	12	35	0	178	30	31	31	300	172	do	F.
135	11	.14	34	13	47	0	88	53	20	98	350	138	do	F.
162	15	.08	22	6.8	4.6	0	65	18	4.5	14	126	83	do	F.
163	9.2	.28	24	3.6	3.8	0	41	25	4.0	19	120	75	do	F.
Wallingford:														
45	13	.09	21	4.2	7.2	0	39	23	8.2	19	139	70	June 30, 1922	F.
81	18	.07	20	6.0	3.8	0	62	9.1	13	2.3	103	75	do	F.
Durham:														
5	14	.07	16	2.3	4.2	0	47	11	1.6	5.4	81	49	do	F.
41	13	.07	30	3.7	10	0	72	23	9.4	19	167	90	do	F.
82	21	.07	4.0	2.2	[c]405	31	403	173	263	Trace	1,132	19	do	F.
84	15	.05	24	12	44	0	205	20	6.6	5.1	222	109	do	F.
New Haven municipal supply:[d]														
A	5.9	.16	4.9	1.7	[e]3.1	0	15	7.6	3.4	.22	39	19	Nov. 29, 1921	F.
B	6.7	.06	22	3.3	[f]5.8	0	62	13	7.6	1.6	94	69	do	F.

[a] F, Margaret D. Foster; R, H. B. Riffenburg.
[b] Calculated.
[c] Na, 401; K, 4.2.
[d] A, West River, which furnishes about one-third of city supply. B, Mill River, which furnishes about one-third of city supply.
[e] Na, 2.0; K, 1.1.
[f] Na, 4.0; K, 1.8.

The qualities of the dissolved constituents range within rather wide limits. Most of the ground waters analyzed are moderately low in mineral content and rather hard, and so far as the mineral constituents are concerned should be satisfactory for ordinary domestic use. Branford No. 35 and New Haven No. 74 have large quantities of silica, probably because their source is in the trap rock, which is of volcanic origin. Several of the waters represented were contaminated by sea water; examples of such waters are Branford No. 45 and New Haven No. P–24. Durham No. 82 is an unusually soft water of high mineral content; the quantities of chloride and total hardness indicate contamination by sea water or percolation of normal ground water through marine deposits, accompanied by a natural softening process that has replaced the calcium and magnesium. The analyses of surface waters represent part of the municipal supply for New Haven, each source furnishing about one-third of the city supply. The water of West River is low in mineral content and soft; that of Mill River is low in mineral content but slightly hard.

SOURCE AND SIGNIFICANCE OF MINERAL CONSTITUENTS OF NATURAL WATERS

Silica (SiO_2) is an abundant constituent of sand and rocks but in natural waters is usually present in quantities less than 30 parts per million. Silica is one of the constituents that contribute to the formation of scale in boilers.

Iron (Fe) is dissolved from most rocks and to some extent from water pipes. Quantities of iron greater than one part per million usually precipitate when the water is exposed to the air. Several of the samples contained a precipitate of iron when analyzed, although they were clear when collected. In these samples the quantities of iron in solution and precipitated were determined and the total quantity reported. Waters with large quantities of iron are objectionable because of the stains they make on clothes and on enamel and porcelain wares.

Calcium (Ca) and magnesium (Mg) are dissolved from most rocks but mainly from limestone and dolomite. Ground waters at several localities in this area have relatively high magnesium in proportion to calcium, indicating probable contamination by sea water. Calcium and magnesium cause hardness and with silica and suspended matter form boiler scale. Waters high in magnesium and chloride will probably cause corrosion in steam boilers.

Sodium and potassium (Na+K), the alkalies, are dissolved from practically all rocks. These elements have similar chemical and physical properties and are usually determined together in water analyses. Waters having more than 100 parts per million of alkalies will foam considerably when used in steam boilers.

Carbonate and bicarbonate (CO_3 and HCO_3) result from solution of carbonate rocks by waters containing carbon dioxide. Few natural waters contain carbonate. The hardness caused by calcium and magnesium bicarbonates is called carbonate hardness.

Sulphate (SO_4) is dissolved from practically all rocks. Hardness of water due to sulphates of calcium and magnesium is more serious in steam boilers than carbonate hardness.

Chloride (Cl) is dissolved in small quantities from most rocks. Several of the waters from this area contain quantities of chloride greater than are present in natural unpolluted waters, indicating contamination by human agencies or by sea water.

Nitrate (NO_3) is dissolved mainly from oxidized organic material. Several of the ground waters of this area have large quantities of nitrate that may come from pollution by animal or human excreta or waste products of human agencies.

RELATION OF QUALITY OF WATER TO FORMATIONS

The quantities of dissolved constituents and the chemical character of natural waters must depend upon the nature of the material with which they come in contact. The analyses of ground waters from this area show rather wide ranges in the quantities of dissolved constituents even in waters from the same formation. The following table gives the maximum and minimum quantities of dissolved constituents in the 49 ground waters analyzed for this report:

Maximum and minimum quantities of dissolved constituents of ground waters of the New Haven area [a]

[Parts per million]

	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate radicle (HCO_3)	Sulphate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Total dissolved solids at 180° C.	Total hardness
Maximum	99	1.7	127	79	496	466	232	885	185	1,803	641
Minimum	6.2	.04	4.0	1.7	3.4	13	6.3	1.6	Trace.	46	19

[a] Based on the analyses of 49 ground waters given in table on p. 36.

These ranges are about the same for waters from the stratified drift, till, Triassic sandstone, and crystalline rocks in this and surrounding areas. Many of the analyses indicate contamination by human agencies or by sea water, or possibly by both. Contamination by sea water is discussed in a special report.[22] Waters contaminated by human agencies are dangerous for domestic use but may be satisfactory for use in boilers; those contaminated by sea water are likely

[22] Brown, J. S., A study of coastal ground water with special reference to Connecticut: U. S. Geol. Survey Water-Supply Paper 537, 1925.

to be objectionable for both domestic and boiler uses. Water from shallow wells is generally more liable to contamination than that from deep wells, but some of the analyses indicate contamination of water in wells drilled in the sandstone and in crystalline rocks. Water in drilled wells may be contaminated by human agencies as a result of improper well casing and covering, or the contamination may be due to polluted water in the fissures and joints of the rock in which the well is drilled.

RECOVERY OF GROUND WATER

METHODS USED

The methods of sinking wells and getting the ground water to the surface vary according to the purpose for which the water is to be used, the amount of water needed, the depth to water, and the character of the rocks. The methods applicable in Connecticut, especially with reference to obtaining municipal water supplies, are carefully described by Ellis.[23]

Wells in the New Haven area are of three kinds—dug, driven, and drilled. Dug wells were used earliest and have always been the most numerous for domestic water supply. Springs also are an important source of water for domestic use. The relative number of springs and of wells of the different kinds that were examined in the New Haven area are given in the table below. Detailed records of these 3,787 wells and springs appear in the tables given in the descriptions under the respective towns. Virtually all of them are used for domestic supply or for stock. In addition, more than 50 large pumping plants were examined and are described in detail in the text.

Relative number of springs and of different kinds of wells used for individual water supplies, examined in the New Haven area

Town	Dug wells	Driven wells	Drilled wells	Springs
Clinton	208	6	1	3
Madison	304	13	5	7
Guilford	332	None.	39	21
Branford	342	3	12	12
East Haven	73	13	40	8
New Haven	61	4	18	13
Orange	245	6	40	24
Milford	254	6	12	12
Woodbridge	117	None.	29	14
Bethany	88	None.	7	11
Hamden	165	1	42	16
North Haven	134	6	41	16
North Branford	126	6	12	21
Wallingford	182	5	22	20
Durham	67	1	7	23
Haddam	148	None.	6	19
Chester	138	None.	None.	3
Killingworth	153	None.	None.	4
	3,137	70	333	247

[23] Gregory, H. E., and Ellis, A. J., Ground water in the Hartford, Stamford, Salisbury, Willimantic, and Saybrook areas, Conn.: U. S. Geol. Survey Water-Supply Paper 374, 1916. Ellis, A. J., Ground water in the Waterbury area, Conn.: U. S. Geol. Survey Water-Supply Paper 397, 1916.

DUG WELLS

DEPTH

Dug wells usually penetrate till or stratified drift; many are sunk to bedrock, but few penetrate very far into bedrock. Dug wells for domestic supply are generally from 10 to 30 feet in depth, although the minimum depth observed in the area was about 3 feet and the maximum was 56 feet. The accompanying table gives the average depth of dug wells, by towns. The mean for the New Haven area is 19 feet.

Average depth of dug wells in the New Haven area

Town	Depth (feet)	Number of records	Town	Depth (feet)	Number of records
Clinton	16	208	Hamden	24	164
Madison	17	301	North Haven	18	124
Guilford	16	354	North Branford	21	125
Branford	19	343	Wallingford	23	176
East Haven	18	69	Durham	20	67
New Haven	19	56	Haddam	18	148
Orange	20	244	Chester	16	138
Milford	20	254	Killingworth	19	153
Woodbridge	19	117			
Bethany	19	88		19	3,129

YIELD

Most dug wells in stratified drift yield a fairly large supply if they penetrate several feet below the water table. Most wells in till and bedrock yield a supply that is comparatively small but ordinarily sufficient for all the requirements of individual families.

Very few tests have been made to determine the actual yields of dug wells in Connecticut. The writer made observations on a dug well of the New Haven Normal School of Gymnastics, East Haven (East Haven, No. 129). This well is 12 feet in depth and 2 feet in diameter and is lined with tile. It penetrates fine sandy stratified drift. The depth of water in the well on the date of observation, April 22, 1919, was 4 feet; that is, the water level was 8 feet from the surface. The well is equipped with a power pump driven by a small gasoline engine, which is capable of drawing the well practically dry. Observations on the rate of drawdown during pumping and on the rate of recovery thereafter are given in the table below.

Rate of drawdown and recovery in well of the New Haven Normal School of Gymnastics (East Haven, No. 129), April 22, 1919

Time (p. m.)	Drawdown (feet)	Rate of inflow (gallons per minute)
1.38 Pumping commenced	0.00	
1.46	1.80	
1.51	2.45	
2.00	3.00	
2.04 Pumping ceased	3.20	
2.10	1.80	5.5
2.15	1.15	3.0
2.20	.70	2.1
2.25	.55	.7
2.32	.30	.8

The yield of wells increases as the level of water in the well is lowered below the water table, because the pressure head of the surrounding water becomes greater and the area available for seepage into the well increases. During the first six minutes after pumping ceased this well refilled at a mean rate of 5.5 gallons a minute, equivalent to very nearly 8,000 gallons a day. By keeping the water level as low as possible it could be made to yield at a rate even greater, perhaps 10,000 gallons a day. This yield is high for a dug well, even in stratified drift. Palmer[24] tested a dug well in stratified drift which, with a drawdown of 1.75 feet, yielded about 3.5 gallons a minute, or 5,000 gallons a day. He made similar tests on a well in till that indicated a possible yield of only about 320 gallons a day and on a well in sandstone that had a capacity of only about 216 gallons a day.[25]

The Jennings & Griffin Manufacturing Co., Wallingford, reports a yield of about 17 gallons a minute from a dug well in drift and sandstone, with a drawdown of 2 or 2½ feet (Wallingford, No. P-1).

As the diameter of dug wells is increased their yield increases, and wells of exceptionally great diameter are sometimes constructed where a large supply is necessary. The well on the State Game Farm, Madison (Madison, No. 219), is an example. It is 12 feet in diameter and penetrates stratified drift. Pumping with a small gasoline engine produces no noticeable drawdown. The Naugatuck Valley Ice Co., in the city of Bridgeport, has a dug well in till reported to be 40 feet deep and 30 feet square. This well is said to yield 60 gallons a minute, but it can be drawn dry with the large pumping equipment in use.

FAILURE

Many dug wells go dry occasionally, some of them almost every year. Usually the failure occurs during the months from June to September, particularly during the short but severe dry spells that generally occur once or twice each summer. Other wells become very low at such times but continue to yield a little water. The data on this subject obtained for individual wells are given in the tables under the heading "Does well fail?"

It is rather difficult, for several reasons, to obtain satisfactory information about the failure of wells. At many places the wells were examined when no one was around to supply the data. At other places the informants had used the well and knew its record for only a very short time. Furthermore, many people plainly object to stating that their wells ever fail, because such a statement

[24] Palmer, H. S., Ground water in the Norwalk, Suffield, and Glastonbury areas, Conn.: U. S. Geol. Survey Water-Supply Paper 470, p. 41, 1920.

[25] Palmer, H. S., Ground water in the Southington-Granby area, Conn.: U. S. Geol. Survey Water-Supply Paper 466, pp. 46-51, 1921.

detracts from the value of their property. The writer would not be surprised, therefore, if the number of wells that fail, at least occasionally, were at least twice as great as given in the tables below. However, the tables are significant and valuable for comparison.

Dug wells in the New Haven area that occasionally fail

Town	Till or bedrock [a]			Stratified drift [a]			All		
	Total number	Failures		Total number	Failures		Total number	Failures	
		Number	Per cent		Number	Per cent		Number	Per cent
Clinton	80	11	14	128	1	1	208	12	6
Madison	126	33	26	178	15	8	304	48	16
Guilford	152	40	26	180	9	5	332	49	17
Branford	189	37	20	153	11	7	342	48	14
East Haven	23	3	13	50	2	4	73	5	7
New Haven	28	1	4	33	1	3	61	2	3
Orange	193	33	17	52	3	6	245	36	14
Milford	114	11	10	140	6	4	254	17	7
Woodbridge	74	15	20	43	2	5	117	17	15
Bethany	65	6	9	23	6	26	88	12	14
Hamden	70	16	23	95	4	4	165	20	12
North Haven	38	7	18	96	5	5	134	12	9
North Branford	68	13	19	58	4	7	126	17	13
Wallingford	97	19	20	85	3	3	182	22	12
Durham	30	6	20	37	9	24	67	15	22
Haddam	104	16	15	44	10	23	148	26	18
Chester	68	7	10	70	11	16	138	18	13
Killingworth	133	22	17	20	2	10	153	24	16
The area	1,652	296	18	1,485	104	7	3,137	400	12

[a] Wells wholly in bedrock are grouped with those in till; wells partly in bedrock with those in till or stratified drift, according to the surface material at the well.

Dug wells wholly or chiefly in bedrock that occasionally fail [a]

Town	Number of wells	Reported failures		Town	Number of wells	Reported failures	
		Number	Per cent			Number	Per cent
Clinton	10	3	30	Hamden	10	2	20
Madison	13	4	31	North Haven	11	3	27
Guilford	14	6	43	North Branford	5	4	80
Branford	27	9	33	Wallingford	29	6	20
East Haven	3	1	33	Durham	12	4	33
New Haven	19	5	26	Haddam	3	2	67
Orange	25	4	16	Chester	5	1	20
Milford	8	3	37	Killingworth	4	1	25
Woodbridge	5	2	40				
Bethany	2	1	50	The area	205	61	34

[a] Includes wells wholly in bedrock, wells that penetrate at least 7 feet of bedrock, and wells in which at least one-third the total depth is in bedrock. Wells marked "probably" bedrock in the tables under towns are also included.

The first table shows the comparative frequency of failure of wells in the areas of till and of stratified drift. Wells wholly in bedrock, which are few in number, are grouped with those in till, and no distinction is made for wells that penetrate to or into bedrock below the surface, as the exact log is often difficult to obtain or verify. The table shows that 18 per cent of the wells in till-covered areas and 7 per cent of those in areas of stratified drift are known to fail. This emphasizes the fact that the water table in till fluctuates much more than that in stratified drift. (See p. 27). As a consequence more wells in till fail because the water table sinks below the bottom of the well. At some places such failures could be prevented by digging the well somewhat deeper while it is dry, but if the well ends in bedrock this is difficult. Failure of a well that is wholly in stratified drift could, as a rule, easily be prevented by digging the well a little deeper. This can be done by digging down a few feet while the well is dry and placing a length of tile or cement well pipe in the bottom.

The second table is based on the records of wells that are definitely known to penetrate bedrock wholly or for a large part of their depth. Presumably they are supplied mainly by water from joints. Reported failures in such wells average 34 per cent, a very high ratio compared with that for wells in either till or stratified drift, especially considering the fact that most of these wells are included in the figures in the first table; if the wells in bedrock were not included the reported failures in till would probably be reduced to between 16 and 17 per cent and in stratified drift to about 6 per cent.

LINING

An important feature of the construction of dug wells is the lining used to prevent the wells from caving. Not many years ago nearly all linings were made of rough till boulders, and this type of lining is still numerically preponderant. Brick is used occasionally, and in recent years tile and concrete have been used a great deal. Concrete linings under the trade name "cement well pipe" are manufactured in the New Haven area. Popularly they are more often called "concrete tile." The cement well pipe comes in hollow cylinders, usually 3 feet in length and 30 or 36 inches in diameter, with walls about 3 inches in thickness. It is especially suitable for wells in stratified drift. The first joint is set up where the well is to be dug, and the dirt is excavated by men working on the inside. This allows the joint to settle, and as it sinks beneath the surface another is added, and so on. Cement well pipe and tile make smoth linings, and as they are cheap and easy to install they are probably the most satisfactory type in areas of stratified drift. In till and bedrock, however, they are more difficult to place. Boulders in the till make the digging more difficult and in bedrock blasting is necessary. Generally the well must be dug first and the lining inserted afterwards, so that the advantages of tile and concrete are less. A point in their favor is that they exclude snakes and burrowing animals. The table below gives the number of wells with the different types of lining observed in the towns of this area.

54355—28——4

Kinds of lining used in dug wells in the New Haven area

Town	Stone	Cement well pipe	Tile	Brick	Number of records
Clinton	145	33	24	1	203
Madison	263	24	7	None.	294
Guilford	293	28	3	None.	324
Branford	227	67	7	None.	301
East Haven	41	10	4	2	57
New Haven	21	30	4	None.	55
Orange	186	36	7	1	230
Milford	201	44	None.	None.	245
Woodbridge	115	1	None.	None.	116
Bethany	88	None.	None.	None.	88
Hamden	119	30	None.	8	157
North Haven	81	3	14	21	119
North Branford	113	8	None.	3	124
Wallingford	106	10	None.	8	124
Durham	67	None.	None.	None.	67
Haddam	144	None.	4	None.	148
Chester	136	None.	2	None.	138
Killingworth	149	2	2	None.	153
The area	2,495	326	78	44	2,943

DRIVEN WELLS

CONSTRUCTION

A driven well is made by driving into the ground, either with a sledge hammer or with a special driving apparatus, a hollow pipe which usually has attached to its lower end a perforated metal strainer 3 to 5 feet in length. On the end of the strainer is a sharp point or shoe, which facilitates driving. The perforations in the strainer admit water into the well. Brass strainers are to be preferred because they do not become clogged by rusting, like iron ones. Driven wells can also be made by placing a heavy or weighted pipe upright in the ground and using a jet of water under high pressure on the inside to flush out the sand, allowing the pipe to sink. Water enters the well through the open end at the bottom. The pipe or casing can be perforated by special punching machines at any desired point in order to admit water from other levels.

After the well is made a pump is attached to its pipe at the surface. Hand pumps are commonly used in wells for domestic supply. Where a large quantity of water is needed as for a city or factory, a number of driven wells, called a "gang," are often attached to one continuous main and pumped from a central pumping station. There are many such pumping plants in and near the city of New Haven. (See p. 104.) Frequently 10 to 20, sometimes 30 to 40, wells are used in a gang.

Driven wells are practicable only in the stratified drift. On sand plains where water is not more than 25 feet from the surface they are very satisfactory, and many are in use.

In the New Haven area driven wells are 1 to 4 inches in diameter, but most of them have an interior diameter of about 2 inches.

YIELD

The yield obtainable from driven wells depends on several factors, particularly the perviousness of the surrounding material, the diameter of the well, the size and condition of the strainer, the depth of water in the well, and, in gangs, the space between wells.

As the size of a driven well compared with a dug well is very small indeed, the surrounding material must admit water very freely. Driven wells in till are usually unsuccessful, because the rate of inflow is too small. In the stratified drift fine sand sometimes clogs the openings in the strainers and causes low yields.

Wells 3 to 4 inches in diameter seem to be the most satisfactory. Larger wells will yield a little more water, but increasing the diameter greatly increases the difficulty of sinking the well. Large strainers admit more water then small ones; strainers 10 feet or more in length are obtainable. Iron strainers frequently rust and become badly clogged, and even brass strainers probably become clogged to some extent from chemical action. Well pipes are often pulled up, and the strainers renewed. Steam or compressed air is also forced into wells to dislodge material that clogs the strainers.

In driven wells, as in dug wells, the yield obtainable depends on the practicable depth of drawdown, the yield increasing as the water is drawn below the surrounding water table. However, if the water level is lowered by pumping below the top of the strainer air may be drawn in through the strainer from the surrounding porous earth, thus causing a decrease in yield and serious difficulty in the operation of the pump. For this reason the top of the strainer should be at least a few feet below the water table, and it is desirable to maintain several feet of water in the well.

Wells used in gangs should be spaced some distance apart in order that they may draw on a considerable territory without material interference. For small wells not heavily pumped 20 feet is probably a sufficient interval, but for larger wells pumped at a high rate the interval should be at least 50 feet. If possible they should be arranged in lines perpendicular to the direction of underflow, which in normal circumstances is in the same general direction as the local surface drainage.

One plant in New Haven reported a measured yield of 280 gallons a minute for many hours from a single driven well 3 inches in diameter. The average yield under all conditions, however, appears to be 5 to 20 gallons a minute.

DRILLED WELLS

CONSTRUCTION

Drilled wells are commonly used where the drift is thin or absent and it is necessary to penetrate bedrock. Virtually all drilled wells in the New Haven area are drilled with a percussion or "churn" drill and are 6 inches in diameter. Casing is always used from the surface down to bedrock but rarely in bedrock.

DEPTH AND YIELD

Wells for domestic supply are usually 50 to 150 feet deep; those used for industrial supplies are usually deeper but seldom more than 500 feet. For most wells described here the depth given is that reported by the owner or user. As drilling is paid for by the foot, the depth is an element of cost; hence most of the reports probably are reasonably accurate. Reports obtained for 306 drilled wells indicate that their average depth in the New Haven area is 88 feet.

For reasons given on page 28, the yield of drilled wells is uncertain and variable. Accurate information is hard to obtain, but drillers very often test a well immediately after completion to see if it will yield a quantity of water sufficient for its proposed uses. If the yield is large their methods probably do not indicate nearly the maximum rate at which the well would yield water, but if it is small the well is drawn dry and a good estimate can be made. Most of the yields reported in the tables were obtained in this way. The average as given in the table below, based on 64 reports, is 19 gallons a minute. Many of the shallower wells used for household supply yield much less, and a few fail entirely in dry weather. The largest yield reported is 212 gallons a minute, from the well of the H. I. Judd Co., Wallingford (No. P-4).

Depth and yield of drilled wells in the New Haven area

Town	Depth		Yield	
	Number reported	Average (feet)	Number reported	Average (gallons per minute)
Clinton	1	56	1	3
Madison	5	115	1	25
Guilford	35	76	7	44
Branford	9	114	---	---
East Haven	30	71	3	6
New Haven	18	92	2	5
Orange	32	96	3	6
Milford	24	80	2	20
Woodbridge	25	79	8	9
Bethany	6	69	2	7
Hamden	38	72	6	11
North Haven	40	82	17	6
North Branford	9	63	1	50
Wallingford	17	70	1	7
Durham [a]	3	131	2	17
Haddam	6	111	1	15
Chester	None.	None.	None.	None.
Killingworth	None.	None.	None.	None.
Others [b]	8	333	7	63
The area	306	88	64	19

[a] Does not include the 980-foot flowing well on the Eick place, No. 82, drilled in prospecting for coal.
[b] Two wells of New Haven Dairy Co. and one of Hubbel Dairy Co., New Haven; one well of Acme Wire Co. and one of Whitney-Blake Co., Hamden; one well each of New York Insulated Wire Co., H. I. Judd Co., and Jennings & Griffin Manufacturing Co., Wallingford. All these wells supply factories.

METHODS OF LIFTING WATER

Several different methods are employed to raise water from wells. Where a large quantity of water is needed, as for industrial supplies, pumping plants driven by steam, electricity, or, less often, by internal-combustion engines are used. In many private houses running water is supplied by the aid of power appliances, but most individual supplies for domestic or farm use where the amount of water consumed generally is less than 1,000 gallons or at most not more than a few thousand gallons daily depend upon hand-lifting devices or hand pumps. On many shallow dug wells the only lifting device used is a bucket attached to a rope or to a snap in the end of a stick, which is lowered by hand.

Palmer[26] has given a rather complete description of lifting devices used in Connecticut.

The writer's classification used in the tables in this paper is somewhat less elaborate than Palmer's and is as follows:

Hand bucket: Bucket is attached to a rope and lowered by hand.

Pulley: Bucket is lowered by a rope working over a pulley, or sheave wheel.

Hand windlass: Bucket rope winds on a drum turned by a crank.

Sweep: Bucket hangs from one end of a long pole hinged over a forked post or other support; the opposite end of the pole carries a weight as a counterbalance. (See pl. 15, *B*.)

Hand pump: (*a*) Plunger type, including pitcher pumps and others operating by suction; (*b*) chain pump, including all pumps using an endless chain turned by a crank.

The hand bucket, the pulley, the windlass, and the sweep are all open to the criticism of being rather unsanitary, as the bucket and rope usually come into contact with the hands, and it is difficult to make the well curbing and cover tight and still allow for raising and lowering the bucket. Wells fitted with hand pumps can more easily be closed tightly. Nevertheless, the pulley is used in more than half the dug wells in the area. Hand windlasses and sweeps were once popular devices but nowadays are common only in a few localities, such as Haddam. Hand pumps, including both the plunger pump and the chain pump, are growing in popularity and are now used in about one-third of the dug wells in the area.

Lifting devices used in dug wells in the New Haven area

Town	Pulley	Hand pumps		Hand windlass	Sweep
		Plunger type	Chain		
Clinton	147	15	16	1	3
Madison	160	64	21	7	7
Guilford	131	77	14	12	7
Branford	190	50	40	3	2
East Haven	26	11	5	1	1
New Haven	26	15	5	None.	None.
Orange	127	58	12	5	2
Milford	147	38	30	1	2
Woodbridge	62	21	10	4	None.
Bethany	41	15	8	5	2
Hamden	111	22	14	2	None.
North Haven	50	35	20	6	2
North Branford	59	33	19	3	None.
Wallingford	68	23	10	6	2
Durham	19	17	4	18	2
Haddam	21	32	7	66	3
Chester	61	18	32	9	1
Killingworth	72	14	20	16	4
The area	1,518	558	287	165	40

26 Palmer, H. S., Ground water in the Southington-Granby area, Conn.: U. S. Geol. Survey Water-Supply Paper 466, 1921; Ground water in the Norwalk, Suffield, and Glastonbury areas, Conn.: U. S. Geol. Survey Water-Supply Paper 470, 1920.

On driven wells, with very few exceptions, the lifting device used is a hand pump, generally of the type known as a "pitcher" pump. These pumps are very easily attached to the upper end of the well pipe. Windmills are used on a few driven wells, and power-driven pumps can be used if desired. On drilled wells for domestic supply hand pumps are commonly used.

PRIVATE WATER SYSTEMS

A considerable number of private houses have running water, supplied either from an elevated storage tank or an air-pressure tank, or by a siphon or gravity pipe line from a spring or well at an altitude higher than the house. Tank systems generally depend on pumps driven by electricity, gasoline motor, or windmill. A few hydraulic rams are used to elevate water from springs to houses.

The relative number of these installations of different types is shown in the table below. Not all the windmills and pumping plants listed supply running water, however. Some of them merely take the place of hand devices for lifting.

Private water-supply systems equipped with mechanical lifting devices, siphons, or gravity pipe lines in the New Haven area

Town	Pumps driven by gasoline or electricity	Windmills	Hydraulic rams	Siphon or gravity pipe lines
Clinton	2	2	None.	1
Madison	4	3	None.	None.
Guilford	16	9	None.	4
Branford	5	2	None.	3
East Haven	4	2	1	None.
New Haven	[a] 4	1	None.	1
Orange	30	8	1	5
Milford	[a] 14	3	1	2
Woodbridge	13	8	2	5
Bethany	1	2	None.	8
Hamden	[a] 14	9	2	6
North Haven	10	2	1	2
North Branford	5	1	4	13
Wallingford	8	3	None.	5
Durham	1	None.	4	10
Haddam	2	3	None.	18
Chester	None.	1	None.	8
Killingworth	None.	None.	None.	1
The area	133	59	16	92

[a] Includes one steam pump that should more properly be classified as an industrial supply.

The gravity pipe line, wherever it is practicable, is the ideal method of obtaining a private water supply, for both convenience and economy. (See fig. 13.) If it is difficult to lay a gravity line, a siphon may be used. The supply may come from either a spring or a well situated at an altitude sufficient to permit the water to flow to the house. A spring is preferable if conveniently located, but a well usually can be obtained on any slope where there is a reasonable thickness of till, or it may even be dug or drilled into bedrock. Many people go to unnecessary trouble and expense to develop a spring when a well situated nearer the house would be much cheaper.

USES OF GROUND WATER

Water from wells or springs is used almost exclusively for domestic supply in the small villages and the farming districts. In the New Haven area no public supplies of importance are derived from wells, although there are several private cooperative associations that supply small settlements with spring or well water. Some manufacturing concerns use large quantities of well water for many different purposes. The following table gives a partial summary of industrial plants and other large concerns that use well water in considerable quantities and shows the principal uses to which it is applied:

Industrial uses of well water in the New Haven area (by industries)

Kind of plant	Number	Uses of water
Hardware, iron, and brass factories	13	Boilers, cooling, washing.
Cold storage and packing houses	11	Refrigerating, condensers, washing.
Breweries [a]	3	Beer, ice, cooling, washing.
Paper factories	3	Boilers, pulp, cooling, washing.
Wire factories	3	Boilers, cooling, washing.
Textile mills	3	Boilers, textile washing.
Ice plants	2	Ice.
Dairies	2	Cooling and washing.
Brick and concrete plants	2	Pug mills, concrete.
Saddlery factories	2	Washing and drinking.
Gas companies	2	Boilers, washing, cooling.
Colleges and institutions	2	Heating system, swimming pools.
Power plants	1	Condensers and cooling.
Piano factories	1	Washing and drinking.
Confectioneries	1	Cooling.
Emery goods factories	1	Washing emery.
Ice cream factories	1	Refrigerating.
Clock factories	1	Washing.

[a] Some discontinued.

Industrial uses of well water in the New Haven area (by processes)

	Number of plants
Steam boilers	10
Ammonia refrigerating machines, water jackets, condensers	29
Washing floors, coal, coke, acid pickle, bottles, etc	35

Nearly all the well water in this region is hard compared to the surface water and relatively poor for use in boilers, as it forms a hard scale. In fact, well water has never been used in boilers with unqualified success, except in a few plants where it has been softened by chemical treatment. For such use, therefore, city water or water from any available pond or stream is generally preferred.

Where quality is of small importance, as in washing operations of various kinds, ground water is entirely satisfactory and is pumped by many concerns at a cost reported to be less than the price of city water. This is especially true where waste power is available to do the pumping.

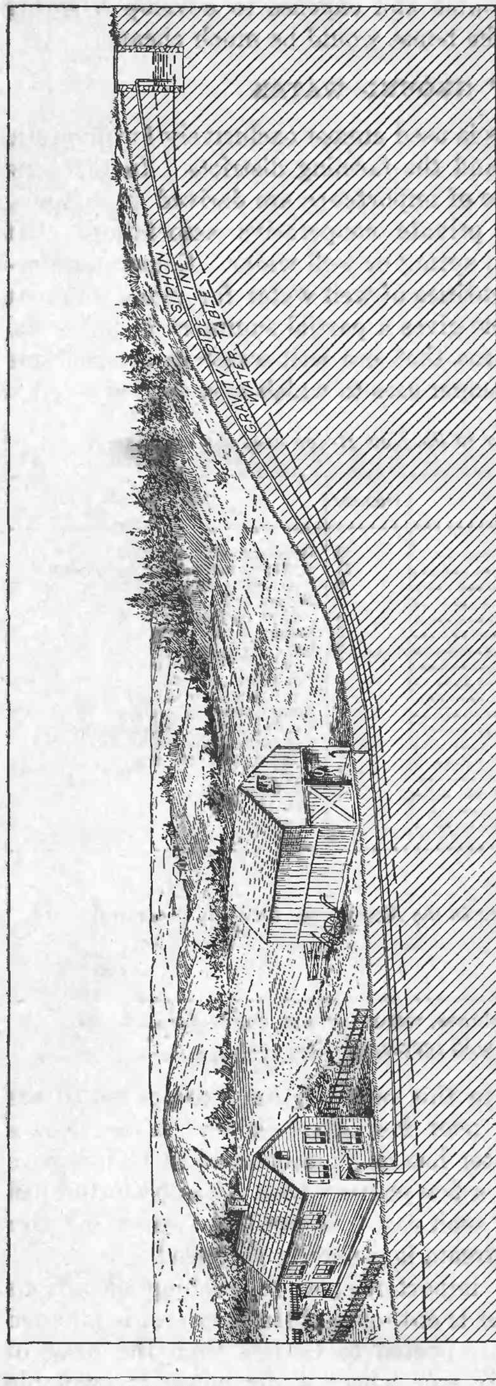


FIGURE 13.—Diagram of siphon and gravity systems for domestic waterworks. (After Ellis)

For cooling processes ground water has a preeminent advantage over surface water. The average temperature of ground water as drawn from ordinary wells is about 50°, or approximately the same as the mean annual temperature of the region; and this temperature is very nearly uniform throughout the year. Consequently, there is no difficulty about freezing in winter, and in summer there is a decided saving of water. The mean temperature at New Haven for June, July, and August is 69⅓°.[27] If this represents the average summer temperature of surface water, ground water at this time is almost 20° cooler.

It is obvious that for condensing steam in jet condensers when the discharge is usually at about 100° F., the comparative value of ground water at 50° is 1⅔ that of surface water at 70°; that is, only three-fifths as much ground water is necessary to perform the same work. In surface condensers where the temperature of waste

[27] Gregory, H. E., Underground water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 322, p. 25, 1909.

water is still lower, say 85°, the value of ground water becomes more than twice that of surface water. The same relation holds true also in other cooling processes. For this reason ground water is distinctly to be preferred for this purpose. It is noteworthy that every cold-storage plant and packing house in New Haven uses ground water in its refrigerating processes. This example could be followed with benefit by other establishments where cooling is of primary or secondary importance.

DESCRIPTIONS OF TOWNS

SCOPE

The descriptions of towns in the succeeding pages follow as closely as possible a standard outline. The material on area, population, and industries, is taken mainly from the Connecticut State Register and Manual.[28] The statements regarding bedrock geology are based upon the general descriptions given and references credited on page 5. To avoid repetition, most of the material of general interest has been placed under appropriate headings in the first part of the paper, and under individual towns are given only those facts relating to geology and water supply which exhibit some uncommon features of the town described or are of particular interest in that town. The tables of records contain the concrete data on which the conclusions in this report are based, and they will be useful whenever it is necessary to consider in detail the water-supply problems of any particular locality.

Doubtless the most valuable part of the description under each town is the summary of possibilities for the development of ground water.

A considerable number of the wells, springs, and pumping plants situated near the shore which are listed in the tables of records in this report are described in much greater detail in the separate report dealing with coastal ground water.[29] Most of those descriptions also contain analytical data. The tables immediately following give the numbers borne by the wells, springs, or pumping plants in the two reports, for convenience in cross reference.

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[28] Published periodically at Hartford by the State.

[29] Brown, J. S., A study of coastal ground water with special reference to Connecticut: U. S. Geol. Survey Water-Supply Paper 537, 1925.

Numbers of wells, springs, and pumping plants as used in Water-Supply Papers 540 and 537

Clinton

W. 540	W. 537	W. 540	W. 537
80	174	92	161
81	172	168	163
82	173	169	162
83	171	180	156
84	170	186	157
85	169	187	158
86	168	195	159
87	167	196	160
88	166	200	155
89	165	216	154
91	164		

Madison

248	137	266	146
249	138	267	147
250	139	268	148
251	140	290	149
252	141	325	150
253	142	326	151
254	143	327	152
255	145	329	153
256	144		

Guilford

205	106	260	119
221	105	261	120
223	101	262	121
224	100	263	122
225	102	264	123
226	103	269	129
227	104	271	128
244	107	272	127
245	109	273	126
246	108	274	125
247	110	275	124
248	111	308	130
249	112	309	131
250	113	312	133
251	114	314	132
252	115	358	134
253	116	402	135
254	117	403	135
259	118	417	136

Branford

62	68	225	90
66	69	227	99
71	62	230	91
72	59	231	92
73	60	232	94
74	61	233	93
78	70	234	98
80	80	235	97
82	81	236	96
83	82	237	95
87	83	332	75
214	86	333	74
215	84	334	73
216	85	337	72
217	87	338	71
222	88	344	77
223	89	346	78
		347	79

East Haven

W. 540	W. 537	W. 540	W. 537
105	67	116	58
106	66	118	57
108	63	133	56
109	65	134	55

New Haven, wells and springs

48	46	80	52
59	47	81	53
67	50	96	54
79	51		

New Haven, pumping plants

9	28	31	44
11	26	32	43
13	25	33	42
14	24	34	35
17	27	35	36
21	30	36	37
22	31	37	38
23	32	38	33
24	40	40	34
26	39	41	29
27	41	43	23
28	45	45	22
29	48	[a] 49	21
30	49	[a] 50	20

[a] In West Haven. Described in this report under Orange.

Orange

160	5	313	19
310	16	[b] P-49	21
311	17	[b] P-50	20
312	18		

[b] Pumping plants in West Haven.

Milford

30	6	143	14
65	4	204	15
69	3	282	9
76	2	286	8
134	10	293	7
137	11	307	13
139	12		

CLINTON

AREA, POPULATION, AND INDUSTRIES

Clinton is the easternmost coast town in the New Haven area and is situated between Madison and Westbrook. It is nearly rectangular in form, extending in a north-south direction for 5 miles and in an east-west direction for 3 miles. It has an area of 10,524 acres, or 16.4 square miles. The town was taken from Killingworth and incorporated in 1838. Its population in 1920 was 1,217, the greater part concentrated in the village of Clinton. The principal industry is agriculture. The percentage of tilled land is much greater than in most of the other towns, because the topography and soil are favorable, even on many of the hills. Nevertheless, probably half the area of the town is woodland. Fishing is an important industry. There is one large factory, which makes drugs and extracts. Grove Beach, on the eastern part of the Clinton shore, is an attractive summer resort.

TOPOGRAPHY AND DRAINAGE

The hills along the northern boundary of the town are between 200 and 300 feet above sea level. From them the surface slopes southward gradually down to sea level. Near the shore lies a plain of considerable extent which is generally less than 20 feet above the sea. The relief at some places is from 100 to 200 feet, but the surface of the town as a whole is less rugged than that of adjoining towns, especially those to the north. Clinton is drained by several streams, which flow slightly east of south. The largest of these are Menunketesuck River, Indian River, and Hammonasset River. Hammonasset River forms the boundary between Clinton and Madison. Salt marshes are extensive along the coast, but fresh-water marshes are less common than in the inland towns, such as Killingworth, which lies just north of Clinton.

GEOLOGY

Bedrock.—Crystalline gneiss underlies the whole of Clinton. The Stony Creek granite gneiss occurs in the southern third of the town. It forms prominent outcrops in the northern part of the village, near the railway station, and also occurs as large drift boulders on the beach at Hammock Point. A belt across the central part of Clinton, from east to west, is underlain by the Mamacoke gneiss. In the northern part of the town there are small areas of the Middletown gneiss and Haddam granite gneiss. Except in a locality about 2 miles a little east of north from the village, exposures of bedrock are less common in Clinton than in most of the adjoining towns.

Drift.—Till is the surface formation over about two-thirds of Clinton. About a mile northeast of the village lies a drumlin of typical form, locally known as Cow Hill. The till cover here is at least 25 feet thick, as shown by well records, and at some places is probably even thicker.

Stratified drift is the surface formation over about one-third of Clinton. It occurs mainly along the shore in the southern part of the town and in a broad valley north of the village of Clinton. Streams have eroded it so that it remains chiefly as terraces or dissected plains. The terraces are found inland along the courses of the streams; the dissected plains are near the shore. The southern part of the village of Clinton occupies the chief area of dissected plain. The areas of stratified drift are more favorable for cultivation than the areas of till and as a result contain about 90 per cent of the population of the town.

WATER SUPPLY

The Guilford-Chester Water Co. supplies water from a reservoir on Menunketesuck River in the northern part of the town to the village of Clinton and to the shore resort Grove Beach. Its service includes all the thickly settled territory in the areas of stratified drift. A part of the valley of Indian River that is near the company's mains also enjoys the benefit of the public supply. Elsewhere the town depends on wells, and even in the area accessible to the public supply there are still many wells in use. Water is needed mainly for domestic use and for stock, as the chief industry is farming. The one factory in the town uses water from the public supply.

In the appended tables 218 individual ground-water supplies are described. They comprise 208 dug wells, 6 driven wells, 1 drilled well, and 3 springs. The location of these supplies is shown on Plate 5 and Figure 14.

Wells.—The average depth of dug wells in Clinton, based on 208 records, is 16 feet, the same as in Guilford and Chester. (See table.) Of these wells 124 are in stratified drift and 84 in till or bedrock. The deepest well recorded (No. 167, belonging to Mrs. Hilliard), is only 28 feet in depth. It penetrates till and bedrock. Wells 65 and 127, in stratified drift, are 27 and 26 feet in depth, respectively. Well 18, entirely in till, is 23 feet in depth.

Most of the few driven wells in the town are in Grove Beach. There were originally many more wells of this inexpensive and easily constructed type, but the installation of a public water supply has caused them to be abandoned. Driven wells are more easily obliterated than dug wells, and they are rarely valued for sentimental associations as many dug wells are valued. For these reasons they are not long preserved if they are not continuously in use.

Springs.—The three springs examined in Clinton are at the foot of till slopes bordering valleys. The water seeps from drift, and the supply is very small.

Suggestions for development.—The glacial drift in Clinton yields an abundant supply of water for domestic use and for stock. Shallow wells such as are used at present are generally very satisfactory.

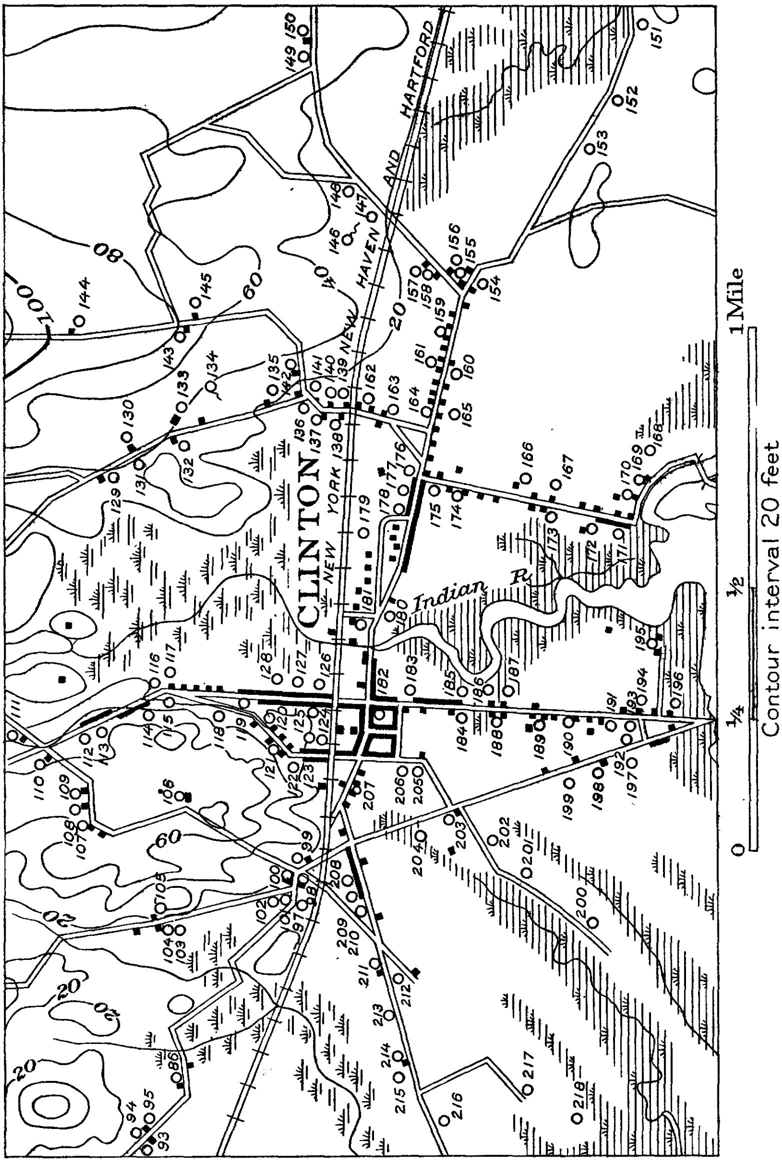

FIGURE 14.—Map of Clinton and vicinity, showing location of wells and springs. (Base from map of Guilford quadrangle, surveyed in 1890)

The siphon or gravity pipe line to supply running water to individual houses could be used more extensively in the northern part of the town, where till-covered slopes rise higher than the houses to be supplied. The areas of stratified drift are capable of supplying a great quantity of ground water. The valley of Indian River north of the village would be a particularly favorable locality for developing a large supply.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Clinton

[Observations made June 5 to 13, 1919. a before number of well indicates that well is abandoned. Dagger (†) indicates that notes are given in Water-Supply Paper 537; for equivalent numbers in that report, see table on p. 52]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
1	R. W. Clark	200	Hill	17	8	Till	Sweep	No.
2	do	200	do	18	14	do	Pulley	Yes.
3	Charles Hesser	200	Hill flat	12	3	do	None	No.
4	Barllegar (?)	180	Hill	14	10	Till to bedrock	Pulley	No.
[a] 5	C. D. Manwaring.	190	Slope	18	8	do	Chain pump	No.
6	Schwear (?)	140	do	12	5	Till	Pulley	No.
7	Goodwin	120	Hill	18	15	do	do	(?).
8	A. J. Carter	60	Valley flat	22	15	Stratified drift	do	No.
9	Mrs. Anna Johnson.	60	do	22	19	do	do	No.
10	Gerl	65	do	23	20	do	do	No.
11	F. Feldtman	80	do	20	15	do	Hand pump	No.
12	W. Beebe	80	do	20	14	do	Pulley	No.
13	Geo. Gerl	180	Hill	18	13	Till	do	Yes.
14	M. A. Kelsey	200	do	15	10	Till to bedrock	do	No.
15	H. Kelsey	175	Hill flat	13	6	Till	do	No.
16	P. Houpert	190	do	16	9	do	Sweep	No.
17	do	200	Hill	20	15	do	Pulley	(?).
18	C. Funk (?)	190	do	28	23	do	do	(?).
19	F. Fasspinter	180	do	17	10	do	do	No.
20	do	180	do	19	16	do	do	No.
21	Balok	180	do	21	17	do	do	No.
22	N. J. Kelsey	165	do	16	9	do	Chain pump	No.
23	Spencer	180	do	29	21	do	Hand windlass	(?).
[b] 24	William Bumpus.	160	Valley	12		Till and bedrock		No.
25	do	160	do	12	7	do	Hand bucket	Yes.
26	Jones	140	Hill	27	14	Till	Pulley	Yes.
27	John Miller	180	do	21	15	Chiefly bedrock	do	Yes.
28	Charles Carter	190	do	16	12	Till to bedrock	do	Rarely.
29	Geo. S. Carter	180	do	23	15	Probably bedrock	do	No.
30	E. D. Smith	80	Valley	18	15	Stratified drift	Hand pump	No.
31	Koth (?)	60	do	10	8	do	Pulley	No.
32	Keiber	70	Valley flat	8	5	do	do	No.
33	do	70	do	10	6	do	Chain pump	No.
34	Braddock	100	Slope	15	9	Till	Hand pump	No.
35	do	100	do	25	8	do	Pulley	No.
36	E. O. Kelsey	60	Valley flat	27	22	Stratified drift	Hand pump	No.
37	Williams	60	do	25	20	do	Pulley	No.
38	W. L. Goodale	80	Flat	25	18	Stratified drift to bedrock.	Chain pump	No.
39	Burton Kelsey	60	Valley	16	10	Stratified drift	Hand pump	No.
40	Frank	80	Valley flat	19	13	do	Pulley	No
[c] 41	C. E. Carter	70	Flat	27	24	do	do	No.
42	Ells	65	do	17	11	Stratified drift and probably bedrock.	do	No.
43	Hurd	60	do	22	18	Stratified drift	do	No.
44	Le Baron	60	do	13	9	Stratified drift to bedrock.	do	No.
45	Mrs. Baxter	60	do	10	5	do	do	No.
46	Anna Wilcox	130	Slope	15	9	Till to bedrock	do	Yes.
[d] 47	E. H. Wright	175	Hill	11	5	Till	Pipe line	No.
48	do	160	Slope	17	8	do	Chain pump	No.
49	Stevens	180	Hill	18	9	do	Pulley	No.
50	Higgins	190	do	15	7	do	Chain pump	Rarely.

[a] Water level fluctuates from near top to near bottom.
[b] Overflows in winter.
[c] Water is never over 5 feet deep in well.
[d] Gravity pipe line laid from bottom of well to house.

Records of wells and springs in Clinton—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
51	Higgins	190	Hill	19	7	Till	Chain pump	No.
52	J. H. Cook	200	Hill flat	12	5	do	Pulley	No.
53	Irmschief (?)	20	Terrace	19	11	Stratified drift	do	No.
54	S. E. Scranton	40	Valley	10	3	Till	Hand bucket	(?).
55	W. Sprague	30	Slope	10	5	Till to bedrock	Pulley	Yes.
56	Doolittle	20	Terrace	20	18	Stratified drift	do	Almost.
58	Geo. Steward	35	Valley	12	8	do	do	No.
59	Schremp (?)	60	Terrace	14	10	Till to bedrock	do	No.
60	Weibrecht	40	Valley	12	7	do	do	No.
61	John Walker	30	Flat	11	6	Stratified drift	do	No.
62	Ackerman	40	do	15	10	do	do	No.
63	William Collins	60	do	14	20	do	do	Almost.
64	Juzhler (?)	60	do	24	20	do	do	No.
65	N. I. Stevens	60	do	27	20	do	do	No.
66	L. Roth	40	Valley flat	8	3	do	Sweep	No.
67	Heser	30	Terrace	15	12	do	Pulley	No.
68	Pratt	40	Sink	15	12	do	do	No.
69	Marcus Post	40	Flat	24	20	do	do	No.
70	E. Stevens	30	do	27	25	do	do	No.
71	John Kozlik	140	Hill	19	8	Till	do	Yes.
72	do	140	do	23	8	do	do	No.
73	Kokojan	130	Hill flat	15	3	do	do	Yes.
74	do	130	do	20	7	do	Chain pump	No.
75	Donzello	120	Hill	2	7	do	Pulley	No.
•76	Albert Bailey	40	Flat	15	8	Till to bedrock	(?)	No.
77	Herman Scheld	20	Valley	17	10	Stratified drift	Chain pump	No.
78	H. Stannard	30	Hill	19	14	Till (?) to bedrock	Pulley	No.
79	Flynn	20	Terrace	19	14	Stratified drift	do	No.
†80	Mrs. Atwater	15	Ridge	16	13	do	Hand pump	No.
†82	Watrous	5	Swamp	9	2	do	do	No.
†84	Howland	10	Ridge	9	7	do	Pulley	Almost.
a†86	Frank Buell	5	Beach	8	6	do	Hand pump	
a†87	C. Buell	5	do	7	6	do	do	
a†89		18	Flat	22	19	do	None	
90	Brainerd	20	do	24	20	do	Hand pump	No.
†91	Matthewson	8	Ridge	12	10	Till	None	No.
†92	Christine Buell	4	Low island	7	5	Stratified drift	Pulley	No.
93	Hugh Burns	15	Flat	14	12	do	do	Yes.
94	Arthur Miller	20	do	14	10	do	Hand pump	No.
95	I. W. Miller	20	do	19	15	do	Pulley	No.
96	Jos. Samonsky	15	do	14	11	do	do	No.
97	Sohl (?)	20	do	13	9	do	do	No.
98	Gaylord	15	Valley	15	10	do	do	No.
99	Meigs	(?)	Slope	15	10	Till to bedrock	do	Yes.
100	Winter	15	Valley	11	6	Stratified drift	do	No.
101	A. H. Swain	15	do	12	7	do	Chain pump	No.
102	Lessner	15	do	11	6	do	Hand pump	No.
103	Sewell	15	do	15	7	do	Pulley	No.
104	Schottman (?)	15	do	10	5	do	Chain pump	No.
105	Franzen	40	Slope	17	8	Till to bedrock	Pulley	No.
106	Ford Allen	80	Hill flat	12	7	Till	do	(?).
107	Z. E. Morgan	60	Hill	15	11	Till 6 feet, bedrock 9 feet.	do	Yes.
108	Snell	65	do	19	13	Till 15 feet, bedrock 4 feet.	do	No.
109	Booth	65	do	19	13	Till and bedrock	do	Almost.
110	Foerch (?)	60	do	18	13	do	do	No.
111	Jesse H. Buell	40	Slope	17	13	Stratified drift	do	No.
112	Kelsey	55	Hill	14	11	Till	do	(?).
113	Frank Buell	55	do	17	12	Till and bedrock	do	No.
114	C. H. Buell	55	do	19	14	Till 9 feet, bedrock 10 feet.	do	No.
115	A. W. Buell	50	do	17	13	Till 9 feet, bedrock 10 feet.	do	Rarely.
116	D. D. Buell	40	do	24	15	Till 6 feet, bedrock 18 feet.	do	No.
117	Mrs. Lord	40	do	18	13	Till and bedrock	do	Yes.
118	C. S. Hull	40	Slope	18	10	Till 8 feet, bedrock 10 feet.	do	No.
119	Mark Smith	40	do	20	11	Chiefly bedrock	do	No.
120	Clarence Stevens.	20	Flat	20	14	Stratified drift	(?)	Almost.
121	Baxter	20	Slope	14	9	Chiefly bedrock	Pulley	No.

• Water level fluctuates between 2 feet from top and 3 feet from bottom.

Records of wells and springs in Clinton—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
122	E. L. Harris	20	Flat	15	10	Stratified drift 6 feet, bedrock 9 feet.	Pulley	No.
123	Phelps	20	do	22	17	Stratified drift	do	No.
124	W. H. Stafford	20	do	21	18	do	do	No.
125	Mrs. Wood	20	do	21	16	do	do	No.
126	Burroughs	20	do	21	17	do	do	No.
127	Brown	20	do	26	18	do	do	No.
128	D. A. Redfield	20	do	20	16.	do	do	No.
[f]129	Frank Kokojan	40	Valley	19	17	do	do	No.
[g]130	do	45	Slope	18	13	Till	Chain pump	No.
131	William Haag	40	Valley	21	15	Till and bedrock	Pulley	No.
132	Doane	30	do	20	14	Till	do	No.
133	Geo. E. Lane	40	Slope	15	10	Till to bedrock	do	No.
135	G. Dee	30	do	8	3	Till	do	No.
136	Post	20	Flat	17	11	Stratified drift	do	No.
138	Frances Griffing.	20	do	20	16	do	do	No.
139	J. S. Fletcher	20	do	18	15	do	do	No.
140	Morris Hyatt	20	do	21	18	do	do	No.
141	Lewis Stone	20	do	21	19	Stratified drift to bedrock.	do	Rarely.
142	Stevens	40	Slope	10	7	Till to bedrock	do	No.
143	Robert Rose	70	Hill	24	17	Till	do	No.
[h]144	J. T. Abrams	100	do	15	6	do	do	No.
145	Rice	70	do	20	8	do	do	No.
[i]147	Henry E. Buell	20	Bench	18	10	Till and bedrock	do	No.
148	George Buell	30	Slope	17	9	do	do	No.
149	H. C. Braun	45	Hill	10	5	Till	Hand bucket	No.
150	do	50	do	18	10	do	do	No.
151	C. S. Palmer	20	Valley	9	2	Stratified drift	Gasoline engine.	No.
152		20	Ridge	13	10	Till	Pulley	(?).
153	Mrs. Spratt	20	Flat	10	4	do	Hand bucket	No.
154	Chittenden	10	do	12	7	Stratified drift	None	No.
155	D. S. Dibbel	10	do	13	7	do	Chain pump	No.
156	Buell	10	do	14	10	do	Pulley	Almost.
158	Wm. E. Doane	10	do	11	8	do	do	No.
159	J. Dowd	15	do	12	7	do	do	No.
160		15	do	12	7	do	do	No.
161	Merrils	15	do	18	9	do	Chain pump	No.
162	Sutherland	20	do	19	15	do	Pulley	No.
163	Jeanette Lane	20	do	17	13	do	do	No.
164	John Peck	20	do	15	12	do	do	No.
165	George Brook	20	do	15	10	do	do	No.
166	Buell Bros	20	Ridge	21	17	Stratified drift to bedrock.	do	No.
[j]167	Hilliard	(?)	Hill	28	21	Till and bedrock	do	No.
a†168	C. F. Root	12	Flat	14	11	Stratified drift	None	No.
†169	Charles Hurd	10	do	13	11	do	Pulley	No.
170	Pike	10	do	12	10	do	do	(?).
171		10	Ridge	10	8	do	do	(?).
172	Caroline Oakes	15	Flat	16	14	do	do	No.
173	Mrs. Rossiter	15	Slope	16	13	do	Chain pump	No.
174	Henry Spencer	20	Flat	17	12	do	do	No.
175	Kelsey	20	do	19	15	do	Hand pump	No.
[k]176	Wall	20	do	20	15	do	Pulley	No.
177	A. Stevens	20	do	20	18	do	do	No.
178	Stanton estate	20	do	17	14	do	Chain pump	No.
179		15	do	18	14	do	Pulley	No.
a†180	Ely A. Elliot	4	Valley	8	5	do	do	No.
181	H. A. Redfield	15	do	12	8	do	do	No.
182	J. L. Hull	20	Flat	19	15	do	do	No.
183	R. D. Lively	20	do	21	17	do	do	No.
184	C. R. Buell	10	Valley	9	5	do		No.
185	Wellman	15	Flat	20	15	do	Pulley	No.
†186	Buell	10	Valley	9	5	do	do	No.
†187	Chr. Buell	10	do	7	5	do		No.

[f] Level fluctuates almost none at all.
[g] Very wide fluctuation of water level.
[h] Water level fluctuates between 2 feet from top and 2 feet from bottom.
[i] Said to have been spoiled by dressing of oil on adjacent lot.
[j] Dug about 1900. Cost $100.
[k] Sometimes full to top, water "milky."

Records of wells and springs in Clinton—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
188	Hull	15	Flat	16	5	Stratified drift	Pulley	No.
189	L. F. Griswold	15	do	17	13	do	do	No.
190	E. A. Pelton	15	do	18	14	do	do	No.
191	E. T. Bushnell	15	do	16	12	do		No.
192	I. N. Parmellee	15	do	15	10	do		No.
193	E. C. Watrous	15	do	17	10	do	Pulley	No.
194	W. H. Pollard	15	do	19	12	do	do	No.
†195	M. L. Blaisdell	10	Ridge	15	12	do	do	No.
†196	John F. Parker	2	Marsh	6	2	do	do	No.
197		15	Flat	15	10	do	do	No.
198	Chatfield	15	do	18	13	do	do	No.
199	A. Gaylord	15	do	17	13	do	do	No.
†200	Geo. A. Stevens	15	Ridge	14	9	do	Windmill	No.
201	Gauss (?)	15	Flat	19	11	do	Electric pump	No.
202	John Mear	15	do	17		do	Pulley	No.
203	E. Corcoran	15	do	18	13	do	do	No.
205	J. W. Green	20	do	16	13	do	do	No.
206	A. M. Buell	20	do	14	8	do	do	No.
207	Woodstock	20	do	20	15	do	do	No.
208	E. M. Hurd	20	do	15	12	do	do	No.
a209	Graham	20	do	14	11	do	Hand pump	No.
210		20	do	18	11	do	Pulley	No.
211	Myer	15	do	12	9	do	do	No.
212	L. C. Krummel	15	do	19	9	do	Windmill	No.
213	Nelson King	15	do	14	7	do	do	No.
214	Harriet King	15	do	14	9	Stratified drift to bedrock.	Chain pump	No.
215	do	15	do	13	8	do	Pulley	No.
217	Tucker	10	do	6	3	Stratified drift	Hand pump	No.
218	F. H. Pollard	10	do	10	7	do	Pulley	No.

Driven wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Diameter (inches)	Kind of rock	Equipment	Does well fail?
†81	Post	4	Beach	±10	1	Sand	Hand pump	No.
†83	Mrs. Hilliard	4	do	±10	1½	do	do	No.
†85	Weise	10	Ridge	±20	2	Stratified drift	do	No.
188	Redfield	2	Beach	±10		do	do	No.
137	Post	20	Flat		2	do	do	No.
†57	Franklin Buell	15	do		1-2	do	do	No.

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Kind of rock	Equipment	Yield (gallons per minute)
†216	Russel Dowd	15	Hill	56	Till 3 feet, bedrock 52.5 feet	Hand pump	3

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
57	E. R. Shattuck	20	Head of valley	Stratified drift	Stoned pit 2.5 feet deep.	[1]1
134	I. Gurelik	40	Small depression on slope.	Till	3-foot tile	[1]1-2
146	Henry E. Buell	20	Side of ravine	Drift in stream course.	Stoned pit 5 feet deep.	(?)

[1] Estimated.

MADISON

AREA, POPULATION, AND INDUSTRIES

The town of Madison was taken from Guilford and incorporated in 1826. It lies between Guilford on the west and Clinton and Killingworth on the east. Hammonasset River forms the eastern boundary throughout the length of the town. Although Madison has a shore front about 7 miles long, the average width of the town from east to west is only about 3 miles. The length from north to south is about 14 miles. The area is 25,948 acres, or 40.5 square miles, and the population in 1920 was 1,857. Probably more than 90 per cent of the population lives in a belt 2 or 3 miles wide near the shore. There are two distinct centers of settlement—Madison proper, near the shore, and North Madison, in the interior. The former is preeminently a residence section and summer resort; the latter is a purely agricultural district. In the extreme northern part of the town another small farming community centers about the place known as Rockland. The chief industry of Madison is agriculture. Fishing is of some importance, and there are one or two small factories, which make school supplies, such as crayons. Except in the narrow strip of land near the shore probably 75 per cent of the area of the town is unimproved woodland.

TOPOGRAPHY AND DRAINAGE

The highest point in Madison is on the Madison-Durham line in the northwest corner of the town, where one hill rises to an altitude of slightly more than 600 feet above sea level. From this locality southward the hills gradually decrease in height until sea level is reached. The maximum local relief is about 400 feet in the northwest corner of the town, but the average does not exceed 100 to 200 feet. The drainage is southward, the eastern half of the town being tributary to Hammonasset River and most of the western half to East River and Neck River, streams which flow near the Madison-Guilford line.

The shore line of Madison is much more regular than those of most other towns in the New Haven area, chiefly because along the entire shore line stratified drift is the surface formation and outcrops of bedrock are uncommon. Consequently the waves, by eating away the stratified drift in exposed areas and building bar beaches across the mouths of small streams, have destroyed the irregularities of the shore line.

GEOLOGY

Bedrock.—All of Madison is underlain by crystalline rocks. The principal formations are the Mamacoke gneiss, Middletown gneiss, and Haddam granite gneiss. The Mamacoke gneiss occupies practically all the strip of country about 1 mile wide between the New York, New Haven & Hartford Railroad and Long Island sound. The Middletown gneiss occupies a belt about 2 miles wide just north of the railroad. The Haddam granite gneiss underlies nearly all the rest of Madison. Exposures of bedrock are few and inconspicuous in the southern part of the town, but in the northern half outcrops are very common, especially on the hillsides and in the valley bottoms.

Drift.—Till is the prevailing surface formation over all of Madison except a belt 1 to 2 miles wide along the shore. It occurs particularly on the slopes and hilltops and covers more than 75 per cent of the entire area. Considerable areas of till near North Madison and north toward Rockland are cultivated, but most of the till-covered land is wooded. A line of drumlins extends irregularly across the town near North Madison and includes Race Hill, Cranberry Hill, Walnut Hill, and High Hill. The till is usually only a few feet thick, but in the drumlins it has a measured thickness of 25 to 50 feet and in places may be 100 feet. Well records show thicknesses of 27.5 feet at Summer Hill (well 48), 28 feet near Cranberry Hill (well 55), 46 feet near Race Hill in a well which just reached bedrock (well 55), 27.5 feet on Walnut Hill (well 70), and 27.5 feet farther south (well 80).

Stratified drift is the surface formation over most of a belt of country 1 to 2 miles wide adjoining the shore, and smaller areas occur along the valley of Hammonasset River and in some of the minor valleys. The streams have eroded much of the stratified drift, leaving the remainder as terraces and remnants in the lowlands. These same streams are now depositing some material, and their flood plains at places are wet and marshy. Near the sea there are salt meadows. The thickness of stratified drift varies, depending on the depth to bedrock at different localities, but generally does not exceed 25 feet. Well 121 shows stratified drift to a depth of 26 feet, well 181 to 28.5 feet, and well 157 to 43 feet, which is the greatest thickness recorded.

WATER SUPPLY

The Guilford-Chester Water Co. supplies water to nearly all that part of Madison lying south of the railroad. Its system has been extended along most of the shore about as fast as houses have been built, so that wells are uncommon. But in the earlier-settled parts of the town, along the Madison turnpike, many old-fashioned dug wells are still in use, even where city water may be obtained. Dug wells are the prevailing source of supply over the rest of Madison. There are also some driven and drilled wells in use and a few springs. The chief need for water is for domestic use and for stock, as the only industry of the town is agriculture.

In all, 329 individual water supplies in Madison were examined, including 304 dug wells, 13 driven wells, 5 drilled wells, and 7 springs.

This number probably includes more than 75 per cent of the entire number of supplies. The records of these supplies are given in the appended tables, and their location is shown on Plate 5.

Wells.—The average depth of 301 dug wells was 17 feet. The deepest dug well is that of William R. Smith (No. 57), 46 feet deep, which penetrates till to the contact with bedrock. Other deep wells in till are Nos. 48, 70, and 80, each 27.5 feet deep, and No. 55, 28 feet. The deepest well in stratified drift is that of L. Peterson (No. 157), 43 feet. Wells 121 and 181 are 26 and 28.5 feet deep, respectively. Well 194 is 37 feet deep and penetrates bedrock from the surface.

The equipment used for lifting water from dug wells is generally the rope and pulley or the hand pump. (See table.) Rope and pulley are used on 53 per cent of the wells, hand pumps of the plunger type on 19 per cent, and chain pumps operated by a crank on 7 per cent. There are a few hand windlasses, sweeps, and windmills. Only two power-driven pumps were in use. No siphons or gravity systems were found, although it would seem that these types could be used more extensively with good results.

Driven wells are found only in the stratified drift and are nearly all in the southeast corner of Madison. The five drilled wells examined range from 33 to 280 feet in depth. A yield of 25 gallons a minute was reported for one of these, but no data could be obtained for the others.

An analysis of a sample of water from the 12-foot dug well of the Madison State Game Farm (No. 219) is given on page 36. This water is moderate in mineral content and hardness and is satisfactory for most purposes. An analysis of a sample of water from the 147-foot drilled well of F. Bushnell (No. 280) is given on page 36. This water is soft, low in mineral content, and satisfactory for most purposes.

Springs.—Most of the seven springs examined occur at the heads of ravines or the borders of valleys. Three appear to be supplied entirely or in part from bedrock. The others receive seepage from drift. The yields do not exceed a few gallons a minute.

Suggestions for development.—If proper consideration is given to sanitation, the prevailing types of wells are satisfactory for domestic supply. Driven wells, which are cheaper than dug wells, could be used more in the stratified drift. Hillside wells located in positions to yield a siphon or gravity supply could be used more, especially in the northern part of the town. Large supplies of water could be obtained from the stratified drift by shallow wells, either dug or driven.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Madison

[Wells 1 to 81 were examined Oct. 29 to Nov. 1, 1919; wells 82 to 329, May 28 to June 13, 1919. a before number of well indicates that well is abandoned. Dagger (†) indicates that notes are given in Water-Supply Paper 537; for equivalent numbers in that report, see table on p. 52]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
1		320	Valley	10	4	Till	None	(?).
2	Friedritch	300	Valley flat	10	7	Stratified drift	Sweep	No.
3		290	do	12	9	do	None	No.
4	J. Pandian (?)	290	do	10	5	do	Pulley	No.
5	A. Pandian (?)	300	do	12	10	do	Sweep	No.
6	Scherl (?)	300	do	13	10	do	Hand pump	No.
7	F. Fippinger	300	do	10	7	do	do	No.
8	Crook	300	do	15	10	Stratified drift to bedrock.	Pulley	No.
9	Seifert	300	do	4	2	Till to bedrock	None	Yes.
11		340	Hill	17	15	Till probably to bedrock.	Pulley	(?).
12		440	Valley	11	5	Till	Hand pump	No.
13	Fred Mayor	400	do	14	5	Till to bedrock	Hand bucket	Rarely.
14		360	Slope	16	11	Till probably to bedrock.	None	(?).
16	Jos. Rene	380	do		12	Till to bedrock	Hand pump	Yes.
17	Rossi (?)	320	do	20	12	do	Pulley	Yes.
18	R. Stevens	300	Valley	11	6	Till		Yes.
19	L. B. Stevens	320	Slope	16	8	Till to bedrock	Hand bucket	No.
20		360	Hill	12	5	Till	do	(?).
21	V. E. Stevens	320	Slope	14	6	do	Hand pump	Almost.
22	Ashlander	300	Valley	12	8	Till to bedrock	Sweep	No.
a23	Hammonasset Club.	300	Valley flat	10	8	Stratified drift	None	No.
24		310	Terrace	13	6	Stratified drift to bedrock.	Pulley	(?).
25	Ackerman	300	Valley	18	16	Stratified drift	do	No.
26		280	do	11	8	do	None	(?).
27	A. Kulisch	400	Hill	16		Till to bedrock	do	Yes.
28		310	Valley	14	10	Stratified drift probably to bedrock.	do	(?).
29	Hansen	300	Ridge	23	15	Till	Pulley	No.
30		400	Hill	22	15	do	None	(?).
31		390	Slope	28	20	do	do	No.
32		380	do	15	12	do	do	No.
34	Wm. A. Stone	360	do	16	9	do	Pulley; hand pump.	(?).
35	Remper	380	do	16	11	Chiefly bedrock	Pulley	No.
36		360	Valley	16	11	Till	do	(?).
37	Wm. A. Stone	385	Hill	26	15	do	do	Rarely.
38	Boenig (?)	390	do	24	10	do	do	(?).
39	Marcus	385	do	20	8	do	do	Rarely.
[a]40	Nary	380	do	26	11	do	do	No.
41	Dudley	380	do	18	8	Till and bedrock	do	No.
42	Odau	360	do	20	15	Till	Hand pump	No.
43	Eckhardt	365	do	13	5	do	Hand bucket	No.
[b]44	Krausch	340	do	14	6	do	Hand pump	No.
45	E. Dudley	400	do	19	11	do	Chain pump	Yes.
46	Jandatir (?)	360	Slope	10	2	do	Pulley	No.
47	August Proll	360	Hill	21	8	Till to bedrock	Hand pump	No.
48	Breidtbach	350	do	28	10	Till	do	No.
49	Serian (?)	340	Slope	20	14	Till to bedrock	Sweep	Yes.
50	I. Chittenden	280	do	13	7	Till	Pulley	Yes.
52	Blake	280	Valley	8	2	do	None	No.
[c]53	Entner	280	Hill		9	Till and bedrock	Hand pump	(?).
54	Hartman	280	do	19	10	Chiefly bedrock	do	Yes.
55	T. D. Hopson	280	do	28	11	Till	Pulley	No.
56	James Hill	400	Slope	25	5	do	do	No.
57	Wm. R. Smith	260	do	46	30	Till to bedrock	do	No.
58	Cook	290	Hill	34	14	Till probably to bedrock.	do	Rarely.
59	Reifschneider	300	do	27	15	Till	do	Rarely.
60	Bremer (?)	115	Terrace	14	12	Stratified drift	Hand pump	Rarely.

[a] Water reported to be soft in winter and hard in summer.
[b] An adjacent well 10 feet deep, with rock bottom, fails often.
[c] Sometimes overflows.

Records of wells and springs in Madison—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
61		115	Valley	14	10	Stratified drift	None	Rarely.
62	Norton	160	Slope	13	9	do	Pulley	Yes.
63	Richert	140	do	14	10	do	do	No.
64		160	Ridge	16	12	Till	do	(?).
65	Smith	160	Flat	20	15	do	do	No.
66	Crook	160	Bench	12	6	do	None	No.
67	Harry Smith	130	Flat	15	10	do	Pulley	No.
68	Schraner	160	Ridge	22	11	do	do	No.
69	Jos. Rugge	170	Valley	14	9	Till to bedrock	Hand windlass	No.
70	Houserman	365	Hill	28	10	Till	Pulley	Yes.
71	Congregational Church.	280	do	27	15	do	do	No.
72	Wafer	285	do	23	10	do	Chain pump	Yes.
73	Jos. Menzel	285	do	22	12	Till 16 feet, bedrock 6 feet.	Pulley	No.
74	Norton	260	Slope	24	15	Till 10 feet, bedrock 14 feet.	Hand pump	No.
75	do	270	do	21	12	Till to bedrock	Hand windlass	Yes.
76	Monger	260	Flat	22	15	Till	Pulley	Rarely.
77		265	Hill	23	12	do	Hand windlass	No.
78	Thompson	270	do	27	15	do	do	No.
79	Schlaegel	265	do	26	13	do	Hand pump	No.
80	Joel M. Hill	270	do	28	10	do	Hand windlass	Rarely.
81	Richard Glass	265	do	23	11	do	do	No.
82	Pressnall	280	do	23	10	do	Pulley	No.
83	Herman Jacobs	160	Slope	20	6	do	do	No.
84	Geo. Essweim	150	do	23	15	do	Hand bucket	No.
85	Gesner	150	Hill flat	12	5	do	Hand windlass	No.
86	Chas. Vidali	180	Hill	24	18	Till 15 feet, bedrock 9 feet.	Pulley	No.
87		170	do	19	11	Till	Hand pump	(?).
88	Gross	120	do	19	12	Till to bedrock	Pulley	Yes.
89	Chas. Roller	90	Valley	8	2	Till	Hand pump	No.
90	Scheibler	90	do	12	9	do	Sweep	No.
91	Christensen	80	Slope	10	6	Till to bedrock	Gasoline engine.	Almost.
92	Maurer	75	do	11	6	Till	Sweep	No.
93	Nickolls	80	Flat	15	9	do	Pulley; hand pump.	No.
94	Kolln (?)	80	do	10	6	do		No.
95	John Voegtle	100	do	18	10	do	Pulley	No.
97	Weissburn	120	Slope	19	9	Till to bedrock	do	Rarely.
98	Ingrisch (?)	100	do	14	10	Till	do	No.
99	D. W. Husted	80	do	15	10	Till to bedrock	Sweep	No.
100	John Day	160	Hill	19	8	Till	Pulley	No.
101	do	160	do	17	7	do	do	No.
102	P. Merijoni		do	19	7	Till to bedrock	Hand windlass	No.
103	Busselman	50	Slope	26	20	Chiefly bedrock	Pulley	No.
104	Barnes	40	Valley	13	8	Till (?)	Hand pump	No.
a105	Dan Kane	80	Hill	23	11	Till	Pulley	Yes.
106	Johnson	80	Hill flat	18	6	do	Hand bucket	Rarely.
107		80	Hill	24	7	do	Pulley	No.
108	Johnson	80	do	18	5	do		Yes.
109	Evarts	70	do	15	5	do	Pulley	No.
a110		70	do	18	7	do	None	
111	P. Lazarovitch	60	do	17	7	do	Pulley	No.
112	Nankovitch	50	Slope	25	13	do	do	Rarely.
113	do	40	Valley		3	Stratified drift	None	No.
114	Koenke	40	Hill	23	19	do	Pulley	Rarely.
115	DeWitt	30	Flat	18	14	do	do	No.
116	Jurash	40	Hill	10	5	Till	do	No.
117	Schuman	40	do	14	5	Till to bedrock	do	No.
118	B. B. Monger	40	Flat	18	13	Stratified drift	Hand pump	No.
a119	Souter (?)	36	Hill	19	14	do	None	No.
120	do	35	do	18	13	do	Hand pump	No.
121	Sherman	40	Flat	26	22	do	Chain pump	Almost.
122	A. Underwood	30	do	24	20	do	Pulley	No.
123	Johnson	30	do	20	18	do	do	No.
124	Day	35	do	20	17	do	do	No.
125	Schrensky (?)	90	Hill	13	10	Till to bedrock	do	No.
126	Fred Vings (?)	40	Valley	15	8	Till (?)	do	No.
127	Alec Schoen	40	Terrace	19	15	Stratified drift	do	No.

a Sometimes water is only 2 feet below top; sometimes well goes dry.

Records of wells and springs in Madison—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
128	Bauer	40	Flat	16	13	Stratified drift	Pulley	Almost.
129	Madison State Game Farm.	40	do	14	11	do	Chain pump	No.
130	A. Tschofen	40	do	15	10	do	do	No.
131	Hoerndler	80	Hill flat	13	5	Till	Pulley	Yes.
133	Zimmerman	100	Hill	24	10	Till probably to bedrock.	do	No.
135	Schmitting	80	do	18	10	Till	Pulley; hand pump.	Almost.
137	Longhorst	85	do	17	10	do	Hand pump	No.
138	do	80	do	13	8	do	Pulley	No.
139	Mantler	90	Hill flat	16	8	do	Hand pump	No.
140	do	90	do	11	3	do	Pulley	No.
141	Lawton	80	do	9	5	do	do	(?)
142	do	80	do	12	6	do	do	No.
143	Wm. Pepper	80	do	15	6	Till (?) to bedrock	Hand pump	No.
144	Mrs. Spencer	75	Valley	18	12	Stratified drift	Pulley	No.
145	John Bill	100	Hill	24		Till 13 feet, bedrock 11 feet.	Hand pump	No.
146	Schlau (?)	100	Slope	19	10	Till	Pulley	No.
147	Christopher	100	Hill	19	10	Till to bedrock	do	Yes.
148	Waldman	95	do	15	7	Till	Hand pump	No.
149	do	95	do	16	10	do	do	No.
150	Field	95	do	12	5	Till to bedrock	do	Almost.
151	Gleishman	100	do	14	8	do	do	No.
152	Mucer (?)	100	do	13	7	Till	Pulley	No.
153	C. T. Woodruff	85	do	16	8	Till to bedrock	do	Almost.
154	J. D. Kelsey	85	do	13	6	do	Gasoline engine.	No.
155	Howard Kelsey	70	Slope	19	15	Till	Hand pump	No.
156	Fred Petersen	75	Valley	31	21	Stratified drift to bedrock.	Pulley	No.
157	L. Petersen	60	Flat	43	36	Stratified drift	Hand pump	No.
159	K. Veugtli	50	Slope	13	6	do	Pulley	No.
• 160	Chas. Schaffer	80	Hill	32	15	Bedrock	Pulley; hand pump.	No.
161	Ford	60	Valley flat	20		Stratified drift		No.
162	Martinson	60	do	19	10	do	Pulley; hand pump.	No.
163	Mrs. Coe	60	do	18	8	do	Pulley	No.
164	William Coe	60	do	12	8	Stratified drift to bedrock.	do	Yes.
165	Marsh	60	do	20	9	Stratified drift (?)	Chain pump	No.
166	Schweitzer	65	do	17	12	do	Pulley	Yes.
167	A. Lohman	60	do	17	9	Stratified drift	Chain pump	No.
168	do	60	do	18	11	do	Pulley	Almost.
169	R. D. Coe	65	Slope	22	13	Till (?)	Pulley; hand pump.	No.
170	Frank Meigs	60	do	19	11	Till to bedrock	do	No.
172	L. A. Dowd	60	do	25	12	Till 12.5 feet, bedrock 12 feet.	Pulley	Yes.
173	Henry Snyder	50	do	18	14	Till (?) to bedrock.	Hand pump	No.
174	Hammer	20	Flat	15	9	Stratified drift (?)	Pulley	Yes.
175	J. M. Marsh	20	do	13	8	Stratified drift	do	No.
176	Wise	40	Slope	20	5	Till	do	No.
177	J. D. Griffith	25	Flat	28	23	Stratified drift	do	No.
178	Penfield	25	do	31	25	do	Windmill	No.
179		20	do	20	14	do	Pulley	No.
180	New	15	Valley	10	5	do	Pulley; hand pump.	No.
181	H. Dowd	30	Terrace	29	19	do	do	No.
182	Geo. Maurer	60	Slope	13	9	Till	Pulley	Yes.
183	Kolln (?)	40	do	9	5	do	Hand pump	No.
184	do	50	do	18	9	Till to bedrock	Pulley	Yes.
185	Lois Bailey	60	Hill	19	8	Till	do	Yes.
186	John Heinold	20	Flat	15	10	Stratified drift	None	(?)
187	Maseole	45	Hill	13	9	Till	Pulley	No.
188	Milton Meigs	50	do	19	15	Till to bedrock	Sweep	No.
189	Nealy	45	Slope	13	8	Till	Chain pump	No.
190	Chas. Kapp	20	Flat	4	10	Stratified drift	Hand pump	No.
191	Wm. Maurer	20	Terrace	18	15	do	Pulley	(?).
192	R. Christopher	30	Slope	15	12	do	Hand pump	No.
193	Mrs. Davis	40	Valley	13	8	do	Pulley	No.
194	do	50	Hill	37		Bedrock	Hand pump	Almost.

• Cost $300 to dig in 1910.

Records of wells and springs in Madison—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
196	J. Kline	40	Flat	27	25	Stratified drift	Hand pump	Yes.
197	A. P. Hall	40	do	26	23	do	Pulley	No.
198		35	do	24	20	do	Hand pump	No.
200	Hawley	20	do	14	11	do	Pulley; hand pump.	No.
201	do	20	do	18	15	do	Pulley	No.
203		20	do	21	18	do	do	No.
204	H. B. Hunter	20	do	17	13	do	Pulley; hand pump.	No.
205	Samuel Scranton.	20	do	14	9	do	Hand pump	No.
207	Willard	20	Valley	11	6	do	Windmill	No.
209	Burke	20	do	8	4	do	Hand pump	No.
210	Chas. Scranton	50	Flat	16	11	do	Pulley	No.
211	Jos. Heneier	40	do	20	14	do	Chain pump	No.
212	Willard	30	Valley	11	6	do	Pulley; hand pump.	Yes.
213	Tubandt	40	Flat	20	16	do	Hand pump	Almost.
214	Mulusky	20	Hill	20	17	do	Pulley	Yes.
a215	do	15	Valley	10	5	do	None	(?).
216	S. Calhoun	60	Slope	18	5	Chiefly bedrock	Pulley	Rarely.
217	Kane	30	do	22	19	Stratified drift (?)	do	No.
218	Hull	20	do	12	9	do	do	No.
f 219	Madison State Game Farm.	40	Flat	12	7	do	Gasoline engine.	No.
220	Johnson	20	do	15	7	Stratified drift to bedrock.	Pulley	No.
221		25	do	16	10	Stratified drift	Chain pump	(?).
222	E. W. Monger	20	do	21	17	do	Pulley	No.
223		20	do	13	7	do	do	(?).
224	Geo. Monger	20	do	15	7	do	Chain pump	Rarely.
225		20	do	19	10	do	do	No.
226	E. M. Clark	25	do	17	7	do	Hand pump	No.
227	Charles Ely	25	do	12	8	do		No.
228	Talford	20	Terrace	17	14	do	Pulley	No.
229	Mrs. Ramsey	10	Valley	12	8	do	Hand bucket	No.
230	Mrs. Ainsworth	10	do	10	6	do	Pulley	No.
231	Fenner	10	do	9	5	do	do	No.
232	Chalker	10	do	12	8	do	Hand bucket	No.
233	Jilson (?)	20	Flat	21	9	Stratified drift (?)	Pulley	No.
234	Caroline Leete	20	do	20	16	Stratified drift	do	Almost.
235	Lottie Hull	20	do	13	9	do	Chain pump	
236	Schoenknecht	5	Valley	8	3	do	Pulley	No.
237	L. W. Howell	20	Ridge	17	11	Chiefly bedrock	do	No.
238	Pardee	20	Valley	16	10	Stratified drift	do	No.
a239	L. W. Howell	20	Ridge	18	15	Probably bedrock	None	Yes.
240		15	Valley	12	6	Stratified drift	Pulley	(?).
241	Cassimere	20	Ridge	14	10	do	do	No.
242	do	20	do	18	13	do	do	No.
243	Wellman	20	Hill	16	7	Stratified drift to bedrock.	do	No.
244	Knox	20	Flat	14	9	Stratified drift	do	No.
245	Andrew Watrous.	20	do	16	12	Stratified drift 13 feet, bedrock 3 feet.	do	Almost.
246	W. S. Parmelle	20	do	13	10	Stratified drift	Hand windlass	Almost.
a247		20	do	23	16	do	Chain pump	(?).
†248	Eugene Hall	14	Ridge	18	16	do	None	No.
†249		15	Flat	16	13	do	Chain pump	
a†250	Thompson	15	do	20	17	do	None	No
†251	Reader	20	do	24	18	do	do	(?)
†252	M. O. Hotchkiss	15	do	19	11	do	Chain pump	No
†253	do	20	do	19	12	Stratified drift and probably bedrock.	do	No
†255		5	do	8	5	Stratified drift	Hand pump	No.
†256	Stewart Smith	5	do	9	5	do	do	No.
257	Mrs. Blakeman	20	do	10	5	do	Pulley	No.
258	Jennie Watrous	15	do	15	8	do	do	No.
259	Whedon	20	do	14	9	do	Chain pump	No.
260	do	20	do	13	7	do	Pulley	No.
261	John Bennet	20	do	20	15	do	do	No.

f Diameter 12 feet. About 1,000 gallons pumped daily by 2½-horsepower gasoline engine. Draw down said to be scarcely noticeable.

Records of wells and springs in Madison—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
262	Simpson	20	Flat	15	12	Stratfield drift	Pulley	No.
263	Geo. Whedon	20	do	20	15	do	do	No.
264	Busch	20	do	15	7	do	Chain pump	No.
265	Kelsey	20	do	12	7	do	Pulley	No.
a†266	John Bennet	5	do	12		do	Windmill	No.
†267	Dr. Parker	2.5	Beach	9	5	do	Hand pump	No.
a†268	A. S. Clark	3	do	9	4	Stratified drift to bedrock.	None	No.
269	Ayer	3	Flat	10	4	Stratified drift	Hand pump	No.
270	R. J. Buell	20	do	14	7	do	do	No.
271	Derendahr (?)	20	do	11	5	do	Pulley	No.
272	W. J. Pierce	20	do	11	5	do	do	No.
273	Thomas Scranton.	20	do	11	8	do	Hand pump	Almost
274	W. D. Whedon	20	do	14	9	do	Pulley	No.
275	Calhoun	15	do	12	5	Bedrock	Chain pump	No.
276		15	do	10	6	Stratified drift	Hand pump	No.
277	F. W. Seaham	20	do	20	14	do	Hand bucket	Yes.
278	E. A. Dowd	20	do	12	8	do	Hand pump	Yes.
279	W. S. Hill	20	do	14	10	do	Pulley	No.
281	A. Scranton	20	Hill	16	9	Chiefly bedrock	None	No.
a282	Theis	20	Flat	17	12	Stratified drift	do	No.
284	Schroeder	5	Valley	9	6	do	Pulley	No.
285	Redfield	15	do	13	10	do	Hand pump	No.
286	Booth	20	Flat	17	9	do	Pulley	No.
287	W. Frances	20	do	16	8	Stratified drift to bedrock.	do	No.
288	E. Stone	20	do	20	12	Stratified drift	do	No.
289		15	do	10	8	do	Chain pump	(?).
a†290	Robert S. May	7	do	12	9	do	None	(?).
291	Shore Line Electric Co.	15	Slope	16	10	do	Pulley	No.
292	Graves	20	Flat	14	8	do	None	No.
293	F. W. Williams	40	Hill	15	10	Till to bedrock	Pulley	Rarely.
294	Josifko	20	Slope	15	10	Stratified drift to bedrock.	do	Yes.
295	Ayer	20	do	8	4	Stratified drift	do	No.
296	William Hine	20	Terrace	15	12	do	do	No.
297	Fred Daniels	20	Slope	18	14	do	do	No.
298	Charles Jones	20	Terrace	16	13	do	do	No.
299	Lees	20	Hill	18	15	Some bedrock	do	No.
301	Madison Poorhouse.	20	Valley	15	10	Stratified drift	do	No.
302	Walter Lewis	20	Terrace	29	25	do	do	Rarely.
303	do	20	do	19	15	do	do	No.
304	John Sloboda	20	Flat	15	11	do	Hand pump	No.
305	L. B. Leete	20	do	16	13	do	Pulley	No.
306	N. D. Meigs	20	do	21	19	do	do	No.
307	S. L. Chard	20	do	15	12	do		No.
308	do	20	do	16	13	do	Hand pump	No.
309	Willis Meigs	20	do	17	14	do	Pulley	No.
310	Shore Line Electric Co.	15	do	15	12	do	Hand pump	No.
312	C. H. Beckwith	20	do	17	14	do	Pulley	No.
314	L. J. Brockett	20	do	17	14	do	do	No.
315	Gladwyn	20	do	15	11	do	Pulley; also power pump.	No.
316	C. F. Dudley	15	do	13	10	do	Pulley	No.
317	do	15	do	13	10	do	do	No.
318	P. Hard	15	do	10	8	do	do	No.
320	Watson Bradley	20	Hill	16	14	do	do	No.
321		20	Flat	15	11	do	do	No.
323	Miller	25	Hill	24	21	Stratified drift to bedrock.	do	No.
†325	Willard	20	Slope	12	9	Stratified drift	do	No.
†326	C. Meigs	10	Flat	8	4	do	Hand pump	No.
328		2	do	7	2	do	None	No.
†329	Winchester Repeating Arms Co.	15	Hill	16	14	do	Hand bucket	No.

a Diameter 10 feet.

Records of wells and springs in Madison—Continued

Driven wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Diameter (inches)	Kind of rock	Equipment
158	Loveday	40	Valley		2	Stratified drift	Hand pump.
[h]195	New York, New Haven & Hartford Railroad.	40	Flat		3	do	Do.
199	G. L. Parmelle	20	do	10–15	2	do	Do.
202	William Johnson	20	do	29	2	do	Do.
206	Knox	20	do		2	do	Do.
208	Stannard	20	do		1	do	Do.
283	W. A. Wilcox	20	do	23	2	do	Do.
311	C. H. Meigs	20	do	16	1.5	do	Do.
313	C. H. Beckwith	20	do	15	1.5	do	Do.
319		15	do	8–10		do	Do.
322	James Dowd	20	do	18	1.5	do	Do.
324	George Haig	20	do		1.5	do	Do.
†327	C. Meigs	2	Edge of salt marsh	±10	1–2	do	Do.

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Yield (gallons per minute)
33	B. Tennyson	360	Slope	70		Nearly all bedrock	Hand pump	
132	Sonnichsen	100	Hill	60	12	Till 16 feet, bedrock 44 feet.	do	
134	J. Sonnichsen	110	do	150		Chiefly bedrock		
†254	G. U. Root	5	Flat	150	5	Stratified drift 32 feet, bedrock 118 feet.	Windmill and gasoline engine.	25
280	F. Bushnell	20	Hill	147	5–10	11 bedrock	Gasoline engine	

Springs

No. on map	Owner	Altitude above sea level	Topographic position	Source	Improvements	Yield (gallons per minute)
10	Seifert	300	Gentle slope	Bedrock under thin till cover.	Trench 2 feet wide and deep in till.	2 (est.)
15	Joseph Rene	340	Base of slope	Till	Open pit 2 feet deep.	2½
51	I. Chittenden	280	Head of ravine	Seep from till	None	
96		50	Valley at foot of bluff.	Seep from stratified drift.	Small open pit	
[i]136	Schmitting	60	Side of valley	Probably from bedrock but emerges through stratified drift.	Stone-walled pit 4 by 6 feet.	3–4 (est.)
171	L. A. Dowd	60	Valley at head of stream.	Seep from till(?)	Pit 3 feet deep, concreted.	
[j]300		60	Head of ravine	Till and bedrock	Pit, board cover	

[h] Driven inside dug well 18 feet deep.
[i] Called Crystal Spring. Water boils up from rock crevices through sand and emits bubbles of gas. Water has sometimes been sold as beverage.
[j] Gravity pipe line to house.

GUILFORD

AREA, POPULATION, AND INDUSTRIES

Guilford has a relatively short water front but extends northward for more than 11 miles, with an average width of about 4 miles. Its total area is 30,193 acres, or 47.2 square miles. Its population in 1920 was 2,803. The town was settled in 1639 and prides itself upon possessing the oldest house in Connecticut, the home of Henry Whitfield, one of the founders of the colony. Guilford is also known as the birthplace and home of the poet Fitz-Greene Halleck (1790–1867). The town is divided geographically into two parts, which center about the villages of Guilford and North Guilford. Between the two parts is a belt of rough, wooded country with few roads or houses. The principal industry of Guilford is agriculture, but considerable quarrying is done, and there are a few small factories making iron products, furniture, and canned foods. Sachem Head, on the Guilford shore, is a well-known summer resort.

TOPOGRAPHY AND DRAINAGE

The highest land in Guilford is on Totoket Mountain, a broad trap ridge in the northern part of the town. The crest of the ridge is from 600 feet to about 780 feet in altitude. Near North Guilford the hills rise to an altitude of about 300 feet, and from them the surface slopes gradually southward to sea level. In the northern part of Guilford there is some very rugged country with a relief of about 500 feet, but in general the relief does not exceed 100 feet. Most of the streams flow southward through a number of narrow parallel valleys. The two principal streams are West River and East River, both of which reach Long Island Sound at Guilford Harbor. A small area in the northern part of the town is drained northward into Durham.

The Guilford shore is steep and rocky, with many off-shore rocks. Its beaches are few and consist mainly of short bars at the heads of small bays.

GEOLOGY

Bedrock.—All of Guilford except the northwest corner is underlain by crystalline rocks. The most abundant are the Stony Creek granite gneiss and the Middletown gneiss.

The Stony Creek granite gneiss underlies the southwestern part of Guilford, in the vicinity of Leete Island and Sachem Head, and extends 3 or 4 miles into the interior. It has been quarried at Hoadley Point, near Leete Island, and at other localities. Northeast of the area of Stony Creek granite gneiss is the area of Middletown gneiss.

The northwest corner of Guilford is underlain by Triassic sandstone and trap rock. Along the eastern face of Quonnipaug Mountain the sandstone is very hard and conglomeratic and is well exposed in a steep bluff. Great blocks have fallen from the cliff and cover the slope along the road at Lake Quonnipaug. Some of the blocks have rolled into the lake, where they are exposed above the water level. Trap rock forms the upper part of Totoket Mountain and is exposed throughout large areas, particularly where the slopes are steep, as at Bluff Head.

One of the most striking topographic features of the town of Guilford is the valley developed along the fault zone at the contact between the crystalline rocks and the Triassic sandstone and trap.

Drift.—About 90 per cent of the area of Guilford is covered by till. It occupies the hills and slopes and ranges in thickness from a few inches to 40 feet or more. In the region underlain by the Stony Creek granite gneiss, in the southwest corner of the town, the till cover is very thin, and large patches of bare rock are exposed. The records of wells 203 to 273 indicate that the till in that area rarely exceeds 15 feet in thickness. Farther north and east on Moose Hill, Prospect Hill, Hungry Hill, and Clapboard Hill the till is more than 25 feet thick. (See records of wells 148, 149, 173, 186, 187.) The greatest thickness of till reported is 38 feet on Moose Hill, in well 186. Over the sandstone and trap in the northwest corner of the town the till cover in few places exceeds 10 feet in thickness. Near North Guilford there are two conspicuous drumlins, joined together in the fashion of Siamese twins, which are called Sugar Loaf Mountain. They stand nearly 200 feet above the surrounding land, but it is doubtful if all this thickness is till.

Stratified drift is the surface formation over about 10 per cent of the area of Guilford. It occurs in narrow belts along the larger valleys and underlies a plain of considerable extent on which the borough of Guilford is situated. Even in the Guilford plain, however, outcrops of bedrock are common, and the thickness of the stratified drift rarely exceeds 40 feet. The Spencer & Sons Foundry, near the center of the borough, reports having drilled a well 80 feet deep which did not reach bedrock, but this is exceptional. The deepest dug well, No. 6, in the north end of the town, measured 39 feet in depth and was entirely in the stratified drift.

WATER SUPPLY

The chief uses of ground water in Guilford are for domestic supply and for stock, as the principal industry of the town is agriculture. The borough of Guilford and some contiguous areas are supplied with water by the Guilford-Chester Water Co. from a reservoir in Killingworth. The pressure reservoir for Guilford is on Clapboard Hill. Wells are the chief source of supply outside the borough, and even within its limits many wells are still in use, as the owners prefer well water to that of the public supply, especially for drinking. The table following this description gives the records of 357 dug wells, 39 drilled wells, and 21 springs. About one-fourth of these supplies are in the borough of Guilford. Probably 60 to 75 per cent of the wells in the town were examined. The location of wells and springs is given in Plate 5 and Figure 15.

Wells.—The kind of well used depends largely on the nature of the formation. Where till or stratified drift is thick enough to yield water, dug wells prevail. Where bedrock is at or near the surface drilled wells are common. For this reason drilled wells are numerous in the southwest part of the town near Sachem Head and Leete Island and also in a small area in the northwest corner of the town, where the Triassic sandstone is only thinly covered by till.

The deepest dug well in stratified drift is No. 6, which is 39 feet in depth, and the deepest in till is No. 186, which is 38 feet in depth. Some dug wells are only 4 to 6 feet deep—hardly more than pools in swampy ground. The average depth of 354 dug wells in the town is 16 feet.

Most of the dug wells yield adequate supplies for a family, but the percentage of failures is high compared with that in most other large towns and in the area as a whole. (See table.) Analyses of samples of water from 5 dug wells in Guilford (Nos. 148, 149, 150, 151, and 224) are given on page 36. The waters represented by Nos. 148, 149, 150, and 151 are moderately high in mineral content and, with the exception of No. 150, are rather hard and will form considerable scale in boilers. No. 224 is highly mineralized and shows contamination by sea water.

Of the 39 drilled wells examined 35 average 76 feet in depth. The deepest well (No. 403) is 300 feet in depth, but most of them do not exceed 100 feet. The average yield of 7 for which reports were obtained is 44 gallons a minute. As a rule the supply from a drilled well is sufficient for a family but is less than that of a dug well. The futility of deep drilling is illustrated by a comparison of wells 402 and 403. No. 402 is a dug well in stratified drift, 15 feet in depth, which supplies more than a thousand gallons a day for the use of a large residence and a stock farm. No. 403, a drilled well 300 feet deep, in the center of the dug well, yielded only about a quart a minute and was abandoned. An analysis of a sample of water from the 140-foot drilled well of B. W. Bishop (No. 280) is given on page 36.

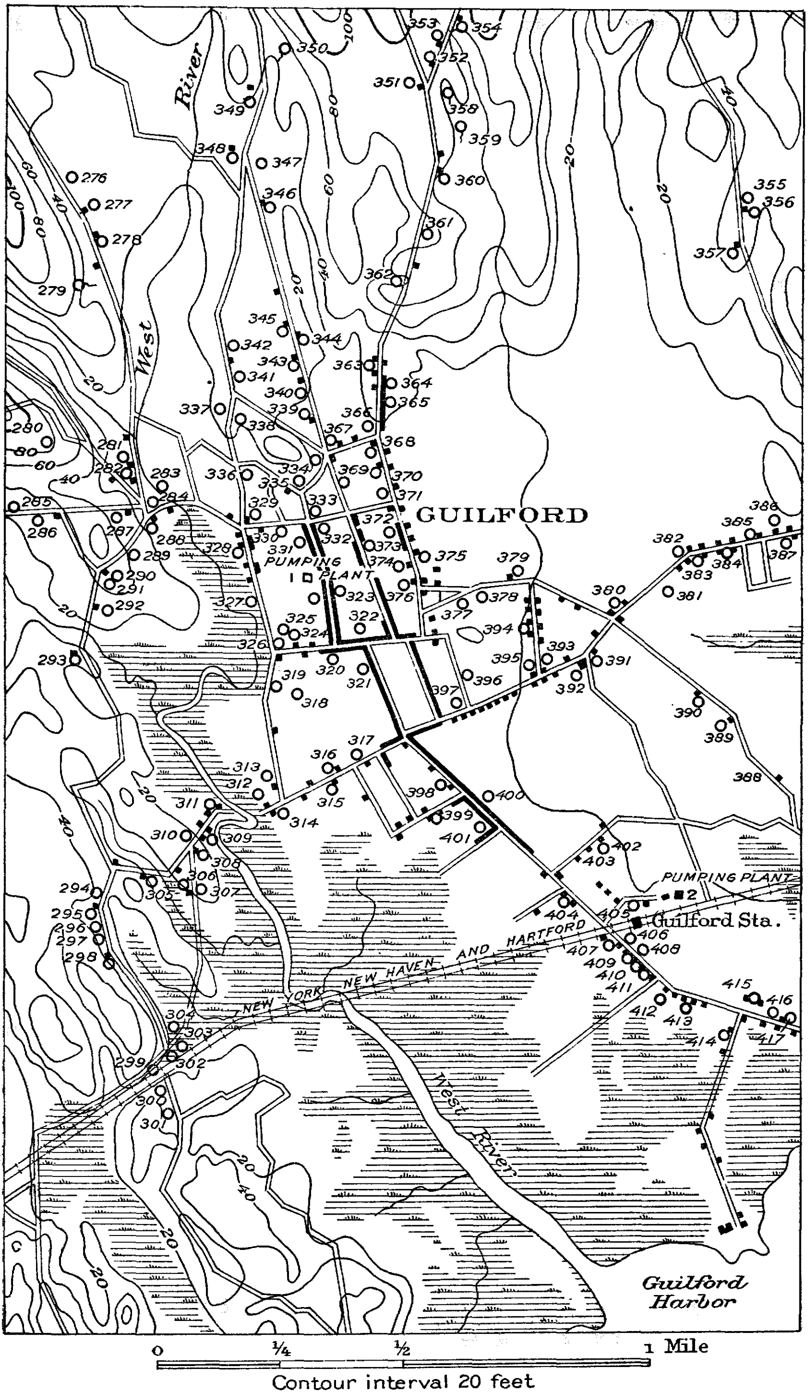

FIGURE 15.—Map of Guilford and vicinity showing location of wells and springs. (Base from map of Guilford quadrangle, surveyed in 1890)

This water is moderately low in mineral content and hardness and is satisfactory for most purposes.

Springs.—The 21 springs examined occur in typical topographic situations, usually at the foot of steep slopes or rock ridges, at the edges of valley flood plains, or at the heads of small ravines. Three issue at the base of stratified drift terraces. Eight appear to issue from till, and the remaining 10 from fractures in rock. Generally rock fractures are the real source of springs that issue through a drift cover, as shown by excavations. No. 102, owned by Wilcox Bros., is a good example. It issues on the edge of a flood plain, apparently in stratified drift, but the excavation of a reservoir 4 feet deep revealed the water bubbling up through crevices in the bedrock. Most of the springs yield only a few gallons a minute. The Wilcox spring, one of the strongest, had a measured flow of 8 gallons a minute.

Industrial supplies.—The two pumping plants in Guilford are shown in Figure 16 and are described below.

1. Spencer & Sons Iron Foundry. Originally water for the foundry was taken from a shallow dug well in stratified drift. The yield was inadequate, and a drilled well 3 inches in diameter was sunk inside the dug well to a depth of 80 feet, entirely in stratified drift. This overflowed into the dug well, which acted as a reservoir. The water was used for the entire factory supply, including drinking and boiler feed. It deposited much hard scale, and as the supply became inadequate for growing needs, the well was abandoned several years ago for city water.

2. Knowles-Lombard Co. canning factory. Water is obtained from a dug well in stratified drift. The well is 10 feet in diameter and is reported to be 18 feet deep. The depth to water is about 6 feet. The water is used for washing and rougher factory needs through the canning season but is too hard to be used in boilers. The water level is not visibly lowered by pumping with a 2½-inch double-action steam pump.

Suggestions for development.—Much water could be recovered by shallow dug or driven wells in the areas of stratified drift, particularly on the Guilford plain. The prevailing methods of obtaining domestic supplies of water from dug or drilled wells are generally satisfactory. Dug wells would probably yield as good water and in greater quantity than drilled wells, but there is some preference for drilled wells because the water is believed to be better protected from pollution.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Guilford

[Observations made May 11 to 28, 1919, except well 250, which was examined June 16, 1919, and wells 1-90, which were examined Nov. 1 to 6, 1919. a before number of well indicates that well is abandoned. Dagger (†) indicates that notes are given in Water-Supply Paper 537; for equivalent numbers in that report, see table on p. 52. For descriptions of pumping plants, which are numbered in a separate series, see p. 73]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
1	Durant	300	Ridge	13	10	Till	None	(?).
2	Polici (?)	240	Slope	10	3	do	Hand bucket	(?).
4	Seifert	180	Valley	15	8	Stratified drift	Hand pump	No.
6	Meyer Huber	220	Terrace	39	35	do	Hand windlass	No.
8	Rusconi	180	Valley	22	16	do	Pulley	No.
9	Meyer	175	do	4	1	do	Hand pump	No.
10	O. Cummings	300	Sink on hill	12	3	Till and sandstone.	Gravity pipe line.	Yes.
11	Christie	340	Hill	17	12	do	Pulley	Yes.
14	Norton	280	Bench	27	19	Till 8 feet, sandstone 19 feet.	do	Yes.
15	W. Rossiter	250	Terrace	28	20	Till and sandstone.	do	Yes.
16		240	do	28	22	Till and probably sandstone.	do	(?).
17	Adams	240	Slope	20	9	Till 8 feet, sandstone 12 feet	do	No.
19	John Ramonat	330	Valley	8	2	Till to sandstone	Hand bucket	No.
20	Anderson	340	Slope	14	6	Till 6 feet, sandstone 8 feet.	None	Yes.
22	Byronton	340	do	23	13	Till and sandstone.	Pulley	Yes.
26	Hubbard	340	Hill	24	14	Till and probably rock.	do	Yes.
27	Chittenden	330	Slope	21	11	Till and sandstone.	do	No.
28	W. H. Potter	340	Hill	19	7	Till to sandstone	do	No.
30		325	Terrace	18	8	Stratified drift and probably rock.	Hand pump	No.
31	Wettemann	330	Bench	13	6	Till and probably rock.	Chain pump	No.
32	Kiesel	330	do	14	8	Till and sandstone.	Hand bucket	No.
33	Dolph	360	Hill	24	14	do	Pulley	Yes.
35		200	Slope	12	6	Till and probably sandstone.	do	(?).
36	Tivas	230	Hill	16	7	Till	Chain pump	No.
37	F. W. Elliot	225	do	13	4	Till and bedrock	Windmill	No.
38	S. J. Bradley	230	do	19	12	do	Pulley	No.
39	F. Hubbard	230	do	26	10	Starts in till	Chain pump	No.
40		220	Slope	21	10	do	Hand windlass	(?).
41	E. L. Hubbard	210	Hill	26	13	Till and bedrock	Pulley	Rarely.
42	R. B. Fowler	200	Slope	20	10	Till	do	No.
43	Emmons	200	do	17	12	Till and bedrock	do	Yes.
44	Baldwin	180	Hill	18	7	Starts in till	do	No.
45	Jos. Schaffer	170	Slope	22	13	Till	Hand windlass	No.
46	Fowler	175	do	13	5	do	Pulley	Almost.
47	G. Devens	140	Terrace	20	16	Till and probably rock.	do	No.
48	Lane	140	do	16	7	Till and bedrock	do	No.
49	Nathan Dudley	160	Slope	18	14	Till and probably rock.	do	No.
50	Ira Dudley	200	do	18	14	Stratified drift	Hand windlass	Yes.
51	do	280	Hill	21	7	Till	Pulley	No.
a 52	Harrison	260	do	30		Till and probably sandstone.	Gasoline engine.	No.
54	C. Stutzueller (?).	220	Slope	12	6	Till and sandstone.	Hand pump	No.
55	W. E. Lane	285	Hill	19	8	do	Pulley	No.
56	J. B. Dudley	280	do	21	12	Probably sandstone.	do	Yes.
59		300	Valley	13	4	Till	do	No.
60	W. J. Lane	280	do	7	2	Till to sandstone	Chain pump	No.
63	Rossiter	300	Slope	16	10	do	Pulley	No.

a Depth reported. Piped to house ¼ mile away.

Records of wells and springs in Guilford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
65	Congregational Church.	350	Hill	18	3	Till	Pulley	No.
66		345	do	20	5	do	None	(?).
67	Chittenden	240	Bench	17	7	Till and probably sandstone.	Pulley	No.
68	Edw. Rossiter	240	do	15	7	Till and sandstone.	do	Yes.
69	Edw. Chapman	180	Slope	16	9	do	Sweep	No.
70		180	Valley	10	6	Stratified drift	None	(?).
71	C. Hiccock	180	do	10	6	do	Chain pump	No.
72	E. L. Baker	180	do	20	17	do	Pulley	No.
73	Geo. Bartlett	180	do	20	16	do	do	No.
74	In public road	180	do	15	11	do	None	No.
76		180	do	16	10	do	Pulley	No.
77	Fred Smith	180	do	10	5	Till to bedrock	Hand bucket	No.
88		180	do	12		Stratified drift	Pulley	No.
89		190	do	15	8	do	do	No.
80	W. L. Scranton	175	do	10	5	do	Chain pump	No.
82	F. Chittenden	175	Terrace	17	12	do	Pulley	No.
84	Kintz	210	do	17	14	do	do	Yes.
85	Hesselink	190	do	22	19	do	do	No.
86	R. E. Scranton	190	do	16	12	do	do	No.
87	Haggerty	190	do	19	15	Stratified drift to bedrock.	do	No.
88		180	do	24	20	Stratified drift	None	(?).
89	Martin	180	Valley	16	12	Stratified drift probably to bedrock.	Pulley	(?).
90	Miller	120	do	10	8	Stratified drift	Hand bucket	Yes.
91	Schaf (?)	160	Hill	19	10	Till	Hand pump	No.
92	W. H. Lee	110	Slope	17	10	Till and probably rock.	Pulley	(?).
93		100	Valley	16	9	Probably till	None	
94	Woodruff	180	Swamp	6	1	Till	Gasoline engine.	No.
95	Molluski (?)	120	Hill	25	18	Till to bedrock	Pulley	Yes.
97	Harold	160	do	15	10	do	Hand pump	No.
98	Weed	160	do	22	10	Till	Pulley	No.
99	Cobb	160	do	23	5	do	Hand pump	No.
100	Cohen	130	Slope	17	2	Till, probably to rock.	Hand bucket	No.
101	do	120	do	20	13	Till	Chain pump	No.
103	W. C. Bishop	140	Hill	13	5	Till to bedrock		No.
104	Heckler	140	do	22	9	Till and probably rock.	Hand pump	No.
105	W. C. Bishop	140	do	11	3	do	Chain pump	Yes.
a106	E. Gillington	160	do	20	12	Till	do	No.
107	Davis	50	Valley flat	24	18	Stratified drift	do	Rarely.
b108	do	50	do	23	21	do	Pulley	No.
109	Frenchini (?)	40	do	16	12	do	Chain pump	No.
110	A. D. Monger	40	do	20		do		No.
111	Parmelle	50	do	25	20	do	Hand pump	No.
112	Dr. Hall	40	do	26	19	do	Chain pump	No.
113		40	do	23	15	do	Hand pump	No.
114	A. Costello	40	do	22	15	do	Pulley	No.
115	Fred Dudley	40	do	19	14	do	do	No.
116	Hasmott(?)	140	Hill	9	5	Till 3 feet, rock 6 feet.	do	Yes.
117	Warner	40	Valley flat	18	11	Stratified drift	Hand pump	No.
118	Spencer	40	do	17	9	do	do	No.
119	E. C. Meigs	40	do	15	10	do	Chain pump	No.
120	S. Parmelle	40	do	15	10	do	Pulley	No.
a121		40	do	14	10	do	None	Yes.
122	Geo. Hofer	40	do	15	10	do	Hand pump	No.
123	Firstle	200	Hill	30	14	Till	Pulley	No.
124	Essweim	190	do	22	8	Till and rock	do	No.
125	H. E. Parmelle	40	Valley	18	12	Stratified drift	do	No.
126	Parmelle	90	Slope	20	3	Till and probably rock.	Windmill	No.
127	do	90	Sink on hill	20	10	Till and rock	Pulley	Yes.
128	Dodge	140	Hill	20	6	Till	Hand pump	No.

b No fluctuations of level ever noted.

Records of wells and springs in Guilford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
129	Carl Vahaben	140	Hill	21	12	Till	Pulley	Yes.
130	Murray	100	Slope	22	15	do	Sweep	No.
132	Barnes	60	Hill	14	7	Chiefly rock	Hand pump	Yes.
133	Schutte	100	do	28	13	Till	Hand windlass	No.
134	May	80	do	20		do	Chain pump	Almost.
c135	F. B. Bishop	15	Terrace	15	8	Stratified drift	Hand pump	No.
136	Charles Williams	12	Flat	14	7	do	do	No.
137	C. C. Knowles	7	do	12	8	do	Pulley	No.
138	C. H. Cutler	10	do	8	3	do	Hand pump	No.
139		20	do	15	8	do	Pulley	No.
140	Geo. E. Norton	30	Slope	10	5	Till and probably rock.	None	No.
141	Joe Dominic	60	do	12	5	Till	do	(?).
142		60	do	13	9	do	Pulley	No.
143	Blatchley	15	do	19	11	Stratified drift	Chain pump	No.
144	Joe Tastori	5	Marsh	5	1	do	None	No.
145	Turner	40	Slope	16	8	Till and probably rock.	Pulley	No.
d146	G. L. Criswold	40	do	16	9	Till	do	No.
e148	Paul Dudley	100	Hill	35	10	do	do	No.
f149	H. C. Dudley	100	do	33	12	do	do	No.
150	Willis Nettleton	95	do	20	5	do	Hand pump	No..
g151	E. Griswold	100	do	28	14	do	do	No.
152	Nettleton	90	do	26	5	do	do	No.
153	Wm. Dudley	60	Slope	15	8	do	Chain pump	No.
154	Eli Dudley	40	do	12	6	do	Hand pump	No.
155	A. A. Dudley	40	do	13	7	do	do	No.
156	Jos. E. Dudley	30	do	11	7	Till probably to rock.	Pulley	No.
157	Eli Dudley	25	do	10	6	do	do	(?).
158	do	30	Terrace	24	21	Stratified drift	do	Yes.
159	Gloss (?)	40	Slope	17	9	Till to rock	Hand pump	No.
160	W. Baise	40	do	17	7	do	Pulley	No.
161	Mrs. Foote	40	Terrace	16	8	Stratified drift	Hand rope and bucket.	No.
162	Luttig	40	do	18	7	Chiefly bedrock	Pulley	No.
163	Blanchley	50	Slope	16	12	Till and probably rock.	Hand bucket	No.
164	Evarts	60	do	13	5	Till and bedrock	Pulley	Yes.
165	Geo. Lovell	50	do	12	5	do	do	Yes.
166	Fuchs	80	do	13	6	Till	do	No.
167		100	Valley	8	3	do	Hand pump	Yes.
169	McConnel	120	Hill	23	16	do	Pulley	No.
170	J. Buchda	120	do	14	7	do	Hand pump	No.
171	Ira Brewer	110	do	19	11	do	Pulley	No.
172	I. Testori	125	Swamp	5	0	do	None	No.
174	Connecticut Stock Farm.	70	Valley	19	9	do	Hand pump	No.
175	do	70	do	12	6	do	Hand bucket	No.
176	Wall	100	Slope	9	0	Till and rock	None	No.
h178	Bremmer	160	Hill	18	3	Till	Hand pump	No.
179	A. Novarthe	100	do	15	7	do	Pulley	Yes.
180	do	100	do	24	2	do	do	No.
181	F. Balzerouski	180	Slope	15	5	do	Sweep	No.
182	Harrison	170	Hill	15	9	Till and bedrock	Pulley	Yes.
a184		110	Valley	12	5	Till	None	(?).
185	E. G. Fisher	120	Hill	20	3	do	Hand windlass	No.
i186	Kneuer	190	do	38	20	Till to bedrock	Pulley	No.
187	do	190	do	30	15	Till	Hand pump	No.
188	R. I. Kelsey	160	do	20	4	do	Pulley	Yes.
189	A. C. Blever	100	do	22	5	do	Gasoline engine.	No.
190	W. C. B. Goldsmith.	90	do	16	10	do	Pulley	Yes.
191	do	80	Slope	9	3	do	None	No.
192	Miner	80	do	15	6	do		Almost.
193	do	75	do	15	7	do	Hand pump	No.
194		100	do	15	7	do	Pulley	No.
195	J. Woiharski	80	Valley	8	3	Stratified drift	do	No.

c Water reported to be hard after rains when well is full.
d Water reported to be exceptionally hard when well is very full.
e Fluctuation of level nearly from top to bottom.
f Sometimes only 2 feet of water in bottom.
g Water is said to "sweat in" from all sides and to be harder when the well is very low.
h Range of fluctuation about 15 feet.
i Sometimes as little as 6 feet of water

Records of wells and springs in Guilford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
196		80	Hill	25	7	Till	Pulley	(?).
197	M. Smith	80	Slope	24	7	do	Chain pump	(?).
198	Peilroth	80	Flat	24	10	do	Pulley	No.
200	Quartz	50	Slope	15	5	do	Hand windlass	No.
[1]201	do	40	do	13	5	do	Hand pump	No.
202	Mrs. Dergan	30	Valley	16	7	Stratified drift	Pulley	No.
204	Butler	100	Hill	25	7	Till to rock	do	No.
206	W. C. White	100	do	22	13	Till and probably rock.	Hand windlass	Almost.
207	Esterly	90	do	20	5	Till	do	No.
208	John Doane	80	do	22		do	Hand pump	No.
209	Lenholt	60	do	18	5	Till to rock	do	Yes.
210	Good	60	do	19		do	do	Yes.
211	Mrs. Seman	30	Slope	15	8	Till and rock	do	No.
212	Wm. S. Leete	40	do	13	8	Till	Chain pump	No.
213	David Beattie	30	Valley	13		do	do	Yes.
214	Samdon	40	do	17	10	Till to rock	Hand pump	Yes.
215	E. Anderson	20	do	14	5	Stratified drift	Chain pump	No.
216	A. Tonelli	20	Slope	16	4	Bedrock	Hand pump	Rarely.
217	O'Keefe	10	Valley	13	5	Stratified drift	Chain pump	No.
218	Thos. Hannigan	15	do	10	7	Stratified drift to rock.	do	No.
219	Beattie estate	15	Terrace	18	12	Stratified drift	Pulley	No.
220	Hackett	10	do	10	8	do	None	No.
†221	John R. Walker	10	Valley	9	5	do	Chain pump	No.
222		4	Edge of marsh.	10	5	do	Pulley	No.
†223	Mrs. Beattie	10	Slope	13	5	Stratified drift and rock.	Chain pump	No.
†224	Peter Beattie	4	Flat island	12	6	Stratified drift	Pulley	No.
†225	Mrs. Clark	14	Hill	22	14	Rock	Hand pump	No.
†226	do	4	Valley	12	5	Stratified drift	Chain pump	No.
†227	do	5	do	13	3	do	Electric pump	No.
229	Robt. Leete	30	Hill	15	13	Chiefly rock	Pulley	Yes.
231	Wm. S. Leete	30	Slope	16	9	Till 3 feet, rock 12 feet.	Chain pump	Almost.
232	Fields	15	do	13	7	Stratified drift	do	No.
236	Bayha	30	Valley	6	2	Till	Hand pump	No.
237	Chas. Hill	30	do	12	5	Till to bedrock	Pulley	No.
238	Sheppard	35	do	12	6	Till	Hand pump	No.
239	Richard Benton	40	Flat	14	6	Till 11 feet, rock 3 feet.	Hand windlass	Yes.
240	do	40	do	14	5	Till 12 feet, rock 2 feet.	Hand bucket	Almost.
241	Benton	40	Valley	10	2	Till to rock		No.
242	W. B. Davis	20	do	13	5	Till	Hand pump	No.
243	Edw. Elliot	10	Slope	±20		Till and probably rock.	do	No.
†244	Mrs. C. Mitchell.	10	Ridge	18	7	Bedrock	Chain pump	No.
†250	H. C. Noble	7	Flat	12	7	Till to rock	Electric pump	No.
†251	do	5	do	15	5	Till 10 feet, rock 5 feet.	do	No.
†252	Mrs. C. Barker	5	do	10	3	Till and rock	Hand pump	No.
†253	Barker	10	Slope	9	5	do	do	Almost.
†254		3	do	9	3	Till	Chain pump	No.
[2]255	H. C. Noble	20	Hill	22	6	Bedrock	Electric pump	No.
256	Sachem Head Hotel.	10	Swamp	21	2	Till	do	No.
257		20	Hill	19	6	Chiefly bedrock	Hand pump	(?).
258	Benton	10	Valley	7	2	Stratified drift (?)	Gasoline engine.	No.
†263		4	Beach	9	5	Stratified drift	Hand pump	No.
†264		5	do	8	7	Sand	do	No.
265		4	Terrace			Stratified drift	do	No.
[3]268	D. R. Spencer	40	Hill	14	5	Till and probably rock.	Chain pump	No.
270	Mrs. Carlin	15	Slope	9	5	Chiefly rock	Hand pump	No.
†273	Stevens	20	Hill flat	20	8	Till and probably rock.	do	No.
a†275	do	5	Beach	11	7	Stratified drift	Pulley	No.
276	L. R. Miller	30	Valley flat	16	7	do	Chain pump	No.
277	Chittenden	30	do	25	17	do	Hand pump	No.
278	Bishop	30	do	18	9	do	Hand windlass	No.

[1] Water said to be hard after rains.
[2] Diameter 20 feet.
[3] Also supplies water by siphon to house below.

Records of wells and springs in Guilford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
281	Cariss	20	Valley flat	10	5	Stratified drift		No.
282	Clayton	20	do	13	7	do	Pulley	No.
283	Stevens	10	do	13	9	do	Hand pump	No.
284	Nelson Norton	10	do	10	5	do	Chain pump	No.
285	Vogel	30	Valley	20	10	do	Hand pump	No.
286	Hull	25	Valley flat	22	15	do	Chain pump	No.
287	Bishop	40	Slope	22	13	Till	do	No.
288	Chriestein	10	Valley flat	10	4	Stratified drift	None	No.
290	S. C. Spencer	40	Hill flat	17	10	Till	Hand pump	Yes.
291	do	40	do	20	13	do	do	No.
292	Spencer	30	Slope	15	8	do	Pulley	No.
293		20	Terrace	25	15	Stratified drift		No.
294	Mrs. Jacobs	20	Valley	13	8	Stratified drift to rock.	Hand bucket	No.
295	Chas. Bowen	10	do	13	4	Stratified drift	Chain pump	No.
296		15	do	13	1	Stratified drift (?)	Pulley	No.
297	May P. Hunt	20	do	10	1	Stratified drift (?) and bedrock.	do	No.
298		20	Slope	8	4	(?)		(?).
299	Barnard	40	Valley	12	5	Till	Hand bucket	No.
300	Phillip White	40	Slope	17	11	Till and probably rock.	Pulley	Almost.
301		40	Valley	14	5	Till	do	(?).
302	Tom O'Neal	30	Hill	13	7	Till and probably rock.	do	No.
303	Stannard	10	Valley	7	2	Stratified drift	do	No.
304	Hunt	5	Edge of marsh.	4	1	do	None	No.
305	Ashman	20	Ridge			do	Hand pump	No.
306	Chas. Crocker	5	Valley	5	1	do	do	No.
307	Owen Daly	20	Ridge	16	9	do	do	Yes.
†308	Geo. Brown	20	do	14	9	Stratified drift 10 feet, rock 4 feet.	Pulley	Almost.
†309	Louise Ross	10	Slope	16	9	Stratified drift	do	No.
310	Crum	20	Ridge	17	9	do	None	(?).
311	Blatchley	15	Slope	13	8	do	Pulley	No.
†312	Sullivan	5	Valley	6	2	do	do	No.
313	Chittenden	10	Flat	9	5	do	Hand bucket	No.
†314	Guilford Poorhouse.	5	Valley	6	2	do	Hand pump	No.
315	Meigs	10	Flat	9	5	do	Chain pump	No.
316	G. Lush	10	do	10	6	do	do	No.
a317		10	do	8	1	do		No.
318	Chittenden	15	do	18	3	do	Windmill	No.
319	do	15	do	15	10	do	Hand pump	No.
320	Hubbard	10	do	13	7	do	Sweep	No.
321	Sheppard & Fowler.	15	do	14	8	do	Chain pump	No.
322		15	do	15	10	do	do	No.
323	West	15	do	10	5	do	Pulley	No.
324	Stone	15	do	13	7	do	Chain pump	No.
325	do	15	do	13	9	do	Hand pump	No.
326	do	15	do	15	1	do	do	No.
†327	Boone	5	Valley	6	1	do	None	No.
328	John Page	3	do	9	3	do	Pulley	No.
329	Bristol	15	Flat	12	7	do	Chain pump	No.
330	Mack	20	do	25	20	do	Pulley	No.
331	E. B. Leete	20	do	22	15	do	do	No.
332	Hubbard	20	do	20	13	do	do	No.
333	Stone	20	do	16	10	do	Sweep	Rarely.
334		20	do	12	2	do	Pulley	(?).
335	Potter	20	do	18	5	Stratified drift (?) to rock.	Chain pump	Yes.
336	Phelps	20	do	27	21	Stratified drift	Hand pump	No.
337		20	do	15	10	do	Pulley	No.
a338	Landon	20	do	15	8	do	do	No.
339	O'Neil	20	do	14	4	do	Chain pump	No.
340	J. B. Tillman	20	do	14	5	do	do	No.
a341	Sullivan	25	do	16	10	Stratified drift to bedrock.	do	Yes.
342	Roy Loper	25	do	18	11	Stratified drift	None	No.
343	Wm. Norton	20	do	15	6	do	Hand bucket	No.
344	Stevens	20	do	14	7	do	Hand pump	No.

a Water reported to be hardest in summer.

Records of wells and springs in Guilford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
345	A. B. Griswold	25	Flat	11	6	Stratified drift and rock.	Hand pump	No.
346	White	30	do	14	8	Stratified drift to rock.	Chain pump	No.
347	Robt. Maynard	30	do	15	10	do	Pulley	No.
348		30	do	16	10	Stratified drift	do	(?).
349	Vincenzo	40	do	12	3	Stratified drift to rock.	do	Yes.
352	Parker	100	Hill	20	11	Till and probably rock.	do	No.
353	Ledoux	100	do	19	13	Till and rock	Hand pump	Yes.
354	E. L. Bishop	100	Valley	8	5	do	Pulley	No.
355	G. Anderson	40	Terrace	16	6	Till	do	No.
356	do	40	do	17	8	do	Chain pump	No.
357	Carter	40	do	18	11	Stratified drift	Hand pump	Rarely
360	Gilbert Allen	80	Hill	15	10	Till and rock	Pulley	Yes.
361	Wodka	80	Valley	14	4	Till	Hand bucket	(?).
362	Bullard	80	Hill	25	22	Till 5 feet, rock 20 feet.	Hand pump	Yes.
363	A. Griswold	20	Valley flat	14	6	Stratified drift	Pulley	No.
364	Geo. Starr	20	do	15	8	do	Hand pump	No.
365	Howell	20	do	14	7	do	do	No.
366	Wilcox	20	do	11	8	do	Sweep	No.
367	Sullivan	15	do	13	5	do	Hand pump	No.
a368	Potter	20	do	15	7	do	Pulley	No.
369	Hawley	20	do	15	8	do	do	No.
370	Rossyn	15	do	13	6	do	Sweep	No.
371	do	15	do	10	5	do	Pulley	No.
372	Benton	15	do	11	4	do	Sweep	No.
373		15	do	13	5	do	Chain pump	(?).
374	Wright	10	do	10	4	do		No.
375	John Benton	15	do	10	5	do	Pulley	No.
376	Seward	10	do	14	7	do	Hand windlass	No.
377	Anderson	10	do	12	2	do	Chain pump	No.
378	Copeck	10	do	10	3	do	Pulley	No.
379	Lee	15	do	9	3	do	do	No.
380	Chas. Miller	15	do	12	4	do	Chain pump	No.
381	Dudley	15	do	14	4	do	do	No.
382		15	do	12	6	do	do	No.
383		15	do	13	8	do	Hand pump	No.
384	Verhayden	15	do	14	9	do	Pulley	No.
385	Field	15	Flat	11	7	do	do	No.
386		15	do	12	9	do	do	No.
387	Grosman	15	do	15	9	do	do	No.
388	G. F. Fuller	15	Hill	15	7	All rock	Hand bucket	No.
389	Rich	10	Valley	9	12	Stratified drift	Pulley	Almost
390	Herpst	10	do	12	5	Till (?) and rock	Chain pump	No.
391	Griffin	15	Flat	12	5	Stratified drift	Gasoline engine.	No.
392		15	do	14	7	do	Sweep	(?).
393	Geo. B. Rolfe	10	do	13	5	do	Chain pump	No.
394	Sullivan	15	do	10	3	do	Pulley	No.
395	Dudley	10	do	11	3	do	do	No.
396	C. M. Lee	15	do	14	7	do	Chain pump	No.
397	Mrs. Lane	15	do	10	3	do	do	No.
398	Prendleton	10	do			do	Hand pump	No.
399	John Anderson	10	do	12	8	do	Chain pump	No.
400	Norton	10	do	10	5	do	do	No.
401	C. D. Forsyth	10	do	12	7	do	do	No.
†a402	Woodruff	10	do	15	5	do	Electric pump	No.
404	Stevens	10	do	14	7	do	Hand pump	No.
405	Hall	10	do	15		do	do	No.
406	Norton & Roberts.	10	do	15	5	do	Chain pump	No.
407	Hill	10	do	10	5	do	Hand pump	No.
408	Fred Hart	10	do	15	5	do	Pulley	No.
409	Sullivan	10	do	12	5	do	do	No.
410	Mrs. Shay	10	do	15	5	do	Hand pump	No.
411	Page	10	do	15	9	do	do	No.
412		10	do	12	7	do	Pulley	No.
413	Champion	10	do	10	5	do	Hand bucket	No.
414	Kelsey	7	do	8	3	do	Chain pump	No.
a415		20	Ridge	+30	18	do		No.
416	Levi Thrall	15	Hill	22	18	do	Chain pump	No.
†417	E. L. Perry	10	Slope	16	+10	do	Hand pump	No.

a No. 402 supplies 1,000 gallons or more a day for large farm. It was dug around the drilled well, No. 403, the yield of which was inadequate.

Records of wells and springs in Guilford—Continued

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
12	Robt. Rossiter	300	Slope	50	C.L.Wright	Nearly all sandstone.	Hand pump	
13	Norton	300	Bench	50	do	Till 6 feet, sandstone 44 feet.	do	3½
18	A. Lindquist	340	Hill		do	Sandstone	do	2
21	Bartlett	300	do	92	do	Till 4 feet, sandstone 88 feet.	Windmill	2
24	Lindquist	365	do	80	do	Nearly all sandstone.	Hand pump	
25	Chas. Bartlett	360	do	78		do	Gasoline engine	
29	Potter	340	do	76		Till 2 feet, trap 74 feet.	Hand pump	4
34	Schlosser	340	Slope	48	C.L.Wright	Till 8 feet, trap 40 feet.	do	7
53	Tichy	260	Hill	66	do	Nearly all sandstone	do	
58	F. Rossiter	260	Slope	149	do	do	Windmill	
62	Henry Atwater	365	Hill	85	do	do	Hand pump	
75	Schultze	220	Slope	43	do	do	do	
168	Bennet	100	Hill	68		Chiefly bedrock.	do	
173	R. H. Woodruff	175	do	150		Till 25 feet, bedrock 125 feet.	Windmill	
[b]177	Munde	160	do	111	L. Basset	Nearly all bedrock.	Hand pump	
[c]199	Patrick	50	Slope	45		Till 8 feet, bedrock 37 feet.	do	
203	Good	110	Hill	65	C.L.Wright	Chiefly bedrock.	do	
†205	Richard Leete	100	do	50	do	Till 10 feet, bedrock 40 feet.	do	−1
228	John Beattie	50	do	35		Till 4 feet, bedrock 31 feet.	do	
230	G. M. Leete	40	do	34		Till 4 feet, bedrock 30 feet.	do	
233	Miner Leete	70	do	40		Till 5 feet, bedrock 35 feet.	do	
†245	G. H. Mitchell	5	Flat	65	C.L.Wright	Nearly all bedrock.	do	
a†246	do	5	do	90	do	do	None	
†247	Robert Mitchell	6	Ridge	27+	do	Bedrock	Hand pump	
†248	F. S. Baker	7	Flat	80-90	do	Nearly all bedrock.	Windmill	
†249	J. B. Miner	3	do	38	do	do	Electric pump	
†259	Chamberlain	15	Hill	100		Chiefly bedrock.	Hand pump	
260		15	do	Over 100		do	do	
261		15	do	About 50		do	do	([d])
[e]262		5	Slope	(?)		do	do	
266		20	do			do	Electric pump	
269	Mrs. Carlin	20	Hill	50		do	Hand pump	
†271	Gerrish	15	do	35-40		do	do	
†272	Stevens	20	do	63		do	do	
†274	Anderson	15	do	50		do	do	
280	Bishop	80	do	140	Grant	do	Windmill	10
289	Comenski	40	do	40	L. Basset	do	Hand pump	3½
351	Foster	90	do	55		do	do	
[a]†403	Woodruff	10	Flat	300	L. Basset	Stratified drift and bedrock.	do	([f])

[a] No. 402 supplies 1,000 gallons or more a day for large farm. It was dug around the drilled well, No. 403, the yield of which was inadequate.
[b] First drilled 60 feet but failed in summer and was deepened.
[c] Drilled in dug well 17 feet deep but failed.
[d] Fails.
[e] In bottom of dug well 12 feet deep.
[f] Very small.

Records of wells and springs in Guilford—Continued

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
3	Fred Nowak	180	Foot of terrace bluff.	Marshy seep from gravel.	Large pool housed over gasoline engine.	
5	Seifert	200	Valley	Stratified drift	Open hole in gravel	[t]2
7	In public road	200	Valley, foot of bluff	Bedrock under stratified drift.	Tile sunk 3 feet to bedrock.	
23	Fowler	340	Valley	Seep from till	Windmill	
57	J. B. Dudley	240	Valley, foot of sandstone ridge.	Fractures in sandstone.	Stoned pit 4 feet deep; windmill.	
61	Episcopal Church.	320	Valley, swamp	Seepage from stratified drift.	Tile sunk in gravel	[t]2-3
64	Rossiter	280	Valley	Seep from till	Barrel sunk in earth	
81	W. L. Scranton	200	Side of ravine	Fractures in bedrock.	Stoned pit; pipe line to house.	
83	Chittenden	200	Head of ravine	Sandstone	Covered pit; gravity pipe line to houses.	[t]2-4
96	Pettinchi	160	Foot of hill, border of swamp.	Till and perhaps rock.	Pit 4 feet deep; pump	
102	Wilcox Bros	70	Foot of hill, flood plain of stream.	Fractures in bedrock.	Concrete-lined pit; gasoline engine.	8
131	Murray	100	Head of small valley.	Bedrock	Large pit housed in	
147	Bartlett	60	Gentle slope	Till	Box sunk in till; gravity pipe line to house.	([u])
183	Rue	100	Valley, foot of hill	Probably bedrock beneath till.	Square boxed pit	2-3
234	Miner Leete	40	Valley	Seepage into drift-filled rock basin.	None, open pools	
235	Chas. Hill	15	Edge of steep-sided valley.	Seepage from drift	Stone-walled open pit	
[v]267	Griffine	2	Shore, at foot of slope.	Fractures in bedrock.	Masonry-lined pit and spring house; windmill.	
279	Stone	40	Hillside	do	Small open pit	([w]).
350		40	Small depression	Seepage from till and bedrock.	None	([x]).
358	A. M. White	75	Head of valley	do	Square covered pit; hand pump.	[t]1-2
359	Gilbert Allen	70	do	Probably bedrock	Small boxed pit	

[t] Estimated.
[u] Very small; almost fails.
[v] Only 2 feet above high tide.
[w] Small; fails.
[x] Several.

BRANFORD

AREA, POPULATION, AND INDUSTRIES

Branford is a coast town lying between Guilford and East Haven. It is roughly semicircular, the coast forming the straight side of the semicircle with an air-line length of about 6 miles. The shore line is very crooked, however, so that its actual length is much greater than 6 miles. The area of the town is 15,219 acres, or 23.8 square miles. The population in 1920 was 6,627. Besides the Borough of Branford there are settlements at Short Beach, Pine Orchard, and Stony Creek, all of which are shore resorts. The population is mainly concentrated in the borough and the shore villages; the agricultural interior is thinly settled. Agriculture, fishing, quarrying, and the manufacture of malleable-iron goods and wire are the principal industries. The Branford Memorial Library, a gift of one of its former citizens, is one of the town's justly celebrated institutions, being remarkable both in beauty and completeness for a place of such size.

TOPOGRAPHY AND DRAINAGE

The greatest altitude in Branford is about 260 feet, on Saltonstall Ridge, near the northern boundary. Toward the south the hills gradually decrease in height to sea level. The relief does not generally exceed 100 feet, but nevertheless the topography is very rugged and irregular. Branford River, which flows southwest across the town, drains a larger area than any other single stream. A smaller area in the western part of the town is drained through Farm River, Lake Saltonstall, and several small brooks. There are also several small streams in the eastern part that flow directly to the sea.

GEOLOGY

Bedrock.—The southeastern two-thirds of Branford is underlain by crystalline rocks and the northwestern third by Triassic sandstone and trap. The crystalline rocks are mainly of two varieties, the Stony Creek granite gneiss and the Branford granite gneiss. The Stony Creek gneiss occupies a triangular area in the southeast corner of the town. The Branford gneiss occupies a belt extending northeastward from Short Beach and including the Borough of Branford.

Drift.—Till is the surface formation over probably more than 80 per cent of the area of Branford. In the southeastern part of the town it contains many boulders of the underlying gneisses. In the drumlin area near Cherry Hill, however, the till is mostly a red clay derived from the shaly sandstone and is fairly free of boulders. The maximum thickness of till recorded in wells is 37.5 feet (No. 145), but the average is much less.

Stratified drift occurs in the valleys, the main deposit lying along Branford River and extending across the town. There are also many small isolated patches, particularly along the shore. Originally the stratified drift formed an extensive narrow plain in the Branford River Valley, but it has been cut away until only terrace remnants are left. Much of the lower part is now flooded by salt water and constitutes tidal marshes. A large part of the Borough of Branford stands on stratified drift, through which bedrock and till crop out at many places. It is in this region also that the cover of stratified drift appears to be the thickest. A thickness of 42 feet is recorded in the Morton well (No. 279) on Montowese Street, and more than 30 feet in several other wells. There may be even more at some localities.

WATER SUPPLY

Water from Branford Reservoir on Queach Brook is supplied to the Borough of Branford and to the shore settlements, except

Stony Creek, by the Branford Water Co., a subsidiary of the New Haven Water Co. This supply has been available for only a few years, however, and has not been extended to all the territory it can serve. Many wells are still in use in Branford Borough, either because the public supply is not available or because the users prefer well water. When the public supply is not taken, wells are the chief source of water for domestic use and stock. The appended table describes 370 individual water supplies, 343 of which are derived from dug wells. There are 12 drilled wells, 12 springs, and 3 driven wells. The records cover probably 75 per cent of all the wells in the town. Locations of these supplies are shown on Plate 5 and Figure 16. Dug wells usually derive their water from the drift, though some penetrate bedrock. The percentage of failures is higher than the average for the area. (See table.)

Wells.—The average depth of 343 dug wells is 18.5 feet, but the depth ranges from only a few feet up to 50 feet. The 50-foot well (No. 246) is almost entirely in bedrock and owing to its position on a hill goes dry in summer. Few of the wells exceed 30 feet in depth. The average depth to the water table, based on 344 measurements, is 11 feet. In till the average is 8 feet, and in stratified drift 14 feet. An analysis of a sample of water from the 23-foot dug well of Mr. Piscitella (No. 45) is given on page 36. This water is very hard and is not very satisfactory for most purposes.

Drilled wells are uncommon in Branford, but a few are used to obtain water from bedrock. Several in the western part of town are drilled in trap rock. Two drilled wells (Nos. 32 and 37) flow, though their yields are small. The conditions that cause these wells to flow are described on page 34. An analysis of a sample of water from the 78-foot drilled well of J. H. Kennedy (No. 35) is given on page 36. The water is moderately low in mineral content and hardness and is suitable for most purposes.

Springs.—Springs are used for domestic supply in a few places, particularly the rural regions. Three are equipped with gravity pipe lines. The yields are a few gallons a minute. Lanphier Spring (No. 78) is notable because it is located on the beach and occasionally is flooded by high tides. The water, however, quickly freshens after the tide recedes.

Suggestions for development.—Ground water is not now used for industrial purposes in Branford. Where tried it has generally been found to be hard and unsatisfactory for boilers. Large quantities of ground water could be obtained from the stratified drift in the valley of Branford River and elsewhere. The most favorable localities are indicated by the dot pattern on Plate 5. Driven wells could be used more commonly in the stratified drift to good advantage.

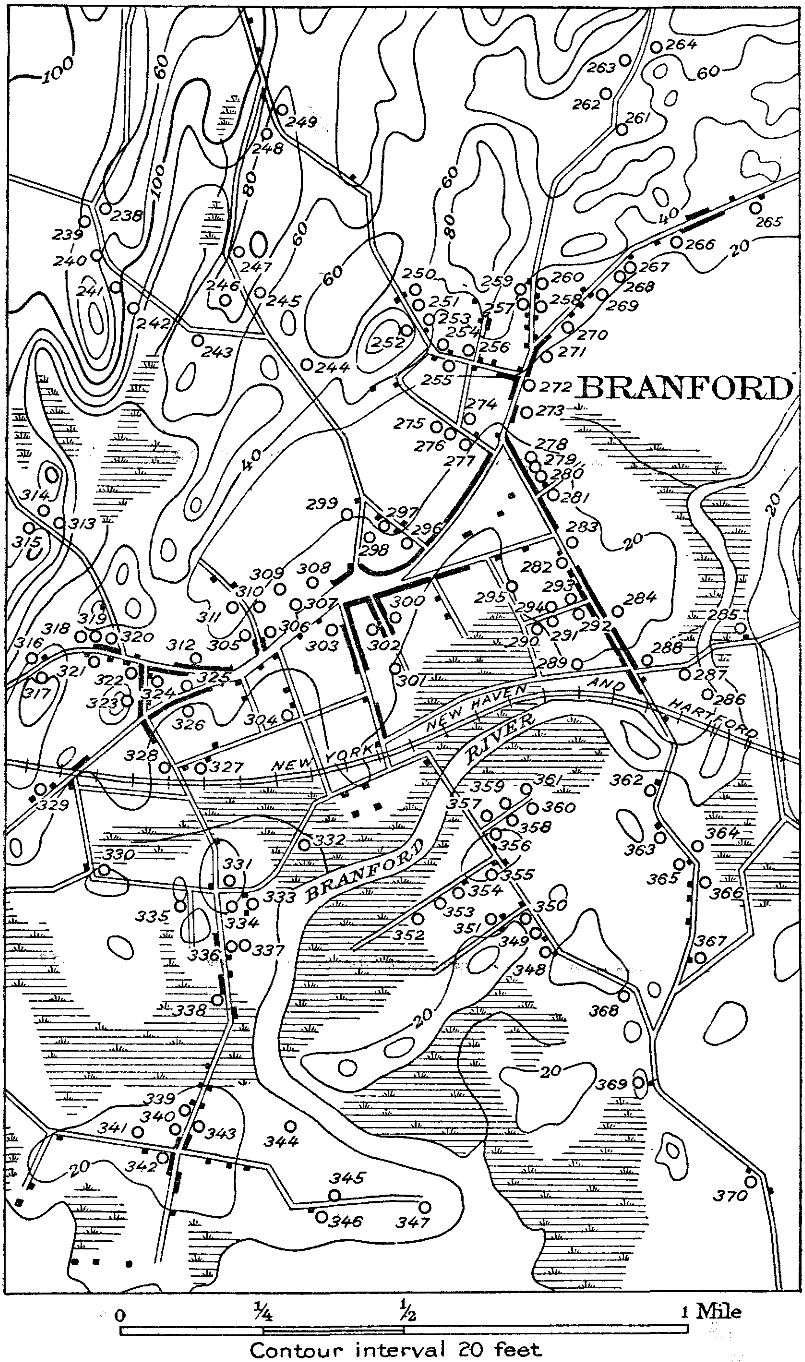

FIGURE 16.—Map of Branford and vicinity showing location of wells and springs. (Base from map of New Haven quadrangle, surveyed in 1890)

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Branford

[Observations made Apr. 14 to May 16, 1919, except well 237, which was examined June 21, 1919. a before number of well indicates that well is abandoned. Dagger (†) indicates that notes are given in Water-Supply Paper 537; for equivalent numbers in that report, see table on p. 52]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
2	E. Klaus	180	Valley	18	10	Till	Pulley	Yes.
3	Donardio	200	Slope	21	14	Till and bedrock	do	Yes.
4		220	Hill	20	11	Till	do	(?).
5	Ranalla	120	Valley	21	10	do	do	No.
7	Bonitatibos	180	do	14	6	Till and sandstone.	do	No.
10	Wm. Johnson	120	do	12	5	Till	do	No.
[a]12	Wilcox	100	Hill	34	10	do	do	No.
13		80	Valley	11	2	do	None	No.
14		90	Hill	21	10	do	Chain pump	Yes.
15	Louis Sperigo	100	do	24	5	do	Pulley	No.
16	Goldsmith	120	do	19	14	do	do	No.
17	Magott	40	do	10	8	do	None	No.
19	Cameron	40	Slope	22	10	do	Pulley	(?).
20	Stent	200	Hill	30	6	Till and probably sandstone.	do	No.
21	Leroy Stent	200	do	32	15	do	do	No.
22	Struzinski	200	do	28	11	do	do	Yes.
23	do	200	do	29	8	Till	do	No.
24	J. Cuwalik	180	do	27	8	do	do	Almost.
25	Ryer	16	Slope	15	10	Till and sandstone.	do	No.
26	Miglin	180	Hill	18	6	Till	do	No.
27		170	do	18	10	do	do	(?).
28	Petre	160	do	13	5	do	Chain pump	Almost.
29	Yblansky	160	Slope	21	6	Till and probably sandstone.	Pulley	(?).
30	do	160	do	12	5	Till	do	No.
a31		75	do	13	3	do	None	(?).
36	J. Paserello	50	do	26	5	Till 20 feet, trap 6 feet.	Hand bucket	(?).
39	Saltonstall School	40	do			Till	Hand pump	No.
40	F. Damico	100	do	15	3	do	Pulley	(?).
42	Schulusky (?)	110	Valley	12	2	do	do	No.
43		125	Slope	30	6	do	Hand bucket	No.
44		135	do	27	8	do	Pulley	(?).
45	Piscitella	135	do	23	11	do	do	No.
46		100	Hill	16	6	do	do	(?).
47	Bradley	100	do	18	9	do	do	(?).
49	A. B. Plant	20	Valley	17	15	Stratified drift	do	No.
50	Foote	20	do	15	5	Till	Hand bucket	No.
51	McGrail	30	Slope	18	11	do	Pulley	No.
52	I. S. Hopkins	15	do	10	0	do	Gasoline engine.	No.
53	A. B. Plant	20	do	24	18	Stratified drift to bedrock.	Pulley	No.
54	do	20	do	16	11	Stratified drift	do	No.
55	do	20	Valley	15	8	do	do	No.
56	Woodward	10	do	12	5	Stratified drift (?).	None	Almost.
57	Robt. Wood	10	do	8	4	Stratified drift	Hand pump	No.
58	Stone	5	do	12	5	Stratified drift to bedrock.	Pulley	No.
59	Woodward	10	do	15	8	Stratified drift (?).		No.
60	O. Holtamel	60	Slope	13	9	Till to bedrock	Hand bucket	Yes.
61	C. H. Mitchell	30	do	27	6	do	do	No.
†62	Connecticut Trap Rock Co.	10	Valley	15	8	Stratified drift	Hand pump	No.
63	W. L. Hall	50	do	12		Till	Pulley	Yes.
64	M. Gallagan	40	do	15	2	do	do	No.
65	D. B. Basset	40	do	8	3	do	Chain pump	Yes.
†66	Emil Bradley	20	do	11	4	do	Pulley	No.
a68	Henry Pinches	20	Slope	12	8	Stratified drift		(?).
a69	Chas. O. Saxton	15	do	14	10	do		No.
a70	Robt. Jacobs	25	Valley	6	16	Stratified drift and bedrock.	Hand pump	No.

[a] Range of fluctuation 6 or 8 feet.

Records of wells and springs in Branford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
a†71	Geo. F. Reynolds	4	Beach	6	5	Stratified drift	Hand pump	Yes.
†72	E. R. Kelsey	4	Flat	12	3	Till 9 feet, bedrock 3 feet.	Hand bucket	No.
†73	do	8	Hill	12	3	Till to bedrock	Hand pump	No.
†74	do	3	Valley	12	6	Marsh mud to bedrock.	None	No.
76		20	do	13	5	Till	Pulley	(?).
77	W. A. Noble	20	Hill	19	13	Stratified drift to bedrock.	Hand pump	No.
79		10	Valley	11	8	Stratified drift	Pulley	(?).
†80	Toole	4	Flat	7	5	Bedrock	Hand pump	No.
81	Cook	15	Slope	17	7	Chiefly bedrock	Pulley	No.
a†82	W. A. Bryan	20	Flat	26	22	Stratified drift		No.
†83	do	18	do	23	18	do	Chain pump	No.
84		5	do	11	9	do	Hand bucket	No.
85	F. E. Wilford	15	Slope	15	13	do	Pulley	Yes.
86	Dickinson	20	Hill			do	Hand pump	No.
88	J. H. Bradley	15	do	10	5	do	do	Yes.
89	Hotchkiss	30	Slope	25	6	Till		No.
90	Todd Smith	15	Flat	19	14	Stratified drift	Chain pump	No.
91	Mrs. Blackstone	70	Hill	21	5	Till and probably rock.	Pulley	No.
92	Bishop	60	do	24	8	Till	do	No.
93	Holcomb	60	Slope	17	10	do		Yes.
94	Geo. Blackstone	40	do	16	10	Till and probably rock.	Pulley	(?).
95	Tyler	40	do	15	5	Till to bedrock	Hand pump	No.
96	Collins	40	Valley	13	6	Till	Pulley	No.
97	Mrs. Connely	10	Swamp	8	0	do	Hand pump	No.
98	Dwyer	30	Valley	28	20	do	Pulley	Yes.
99		20	Slope	20	13	Till (?)	do	Yes.
100		15	Valley	17	10	Stratified drift	do	No.
101		20	Valley flat	15	10	do	Chain pump	No.
a102	A. C. Newton	20	do	19	15	do	Pulley	No.
103	A. A. Altrmatt	10	do	15	9	do	Chain pump	No.
104		5	do	8	6	do	Hand bucket	No
105	E. Bartholomew	10	do	17	8	do	Hand pump	No.
106		5	do	11	7	do	Pulley	No.
107	Jas. Kennedy	6	do	9	5	do	do	No.
108	E. M. Yale	30	do	18	12	do	Chain pump	No.
109	Hamm	30	Slope	20	13	do	Pulley	No.
110	Cadwell	40	Flat	15	10	do	Hand pump	Rarely.
111		40	Valley	13	4	do	do	(?).
112	Collins	60	Slope	20	10	Till	Pulley	Rarely.
113		20	Valley	22		Stratified drift	Chain pump	No.
114	Geo. W. Morgan	40	do	16	11	do	None	No.
115	Mike Rice	40	do	17	10	do	Chain pump	No.
116	Bartholomew	50	do	22	17	do	Pulley	No.
117	do	50	do	19	14	do		Rarely.
118	Samuel Foote	40	do	19	15	do	Hand bucket	No.
119	N. S. Rose	40	do	19	14	do	do	No.
121	A. Grannis	100	Hill	30	10	Till and bedrock	Pulley	Rarely.
122	Linsley	60	Slope	26	13	do	do	Rarely.
123		30	Valley	19	15	Stratified drift	Hand bucket	No.
124	Plan (?)	100	Hill	28	10	Till and probably rock.	Pulley	No.
125	Mrs. Parmer	120	do	35	20	do	do	No.
126		150	Hill flat	23	3	do	do	No.
127	N. Dobiago	150	do	27	5	Till	Sweep	No.
128	T. C. Cook	140	do	17	10	Till to bedrock	Hand pump	No.
129	John Lutz	150	do	23	7	Till	do	No.
130		140	do	15	8	do	Chain pump	(?).
131		140	do	10	3	do	Pulley	(?).
132	Honce	140	do	25	14	Till and bedrock	do	No.
133	Harry Cook	130	do	18	12	Chiefly bedrock	Hand pump	No.
[b]134	do	120	do	8	2	Till and probably bedrock.	do	No.
135	do	130	do	13	10	do	do	Yes.
136	Larkins	110	do	13	3	Till	Chain pump	Rarely.
[c]137	Dibble	100	Hill	15	5	do	Hand bucket	No.
138		100	Hill flat	11	3	do	Pulley	(?).
139	Kowalski	110	Hill	17	2	do	do	No.
140	do	110	do	28	7	do	Hand bucket	No.

[b] Located in small depression on hill. Quality of water poor, owing to contamination by surface water
[c] Level fluctuates about 10 feet.

Records of wells and springs in Branford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
141	B. F. Linsley	120	Slope	26	10	Till	Pulley	No.
142	L. A. Fiske	40	Ridge	21	13	Stratified drift	do	No.
143	R. N. Fiske	40	Valley	13	7	do	do	No.
144	Clausan	80	Hill	22	8	Till	do	No.
145	Fitzgerald	90	do	38	8	do	do	No.
146		80	do	17	2	do	Chain pump	No.
147	Jas. Dunnigan	80	Slope	18	7	do	Pulley	No.
148	do	80	do	10	1	do	None	Yes.
149		40	do	18	11	do	Hand pump	Almost.
150	Humphreys	40	Valley	21	15	Stratified drift	Pulley	No.
151	Crowther	40	do	18	13	do	do	No.
152	C. A. Blackstone	60	Hill	28	13	Till	do	No.
153	do	50	Slope	15	8	do	Hand bucket	Yes.
154	do	40	Hill	22	5	do		No.
[d]155	do	40	Slope	20	8	do	Pulley	Almost.
156	Knapp	20	Valley	10	5	Stratified drift to bedrock.	do	No.
157	Wm. Keenan	30	Hill	14	7	Till	Hand bucket	No.
158	R. Blackstone	35	do	21	6	do	Pulley	No.
159	Johnson	40	Valley	19	12	do	do	No.
160	L. C. Griffin	30	do	21	19	Stratified drift	Hand pump	No.
161	Record	20	do	14	13	do	Pulley	Almost
164	Allan	5	Terrace	9	5	Beach sand	Chain pump	No.
a165	do	25	Hill	30	24	Bedrock	None	No.
166	Rowe	10	Valley	13	4	Till (?)	Hand bucket	No.
167	Hoadley	10	do	10	5	Stratified drift	Chain pump	No.
169	A. Desautos	20	do	15	9	do	Pulley	Yes.
170	W. H. Record	15	do	8	3	do	do	No.
171	Mrs. Ray	20	do	13	9	do	do	No.
172	do	35	Slope	15	8	Till	do	Yes.
173	Ives	40	do	16	10	Till 6 feet, bedrock 10 feet.	do	Yes.
174	Whiting	60	Hill	28	14	Till 13 feet, bedrock 15 feet.	do	No.
175	D. Creem	20	Valley	13	8	Stratified drift		Yes.
176	do	20	do	9	5	do	Pulley	No.
[e]177	Jas. Daly	20	do	5	0	Till (?)	Hand pump	No.
179	A. O'Connor	120	Hill	14	5	Till to bedrock	Hand bucket	Yes.
180	do	120	do	13		do	do	Almost.
181	Ashma	120	Hill flat	10	3	do	Pulley	Yes.
183	Steve Tucker	100	Valley	11	1	Till	Sweep	No.
184	Connecticut Trap Rock Co.	100	Hill	27	13	Till 4 feet, bedrock 23 feet.	Pulley	Yes.
185	M. Matthewson	10	Valley	6	1	Stratified drift	None	No.
186	Mrs. King	60	Hill	13	4	Till and probably rock.	Pulley	No.
187		60	do	20	8	do	Chain pump	No.
188	Northam	60	do	16	5	Till	do	No.
189	do	60	Slope	25	11	Chiefly bedrock		Yes.
190	Daugherty	20	do	19	14	Till to bedrock	None	Yes.
191	Hendrickson	10	Valley	9	5	Till	Chain pump	No.
192	Johnson	10	do	7	2	Stratified drift	Hand pump	No.
193		10	do	10	3	do	Chain pump	No.
194		40	Slope	15	7	Till	Pulley	(?).
195	Patmer	10	Valley	14	8	Stratified drift	do	(?).
196		10	do	7	2	do	Hand pump	No.
197	Patmer	15	Slope	15	10	do	do	No.
198		20	do	15	10	do	do	No.
199	Jos. Medlyn	20	do	14	7	Till 10 feet, bedrock 4 feet.	Chain pump	No.
200	L. Brachaculte	20	do	22	15	All bedrock	Hand pump	No.
201	McMillan	20	do	15	5	Till	do	No.
202	Beattie	15	Valley	12	9	Stratified drift	Pulley	No.
203		10	do	10	4	do	Chain pump	No.
204	P. Ablondi	20	Slope	15	8	Till and bedrock	do	No.
205	Harry Page	15	do	13	5	Bedrock	Pulley	No.
206	Rose Page	20	do	19	11	do	Hand windlass	Yes.
207	Matthewson	15	do	19	7	do	do	No.
a208	W. J. Howd	20	Valley	13	3	Till	do	No.
209	E. H. Howd	10	do	25	17	Bedrock	Hand windlass	No.
210	Mrs. Lew	20	do	10	3	Till to bedrock	Chain pump	Yes.
211		20	Hill	34	10	Bedrock	None	No.

[d] Has had as little as 1½ feet of water in bottom.
[e] Range of fluctuation 3½ feet.

Records of wells and springs in Branford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
212	Brainerd	40	Hill	35	19	Nearly all bedrock.	Pulley	No.
213	Lazari	20	do	20	14	do	do	Yes.
214	Mary Crawley	5	Slope	10	6	Till and probably rock.	do	No.
215	E. W. Vedder	5	Valley	8-10	4	Stratified drift (?)	Hand pump	No.
216	do	19	Hill	23	20	Chiefly bedrock	Pulley	No.
†217	Henry Hall	10	Slope	15	10	do	do	No.
218	Brainerd	10	Valley	18	5	Till and probably rock.	Windmill	No.
219	do	10	do	9	2	Till	Hand pump	No.
220	Milne	40	Hill	18	11	Bedrock	Chain pump	No.
221	G. Southerstrom	25	Valley	8	2	Till	do	No.
†222	Fisher	5	Flat	13	4	Till to bedrock	do	No.
†223	Fairchild	2	Salt marsh	5	1	Drift	do	No.
224	Heffernan	15	Slope	15	10	Chiefly bedrock	do	Rarely.
†225	Allan	10	Ridge	17	7	Till and probably bedrock.	Pulley	No.
226	Cartenhaus	10	Valley	15	5	do	Chain pump	No.
a†227		14	Slope	23	8	Chiefly bedrock	do	No.
228	P. Burne	5	Valley	13	5	Till (?) to bedrock.	Pulley	No.
229		10	do	20		Till and probably rock.	Chain pump	(?).
†231	J. J. Phelps	14	do	14	7	Chiefly bedrock	Pulley	No.
†232		8	Ridge	14	5	do	do	Yes.
†233		11	do	20	7	do	do	Yes.
†235	Jas. Elton	25	Hill	34		Till 4 feet, bedrock 30 feet.	Hand pump	No.
†236	Mrs. Drew	5	Flat	11	7	Till, probably to rock.	Chain pump	No.
†237	A. E. Verril	10	do	18	8	Till	Hand pump	No.
238	Wm. Kowak	140	do	15	5	do	Pulley	No.
239	O'Brien	130	Slope	18	10	do	do	(?).
240	do	120	Hill		11	Till and probably trap rock.	do	No.
241	do	100	Slope	15	8	Till	do	No.
242	do	80	do	13	3	do	do	(?).
243		60	Flat	11	6	Till and bedrock	do	Yes.
244	E. V. Rawley	50	Valley	10	2	Till	Hand bucket	No.
245	A. Piertzky	75	Hill	13	10	do	Hand pump	No.
f246	Dory	80	do	50	18	Till 2 feet, bedrock 48 feet.	Gasoline engine.	Yes.
247		80	do	16	8	Till	Pulley	(?).
248	L. Mannix	60	Valley	23	10	Till and bedrock	do	No.
249		80	Slope	19	15	Till and probably rock.	do	(?).
250	Robert Foote	50	do	21	15	do		(?).
251	Connely	40	do	21	13	Till		No.
252	John Matthews	60	Hill	26	13	do	Hand pump	No.
253	Misskerr	40	do	14	9	Till and bedrock		Yes.
254		20	Slope	26	19	Till	Hand bucket	Yes.
255	Montgomery	10	Valley	12	7	Till to bedrock	Hand pump	Rarely.
256		10	do	9	4	Till (?)	None	No.
257	Fresco	15	do	16	9	do	Pulley	No.
258	Daly	10	do	11	5	Stratified drift (?)	do	No.
a259		15	Slope	15	10	Till		(?).
260		10	Valley	10	5	Till (?)	Hand bucket	No.
261	Thos. Samson	20	do	11	8	Stratified drift (?)	Pulley	Almost.
262	Callahan	20	do	15	12	Stratified drift	None	No.
263	Creem	30	Slope	18	13	Till	Pulley	Yes.
264	do	20	Valley	13	5	Stratified drift	do	No.
265	Mrs. Barron	15	do	27	14	do	do	No.
266	C. M. Altrmatt	15	do	15	10	do	do	No.
267	C. L. Squires	20	do	14	8	do	do	Rarely.
268	L. B. Goodrich	20	Terrace	22	15	Stratified drift to bedrock.	do	No.
269	Wm. Regan	20	do	20	12	Stratified drift	do	No.
270	G. L. Beech	20	do	19	10	Stratified drift to bedrock.	do	No.
271	do	20	do	18	13	Stratified drift	do	(?).
272	Tamalavetz	10	Valley	10	5	do	do	No.
273	Mike Rice	10	do	14	6	do	do	No.
274	M. O'Brien	15	Slope	15	12	do	do	No.

f Construction cost $400 in 1911.

Records of wells and springs in Branford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
275		15	Slope	20	14	Stratified drift	Pulley	No.
276	Buckley	20	do	25	22	do	do	Almost.
277		25	Hill	31	25	do	do	No.
278	R. Bradley	35	do	36	30	do	do	No.
279	Mrs. M. Morton	30	do	42	34	do	do	No.
280	Coyle	30	do	30	24	do	do	No.
281	Ida Gerald	30	do	36	25	Stratified drift and bedrock.	do	No.
282	Merril	25	do	26	23	Stratified drift	do	No.
283		30	do	24	20	do	do	No.
284		20	do	28	21	do	do	No.
†285	W. Blackstone	10	Slope	15	10	do	Chain pump	No.
286	F. A. Hosley	10	Valley	13	9	do	Hand pump	No.
287	do	15	Slope	16	11	do	do	Yes.
288	C. H. Foote	20	Hill	25	15	do	Chain pump	No.
289		20	do	24	19	do	Pulley	No.
290		20	do	23	17	do	do	(?).
291	M. E. Hobart	25	do	30	25	do	do	No.
292	G. L. Sheldon	25	do	33	23	do	do	No.
293	Harding	25	do	29	24	do	do	No.
294	Hart	25	do	33	26	do	do	No.
295		20	do	25	20	do	do	No.
296	Callahan	15	Slope	20	14	do	do	Yes.
297		15	do	19	14	do	Chain pump	No.
a298		20	do	31	20	Stratified drift (?)		(?).
299	J. Donnelly	15	do	23	18	Stratified drift	Pulley	No.
300	O. A. Johnson	15	do	15	4	Till (?)	do	No.
a301		20	Hill	24	13	Till and probably rock.	None	(?).
302	C. A. Hoadley	20	do	19	9	do	Pulley	No.
303	V. T. Hammer	25	do	29	16	do	do	No.
a304		20	Slope	18	17	Stratified drift (?)	None	Yes.
305	John Connely	30	Hill	24	22	Stratified drift (?) to bedrock.	Pulley	No.
306	Tobin	30	do	25	18	do	do	No.
307	Morey	25	do	18	12	Till (?)	do	No.
308	F. E. McKeogh	20	do	20	14	do	Hand pump	No.
309		20	do	20	14	Till	Pulley	No.
310	Tobin	25	do	20	13	Till (?)	do	No.
311	J. L. Jones	20	Slope	20	11	Till	do	No.
312		20	do	15	12	do	Hand bucket	No.
313	Svedr	70	Hill	18	8	Trap rock	Pulley	Yes.
314	do	70	do	16	6	Till 7 feet, trap 9 feet.	Hand pump	No.
315		70	Valley	13	4	Till 9 feet, trap 4 feet.	Hand bucket	No.
316	Jas. Barker	20	Slope	21	11	Till	Pulley	No.
317	do	40	do	17	12	Till and bedrock	Hand pump	Yes.
318	W. M. Smith	25	do	17	12	do	Pulley	Yes.
319	A. W. Wood	20	Flat	23	20	Stratified drift	do	(?).
320	P. Zacawich	20	do	29	22	do	Hand bucket	No.
321	Jos. Zaecker	20	do	27	20	do	Pulley	No.
322	Thos. O'Brien	20	do	24	16	do	do	No.
323	J. Kelly	40	Hill	26	15	Till and probably rock.	do	No.
324	Mrs. Sliney	20	Flat	26	16	Stratified drift (?)	do	No.
325		30	Hill	25	21	Till and bedrock	do	No.
326	V. Zvonkovich	20	Slope	17	12	Till (?)	do	No.
327	Maturo	20	Valley	24	15	Stratified drift (?)		No.
328	E. R. Monroe	20	do	28	20	Stratified drift	Pulley	(?).
329	John Trkvrs	35	Slope	28	21	Till and probably bedrock.	do	No.
330		25	Ridge	28	25	Stratified drift	do	(?).
331		20	Hill	25	20	do	do	No.
†333	F. Jourdon	5	Valley	9	5	do	Chain pump	No.
†334	do	20	Hill	25	20	do	do	No.
335	Gibbs	20	do	25	21	do	Pulley	No.
336	A. G. Ely	15	Slope	19	13	do	Chain pump	No.
†337	do	10	do			do	Hand pump	No.
†338	Episcopal Church	15	do	18	14	do	Pulley	No.
a339		30	Hill	32	28	do	do	No.
340	Gibbard	25	do	28	25	do	do	No.
341		25	do	28	23	do	Chain pump	No.

Records of wells and springs in Branford—Continued

Dugs wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
342	D. Averill	20	Hill	27	21	Stratified drift	Pulley	No.
343	Roy Averill	25	do	28	26	do	do	No.
†344	Ely	15	Valley	20	16	Till	Hand pump	No.
345	Stiehl	15	Ridge	14	10	Stratified drift	Pulley	No.
†346	H. Stannard	10	Slope	13	9	do	do	No.
a†347		10	do	13	9	do	do	No.
348	Edw. Camp	20	Flat	24	19	do	do	No.
349	Erickson	20	do	24	19	do	do	No.
350		20	do	23	18	do		No.
351		20	do	25	20	do	Pulley	No.
352	Henry Murray	25	Hill	30	25	do	do	No.
353	Mantelius	20	do	26	21	do	do	No.
354	Danberg	20	Flat	26	23	do	do	No.
355	Wm. Johnson	25	Hill	29	24	do	do	No.
356	Geo. Tahune	20	do	28	24	do	do	No.
357	McCarty	15	Slope	17	14	do	do	No
358	Glaucus	20	Flat	21	18	do	do	No.
359		15	Slope	19	13	do	do	No.
360	Price	15	do	22	18	do	do	No.
361	J. Erickson	20	do	27	20	do	do	No.
362	Danforth	15	do	15	12	do	Chain pump	No.
363	Toole	15	Hill	20	16	do	Pulley	No.
364	Farnum	10	Slope	13	9	do	Hand pump	No.
365	I. T. Linsley	20	Flat	22		do	do	No.
366	G. I. Field	15	do	12	9	do	Pulley	No.
367	Hever	15	do	11	6	do	do	No.
368		20	do	20	14	do	do	No.
369	Daugherty	20	Hill	23	17	do	do	Yes
370		15	Slope	18	11	Stratified drift (?)	Hand bucket	No.

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
6	Rosendahl	200	Hill	160		Sandstone	Pumped by compressed air.	
[g] 8	Wm.E. Glenn	180	do	104	Mersek	Chiefly sandstone	Hand pump	
9	Soffer	180	do	114		do	Windmill	
[h] 32	Burton	30	Valley	255	L. Basset	Till, sandstone, and trap.	Gasoline engine	([j])
33		30	do	35		Probably sandstone or trap.	Hand pump	
[i] 34	A. Caruso	70	Hill		L. Basset	Trap		
35	J. H. Kennedy	60	do	78	do	do	Hand pump	
37	Hartley	40	Slope	±70	do	Till and sandstone or trap.		[j] 1.3
38	John Kelly	30	do			Chiefly sandstone	Hand pump	
41		120	do			Till and probably sandstone.	do	
a†230	Fitzsimmons	7	do	60		Bedrock	do	
a†234	Jas. Elton	12	do	150		do	Gasoline engine	

[g] Depth to water 24 feet.
[h] Well normally flows 1 to 2 gallons a minute at surface. Water was struck in sandstone after the drill had penetrated a trap sheet. Six-inch casing extends to depth of 30 feet. A vertical piston pump is installed over well. It is reported that pumping 3,600 gallons in 12 hours lowered level to 177 feet.
[i] In process of drilling when examined. Depth about 40 feet and yield 1 gallon a minute, or less.
[j] Flows.

Records of wells and springs in Branford—Continued

Driven wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Diameter (inches)	Kind of rock	Equipment
67		10	Flat	20	2	Stratified drift	Hand pump.
a†87	C. J. Lounsbury	5	Beach	10-15	2	Beach sand	None.
a†332	Malleable Iron Fittings Co.	5	Valley	15	2	Stratified drift	Hand pump.

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons) per minute
1	E. Klaus	180	Depression near hill top.	Till and fractured trap rock.	Hole 2 feet square; boxed in.	+2
11	Tisk	100	Hillside ravine	Coarse sandstone above shale bed.	Stoned pit; gravity pipe line.	
18	Cameron	60	Ravine	Fractured bedrock	Large reservoir; gravity pipe line.	a8
48	R. U. Plant	40	Hillside bench	Fractures in trap	Concreted pit; gravity pipe line.	5
75	John Murphy	4	Small ravine	Till in bedrock channel.	Housing; hand pump	
1†78	Lanphier Spring	±2	Beach, foot of sea cliff.	Stratified drift	Tile sunk in sand	2
120	A. Grannis	80	Hillside bench	Seep from till and bedrock.	None	
162	Nellie Young	5	Border of swamp	Stratified drift	Brick spring house	2-3
163	Pine Orchard Country Club.	10	Valley, foot of terrace.	do	Covered tile	6
168	New York, New Haven & Hartford Railroad Co.	20	Side of railroad cut	Bedrock fractures	Open pit	
178	A. O'Connor	50	Bench, side of valley	Swampy area in till	None	
182		80	Head of valley	do	Stoned pit 2 feet deep.	+2

a Estimated.
1 Unusually high tides overflow the tile, but the water freshens again within an hour or two after the tide recedes.

EAST HAVEN

AREA, POPULATION, AND INDUSTRIES

East Haven was taken from New Haven in 1785 and lies between New Haven and Branford. It occupies about 2 miles of the coast and extends 7 or 8 miles northward into the interior. Its area is 8,069 acres, or 12.6 square miles. The population in 1920 was 3,520. Part of the town is a suburban residence section of New Haven, and there are several popular summer resorts on the coast, where there are attractive bathing beaches. Practically the only industry is agriculture.

TOPOGRAPHY AND DRAINAGE

Saltonstall Ridge, also called Pond Rock, and certain hills in the northern part of East Haven rise to altitudes of 250 to 300 feet. The northern part of the town contains a series of ridges and valleys, most of which trend northeast; here the relief is from 100 to 200 feet. The southern part of the town is less than 100 feet above sea level and much flatter than the northern part. The village of East

Haven is built upon a small plain, most of which is less than 20 feet above sea level. Most of the drainage of East Haven is carried by Farm River, whose general direction of flow is southward. The lower part of Farm River is also known locally as East Haven River and Stony River.

There are two large fresh-water swamps in the western part of East Haven, which have apparently been lakes at a comparatively recent date but have become filled with sediment and peat deposits until they are now swamps, mostly overgrown with timber. In the district at the south end of the town, where crystalline bedrock occurs, there are also numerous thickly forested fresh-water swamps, which are closely associated with tidal marshes.

The shore line of East Haven was formerly much more irregular than at present, and the waters of the Sound occupied most of the present salt meadows. Wave action and deposition by streams have greatly modified and straightened the original shore.

GEOLOGY

Bedrock.—The southern part of East Haven, including all the rolling land south of the marshes that limit the East Haven plain, is underlain by the Branford granite gneiss, which crops out in low bluffs west of Short Beach (Branford) and at all the projecting points along the shore. Triassic sandstone and trap form the bedrock in the northern part of East Haven. In general sandstone underlies the valleys and lower slopes, and trap forms the ridges and hills.

Drift.—About half of East Haven, exclusive of the trap ridges, is covered by till, which is found over nearly all the slopes and hills that are more than 20 to 40 feet above sea level. At most places the till covering is only a few feet thick and barely suffices to conceal the underlying bedrock and provide a thin layer of soil. The till soil is reddish and rather clayey and is difficult to cultivate.

Stratified drift covers the other half of the area of East Haven. It occurs principally in the valley of Farm River and underlying the low plain on which is located the village of East Haven. There are small bodies of stratified drift in other valleys. Terraces are well developed along the valley of Farm River above East Haven village, where they rise 20 to 30 feet above the flood plain. The roads through the valley follow the terraces at the valley border, and all the houses are built on the terraces.

WATER SUPPLY

The New Haven Water Co. serves nearly all the population of East Haven south of the New York, New Haven & Hartford Railroad. Its mains supply the village of East Haven and extend to Momauguin and the more populous shore resorts. A small settlement west of Short Beach is supplied in summer by mains from that village laid on the surface of the ground. In winter these mains are drained to prevent freezing. All the northern part of the town, however, depends on wells. The appended table gives the records of 134 individual water supplies, comprising 73 dug wells, 40 drilled wells, 13 driven wells, and 8 springs. (See pl. 5.)

Wells.—The dug wells are all shallow and usually derive water from the drift or from the saturated zone at the contact between drift and sandstone. Of the 73 dug wells 50 are wholly in stratified drift. The average depth of 69 dug wells in East Haven was 18 feet, a little less than the average for the whole area. (See table.) There are no dug wells of unusual depth, the deepest being Nos. 45 and 82, each of which is 32 feet deep and in stratified drift. Well 8, 25 feet in depth, is the deepest well in till.

The average depth of the water table, from 66 measurements, is 12 feet. In stratified drift 48 measurements give an average depth of 13 feet. The water table in stratified drift is fairly uniform over extensive areas. Thus in East Haven village the depth to water corresponds closely with the altitude of the land above sea level. The relation of the water table in stratified drift to controlling surface-water features is discussed on pages 21–26 and illustrated by a figure from East Haven (fig. 4, B).

Nearly all the drilled wells of East Haven are in the northern part, in the area underlain by sandstone. The average depth of 30 wells reported was 71 feet. The yields of drilled wells appear to be generally very small. Three reported yields are 12, 4½, and 2 gallons a minute. Five drilled wells are said to fail, and another gives only a "very small" yield. In general, however, the yields are adequate for household use or stock supply.

Driven wells are used only in the areas of stratified drift, principally near Foxon, in the Farm River valley. Most of them are 2 inches in diameter and less than 25 feet deep.

Springs.—Springs are common in the northern part of the town at the base of ridges of either sandstone or trap. Most of them appear to be fed through joints in the bedrock. They are especially characteristic of the steep western slopes rather than the gentle eastern dip slopes. (See pl. 5.) Their yields seldom exceed 2 or 3 gallons a minute. There are many more springs in the town than the few recorded as being in use for water supplies.

Suggestions for development.—Much water could be recovered from the East Haven plain just south of the village or from the stratified drift farther north along Farm River. For domestic supply, however, the use of dug or drilled wells is satisfactory. It may be better in many places to choose a good location for a dug well in preference to drilling, as the yield of a drilled well is problematic and may be insufficient.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in East Haven

[Observations made April 15 to 30 and July 2 to 5, 1919. a before number of well indicates that well is abandoned. Dagger (†) indicates that notes are given in Water-Supply Paper 537; for equivalent numbers in that report, see table on p.52]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
1	Bookmeyer	130	Hill	18	13	Till	Pulley	No.
2	M. McGrath	130	Slope	15	10	Chiefly sandstone	do	Yes.
3	Neubig	140	do	23	21	do	do	Yes.
8	B. Thompson	160	do	25	13	Till	Sweep	No.
10	W. M. Bailey	100	do	24	20	Till and sandstone	Pulley	Yes.
30	A. J. Grannis	40	Terrace	18	14	Stratified drift and trap rock.	Hand bucket	No.
31	C. W. Grannis	40	do	19	16	Stratified drift	Pulley	No.
32	E. C. Goodrich	45	do	25	21	Stratified drift and sandstone.	do	No.
33	do	45	do	23	21	Stratified drift and trap rock.	do	Yes.
34	Thomas Bennet	40	do			Stratified drift	Gasoline engine.	No.
37	James Cannon	40	do	24	23	Stratified drift and trap rock.		Almost
40	Tomasi	40	do	26	24	Stratified drift	Pulley	No.
41	John Karlson	60	do	27	25	do	do	No.
43	Dorman	60	do	±30		do	Hand pump	No.
45	Sowens	60	do	32	27	do	do	No.
49	Page	40	Valley	15	13	do	Pulley	No.
50	H. Jacobs	40	do	15	12	do	do	No.
51	do	40	do	16	11	do	Hand pump	No.
52	T. Bigigli	40	do	20	17	do	Pulley	No.
56	J. H. Fowler	40	Slope	20	18	do	Hand pump	No.
58	L. A. Grannis	40	do	25	22	do	Pulley	No.
59	Spangler	80	do	13	8	Till and sandstone	Hand pump	No.
63	Defelipo	70	Valley	30	25	Stratified drift	Pulley	No.
69		140	do	18	Dry.	Stratified drift and trap rock.	do	Yes.
71	State Rifle Range	140	do	10	6	Stratified drift	None	No.
72	L. C. Higgin	40	Slope	30	25	do	Pulley	No.
77	Smith	40	do	27	22	do	Hand pump	No.
78	Rocco Tezzi	40	do	20	15	Stratified drift and sandstone.		No.
82	P. Delucco	40	Terrace	32	28	do		No.
83	Charles Davis	20	Flat	25	21	Stratified drift	Pulley	No.
84		20	do	10	5	do	Chain pump	No.
85		40	Slope			Chiefly sandstone	Hand bucket	(?).
a86		10	Flat		3	Stratified drift		No.
88		15	do		9	do		No.
89	E. R. Andrews	25	do	21	17	do	Hand bucket	No.
90	Jilinski	15	Valley	15	12	do	do	No.
91	James Malone	15	do	15		do		No.
92	Bradley	20	Flat	25	17	Stratified drift and rock.	Hand bucket.	No.
93	Leland Thompson.	25	do	30	25	Stratified drift	Chain pump	No.
94	James Smith	20	do	30		do		No.
95	Smith	15	do	14	10	do	Hand pulley	No.
a96	M. K. Beardsley	20	do	17	12	do	do	No.
97	C. Street	20	do	19	14	do	do	No.
98	C. J. Tuttle	10	do	11	6	do	do	No.
100	L. Pelligree	10	do	9	5	do	do	No.
101		5	do	6	2	do	do	No.
102	G. W. Foller	25	Hill	20	17	Till		No.
103	Thomas Schusky	20	Valley	21	14	Stratified drift	None	No.
†105	H. S. Hitchcock	5	do	11	4	do	Chain pump	No.
†106	A. E. Hitchcock	2	do	6	2	do	Hand pump	No.
107	Robert Weeden	5	Slope	9	4	Till	do	No.
†108	W. B. Talmadge	7	Hill	13	6	Bedrock	Chain pump	Almost.
110	C. H. Hilton	30	Valley	6	0	Till	None	No.
112	C. A. Terhune	50	Hill	14	5	do	Chain pump	No.
113	Frank Schusky	40	do	13	4	do	Pulley	No.
114	James L. Jennings.	40	do	10	3	do	do	(?).
115	Mrs. Sheppard	17	Bench	12	3	Till and probably bedrock.	Hand windlass	No
a†116	Charles Bartley	3	Valley	9	3	Stratified drift (?)	None	No.
117		8	Flat	15	1	do	do	No.
†118	Prentiss	5	Beach	8		Stratified drift and bedrock.	do	No.

Records of wells and springs in East Haven—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
119	George Cadwell	20	Hill	14	8	Till	Hand bucket	No.
121	Robert Dunlap	20	Valley	6	2	Till and probably bedrock.	None	(?).
123	New Haven Normal School of Gymnastics.	20	do	11	3	Till	Hand pump	No.
124	A. Trapp	20	Hill	23	11	Stratified drift	Hand bucket	No.
125		30	do	15	8	Stratified drift and probably bedrock.	None	(?).
126	New Haven Normal School of Gymnastics.	20	Slope	17	8	Stratified drift	Hand bucket	No.
127	Thomas Bowden	10	Valley	9	6	do	do	No.
•129	New Haven Normal School of Gymnastics.	10	do	12	8	do	Gasoline engine.	No.
130	do	15	Ridge	14	9	Stratified drift and probably bedrock.	None	(?).
131	William E. Jones	15	do	20	13	Stratified drift	Pulley	No.
132	Max Praeger	20	Hill	25		do	Hand pump	No.
†133		10	Slope	13	9	Stratified drift (?)	Hand bucket	No.
†134	A. P. Luddington.	8	Ridge	10	7	Stratified drift and bedrock.	Hand pump	No.

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
5	Ralph Torelli	100	Slope	73		Chiefly sandstone	Hand pump.	
6	W. E. Talmadge	120	Valley	63		do	do	
9	Hurlburt	175	Hill			do	do	
12	R. Spinello	190	do	113	L. Basset	do	Gasoline engine.	
13	do	160	Slope	52	do	do	Hand pump.	
14	Capello	160	Valley	60	C. L. Wright	do	do	
15	Albino	180	Hill	80		do	do	
17	Grillo	200	do	52		do	do	
18	Enocharte	140	do	75		do	do	
19	A. Rodondo	100	Flat	31		do	do	
20	Vubleski	100	Hill	80		do	do	
21	Pinto	80	Valley	38		do	do	
22	Diombino	80	Hill	75		Sandstone	do	
23	Dwyer	80	Slope	70		do	do	
24	James Mell	140	do	90		Chiefly sandstone	do	
26	Meyrowitz	90	do	95		do	do	
27	Hurlburt	120	do	52		do	do	
28	do	100	Hill	100		do	do	
29	E. S. Thompson	100	do	62		Till 5 feet, sandstone 50 feet, trap 7 feet.	Air pressure pump.	12
40	Sperry	80	Slope	133	L. Basset	Part stratified drift, chiefly trap.	Hand pump.	2
53	Healey	140	do	100	C. L. Wright	Probably sandstone.	do	
54	J. Paulman	120	Hill	60	do	do	do	(b)
55	C. Paulman	140	do	73		Chiefly trap	do	
60	M. E. Elliot	90	Slope		L. Basset	Sandstone	do	
61	McFellon	100	Valley	25		Chiefly sandstone	do	(c)
64	P. Silverglide	120	Hill			do	Hand pump.	(d)
65	Miller	130	do	70	C. L. Wright	do	do	
66		140	do			do	do	
67	Kronberg	130	Slope		L. Basset	Sandstone or trap	do	(e)

[a] Measured yield 5.5 gallons per minute. See also p. 40.
[b] Small; fails.
[c] Fails.
[d] Fails often.
[e] Very small.

Records of wells and springs in East Haven—Continued

Drilled wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
68	Kempter	125	Slope	108		Sandstone	Gasoline engine.	
74	Santos	120	do			Till and sandstone.	Hand pump.	
75	William Dixon	100	Hill	65		Probably sandstone.	do	
76	Kolberg	80	Valley		L. Basset	do	do	
79	Melcher	40	Slope		do	Chiefly sandstone.	do	
80	Hoffman	80	Hill	90		do	do	
81	Auger	50	do	72	L. Basset	do	do	([a])
a87	Jude	15	Flat			Stratified drift and sandstone.	Windmill	
a†109	William B. Talmadge.	10	Valley	65	C. L. Wright	Till 10 feet, bedrock 55 feet.	Hand pump.	4½
120	A. W. Jones	10	do	22		Till and bedrock.	do	([a])
122	Frank	25	Hill			Bedrock	do	

Driven wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Diameter (inches)	Kind of rock	Equipment
35	J. H. Broxie	40	Terrace	35	2	Stratified drift	Hand pump.
36	Kirber	40	do		2	do	Do.
38	Sambrano	40	do	16	2	do	Do.
39	Mrs. Getz	40	do		1½	do	Do.
42	Gilson	60	do	28	1½	do	Do.
46	DePolo	60	do		2	do	Do.
47	Cameron	60	do		2	do	Do.
48	Adamec	60	do	33	1½	do	Do.
57	J. H. Fowler	30	Valley	33	2	do	Windmill.
58	G. Vitable	40	Terrace	21	1½	do	Hand pump.
73		40	do		2	do	Do.
99		10	Flat	20	1½	do	Do.
128	N. S. Quick	30	Hill	45	2	do	Do.

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
4	Neubig	120	Valley, foot of trap ridge.	Fractures in trap rock.	Pit 3 by 4 by 3 feet walled with concrete; spring house.	3
7	William Brockett.	140	Valley, foot of hill.	Till; water may come from rock.	Stone-walled pit; hand pump.	1
11	Hemmingway estate (?).	200	Ravine	Fractured trap rock	Stone-walled pit; hydraulic ram.	[f]10
16		120	West base of sandstone ridge.	Fractured sandstone	Tile curbing	±2
25	M. Rosendort	70	Valley	Probably sandstone or trap.	Open pit 2 feet deep.	1
62	Smith	40	Swampy valley	Seepage in drift	Two pits 5 feet deep, stone-walled.	([g])
104	Henry B. Leete	5	Edge of marsh	Seepage from drift (?).	Barrel sunk in earth.	2-3
111	A. E. Cooper	40	Narrow valley	Seepage in drift-filled rock channel.	Open pit	

[a] Falls. [f] Estimated. [g] Sometimes fails.

NEW HAVEN

AREA, POPULATION, AND INDUSTRIES

New Haven is the only city in the New Haven area and the largest city in Connecticut. It was settled in 1638 by the Puritans and received its present name in 1640. The original settlers laid out the part of the city in the vicinity of the Green in practically the same form it has at present. The town and city are consolidated, and the city has acquired practically all governmental functions. The area of New Haven is 14,260 acres, or 22.3 square miles. Its population in 1920 was 162,537.

Manufacturing is the chief industry in New Haven. The census taken in 1919 listed 769 establishments, whose main products are firearms and ammunition, corsets, foundry and machine-shop products, hardware of many kinds, rubber goods, paper and paper boxes, automobile accessories, wire, clothing, and packing-house products. Fishing and oyster culture are industries that contribute materially to the city's commercial importance. Shipping facilities are good, both by water and by rail. New Haven is the home of the main office of the New York, New Haven & Hartford Railroad lines, of which six branches serve the city.

TOPOGRAPHY AND DRAINAGE

New Haven occupies the southern tip of the Central Lowland of Connecticut, and most of the city is built upon a comparatively level plain, which does not exceed 60 feet above sea level. Near the northern border of the town rise four trap ridges, which break the continuity of the plain. They are known as East Rock, Mill Rock, Pine Rock, and West Rock, or collectively as the Four Rocks. Mill Rock and most of Pine Rock are just over the town boundary in Hamden. East Rock and West Rock, which are the highest and rise to 359 and 440 feet, respectively, above sea level, are within the confines of New Haven. Both East Rock and West Rock have been set aside as city parks.

The part of New Haven lying east of the harbor and Quinnipiac River contains many small hills of sandstone and trap, which are usually elongate from north to south and rise 100 to 250 feet above sea level. West of the city rises the highland area of crystalline rocks. A small corner of this highland near Westville, which has a maximum altitude of 360 feet above sea level, is included within the limits of New Haven.

Viewed from any of its surrounding heights the city of New Haven is seen to occupy the bottom of a huge horseshoe-shaped basin, which opens southward to Long Island Sound.

Three large streams, Quinnipiac, Mill, and West Rivers, whose sources are farther north, flow across the city and discharge into New Haven Bay. These streams carry most of the drainage of New Haven. Throughout most of their courses across the city they are tidal and traverse salt meadows of considerable extent.

GEOLOGY

The pre-Triassic crystalline rocks are exposed in two small areas in New Haven. The smaller of these is an area of the Branford granite gneiss about a mile long and less than half a mile wide on Lighthouse Point, at the southeast corner of the town. The other is a triangular area of the "Milford chlorite schist" about 1½ miles long on each side, southwest of Westville.

Triassic sandstone underlies nearly all of New Haven and is most extensively exposed at the western bases of East Rock and West Rock and in the area of the harbor. Trap rock is exposed most prominently in the cliffs of East Rock and West Rock, where it forms nearly sheer precipices above the sandstone, till, and talus below. Throughout Fair Haven the trap occurs as small dikes, most of which are a few inches to a few feet in width, cutting the sandstone. These dikes generally occur along ridges.

Drift.—In the northern and western parts of New Haven till forms most of the land that is 60 feet or more above sea level. In Fair Haven and farther south till extends down to about 20 feet above sea level, and at places near Lighthouse Point it extends down to the beach. The proportion of the town covered by till is relatively small, however, probably about one-third of its area, and at most places the till is very thin. The deepest wells recorded in the till are those of Veatch (No. 41), 27 feet, M. A. Regan (No. 87), 25 feet, and E. Meara (No. 89), 16 feet. The Meara well ends on bedrock. (See pl. 5.)

Stratified drift is the surface formation in approximately two-thirds of New Haven. It underlies all the plain on which the main part of the city stands and also occurs in the valley of West River and as a narrow strip along most of the eastern shore of the harbor. The maximum thickness of stratified drift in New Haven is unknown. Several dug wells penetrate from 30 to 45 feet of it. Sargent & Co. sunk a test well 110 feet in stratified drift at their plant on the water front at the mouth of Mill River. Farther north on Mill River the National Folding Box Co. reported bedrock below the stratified drift at depths of 75 to 90 feet. It is not unlikely that the depth of stratified drift at some places may be as much as 200 feet.

In New Haven Harbor and in the adjacent tidal estuaries there is being deposited at the present time a layer of black mud, which at some places is at least 20 to 30 feet thick. (See p. 11.)

WATER SUPPLY

PUBLIC SUPPLY

The New Haven Water Co. furnishes the public supply for the city of New Haven. The company's storage reservoirs and catchment areas are all outside the city limits. The largest reservoir is the artificial lake called Whitney Lake, just north of New Haven, in Hamden, which was made by damming Mill River. Most of the drainage basin is in Hamden and Cheshire. Lake Wintergreen is a small natural reservoir in Hamden. Lakes Dawson, Watrous, Bethany, Chamberlain, and Glen are artificial reservoirs constructed by damming parts of the West River drainage system in Woodbridge and Bethany. Wepawaug Reservoir, in Orange, discharges by tunnel into Maltby Lakes, also in Orange, and the two are an important part of the supply. Lake Saltonstall, in Branford, which receives the flow of Farm River by tunnel, also supplies New Haven. Pressure reservoirs for New Haven are located on Mill Rock, in Hamden, and on Reservoir Hill, in Fair Haven East. The other storage reservoirs afford natural pressure by gravity.

The water company uses seven Bigelow boilers,[30] two Worthington pumps of 20,000,000 gallons capacity (24 hours), two Allis-Chalmers pumps of 20,000,000 gallons capacity, and one Builders pump of 10,000,000 gallons capacity. Pipe lines aggregate 253 miles in length, and their diameter ranges from 4 to 30 inches. The pressure is from 35 to 45 pounds to the square inch. In 1915 the average consumption was 23,000,000 gallons a day, service connections numbered 22,000, and the charge for metered water ranged from 10 to 18 cents per 1,000 gallons.

The public supply is available in all parts of New Haven except a few suburban districts, where wells are still used for domestic supply. Ground water in the thickly settled parts is not considered desirable for drinking because of the great danger of pollution by human, animal, and factory wastes. Analyses of water used in the public supply are designated A and B on page 36.

GROUND WATER FOR DOMESTIC USE

Ninety-six wells and springs in New Haven that furnish water for domestic use regularly or occasionally were examined. Of these, 61 are dug wells, 18 drilled wells, 4 driven wells, and 13 springs. (See pl. 5.) A few of the wells are near the western and northern borders of the town, but most of them are in the eastern part, in the localities known as Fair Haven East, Morris Cove, and Lighthouse Point. In this part of the town, where the land is hilly and the population relatively sparse, the public supply has not been extended to all the houses.

[30] Statistics taken from the McGraw-Hill Waterworks directory, 1915.

Of the 61 dug wells, 33 are in stratified drift and 28 in till and bedrock. The average depth of 56 dug wells is 19 feet, the same as the average for the whole area. (See table.) The two deepest dug wells in the town are those of Mitchell (No. 5) and Carham (No. 11), each 45 feet deep, in stratified drift. The deepest wells in till are those of M. A. Regan (No. 87), 25 feet, and Veatch (No. 41), 27 feet. Well 17, belonging to the Connecticut Agricultural Experiment Station, is 28 feet deep and is chiefly in sandstone.

The 18 drilled wells in New Haven, with one exception, are east of the bay and Quinnipiac River. All but two are almost entirely in sandstone. The average depth is 92 feet, considerably greater than the average in most of the other towns in this area where more than a few wells were examined. (See table.) One well was reported as yielding 5 gallons a minute and another 4 gallons.

The chemical constituents of several waters from driven wells in New Haven are shown by analyses given on page 36. The degree of hardness and the quantity of dissolved constituents differ. Water from the 90-foot drilled well of M. H. Marlin (No. 75) is moderately low in mineral content but rather hard and will form considerable scale in boilers.

Of the 13 springs examined at least 8 appear to issue from fractures in bedrock, either sandstone or trap. Four are mainly till seepages. Cold Spring (No. 18), in Cold Spring Park, New Haven, comes from stratified drift and probably emerges at the top of a local clay bed in the drift. It may possibly be only an overflow seep above the tidal mud of the adjacent salt marsh. Colonial Spring (No. 19), in East Rock Park, is apparently fed through fractures in trap and sandstone. An analysis of water from this spring and from a spring on the Townsend place, Nos. 19 and 79, are given in the table on page 36. The waters represented are moderately low in mineral content and hardness and are suitable for most purposes. Springs are especially abundant in Fair Haven East, where they occur most commonly near the base of sandstone ridges. In this locality there are a great many unused springs and seeps not shown upon the map.

The ground water of New Haven is generally of satisfactory quality for domestic use wherever its sanitary purity is unquestionable. It is commonly harder than the city water, which is therefore preferred where available. In the Fair Haven East area cisterns were used commonly to provide water for laundry work before city water became available to most of the population.

GROUND WATER FOR INDUSTRIAL USE

The principal uses of ground water by industrial plants in the New Haven area are discussed on page 49, where tables are given showing the different kinds of concerns that use ground water and the purposes for which it is used. About 90 per cent of the data in these tables relate to plants in the city of New Haven, which can be regarded as practically representative.

Approximately half the estimated quantity of ground water developed in New Haven is used by the two large paper companies—the National Folding Box Co. and the New Haven Pulp & Board Co.

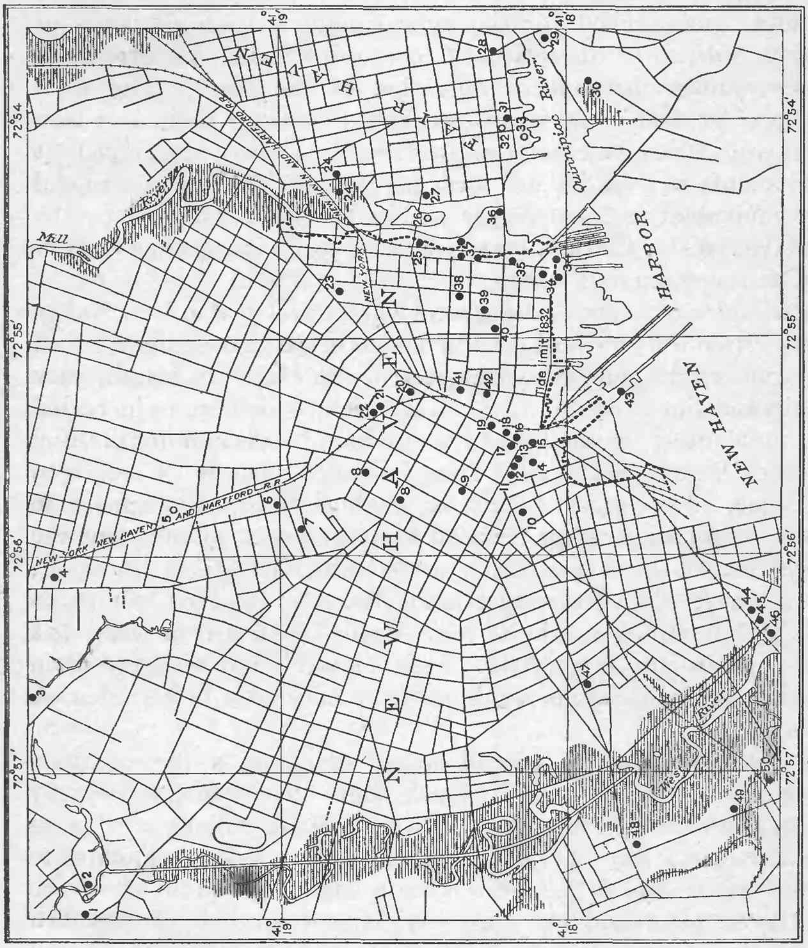

FIGURE 17.—Map of parts of New Haven and Orange showing location of pumping plants. (Base from U. S. Coast and Geodetic Survey)

Most of the other half is used for refrigerating and other cooling processes and for rough uses, such as washing floors and acid pickle.

The locations of pumping plants in New Haven and an adjacent part of Orange are shown in Figure 17. The table on page 104 gives data on the number of wells in each plant and the estimated quantity of water used.

The estimates of the quantity of water used are not exact, but they indicate that the normal daily consumption of ground water in New

Haven is between 3,000,000 and 5,000,000 gallons. Wherever possible estimates were based on measurements or estimates made by officials of the plants, and the indicated displacement of the pumping machinery during normal operation was computed from the dimensions and speed of the pumps. At a few places rough measurements of the discharge into tanks were made. At other places a fair average yield for the type and number of wells was determined and applied for the approximate number of hours of operation, with some discretionary revision of figures to correspond with the known methods of operation of the plant. The total quantity of ground water developed in the lowland basin in which New Haven stands includes also a small quantity developed at near-by plants in Hamden and Orange; it constitutes an additional supply equivalent to 15 to 25 per cent of the total furnished by the New Haven Water Co. and its subsidiaries to all its patrons in New Haven and surrounding towns.

Practically 98 per cent of the ground water developed in New Haven is derived from the stratified drift by means of gangs of shallow driven wells. Such wells, properly constructed, are cheap to install, easy to repair, and almost certain to give a fair yield, which can be increased almost indefinitely by increasing the number of wells and distributing them over a sufficient area. The yield of driven wells seems to be variable. The largest yields, ascertained from what appear to be reliable sources, average from 10 to 40 gallons a minute, but the average for all the wells, which are in different stages of repair, is much lower. The National Folding Box Co. obtained test yields of 240 to 270 gallons a minute from single 3-inch driven wells, but this is an unusually large yield. It is advisable not to figure upon more than 5 to 10 gallons a minute from each well in planning an installation.

The total quantity of ground water available in the stratified drift of New Haven probably is much larger than would be used by any contemplated development. Five million gallons a day is 15.35 acre-feet a day or 5,475 acre-feet a year. This amounts to 1 foot of water over 8.75 square miles a year. No doubt all of the New Haven plain and the tributary Mill River belt of stratified drift in Hamden contribute directly by underflow to the ground water of New Haven, and there is also a contribution from adjacent till slopes. The stratified drift alone covers 12 to 15 square miles in New Haven and Hamden. In addition the underflow of a large area in the Quinnipiac Valley coming through Fair Haven is available to pumping plants in New Haven.

One important fact not to be overlooked, however, is that too rapid removal of water in the relatively small area of the New Haven lowland may induce sea water to penetrate the water-bearing strata. More than 90 per cent of the ground water now pumped comes from an area less than a mile in diameter near the mouth of Mill River. The National Folding Box Co. reports a pronounced lowering of the water table there in the last four years. If this continues, it will indicate that water is being removed faster than it can be replaced by underground percolation. The inevitable result will be the steady incursion of sea water from the harbor at an increasing rate. Already there seems to be some suggestion of this tendency in the high chloride content of water from such plants as those of Sperry & Barnes, Sargent & Co., the New Haven Gas Light Co., and the National Folding Box Co. It would be well for these companies to check up this deterioration of the quality of water by means of frequent analyses, particularly of chloride. Definite observations on the lowering of the water table would also be desirable. It would be much better if, in the future, large pumping plants could be distributed at greater distances apart.

The general quality of the ground water for industrial uses has not been entirely satisfactory. Very few plants have been able to use ground water in boilers in place of city water, because of the great amount of hard scale formed. Analyses on page 36 give the chemical constituents of waters from several driven wells in New Haven, which differ in hardness and dissolved constituents. Most plants regard ground water as of doubtful purity for drinking, and this opinion is frequently, though not always, supported by sanitary analyses. For rough uses, ground water is thoroughly satisfactory. In condensers and refrigerating processes ground water is preferred to city water, because its temperature is more uniform and in summer is lower than the temperature of city water and therefore makes the water more efficient in cooling. (See p. 50.)

Near the harbor salt water enters many wells in greater or less amount and renders the water unfit for use in places where it would come into contact with metal or machinery. The relations of salt and fresh ground water are treated fully in a separate report.[31]

[31] Brown, J. S., A study of coastal ground water, with special reference to Connecticut: U. S. Geol Survey Water-Supply Paper 537, 1925.

Ground water used by pumping plants in New Haven

Plants using driven wells

No. on Fig. 17	Owner	Number of wells	Number of hours pumped per day	Total yield (thousand gallons per day)	Approximate yield per well (gallons per minute)	Remarks
1	Geometric Tool Co	1	9?	5	10	Estimated.
2	Greist Manufacturing Co	2	9?	10	10	Do.
3	Farnham Farms	1	3?	1	5	Do.
7	Semon Ice Cream Co	21	24	150	4	Computed by pump displacement.
8	Yale University	61	1?	13	3	Estimated.
9	Young Men's Christian Association.	5	9?	10	5	Do.
10	Bradley-Smith Confectionery Co	15-20	9?	4	½	Do.
11	L. C. Bates Co	20?	24	100	3½	Computed by pump displacement.
12	Bradley & Dillon	6	24	10	1	Estimated.
13	Dillon & Douglas	5	24	140	18	Computed by pump displacement.
14	Hull Brewing Co	9	10	50	10	Estimated.
16	Cudahy Packing Co	1	24	7	5	Do.
17	Alexander & Links	1	24	7	5	Do.
18	Armour & Co	3	24	15	3	Do.
19	Morris & Co	2	24	10	3	Do.
20	Centerfreze Ice Co	4	9?	50	25	Reported.
21	Charles B. Hendryx Co	10	9	20	4	Estimated.
23	Hygienic Ice Co	5	24	250	40	Reported.
24	National Folding Box Co	72	24	1,250	14	Measured by company.
27	Connecticut Co	5	24	25	4	Reported.
28	Yale Brewing Co	36	24	30	1	Computed by pump displacement.
31	New England Warp Co	4	9	25	10	Estimated.
34	Sargent & Co	48	9	300	1½	Based on gaging of one group.
35	W. & E. T. Fitch Co	16±	8?	40	6	Estimated.
36	New Haven Gas Light Co	25	24	150	4	Do.
37	New Haven Pulp & Board Co	27	24	1,250	30	Based on displacement.
38	New Haven Clock Co	6	5	15	10	Gaged and reported.
39	O. B. North Co	2	10?	10	10	Computed by pump displacement.
40	B. Shoninger Co	2	12±	40	15	Do.
41	H. B. Ives Co	5	9	15	6	Estimated.
42	Strouse & Adler	2	2?	1	5	Do.
43	Sperry & Barnes	40	24	500	7	Do.
46	Howard Co	1	9	3	5	Do.
47	Philip Fresenius's Sons	25-30	8?	15	1	Do.
		487		4,501		

Plants using dug wells

No. on Fig. 17	Owner	Number of wells	Number of hours pumped per day	Total yield (thousand gallons per day)	Approximate yield per well (gallons per minute)	Remarks
15	Federal Packing Co	1	24	5	3	Estimated.
22	McLagon Foundry	1	9	5	10	Do.
25	Oriental Emery Co	1	9	5	10	Do.
45	Malloy Buckle Co	2	10	10	5	Computed by pump displacement.
		5		25		

Plants using drilled wells

No. on Fig. 17	Owner	Number of wells	Number of hours pumped per day	Total yield (thousand gallons per day)	Approximate yield per well (gallons per minute)	Remarks
4	New Haven Dairy Co	2	24	70	25	Computed by pump displacement.
6	Hubbel Dairy Co	1	6	15	40	Reported.
		3		85		

Grand total estimated daily draft of ground water in New Haven, 4,611,000 gallons.

All industrial pumping plants in New Haven that were examined are shown on Figure 17 and are described below:

1. The Geometric Tool Co. (information by E. E. Metzger, general superintendent). Uses city water for most purposes but has one 2-inch driven well 105 feet deep, which penetrates only sand and gravel (stratified drift). The 2-inch pipe was placed inside a 6-inch casing, which was set first and then withdrawn. The well was made in 1916. It is pumped to its maximum capacity, and the water is used for rough washing, but the supply is too small for the company's entire needs.

2. Greist Manufacturing Co. (information by Mr. Smith, engineer). Depends mainly on city water. Two shallow driven wells supply water for some rough uses in the factory. The quantity and quality of the well water used are not very definitely known. Water is found in sand (stratified drift) at a depth of about 5 feet, on the company's land adjoining West River.

3. Farnham Farms (information by Mr. Brown, foreman). Produce garden truck for the New Haven market. City water has never been available, and they depend mainly on wells. Some brook water is used for washing vegetables. There is one 2-inch driven well of unknown depth, equipped with a windmill. Two dug wells, one 15 and the other 13 feet in depth, have power-driven pumps. All the wells are in stratified drift. The water is used for domestic purposes, stock, and the irrigation of gardens.

4. New Haven Dairy Co. (information by Mr. Rathgaber, engineer). Uses city water in boilers, well water for all other purposes. There are two wells drilled in sandstone, 175 and 165 feet deep. The deeper well has been in use 20 years and is pumped continuously at a rate of about 30 gallons a minute by means of a single acting vertical steam pump 3¾ by 16 inches, which makes 50 strokes a minute. The theoretical displacement is 38 gallons a minute. The other well is equipped with a pump of slightly smaller piston diameter and delivers 20 gallons a minute. The water is rather hard but is used successfully for ammonia condensers, washing, drinking, and other purposes.

5. Winchester Repeating Arms Co. (information by A. T. Currier, superintendent of construction). Now uses city water entirely. The company drilled two deep test wells about 1900, both of which were practically dry. One of these wells is described as follows:[32] "The Winchester Repeating Arms Co. reports that it drilled 4,000 feet in red sandstone, but except for surface leakage it was a dry hole, water being run in to work the tools. * * * The hole was 8 inches in diameter and was cased to 500 feet, but the casing was withdrawn when the well was abandoned."

6. Hubbel Dairy Co. (information by manager and foreman). Uses city water to some extent. In addition the company has a 6-inch well, 250 feet deep, drilled in 1917. The well is said to yield 40 gallons a minute. It is pumped six or seven hours a day and supplies water for cooling. A vertical pump attached to a walking beam driven by steam engine is used. The water comes from sandstone and is of good quality for drinking though somewhat hard. It is used mainly for washing floors and utensils and for cooling milk.

7. Semon Ice Cream Co. (information by Mr. Burdick, engineer). Uses city water for drinking and for boilers and ground water for ammonia condensers and water jackets. There are twenty-one 2-inch driven wells located in the engine room, spaced at intervals of 10 feet. The wells are 20 to 40 feet in depth and 2 inches in diameter and penetrate sand (stratified drift). They are pumped 24 hours a day by a vertical three-cylinder belt-driven Deane pump with a displace-

[32] Gregory, H. E., U. S. Geol. Survey Water-Supply Paper 102, p. 147, 1904.

ment capacity of about 150 gallons a minute but an actual delivery considerably less, owing to slippage.

8. Yale University (information by Mr. Barnes, superintendent of lighting and heating). City water is supplied to all the university buildings for general uses. There is a gang of driven wells at the gymnasium, near Elm and High Streets, and another at the dining hall. The gymnasium is supplied by a group of 54 wells, and the dining hall by a group of 7. The wells at the gymnasium formerly supplied about 100 gallons a minute, but this yield is said to have dropped recently to about 50 gallons. The water is used for the swimming pool.

9. Young Men's Christian Association (information by Mr. Fisher, master mechanic). The building on Temple Street, near Chapel, which was occupied by the Young Men's Christian Association until the summer of 1919, depends entirely on driven wells for its water supply. It is said that aside from the greater cost of city water, the city mains do not afford sufficient pressure for fire protection, and as it was necessary to pump water to a reservoir on top of the building, an independent supply was developed. Five wells, said to be 90 feet deep and 4 inches in diameter, were driven about 1904, and the casings have been drawn up once to renew the points. They are entirely in the stratified drift. The quantity of water available far exceeds the demand. The water is used for drinking, for lavatories, and for the heating system. It deposits much scale in pipes.

10. Bradley-Smith Confectionery Co. (information by Mr. Hawley). Uses 15 or 20 driven wells 2 inches in diameter and 8 to 14 feet deep. These supply water for cooling candy, also for use in lavatories. The wells are in sand, and fine sand continually rising with the water has given so much trouble by clogging pipes that the company is considering abandoning the wells.

11. L. C. Bates Co. Has a large number of driven wells, but the exact location and details of their construction are not known. Seven wells are in a cluster under the coal bin. All the wells are 2 inches in diameter and probably less than 40 feet in depth. They are pumped continuously in summer, and the water is used in refrigerating. A double-cylinder pump, measuring 10 by 8½ by 12 inches and making 16 single strokes a minute, is used. The indicated displacement is therefore about 90 gallons a minute. City water is used for purposes other than refrigerating.

12. Bradley & Dillon (information by the company's engineer). Cold-storage plant. City water is used for all purposes except refrigerating. There are six driven wells 2 inches in diameter scattered at distances of 10 or 15 feet. The wells are believed to be about 40 feet deep and are wholly in sand and gravel. The quantity of water used is unknown, but the discharge indicates a yield of perhaps 10 gallons a minute. More is used in summer than in winter.

13. Dillon & Douglas (information by Mr. Gates, engineer). Cold-storage plant. Uses city water in boilers, but well water for refrigerating. There are five driven wells 2 inches in diameter and of unknown depth, in stratified drift. The wells are pumped continuously, but about twice as much water is used in summer as in winter. The capacity of the wells has never been tested, but at the time of inspection, in June, 1919, the indicated displacement was about 100 gallons a minute.

14. Hull Brewing Co. (information by E. J. Grandjean, foreman). Uses nine driven wells 2 inches in diameter and 35 feet deep, entirely in coarse sand. Cook strainers are used and have been renewed about three times in 14 years. The wells are pumped steadily 10 hours a day, but the yield is unknown. The water is used for cooling, for condensers, and for rough uses around the plant. The well water was found too hard for boiler use, and city water was substituted for it.

15. Federal Packing Co. (information by the foreman). One dug well, reported to be 15 or 20 feet deep, supplies water for cooling and all other uses except drinking, for which, it is said, water is hauled.

16. Cudahy Packing Co. (information by Mr. Jones). One well, but nothing is known as to its kind, depth, or other details. Water is pumped by an automatic electric pump and supplies the refrigerating machine only.

17. Alexander & Links. Dealers in meat and provisions. Use one 2-inch driven well about 40 feet deep to supply the refrigerating machine. An analysis of this water (P–17) is given on page 36. City water is used for all other purposes.

18. Armour & Co. Have city water but use well water for cooling. Three wells 2 inches in diameter and 33 feet deep are pumped by an automatic electric pump. The yield is unknown, but the stream of waste water is small and probably does not exceed 10 gallons a minute. The water is used only for refrigerating and so is drawn more in summer than winter. The wells have been in use since 1914 and have been rather troublesome because of fine sand, which rises with the water and settles in all the conduits, choking them badly.

19. Morris & Co. (information by Mr. Kram, manager). Use city water and in addition have two driven wells, 2 inches in diameter and 30 feet deep, located under the building. They are pumped almost continuously in summer. The water is used for cooling only, and after circulating through ammonia pipes wastes into the sewer. The amount is unknown but is not large.

20. Centerfreze Ice Co. (information by Mr. Sweet, engineer). Has experimented with wells for several years, with unsatisfactory results. The last four wells were completed in 1919 and are 2 inches in diameter. Two are driven 40 feet and two 30 feet in the bottom of ordinary dug-well excavations about 20 feet deep, which just reach the water table. The material penetrated is sand with some quicksand. The wells, on completion, yielded about 100 to 120 gallons a minute by pumping and flowed 15 to 20 gallons a minute at the 20-foot level in the bottom of the pits. The chief difficulty seems to have been that the water table is a trifle too deep for successful pumping by suction lift from the surface. The water is used chiefly for cooling.

21. Charles B. Hendryx Co. (information by manager and engineer). Manufactures wire articles, iron railings, etc. City water is used for boilers and for drinking, well water for washing acid pickle and other rough uses. There are 10 driven wells 2 inches in diameter and 53 feet deep from a level 5 feet below the surface. Even after the lift is reduced by setting the pump down 5 feet there is great difficulty in pumping, as the water table is almost below the reach of suction. Pumpage at neighboring plants seems to affect the supply noticeably. The yield has diminished in nine years from 86 gallons a minute to about half that. The water is reported to be unfit for boilers without treatment.

22. McLagon Foundry Co. (information by manager). Uses city water for most purposes. There is one dug well 25 feet deep in sand, in which the water is usually 3 or 4 feet deep. The well is pumped most of the time, and the water is used for rough washing. The water level is said to be affected by pumping at near-by plants. At times the well is nearly dry.

23. Hygienic Ice Co. (information by Mr. Vanderveer, chief engineer). In addition to city water this company has used wells for several years, but has always had considerable difficulty in getting an adequate supply and in sinking wells satisfactorily. Part of these troubles arise from the fact that the depth to water is about 25 feet and the drawdown is so great that the lift required is too much for pumps located on the surface. The latest and most satisfactory installations are at the bottom of two pits, one 25 feet deep and the other 30 feet, both about 14 feet square and lined with concrete. The pumps are set at the bottom of the pits, and the wells are driven to a depth of 48 feet below the bottom. One pit contains two wells and the other three, all 2 inches in diameter, and fitted at the bottom with 10-foot strainers. The quantity of water pumped is about 200 gallons a minute, 24 hours a day. The water is used for cooling, and, after treatment, for boilers. On page 36 is an analysis (P–23) made in 1919 of water from other wells located near by on the property.

24. National Folding Box Co. (information by Mr. Peck, master mechanic). Has the largest pumping plant in the New Haven area. There are 72 driven wells, divided into two groups of nearly equal number east and west of James Street. All are pumped from one central plant, west of James Street. The pump house is sunk down below sea level. The wells are pumped continuously at an average rate of nearly 1,000 gallons a minute (1,250,000 gallons a day). The water is used in paper-pulp processes and also for all factory supply except for boilers and drinking. Any excess in the supply is returned through the system.

The wells are 3 inches in diameter and 60 to 75 feet deep and at the bottom carry 20-foot Cook strainers. They are located in approximately east-west lines at intervals of about 20 feet. The wells west of James Street are in a tidal marsh that has been reclaimed by filling. They penetrate 18 to 20 feet of slime and mud, below which is fine sand (stratified drift). A bed of coarse gravel is found at about 60 feet, and from this the wells draw their supply. Some unusually large yields were indicated in the preliminary pumping tests. It is reported that 40 wells west of James Street were pumped at a rate of 1,640 gallons a minute (41 gallons a well) for 36 hours without apparently affecting the supply. In individual tests certain wells yielded 240, 260, 270, and 280 gallons a minute for sustained periods. Wells 3 inches in diameter are said to yield nearly as much as wells 6 inches in diameter, some of which were tried experimentally. The plant has been delivering at its present rate since about January 1, 1917. It is said that the water table is gradually falling, as indicated by the level at which water stands in the wells during occasional temporary shutdowns. The drop was about 4 feet the first year and 2 feet the second.

When the plant was first operated tests were made to determine whether or not the wells were affected by salt water, which is present in Mill River, just west, and more or less permeates the old salt marshes. No evidence of contamination was discovered, and the water west of James Street was of practically the same quality as that east of the street, farther from the river. However, a sample collected at the pump delivery July 9, 1919, tested 514 parts per million of chloride. An analysis of the water (P–24) is given on page 36. The results indicate that at present there is considerable salt in the water. This has been induced by the heavy drain on the underground supply. As a general rule the thick bed of mud encountered in the salt marshes and beneath the harbor appears to constitute an effective barrier to the access of salt water, but its resistance is overcome to some extent by exhaustion of the water from the underlying water-bearing sand, which is relatively full of fresh water. It is possible that the salt may enter, to some extent at least, by infiltration around well casings, but this method of contamination is not regarded as very likely at this place, because tidewater seems to be thoroughly excluded from the land on which the wells are situated.

It may be noted that pumpage of 1,000 gallons a minute throughout a year represents a volume of water that would cover 1 square mile to a depth of 2.52 feet. Allowing a porosity of 30 per cent for stratified drift, this would lower the water table over 1 square mile by 8.4 feet.

25. Oriental Emery Co. In addition to city water for drinking, etc., this company has one dug well, lined with cement well pipe. It is 10 feet deep, and the depth to water is 8½ feet. The well is dug in sand. It is pumped regularly to supply water for washing emery.

26. United Illuminating Co. (Information by Mr. Clark, chief engineer). Power plant on an island in Mill River, which is tidal. It is stated that the company once used a gang of about 20 driven wells, 2 inches in diameter and more than 100 feet deep. The water was too hard for boiler use and contained much mica and fine sand. The yield of the wells was about 7 gallons a minute. They had no strainers but were open at the bottom. Although the island is completely surrounded by tidewater, the wells are said not to have been salty. They have been abandoned for several years.

27. Connecticut Co. (information by Mr. Farnham and Mr. Wilson). Power plant, at Grand Avenue and Mill River. Uses chiefly city water. There are five 2-inch driven wells in the northeast corner of the property, which are said to range from 16 to 50 feet in depth. They are about 200 feet from tidewater, on land that has been built up from salt marsh. About 20 gallons a minute is pumped from the wells continuously, which is not nearly their capacity. The water is used for cooling, chiefly in water jackets. It is not desirable for boilers or turbines because too much scale is formed. An analysis of a sample of water from this group of wells (P–27) is given on page 36.

28. Yale Brewing Co. (information by Mr. Richle). Depends mainly on city water but has for a long time used some wells. At present there are thirty-six 2-inch driven wells, about 18 feet deep, located in the small triangular court at the intersection of Ferry and Chapel Streets. The wells penetrate sand (stratified drift) and are about 500 feet from salt water. A great many of them are now unproductive owing to clogging or rusting. The wells are pumped continuously, and the water is used for washing floors, cases, etc. The yield is not known, but the indicated pump displacement at the time the place was visited, was about 25 gallons a minute (7 by 7 by 10 feet, 50 single strokes per minute). A sample of the water July 9, 1919, contained 143 parts per million of chloride. An analysis (P–28) is given on page 36. Results indicate very slight if any contamination by sea water. The company once had under its plant two drilled wells about 100 feet deep, which penetrated sandstone most of the way. They were abandoned because the supply was wholly inadequate. The water was not saline, it is said.

29. American Steel & Wire Co. (information by Mr. Bowman, engineer). An abandoned drilled well in sandstone only a few feet from tidewater. It is said to have been 150 feet deep and to have given a small supply of bad, salty water.

30. American Steel & Wire Co. (information by Mr. Bowman, engineer). Uses some city water, but until recently has depended mainly on wells. Its property completely surrounds that of the Penn Seaboard Steel Corporation, whose plant was actively operated in 1918 but suspended work on the termination of the war. There are said to have been originally 51 driven wells, sunk in 1902, 40 of them on the property now owned by the Penn Seaboard Steel Corporation and 11 on the land of the American Steel & Wire Co., near the southwest boundary between the two properties. The wells are 12 to 18 feet deep, 2 inches in diameter, and irregularly spaced. They penetrate sand (stratified drift). The surface is 5 to 10 feet above sea level. For several years the company used the entire group of 51 wells and had no trouble about getting plenty of water. During the war the Penn Seaboard Steel Corporation began to operate its plant very extensively. The suction was cut at the boundary line, and the 40 wells on its property were pumped to capacity. It was found, however, that less than half of these were yielding water, owing to deteriorated casings and other causes. During the later part of 1918 water was pumped continuously at the rate of approximately 10,000,000 gallons a month, or about 10 gallons a minute to the well for 20 wells. The water was tested when pumping was first begun on these 40 wells and is said to have been found fit for drinking, although it contained slight traces of bacteria and chloride. But under this heavy draft it became very salty, the wells evidently having drawn salt water from the harbor, which is about 400 feet away. The wells were not pumped during the period of this investigation, and no samples were obtained.

31. New England Warp Co. (information by Mr. Matthewson). Uses city water for most purposes but pumps well water for washing wool. There are four 2-inch wells 15 or 20 feet deep in sand (stratified drift), which just reach water. They have been used for 15 years, the points being renewed occasionally. The amount of water used is unknown but is not nearly so great as that used by the larger plants in New Haven. The water is regarded as hard but not saline. A sample collected July 9 contained 26 parts per million of chloride. The more complete analysis (P–31) is given on page 36. The results indicate no traces of sea water, although the wells are only about 300 feet from the shore.

32. Kilborn & Bishop. Abandoned their wells in 1918. No reliable information was obtained about the wells except that they are not "salty."

33. Bigelow Co. (information by Mr. Barnum and Mr. Barnes). Recently abandoned its pumping plant, which had 30 or 40 driven wells, about 28 feet deep. The water was used in testing boilers manufactured by the company but caused them to rust badly. A drilled well 175 feet deep, which just penetrated rock, yielded too small a supply of water. The casing was removed, admitting salty water.

34. Sargent & Co. Use large amounts of both city water and ground water. The ground water is used most in condensing steam and to some extent for washing floors, acid pickle, etc. It is unsatisfactory for boilers, drinking, or electroplating. There are five groups of driven wells, most of which are 2½ inches in diameter and about 35 feet deep. Three of the groups are in use at present. Group A consists of 16 wells 2½ inches in diameter. A number of 2-inch wells are also connected to the group, but they have not been cleaned out for many years and are thought to yield practically no water. Group B consists of twenty 2½-inch wells. Some 2-inch wells, also probably useless, are connected with this group. Group C consists of twelve 2½-inch wells about 30 or 35 feet deep. Groups D and E are abandoned. The wells of Group A are on filled land which was originally tidal and penetrate about 6 feet of till, 4 feet of black harbor mud, then fine sand (stratified drift). Groups B and C are on land which was originally above tidewater and penetrate sand. The shore formerly extended only about 160 feet south of Water Street at the factory grounds, but the tidal flat has been filled in for a distance of 1,000 to 1,500 feet. East of the plant, however, docks still extend nearly to Water Street. On August 6, 1919, a special study of these wells was attempted to find out whether the water was contaminated by sea water and, if so, the relative degree of contamination between the groups, as well as to note any apparent tidal effects or daily fluctuation in quality.

The three groups of active wells (A, B, and C) are pumped about nine hours a day, from 8 a. m. to 5 p. m., and the water is used in jet condensers. Unfortunately, it was not possible to obtain samples directly from the wells, but samples of the condenser discharge from Groups A and B were collected at hourly intervals, and a single sample was obtained from Group C. These samples represent the well water plus a small amount of condensed steam. The results show that there was practically no variation in salinity due to tides, but they indicate very high contamination in group A, about 3,700 parts per million of chloride, and relatively low contamination in Groups B and C, about 100 parts per million of chloride. Evidently the wells on filled land are much more seriously affected, either because of their proximity to the present margin of salt water or for some more obscure reason. It is suspected that salt water enters the wells of Group A through open breaks in corroded casings.[33] This is indicated by the fact that a sample from a single detached well of this group contained only 194 parts per million of chloride. The analysis of water from this well (P–34) is given on page 36.

Mr. Henry Sargent states that several years ago a test well was sunk 640 feet south of Water Street and thus several hundred feet beyond the original shore line. The depth reached was 110 feet. The well penetrated 25 or 30 feet of mud, then fine sand which grew progressively finer. The water was thoroughly fresh and fit to drink, but the well was never used.

35. W. & E. T. Fitch Co. Uses both city water and well water, the latter chiefly in condensers and for floor washing. There are two groups of wells, one at the north end and one at the south end of the building. The northern group comprises six wells 23 feet deep, spaced about 10 feet apart, which are reported to yield very little water. The other group has a larger number of wells about 30 feet deep, spaced 10 feet apart and arranged in two rows; these wells are 2 inches in diameter and penetrate stratified drift. The wells at this plant are about 400 feet from tidewater in Mill River, and the surface of the ground is about 10 feet above sea level. A sample of water collected July 9, 1919, ran 145 parts per million of chloride. An analysis made by the company in 1916 shows 104 parts per million of chloride. This content is high but does not necessarily indicate the presence of salt water.

36. New Haven Gas Light Co. (information by Mr. White, superintendent). Uses city water for boilers and for drinking, well water for condensers and for quenching coke, and salt water from Mill River for washing floors and other rough uses. The salt water is used only because the wells do not yield an adequate supply. There are two groups of 2-inch driven wells. One group of 15 wells is west of the railway tracks at the southeast corner of Green and East Streets. No samples were taken from this group. The other group consists of 10 wells arranged in an east-west line parallel to Chapel Street at the west end of Mill River bridge. Five of these wells are 42 feet deep, and five are 37 feet deep. The water table is said to stand approximately at mean sea level. The wells are in ground which was originally a tidal marsh and penetrate a few feet of mud, then fine sand (stratified drift). Only the elevated approach to Mill River bridge separates the wells from tidewater on the south. A complete analysis of a composite sample of water from 7 of the 10 wells is given on page 36 (P–36). The chloride content is 439 parts per million and indicates the presence of sea water in considerable quantity.

37. New Haven Pulp & Board Co. Uses city water for boilers and drinking but pumps ground water for pulp mixing and rough uses. There are two groups of wells, one of 19 wells west of the railway tracks and 300 to 400 feet from Mill River, the other of 8 wells east of the tracks, very near the river. All are 2-inch driven wells about 30 feet deep. All the wells are pumped to capacity 24 hours a day. In fact, the wells in the group near the river appear to be greatly overtaxed, and the pump seems to be working on vacuum a large part of the time. Double-acting steam pumps 12 by 18 inches making 50 strokes a minute are used, so the indicated displacement for each group of wells is about 800 gallons a minute. The well water was used at first for drinking but later was condemned for this purpose and abandoned. It is said to have become noticeably bad, particularly in the wells nearest the river. None of the present employees of the plant are very well informed about the details of the wells. A sample of the water from the western group of wells collected July 12, 1919, ran 746 parts per million of chloride, which indicates considerable contamination by salt water.

38. New Haven Clock Co. (information by Mr. Leicester and Mr. Gillette, plant foreman). Uses six driven wells 3 inches in diameter and 50 feet deep.

[33] Brown, J. S., op. cit., pp. 62–63.

They were driven in 1918, replacing other wells previously used. The wells are 22 to 41 feet apart, in an east-west row on the west side of Hamilton Street. The water is used for washing, electroplating, and general factory purposes. City water is used for boilers and for drinking. The wells are pumped intermittently during the 10-hour day shift by an automatic electric pump, which runs about half the time. The amount pumped is reported to be approximately 14,000 gallons a day. A measurement of the delivery in the tank showed a pump yield of 64 gallons a minute during actual running of the pump. This would make a little more than 19,000 gallons in five hours.

39. O. B. North Co. (information by Mr. Nearing, manager, and Mr. Reynolds, engineer). Uses city water for boilers and well water for all other purposes. The well water was tried in boilers for a year, but even after using caustic soda and heating it formed a heavy scale. There are three wells, 35, 39, and 41 feet deep, of which only the first two are in use. They are in the cellar under the plant and were driven about 1910. Brass strainers 4 feet long are used. One well is pumped by a steam pump, the other by a belt-driven pump, but neither the quantity of water used nor the capacity of the wells is very accurately known. The steam pump is 6 by 4 by 6 inches and makes 40 strokes a minute, delivering against a 60-foot head. The indicated displacement is about 12 gallons a minute. The belt-driven pump is 5 by 6 inches and makes 32 strokes a minute; the indicated displacement is 15 or 16 gallons.

40. B. Shoninger Co. (information by Mr. Barnes, superintendent). Uses city water for boilers and well water for all other purposes. There are two 2-inch driven wells, each about 25 feet deep, one of which has been used for 30 years and the other for 15 years. The wells are about 10 feet apart, along the sidewalk. They penetrate sand and gravel. Formerly they were used only in summer, and strainers had to be renewed annually, but with continuous use this has been unnecessary. During the day a belt-driven pump runs nine and one-half hours, pumping at a maximum rate of about 2,000 gallons an hour. At night the wells are connected with a small steam pump that delivers perhaps 4,000 gallons an hour, pumping intermittently.

41. H. B. Ives Co. Uses city water for boilers and well water for all other purposes. There are five 2-inch driven wells 20 to 30 feet in depth. The wells are entirely in sand and have given no trouble over a long period of use. They are pumped nine hours a day, but the rate is unknown. About 250,000 gallons a month of city water is used, and the quantity of well water used is believed to be much larger.

42. Strouse & Adler. Use two driven wells in summer. The water is used for drinking because it is cool and refreshing. The wells are 2 inches in diameter, are reported to be 50 feet deep, and penetrate sand.

43. Sperry & Barnes (information by Mr. Kling). Use well water for condensers and other cooling purposes and for washing floors. There are 40 driven wells 2 inches in diameter and 47 feet deep below the present surface, which is scarcely above high tide. The wells are in a line that extends about 400 feet southeast from the end of Brewery Street along the narrow peninsula of filled land on which the plant is situated. The wells used at present were driven in 1913, and the following approximate log is given:

Log of wells of Sperry & Barnes Co.

Material	Thickness (feet)	Depth (feet)
Fill and harbor mud	35	35
Hardpan	8	43
Gravel	4	47

The hardpan is described as "red rock sand" and probably is only a layer of hard sandstone gravel (stratified drift). The wells are pumped nearly to capacity 24 hours a day. The yield is thought to be at least 200 to 300 gallons a minute. The well water is of very poor quality, unfit for drinking or for boiler use. At first it was very much better than at present and was used considerably for drinking. An analysis is given on page 36 (P–43). The chloride content, 885 parts per million, indicates a very considerable quantity of sea water.

44. Grant Hammond Manufacturing Corporation. Plant idle in 1919. Has one 2-inch driven well of no great depth, which has supplied water for drinking and general factory uses for several years. The city water is used for boilers because the well water is too hard.

45. Malloy Buckle Co. Uses city water in boilers and well water for most other purposes, such as electroplating, washing pickle, and cleaning floors. There are two dug wells, each 25 feet deep, lined with cement well pipe. They are entirely in sand. The depth of water in the wells is normally about 2½ feet but is quickly lowered by pumping. The pump runs 10 hours a day and delivers about 10 gallons a minute.

46. Howard Co. (information by Mr. Howard and Mr. Harrison). Uses city water for boilers and drinking because well water is said to be too hard. Has one 2½-inch driven well 26 feet deep, which penetrates sand and reaches water at about 12 feet. A pump driven by a small electric motor is run during the day, seven days a week, pumping 2,000 to 4,000 gallons of water a day from the well. The water is used in pug mills and in mixing concrete, for which quality does not have to be considered.

47. Philip Fresenius's Sons (information by Mr. Herpich, bookkeeper). The Fresenius brewery was producing ice in the summer of 1919. It uses city water for boilers and well water in condensers and ice manufacture. There are 25 or 30 2-inch driven wells about 25 feet deep below the cellar floor. They were sunk about 1890, and the strainers have been renewed several times. Several thousand gallons is used daily, but the exact quantity is unknown.

48. American Mills Co. Described under Orange, page 119.

49. Connecticut Fat Rendering & Fertilizing Corporation. Described under Orange, pages 119–120.

50. New Haven Rendering Co. Described under Orange, page 120.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in New Haven

[Observations made Apr. 17 to 28, June 20 to July 2, and Nov. 10 to 24, 1919. Dagger (†) indicates that notes are given in Water-Supply Paper 537; for equivalent numbers in that report, see table on page 52. For descriptions of pumping plants, which are numbered in a separate series, see pp. 105-113]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth of water (feet)	Kind of rock	Equipment	Does well fail?
1	Miller	80	Valley	9	6	Stratified drift	Chain pump	No.
2	Beni	80	do	9	5	do	do	No.
3	Cummins	200	Slope	20	15	Stratified drift to bedrock.	Pulley	Yes.
4	Hotchkiss	120	Valley	12	9	Stratified drift	None	No.
5	Mitchell	50	Plain	45	33	do	Pulley	No.
6	A. N. Farnham	30	Terrace	29	21	do	do	No.
7	do	25	do	23	21	do	do	No.
8	Frasier	20	do	25	22	do	do	No.
9	West Rock Park	340	Hill flat			Trap rock	Hand pump	No.
10		40	Plain	35	32	Stratified drift	Pulley	No.
11	Carham	40	do	45	40	do	Chain pump	No.
12		50	do	34	25	do	Pulley	No.
13		40	do	33	23	do	do	No.
14	McFarnum	40	do			do	Hand pump	No.
16		50	do	32	29	do	Pulley	No.
17	Connecticut Agricultural Experiment station	140	Hill	28	20	Chiefly sandstone	Hand pump	No.
20	O'Neal	20	Plain	25	20	Stratified drift	Pulley	No.
21	Donahue	20	do			do	do	No.
23	Mrs. Doyle	35	do	40	33	do	do	No.
24		40	Slope	14	11	Stratified drift to sandstone.	Hand pump	(?).
26	John Kaslosky	40	do	20	16	Probably sandstone.	Pulley	No.
28		15	Valley	11	7	Stratified drift	Hand pump	No.
29	W. S. Swayne	40	Slope	22	21	Probably sandstone.	do	Yes.
31		40	do	26	23	Stratified drift and probably sandstone.	do	(?).
32		60	do	24	20	Probably sandstone.	Pulley	(?).
33	Oldberg	20	Valley	13	7	Stratified drift	Hand pump	No.
34		20	do	13	8	do	Pulley	No.
35	Nicholas	15	do	9	6	do	Hand pump	No.
36	do	15	do	9	5	do	Pulley	No.
37	Hemmingway	15	do	10	6	do	Hand pump	No.
38	Cheney	15	do	8	5	do	Pulley	No.
41	Veatch	60	Slope	27	20	Till	do	No.
43	Del Grego	30	Valley	18	10	Stratified drift	do	No.
44	Kolsinger	40	do	26	13	do	do	No.
46		20	do	12		do	Hand pump	No.
47		20	Slope	13	11	Till or sandstone	Pulley	(?).
†48	Ball	10	do	13	9	Probably sandstone.	None	No.
49		20	do	15	8	do	Pulley	(?).
57	G. E. Emerson	100	Hill	40	30-40	Sandstone	None	No.
58	A. Linsley	20	Slope	17	10	Till or sandstone	Pulley	(?).
†59	G. B. Thrall	8	Valley	10	5	Sandstone	do	No.
61	H. A. Niles	20	Slope	25?		do	Hand pump	
62	B. A. Chamberlain	40	do	20?		do	do	No.
63	R. M. Moschette	40	do	10	5	do	None	No.
65	Jacobs	10	Plain	8	3	Stratified drift	Pulley	No.
66	H. E. Jacobs	10	do	9	4	do	Chain pump	No.
69	John Jaeger	20	Slope	12	2	Till 3 feet, sandstone 9 feet.	do	No.
77	C. H. Smith	20	Flat	14	6	Chiefly sandstone	None	No.
78	L. Tamarack	20	do	22	13	do		No.
†81	Fort Hale Park	10	Ridge	12	10	Trap rock	None	No.
82	Wm. Ralston	10	Flat	9	4	Probably sandstone.	do	Yes.
83	H. Slocumbe	40	Slope	12	4	do	Pulley	Yes.
85	James Ferguson	60	do	26	15	Till and probably sandstone.	Hand bucket	No.

Records of wells and springs in New Haven—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth of water (feet)	Kind of rock	Equipment	Does well fail?
86	P. Arone	10	Valley			Stratified drift	Hand pump	Yes.
87	M. A. Regan	40	do	25	9	Till	do	Rarely.
88	Fort Hale Park	20	Slope		8	Probably sandstone.	None	Yes.
89	E. Meara	40	do	16	4	Till to rock		No.
91	W. T. Nott	20	do	13	4	Probably trap rock.	None	Yes.
92		15	Flat	15	10	Stratified drift	do	No.
94	G. Trionfo	10	Slope	12	5	Till and bedrock	Hand bucket	No.
95		20	Hill	8	4	do	None	(?).

Driven wells

No. on map	Owner	Elevation above sea level (feet)	Topographic position	Depth (feet)	Diameter	Kind of rock	Equipment
15	Hamilton	45	Plain	53	2	Stratified drift	Hand pump.
25		20	do		1½	do	Do.
*†67	Simon Eddy	10	do		1	do	Do.
93	W. R. Benjamin	10	do	7	1½	do	Do.

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
22	Harmon	40	Hill	75	Van Buren	Nearly all sandstone.	Hand pump	
27	J. F. Dunn	20	Valley	77	L. Basset	do	do	5
30	Hemmingway	50	Slope			Probably sandstone.	do	
42	A. Dagostino	30	Valley	70		Till and sandstone	do	
45	Collins	75	Slope	85	L. Basset	Sandstone	do	
50	R. G. Davis	100	Hill	137	C.L. Wright	do	Gasoline engine.	
51		160	do	90		Chiefly sandstone	Hand pump	
52	Gelston	100	Slope	60		Probably sandstone.	do	Fails.
55	C. W. Blakesley	100	Hill	65		do	do	
56		100	do	75		do	do	
60	Michael Etzel	50	do	85		Chiefly sandstone	Steam pump	
70	Cowles Tolman	160	do	190	L. Basset	do	Gasoline engine.	
71	B. A. Tucker	180	do	226	C.L. Wright	Till 8 feet, sandstone 218 feet.	do	4
72	Leo Misbach	60	Slope	50	do	Chiefly sandstone	Hand pump	
73	John de Phillip	50	do	84		do	do	
75	M. H. Marlin	120	do	90	C.L. Wright	Trap rock	Windmill	
90	A. Vertefeuille	30	do	76	L. Basset	Chiefly sandstone	Hand pump	
96	Mary Herrick	10	do	23	John King	All bedrock	do	

* Polluted by waste material, oily.

Records of wells and springs in New Haven—Continued

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
18	"Cold Spring"	−10	Foot of terrace bluff	Seepage in gravel (stratified drift) probably over clay beds.	Masonry-lined drinking fountain.	−1
19	"Colonial Spring"	20	Base of East Rock	Probably fractures in sandstone.	Stone-lined drinking fountain.	
39	B. Drappieurg	20	Head of ravine	do	Spring house over excavation.	
40	Bray	120	Side of ravine	Seepage in drift and sandstone along brook.	Tile sunk in earth. Gravity pipe line.	
53		40	do	Probably from sandstone.	Open pit	
54		30	Gentle slope in valley.	Joints in sandstone	do	2-3
64		20	Near base of hill	Till or sandstone	Conducted to stone bowl at roadside.	−1
68	A. J. Allen	20	do	Fractures in sandstone.	Brick-walled pit	1-2
74		70	Valley	Seepage into marshy till-filled valley.	Stone reservoir about 10 feet square.	
76	G. Kallert	50	Slight valley in hillside.	Seepage in till	Open pit	
79	Townsend	40	Near point of ridge	Fractures in trap dike.	Board-walled pit	1-2
80	Geo. H. Townsend.	5	Foot of hill, edge salt marsh.	Fractures in sandstone.	Well-like pit 6½ feet deep.	1-2
84	James Ferguson	40	Foot of steep hill	Probably from fractured trap dike.	Piped to spring house.	−1

ORANGE

AREA, POPULATION, AND INDUSTRIES

Orange is a shore town and was formed in 1822 from parts of New Haven and Milford. Its area is 18,388 acres, or 28.7 square miles, and its population in 1920 was 16,614. It is a town of many contrasts. The part of Orange known as West Haven [34] is a suburb of New Haven and has many social and economic relations with the city. Within West Haven there are several factories, which produce hardware, fertilizer, packing-house products, textiles, and other goods similar to those of New Haven factories. A portion of West Haven, known as Savin Rock, is a very popular pleasure resort. The remainder of the Orange coast is a residence section and summer resort of growing importance. The interior of the town, away from these populous fringes, is a thinly settled agricultural region. The village of Orange is attractively situated on high land, and its quiet atmosphere affords a pleasant contrast to the activity that characterizes other parts of the town.

Two lines of the New York, New Haven & Hartford Railroad and two trolley lines cross the town, and there are a number of improved roads. Nevertheless many parts are almost as undeveloped as if these facilities were not available within a mile or two.

[34] By act of the legislature of 1921 West Haven was taken from Orange and made a separate town.

TOPOGRAPHY AND DRAINAGE

Orange is bounded on the southeast by Long Island Sound and on the east and west by West River and Housatonic River, both of which are tidal streams. In the interior of the town are several valleys, which take a course slightly west of south, approximately parallel to the large streams on the eastern and western boundaries. The principal valleys, named from east to west, are those of Cove River, Oyster River, Indian River, and Wepawaug River. Between the valleys are prominent hills and ridges. The general surface of the town slopes southward, descending from slightly more than 300 feet above sea level in the hills along its northern border to sea level at its southern border. Glaciation and the nature of the underlying bedrock have combined to produce smooth, rounded hills and slopes in most of the town, but in the vicinity of the Maltby Lakes the topography is more rugged. The valleys are narrow, and the only large body of level land is the plain on which West Haven is built.

GEOLOGY

Bedrock.—The bedrock underlying the glacial deposits of Orange is of three kinds. That under the stratified drift of the lowland plain at West Haven and northward is presumed to be Triassic sandstone, though this presumption is based on the topographic and geologic relations in adjacent towns, as there are no exposures of the sandstone in Orange. The "Milford chlorite schist" underlies a belt of country from 2 to 3 miles in width extending from Maltby Lakes southward across the eastern part of Orange. The Orange phyllite occurs in all the western half of Orange.

Drift.—Till covers about 75 per cent of the area of Orange. It occupies nearly all the slopes and hills. Although boulders are very plentiful (pl. 7, *A*), they are less numerous than in the till of many other regions. Because of this and because the topography of Orange is rolling rather than rugged, the town is better adapted to farming than many other towns of the New Haven area and contains considerably more cleared land. The till in Orange has a characteristic topographic expression in the drumlin. There are several very perfect drumlins, such as Marsh Hill, Jones Hill, and Grassy Hill, as well as others less perfect in form. The till in the drumlins of Orange is unusually thick; at many places it exceeds 30 feet and at others it is probably as much as 100 feet. The table below gives some of the greatest depths recorded from wells. Each of the wells listed is located on a drumlin and is a dug well entirely in till, except No. 187, which is a drilled well 80 feet deep that penetrates 40 feet of till.

Depth of till penetrated by wells in Orange

	Feet		Feet		Feet		Feet
Well 62	42	Well 187	40	Well 244	43	Well 292	45
121	39	227	29	247	31	301	33

Stratified drift covers about one-fourth of Orange. The largest body is in the vicinity of West Haven, where the New Haven plain extends into Orange. The valleys of Indian River and Wepawaug River contain narrow but persistent bodies of stratified drift; there is a very narrow band along the valley of Housatonic River; and small isolated patches occur elsewhere.

WATER SUPPLY

The East Haven Water Co., owned by the New Haven Water Co., furnishes a public water supply to West Haven, Savin Rock, and the populous shore district of Orange. The water is drawn from Phipps Lake, near West Haven, and from Maltby Lakes. A small company controlled by Mr. Woodruff, of Orange Center, supplies a few families in that locality with water from springs on Grassy Hill. The rest of the town depends on wells and springs.

In all, 314 individual water supplies were examined and are recorded in the appended table. They include 245 dug wells, 40 drilled wells, 5 driven wells, and 24 springs. These form a large percentage of the total number of wells in use, except in the suburban sections near West Haven, where a dense population depends mainly upon wells; there the records given may not represent more than half of the existing wells. In West Haven and the adjacent parts of Orange where the public supply has long been available wells are very uncommon.

Wells.—Dug wells in Orange average 20 feet in depth, slightly greater than the general average for the New Haven area. The deepest one, No. 292, belonging to P. J. Allspaugh, is 45 feet in depth, all in till. Other deep wells in till are listed in the table. The deepest wells in stratified drift are Nos. 77, 78, and 79, which are 36, 37, and 26 feet deep, respectively. They are on a high terrace of the West Haven plain, where the water table lies deep. Well 212, 31 feet in depth, penetrates 29 feet of bedrock. The average depth to the water table in Orange, as indicated by data from 241 dug wells, is 13 feet.

The 40 drilled wells examined are distributed fairly evenly over the area underlain by crystalline bedrock. In many places they are drilled not because water is unobtainable from dug wells or because rock is exposed at the surface but because drilled wells properly cased are thought to be less subject to pollution. Consequently many of the drilled wells in Orange penetrate 5 to 40 feet of drift before reaching bedrock. The average depth of 32 drilled wells in Orange is 96 feet. The yields reported from three wells were about 0.15, 8, and 10 gallons a minute. Most of the yields are small, particularly in the Orange phyllite, or "slate," and the unusual depth of several wells drilled for domestic use is accounted for by the fact that very little water was obtained.

Analyses of samples of water from two drilled wells (16 and 125) are given on page 36. The waters represented are moderately low in mineral content but are rather hard and would form considerable scale in boilers.

Driven wells are uncommon in Orange, although they could be used to advantage in the valleys where stratified drift occurs. Three of the five examined are on a part of the West Haven plain to which the public supply has not been extended.

Springs.—Of the 24 springs examined 16 appear to derive their water from seepage in till, usually on till-covered slopes. Six issue from bedrock fractures or joints. The topographic locations are characteristic, at the heads of valleys or along small irregularities in slopes where the surface of the ground suddenly dips beneath the water table. The yields of several springs are large, 5 to 20 gallons a minute.

Private systems of running water supplied from elevated tanks or by siphons, gravity pipe lines, or hydraulic rams are unusually common in Orange (see table), 47 such installations being recorded.

Ground water for industrial use.—Ground water in Orange is used for industrial purposes only at a few factories in West Haven. The location of three large pumping plants is shown in Figure 17, where they are numbered 48, 49, and 50, in continuation of the series of numbers for pumping plants in New Haven. These plants are described below.

48. American Mills Co. Has connections with the public water supply for emergency use but depends mainly on well water. There are eight 2-inch driven wells, space about 12 feet apart. The depth to water is 32 feet, and the pumps are set 6 feet below the surface to lessen the lift. The water is used for drinking and all factory uses, including boiler feed. The water used for boilers is treated and has given satisfaction for 13 years. The quantity pumped is not known.

49. Connecticut Fat Rendering & Fertilizing Corporation. Uses public water for boilers and drinking and well water for washing floors and condensing. There are 12 wells in two east-west rows, near the office on Front Street. The wells are 2 inches in diameter and 45 feet deep and penetrate sand. They were driven in 1916. They are pumped almost continuously at a rate of about 100 gallons a minute (pump dimensions 7½ by 6 by 12 inches, 34 single strokes a minute, double acting). The water is very hard and deposits a heavy white incrustation where it wastes over a concrete floor. An analysis (P–49) is given on page 36. The chloride content (574 parts per million) indicates the presence of a large quantity of sea water. The wells are located on a very narrow point of land between two salt marshes, yet even under these circumstances it seems rather strange that contamination should be so high, especially in comparison with that in the wells of the New Haven Rendering Co. (No. 50) near by.

50. New Haven Rendering Co. Uses city water for boilers and well water for floor washing, condensing, cooling, and drinking. Eleven 2-inch driven wells are located in an irregular north-south line, at intervals of 20 feet. They penetrate sand (stratified drift) entirely and are 25 to 30 feet deep. The wells are about 300 feet west of the plant, very near the edge of a salt marsh. A sample of this water is tested every week to make sure of its sanitary purity for drinking. A sample taken July 9, 1919, ran 22 parts per million of chloride, which is not indicative of salt water. The wells are pumped at a rate of about 100 gallons a minute. The company once had some wells on the very narrow point of land on which the plant is situated, directly between two salt marshes, a situation similar to that of the wells of the Connecticut Fat Rendering & Fertilizing Corporation (No. 49) but worse, being nearer the end of the point. The water was very bitter and brackish, and the wells were abandoned.

If each of the three plants uses 100 gallons a minute for an average of 20 hours a day, the total quantity of water developed is 120,000 gallons a day.

Suggestions for development.—The prevailing methods of obtaining ground water for household use by dug and drilled wells are satisfactory. More use could be made of wells and springs located favorably for the installation of gravity water systems or hydraulic rams. Many drilled wells seem to be used where dug wells probably would yield more water at less cost. Ground water for industrial uses could be developed in large quantities on the West Haven plain or in other extensive areas of stratified drift, such as the Wepawaug Valley. The best method is by means of driven wells such as those of the three large plants which now use ground water. Pumping plants established very near the shore or salt meadows are likely to yield water more or less contaminated by the salt water. The ground water beneath the West Haven plain is probably derived from rainfall within the limits of the plain, and it is doubtful, considering the small area of the plain, whether more than a million gallons a day could be pumped without danger of drawing sea water into the sand.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Orange

[Observations made July 7 to 31, 1919. a before number of well indicates that well is abandoned. Dagger (†) indicates that notes are given in Water-Supply Paper 537; for equivalent numbers in that report, see table on p. 52. For descriptions of pumping plants, which are numbered in a separate series, see pp. 119-120]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
1	W. Kinney	50	Terrace	19	16	Stratified drift	Pulley	No.
2	Voker	50	do	25	23	do	do	No.
4	Robert Saunders.	180	Slope	17	12	Till 11 feet, bedrock 6 feet.	do	No.
8	Beers	200	Hill	23	16	Till 14 feet, bedrock 9 feet.	Electric pump	No.
10	W. S. Hine	240	Slope	14	10	Till	Pulley	No.
12	Busch	260	Hill	15	9	do	do	No.
14	McGrath	270	do	30?	18?	Till 22 feet, bedrock 8 feet.	Electric pump	No.
17	P. G. McDermott.	185	do	24	16	Till and bedrock		No.
18		180	do	15	10	Till 10 feet, bedrock 5 feet.	Pulley	No.
19	T. N. Brons	190	do	16	10	Till	Chain pump	No.
20	Dwight Clark	180	Slope	22	15	do	Pulley	No.
22	Maud	180	do	14	7	do	Electric pump	No.
23	Floyd Lindley	190	Hill	18	10	do	do	No.
29		220	do	10	8	Till and bedrock	Hand pump	Yes.
•30	D. E. Russel	210	do	14	10	Some bedrock	do	No.
32	E. J. Hall	200	Flat	11	8	Till and bedrock	do	No.
34	R. D. Pryde	240	Hill	20	13	Till	do	Rarely.
35	Race Brook Country Club.	230	do	19	11	do	Sweep	No.
40	R. Shillinglaw	280	do	23	16	Till 6 feet, bedrock 17 feet.	Hand pump	No.
41	Laity	280	do	23	17	Till	do	(?).
42	Mary McCarty	210	Valley	12	9	do	Pulley	No.
46	H. E. Cook	210	do	10	7	do	Gasoline engine.	No.
47	E. D. Bailey	250	Hill	21	19	Probably bedrock	Hand pump	No.
48	Cummings	210	Slope	7	5	Till	Gravity pipe line.	No.
49	do	200	do	15	12	Till and bedrock	None	No.
50		200	Valley	15	10	Till	Pulley	No.
52	Riggs	225	Hill	23	19	Till and bedrock	do	No.
53	H. E. Russel	240	do	26	19	Chiefly bedrock	Chain pump	No.
54	Frank Peck	220	Valley	12	5	Till and bedrock	Gasoline engine.	No.
55	H. E. Russel	230	do	19	9	Till	Windmill	No.
56	Peterson	240	do	11	5	do	Hand pump	No.
58		220	Slope	27	7	do	None	(?).
59		220	do	22	7	do	Pulley	No.
60	Felice	240	do	17	10	do	do	No.
61	S. Lonza	240	Hill	29	15	Till and probably bedrock.	do	No.
62	P. Caputo	275	do	42	15	Till	do	No.
63	S. Bruno	250	do	19	9	do	Hand pump	No.
64	J. Ciareglio	220	do	22	17	Till and bedrock	Pulley	No.
65	Ciareglio	200	Slope	27	21	Till	do	No
66	T. Anguillare	190	do	27	22	Till and bedrock	do	No.
67	do	150	Valley	17	9	Till	do	Rarely.
70	Hoffstadt	120	Bench	10	5	do	Hand pump	No.
71	H. E. Kilborn	90	Slope	37	25	Till (?)	Pulley	No.
73	W. Johnson	100	Bench	18	15	Till and probably bedrock.	do	No.
73	Mrs. Dunn	100	Valley	7	5	Till	do	No.
74		160	Flat	20	15	do	do	No.
75	Angelo Petrillo	140	Hill	14	6	Till and bedrock	Sweep	No.
77	M. Krulcy	30	Flat	36	33	Stratified drift	Pulley	No.
78	Lynch	30	do	37	33	do	do	No.
79	Murray	30	do	36	30	do	do	No.
80	Atwood	30	do	33	27	do	do	No.
81	C. L. Alling	35	Slope	21	16	Stratified drift (?)	Chain pump	No.
83	C. W. Huffman	120	do	36	31	Till and bedrock	Gasoline engine.	Yes.
85	F. S. Sanford	130	do	9	4	Till	Hand pump	No.

• Water said to be hardest in spring.

Records of wells and springs in Orange—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
86	O. Richard	140	Hill	12	10	Chiefly bedrock	Hand bucket	(?).
87	Bruyette	140	do	10	5	do		No.
88	Mrs. Arnold	120	Slope	10	8	Till and bedrock	Hand pump	Rarely.
89	Martino	120	do	23	17	Till 2 feet, bedrock 21 feet.	do	No.
90	Albertson	140	Hill	11	7	Till and bedrock	do	No.
93	Jo Villang	120	Slope	24	19	do	do	No.
94		130	do	22	20	Chiefly bedrock	do	No.
95	Carmen Manzo	100	do	11	8	Till and bedrock	Hand bucket	No.
96		100	do	19	15	do	None	No.
97	Cuthill	100	do	32	30	do	Pulley	Yes.
98		140	Hill	14	10	Till and bedrock	Hand pump	No.
99	Logiodice	120	do	27	21	Till	Pulley	No.
100	Fauner	140	do	18	13	do	Hand pump	No.
101	Phillips	130	Slope	14	11	Till and bedrock	Pulley	No.
102	C. Calogers	140	Hill	19	17	do	do	No.
103	Alling	170	Slope	33	21	Chiefly bedrock	Windmill	No.
104	A. E. Schaeff	160	do	20	18	Till and bedrock		Yes.
105	Hill	160	Hill	36	29	do	Pulley	No.
108	Marks	160	Valley	15	11	Chiefly bedrock	do	No.
109	Lindquist	180	Slope	22	18	Till and bedrock	Hand pump	No.
110	Edward Cronin	190	Hill	23	15	do	Pulley	No.
111	Thomas Cronin	180	Slope	20	16	Till and bedrock	do	No.
112	H. W. Hayford	190	do	24	17	Till	do	No.
113	L. Meyer	200	Hill	25	16	do	do	No.
114	Blennerhasset	190	Valley	15	12	Till and bedrock	do	No.
116	F. C. Sperry	200	Hill	30	15	Till	Electric pum	No.
117	Mrs. Haliwell	210	do	19	10	do	Hand bucket	No.
118	Affington	180	Slope	13	7	do	Pulley	No.
119	Bronson	190	do	22	15	do	Chain pump	No.
120	A. J. Peterson	170	Flat	14	7	Till and bedrock	do	No.
121	Charles Murdock.	220	Hill	39	13	Till	Hand pump	No.
122	E. W. Russel	220	Hill flat	15	10	do	do	No.
123	Andrews	225	do	10	3	do	Windmill	No.
126	W. M. Andrews	200	Valley	22	10	Chiefly bedrock	do	Rarely.
127	Woodruff	160	do	34	13	Till and probably bedrock.	Chain pump	No.
128	do	150	Bench	18	15	do	Pulley	No.
129	W. Woodruff	140	do	19	17	Stratified drift (?)	do	No.
130	do	125	Valley	21	18	Stratified drift	do	No.
131	Pardee	130	Valley flat	25	21	Stratified drift 21 feet, bedrock 4 feet.	Hand pump	No.
132	A. D. Clark	130	do	24	20	Stratified drift	Pulley	No.
133	Meuller	200	Hill	12	8	Chiefly bedrock	do	Almost.
135	C. S. Russel	130	Terrace	25	20	Stratified drift	do	No.
136	John Russel	140	Slope	17	13	Till and bedrock	do	No.
140	H. F. Stone	260	Hill	23	18	do	Electric pump	No.
141	James Neal	240	Slope	27	20?	Till and probably rock.	Hand pump	No.
142	H. P. Treat	200	do	20	16	do	do	Yes.
144	C. R. Treat	100	Valley	23?	20?	Stratified drift	Electric pump	No.
[c]146	Tynan	75	Slope	31	29	Till and probably bedrock.	Pulley	Yes.
147	Tracy	100	Valley	8	4	Till and bedrock	Hand bucket	No.
148	Chris Winkle	120	Slope	19	16	Stratified drift (?)	Pulley	No.
149		150	Hill	24	17	Till and rock (?)	do	No.
150		140	Valley	11	5	do	do	No.
152	C. K. Rourke	180	Hill	12	9	do	Chain pump	Rarely.
153		220	do	14	11	Till and bedrock	Pulley	(?).
a155	J. H. Byrne	160	Flat	11	9	do	do	(?).
157		160	Valley	7	4	Till	Hand bucket	No.
158	J. Parmere	140	do	13	10	Till and bedrock	Pulley	Yes.
159	F. Chellio	140	Slope	18	14	Till	do	No.
a162	E. B. Clark Seed Co.	110	do	18	17	Chiefly bedrock	do	Yes.
163	do	80	Valley	15	13	Stratified drift	do	No.
164	Adams	150	Terrace	19	14	do	do	No.
a165	E. B. Clark Seed Co.	90	Valley	18	15	do	do	No.
166	do	100	do	16	12	do	do	No.
167	do	100	do	18	15	Stratified drift and bedrock.	do	Yes.

[b] Water hardest when well is very full.
[c] Usually dry from August to November.

Records of wells and springs in Orange—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
169	W. E. Clark	110	Slope	18	14	Stratified drift (?)	Hand windlass	No.
171	Mrs. Wright	190	Hill	17	11	Till	Chain pump	No.
172	W. J. Scobie	160	Valley	13	8	Till and bedrock	Pulley	No.
173	Olson	200	Hill	21	16	do	do	No.
174	John Clark	220	do	22	16	do	Hand pump	No.
175	Otis	220	do	19	14	do	None	Yes.
176	H. C. Stevens	225	do	20	15	Till 18 feet, bedrock 2 feet.	Pulley	Rarely.
177	E. C. Russel	220	Slope	20	17	Till and bedrock	do	No.
178	W. Russel	220	Hill	23	18	Till and probably rock.	do	No.
179	B. T. Clark	220	do	25	15	Till and bedrock	do	Rarely.
180	Boppert	220	do	22	16	do	Hand windlass	Rarely.
181	W. Woodruff	225	do	19	13	do	Pulley	No.
182	S. G. Grillo	220	do	34	12	Till and probably rock.	do	No.
183	Mrs. Andrews	210	Slope	23	15	do	do	No.
185	J. W. Baldwin	190	do	27	17	Till and bedrock	do	Rarely
186	do	180	do	24	21	do	do	Yes.
188	Henry Clark	200	Hill	24?	18?	Till	Hand pump	No.
189	John Urban	180	do	15	10	do	None	(?).
190	Halen Farm	140	Valley	13	5	do	Windmill	No.
191	C. Treat	165	Hill	37	15	Till and bedrock	do	No.
192	do	160	do	20	11	Till	Pulley	No.
193	Halen Farm	160	do	9	5	Till and bedrock	do	(?).
194	Klages	80	Valley	13	7	Stratified drift	Hand pump	No.
195		80	do	10	6	Stratified drift and bedrock.	Pulley	No.
196	Lazario	100	do	13	10	Till and bedrock	do	Rarely
200		130	Hill	18	14	do	do	(?).
203	Boohle (?)	90	Valley	21	19	Stratified drift and bedrock.	do	Rarely
204	Peterson	80	do	20	18	Chiefly bedrock	do	No.
205	F. E. Smith	80	Terrace	13	10	Stratified drift and bedrock.	Hand pump	No.
206	Rapetski	90	Valley	26	20	Stratified drift	Pulley	No.
207	Cohen	90	do	23	18	do	do	No.
208	F. Cacafano	80	Slope	10	8	Till and bedrock	Hand bucket	Yes.
209	Torello	75	Hill	22	11	Till	Hand pump	No.
210	Tony Ferino	80	do	39	18	Till and bedrock	Pulley	No.
211	A. Solleme	80	do	25	21	do	do	Yes.
212	F. Pusillo	90	do	31	23	Till 2 feet, bedrock 29 feet.	do	No.
213	J. W. Bailey	120	do	28	19	Till and bedrock	Hand pump	No.
214	F. Rienzo	130	do	27	16	do	Pulley	No.
215	Foyer	110	Slope	20	11	Chiefly bedrock	Chain pump	No.
216	A. Foyer	90	Valley	18	15	Stratified drift (?) and bedrock.		No.
217	J. Cuzzoreo	140	Slope	29	19	Till and bedrock	Pulley	Rarely
218	Buckholtz	100	Valley	16	14	Stratified drift (?)	do	No.
219	V. C. Malloy	160	Hill	21	10	Till 11 feet; bedrock 10 feet.	Hand pump	No.
220	D. Bai	120	Slope	15	12	Till	Pulley	Yes.
221	Soretto	140	do	25	15	do	Hand pump	No.
222	Crosby	100	do	29	16	Till and bedrock	Pulley	Rarely
[d]223		120	Flat	25	24	do	Hand bucket	Yes.
224	F. Mango	140	Hill	25	15	Till	Pulley	No.
225	Shore	140	do	22	13	do	do	No.
226	do	140	do	13	8	do	do	No.
227	T. Lombarle	140	do	29	20	do	do	No.
228	M. Rosoff	150	do	15	7	do	do	No.
229	Honore	150	do	13	8	do	Hand pump	No.
230	T. Lombarle	150	do	26	9	Till and bedrock	Pulley	No.
231		150	do	36	11	Till and probably rock.	do	No.
232	McMann	150	do	35	14	do	do	No.
233	Ryskiewicz	180	Slope	26	11	Till and bedrock	Hand pump	No.
[e]235	Hayes	160	do	18	9	Till	Pulley	Rarely.
236	W. F. Fanning	150	do	17	12	Till 6 feet, bedrock 11 feet.	Hand pump	No.
238	S. Zida	125	Valley	10	7	Till (?)	do	No.
239	Castle	130	Flat	24	12	Till 21 feet, bedrock 3 feet.	Chain pump	No.

[d] Drilled well reported to be 75 feet deep inside dug well.
[e] Water level fluctuates from top to bottom.

Records of wells and springs in Orange—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
240	Castle	130	Flat	13	7	Till	Hand pump	No.
241	Peterson	140	Slope	10	6	do	do	No.
244	V. Algerric (?)	180	Hill	43	30	do	Pulley	Yes.
245		170	do	28	11	do	do	(?).
246	Mrs. Morrisay	140	do	22	10	do	do	No.
247	do	110	Slope	31	21	do	do	No.
248	Neilson	120	do	24	14	do	do	No.
249	do	150	Hill	21	10	do	do	No.
250	R. Campotut (?)	100	Slope	21	10	Till and bedrock	do	No.
251	Westmire	110	Hill	13	10	do	do	No.
252	F. Mcffio	100	Slope	11	6	do	do	Yes.
253	V. Pergolato	90	do	19	12	do	do	No.
254	Sabatasso	140	Flat	20	8	do	do	No.
255	Giamatti	160	do	15	10	Till	Hand pump	No.
[f]256	Nacca	200	Hill	24	12	Till and bedrock	Pulley	Yes
257	Caccavello	200	do	36	17	Till and probably rock.	Chain pump	No.
258		60	Valley	18	15	Till (?)	Pulley	(?).
259	Smith	75	Slope	8	5	Chiefly bedrock	Hand pump	No.
260	Galka	60	Valley	12	8	Till and bedrock	Pulley	No.
261	Jantger	80	Hill	12	7	Bedrock	do	No
a262	Wagner	80	do	15	7	Till and bedrock	None	No
262	Mrs. White	85	do	10	7	do	Hand pump	(?).
264	A. L. Jakubiszyn	100	Flat	14	9	do	Pulley	No.
a265	Golway	20	do	24	14	Stratified drift	do	No.
266	Hyde	20	do	19	16	do	do	No.
267	Vidou	20	do	23	18	do	Hand windlass	No.
a268	Grillo	20	do	19	15	do	Pulley	No.
269	Platt	20	do	22	19	do	do	No.
270	G. Thomas	20	do	20	18	do	do	No.
271		15	do	16	14	do	do	No.
272	Stevens estate (?).	20	do	15	13	do	Hand buckets	No.
73	B. Gilhuly	30	Slope	24	13	Chiefly bedrock	Hand pump	No.
274	Kirpatsy (?)	20	Flat	16	8	Stratified drift	do	No.
275	H. J. Sorensen	40	Hill	39	10	Till 10 feet, bedrock 29 feet.	do	No.
276	Rice	40	do	12	7	Bedrock	Pulley	Yes.
277	Fred Griffin	40	do	19	10	do	do	Yes.
280	Charles Stannard.	60	Slope	21	17	Till and probably rock.	Hand pump	Yes.
282	Strand	120	do	26	19	Till	Hand bucket	Yes.
283	Harrison	90	Hill	30?	22?	do	Hand pump	No.
[e]284	George Hall	120	Slope	17	11	do	Pulley	Yes.
285	Jasudowicz	100	do	18	12	do	do	No.
286	Lindgren	120	Hill	20	18	do		No.
287	do	110	Slope	12	6	do	Gasoline engine.	No.
288	Rider	100	do	14	8	do	Hand bucket	No.
289	Fred Ziegler	80	do	15	8	do	Hand pump	No.
290	do	80	do	13	8	do	do	No.
291	James H. Mills	100	do	20	12	do	Pulley	No.
292	P. J. Allspaugh	160	Hill	45	25	do	Hand pump	No.
293	E. Hubbard	50	Terrace	15	10	Stratified drift (?) and bedrock.	Hand windlass	Almost
294		50	do	17	13	Drift 5 feet, bedrock 12 feet.	do	(?).
295	Brough	60	Hill	30	10	Till and bedrock	Hand pump	No.
296	Warner	50	Terrace	17	8	Till	do	No.
297	Gunning	80	Slope	31	11	do		No.
298	Rockefeller	110	Hill	30	20	Till and bedrock	Gasoline engine.	No.
299	do	100	Slope	15	10	Till	Hand pump	No.
300	Thompson	90	do	20	15	do	do	No.
301	D. Buschen	120	Hill	33	20	do	do	No.
302	Mrs. Lynch	60	Slope	15	10	Till and bedrock	Pulley	No.
303	T. Young	10	Terrace	12	7	Stratified drift	do	No.
304	Murray	10	Valley	5	1	do	Hand pump	No.
307	Dubee	10	Terrace	18	3	do	Chain pump	No.
a308	Schussler	20	Slope	11	5	Till	Pulley	No.
309	James Murray	10	Terrace	13	5	(?)	Hand pump	No.
†310	E. V. Ball	5	Flat			Stratified drift and bedrock.		No.
†313	Frederick	5	Beach	11	9	Stratified drift	Pulley	No.
314	William Johnson.	15	Flat	15	13	do	do	No.

[f] Water level fluctuates nearly from top to bottom.
[e] Water level fluctuates from top to bottom.

Records of wells and springs in Orange—Continued

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
3	Wheeler	200	Hill	46		Soil 10 feet, bedrock 36 feet.	Hand pump	
5	George Wheeler	180	Slope	40	Knight	Chiefly bedrock	Electric pump	
6	O'Flaherty	180	Valley	90		do	do	
7	Roome	200	Hill	100	Chatfield	All bedrock	do	
11	Skolsky	230	Slope	80	Knight	Chiefly rock		
13	Morse	260	Hill			do	Hot-air engine.	
16	W. F. Gilbert	185	Flat	165		Till 8 feet, bedrock 157 feet.	Gasoline engine.	
21	F. C. Baldwin	180	Slope	70	Atwood	Chiefly bedrock	Electric pump	
[h]26	N. L. Smith	300	Hill	62	Knight	Till 11 feet, bedrock ("slate") 51 feet.	do	8
27	Tomkins	290	do	52		Bedrock ("slate")	do	
31	C. S. Russel	200	do	35	Nolan	Till 6 feet, bedrock 29 feet.	Hand pump	
[i]33	C. S. Clark	220	do	215		Bedrock ("slate")	Power pump	
36	Sperry	210	Valley	60	L. Basset	Chiefly bedrock	Hand pump	
37	E. L. Stevens	240	Hill	75		Till 23 feet, bedrock 52 feet.	Electric pump	
38	Mrs. Weber	270	do	125		Bedrock ("slate")	Hand pump	
39	Capelle	280	do	165	Chatfield	Till 10 feet, bedrock ("slate") 155 feet.	Electric pump	10
44	H. E. Cook	240	do	190	Nolan	Bedrock ("slate")	Hand pump	([j])
45	Mrs. Warner	230	Valley	45		Chiefly bedrock	do	
51	McMann	200	Slope	52	Wheeler	do	Gasoline engine.	
57	Hulse	240	Hill	95		do	Hand pump	
68	Ginini	160	Slope			do	do	
82	Meyer	80	do	80	L. Basset	Till 20 feet, bedrock 60 feet.	do	
84	C. W. Huffman	120	Hill	80		Till 6 feet, bedrock 74 feet.	Power pump	
91	Lutile	120	do	41		Chiefly bedrock		
92	Slade	120	do	100		do	Hand pump	
a106	Nary ([k])	170	Valley	48		do	None	
115	George Hill	180	Hill			do	Electric pump	
125	I. Andrews	220	do	275	Chatfield	Bedrock ("slate")	do	
134	Coburn	130	Terrace	50	Knight	Stratified drift 25 feet, bedrock 25 feet.	Hand pump	
138	J. M. Stone	260	Hill	70		Chiefly bedrock	Electric pump	
139	Gardner	260	do	60		do	Gasoline engine.	
151	C. K. Rourke	180	do	40	Wheeler	Till 13 feet, bedrock 27 feet.	Hand pump	
168	E. B. Clark Seed Co.	100	Valley	95		Chiefly bedrock	do	
184	F. P. Lewis	200	Slope			do	do	
187	Henry Clard	200	Hill	80	Underwood	Till 40 feet, bedrock 40 feet.	Power pump	
197	W. H. Lee	100	do			Chiefly bedrock	Hand pump	
[k]201	do	120	Valley	300		do	Electric pump	
202	do	100	do			do	Hand pump	
234		160	Hill	40		do	do	
278	W. E. Blair	60	Slope	300		Bedrock ("slate")	do	

Driven wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Diameter (inches)	Kind of rock	Equipment
76		30	Terrace		2	Stratified drift	Windmill.
198	James Beattie	120	Valley	21	3	do	Hand pump.
305	Kohrer	20	Terrace	25	1¼	do	Do.
†311	Failer	10	Flat	20	1¼	do	Do.
†312	A. Sparandeo	12	do	14	1¼	do	Do.

[h] Drilled for $2 per foot in 1914. Cut rate allowed as slate was easy drilling.
[i] Yielded a little water at 100 feet; none below to 215.
[j] 1¼ pints.
[k] Supplies 15,000 to 20,000 gallons daily for large dairy farm. Used in boilers, although quite hard.

Records of wells and springs in Orange—Continued

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
9	W. S. Hine	200	Head of valley	Seep from till in marshy area.	Board-covered pit; windmill.	([1])
15	P. C. McDermott	200	Base of rocky cliff	Seep from fractures in schist.	Stoned pit 2 feet deep	
24	Harmon	240	Slight valley on slope.	Seepage in till	Well-like excavation in till; gravity pipe line.	
25	do	300	Slope near top of hill.	Large marshy seep in till.	Reservoir 50 by 12 by 3 feet; gravity pipe line.	
28	E. L. Clark	260	Hillside	Seep from till, collected in ditches.	Hydraulic ram	[m]5–10
43	M. McCarthy	210	Small valley on slope.	Seep from till over bedrock surface.	Stoned pit	1–
69	Public road	120	Base of roadside cut.	Fractures in bedrock.	Piped to trough beside road.	[m]½
107	Nary	150	Valley, stream course.	Seepage under railroad (fill).	None	8–10
124	L. F. Andrew	220	Gentle slope	Hillside marsh in till.	Gravity pipe line to house.	
137	Calhoun	160	Valley, marshy	Seepage in till	Concreted pit; electric pump.	
143	Treat	100	Base of hill	Fractures in schist	Open pit; piped to horse trough.	1–
[a]145	W. Woodruff	180	Small valley on hill.	Seepage in till over bedrock.	Windmill pumps from open pit to reservoir.	10–20
154	P. Berry	160	Small valley on hillside.	Bedrock fractures	Open excavation	1–
156	John Rohoer	150	Edge of swampy valley.	Seepage in till (?)	Well-like hole 5 feet deep to rock.	
†160	E. B. Clark Seed Co.	140	Hillside	Bedrock fractures	Stoned pit; gravity pipe line.	1–
161	do	140	do	Till drumlin cap	Stoned pit 6 feet deep	
170	Walter Clark	160	do	Seep from till, drumlin.	Pit 10 feet deep; gravity pipe line.	
199	W. H. Lee	140	Valley, base of hill	Marshy seep from till.	Spring house over excavation.	
237	W. F. Fanning	140	Edge of low swamp.	Seepage into valley	do	1–2
242	J. F. Riemer	140	Base of slope	Marshy seep from till.	do	2–3
243	James H. Mills	100	Hillside	Seep from till	Two pits 3–4 feet deep; gasoline engine.	1–2
279	Demler	60	Side of small ravine, base of ledge.	Bedrock (slate) crevices.	Open pit	1–
281	C. P. Stannard	60	Base of hill	Till and bedrock contact.	do	
306	David Platt	40	Hillside, drumlin	Seep from till	Stoned pit 7 feet deep	

[1] Very small.
[m] Estimated.
[a] Supplies a small local water system in Orange Center.

MILFORD

AREA, POPULATION, AND INDUSTRIES

Milford was separated from New Haven in 1664. It lies south of Orange and occupies a triangle each side of which is 6 or 7 miles long, bounded by Orange, Housatonic River, and Long Island Sound. Its area is 16,290 acres or 25.4 square miles, and its population in 1920 was 10,193. The main center of population is the town proper of Milford (distinguished from the township). This is an attractive residence section and summer resort, as is also the Borough of Woodmont. Walnut Beach (formerly Meadows End) and Devon (formerly Naugatuck Junction) are villages that are growing in size and popularity. Milford, like Orange, retains many of its earlier agricultural characteristics along with its more recent development of summer resort and playground. The New York division of the New York, New Haven & Hartford Railroad passes through the southern part of Milford and a branch line, which is part of the Naugatuck division, through the western part. The New Haven-Bridgeport trolley also runs through the town. The chief industry of Milford is agriculture, and there is much specialization in seed and nursery culture. More land in the town is tillable than in most other towns of the New Haven area; nevertheless, probably half the total area is still wooded. There are several small factories in the town of Milford, whose products include rubber goods, woodwork, brass fittings, and hats. The oyster business also is important.

TOPOGRAPHY AND DRAINAGE

The highest altitudes in Milford are in the northwestern part of the town, where hills near the Housatonic River rise more than 200 feet above sea level, but the altitude of most of the town is less than 100 feet. The surface slopes southward or slightly west of south. The relief in most parts of the town is from 50 to 100 feet, and the topography is not rugged except in the small area that includes the highest hills in the northwestern part. The drainage flows southward through several streams into the Sound. Oyster River and Housatonic River respectively drain the eastern and western edges of the town; Indian River and Wepawaug River discharge the drainage of the central portion into Milford Harbor. Although the main streams flow southward, the smaller ones are erratic, some even flowing northward, because of glacial disturbances.

The coast line of Milford is characteristic of areas where drift is present, and outcrops of bedrock are few. It is made up of a number of straight or gradually curving sandy beaches, which are ideal for bathing.

GEOLOGY

Bedrock.—Pre-Triassic crystalline rocks underlie all of Milford. The principal recognized kinds are the "Milford chloride schist" and the Orange phyllite. A line extending from the mouth of the Housatonic to the Orange boundary in such a way as to divide the town into nearly equal parts would approximately separate the main bodies of the two kinds of bedrock. The "Milford chlorite schist" lies southeast of the line on the coast, and the Orange phyllite northwest of it, in the interior. There is, however, an isolated body of the

Orange phyllite at Woodmont, which crops out prominently near the shore. Bedrock crops out at many places in the area north of the New York, New Haven & Hartford Railroad but only here and there south of the railroad.

Drift.—The total area of till in Milford is probably slightly less than half the area of the town, and of stratified drift slightly more than half. Till and stratified drift are distributed in a number of parallel strips trending northeastward, the till generally occupying the ridges and the stratified drift the valleys. These valleys, however, do not everywhere correspond with the present drainage system but correspond to glacial valleys now abandoned. (See pp. 16, 17.

In Milford the till has more than its usual prominence in topographic form. Great masses of it are heaped into drumlins which rise 100 feet or more in height. There are six prominent drumlins in a cluster near Pond Point. In Milford, as elsewhere, the topography of the stratified drift is generally characterized by small plains or terraces.

The thickness of till and stratified drift is generally less than 50 feet, but it may be as much as 100 feet at some places. The best data on the thickness of drift come from well records. Of 254 dug wells 70 penetrate to or into bedrock. The following table shows some of the greatest recorded thicknesses of drift penetrated in wells. The dug wells listed in the table are entirely in drift. Most of the drilled wells penetrate below the drift, and the depth given here is therefore, the entire thickness of the drift above the bedrock; but wells 140, 147, and 204 do not penetrate to the bottom of the thick deposits of drift at those places.

Depth of drift penetrated by wells in Milford

Dug wells

Wells in till		Wells in stratified drift	
No.	Depth (feet)	No.	Depth (feet)
144	38	94	42
145	41	95	42
146	56	98	35
179	29	113	35
271	35	114	35
281	39	208	32
69	42		

Drilled wells

28	43	118	40
35	28	119	26
147	80	140	53
		204	35

These figures show that thicknesses of 30 to 50 feet of till and stratified drift are not uncommon. The greatest recorded thickness, 80 feet, is on a drumlin, and it would not be surprising if the maximum thickness exceeds 100 feet.

WATER SUPPLY

The Milford Water Co., a subsidiary of the New Haven Water Co., supplies water to Milford, Devon, and all the settlements along the shore. Its storage reservoir is on Beaver Brook between Milford and Devon, and its pressure reservoir is near by. The part of Milford that is not provided with public water depends on wells and springs. Even in the area supplied with public water there are still many wells in use.

Well water is used for industrial purposes only by the Gulf Refining Co., near Devon. The water is drawn from a dug well in stratified drift, which is pumped occasionally for boiler use, but its quality is said to be unsatisfactory. Contamination by salt water from Housatonic River has been suggested as the reason for its poor quality, but this is probably not the true explanation. All the factories at Milford use the public supply.

The appended table gives the records of 307 individual water supplies examined in Milford. There are 254 dug wells, 26 drilled wells, 15 driven wells, and 12 springs. Their locations are shown in Plate 5 and Figure 18.

Wells.—Dug wells in the till or stratified drift are the commonest source of supply for domestic uses and stock. Of the 254 dug wells, about 140 are in stratified drift, even though the area provided with a public supply is largely in the regions of stratified drift. About 70 of the dug wells penetrate to or into bedrock, and the rest are entirely in the drift. Most of the wells yield a supply adequate for household use. The average depth of all dug wells is 20 feet, slightly more than the average for the whole New Haven area. The deepest wells are listed on page 128 in connection with the discussion of the thickness of drift. The deepest dug well in the town and in the whole New Haven area is No. 146, which is 56 feet deep. This well belongs to W. L. Merwin and has been used for several generations. The depth to the water table, as indicated by measurements in 249 dug wells, is 15 feet. Analyses of samples of water from three dug wells in Milford (Nos. 76, 145, and 159) are given on page 36. No. 145 is moderately low in mineral content but is rather hard and will form considerable scale in boilers. The other two waters are soft, low in mineral content, and satisfactory for most purposes.

Drilled wells are not very numerous but are fairly evenly distributed over the town. The average depth of 24 drilled wells is 80 feet. Two reported yields are 30 gallons and 9 gallons a minute. One well is reported to fail, and one is easily pumped dry. The 15 driven wells are located mainly on low ground in stratified drift, near Devon and Milford.

Springs.—Of the 12 springs found in use 3 issue from till at favorable topographic situations on slopes, 3 are at the base of terraces

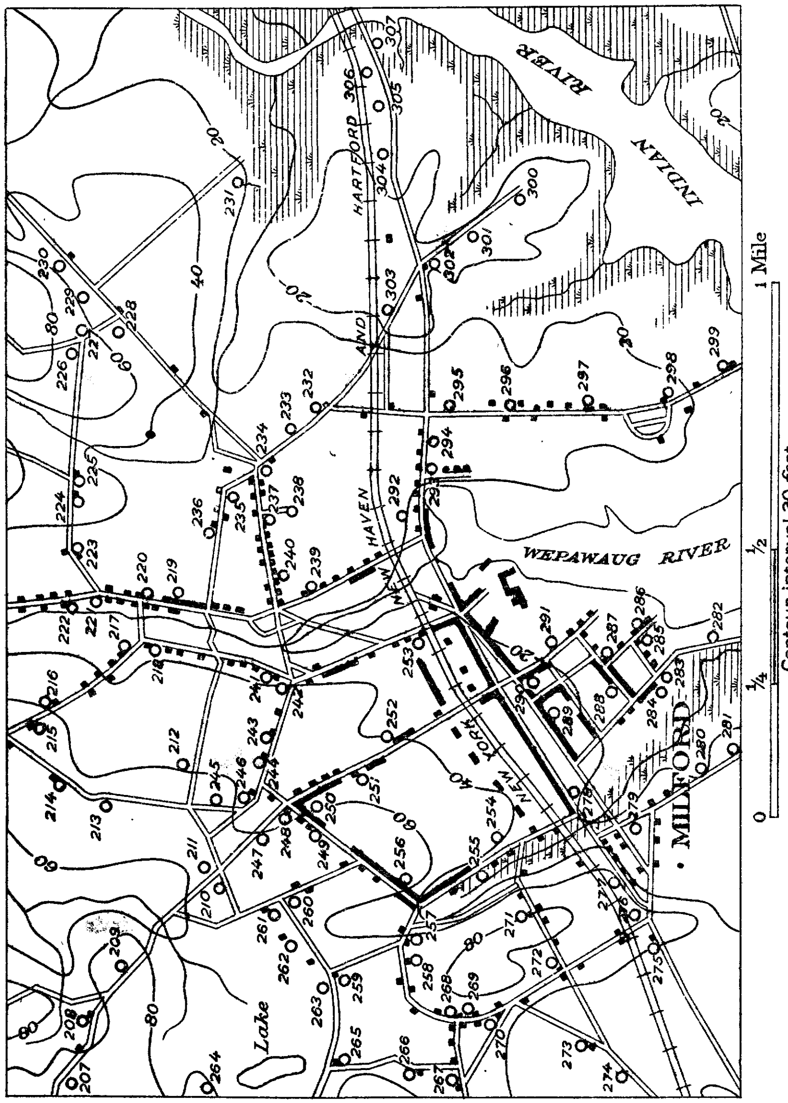

FIGURE 18.—Map of Milford and vicinity showing location of wells and springs. (Base from map of Bridgeport quadrangle, surveyed in 1889)

in stratified drift and represent seepages at the border of swampy valleys, and 6 are from sources more obscure, possibly joints in bedrock or seepage in drift, or both. Some of the springs yield several gallons a minute. No. 65, belonging to Roger Bros., called the Camp Meeting Spring, is carefully improved and protected, and the water is sold for use as a beverage. It is in dense woodland, far removed from habitations or sources of pollution.

Suggestions for development.—For small individual water supplies the present methods of development are satisfactory. Driven wells could be used more commonly in the lowland areas of stratified drift at less cost and probably with greater satisfaction than dug wells. Generally drilled wells are not necesary, although at some places water can not be obtained in the thin drift cover, particularly in the high area northeast of Devon, where a thin layer of stratified drift rests upon the bedrock at an altitude considerably above the controlling surface-water feature, Housatonic River. Under such topographic conditions ground water quickly drains out of the porous drift and dug wells sunk to bedrock are likely to contain but little water. Therefore, in this and some similar areas bordering Housatonic River drilled wells are more reliable than dug wells. Gravity water systems from properly located dug wells or springs could be used to a considerably greater extent and with increased convenience. Much ground water could be recovered from the stratified drift of several valleys, such as the plain north of Woodmont, the valley of Indian River, near Milford, and the tract between Devon and Walnut Beach. In these areas driven wells probably would be the most successful method of development.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Milford

[Observations made July 14 to 30, 1919, except well 136, which was examined Apr. 12, 1919. a before number of well indicates that well is abandoned. Dagger (†) indicates that notes are given in Water-Supply Paper 537; for equivalent numbers in that report, see table on p. 52]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
2	Brennan Bros	140	Hill	23	18	Till and probably bedrock.	Windmill	No.
3	do	140	do	26	18	do	Pulley	No.
[a] 4	A. N. Beard	80	Terrace	17	9	Till	Gasoline engine.	No.
5	Dragan	60	Valley flat	23	17	Stratified drift	Pulley	No.
6	Ignatowski	60	do	15	12	Stratified drift and probably bedrock.	Chain pump	No.
7		80	Hill	22	17	Till	Hand pump	No.
8	R. E. Reed	60	Terrace	16		Stratified drift	do	No.
9	Anderson	60	Valley flat	22	20	do	Pulley	No.
10		120	Hill	15	12	Till	do	No.
11	W. G. Peat	180	do	12?	7?	do	Electric pump	No.
12	Nettleton	190	do	19	12	do	Pulley	No.
13	Nagorski	195	do	19	14	do	do	No.
14	Reynold	80	Terrace	14	10	Stratified drift	do	No.
15	W. S. Bristol	80	do	16	10	do	do	No.
16	Hardy	90	Valley flat	12	7	do	do	No.
17	do	95	do	18	12	Stratified drift (?) and bedrock.	do	No.
18	Bristol	100	Ravine	5	2	Till and bedrock	do	Yes.
19		90	Flat	17	15	Stratified drift and bedrock.	Hand pump	(?).

[a] Pumped at rate of 500 gallons in 20 minutes, the drawdown is said to be about 4 feet. Water reported hardest in spring, when well is full.

Records of wells and springs in Milford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
20		100	Slope	15	13	Till	Hand windlass	(?).
21	Woodruff	110	do	17	14	do	Pulley	(?).
22	A. J. Platt	130	Hill	21	15	Till and bedrock	do	No.
23	W. S. Clark	45	Valley	16	14	Stratified drift	Chain pump	No.
24	Stephen Karl	40	do	8	5	do	Hand pump	No.
25	Law	50	Flat	15	11	Stratified drift and bedrock.		No.
26	Warner	50	do	14	10	Stratified drift	Pulley	No.
27	Townsend	45	Flat	18	15	do	do	Rarely.
29	Lush	80	Hill	17	14	Till	Chain pump	No.
32	Harry Quick	100	Slope	21	11	do	Pulley	No.
33	H. C. Smith	100	Hill	16	12	Till and bedrock	Chain pump	Yes.
34	Platt	80	Slope	22	10	Till	Pulley	No.
36	E. B. Clark	80	Flat	22	16	do	do	No.
37	Platt	80	Hill	24	20	Till and bedrock	Gasoline engine.	No.
39	Frank Platt	60	Slope	22	12	Stratified drift	Pulley	No.
40	A. Botsford	60	Terrace	13	9	do	Hand pump	No.
41	D. Omstead	50	do	13	10	do	Pulley	No.
42	B. N. Smith	40	Valley	12	10	do	do	No.
43	Albert Clark	80	Hill	17	11	Till	do	No.
44	Peter Aldo	85	do	18	7	do	Chain pump	No.
45	Hind	60	Terrace	16	10	Stratified drift	Pulley	No.
46	J. Clark	70	do	15	10	do	do	No.
47	Mrs. Miller	75	do	7	5	do	do	No.
48	E. C. Clark	195	Hill	18	13	Till and bedrock	Chain pump	No.
50	J. E. Rogers	200	do	24	20	Till 15 feet, bedrock 9 feet.	Pulley	Yes.
51	Ruger Bros	180	Slope	18	13	Till and probably rock.	do	Yes.
52	J. Stanweske	160	do	17	11	do	do	No.
53	McLaughlin	140	Hill	22	15	Till and bedrock	do	No.
54	Davis	110	do	14	9	do	Chain pump	Yes.
56	Helwig	80	do	20	12	do	Pulley	No.
57	John Rice	100	do	12	7	Till	do	No.
58	H. P. Helwig	90	do	13	10	do	do	No.
59	Tilert	90	Slope	17	12	Till and bedrock	Chain pump	No.
60	George Burnell	120	Hill	21	18	do	Pulley	Yes
61	Grabber	120	Flat	16	13	Till	Hand pump	No.
62	Fedricks	100	Hill	20	17	Chiefly bedrock	Pulley	No.
63		100	do	18	Dry.	do	do	Yes.
64	T. Cirkot	80	Valley	24	22	Till and bedrock	do	(?).
68	Bock	25	Terrace	15	11	Stratified drift and bedrock.	Hand pump	No.
†69	Mrs. Lewis	40	do	42	40	Stratified drift	Hand windlass	No.
72	Smith	80	Slope	23	20	Stratified drift and bedrock.	Pulley	No.
75		60	Terrace	30	23	do	do	(?).
†76	Gulf Refining Co.	25	do	24	22	Stratified drift	Steam pump	No.
77	John Mondo	65	Hill	23	19	Stratified drift and bedrock.	Hand pump	Rarely.
78	Steve	60	Slope	24	23	Stratified drift and probably bedrock.	Hand bucket	Yes.
79	Kirk	60	do	28	25	Stratified drift and bedrock.	Hand pump	(?).
85	Sachse	45	Valley	7	5	Stratified drift	None	No.
86	John Gucci	75	Slope	17	15	Stratified drift and bedrock.	Hand bucket	Yes.
87	Page & Martin	60	Terrace	28	25	Stratified drift	Pulley	No.
89	Brensinger	75	Valley	16	14	do	Hand windlass	No.
90	F. Benjamin	80	do	12	7	Till and probably bedrock.	Sweep	No.
91	do	90	Slope	18	14	Till and bedrock	Pulley	Yes.
92	Donald Page	80	Terrace	23	19	Stratified drift	do	No.
[b]†94	James Lyons	70	Flat	42	38	do	do	No.
95	William Leary	70	Hill	42	40	do	Hand pump	No.
[a]97	Fenedon	60	Bottom of kettle-hole.	22	19	do	Pulley	No.
98	Thomas Bain	70	Flat	35	30	Stratified drift and bedrock.	do	No.
99	Tony Kannia	60	do	29	26	Stratified drift	do	No.
100	Dorsey	55	do	14	9	Till	do	No.
101	Whitford	60	do	15	10	Starts in till	do	No.
102	Cushman	60	do	19	15	Stratified drift	do	No.
103	James Tibbals	60	Hill	19	10	Till	Chain pump	No.

[b] Cost complete, in 1910, with curb, rope, and pulley, was $130. The digging cost $100.

Records of wells and springs in Milford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
104	Semon	60	Hill	10	6	Till	Chain pump	No.
a105	Judd	40	Flat	22	20	Stratified drift	None	No.
106	LaCoeur	35	do	15	12	do	Hand bucket	No.
107	Nettleton	20	do	21		do	Chain pump	No.
108	Cole	25	do	21	17	Stratified drift and bedrock.	Pulley	No.
109	J. W. Banks	40	Hill	25	23	Probably part bedrock.	do	No.
110	Baldwin Estate (?).	20	Valley	20	14	Stratified drift and bedrock.	do	No.
111	do	40	Hill	20	15	Drift 10 feet, bedrock 10 feet.	do	Yes.
112	Henry Webb	40	Flat	28	23	Stratified drift and bedrock.	do	No.
a113	Beard	40	do	35	31	Stratified drift	None	No.
114	F. S. Baldwin	40	do	35	29	do	Pulley	No.
116	Baldwin	20	Ridge	20?		do	Hand pump	No.
123	Tibbals	20	Flat	11?	7?	do	do	No.
125	Basset	40	Hill	15?	10?	Till 10 feet, bedrock 5 feet.	do	No.
126	James R. Hine	20	Flat	18	15	Stratified drift and bedrock.	Pulley	Rarely.
127	Pritchard	20	do	15	12	Stratified drift	Chain pump	No.
128	E. Smith	40	Hill	19	14	Till	do	No.
129	Beers	50	do	11	6	do	do	No.
130	Kish	50	do	14	7	do	do	No.
131	C. Beardsley	40	Flat	30	27	Stratified drift	do	No.
132	C. W. Goodwin	40	do	26	22	Stratified drift and bedrock.	Pulley	No.
a†134		20	Hill	10	10	Starts in till	None	(?).
135	Pond	40	do	45	28	do	Pulley	No.
136	G. S. Gillette	30	Valley	22	15	Stratified drift	do	No.
138	Nelson Merwin	10	Flat	18	13	do	Sweep	No.
†139	Roy Wilcox	5	Slope	11	6	do	Hand pump	No.
141	Roder	20	Ridge	18	15	do	Pulley	No.
142	Platt	20	Hill	31	14	do	Hand windlass	No.
a143	James Merwin	3	Beach	8	5	do	None	No.
144	Merwin	45	Slope	38	30	Till	Pulley	No.
a145	do	55	do	41	30	do	None	No.
146	W. L. Merwin	60	Hill	56	27	do	Pulley	No.
148	Woodstock	60	Slope	30	13	do	do	No.
149	Joseph Sargales	30	do	25	11	Stratified drift	do	No.
150	Kupzon	30	do	16	12	do	do	No.
151	Charles Clark	20	Terrace	31	15	do	Hand pump	No.
152		15	do	13	10	do		No.
153	Clark	10	Valley	10	8	do	Pulley	No.
154	Lukacovic	40	Terrace	18	15	do	do	No.
155	Joseph Cheinok	50	do	19	17	do	do	No.
156		50	do	10	7	Stratified drift and bedrock.	do	No.
157	H. Logan	60	Flat	16	13	Stratified drift	do	No.
159	A. Thomas	60	Terrace	28	24	do	do	No.
160	Mike Chonka	60	do	35?	30?	do	Hand pump	No.
161	Putney	50	do	29	26	do	Chain pump	No.
162	Mrs. Watson	50	Hill	18	15	Stratified drift (?) and probably bedrock.	do	(?).
163	N. Rezee	50	Terrace	13	10	Stratified drift	Hand pump	No.
164	Mocek	50	Valley	9	5	Till	Chain pump	No.
165	H. E. Swift	60	Terrace	19	15	Till and bedrock	Pulley	No.
168	Conti (?)	80	Slope	15	13	do	None	(?).
169	Ralph Fox	60	Hill	15	13	Till (?) to bedrock.	Hand bucket	No.
171		60	Valley	10	7	Till and probably bedrock.	Hand pump	(?).
173	Woodmont Nurseries.	50	Flat	18?	14?	Stratified drift	do	No.
174	J. F. Nordeck	50	do	8	3	Chiefly bedrock	do	No.
175	New York, New Haven & Hartford Railroad.	50	Valley	12	8	Till and bedrock	do	Yes.
176	do	80	Hill	20	15	do	do	Yes.
177	L. T. Ellis	80	do	35	12	Till	Pulley	No.
178	Elm City Nursery.	80	do	26		do	Hand pump	No.

Records of wells and springs in Milford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
179	Bush	60	Slope	29	16	Till	Gasoline engine.	No.
180	Mrs. Rice	20	Terrace	13	10	Stratified drift	Pulley	No.
181	Razee	20	do	22	18	do	do	No.
183	Geafano	20	do	24	19	do	Hand pump	No.
184	Babson	20	do	18	15	do	do	No.
185	Beach	20	do	13	10	do	do	No.
189	Quirk	25	Valley	14	10	do	do	No.
190	Cobb	25	do	15	10	Stratified drift 12 feet, bedrock 3 feet.	do	No.
191	H. Lynch	60	Hill	26	22	Till and bedrock	Pulley	No.
192	F. Farley	25	Valley	17	12	Stratified drift and bedrock	Hand pump	No.
193	Bauer	20	do	15	11	Stratified drift	Gasoline engine.	No.
194	Hall	20	do	12	8	do	Hand pump	No.
195		15	Flat	18	10	do	do	No.
196	Beryl	20	Slope	19	15	do	Pulley	(?).
197	J. L. Merwin	20	Terrace	21	17	do	do	No.
199		20	Hill	28	26	do	Hand pump	No.
200	Beech	15	Flat	17	10	do	Pulley	No.
201	do	15	do	14	11	Stratified drift and bedrock.	Hand pump	No.
202	Knapp	20	Slope	25	12	Chiefly bedrock	Chain pump	No.
203	Butrick	20	do	25	12	do	do	No.
a205	Frank	25	Hill	19	17	Stratified drift	None	(?).
206	Anderson	15	Terrace	18	15	do	Pulley	No.
208	E. M. Benjamin	70	Hill	32	28	do		No.
209	Fred Smith	80	do	31	27	do	Pulley	Almost.
210	Charles Proctor	60	do	28	19	Starts in till		No.
211	F. M. Smith	60	Slope	14	8	Till	Pulley	No.
212	H. E. Bristol	60	do	20	11	do		No.
213	D. L. Clark	50	do	14	8	do	Pulley	No.
214	do	45	Valley	7	5	do	do	No.
215		40	do	10	6	do	do	(?).
216	D. L. Clark	40	do	12	10	Stratified drift	do	No.
217	Durant	35	do	13	9	Stratified drift and bedrock.	do	No.
218	Chatfield	40	do	14	8	Stratified drift	do	No.
219	Edsol Bristol	30	do	15	7	Stratified drift and bedrock.	do	No.
220	Albert Fox	40	Terrace	17	10	Stratified drift	do	No.
221	Diehl Clark	35	Valley	10	6	do	do	No.
222	J. H. Welch	35	do	9	6	do	do	No.
223	N. Williams	40	Flat	12	9	do	Hand pump	No.
224	Bristol	40	do	13	10	do	Pulley	No.
225	W. Stanley	40	do	13	9	do	do	No.
227	Thomas Perrien	60	Valley	13	11	Till	do	No.
228	Venter	50	Terrace	18	15	Stratified drift	Chain pump	No.
229	E. Clark	50	do	20	15	do	Pulley	No.
232	M. T. Nolan	25	do	28	25	do	do	No.
233	Healy	25	do	29	25	do	do	No.
234	A. Nettleton	25	Flat	30	25	do	do	No.
235	E. T. Clark	25	do	22	17	do	Chain pump	No.
236		30	Hill	10	7	Probably till	None	(?).
237	Dyas	30	do	21	16	Till	Pulley	No.
238		25	Flat	18	15	Stratified drift	Hand pump	No.
239	Nettleton	30	do	18	11	Stratified drift 13 feet, bedrock 5 feet.	Pulley	No.
240	Mrs. Morris	30	do	16	9	Partly bedrock	do	No.
241	Merwin	40	Terrace	17	12	Stratified drift	do	No.
242	Smith	40	do	18	13	do	do	No.
243	Goldsmith	50	Slope	15	9	Till	Hand pump	No.
244	J. Machejska	50	do	18	9	do	Chain pump	No.
245	Clark	70	Hill	20	12	do	Pulley	No.
246	Merwin	60	do	18	11	Till and bedrock	do	No.
247	M. Zorotsky	60	do	25	19	Till	do	No.
248	Baldwin	60	do	30	16	do	do	No.
249	F. Pizzaro	60	do	16	8	do	do	No.
250	Nagorski	60	do	24	19	do	Hand pump	No.
251	Phean	55	do	24	18	Till and bedrock	Pulley	No.
a252	T. B. Post	40	do	18	7	Till and probably bedrock.	None	No.

Records of wells and springs in Milford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
253	Johnson	30	Terrace	12	9	Till and bedrock	Pulley	No.
254	Mrs. Kemp	40	Hill	19	16	Till	Chain pump	Almost.
255	Filter	40	Slope	14	10	do	Pulley	No.
256	John Dempsey	60	Hill	12	9	Till and bedrock	do	No.
257	J. Voytershark	60	Slope	19	14	Till and probably bedrock.	Chain pump	No.
258	J. H. Mayer	80	Hill	30	25	Till	Pulley	No.
259	Fenn	60	Valley	16	10	do	do	No.
260	H. Botsford	70	Hill	17	11	Till and bedrock	do	No.
a261	Livingston	70	do	17	13	do	do	No.
262	M. C. Ford	70	do	18	14	do	do	No.
263	Moger	70	do	31	27	Stratified drift	do	No.
265	Johnson	80	do	22	17	do	do	No.
266	Frank Andrews	75	do	24	20	do	do	Rarely.
267	Ritchie	70	Slope	25	20	Stratified drift and probably bedrock.	do	No.
268	Luther Hine	80	Hill	38	32	Till (?) and bedrock.	do	No.
269	Curtis	75	Slope	32	29	do	do	No.
270	Howarth	70	do	25	20	Stratified drift (?).	do	No.
271	Campbell	80	Hill	35	23	Till	do	No.
272	Clark	65	Valley	15	8	do	Chain pump	No.
273	C. F. Williams	50	Flat	17	11	do	None	No.
274		50	do	18	12	do	Hand pump	No.
275	M. Clark	60	Ridge	19	12	do	Chain pump	No.
276	R. N. Smith	60	do	20	12	do	Pulley	No.
277	A. H. Bristol	70	Hill	27	20	Till and bedrock	do	No.
278	W. S. Putney	25	Flat	11	5	Till and probably rock.	do	No.
279	Tibbals	20	do	15	10	Stratified drift and bedrock.	Chain pump	No.
280	McGowan	25	do	27	23	Stratified drift	Pulley	No.
281	Peltzer	40	Hill	39	37	Till	do	Yes.
†282	Purcell	18	Flat	22	18	Stratified drift	do	No.
283	Baird	20	do	22	18	do	do	No.
284	H. A. Smith	20	do	25	20	Stratified drift and bedrock.	Chain pump	No.
285	Delayne	20	do	20	18	Stratified drift	Pulley	No.
286	Witwell	20	do	23	20	do	do	No.
a287	Cornwall	20	do	22	18	do	None	No.
288	Hawkins	20	do	20	17	do	Pulley	No.
a289	Irving	20	do	15	11	do	None	No.
290	Tibbals	20	do	19	15	do	Pulley	No.
291	Burgess	20	do	20	13	do	do	No.
a292		20	do	28	23	do	do	No.
293		20	do	27	23	do	do	No.
a294	Axton	20	do	24	19	do	do	No.
295	O'Connor	20	do	27	22	do	do	No.
296	Johnson	20	do	20	17	do	do	No.
297	Meyers	20	do	19	15	do	do	No.
298	Coggershall	20	do	15	12	do	do	No.
299		15	do	15	12	do	Hand windlass	No.
a300	Milford Cemetery	15	do	15	12	do	None	No.
301	Leddy	15	do	10	7	do	Chain pump	No.
302	George Wheeler	20	do	23	18	do	Pulley	No.
303	C. Kane	25	do	26	23	do	do	No.
304	Clark	15	do	13	10	do		No.
305	George Mitchell	15	do	17	14	do	Pulley	No.

Records of wells and springs in Milford—Continued

Driven wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Diameter (inches)	Kind of rock	Equipment
96	Donald Page	60	Valley	16	1	Stratified drift	Hand pump.
115	Lordson	15	Flat	15-20	1	do	Do.
117	Kelley	15	Valley		1	do	Do.
120	John Nuttoli	20	Flat	27	1½	do	Do.
122	Snyder	10	do	15		do	Do.
a133	Mrs. Crone	20	do	25?	1½	do	Do.
167	Essdorf	50	Valley		1	do	Do.
170	Oldshaw	55	do	25?	1	do	Do.
182	Coe	20	Flat		1	do	Do.
186	F. Farley	20	do	20?	1½	do	Do.
187	Quirk	20	do	16	1¾	do	Do.
188	W. A. Stone	25	do	16?	1	do	Do.
230	T. Sapitowicz	50	do	24	1½	do	Do.
306	Hubbel	10	do	15?	1	do	Do.
†307	George Smith	4	Marsh	30	1¼	do	Do.

Drilled wells

No on map	Owner	Altitude above sea level	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons) per minute
1	Krakowski	140	Hill	75	Wheeler	Chiefly bedrock	Hand pump	
28	C. I. Platt	90	do	100	do	Till 43 feet, bedrock 57 feet.	Gasoline engine.	(c)
31	J. F. Robinson	110	do	167	Knight	Till 15 feet, bedrock 152 feet.	Windmill	
35	W. C. Platt	85	do	100	Chatfield	Till 28 feet, bedrock 72 feet.	Windmill and gasoline engine.	
49	E. L. Nettleton	200	do	148	Wheeler	Till 15 feet, bedrock 133 feet.		30
55	Worrol	80	Slope	160		Chiefly bedrock	Gasoline engine.	
70	Caswell	100	Hill	65	Wheeler	All bedrock	Hand pump.	
73	Newhall	80	do	70	do	Till 15 feet, bedrock 55 feet.	do	
74	H. C. Hammond	80	Terrace	58	do	Chiefly bedrock	do	
80	Ober	60	Hill	100	Stratford Artesian Well Co.	Till 8 feet, bedrock 92 feet.	do	
81	J. Davidson	60	do	60	Wheeler	All bedrock	Gasoline engine.	9
82	Mason	60	do	48	Gardner	Chiefly bedrock	Hand pump.	
83	A. Berenot	60	Terrace	45	Wheeler	do	do	
84	Morrell	50	Slope	60	do	do	do	
93	Armstrong	85	Hill	75		do	do	(d)
118	Junjet (?)	20	Flat	87	Wheeler	Stratified drift 40 feet, bedrock 47 feet.	do	
119	Washburn	20	do	69	do	Stratified drift 26 feet, bedrock 43 feet.	do	
121	O. Pinto	20	do	60		Stratified drift and bedrock.	do	
124	Butterworth	40	Hill	40		Chiefly bedrock	do	(e)
†137	Gaskill	25	Terrace	85		Stratified drift and probably bedrock.	do	
140	George Wilcox	20	Flat	58	W. G. Roder	Stratified drift	Gasoline engine.	
fa147	W. L. Merwin	70	Hill	80		Till	Windmill	
†204	Charles E. Chapin	20	Slope	35		Stratified drift	Hand pump.	
207	John Tilert	85	Hill			Chiefly bedrock	do	
226	N. Williams	80	do			do	do	
264	Southworth	80	do	75		do	Gasoline engine.	

c Easily pumped dry. d Large. e Fails. f Drilled 40 feet in bottom of dug well 40 feet deep.

Records of wells and springs in Milford—Continued

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
†30	George Clark	100	Edge of marshy valley.	Seepage from till	Large excavation, stoned and covered. Feeds to hydraulic ram; pipe line ¼ mile long.	([d])
38	W. G. Platt	75	Slope near top of hill.	Till	Stoned pit 8 feet deep. Gravity pipe line.	
†65	Roger Bros. "Camp Meeting Spring."	100	Base of hill, edge of swampy valley.	do	Spring house over stoned pit.	10?
66	Ryan	100	Ravine	Bedrock fractures	Spring house over excavation. Gasoline engine.	
67	Bock	75	Base of terrace bluff.	Stratified drift	Stone reservoir. Gravity pipe line to 4 houses.	([e])
71	Caswell	90	Base of hill	Crevices in bedrock	Barrel in sand at base of ledge.	−1
[h]88	Donald Page	80	Swampy valley	Seepage in valley fill; "boils" up through sand.	Concrete-walled pit. Gasoline engine.	5
158	Paul Hudak	50	Narrow valley	From bedrock through stratified drift.	Tile sunk in earth	−1
166	Rose	50	Base of hill, beside brook.	Till and bedrock seepage.	None	
172	Santiff	85	Head of small valley.	do	Barrel sunk in earth	5?
198		10	Edge of salt marsh; base stratified drift terrace.	Stratified drift	Tile sunk in sand. Spring house.	−1
231	Harrison	40	do	do	Concrete caisson covered by spring house.	−1

[d] Large.
[e] Several.
[h] Pumped at rate of 300 gallons an hour without affecting the supply.

WOODBRIDGE

AREA, POPULATION, AND INDUSTRIES

Woodbridge lies south of Bethany and north of Orange; on the east it adjoins New Haven and Hamden, on the west Derby, Ansonia, and Seymour. Its shape is roughly rectangular, about 4 miles wide, from east to west, and about 5 miles long. Its area is 12,758 acres, or 19.9 square miles, and its population in 1920 was 1,170. The town was formed in 1784 from parts of New Haven and Milford. It is an inland town whose only products are those of farm and forest. Although it is but a few miles east or west to busy cities, Woodbridge maintains its rural life almost undisturbed. Only in the corner near New Haven, where the Woodbridge hills are becoming popular as sites for country homes, has agriculture been replaced by an approach to city life. The town hall and a small group of houses constitute Woodbridge Center.

TOPOGRAPHY AND DRAINAGE

The lowest part of Woodbridge is in the southeast corner of the town, in the West River valley, where the river has an altitude of about 70 feet above sea level. The highest altitudes, nearly 600 feet above sea level, are on West Rock Ridge, the crest of which forms the town's eastern boundary, and on the hills in northern Woodbridge. The relief averages from 100 to 200 feet but increases at places to 400 feet. Along the eastern and northern borders the topography is rugged, but elsewhere it is rolling. The general slope of the land is southward, and most of the drainage flows south through West River, Race Brook, and Wepawaug River, but a considerable area in the northwestern part of the town drains westward through Bladens River.

GEOLOGY

Bedrock.—Pre-Triassic crystalline rocks underlie all of Woodbridge except a narrow belt that extends along the eastern boundary, where Triassic sandstone and trap rock occur. The contact between the crystalline rocks and the Triassic sandstone is approximately along the course of West River. The chief crystalline rock of Woodbridge is the Orange phyllite, locally called slate. In the southeastern part of the town there is a narrow belt of the "Milford chlorite schist," and in the northwestern part a small triangular area of the Prospect porphyritic gneiss. Bedrock is exposed at many places on the west slope of the West River valley and on the slopes bordering Bladens River, in the northwestern part of the town. Trap rock occurs throughout West Rock Ridge. Triassic sandstone underlies a very narrow belt between West River and the trap.

Drift.—Till forms the surface of about 75 per cent of the area of Woodbridge, and stratified drift of nearly 25 per cent. The till generally occupies slopes and hills. The greatest accumulations of till are on two drumlins known as Prospect Hill and Round Hill, in the northern part of the town. Stratified drift occurs in the valleys but does not occupy all of them. The main areas of stratified drift are in the valleys of West River, Wepawaug River, and Bladens River, and there are small patches elsewhere.

The thickness of drift in Woodbridge is variable. Some of the greatest thicknesses of till recorded in dug wells are at wells 57, 63, and 112, which penetrate 24, 25, and 26 feet of till, respectively, but No. 29, a drilled well in a drumlin, penetrates 53 feet of till without reaching bedrock. The thicknesses of stratified drift recorded in wells 38, 103, and 107 are 34, 31, and 30 feet, respectively. Probably considerably greater thicknesses are present at some localities.

WATER SUPPLY

Although the surface water from about half the area of Woodbridge passes into storage reservoirs of the New Haven Water Co., Woodbridge itself has no public water supply except in a small part of the West River Valley adjacent to the water mains leading to New Haven. The population of Woodbridge depends almost entirely upon wells and springs, of which 160 were examined. There are 117 dug wells, 29 drilled wells, and 14 springs. Their locations are shown on Plate 5 and their records are given in the appended table. Power devices or other arrangements for individual water systems are common. (See table.)

Wells.—There are 74 dug wells in the till and 43 in the stratified drift. Probably 40 or 50 of these penetrate to or into bedrock, but for some wells the information is too indefinite for determination, though the situation may suggest bedrock very near the surface. The average depth of 117 dug wells is 19 feet, slightly less than that in Orange and Milford, and the same as the average for the whole area. The maximum depths recorded in Woodbridge are less than in several other towns. Well 38, belonging to Mr. Matthewson, is 34 feet deep, the deepest in the town. Analyses of samples of water from two dug wells in stratified drift, Nos. 103 and 107, are given on page 36. These waters are soft, low in mineral content, and satisfactory for most purposes.

Twenty-nine drilled wells were examined. The average depth of 25 of them is 79 feet. Drilled wells are used where rock is so near the surface that water is not obtainable in the drift. They are also used by some who consider that their tight construction gives better protection against pollution. A large proportion of them, therefore, are sunk regardless of the possibility of getting water in the drift and penetrate considerable thicknesses of drift above the bedrock. No. 29, which supplies the Sunnyside Farm, is said to penetrate 53 feet of till without reaching bedrock. The average yield reported for 8 wells is 9.4 gallons a minute, but if one unusually large yield of 40 gallons a minute is disregarded, the average for the remainder is less than 5 gallons a minute. As a rule the yields are adequate for domestic supply. An analysis of a sample of water from the 110-foot drilled well of Silas J. Peck (No. 118) is given on page 36. The water is low in mineral content, moderately hard, and satisfactory for most purposes.

Springs.—The 14 springs examined occur mainly on hillsides or at the heads of ravines. At least 6 appear to be seepages from till, and 5 plainly issue from rock crevices. The source of the others is more uncertain. The yields do not exceed a few gallons a minute.

54355—28——10

Suggestions for development.—Dug and drilled wells, if located with a proper regard for sanitation, are satisfactory sources of domestic supply. Much ground water could be recovered from the stratified drift in the valleys of Wepawaug River, West River, and Bladens River. But it should be understood that areas of thin deposits of stratified drift on hillsides and valley borders, where bedrock is near the surface, are not favorable sites for wells. (See p. 23.) In fact, stratified drift in such situations affords much less favorable conditions for wells than till, because its water drains away freely and the wells go dry. Only in the low valleys, where water is encountered at approximately the level of the adjacent streams, can a large supply be expected.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Woodbridge

[Observations made Nov. 18 to 25, 1919. a before number of well indicates that well is abandoned]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
5	Van Dorman	280	Valley	22	15	Stratified drift, probably to bedrock.	Pulley	(?).
6	Cwick	280	Slope	23	18	Stratified drift and bedrock.	do	No.
7	W. C. Root	350	Flat	20	15	Stratified drift	do	Almost.
9	Pankey	380	Terrace	24	18	Stratified drift and bedrock.	do	No.
11		480	Slope	23	11	Till and probably bedrock.	do	(?).
13	F. Terril	400	do	16	3	Till	Windmill	No.
14	Lindley	280	do	18	6	Stratified drift and probably bedrock.	Pulley	Rarely.
15	Jenny (?)	300	Valley	12	8	Stratified drift	do	No.
16		340	Terrace	17	13	Stratified drift and bedrock.	None	(?).
17	Mrs. Russel	340	do	16	12	do	Pulley	No.
18	Luciana	360	Slope	14	7	Till	Hand pump	No.
19		380	Terrace	23	15	Stratified drift	Pulley	No.
20	Dickinson	380	Valley	17	13	do	do	No.
21		420	Slope	24	14	Till and probably bedrock.	do	No.
22	Payne	440	Hill	15	10	Chiefly bedrock	Chain pump	Yes.
23	Clark	430	Flat	20?	14?	Till and bedrock	Hand pump	No.
25	T. F. Bartlett	440	do	20	13	Stratified drift and probably and bedrock.	do	Yes.
26	Henry Longue	440	Valley	18	10	do	Pulley	No.
27	Ford	440	do	18	10	do	Hand pump	No.
28	John W. Bell	480	Slope	15	9	Till	Pulley	No.
31	Arico Carbini	370	Flat	17	10	do	do	No.
32	N. H. Water Co.	400	Hill	19	12	Till and probably bedrock.	do	Yes.
33	do	400	do	24	17	do	do	Yes.
34	Charles Austen	400	do	22	15	Till and bedrock	do	No.
35		200	Slope	15	8	Chiefly bedrock	do	(?).
36	F. Doolittle	180	Valley	20	15	Stratified drift	do	No.
a37	Sheppard	220	Slope	18	8	Chiefly bedrock	None	No.
38	Matthewson	130	Terrace	34	30	Stratified drift	Pulley	No.
39	Welsh	120	do	25	16	do	Hand windlass	(?).
a40	Edward Nildoeth	100	do	24	16	do	None	No.
41	Doolittle	90	Valley	18	14	do	Pulley	No.
42	E. B. Devotte	80	do	15	12	do	Head pump	No.
43	Bradley	80	do	15	11	do	Pulley	No

Records of wells and springs in Woodbridge—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
44	Bradley	80	Valley	13	11	Stratified drift	Chain pump	No.
46	Clark	60	Slope	12	7	Till and bedrock	do	No.
50	Thomas	250	do	14	4	Till	do	No.
52	Hubbel	350	do	13	5	do	Hand pump	Yes.
54	Fairchild	270	Hill	19	14	Till and bedrock	Pulley	Rarely.
55	Frank Testa	260	Slope	19	10	Till	Chain pump	No.
56	Smith	360	do	15	2	do	Pulley	No.
57		380	do	24	11	do	do	No.
58		380	do	20	12	do	do	(?).
a59		400	Hill	18	11	do	None	(?).
60	A. E. Warren	390	Slope	20	7	do	Chain pump	No.
61		380	do	17	10	do	Pulley	(?).
63	Williams	380	Flat	25	15	do	Hand windlass	No.
a64	Mrs. Peck	360	do	20	14	Till (?) and bedrock.	None	Yes.
65	M. E. Nicholls	375	do	15	9	Chiefly bedrock	Pulley	Rarely.
66	Arents	375	do	15	9	Till (?)	do	(?).
67	Biesiegel	450	Slope	22	17	Till and bedrock	Windmill	No.
a71	S. H. Street	340	do	25	14	do	None	Yes.
74		330	do	27	10	Till and probably bedrock.	Pulley	(?).
75	Peck	330	Flat	30	15	do	do	No.
77	Tompkins	350	do	14	5	Till	do	No.
78	Rufus Clark	340	do	16	10	Till and bedrock	do	No.
79		330	Valley	9	2	Till	Chain pump	(?).
80	Mrs. E. Kunz	340	Flat	19	10	Till and bedrock	Pulley	Rarely.
81	Warner	360	Hill	19	7	Till 14 feet, bedrock 5 feet.	do	No.
82	W. H. Warner	360	do	21	7	Till and bedrock	do	Rarely.
83		360	do	14	7	Till and probably bedrock.	Hand pump	(?).
85	F. J. Newton	260	Slope	24	13	Till and bedrock	Hand windlass	No.
a90	H. E. Baldwin	340	do	21	8	do	Pulley	No.
92	E. J. Peck	420	do	17	13	do	do	Yes.
93		400	do	24	17	Stratified drift and probably bedrock.	Hand pump	(?).
a94		390	Ridge	16	12	do	None	(?).
95	Skripock	360	Valley	13	8	Stratified drift	Pulley	No.
96	Stoddard	370	Ridge	22	20	do	do	No.
a97	Balison	420	Flat	21	15	do		Yes.
98	I. Cosack	430	Valley	18	10	Stratified drift (?)	Pulley	No.
99	Jack Carey	440	Flat	17	6	Till	do	No.
100	Musaro	400	Slope	17	6	do	do	No.
101	N. J. Peck	300	do	20?		do	Gravity pipe line.	No.
103	P. B. Sperry	240	do	31	25	Stratified drift	Pulley	No.
104	Blackman	220	do	23	14	do	do	Almost.
105	Dudley	220	Terrace	27	19	do	do	No.
106	Drapo	220	do	27	25	do	do	No.
107	Nelson Lewis	220	do	30	24	do	do	No.
108		200	Valley	18	13	do	do	No.
109	M. Baldwin	200	do	14	9	do	do	No.
110	do	200	do	23	16	do	do	No.
111	Clark	340	Hill	22	7	Till		No.
112	Baldwin	340	do	26	10	do	Windmill	No.
113		330	Slope	20	10	do	Pulley	No.
a115	F. M. Baldwin	260	do	14	7	do	None	No.
119	S. J. Peck	345	Hill	23	15	Till 18 feet, bedrock 5 feet.	Hand pump	No.
120	Ferguson	340	do	28	15	Till 17 feet, bedrock 11 feet.	do	No.
121		220	Slope	18	12	Stratified drift	Chain pump	(?).
122	Cabot	225	Terrace	20	17	do	Pulley	No.
123	Wilson	210	Slope	14	10	do	do	No.
124	Little	215	Terrace	17	13	Stratified drift and bedrock.	Hand pump	No.
125	Russel	225	do	24	20	Stratified drift	do	Yes.
126	do	220	do	21	13	do	Pulley	No.
127	Schultz	225	do	25	18	do		No.
128	Coleman	220	Slope	15	12	do	Pulley	No.
129	Tuttle	220	Terrace	22?		Stratified drift and bedrock.		No.
131	F. Beecher	340	Hill	24	14	Till and bedrock	Pulley	Rarely.
132	Newton	310	Slope	11	7	Till	Hand pump	No.

Records of wells and springs in Woodbridge—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
133	McFarland	310	Slope	19	13	Till	Hand pump	No.
135	Burnham	300	...do	16	7	Till and bedrock	...do	No.
136	Bryant	280	Valley	17	10	...do	...do	No.
138	Hotchkiss	270	Flat	19	9	Till and bedrock	...do	Almost.
139	F. G. Sperry	290	...do	15	10	Till	Windmill	Rarely.
141	Callahan	300	Swamp	6	1	...do	None	No.
142	Jones	320	Ridge	20	5	...do	Hand windlass	No.
143	J. E. Cody	320	Slope	20	11	...do	Pulley	No.
144	Clark	320	...do	23	16	...do	Hand pump	No.
145		310	Flat	8	2	...do	...do	No.
146	T. C. Lewis	320	...do	15	10	...do	...do	(?).
150	A. D. Russel	300	...do	17	10	...do	Pulley	No.
151	Harvey	280	...do	24	10	Till and probably bedrock.	Gasoline engine.	No.
152		380	Hill	15	8	...do	Pulley	(?).
153	James McCarty	270	Flat	16	10	Till 14 feet, bedrock 2 feet.	Chain pump	No.
156	H. L. Judson	280	...do	13	7	Till and bedrock	Hand bucket	Almost.
157	George Willows	280	Ridge	20	12	...do	Pulley	Yes.
158	Thomas	270	...do	27	15	...do	Chain pump	Almost.
159	W. D. Howe	240	Slope	25	15	Till and probably bedrock.	Hand pump	No.
160	Matthews	240	...do	30	23	Stratified drift (?)	Pulley	No.

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
[a]2	Chatfield	280	Slope	55		Stratified drift, 20 feet (?); bedrock, 35 feet.	Hand pump	
3	...do	260	Valley	33	Chatfield	Stratified drift and bedrock.	Gasoline engine.	10-15
4	VanDorm	260	...do	108		...do	Windmill	
29	Sunnyside Farm	480	Hill	53		Till	Siphon	
47	Clark	70	Slope	50		Bedrock (slate)	Hand pump	
[b]48		220	Ridge	19		Stratified drift	...do	
49	Munn	280	Hill	138	L. Basset	Till, 3 feet; bedrock, 135 feet.	...do	([c])
51	Costello	320	Bench	125	Church	Till and bedrock	Windmill	
[d]53	G. E. Hubbel	300	Hill	77	L. Basset	Till, 17 feet; bedrock, 60 feet.	...do	3
[e]62	Williams	380	Flat	120	...do	Chiefly bedrock (slate).		-1
68	Biesiegel	450	Slope	80		Till, 17 feet; bedrock, 63 feet.	Windmill	
69	...do	420	...do	85	Chatfield	...do	Gasoline engine.	
72	S. H. Street	340	...do	83	Knight	Chiefly bedrock	...do	40
73	C. E. Peck	330	Flat	43	C.L. Wright	Till, 21 feet; bedrock, 22 feet.	...do	4
76		320	Slope	50		Till and bedrock	Hand pump	
84	Tompkins	340	Flat	100	Chatfield	Chiefly bedrock	Gasoline engine.	
86	Trombley	250	Slope	80	L. Basset	Stratified drift and bedrock.	Hand pump	3½

[a] Drilled 31 feet in bottom of 24-foot dug well, which failed.
[b] Well is 4 inches in diameter.
[c] Small.
[d] Drilled 60 feet in bottom of 17-foot dug well, which failed.
[e] Drilled 100 feet in bottom of 20-foot dug well, which failed.

Records of wells and springs in Woodbridge—Continued

Drilled wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
88	C. C. Hitchcock	320	Slope	70	Knight	Bedrock	Hand pump	
89	Beecher	280	do	43	C.L.Wright	Stratified drift, 7 feet; bedrock 36 feet.	Electric pump.	
117	Deneman	345	Hill	35		Till and bedrock	Gasoline engine.	
118	S. J. Peck	245	do	110	Knight	Till, 12 feet; bedrock, 98 feet.		7½
130	Beattie	220	Slope			Stratified drift and bedrock.		
134	Dunlap	290	Flat	145	Nolan	Till, 17 feet; bedrock, 128 feet.	Electric pump.	3½
140	Callahan	290	do			Chiefly bedrock	do	
147	William A. Bien	360	Hill			do	Gasoline engine.	
148		340	Slope	176	L. Basset	do	Hand pump	
149	Tuttle	360	Hill	49	do	do	do	
154	C. Schoensen	260	Flat	66	Chatfield	do	do	
[f]155	Marks	260	do	48		do	Gasoline engine.	

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
1	Hotchkiss	260	Hillside	Bedrock fractures	Open pit; pipe line to barrel.	5?
8	W. C. Peck	400	Hillside, head of ravine.	Till	Open pit; gravity pipe line.	
10	G. H. Nettleton	440	Hillside	Probably from contact of till and bedrock.	Concrete-lined excavation and spring house; gasoline engine.	+10
12	F. Ferril	400	Small depression on hillside.	Till	Stoned pit 10 feet deep; pump in house.	
24	Newton	420	Head of ravine	Water from bedrock fractures.	Pit, 7 feet deep; gravity pipe line to house.	
30	Public road	280	Foot of small bluff	From bedrock (slate).	Open pit, 2 feet deep	
45	do	120	Foot of hill	do	Open pool	
70		340	Swampy valley	Till	Open pit, 5 feet deep	
7	C. C. Hitchcock	300	Slope	Till and bedrock	Spring house over excavation to bedrock.	
91	Stoddard	410	Hillside	Seep from till	Covered pit, 10 feet deep.	
102	P. B. Sperry	250	Foot of bluff	Bedrock fractures	Excavation to bedrock.	
114	Cabot	260	Hillside	Marshy seep from till.	Spring house and gravity pipe line.	
116	Baldwin	270	Bench on hillside	do	Open ponded pool; feeds hydraulic ram.	
137	L. C. Beecher	300	Depression on slope.	Bedrock and till-bedrock contact.	Open pit; feeds hydraulic ram.	

[f] Drilled 25 feet in bottom of 23-foot dug well, which failed.

BETHANY

AREA, POPULATION, AND INDUSTRIES

Bethany lies north of Woodbridge, south of Prospect and Naugatuck, west of Hamden, and east of Beacon Falls and Seymour. Its shape is roughly rectangular, about 5 miles long, from north to south, and about 4 miles wide. Its area is 12,735 acres, or 19.9 square miles, practically the same as that of Woodbridge. The town was formed from Woodbridge in 1832. It is an inland, agricultural town, even more purely rural than Woodbridge. It contains no railroad lines, no trolleys, no public water supply, no factories, no post offices. Mail is delivered by rural carriers. The population of the town was 411 in 1920 and has been decreasing rather than increasing. Vacant houses are common, and new ones are almost unknown. Bethany has the smallest population of all the towns in the New Haven area.

TOPOGRAPHY AND DRAINAGE

The lowest land in Bethany is in the southeastern part, in the West River valley, about 200 feet above sea level, and in the southwestern part, on Bladens River, 220 feet above sea level. The highest land is on the crests of the trap ridges that form the eastern boundary, where heights more than 800 feet above sea level are reached. Throughout most of the town, however, the highest hills are 600 to 700 feet in altitude. The relief is unusually great for the New Haven area, being generally 200 to 400 feet and at some places even more. Nevertheless, the topography is not remarkably rugged except on its eastern border. The valleys are deep and narrow, the hills rolling. The drainage follows the general slope of the land southward, except in a belt along the northern border of the town where some streams flow westward. The town contains the sources of several large streams, none of which attain much size within its limits.

GEOLOGY

Bedrock.—Pre-Triassic crystalline rocks underlie all of Bethany except a very narrow strip along the eastern boundary. The Prospect porphyritic gneiss is the most widespread. It occurs in a belt extending from southwest to northeast and covering all the town except the northwest and southeast corners. The rock is well exposed along the roads about 1 mile south of Bethany Center. In the southeastern part of Bethany there is 2 or 3 square miles underlain by the Orange phyllite. North of Hackanum Brook, in the northwest corner of the town, is a small area of the Hoosac ("Hartland") schist.

Triassic trap rock forms the ridges along the eastern boundary of Bethany, and immediately west of the trap ridges is a narrow belt, usually not more than a quarter of a mile wide, which is underlain by Triassic sandstone. The exposures of sandstone are few.

Drift.—Till covers about 90 per cent of the area of Bethany—all except narrow belts along the larger streams, where there is a little stratified drift. There is one prominent drumlin along the Woodbridge Bethany line, in the southern part of the town. Stratified drift is irregularly distributed along the courses of Sargent River, West River, Hill Brook, Hackanum Brook, Hopp Brook, and Bladens River. The belts are generally less than a quarter of a mile in width, and the stratified drift lies in patches on the steep valley sides, with bedrock projecting through it at many places. In the southwest corner of Bethany, at the juncture of Hopp Brook and Bladens River, there is a very small terraced plain of stratified drift.

The thickness of drift is variable but generally not more than 20 or 30 feet. Out of 88 dug wells 31 penetrate to or into bedrock. The greatest thicknesses of till and stratified drift shown in well records are given in the table below. Of the wells listed only No. 50 is known to reach bedrock beneath the drift, but the depths given are a fair indication of the maximum thickness of the drift.

Depth of drift penetrated by wells in Bethany

Wells in till		Wells in stratified drift	
No.	Depth (feet)	No.	Depth (feet)
9	32	50	36
44	25	90	35
45	25		
69	25		
85	31		
99	32		

WATER SUPPLY

There is no public water supply in Bethany, though the town contributes much surface water to the New Haven supply. The population depends entirely on wells and springs, 106 of which were examined, including 88 dug wells, 7 drilled wells, and 11 springs. (See pl. 5.) This census covered nearly all the wells and springs and is the most complete survey made in the towns of the New Haven area. The records of these water supplies are given in the appended table.

Wells.—Dug wells are the chief source of ground water in Bethany. Of the 88 dug wells 23 are in stratified drift, the rest in till or till and bedrock. The average depth for 88 wells is 19 feet. The deepest well in the town is No. 50, 36 feet deep. Six drilled wells average 69 feet in depth. The yield of dug wells is generally adequate for a family, but 8 wells are reported to fail regularly and 4 occasionally. Yields of 4½ and 10 gallons a minute were reported from 2 drilled wells.

Springs.—The 11 springs examined occur at favorable locations on slopes or at the heads of valleys. Six or seven appear to derive their water from till, and the rest from crevices in bedrock. The yields are from 2 to 5 gallons a minute.

Suggestions for development.—For the needs of its population the methods used to recover ground water in Bethany are about as satisfactory as will be found. Dug and drilled wells yield adequate domestic supplies. Driven wells could be used at only a very few places. More use could be made of wells and springs so located as to furnish a supply of running water through gravity pipe lines. Very few areas of stratified drift are suited to the development of large supplies; the best locations for these are in the valley below Mount Sanford, in the northeast corner of the town, in the Bladens River valley, at the southwest corner; and in the West River valley, near the Davidson farms, about 1 mile above Lake Bethany.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Bethany

[Observations made Nov. 18 to 22, 1919. a before number of well indicates that well is abandoned]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth of water (feet)	Kind of rock	Equipment	Does well fail?
1	A. Cabres	380	Slope	15	14	Stratified drift and bedrock.	Hand pump	Usually dry.
2		500	Valley	7	4	Stratified drift	Hand bucket	(?).
4	William Lounsbury.	520	do	22	14	Till (?) and bedrock	Hand pump	No.
5	Carrington	540	Swamp	7	1	Till	None	No.
6		420	Terrace	16	12	Stratified drift (?) and probably bedrock.	Hand windlass	(?).
a7	McGinn	440	do	20	15	Stratified drift (?) and bedrock.	Pulley	(?).
9	F. Dodgwick	540	Slope	32	23	Till	do	No.
10	Emil Strong	500	do	18	12	Till and bedrock	Hand pump	(?).
11	Downs	480	Valley	9	5	Till (?)	Pulley	No.
12	Doolittle	480	do	18	10	Stratified drift (?)	do	No.
13	O. B. Hotchkiss	480	do	17	11	do	Chain pump	No.
14	Durley	500	Slope	11	5	Till	Hand pump	Yes.
15	J. Bettingale	680	Hill	15	13	do	Gravity pipe line.	No.
16		620	Slope	20	15	do	None	(?).
17	Durley	630	Hill	20	13	do	Hand pump	No.
18	Lacey	620	do	20	10	do	Pulley	No.
19	W. S. Gilbert	680	Slope	14	9	do	Hand pump	No.
20	Edward Netleton	600	Swamp	10	5	do	Sweep	No.
21	Anderson	600	do	4	1	Stratified	None	No.
22	Oldstrom	600	Terrace	15	10	Stratified drift and bedrock.	Chain pump	Yes.
23		640	Slope	10	5	Till	None	(?).
24		620	do	21	12	Till and probably bedrock.	Pulley	No.
25	Mrs. Coe	620	do	23	9	Till 8 feet, bedrock 15 feet.	Sweep	Rarely.
27	Lees	610	Valley	10	5	Till	Pulley	No.
28	Beecher	620	Slope	22	14	Till and bedrock	do	No.
29	W. H. Perkin	590	do	17	8	Till	Hand pump	No.
32	Carl Johnson	640	Hill	21	10	do	Pulley	No.
33		660	do	23	4	do	do	No.
36	Krell	600	do	18	10	do	Chain pump	No.
37		640	do	12	5	do	None	Yes.
38	N. F. Mansfield	620	do	22	15	Till and bedrock	Pulley	(?).

Records of wells and springs in Bethany—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth of water (feet)	Kind of rock	Equipment	Does well fail?
40	Johnson	630	Hill	14	8	Till and bedrock	Gravity pipe line.	Rarely.
41		620	do	17	10	Till	Hand pump	(?).
43	Mrs. Peck	640	do	29	20	Till and probably bedrock.	Windmill	No.
44	Moran	540	Slope	25	5	Till	Pulley	No.
45		540	do	25	14	do	Hand bucket	No.
47	S. C. Perry	540	Hill	18	10	Till and bedrock	do	No.
48	Parsonage	540	do	15	9	Chiefly bedrock	Chain pump	(?).
49	Mrs. Murphy	550	Slope	20	10	Till and probably rock.	Hand pump	No.
50	Saxton	530	Terrace	36	32	Stratified drift and bedrock at bottom.	Pulley	Rarely.
51	T. Davidson	510	do	12	7	Stratified drift	Hand windlass	No.
52	S. G. Davidson	500	Valley	13	8	do	do	No.
53	Mrs. Beecher	520	Slope	24	17	Till (?)	Pulley	No.
54	P. Harrison	560	Valley	15	5	Till	do	No.
55	Davidson	500	Slope	23	20	Stratified drift and bedrock.	Hand windlass	Yes.
58	Lounsbury	550	Hill	35	21	Till and probably bedrock.	Hand pump	
59	New Haven Water Co.	460	Terrace	23	13	Stratified drift (?) and bedrock.	Pulley	Yes.
60	Munson	480	Ridge	21	15	do	do	Yes.
61	John Menz	470	Terrace	17	9	Till	do	No.
63	F. S. Downs	420	Slope	18	8	do	do	No.
64	L. G. Doolittle	420	do	21	11	do	do	No.
65	William B. Downs.	400	do	20	9	Till and bedrock	do	Rarely
66	Theodore Downs	400	do	16	9	do	do	Yes.
67	A. Doolittle	360	do	25	20	do	do	Rarely
69	McClure	530	Hill	25	14	Till	do	No.
70	Schilf (?)	520	do	19	8	do	do	No.
71		530	Slope	12	3	do	do	(?).
72		560	do	20	10	do	None	(?).
73	T. Allen	530	Valley	7	2	do	Hand pump	No.
75	Downs	520	Slope	25	9	do	Pulley	No.
76	Warner	540	do	21	9	do	do	No.
77	Charles Megin	560	do	15	12	do	Hand windlass	No.
78	do	550	do	27	(?)	Till and bedrock	Hand pump	No.
79		500	Ridge	17	10	Till and probably bedrock.	do	(?).
81	Myers	520	Flat	14	5	Till	Chain pump	No.
82		520	do	12	5	do	do	(?).
83	Liebman Bros	500	do	10	5	do	Pulley	No.
84	do	480	do	16	8	do	Chain pump	No.
85	Seaton	630	Hill	31	3	do	Gravity pipe line.	No.
86	Julius Laber	600	do	18	7	do	Pulley	No.
88		500	do	22	7	do	None	No.
89	Murphy	490	do	22	10	do	Pulley	No.
90		380	Terrace	35	25	Stratified drift	do	(?).
91	Robertson	380	Slope	25	14	Stratified drift and bedrock.	do	No.
92		380	Terrace	25	15	Stratified drift and bedrock (?).	None	No.
93		390	do	20	12	do	Pulley	(?).
94	Alexander Husti	480	do	17	9	Stratified drift	do	No.
95	Chatfield	260	Valley	20	18	do	do	No.
96	Andrews	350	Slope	22	10	do	Chain pump	No.
97	Carrington	430	do	11	8	Till and rock	Hand pump	No.
99	Russel	500	Hill	32	12	Till	Pulley	No.
100	Frank Testa	500	Flat	17	6	Till and bedrock	Hand pump	Yes.
101	Mela (?)	480	Slope	15	6	Till	Pulley	No.
102	Handunetti (?)	420	Hill	16	4	do	None	(?).
103		420	Slope	18	12	do	Pulley	(?).
104	Whitlock	420	Bench	14	5	do	Hand pump	No.
105		480	Hill	20	14	Till and probably bedrock.	Pulley	(?).
106	M. Woodruff	220	Terrace	25	22	Stratified drift	do	No.

Records of wells and springs in Bethany—Continued

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
34	O. E. Carrington	640	Hill	128	Wheeler	Till 18 feet, bedrock 110 feet.		
39	Woodward	640	do	53	Wright	Till 11 feet, bedrock 42 feet.	Hand pump	4.5
42	do	640	do	35	do	Till 14 feet, bedrock 21 feet.	do	
[a]56	Davidson	500	Slope	63		Stratified drift and bedrock.	do	
74	Dayer	550	do			Till and bedrock	Windmill	
80	L. Kaplan	520	Hill	75		Chiefly bedrock	Hand pump	
87	B. A. Carrington	500	do	60	Knight	Till 20 feet, bedrock 40 feet.	do	10

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
3	William Lounsbury	500	Valley, edge of brook.	Till and bedrock fractures.	Small open pit	2–3
8	Saunders	480	Hillside	Fractures in bedrock (slate).	Spring house over excavation; gravity pipe line.	
26	Mrs. Coe	620	Head of ravine	Bedrock	Gravity pipe line to roadside trough.	–5
30	W. H. Perkins	580	Gentle slope	Till	Open pit 6 by 4 feet; pipe to trough.	
31		540	Foot of hill	do	Concrete-lined pit; pump at house.	1–2
35	Krell	600	Smooth, gentle slope.	Bedrock under till cover.	Stoned pit 5 feet deep, board cover.	
46	J. E. Hinman	500	Head of ravine	Seep from till	Open pit 3 feet deep; pumped by gasoline engine.	
57	Lounsbury	620	Gentle slope	do	Pit 10 feet deep, with spring house; gravity pipe line to house.	
62	Strom	400	Slope at base of mountain.	Probably fractures in trap rock.	Open pit; gravity pipe line to house.	
	A. Doolittle	380	Hillside marsh	Seepage in till probably over bedrock.	Trenches in till; pipe to roadside.	
98	Roshay (?)	450	Head of small ravine.	Till	Barrel in earth; gravity pipe line.	4–5

[a] Water is always full of suspended red clay and has never been good. Drilled in 1914.

HAMDEN

AREA, POPULATION, AND INDUSTRIES

Hamden lies immediately north of New Haven. To the east is North Haven, to the north Wallingford and Cheshire, to the west Bethany and Woodbridge. The town consists of an irregular-shaped area 3 to 5 miles in width from east to west and about 8 miles in length. Its area is 21,054 acres, or 32.9 square miles. Hamden was incorporated from New Haven in 1786. The town has a diversity of industries. The southern part, generally known as Whitneyville, is in many respects closely bound to New Haven, of which it is an important residential and industrial suburb. To some extent the urban character is maintained for several miles northward along the Mill River valley, where Augerville, Hamden, Centerville, and Mount Carmel are good-sized villages. The Northampton division of the New York, New Haven & Hartford Railroad crosses the town from south to north and is closely paralleled by a trolley line. In Whitneyville and most of the Mill River valley the public utilities of New Haven, such as light, water, and trolley lines, are available. The manufactured products include firearms and ammunition, wire, brass goods, various kinds of hardware, brick, tile, and clay products, textiles, and leather goods. Outside the towns and villages agriculture is the chief industry. Market gardening and dairying are important branches of farming. The population of Hamden in 1920 was 8,611.

TOPOGRAPHY AND DRAINAGE

The lowest part of Hamden is at the southeast corner, where the tidal marshes of the Quinnipiac Valley are at sea level. The greatest altitudes are on Mount Carmel, which rises 737 feet above sea level in the northeastern part, and on West Rock and the other ridges that form the western boundary of the town, where the altitude ranges from 400 feet to more than 800 feet. The surface is very irregular. Its most conspicuous features are the sharp, narrow ridge along the western boundary, which rises 300 to 400 feet above the adjacent surface; the long north-south valley of Mill River with its narrow terraced plain; the few high isolated hills of irregular shape—Mount Carmel, East Rock, Mill Rock, and Pine Rock; and in the southern part of the town, a plain continuous with the New Haven plain and merging into the terraced plain along Mill River. The general slope of the land is southward, and the drainage is in that direction, most of it being carried by Mill River.

GEOLOGY

Bedrock.—Triassic sandstone and trap are the bedrocks in Hamden. The sandstone underlies nearly all of the town except the high hills and ridges, which are formed of trap. Exposures of sandstone are fairly common on the lower hills and at the base of the trap ridges, but the best exposures are in road cuts.

Drift.—Till forms the surface of nearly two-thirds of Hamden. In general the till covers the hills and slopes, but it is found also in other places. The stratified drift of Hamden underlies the plain at Whitneyville and the terraces along the Mill River valley throughout the length of the town. There are also several isolated patches of stratified drift on slopes and in valleys near the base of the western trap ridges. Some of these occur at altitudes of 400 to 500 feet above sea level.

The thickness of the drift is variable. The till is generally not more than 10 to 15 feet thick but may exceed 25 feet. The stratified drift, particularly in the southern part of Hamden, is much thicker. In it there are many wells exceeding 30 feet in depth, some as much as 50 feet, which do not reach bedrock. In the drilled well of the Acme Wire Co. 223 feet of stratified drift was penetrated, the greatest recorded thickness in the New Haven area.

WATER SUPPLY

The New Haven Water Co. has extensive holdings in Hamden, and most of the surface water of the town passes through its reservoirs at Whitney Lake and Lake Wintergreen. The company's mains supply nearly all the population of the Whitneyville plain and the Mill River valley. Public water has been so long available at Whitneyville that most of the wells that once existed are now abandoned. For analyses of water of the New Haven municipal supply see A and B on page 36. Outside the area supplied by the New Haven Water Co. wells and springs are the chief dependence for water supply. Records of 224 individual supplies are given in the appended table. They cover 165 dug wells, 43 drilled wells, and 16 springs. (See pl. 5.)

Wells.—In spite of the fact that the principal areas of stratified drift are convenient to the public supply, 95 of the dug wells are in stratified drift, and only 70 in till. Of the wells in till about 30 penetrate bedrock, but of those in stratified drift only 8 or 9 reach rock. The average depth of 164 dug wells is 24 feet, the greatest for all the towns in the New Haven area. The average depth to the water table, 17 feet, is also the greatest in the area, because many wells are located on stratified drift terraces which stand so high above the adjacent controlling stream channels that the wells must be deep to obtain water. The average depth to the water table in stratified drift is 21 feet and in till only 10 feet. The deepest dug well is No. 161, which is 50 feet deep. Wells 41, 146, 159, 164, 195, and 197 all exceed 40 feet in depth. Analyses of samples of water from three dug wells in Hamden (Nos. 22, 189, and 208) are given on page 36. The waters represented are moderately low in mineral content and hardness and are satisfactory for most purposes.

Drilled wells for domestic supply are common on the hills and till-covered slopes in Hamden, where the till is in many places too thin to yield any water. They are generally from 50 to 100 feet in depth and average 72 feet. The yields are variable, the average for 6 reported being 10.7 gallons a minute. The lowest yield reported is 2 gallons a minute and the highest 25 gallons a minute.

Analyses of samples of water from four driven wells in Hamden (Nos. 93, 183, 184, and P–5) are given on page 36. The waters represented are moderate in mineral content but are rather hard and will form considerable scale in boilers.

Springs.—Most of the 16 springs examined occur at the foot of hills or terrace bluffs or at the heads of ravines. Two issue from stratified drift, two from joints in sandstone, and the rest, so far as can be seen, from till, though several of them may actually receive water from joints in rock. Several springs have fairly large yields, 5 to 10 gallons a minute.

Ground water for industrial use.—Most of the factories in Hamden use the public water supply or obtain their supply from brooks or rivers on their property. A few have wells that supply water for certain uses, and one or two use ground water extensively. Probably about 100,000 gallons a day of ground water is used by industrial plants in Hamden. The plants using ground water are shown on Plate 5 but are numbered in a separate series designated by the letter P. They are described below.

1. The Woodruff Manufacturing Co., at Mount Carmel, uses water from Mill River for boilers and for most purposes except drinking. For drinking it has one driven well 1½ inches in diameter and about 30 feet deep. The amount of water used is not known.

2. The J. T. Henry Manufacturing Co., at Centerville, uses one dug well 29 feet deep to supply water for drinking, boilers, and all factory uses. It is pumped by a steam pump. The quantity of water used is not great. It is not treated for boiler use but has given good satisfaction. The well penetrates stratified drift and contains 3 feet of water.

3. The American Mills Co. has a large plant at Centerville. River water is used for boilers and most other purposes. A 2-inch driven well supplies drinking water for the plant.

4. The Whitney-Blake Co. uses city water for boilers and condensers, the company's principal use for water. It uses also one drilled well 6 inches in diameter and nearly 400 feet deep, which was drilled in 1917. This well is pumped about 22 hours a day, and the water is used for drinking and other purposes. The quantity used is not known, but the yield of the well is fairly large. It penetrates sandstone below an unknown thickness of stratified drift.

5. The Acme Wire Co. has city water supplied to a sprinkler system of fire protection but uses well water entirely for the boiler supply, drinking water, and other factory needs. The water comes entirely from one drilled well, sunk in 1914. The well is 10 inches in diameter at the top and 6 inches at the bottom and is 703 feet deep. The material penetrated was sand (stratified drift) to a depth of 223 feet and sandstone below that depth. The well was tested when a depth of 500 feet had been reached and yielded 78 gallons a minute; at 600 feet the yield was 90 gallons a minute; and at completion at a depth of 703 feet the maximum yield obtainable was 120 gallons a minute. This yield is large for a drilled well of such depth in bedrock. The quality of the water is unusually good. The hardness averages 59 parts per million, the total solids 100 to 125 parts per million, and the chloride content below 4 parts per million, as indicated by a large number of analyses extending over all the period of use. The water is quite as satisfactory as city water for all purposes.

The well is pumped continuously at a rate of about 60,000 gallons a day. The water is pumped to a large surface reservoir by an air lift set 150 feet deep, and thence to a pressure tank by a centrifugal pump. The pumps run 10 hours daily, which indicates a draft on the well of 100 gallons a minute.

Suggestions for development.—For domestic supply in Hamden dug or drilled wells and springs are a satisfactory source when properly cared for. More use could profitably be made of hillside wells or springs adapted to the use of gravity water systems. The stratified drift of the Mill River valley and the Whitneyville plain would furnish an abundant supply of ground water, which could be recovered best by means of driven wells where the water table is not too deep. However, the water table beneath much of this area stands so low that pumps would have to be set in excavations in order to draw water by ordinary suction. The depth to water should be determined by preliminary tests before plants are installed. The stratified drift that occurs in patches at high altitudes is not a promising source for large supplies of water, because it lies in uneven bodies on bedrock slopes and its water rapidly drains away. The success of the Acme Wire Co. and Whitney-Blake Co. with deep drilled wells is unusual and probably could not be duplicated in many places.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Hamden

[Observations made Nov. 1 to 18, 1919. a before number of well indicates that well is abandoned. For descriptions of pumping plants, which are numbered in a separate series, see p. 151]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
1	Mrs. Warner	530	Slope	18	11	Till	Pulley	No.
2	Podgwait	560	Hill	25	19	do	do	No.
3	C. Jasudowick	560	do	30	24	do	do	No.
4	Stewart	500	Slope	18	12	do	do	No.
7	Johnson	350	Flat	34	31	Stratified drift	do	Yes.
8	Joyce	280	Slope	19	16	Till	Hand pump	(?).
11	Sanford	160	Hill	27	12	Till and sandstone.	Pulley	No.
12	C. Todd	90	Terrace	22	17	Stratified drift	Chain pump	No.
13	Thorpe	90	Valley	14	10	do	Hand pump	No.
14	Atwood	110	Terrace	17	14	do	Hand windlass	Yes.
15	Boilles	120	do	26	22	do	Pulley	No.
16	L. W. Alling	120	Plain	28	25	do	Hand pump	No.
17	A. B. Todd	120	do	26	22	do	Pulley	No.
18	George H. Dudley.	120	do	26	22	do	do	No.
19	do	125	do	31	28	do	do	No.
20		120	do	26	22	do	do	No.
21	H. H. Bradley	120	do	30	28	do	do	No.
22	William Sharpe estate.	125	do	30	28	do	Hand pump	No.
23	Phrom	120	do	33	29	do	Pulley	No.
25		140	Terrace	24	21	do	do	No.
a27	E. H. Young	150	do	29	25	do	do	No.
28	Petrosky	140	do	30	20	Stratified drift and bedrock.	do	No.
29	Pelotti	120	Valley	18	14	Stratified drift	Chain pump	No.
31	Chadwick	160	do	14	12	Stratified drift and bedrock.	Pulley	Rarely.

Records of wells and springs in Hamden—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
32	Owen	200	Slope	15	10	Till and sandstone.	Pulley	No.
33	Doolittle	100	do	6?		Chiefly sandstone.	Gravity pipe line.	No.
34	John Von Hoelser	60	do	11	5	Till	Hand windlass	Yes.
37	Wm. Williams	140	do	29	11	Till and sandstone.	Pulley	Yes.
38	Mount Glen Farm.	125	do	25	10	Probably sandstone.	Chain pump	Yes.
39	Montgomery	90	Valley	14	7	Till	do	No.
41	Wakeman	90	Terrace	44	38	Stratified drift	Pulley	No.
42	A. McKeown	90	do	33	27	do	do	No.
44	Abrams	220	Valley	19	10	do	Chain pump	No.
45	Yale	230	do	15	9	do	Hand pump	No.
46	Wooley	260	do	10	1	Till and sandstone.	Chain pump	Yes.
47	Sheppard	300	Slope	28	21	Stratified drift (?).	do	No.
a48		200	Terrace	26	25	Stratified drift	Hand pump	(?).
50	F. W. Dickerman.	400	Plain	18	13	do	Chain pump	No.
55	D. Prano	280.	Hill	15	10	do	Pulley	No.
57	Lemington	320	Slope	23	13	Till 10 feet, sandstone 13 feet.	do	Yes.
58	L. Warner	270	do	16	10	Till	do	No.
59	H. H. Sheppard	250	do	12	7	do	Chain pump	No.
60	Warner	260	do	13	7	do	Pulley	No.
61	Fluenberg	260	Hill	13	5	do	Hand pump	No.
62	Whitman	220	Slope	11	3	Till and sandstone.	Chain pump	No.
63	Helfend	240	do	17	7	Till	Windmill	No.
65	Espesita	140	Valley	16	12	Stratified drift	Pulley	No.
66	William Baldwin	120	do	18	14	do	do	No.
67	Schwartz	120	do	17	12	do	Hand pump	No.
68	Gamble	75	Plain	30?	25?	do	do	No.
70	Burns	90	Terrace	37	32	do	Pulley	No.
71	Ives	90	do	33	30	Stratified drift and sandstone.	do	No.
72	Leddy	70	Valley	14	8	Stratified drift	do	No.
73	Basset	80	Terrace	34	31	do	do	No.
74	Welch	60	Valley	15	13	do	do	No.
76	St. Marys Church	80	Terrace	33	25	Stratified drift, probably to rock.	Hand pump	No.
78	George Anderson	120	Slope	25	18	Chiefly sandstone.	do	No.
81	Cohen	100	Valley	9	5	Till	Pulley	No.
82	Hermann	100	do	26	21	Stratified drift and probably sandstone.	do	No.
83	Austen	80	Slope	18	11	Till and sandstone at bottom.	do	Yes.
84	R. F. Rachford	75	Plain	25	21	Stratified drift	do	No.
85	Cora Phelps	75	do	28	25	do	do	No.
86	J. Crook	70	do	24	21	do	do	No.
87	Demoni (?)	65	do	24	20	do	do	No.
88	Townsend	65	do	28	22	do	do	No.
89	W. A. Mann	65	Terrace	29	25	do	do	No.
90	Henry	60	do	26	22	do	Electric pump	No.
91	American Mills Co.	60	do	23	20	do	Pulley	No.
92	G. Godini	60	do	24	20	do	do	No.
a94	J. Sanford	80	Flat	37	33	Stratified drift and sandstone.	None	No.
95	P. L. Kington	160	Slope	19	8	Till and sandstone.	Pulley	Yes.
97	V. Kallericius	200	do	24	12	Till	do	No.
98	F. O. Schutzka	230	do	25	20	Till and sandstone.	do	No.
99	Maple Crest House.	220	do	23	13	do	Hand pump	(?).
100	Davidson	200	do	24	15	Chiefly sandstone.	Pulley	No.
102	Kozipski	100	Valley	18	13	Stratified drift (?)	Hand pump	No.

Records of wells and springs in Hamden—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
103	T. Pascarelli	100	Valley	16	7	Stratified drift (?)	Pulley	No.
104	S. Mizenski	100	do	16	12	Till and sandstone.	do	No.
106	George Dorman	140	Hill	23	13	do	do	No.
108	Mix	120	do	27	18	Till and sandstone.	do	Yes.
109	do	180	Terrace	28	18	Stratified drift	do	Almost.
111		80	Valley	12	5	do	do	No.
114	Antigora	200	Hill	24	10	Till and sandstone.	Hand bucket	No.
118	J. Zabiloski	320	do	21	15	Till	Pulley	No.
119	Walter Kelsey	300	Slope	13	10	do	do	(?).
120	F. Kopezinski	290	do	18	8	do	Hand bucket	Yes.
121	J. Skdpnit (?)	300	Hill	25	8	Till and sandstone.		No.
122	O. Munson	280	Slope	14	7	Till	Pulley	Yes.
124	L. B. Dorman	250	do	15	8	Till and sandstone.	do	No.
125	McGinn	240	do	13	8	Till	do	No.
128	C. H. Munson	200	Hill	16	13	do	do	Yes.
129		240	do	13	7	do	Chain pump	(?).
130		220	do	19	10	do	Pulley	(?).
132	New Haven Water Co.	280	do	21	12	Till and probably sandstone.	do	No.
133	Joseph Casseli	200	do	22?		Till	Hand pump	(?).
135	S. Mofinski	260	Slope	14	7	do	Pulley	No.
139	Cocco	70	Plain	36	19	Stratified drift	do	No.
140	Benham	70	Slope	27	10	Till	do	No.
141	do	70	Valley	16	10	Stratified drift	Hand pump	No.
142	Dorman	70	Plain	17	12	Till and sandstone.	Pulley	No.
143	Peterson	70	do	24	17	Stratified drift	do	No.
a144	H. E. Warner	70	do	30	22	do	None	No.
145	Whitney-Blake Co.	70	do	42	37	do	do	No.
146	C. E. Hayes	70	do	45	39	do	Pulley	No.
147	C. R. Turner	80	do	25	22	Stratified drift and sandstone.	do	No.
148	Mrs. Gormley	120	Slope	16	13	Till and probably sandstone.	do	(?).
149	L. P. Kling	140	Hill	22	14	Chiefly sandstone.	Siphon	No.
150	Wetmore	160	do	15	11	do	Hand pump	No.
152	Batch	120	do	25	15	do	Pulley	No.
153	Mrs. Basset	70	Plain	32	26	Stratified drift	do	No.
154		60	do	12	8	do	do	(?).
155	Mix	85	Hill	18	12	Chiefly sandstone.	do	No.
156	Humiston	80	Plain	26	21	Stratified drift and sandstone.	do	No.
157	Mrs. Benham	90	Ridge	16	8	Till and sandstone.	do	No.
158	B. A. Wooding	80	Plain	48	46	Stratified drift	do	Yes.
159	Mrs. Benham	80	do	16	11	Stratified drift and sandstone.	do	No.
160		80	do	50	48	Stratified drift	do	No.
161	Meegan	50	Valley	16	12	do	Hand pump	No.
162	Miller	60	Terrace	25	15	Stratified drift 12 feet, sandstone 13 feet.	Pulley	No.
a163	Thorpe	75	do	48	43	Stratified drift and sandstone.	None	No.
166	New Haven Brick Co.	15	Valley	14	10	Stratified drift	Chain pump	No.
168	Castilione	30	Slope	10	2	Till	Gravity pipe line.	No.
169	John Kane	30	do	10	7	do	Hand pump	No.
170	F. S. Shares	60	do	14	9	do	do	No.
172		20	Terrace	20	16	Stratified drift	Chain pump	No.
173	F. R. Shares	20	do	15	12	do	Pulley	No.
174	Potter	10	Swamp	5	1	do	Chain pump	No.
177	Shares Brick Yard.	20	Slope	9	5	Till	Hand pump	No.
179	Davis	100	do	10	7	Chiefly sandstone	Pulley	No.

Records of wells and springs in Hamden—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
180	Davis	100	Hill	11	3	Till	Pulley	Yes.
181	do	120	do	17	13	Till and probably sandstone.	do	No.
186	William Schiffir	120	do	25	13	Till and sandstone.	do	Rarely.
187	Charles Smith	125	do	22	13	do	do	Rarely.
188	Runn	120	do	25	16	Till 13 feet, sandstone 12 feet.	Hand pump	Yes.
189	Lydia Basset	120	do	14	6	Till	Pulley	Almost
190	Osborne	40	Terrace	23	14	Stratified drift	do	No.
191	Silliman	50	Plain	24	17	do	do	No.
a192	Reeves	40	Terrace	23	13	do	Hand pump	No.
193	Neilson	35	do	12	7	do	do	No.
194	Winchester Co.	70	Plain	42	35	do	Pulley	No.
196	E. H. Moulton	60	do	42	39	do	do	No.
197		60	do	26	20	do	do	No.
a199	Harry Peck	60	Terrace	27	23	do	do	No.
201	Tuttle	60	Plain	28	35	do	do	No.
a202	E. D. Sanford	65	do	39	33	do	None	No.
203	James Hyland	70	do	36	30	do	Pulley	No.
205	J. W. Talmadge	65	do	35	28	do	do	No.
206	W. R. Munson	65	do	36	29	do	do	No.
207	Wooden	60	do	34		do	do	No.
208	W. A. Thomas	50	do	27	24	do	do	No.
209	E. I. Welch	60	do	31	28	do	do	No.
210	L. F. Jones	60	do	36	31	do	do	No.
211	do	65	do	20	15	do	do	Yes.
212	D. W. Thomas	55	do	30	24	do	do	No.
213		55	do	28	24	do	do	No.
214		40	Valley	12	7	do	Chain pump	No.
215		50	Plain	30	25	do	Pulley	No.
a216		65	do	36	30	do	do	No.
217	John Leone	60	do	33	28	do	do	No.
218	Pellet	55	do	30	28	do	do	No.
219	Sheppard	55	do	29	26	do	do	No.
221		15	Valley	13	10	do	do	No.
222	Potter	20	Plain	11	10	do	Chain pump	No.
223	G. A. Johnson	20	do	16	12	do	Pulley	No.

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
6	Joyce	200	Slope	50	Nolan	Till 25 feet, sandstone 25 feet.	Windmill	12
9	Doolittle	220	Flat	50	C. L. Wright	Chiefly sandstone.	Gasoline engine.	
24	George Stramper.	120	Slope	50		do	Hand pump	
30	Lincoln	120	Valley	65	C. L. Wright	Stratified drift and sandstone.	Windmill	(a)
35	Otis	80	Slope	42		Chiefly sandstone.	Hand pump	
43	Dix	150	Hill	85	L. Basset	Sandstone	do	
49	Ziolkowski	250	Valley	75		Stratified drift and sandstone.	do	
56	Kirk	340	Slope	79	C. L. Wright	Till 9 feet, sandstone 70 feet.	Windmill	4
69	Kennedy	80	Terrace	96	do	Stratified drift 30 feet, sandstone 66 feet.	Hand pump	10
75	Fred Brockett	80	do	42	Burton	Stratified drift and sandstone.	do	

a Large.

Records of wells and springs in Hamden—Continued

Drilled wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
77	Werley	180	Hill	44	C. L. Wright	Till and sandstone	Hand pump	
79	Flaherty	180	Slope		do.	Chiefly sandstone	do.	
80	Rinehardt	180	do.	40		do.	do.	
93	Todd	80	Valley	68	C. L. Wright	Till 3 feet, sandstone 65 feet.	Power pump	
96	C. Dietwiler	160	Slope	43	do.	Stratified drift and sandstone.	Hand pump	([b])
101	Davis	200	Hill	56	do.	Till and sandstone	do.	([b])
105	L. Warner	120	do.	85	do.	Chiefly sandstone	do.	
107	Nelson	140	do.	85		do.	do.	
110	John Tuttle	80	Valley	80	C. L. Wright	do.	do.	
115	Thompson	180	Hill	80	do.	do.	do.	
116	Dunbar School	180	do.	50	do.	Sandstone	do.	
117	Hansen	160	Slope	57	do.	Chiefly sandstone	do.	
126	N. Dorman	240	Ridge	30	do.	Till and sandstone	do.	
127	Gorem	240	Flat	92	do.	Chiefly sandstone	Gasoline engine.	
131	Baumgardner	285	Hill	90	do.	do.	Windmill	
134	E. Gorman	280	do.	75	L. Basset	Till 8 feet, sandstone 67 feet.	Gasoline engine.	
137	Ennis	70	Plain	100	do.	Stratified drift 30 feet, sandstone 70 feet.	do.	([a])
138	B. L. Dorman	60	do.	58		Stratified drift and sandstone.	Hand pump	
150	Gormley	120	Ridge	100	C. L. Wright	Chiefly sandstone	Gasoline engine.	([b])
164		90	Slope			do.	Hand pump	
165	Frederick Galt	120	do.			Sandstone	Gasoline engine.	
171	Shares	50	do.	119	C. L. Wright	Till and sandstone	Electric pump	
175	Filomine	40	do.		do.	do.	Hand pump	
176	Frederick McCarty.	20	do.	52	do.	Chiefly sandstone	do.	[c] 1
a178	George B. Price	15	Plain	120	Burton	Stratified drift 80 feet, sandstone 40 feet.	Windmill	
182	Burton	120	Hill	102	do.	Chiefly sandstone	do.	2
183	do.	120	do.	140	do.	Till 18 feet, sandstone 122 feet.	Windmill and gasoline engine.	3
184	Ives	120	do.	65	do.	Till 10 feet, sandstone 55 feet.	Windmill	8
185	Mrs. Street	120	do.	80	L. Basset	Chiefly sandstone	Hand pump	
195	Moulton	60	Plain	96	do.	Stratified drift and sandstone.	Electric pump	
198	C. W. Brock	60	do.	50		Stratified drift 35 feet, sandstone 15 feet.	do.	25
200	George Bernard	60	do.	75		Stratified drift and probably sandstone.	Hand pump	

Driven well

[d]204	Bischoff	60	Plain	38		Stratified drift	Windmill	

[a] Large. [b] Very small. [c] Flows. [d] Well is 1½ inches in diameter.

Records of wells and springs in Hamden—Continued

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
5	Joyce	280	Foot of hill		Hydraulic ram	
10	Warner	180	Ravine, side of valley.	Marshy seep from till	Sunken barrel; feeds hydraulic ram.	2–3
26		130	Foot of terrace	Stratified drift	Spring house over excavation.	
36	Everett	80	Ravine	Joints in sandstone	Spring house; hand pump to house.	
40	Montgomery	60	Valley	Apparently till; probably from bedrock below.	None	±10
51	Fingile (?)	410	Swamp	Till	3-foot tile sunk in ground.	
52		430	Near base of slope	do	Spring house over excavation; gravity pipe line.	±10
53		420	Foot of hill	Hillside marsh in till	Stone-walled pit, 3 feet deep; gravity pipe line.	
54	Hensen	360	Side of ravine	Till	Pit 3 feet deep; pipe to barrel.	5
64		240	Head of hillside ravine.	do	Pit 2 feet deep	
112	Alling	120	Ravine, foot of hill	Sandstone joints beneath thin till cover.	Spring house over large excavation.	5
113	R. H. Nesbit	170	Slope	Till and sandstone	Large excavation at hillside marsh.	
123		260	Foot of hill	Till or sandstone	Pit 2 feet deep; pipe to trough.	5–10
136	Hoffman	120	Hillside	Till and sandstone	Spring house over large excavation; gravity pipe line.	
167	North Hamden Brick Co.	10	Marsh	Thin sand layer over clay bed in stratified drift.	Barrel sunk in earth	1
220	Public road	60	Foot of hill	Sand over sandstone	Barrel sunk in sand	−1

NORTH HAVEN [35]

AREA, POPULATION, AND INDUSTRIES

North Haven was incorporated from New Haven in 1786. It occupies about 7 miles of the Quinnipiac Valley between New Haven and Wallingford. Its width is about 3 miles. The total area is 13,890 acres, or 21.8 square miles. The population in 1920 was 1,968. There are several small villages in the township. The principal industries are agriculture and brick manufacture. Market gardening is especially important in North Haven. Two divisions of the New York, New Haven & Hartford Railroad traverse the town from south to north. The principal stations are North Haven, Montowese, and Clintonville, all of which have post offices. Many of the inhabitants of North Haven work in New Haven, the village of Montowese, particularly, being more or less a suburb of New Haven.

TOPOGRAPHY AND DRAINAGE

The lower part of Quinnipiac River in North Haven is tidal, and the town reaches sea level. The highest altitude is 340 feet on Rabbit

[35] The collection of well data and the geologic mapping in North Haven were done by Mr. Harold T. Stearns, of Wesleyan University. His description of the geology and water supply has been copied as closely as was possible in conformity with the general arrangement adopted for town descriptions.

Rock, an isolated hill in the southeastern part of the town. In general North Haven is trough-shaped, the center of the trough being the Quinnipiac Valley, and its edges the narrow belts of upland that border this valley on the west and east. The Quinnipiac Valley is from 1 to 2 miles wide, the bordering uplands generally less than a mile wide. The prevailing slope of the surface is southward. Quinnipiac River is the principal stream and flows slightly west of south. It receives practically all the drainage of the town. Pine River, its largest tributary, has nearly the same trend throughout most of its course but turns abruptly westward near Montowese to join the Quinnipiac.

GEOLOGY

Bedrock.—Triassic sandstone is the bedrock under practically all of North Haven. Sandstone crops out in many places on the slopes of the upland bordering the Quinnipiac Valley, and at other places it is obscured by only a few inches of drift or residual soil. It is best exposed in road cuts.

Trap rock forms the nucleus of several ridges in the southeastern part of North Haven. The most prominent exposure is on Rabbit Rock, where the trap exhibits well-developed columnar joints.

Drift.—Till occurs mainly on the slopes and hills of the eastern and western uplands. Stratified drift occurs in the valley of Quinnipiac River and to a less extent in the valleys of Fivemile Brook and Pine River. The stratified drift covers more than half the town. In the southern part it rises only about 40 feet above sea level, but farther north it fills the valleys to approximately 100 feet above sea level. The till is probably not more than 30 feet thick at most places. The data in well records are unreliable regarding the depth of till and the presence or absence of sandstone in the wells. Stratified drift in the Quinnipiac Valley reaches a considerable thickness. The following table shows some of the greatest thicknesses of stratified drift recorded in wells. The dug wells are entirely in drift, and the total depth of the drift is therefore greater than the depth listed. The drilled wells penetrate drift and bedrock, and the depth given is the total depth of the drift above the rock.

Depth of stratified drift penetrated by wells in North Haven

Dug wells		Drilled wells	
No.	Depth (feet)	No.	Depth (feet)
26	32	27	40
191	37	28	69
------	-------	33	50
------	-------	39	50
------	-------	135	35

The data given above indicate that the depth of stratified drift at many places may be as much as 50 feet, and as the wells recorded are on the edges of the Quinnipiac Valley it is likely that in the center of the valley the maximum depth of the stratified drift is more than 100 feet.

WATER SUPPLY

The principal streets of Montowese and North Haven carry mains of the New Haven Water Co., but only a small part of the population living on those streets receives water from the mains. The others here and in the rest of the town depend on wells and springs. Records of 191 private supplies, including 128 dug wells, 41 drilled wells, 6 driven wells, and 16 springs, are given in the appended table.

Wells.—The dug wells of North Haven penetrate till, stratified drift, and bedrock. In till-covered areas they usually go to or into the underlying sandstone. The average depth of 124 dug wells is 18 feet, a little less than the general average for the region. The deepest dug well measured is on the C. W. Brockett place (No.191), 37 feet deep in stratified drift. Several others exceed 30 feet in depth.

Drilled wells are much more common in North Haven than in many other towns. They are used particularly in the uplands where the drift cover is thin, but there are several in the Quinnipiac Valley. The average depth of 40 wells is 82 feet. The average reported yield for 17 wells is 6 gallons a minute, the maximum 20 gallons. Well 177, belonging to S. Rogerio, illustrates a common error in the use of drilled wells. This well was sunk through a considerable thickness of stratified drift, which probably would have yielded an abundant supply of water. In the sandstone beneath it was necessary to drill 279 feet for a small supply of water. This well cost $1,000.69, whereas a dug well probably could have been made for $100. In some localities, however, where rock is near the surface, drilled wells are the only practicable source of supply.

Driven wells are uncommon in North Haven.

Springs.—Springs are common, especially in the eastern and western uplands, where they occur at the base of slopes in the sandstone ridges. About half of the 16 springs listed issue from bedrock fractures, and probably most derive a considerable part of their water from joints in rock. Springs so situated as to yield a gravity flow of water are much used in the western upland.

It is worth noting that flowing wells can often be obtained in the clay pits of the Quinnipiac Valley. The water escapes from sandy layers in or beneath the clay and is a serious hindrance to excavating operations.

Suggestions for development.—Large supplies of surface water are available in Quinnipiac River, Pine River, and Fivemile Brook but would not be suited for domestic use without purification. Ground water in almost unlimited quantity can be obtained from the stratified drift of Quinnipiac Valley, but there is at present no apparent need for its further development. Springs, particularly those of the type adapted for gravity installation, could be used at many more places, especially in the western upland where they occur high up on the sandstone slopes. Driven wells could be used more commonly in the stratified drift.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in North Haven

[Observations made Nov. 6 to 30, 1919, except wells 188, 190, and 191, which were examined July 5, 1919]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
6	Prokwyko	120	Slope			Till and sandstone	Hand pump	No.
9	C. Davis	100	do	18	10	do	Gasoline engine.	No.
13	Mills	120	do	15	5	do	Electric pump	No.
15	Donuth	55	Valley	14	10	Stratified drift	Pulley	No.
16	Oberlin	60	Terrace	26	22	do	do	No.
17		130	Hill	19	6	Till and probably sandstone.	do	
18	Palman	120	do	11	8	do	Electric pump	No.
19	Stiles	10	Valley	15	10	Stratified drift	Hand pump	No.
20	Van Durant	20	Terrace	21	15	do	do	No.
21	Babcock	20	do	10	6	do	do	No.
22	A. W. Roberts	20	do	17	11	do	Pulley	No.
23	Torredani	20	Valley	13	6	do	Chain pump	No.
24	Mastriani	20	Terrace	15	10	do	Pulley	No.
25	C. A. Basset	20	do	12	9	do		No.
26	Fisk	40	do	32	27	do	Pulley	No.
29	Cassari	20	do	12		do	Hand pump	No.
30	Malrotti	20	do	10	6	do	Pulley	No.
32	George Todd	40	do	20	15	do	Chain pump	(?).
35	Behrman	40	do	20	10	Stratified drift and sandstone.	Hand pump	No.
36	do	40	do	25	17	Stratified drift and sandstone (?).	do	Almost.
38	H. W. Morse	45	Slope	20	15	Stratified drift 15 feet, sandstone 5 feet.	Sweep	Almost.
40	Smith	20	do	17	8	Stratified drift and sandstone.	Pulley	No.
41	Frenchmead	20	Terrace	16	4	Stratified drift	do	
42	Coradiro	15	do	15	8	do	Chain pump	No.
43	Tuttle	20	do	17	10	Stratified drift 12 feet, sandstone 5 feet.	Hand windlass	No.
44	W. W. Rice	20	do	17	13	Stratified drift and sandstone.		No.
46	Ward	80	Slope	24	10	Till 14 feet, sandstone 10 feet.	Pulley	Yes.
48	Emerson	20	Terrace	11	7	Stratified drift and bedrock.	Chain pump	Yes.
49	Lynch	80	Slope	14	6	Till 8 feet, sandstone 6 feet.	Pulley	No.
50	W. J. Calkins	160	Hill	16?	8?	Till 5 feet, sandstone 11 feet.	Chain pump	Yes.
51	I. E. Mansfield	100	Slope	16	7	Till and probably sandstone.	Pulley	
52	do	100	do	15	6	Till 3 feet; sandstone 12 feet.	do	No
53	Thorner	220	Hill	17		Till and sandstone	Hand pump	No.

Records of wells and springs in North Haven—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
54	Thompson	240	Hill	25	15	Till and sandstone	Hand pump	
61	Chapman	60	Terrace	17	15	Stratified drift 15 feet, sandstone 2 feet.	do	
62	Prentice	60	do	18	11	Stratified drift and till.	Chain pump	No.
64	Stelson	80	Slope	21	14	Till	Hand pump	No.
65	Priest	90	do	14	8	do	do	No.
66	Annizzo	90	do	23	16	do	Pulley	No.
67	H. Smith	230	Hill	35	22	Starts in till	Hand pump	Rarely.
68	Gribus	200	do	16	6	Till	Pulley	No.
69	Louis Tuttle	120	do	12	3	Till and probably sandstone.	do	No.
70	P. Monohan	100	do	25	19	Till and sandstone	do	No.
72	Tuttle	20	Slope	6	2	do		No.
73	Gladell	60	Terrace	25	23	Stratified drift	Chain pump	Almost.
75	Hess	80	do	20	15	do	Pulley	No.
77	Glenn	60	do	6	2	do	do	No.
79	Wiley	60	do	24	20	do	do	No.
80	Lanzetti	60	do	14	10	do	do	No.
81	Bailey	60	do	14	9	do	do	No.
82	Secamp	60	do	11	8	do	do	No.
83	Willis	60	do	15	10	do	do	No.
84	Berginini	60	do	15	10	do	do	No.
86	J. Priest	50	do	11	10	do	do	No.
88	Ed. Senn	140	Slope	21	10	Till	Hand pump	No.
90	Steve Smith	160	Hill	15	7	do	Sweep	No.
94	W. Smith	80	Slope	12	7	Stratified drift 7 feet, sandstone 5 feet.	Chain pump	No.
95	W. W. Stevens	100	Terrace	34		Stratified drift and sandstone (?).	Hand windlass	No.
96	F. L. Clinton	90	do	22	20	Stratified drift and sandstone.	Pulley	No.
97	K. Basset	100	do	34	30	do	Hand windlass	No.
98	Henry Smith	100	do	23	20	Stratified drift 21 feet, sandstone 2 feet.	Hand pump	No.
100	W. E. Fowler	80	do	17	13	Stratified drift	Chain pump	Almost.
101	Nesbitt	100	do	20		Stratified drift and sandstone.	Hand pump	
103	Vibbert	140	Hill	22		Till 19 feet, trap 3 feet.	Chain pump	Yes.
104	do	140	do	17	10	Till	do	No.
105	Wilkinson	140	do	19	10	Till and sandstone	Hand pump	No.
106	New York, New Haven & Hartford Railroad	70	Slope	15	10	Till and probably sandstone.	Chain pump	(?).
107	Sexton	80	do	22	19	Till 6 feet, sandstone 16 feet.	Pulley	No.
108	U. Blakeslee	80	do	32	20	Till and sandstone	Gasoline engine.	No.
110	Richback	60	do	10	5	Till 6 feet, sandstone 4 feet.	Hand pump	No.
111	do	60	do	8	3	Till and sandstone	Chain pump	No.
113	Richards	40	Terrace	8	6	Stratified drift and sandstone.	Hand pump	No.
114	Redder	40	do	15	5	Stratified drift and till (?).	Chain pump	No.
115	Laden	40	do	8	3	Stratified drift	Hand pump	No.
116	Sheppard	40	do	10	7	do	Chain pump	No.
117	Sherman	50	do	27	24	do	Pulley	No.
119	Joe Rogers	75	do	25	23	do	Hand pump	Yes.
120	Hyde	90	Slope	15	9	Till and sandstone (?).	do	No.
124	Nesbitt	50	Valley	10	6	Stratified drift	do	Almost.
125	W. C. Birdsey	100	Slope	12		do	do	No.
126	Bradenini	100	do	19		Stratified drift and probably sandstone.	Chain pump	
127	do	100	do	24	16	do	Hand pump	
128	S. Bailey	100	do	14	9	do	do	No.
129	D. Cusano	160	Hill	25	15	Till	Pulley	Yes.
130	Loyd	100	Flat	23	19	Stratified drift	Hand pump	Almost.
131	Isaacs	100	do	20	14	Till	Pulley	No.

Records of wells and springs in North Haven—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth of water (feet)	Kind of rock	Equipment	Does well fail?
134	Larkins	20	Terrace	21	8	Stratified drift 8 feet, sandstone 13 feet.	Chain pump	No.
136	Guthrod	40	do	14	11	Stratified drift		No.
138	Frost	45	do	11	6	do	Chain pump	No.
139	Wenzel	40	do	21	11	do	Pulley	Rarely.
140	Frost	50	do	17	11	Stratified drift and sandstone.	do	Yes.
141	do	40	do	14	8	Stratified drift	do	No.
142		40	do	14	9	do	do	
143	Culver	40	Flat	16	6	do	do	
145	C. Dagastini	40	Slope	15	6	do	do	No.
146	N. Robinson	20	Terrace	15	9	do	do	
147	Shea	40	do	13	8	do	do	No.
148	Eaton	30	do	20	14	do	do	No.
149	Brockett	20	do	11	4	do	Chain pump	No.
150	H. W. Robinson	30	do	22	16	do	Hand windlass	No.
151	Zuber	20	do	16	13	do	do	
152	G. H. Cooper	40	do	26	21	do	do	No.
153	H. C. Jones	40	do	25	21	do	Pulley	No.
154		40	do	26	20	do	do	
155	A. Mansfield	20	do	15	13	do	do	
156	Palmer	20	do	20	17	do	do	No.
157	L. A. Brockett	25	do	20	17	do	Hand pump	No.
159	N. Daddio	10	Flat	11	6	do	do	No.
161	Payne	20	Terrace	12	6	do	do	No.
162	A. I. Larkins	50	do	27	19	do	Pulley	No.
163	Combatson	40	do	10	8	do	Hand pump	No.
164	Judd	40	do	20	6	do	do	
165	do	20	do	15	9	Stratified drift and sandstone.	do	No.
169	Marks	40	Slope	24	14	Stratified drift and probably sandstone.	Pulley	No.
170	E. L. Ball	60	do	20	10	Till 10 feet, sandstone 10 feet.	Hand windlass	Yes.
171	do	55	do	16	2	Till 6 feet, sandstone 10 feet.	Pulley	No.
172	Crepe	40	Valley	11	9	Stratified drift	do	Yes.
174	Dutton	40	Slope	20	18	Stratified drift and probably sandstone.	Hand windlass	
175	Hollenberg	40	Terrace	25	21	Stratified drift	Hand pump	No.
179	George Barnes	110	Flat	34	24	Stratified drift and probably sandstone.	Gasoline engine.	No.
180	Perry	130	Slope	40	36	Till and sandstone (?).		
183	Dwyer	60	do	21	14	Till 16 feet, sandstone 5 feet.	Pulley	Yes.
185	Hockowitz	60	Terrace	14	10	Stratified drift	Chain pump	No.
186	Wm. Brockett	50	Slope	35?	30?	Stratified drift and sandstone (?).	Hand pump	Rarely.
187	Kopf	50	Terrace	11	6	Stratified drift	Chain pump	Almost.
188	Gerbig	130	Slope	21	17	Chiefly sandstone	Pulley	No.
190	Brockett	120	Flat	24	17	Stratified drift	Hand windlass	No.
191	do	120	do	37	22	do	do	No.

Driven wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Diameter (inches)	Kind of rock	Equipment
31	Malvolti	20	Terrace	12	1½	Stratified drift	Hand pump.
74	Joe Berdaro	60	do	27	1½	do	Do.
76	G. E. Cooper	60	do	30	1½	do	Do.
78	Wiley	60	do	15	1½	do	Do.
87	Wheeler	40	do	17	1½	do	Do.
99	Herbert Smith	80	do	20		do	Do.

Records of wells and springs in North Haven—Continued

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
4	Oscar Smith	110	Slope	40	Wright	Till 11 feet, sandstone 29 feet.	Hand pump	3
5	Goodsell	210	do	37	do	Till 6 feet, sandstone 31 feet.	do	
7	R. E. Dickerman	100	do	35	Burton	Till 3 feet, sandstone 32 feet.	do	
8	Nielson	100	do	35	Wright	Till 5 feet, sandstone 30 feet.	do	
10	Sanso	120	Hill	138	do	Chiefly sandstone	do	5
11	Skow	120	do	130	do	do	do	1½
12	do	120	do	52	do	do	do	1½
14	L. V. Tuttle	68	do	140	do	Till 18 feet, sandstone 22 feet.	Electric pump	
[a]27	E. Gotligliam	40	Terrace	89	do	Stratified drift 40 feet, sandstone 49 feet.	Hand pump	1
28	Maggart	20	do	84	do	Stratified drift 69 feet, sandstone 15 feet.	Hand windlass	
33	Ambro	40	do	55	do	Stratified drift 50 feet, sandstone 5 feet.	Hand pump	10
34	Nelson	20	do	74?	do	Stratified drift and sandstone.	do	
39	H. W. Morse	40	Slope	55	do	Stratified drift 50 feet, sandstone 5 feet.	do	
45	Gavette	45	do	42	do	Stratified drift 5 feet, sandstone 37 feet.	do	
55	Benson	60	do	53	do	Stratified drift 15 feet, sandstone 38 feet.	do	5
56	Miron	40	Terrace	75?	do	Stratified drift 20 feet (?), sandstone 55 feet (?).	do	
58	L. B. Wooding	70	Slope	126	do	Sandstone	do	4
59	do	70	Terrace	35	do	Stratified drift 7 feet, sandstone 28 feet.	do	20
63	Loyd	100	Slope			Till and sandstone	do	
89	S. Smith	160	Hill	150	Wright	do	Gasoline engine	
[b]91	Wm. Smith	140	do	110	do	do	Hand pump	
92	Ivan Boyce	100	Terrace	60	do	do	do	
93	D. L. Clinton	80	Valley	39	do	Stratified drift and sandstone.	do	
109	Fowler	80	Slope	36	do	Till 5 feet, sandstone 31 feet.	do	
118	Emma Potter	80	do	71	do	Stratified drift 15 feet, sandstone 56 feet.	do	
121	Roarke	100	Hill	63	do	Till 5 feet, sandstone 58 feet.		
122	Wm. Hull	100	Slope	166	do	Till 5 feet, sandstone 161 feet.	Hand pump	6
123	do	80	do	42	do	Chiefly sandstone	do	2
135		40	Terrace	40	L. Basset	Stratified drift 35 feet, sandstone 5 feet.	do	
137	Frost	50	do	42	do	Stratified drift 8 feet, sandstone 34 feet.	do	3½
[c]144	Scherb	40	do	93	do	Stratified drift 10 feet, sandstone 83 feet.	do	
166	Mrs. Burns	55	Slope	75		Till and sandstone		
167	Neal	80	do	100	Wright	Till 5 feet, sandstone 95 feet.	Hand pump	6
168	A. L. Chamberlain.	60	do	114		Till 4 feet, sandstone 110 feet.	Gasoline engine	7–10
173	Nutile	60	do	85		Stratified drift and sandstone.		6
177	J. Rogerio	40	Terrace	279	L. Basset	Stratified drift 60 feet (?), sandstone 219 feet (?).	Hand pump	4–5

[a] Cost $155.59. [b] Cost $300. [c] Cost $235.

Records of wells and springs in North Haven—Continued

Drilled wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
178	H. H. Robinson	90	Slope	115	L. Basset	Stratified drift 26 feet, sandstone 89 feet.	Gasoline engine	14
181	E. P. Hull	120	Flat	32	Wright	Stratified drift and sandstone.	Hand pump	
182	E. Smith	100	Slope	45	do	Stratified drift 20 feet, sandstone 25 feet.	Gasoline engine	
184	Adinelfy	60	Terrace	73	do	Stratified drift and sandstone.	Hand pump	
189	Brockett	120	Flat	150?		do	Windmill	

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
1	E. R. Brockett	80	Ravine	Sandstone	Concrete-lined excavation; windmill.	
2	Nebofsky	220	Slope	do	Spring house	
3	Goodsell	140	do	do	Tile sunk in earth; hydraulic ram.	
37	Behrman	50	do	do	Sunken tile; gravity pipe line.	20
47	Bernano	20	Ravine, foot of terrace.	Stratified drift	Bricked excavation and spring house.	
57	Bucki	40	do	Contact of stratified drift and sandstone.	Hand pump from spring house.	10
60	Anoway	80	Slope	Contact of till and stratified drift.	Shed over sunken tile	3-4
71	Tuttle	40	do	Sandstone	Concrete-lined excavation.	
85		60	Terrace	Stratified drift	Spring house	
102		120	Ridge	Contact of sandstone and trap dike.	Covered tile	8-10
112	Patten	70	Slope	Contact of sandstone and till.	Spring house; gravity pipe line to 3 houses.	
132	John Smith	70	do	Sandstone		
133	Kapp	80	do	do	Spring house	
158	L. A. Brockett	20	Base of slope	Stratified drift		
160	Judd	20	Terrace	do	Sunken tile	
176	Olsen	40	do	do	Spring house	

NORTH BRANFORD

AREA, POPULATION, AND INDUSTRIES

North Branford is bordered by Branford on the south, Guilford on the east, Wallingford on the north, and North Haven and East Haven on the west. It was separated from Branford in 1831. The town has a width of about 4 miles from east to west and an average length of about 6 miles. Its area is 16,498 acres, or 25.8 square miles. Its population in 1920 was 1,110. The largest settlements in the town are North Branford and Northford. Northford is the only post office. The chief industry is agriculture, but quarrying has lately become of considerable importance. The only railway in the town is the Branford Steam Railway, which serves the quarry of the New Haven Trap Rock Co.

TOPOGRAPHY AND DRAINAGE

The lowest part of North Branford is in the Farm River valley at the southwest corner of the town where it is less than 40 feet above sea level. Several valleys at the southern and western borders are less than 100 feet above sea level, but most of the town is above that altitude. The highest point is 600 feet above sea level on Totoket Mountain, in the northern part of the town. The average relief is 100 to 200 feet, but in the vicinity of Totoket Mountain it is at places 400 feet. Totoket Mountain is the dominating feature of the topography and extends as a high curving ridge throughout the length of the town. Its western slope is precipitous, but the eastern slope is more gentle. Parallel to the mountain at its western base is the valley of Farm River. Farm River and Branford River, which carry most of the drainage of the town, flow south and southwest.

GEOLOGY

Bedrock.—The southeast corner of North Branford is underlain by pre-Triassic crystalline rock known as the Middletown gneiss.

Most of the town is underlain by Triassic sandstone and trap rock. Trap rock forms the backbone of Totoket Mountain and of its sister, Saltonstall Ridge, part of which lies along the southern border of North Branford.

Drift.—Till forms the surface of about three-fourths of North Branford and stratified drift about one-fourth. The till covers most of the slopes and hills—nearly all the land over 100 feet above sea level, except in the northern part of the Farm River valley, where the till does not descend much below 200 feet above sea level. The principal body of stratified drift in North Branford is in the Farm River valley, where it forms a belt at places nearly a mile wide; there is a narrow band of it along Branford River, a small body near Clintonville in the northwestern part of the town, and a few small patches elsewhere.

The thickness of the drift ranges from a few inches to 45 feet or more. The maximum thickness of till at most places is probably 50 feet, and the maximum of stratified drift is perhaps about 75 feet. The deepest dug well (No. 140) penetrates 45 feet of till; well 135 penetrates 36 feet of till. The deepest well reported in stratified drift is No. 47, which is 43 feet deep. Several other wells penetrate 30 feet or more of stratified drift; all of them are near Farm River, where the greatest body of stratified drift in the town is found.

WATER SUPPLY

The only industrial concern in North Branford that uses much water is the New Haven Trap Rock Co. The company formerly used a well near the quarry but now has a pumping plant at Twin Lakes.

The entire population of North Branford depends for water on wells and springs. Of these supplies 165 were examined, including 126 dug wells, 12 drilled wells, 6 driven wells, and 21 springs.

Wells.—Dug wells in drift are the prevailing source of supply. The average depth of 125 dug wells is 21 feet, which is rather high in comparison with the average in other towns of the area. The deepest dug well in the town is that on the Chivsey place (No. 140), 45 feet deep. Analyses of samples of water from two dug wells in North Branford (Nos. 134 and 135) are given on page 36. The waters represented are moderate in mineral content and rather hard and will form considerable scale in boilers.

Most of the few drilled wells in North Branford are in the hills west of Northford, where sandstone is near the surface. The average depth of 9 drilled wells is 63 feet. One large yield of 50 gallons a minute is reported. One drilled well fails. Driven wells are even scarcer than drilled wells. A few are in use on the stratified drift terraces near Totoket. Wells of this type could be utilized much more than at present. Analyses of samples of water from two drilled wells in North Branford (Nos. 162 and 163) are given on page 36. The waters represented are moderately low in mineral content and hardness and are satisfactory for most purposes.

The depth of the water table in North Branford, from an average of 120 measurements is 14 feet. The average for 49 wells in stratified drift is 17 feet. The difference is due to the fact that most of the wells in stratified drift are dug down from the terrace levels and must penetrate practically to the adjacent stream level to get water. This relation of the water table to the controlling stream level is well exhibited in the Farm River valley. (See p. 21 and fig. 4, *C*.)

Springs.—Springs are used in North Branford more than in most of the other towns and are especially common on both sides of Totoket Mountain near its base. The yields that can be estimated are large, probably averaging from 5 to 10 gallons a minute. At least 7 of the 21 springs clearly issue from rock fractures. Nine are evidently seeps in till. The rest are of more obscure origin. An analysis of a sample of water from the spring of W. F. Hyland (No. 78) is given on page 36. This water is moderately low in mineral content and rather hard.

Suggestions for development.—Much ground water could be recovered from the stratified drift of the Farm River valley, and a considerable amount also along Branford River. Location for driven wells should be chosen so that the lift will not exceed ordinary pump suction.

For ordinary domestic needs dug wells are generally satisfactory. Many more springs and wells adapted to gravity installations could be used to advantage. The village of North Branford would be greatly benefited by a public supply, which probably could be obtained best from the streams or lakes immediately north of the town.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in North Branford

[Observations made Nov. 3 to 8, 1919]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
1	John Carlson	120	Terrace	18	11	Stratified drift and sandstone.	Gasoline engine.	No.
2	Plumley	110	Valley	11	8	do	Chain pump	No.
4	A. L. Stiles & Son.	160	Hill	22	14	Till and sandstone	do	No.
5	Haussman	260	do	25	14	Till	do	No.
8	Charles Ferguson	280	do	22	11	Till and probably sandstone.	do	No.
9	Wellman	300	do	19	8	Till	Hand windlass	No.
10		300	do	19	8	do	Pulley	(?).
11	F. Chicarelli	300	do	29	15	Till and probably rock.	do	No.
12	Bronson	200	Valley	18	11	Stratified drift	do	No.
14	Lindsley	200	Slope	20	10	Till and sandstone	do	No.
15		210	Valley	15	3	Till	Chain pump	No.
16	Beets	200	Terrace	32	24	Stratified drift	Pulley	No.
17		230	Slope	19	13	Till and sandstone	None	(?).
18	Burnham	230	do	21	12	do	Pulley	No.
19	S. Alfano	260	do	14	6	Till (?)	do	(?).
20	Durant Farms	280	Terrace	22	15	Stratified drift	Chain pump	No.
21	J. Bianchi	240	Slope	14	10	do	do	(?).
22	Bonnie Brook Farm.	230	Terrace	29	17	do	Pulley	No.
23	Bergen	220	do	23	18	Stratified drift and sandstone.	Chain pump	No.
24	Famisano (?)	200	do	30?	20?	Stratified drift	Hand pump	No.
27	Henry Davis	190	do	26	22	do	Pulley	No.
28	Barnett	180	Valley	19	16	do	Chain pump	No.
30	Fairbanks	190	Slope	9?		Sandstone	do	No.
31	Smith	175	do	15?	12?	Stratified drift and probably rock.	Hand pump	No.
33	Keenan	160	do	20	8	Till and sandstone	Pulley	Yes.
35	M. E. Wright	240	Hill	17	6	Chiefly sandstone	do	Yes.
36	Bartholomew	180	Terrace	28	19	Stratified drift	do	No.
37	Episcopal Church	160	do	21	15	do	do	No.
38	C. S. Johnson	160	do	18	15	do	do	No.
40	C. H. Ives	230	Slope	6		Till	Gravity pipe line.	No.
42	Fanning	100	Valley	18	15	Stratified drift	Pulley	No.
43	Munson	100	do	15	10	do	Chain pump	No.
44	Mrs. Lindsley	100	do	20	15	do	Pulley	No.
45	Rogers	100	do	16	10	do	do	No.
47		185	Terrace	43	41	do	None	No.
48		170	do	37	31	do	Pulley	No.
49	Vincenzo	160	do	24	20	do	do	No.
50	Richetelli	170	do	36	33	do	Hand pump	No.
51		160	do	24	18	do	Chain pump	No.
52	Cerrone	140	do	13	8	do	Hand bucket	No.
53	J. J. Lund	160	do	38	32	do	Pulley	No.
55	George Bunnel	140	do	17	11	Stratified drift and rock.	Hand windlass	No.
56	I. Bunnel	140	do	25	22	Stratified drift	Pulley	Rarely.
60	Thursman (?)	130	do	37	33	Stratified drift and rock.	do	No.
61	George Harder	120	do	24	21	Stratified drift	do	Yes.
62	Reynolds	120	do	23	17	do	do	No.
63	Butes	120	do	33	20	Stratified drift and sandstone.	do	No.
64		160	Slope	20	15	Till and trap rock	do	Yes.

Records of wells and springs in North Branford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
65	L. Belbutsy	140	Slope	22	5	Till and trap rock	Pulley	No.
66	Hansen	150	Bench	29	6	Till	Hand pump	Almost.
70	Spezzano	90	Terrace	20	15	Stratified drift and rock.	Pulley	Rarely.
71	Ulatowski	100	do	24	20	Stratified drift	Hand pump	No.
72		80	Valley	15	11	Stratified drift and probably trap rock.	Pulley	No.
73	E. E. Robinson	100	Terrace	25	20	Stratified drift	Hand bucket	No.
74	C. E. Page	110	do	29	26	do	Gasoline engine.	Yes.
75	do	140	Slope	16		Till and sandstone	Hand pump	No.
76	Field	160	Hill	8?		Chiefly sandstone	Gravity pipe line.	No.
77	F. L. Wedmore	120	Slope	20	10	Till and sandstone	Hand pump	Rarely.
83		160	Hill	27	10	Till	None	No.
84	Barker	190	Flat	10	4	Till and rock	Hand windlass	No.
85	Ottlick	240	Hill	32?	22?	Till	Hand pump	No.
86	Frank Stone	220	Slope	13	4	do	Pulley	No.
87	Klahner	140	Hill	28	13	Till and sandstone	do	No.
89	Cole	180	do	23	19	do	None	Yes
90	John Jackson	101	Valley	11	1	Till	Hand pump	No.
91	Reed	150	Slope	28	16	Till and sandstone	Pulley	No.
92	Gilbert	170	do	16	8	Till	Chain pump	Rarely.
94	J. R. Harrison	230	Hill	43	20	Till 31 feet, sandstone 12 feet.	Gasoline engine.	Rarely.
96	do	200	Slope	24	12	Till	Pulley	No.
97	do	160	Valley	20	14	Till and sandstone	Chain pump	Yes.
98	Griswold	160	Slope	30	17	Till	Hand bucket	Yes.
100	C. G. Lowe	180	do	22	12	Till and probably sandstone.	Hand pump	No.
101	Hasse	150	do	18	10	Till	do	No.
102	Jacob Machs	140	Valley	16	11	Stratified drift	Chain pump	No.
103	Prokupeck	140	do	19	13	do	do	No.
104	N. H. Snow	300	Hill	21	8	Till	Hand pump	Yes.
105	Glover	120	Valley	12	10	Stratified drift	Pulley	No.
106	Cummings	140	Terrace	29	26	do	do	No.
107	Baydrop	120	Valley	12	10	do	do	No.
109	Torelli	140	Slope	28	20	Till	Hand windlass	No.
110	P. Maturo	140	do	29	23	Stratified drift	Pulley	No.
112	Nelligan	150	do	18	5	Till and sandstone	Hand pump	No.
114	Appelle	110	Hill	19	15	Till	Pulley	No.
115	Mrs. Wigg	110	Terrace	21	18	Stratified drift	do	No.
116	Webster	100	Valley	11	8	do	Hand pump	No.
117	Fowler	120	Slope	15	11	Till and sandstone	do	No.
118	Platt	120	Bench	26	18	do	Pulley	Yes.
119	Holabird	100	Valley	18	15	Stratified drift		No.
120	Mrs. Goodbody	100	Terrace	20	15	do	Hand pump	No.
121	Miller	100	do	20	17	do	Pulley	No.
122	Beers	100	do	18	15	do	Hand windlass	No.
123	Foote	100	do	18	14	do	Hand pump	No.
125	Lyon	120	Slope	21	12	Till (?)	do	No.
126	Lober	90	Valley	14	11	Stratified drift	Chain pump	No.
127	Grovner	100	do	17	5	Till	Pulley	No.
128		90	Terrace	16	10	Stratified drift	Hand bucket	No.
129	Gedney	200	Valley	11	2	Till	Gravity pipe line.	No.
130	do	130	Slope	21	11	Till 15 feet, trap 6 feet.	Pulley	Yes.
131	G. W. Baldwin	140	do	23	14	Till and bedrock	do	No.
132	F. H. Miller	130	do	15	5	do	Hand pump	No.
133	Thompson	100	do	19	11	Till	Pulley	No.
134	Todd	120	Hill	34	13	do	Hand pump	No.
135	F. Gilbert	130	do	36	18	do	Pulley	No.
136	Hill	135	do	27	16	Till and probably rock.	do	No.
137	do	140	do	22	11	Till	do	No.
138	Blair	140	do	21	10	do	do	No.
139	Weber	155	do	28	16	do	do	No.
140	Chivsey	165	do	45	38	do	do	No.
141		140	do	25	8	do	Hand pump	(?).
142	Rowe	100	do	30	10	do	Chain pump	No.
144	J. L. Harrison	100	Valley	18	13	Stratified drift	Pulley	No.

Records of wells and springs in North Branford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
145	Geo. Foote	110	Hill	29	21	Till 2 feet, bedrock 27 feet.	Pulley	Yes.
146		80	Valley	15	12	Stratified drift	Chain pump	No.
148	Ignatowski	140	Hill	26	20	Till	Pulley	No.
149	J. Nacowski	120	do	15	11	do	Hand pump	No.
150		150	do	12	5	do	Pulley	No.
[a]151	New Haven Trap Rock Co.	160	Slope	14		Till and sandstone	Electric pump	No.
152	Snyder	150	Bench	14	11	do	Hand pump	Yes.
153	New Haven Trap Rock Co.	140	Valley	12	5	Till	do	No.
154	Fred Dudley	120	Flat	13	8	do	do	No.
155	Schapiro	110	do	15	12	Stratified drift	do	No.
156	Duddy	110	do	17	13	do	Pulley	No.
157	L. R. Lindsley	105	do	22	17	do	do	No.
158	Hall	110	do	21	17	do	do	No.
159	Deutsch (?)	110	do	33	30	do	Hand pump	No.
165	Marquard	150	Slope	28	20	Till 22 feet, sandstone 6 feet.	Pulley	Yes.

Driven wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Diameter (inches)	Kind of rock	Equipment	Does well fail?
26	Lindsley	180	Valley	12	1¼	Stratified drift	Hand pump	No.
68	A. R. Cannon	110	do	17	1½	do	do	No.
160	Belek	80	do	15–20	1½	do	do	No.
161	Doolittle	80	do	15	1½	do	do	No.
162	J. C. Moore	100	Terrace	30	1½	do	do	No.
163	Reynolds	100	do	32½	1½	do	do	No.

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
3	A. L. Stiles	160	Hill	93	C. L. Wright	Till 28 feet, sandstone 65 feet.		50
6	Anderson	260	do	75	do	Sandstone	Hand pump	
[b]13	Lindsley	250	do		do	Chiefly sandstone	Windmill	
25	M. J. Auger	190	Terrace	55	do	Stratified drift and rock.	Hand pump	
32	Frank Davis	210	Slope	60	do	Sandstone		
34	Congregational Church.	200	do		do	Chiefly sandstone	Hand pump	Fails.
41	C. W. Brock	140	do	99	L. Basset	Till and sandstone	Gasoline engine.	
54	Fourth District School.	160	Terrace			Stratified drift and probably sandstone.	Hand pump	
57	Folkman	160	Slope	50		Probably trap rock	do	
59	George Auger	140	Terrace	50	C. L. Wright	Stratified drift 25 feet, trap 25 feet.	do	
111	Addie Rose	100	do	45		Stratified drift (quicksand).	do	
124	Stevens	100	do	40		Stratified drift	Gasoline engine.	

[a] Yield reported 4 gallons a minute.

[b] Said to have yielded at first a slight flow at surface.

Records of wells and springs in North Branford—Continued

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
7	Dewitt Maltby	260	Ravine	Crevices in sandstone	Spring house over pit 4 feet deep; gravity pipe line.	------
29	Maltby	220	Hillside	do	Gravity pipe line from pit 3 feet deep.	2-3
39	D. Seibold	220	do	Seep from till	Gravity pipe line from two pits 15 feet and 8 feet deep.	------
46	Public road	160	Road gutter on slope.	Till	Pit 7 feet deep; gravity pipe line to horse trough.	------
58	Geo. Auger	140	Base of hill	Probably till, or till and bedrock contact.	None	5-10
67	Gates	140	Base of steep hill	Probably from sandstone crevices but "boils up" through stratified drift.	Gravity pipe line from pit 3 feet in diameter.	10
69	Smith	130	Hillside ravine	Till	Gravity pipe line from open pit.	5-6
78	Hyland	130	Base of hill	Sandstone fractures; may be fed from trap ridge.	Spring house over shallow excavation.	------
79	Aaron Johnson	300	Hillside	Till and trap rock contact.	Gravity pipe line from pit 3 feet deep.	------
80	John Aaronson	150	do	Fractured trap rock	Excavation in bare trap rock slope.	[a] 2-3
81	Frank Scheppy	120	Valley, base of hill	Marshy seep in till	Spring house over shallow pit 6 by 8 feet.	10
82	A. Seltman	150	Slope	Sandstone joints	Spring house over shallow pit.	5-6
88	Cole	120	Base of steep hill	Sandstone at upper limit of till fill in valley.	Open reservoirs feed hydraulic ram.	------
93	J. R. Harrison	140	do	Sandstone at edge of marshy valley.	do	10-20
95	N. Harrison	200	Slope, beside ravine.	Till	Stoned pit feeds hydraulic ram.	------
99	C. C. Lowe	150	Base of hill at edge of swampy valley.	Sandstone	Stone-lined covered pit.	------
108	------	120	Base of hill	Probably from sandstone below stratified drift; "boils."	Shallow pit feeds hydraulic ram.	------
113	Rose	140	Hillside	Till	Barrel sunk in till; feeds gravity pipe line.	------
143	Public road	60	Foot of hill	Probably till	Stone house over buried barrel.	------
147	Lindsley	120	Valley	Marshy seep in till	Gravity pipe line from excavation.	------
164	Williams	130	Ravine on slope	Till	Gravity pipe line from pit 3 feet deep.	------

[a] Fails rarely.

WALLINGFORD

AREA, POPULATION, AND INDUSTRIES

Wallingford was settled in 1670 by colonists from New Haven. The town has an irregular polygonal outline and is from 5 to 7 miles across. Its area is 23,933 acres, or 37.4 square miles. Seven towns adjoin Wallingford, but in general North Haven and North Branford lie on the south, Durham on the east, Meriden on the north, and Cheshire on the west. The principal settlement is the Borough of

Wallingford, near the geographic center of the town. In 1920 the population of the town was 12,010. Two lines of the New York, New Haven & Hartford Railroad pass through Wallingford, the main one passing through the borough, which is an important manufacturing center, its special product being silverware and silver plate. In addition there are brass works and a wire factory. Yalesville and Tracy are small manufacturing villages in the northern part of Wallingford. At Reed Gap, in the extreme eastern part of the town, there are large trap-rock quarries. Agriculture is the chief industry of the rural sections.

TOPOGRAPHY AND DRAINAGE

Topographically there are three distinct regions in the town of Wallingford—the Quinnipiac Valley, a strip 1 to 2 miles wide that runs from north to south across the town and lies at an altitude of 20 to 100 feet above sea level; a western upland about 2 miles wide, which lies at an altitude of 200 to 300 feet; an eastern upland about 4 miles wide, most of which is 200 to 500 feet above sea level. Along the eastern boundary of the town is a long ridge 500 to 800 feet in altitude. The extremes of altitude are 20 feet above sea level, at Quinnipiac, on Quinnipiac River, and 800 feet, on Beseck Mountain, in the northeast corner of the town. The relief varies greatly in the different parts of the town, but averages from 100 to 200 feet in the eastern and western uplands. The surface is deeply dissected, but the topography is not rugged except near the eastern and southeastern borders, where steep cliffs and hills are common. Quinnipiac River is the largest stream and drains about half the area of the town. Pine River, in the eastern part of the town, drains about one-third of the total area. Both streams flow slightly west of south.

GEOLOGY

Bedrock.—The bedrock throughout practically the entire town is Triassic sandstone. Dikes of trap rock cut the sandstone at a few places west of Quinnipiac River, but they are generally small and not very prominent. Trap rock forms the high, bold ridges in the eastern part of the town.

Drift.—Till is found over most of both the eastern and western uplands of Wallingford. It makes fair agricultural land, and large areas of it are cultivated, even though it is usually very thin and sandstone may be present only a foot or two beneath the surface. The thickness of the till appears to be greatest in the northwest corner of the town, where 25 to 30 feet is recorded in several wells (Nos. 3, 100, and 107).

Stratified drift covers about 30 per cent of Wallingford. It occurs mainly in a belt 1 to 2 miles wide along the Quinnipiac Valley, but there are smaller bodies along Pine River and in other small valleys in the eastern upland. The level of drift filling in the Quinnipiac Valley in southern Wallingford is about 60 feet above sea level, and at the northern edge of the town about 100 feet. In the eastern upland the deposits occur in irregular patches along stream courses, and at Reed Gap there is a considerable body at an altitude of 300 feet. The thickness of stratified drift is variable, but in Quinnipiac Valley it probably exceeds 50 feet over considerable areas and may exceed 100 feet at some places. A drilled well at the Judd Brass Works penetrated at least 60 feet of stratified drift. Several dug wells penetrate 40 feet or more of it. A drilled well 80 feet deep entirely in sand (stratified drift) is reported at Reed Gap (No. 64). In Yalesville several wells only 15 or 20 feet deep reach sandstone, although the smooth topography of the stratified drift would not suggest the presence of bedrock so near the surface.

WATER SUPPLY

The Borough of Wallingford is provided with a municipal water supply whose sources are Lanes Pond and Pistapaug Pond, in the northeastern and eastern part of the town. The capacity of Lanes Pond is 35,000,000 gallons[36] and of Pistapaug Pond 1,150,000,000 gallons. Pistapaug Pond is 335 feet above sea level, and this altitude makes it possible to distribute the water directly by gravity, without pumping. The pressure ranges from 95 to 140 pounds to the square inch. No purification is attempted. The average daily consumption is reported as 1,250,000 gallons. The water rate is 20 cents a thousand gallons. This supply has been available for a long time, and as a result wells are very uncommon in the borough. The villages of Yalesville and Tracy and all the farming section depend on wells and springs.

Records of 229 private water supplies are given in the table appended to this description. They include 182 dug wells, 22 drilled wells, 5 driven wells, and 20 springs. (See pl. 5.) Fifty-five of these records were collected by E. C. Miller, of Yale University, in 1907, and some of the wells they represent are now abandoned, although it has not been possible to designate all the abandoned ones in the tables, as not all of these wells were reexamined.

Wells.—Dug wells are the rule in the drift, and many of these penetrate the underlying sandstone. About 75 wells are dug entirely or chiefly in stratified drift. About 89, or nearly half the total number of dug wells, penetrate to or into rock. Wells in till with sandstone beneath are likely to fail, and at many places a drilled well is made in the bottom of the dug well to insure a permanent supply. The average depth of 176 dug wells is 23 feet, a high average

[36] The data are from the McGraw-Hill Waterworks directory, 1915.

for the region. (See table.) The deepest dug well, No. 145, is 45 feet deep. There are several wells more than 40 feet deep.

The average depth to the water table, 16 feet, is unusually great. This is due partly to the large number of dug wells located on the high terrace levels of Quinnipiac Valley, where, as already noted, the water table is low, and partly to the unusual depth to water in bedrock. (See p. 33.)

Drilled wells are used mainly in the till-covered areas where the drift is too thin to permit an adequate supply of water to be obtained from a dug well. Most of them are in the eastern part of the town. The only reported yield is 7 gallons a minute. The average depth of 17 drilled wells is 70 feet. An analysis of a sample of water from the 59-foot drilled well of E. M. Addis (No. 81) is given on page 36. The water is moderately low in mineral content and hardness and is satisfactory for most purposes.

Driven wells in Wallingford are rare, although they could be used more in the stratified drift. However, the depth to water in much of the Quinnipiac Valley is greater than the suction lift of the ordinary pump, and driven wells there would be unsatisfactory without special pumping apparatus. An analysis of a sample of water from the 30-foot driven well of Mr. Hough (No. 45) is given on page 36. The water is moderately low in mineral content and hardness and is satisfactory for most purposes.

Springs.—The 20 springs of Wallingford occur at the heads of ravines, in depressions on slopes, at the base of hills, or along terrace bluffs. About 8 appear to be fed by seepage in till, and 3 or 4 from joints in sandstone. At least 3 emerge on terrace bluffs under circumstances that suggest the presence of an underlying clay bed in the stratified drift as their controlling cause. Most of the yields are not large, although one spring (No. 61) is reported to have been pumped intermittently at a rate of 600 gallons a minute. It receives seepage from a considerable marshy area, and the artificial receiving basin is large enough to equalize the supply for some time.

Ground water for industrial use.—Most of the factories in the Borough of Wallingford use water from the public supply or from ponds in streams located on their premises. The plants situated near the Quinnipiac generally use river water for boilers and for most other purposes except drinking. Five plants pump water from wells for industrial uses. They are shown on Plate 5, where the numbers are prefixed by P, and are described below.

1. The Jennings & Griffin Manufacturing Co. at Tracy has two wells, the better one being a dug well about 30 feet deep and 2½ feet in diameter, which penetrates drift and sandstone on the slope at the east edge of Quinnipiac Valley. The well normally contains 8 or 9 feet of water. It is pumped by an electric pump at a rate of 9,000 to 10,000 gallons in 10 hours. When the well is pumped at this rate, according to a test conducted by the company, the water falls about 2 or 2½ feet in the first hour and then maintains its level. It will rise about 1 to 1½ feet during the first hour after pumping ceases. The water is used for most of the factory drinking supply and for eight or nine near-by houses. A partial analysis shows six parts per million of chloride. The other well is about 200 feet farther west on the level terrace and is drilled 160 feet deep, of which an unknown part is in rock. The well yields a little less than 2 gallons a minute under continuous pumping throughout the day shift. It furnishes a part of the factory supply.

2. The Wallingford Gas Co., located near the east edge of the large lake made by damming Quinnipiac River, has a group of seven driven wells of unknown depth, apparently 4 inches in diameter. The plant is below the terrace bluffs on low land only 5 or 10 feet above the river. The wells are in an east-west row, 12 feet apart. They are pumped continuously 24 hours a day with a small hot-air pump, which probably does not deliver more than 50 gallons a minute. The water is used for boilers and all other purposes, including drinking, although city water is connected for emergency use and can be used for drinking if preferred.

3. The New York Insulated Wire Co. uses one drilled well variously reported as 210 and 250 feet in depth. The best reports indicate that rock was reached at 60 feet, below stratified drift. The water level at present is 48 feet below the surface. The well is 6 inches in diameter and is the only one remaining of a group of three drilled about 1900. Originally it yielded 20 gallons a minute. The water is used only for drinking, river water being preferred for boiler and other uses.

4. The H. I. Judd Co. has a drilled well 599 feet deep made in 1907. It is 8 inches in diameter, and according to the best available information it penetrates stratified drift for 60 feet and sandstone below. The well supplies at present 12,720 gallons an hour, 10 hours a day. It is pumped by air lift. The water is used for washing rough wares, electroplating and some other purposes, but water from the public supply is used for boilers and drinking. Analysis is said to have shown the well water to be too hard for boiler use.

5. Lindler Bros. have a driven well 1½ inches in diameter and about 30 feet deep, made in 1919, to supply a small ammonia refrigerating plant. It is pumped by electric motor and has given satisfaction except for a little trouble with sand getting through the strainer. Water was reached at about 25 feet.

Rough estimates of the quantity of ground water used by the five plants described are as follows:

Estimated quantity of ground water used by industrial plants in Wallingford

	Gallons per day
Jennings & Griffin Manufacturing Co	11, 000
Wallingford Gas Co	50, 000
New York Insulated Wire Co	2, 000
H. I. Judd Manufacturing Co	125, 000
Lindler Bros	2, 000
	190, 000

Suggestions for development.—For individual domestic supplies dug and drilled wells such as are commonly used are satisfactory. More hillside springs adapted for the distribution of water by gravity could be used to good advantage. One such spring at Quinnipiac now supplies six or seven families. Wells may be made to serve in the same way if no spring is convenient. As shown by experience, factories in the Quinnipiac Valley would do better to obtain water in the stratified drift instead of using deep wells. There is a practically unlimited supply of ground water in the stratified drift, which can be obtained by relatively shallow wells of easy construction. It may be too far below the surface at many places for direct suction lift, for the water table is deep beneath the terraces, but the same thing is true of deep wells in rock. The quality of the water in stratified drift is better than that in the underlying sandstone.

The villages of Tracy and Yalesville need a public supply. A surface water supply for Yalesville might be obtained from some brook, such as Broad Brook, 2 or 3 miles away. A ground-water supply, however, could be developed easily in the lowland along Quinnipiac River by the use of driven wells. The wells should probably be located on the flood plain and not on the adjacent terraces, as the terraces are underlain at many places by rock at shallow depth, and but little water is obtainable above the rock. The expense of pumping to a height that would insure sufficient pressure is the chief objection to a public supply from wells.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Wallingford

[Observations made Oct. 7 to 11, 1919, except wells 143 and 161, which were examined Nov. 9, 1919, and wells marked with double dagger (‡), records for which were collected by E. C. Miller, of Yale University, in 1907, and reviewed by the author during this study. a before number of well indicates that well is abandoned. For descriptions of pumping plants, which are numbered in a separate series, see pp. 173–174]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
1	Lepper	220	Slope	8	2	Till	Hand pump	No.
2	Raarup	220	do	17	14	Till and sandstone	do	No.
3	Felipe	200	Hill	30	13	Till	Pulley	No.
4	Fritz	200	do	28	7	Till and probably sandstone.	do	No.
5	O'Kay	210	do	15	10	Till	Hand windlass	No.
6	E. B. Welton	225	do	15	10	do	Hand pump	Yes.
7		100	Slope	14	5	do	Pulley	No.
9	Schwab	140	do	18	13	Till and sandstone	Chain pump	No.
10	W. Winchell	125	do	17	9	Till	do	No.
12	F. W. Wilcox	130	Hill	22	15	Till and sandstone	Hand pump	No.
‡13	Chandler	120	Slope	23	17	Till 15 feet, sandstone 8 feet.		No.
14	Henry Grouse	110	do	12	5	Stratified drift (?) and sandstone.	Chain pump	No.
15	Wm. Burnham	100	do	14	9	Till	Pulley	No.
16	Lewis Ives	100	do	16	9	do	do	No.
17		90	do	18	12	Stratified drift and till.	do	No.
18	H. J. Collins	110	do	12	5	Till	do	No.
19	F. F. Ives	100	do	15	9	do	do	No.
20	Richards	90	Terrace	19	11	do	Hand pump	No.
21	Smiley	80	do	19	14	Stratified drift and sandstone.	do	No.
22	E. S. May	80	do	31	27	Stratified drift 19 feet, sandstone 12 feet.	Pulley	No.
23	F. R. Fritz	80	do	19	15	Stratified drift and sandstone.	do	No.

Records of wells and springs in Wallingford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
24	James McKenzie.	80	Terrace	23	18	Stratified drift and sandstone.	Pulley	No.
25	Fulford	85	do	16	9	do	do	No.
‡26		70	do	32	27	Stratified drift		No.
‡27		65	Valley	25	16	do		No.
‡28		80	Terrace	38	34	Stratified drift 30 feet, sandstone 8 feet.		No.
‡29		80	do	20	16	Stratified drift 16 feet, sandstone 4 feet.		No.
‡30	C. H. Young	80	do	17	13	Stratified drift and sandstone.		No.
‡31	do	80	do	17	13	do		No.
32	Kingsford	90	do	23	20	Stratified drift and probably sandstone.	Pulley	No.
33	Prageman	80	do	35	30	Stratified drift	do	No.
34	J. R. Brown	80	do	35	30	do	do	No.
35	Gillette	80	do	39	35	do	do	No.
37	Daly	90	do	26	25	Stratified drift, probably to rock.	do	Yes.
38	Woodbridge	90	do	27	24	Stratified drift (?)	do	No.
39	Woodgke	95	Slope	12	10	Till	Chain pump	No.
40	Nagle	90	Terrace	20	17	Stratified drift, probably to rock.	Pulley	No.
41	D. R. Robbins	90	do	25	20	Stratified drift		No.
43	Rice	90	do	25	22	do	Hand pump	No.
44	Yale	80	do	25	21	do	Pulley	No.
‡46	Barnes & Co	80	do	40	34	do		No.
‡47	do	80	do	40	34	do		No.
52	J. I. Francis	210	Valley	28	18	do	Hand windlass	No.
53		210	do	13	8	do	Gasoline engine.	No.
57	Barnes & Co	320	Hill	26	20	Till and sandstone (?).	Pulley	No.
58	do	320	Slope	20	14	Probably sandstone	do	No.
59	do	320	do	21	18	do	do	Yes.
63	Ruell	300	Valley	20	17	Stratified drift	do	No.
65	Scarpa	300	do	15	10	do	Hand pump	No.
66	J. T. Moselle	305	Slope	26	22	Stratified drift (?)	Pulley	
67	B. Nalchiodi	300	Valley	13	11	Stratified drift	do	No.
68	J. Manfreda	320	Slope	25	22	do	do	No.
69	M. M. Hall	260	Valley	20	18	do	Hand pump	No.
70		265	Terrace	15	10	do	Pulley	No.
71	Barnes & Co	270	Slope	27	20	Stratified drift and probably sandstone.	Windmill	No.
72	Balsford	260	Hill	23	16	Chiefly sandstone	Pulley	No.
73	L. H. Hall	250	Slope	30	23	do	do	No.
74	Williams	250	do	22	19	do	Gasoline engine.	No.
75	do	240	do	11	7	Till		No.
76	F. I. Cavette	185	Hill	25	18	Sandstone	Pulley	Rarely.
77	F. Fanfrello	280	Valley	16	11	Till	Hand pump	No.
78		280	Slope	18	10	do	Pulley	
79		190	do	23	16	Till and sandstone	do	No.
80	Darrow	190	Flat	15	10	Till	do	Yes.
82	Adams	280	Hill	20	12	Till and sandstone	Hand pump	No.
83	W. J. Self	250	do	25	16	do	Gasoline engine.	No.
84	S. W. Peatross	280	do	24	17	do	Hand windlass	Rarely.
85	Wm. Grier	290	do	33	21	Till 13 feet, sandstone 20 feet.	Pulley	No.
87	F. Walschlanger	300	do	22	12	Till and sandstone	Hand pump	No.
88	Neal	300	do	21	13	Till	do	Yes.
90	Wall	300	do	17	8	do	do	No.
92	H. Hessel	300	do	22	12	Till and sandstone	Pulley	No.
93	F. S. Andrews	325	Slope	10	4	Till	Windmill	No.
94	do	325	do	23	13	Till and sandstone (?)	Pulley	Yes.
95	J. P. Hough	320	do	23	15	do	do	(?).
96	J. B. Anthony	300	Hill	38?	25?	Chiefly sandstone	Hand pump	No.
98	Oliver Hill	230	Flat	21	17	Till 15 feet, sandstone 6 feet.	Hand windlass	Rarely.
100	H. C. Bell	240	do	25	15	Till	Gasoline engine.	No.
101	E. Kirkpatrick	220	Bench	24	17	Probably sandstone	Pulley	

Records of wells and springs in Wallingford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
103	Edell	180	Bench	28	23	Till 6 feet, sandstone 22 feet.	Pulley	Rarely.
104	W. E. Rose	180	do	28	17	Till and sandstone	do	No.
105	Scott	180	do	23	18	Sandstone	do	No.
106	A. Beaumont	170	Slope	23	17	Probably sandstone	do	No.
107	do	180	Hill	26	12	Till	do	No.
‡108		80	Terrace	25	17	Stratified drift		No.
‡109		80	do	25	17	do		No.
‡110	H. Beaumont	80	do	30	24	do		No.
‡111		90	Slope	28	22	Stratified drift 13 feet, sandstone 15 feet.		No.
‡112	C. Galligher	90	do	25	15	Stratified drift 5 feet, sandstone 20 feet.		No.
‡113		90	do	35	5	Stratified drift (?); no rock.		No.
‡114		90	do	30	28	Stratified drift 21 feet, sandstone 9 feet.		Yes.
‡115		80	Terrace	40	36	Stratified drift		No.
‡116		80	do	40	36	do		No.
‡117		50	Valley	15?	6	do		No.
‡118		50	do	15?	6	do		No.
‡119		80	Terrace	20	14	do		
‡120	Frank Rice	80	do	40	34	do		No.
‡121	Churchill	80	do	30	23	Stratified drift 8 feet, sandstone 22 feet.		No.
‡122	Richter	80	do	40	25	Stratified drift 10 feet, sandstone 30 feet.		No.
‡123		80	do	20	16	Stratified drift and sandstone (?).		(?).
125	Hitchcock	300	Slope	25	20	Till and sandstone	Pulley	Rarely.
126	O'Neil	320	do	40	36	do	do	No.
127		340	Hill	27	15	Till and sandstone (?).	do	No.
128	A. A. Tessler	325	do	20	13	Till and sandstone	do	No.
129	Rider	325	do	24	15	do	do	No.
130	George R. Stevens.	300	Valley	10	7	Till	do	No.
131	Toth	310	Slope	15	7	Till and sandstone		Yes.
132		320	Hill	20	13	Till	Pulley	No.
133	P. Tessmer	320	do	13	10	Till and sandstone (?).	Chain pump	(?).
134	J. W. Doyle	340	do	24	12	Till and sandstone	Hand pump	No.
135	Wm. Cook	360	do	21	15	do	Pulley	No.
136		350	do	18	10	Till and sandstone	do	No.
139	Sileski	300	Slope	13	2	Till	Chain pump	No.
143	J. Feste	20	Terrace	8	5	Stratified drift	Pulley	Yes.
‡144	Chas. Rose	80	do	23	16	Stratified drift, trap at bottom.		(?).
‡145		60	do	45	40	Stratified drift		No.
‡147		80	do	25	19	Stratified drift 15 feet, sandstone 10 feet.		(?).
‡148		60	Slope	15	9	Stratified drift 9 feet, sandstone 6 feet.		(?).
a149		80	Terrace	33	30	Stratified drift	Pulley	No.
‡150		80	do	35	30	do		No.
a‡151		90	do	24		do		No.
‡152	P. Garmon	90	do	29	23	Stratified drift 24 feet, sandstone 5 feet.		No.
‡153		90	do	34	29	Stratified drift 22 feet, sandstone 12 feet.		No.
‡154	Seeman	90	do	40	33	Stratified drift		No.
‡155	Biggins	90	do	15	9	Stratified drift 8 feet, sandstone 7 feet.		(?).
‡156		90	do	24		Stratified drift		No.
‡157	W. C. Dudley	90	do	24	19	do		No.

Records of wells and springs in Wallingford—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
‡158	W. C. Dudley	90	Terrace	24	19	Stratified drift		No.
‡159		65	do	25	22	do		No.
‡160	P. Doolittle	65	do	24	22	do		No.
161	Toelle	60	do	19	17	do	Hand pump	No.
‡163	D. P. Bullis	40	Slope	30	25	do		No.
‡166	Siza Hall	80	do	18	12	do		(?).
‡168	J. W. Hall	90	do	30	26	do		(?).
170	Dibello (?)	120	Valley	14	7	Stratified drift and sandstone.	Chain pump	No.
171	C. W. Williams	120	do	18	12	Probably sandstone	Hand pump	No.
172	J. W. Hall	100	Slope		12	Stratified drift (?) and sandstone.		No.
a173		160	Hill	14	8	Till (?)	Pulley	No.
174	A. L. Andrews	160	do	21	13	Probably sandstone	None	No.
176	Henry Jones	220	do	16	6	Till	Pulley	No.
177	W. B. Watson	180	do	26	20	Till 13 feet, sandstone 13 feet.	do	Rarely.
178	J. N. Austen	190	Slope	25	18	Probably sandstone	do	No.
179	John Tucker	175	do	14	7	Till	do	No.
180	Jas. M. Cooper	185	Hill	18	10	Till and sandstone (?).	Sweep	No.
180	do	185	do	17	10	Till and sandstone	Hand bucket	Rarely.
a184	Edgar Hall	160	Slope	15	11	Probably sandstone	None	No.
185	L. O'Herman	180	Flat	12	8	Till and sandstone	Pulley	No.
186	Fred Chetta	200	do	9	2	do	do	No.
‡187	Odet	220	Hill	10	5	do		(?).
‡188	do	200	Slope	25	20	Till		No.
‡190	George Pogmore	80	Terrace	15	9	Stratified drift and sandstone.		(?).
‡191	do	80	do	19	13	Stratified drift 16 feet, sandstone 3 feet.		
‡192	E. R. Warner	80	do	15	12	Stratified drift		No.
‡193	Joseph Houle	80	do	20	11	do		
‡194	W. S. Gales	80	do	5	1	Stratified drift(?)		(?).
‡195	George Huber	80	do	41	38	Stratified drift		No.
‡196	H. B. Hunt	80	do	15	12	do		(?).
197	W. Thrall	75	do	13	9	do	Chain pump	No.
198		80	do	20	16	do	do	No.
199	Comdey	80	do	25?	20?	do	Hand pump	No.
200	C. B. Munson	120	Slope	17	10	Probably sandstone	Pulley	No.
202	S. Pachucki	160	Valley	17	10	do	Sweep	No.
203	Quigley	200	Slope	20	15	Till and sandstone	Chain pump	Yes.
204	Public road	200	Valley	10	2	Till	Sweep	(?).
205	W. H. Harris	240	Hill	32	27	Till and sandstone	Hand pump	Rarely.
206	S. Munson	150	Bench	24	16	do	Pulley	Rarely.
207	Joseph Hochman.	140	do	12	7	Till and sandstone (?).	Hand windlass.	No.
208	Putrine	140	do	18	14	Stratified drift (?)	do	No.
a211	E. H. Norton	220	Hill	20	17	Till and sandstone	None	(?).
212	J. A. Allen	220	Valley	8	5	do	Pulley	Yes.
214	Williams	280	Slope	15	3	Till	None	No.
215	Beaumont	300	Hill	23	20	Till and sandstone	do	No.
216	A. Malchiadi	240	Valley	13	5	do	Sweep	No.
217	Freschi (?)	250	Hill	38	25	Sandstone	Windlass	No.
218	C. Sartori	240	Valley	24	16	Till and sandstone (?).	Pulley	No.
220		200	do	16	6	Stratified drift	Hand pump	No.
221	Ravigno	260	Terrace	25	20	do	Pulley	No.
222		320	Bench	30?		Probably sandstone	Hand pump	Yes.
224	R. Giacomi	320	Valley	17		Till		No.
225	Hosler	340	do	35?	25?	Till and sandstone (?).	Hand pump	No.
226	do	400	Hill			Till	Gravity pipe line.	No.
227	Mackoski	440	do	23	17	Till and sandstone	Pulley	Yes.

Records of wells and springs in Wallingford—Continued

Driven wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Diameter (inches)	Kind of rock	Equipment
42	F. W. Walker	80	Terrace	25?	2	Stratified drift	Hand pump.
45	Huff	90	do	30	2	do	Do.
‡48	Barnes & Co.	90	do	40		do	
‡146		70	do	50		do	Do.
162	Weedon	60	do	35		do	Do.

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
36	Daly	90	Terrace	80		Chiefly sandstone	Hand pump	
50	J. Anderson	325	Hill	99	Pomeroy	do	do	
51	J. R. Hough	340	do	100	do	Till 30 feet, sandstone 70 feet.	do	
[a] 54	C. J. Hammer	230	do		do	Chiefly sandstone	do	
55	Barnes & Co.	340	do			do		
[b] 56	B. L. Gardner	330	do	60		Till 15 feet, sandstone 45 feet.	Hand pump	
64	S. Diguello	300	Valley	82		Stratified drift	do	
81	E. M. Addis	275	Hill	59		Chiefly sandstone	do	
86	Stacy	295	do			do	do	
[c] 89	Joe Lighas	300	do			do	do	
91	Hessel	300	do	72		do	Gasoline engine.	
97	Simpson	300	do	98	Pomeroy	do	Hand pump	7
102	Wilkes	200	do	52		do	Gasoline engine.	
‡124	Masonic Home	120	Slope	40		Till 36 feet, sandstone 4 feet.		
[d] 137	J. A. Martin	360	Hill	55		Chiefly sandstone	Gasoline engine.	
138	Sileski	300	Slope	37		do	Hand pump	
140	Sibley	180	do	45	C. L. Wright	do		
[e] 169	G. H. Clayton	130	do	25		do	Hand pump	
219	Seprenschi	250	do	48		do	do	
223	Stevens	340	Hill	157		do		
228	Mrs. Bartholomew	420	do	80	C. L. Wright	Sandstone	Hand pump	
229	do	420	do	76	do	do	do	

[a] Drilled in bottom of 33-foot dug well which failed.
[b] Drilled in bottom of 30-foot dug well which failed.
[c] Drilled in bottom of 17-foot dug well which failed.
[d] Drilled in bottom of 25-foot dug well which failed.
[e] Drilled in bottom of 15-foot dug well which failed.

Record of wells and springs in Wallingford—Continued

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
8	Schwab	130	Hillside ravine	Seep from till	Board-walled pit	2-3
11	A. J. Brown	175	Hillside	do	Concrete-walled pit	
49	Huff	160	Hillside ravine	do	Gravity pipe line	
60	Thomas Warmslee	300	Valley, edge of swamp.	Till	Stoned pit 5 feet deep	1
61	Connecticut Trap Rock Co.	300	Valley, base of mountain.	Probably from sandstone beneath till (?).	Open pool 30 feet in diameter; power pumping plant.	+600
62	do	280	Edge of stream	From base of stratified drift terrace.	Stone-walled pit 4 feet deep.	2
99	Adams	220	Head of ravine, base of sandstone ridge	Sandstone	Hydraulic ram	5-10
141	A. T. Henry	280	Slope	Seep from till	Gravity pipe line	
142	Hotchkiss	290	Hillside	Seep from till at contact with sandstone.	Gravity pipe line. Supplies 6 or 7 houses.	
‡164	D. P. Bullis	40	Valley, base of terrace bluff.	Stratified drift on clay bed.		
‡165		60	Slope, terrace bluff	Stratified drift, probably above clay bed.	Piped to trough by road.	
167		100	Base of hill	Seep in drift over sandstone.	Concrete lined pit	1
175		140	Hillside road gutter.	Till	Stone lined pit 3 feet in diameter; gravity pipe line.	1-2
182	John Tucker	160	Head of small valley.	Marshy seep in till	Two barrels sunk in earth.	
183		120	Side of ravine	Sandstone joints	None	1
‡189	G. H. Clayton	90	Base of terrace slope.	Stratified drift at sandstone contact (?).	Pit 5 feet deep	
201	C. B. Munson	120	Head of ravine	Sandstone and sandstone-till contact.	Spring house	
209		140	Foot of hill	do	Barrel sunk in earth	
210	J. A. Allen	200	Edge of swampy valley.	Till	Open stone-lined pit; windmill.	5-10
213	Charles Johnson	230	Slope	Marshy seep in till	Several open pits	

DURHAM

AREA, POPULATION, AND INDUSTRIES

Durham was incorporated in 1708. It is bounded on the south by Guilford and Madison, on the east by Haddam, on the north by Middlefield, and on the west by Wallingford. The town is roughly rectangular, slightly over 4 miles wide from north to south and 5½ miles long. Its area is 15,417 acres, or 24.1 square miles. The population in 1920 was 959. The principal industry is agriculture. One small factory in the village of Durham makes tin boxes and allied metal products. Practically all the southeastern third and scattered tracts in the rest of the town are wooded, and a considerable area is swampy. Probably about one-fourth of the land is under cultivation. The principal settlements are Durham and Durham Center, which form practically one village located near the center of the town, and in these settlements and their vicinity is concentrated the greater part of the population. The Air Line division of the New York, New Haven & Hartford Railroad touches the town of Durham, but there are no stations in the town. State highways connect Durham with New Haven, Middletown, and Guilford and carry most of the town's traffic.

TOPOGRAPHY AND DRAINAGE

The lowest land in Durham is the swamp known as Durham Meadows, which stands about 160 feet above sea level. The highest hills reach 700 feet above sea level near Reed Gap, on the western boundary, and 640 feet on Mount Pisgah, in the southern part. The surface of the town has some resemblance to a huge shallow bowl. Durham Meadows, in the central part of the town, is the center of the bowl. High hills surround it on every side except the north, where it is partly open. The topography is uneven and at places rugged. The local relief varies greatly but at many places is from 200 to 400 feet. Coginchaug River is the principal stream. It rises in Guilford just south of the Durham boundary and flows northward across the town, through Durham Meadows. Most of the brooks flow into Durham Meadows.

GEOLOGY

Bedrock.—The southeastern third of Durham is underlain by crystalline bedrock of pre-Triassic age and the rest of the town by Triassic sandstone and trap rock. The main crystalline rock formation is the Bolton schist. In the extreme southeast corner of Durham a narrow belt is underlain by the Middletown gneiss. The best exposures are on the steep slopes near the contact of crystalline and Triassic rocks. Trap rock occurs mainly along the western boundary of Durham, where it forms the high ridges known as Pistapaug Mountain, Three Notches, and Beseck Mountain.

Drift.—Drift covers the bedrock in most of Durham. Probably at least 80 per cent of the area is covered with till. Stratified drift occurs along short stretches of the valleys and forms hillside patches high on the slopes east of Coginchaug River. The principal bodies of stratified drift are in two small valleys near Pistapaug Mountain, in a high valley southeast of Mount Pisgah, and in an irregular belt east of Durham Center.

The thickness of drift varies but is generally not great. Well 52 penetrates 38 feet of till and well 55 penetrates 31 feet. Well 66 penetrates 34 feet of stratified drift. These are probably near the maximum depth for most of the town.

WATER SUPPLY

The Durham Aqueduct Co. supplies water from a reservoir in Middletown to about 50 families in the village of Durham. An association of citizens in Durham Center obtains water from a brook about a mile southeast of that village. Through these two organizations the greater part of the population in Durham and Durham Center is supplied with running water. There are several wells, however, even in the two villages. The rest of the town's population depends upon wells or springs. In the appended table are given the records of 67 dug wells, 8 drilled and driven wells, and 23 springs.

Wells.—Most of the wells in Durham are dug wells penetrating drift, and about half of them go to or into the underlying bedrock. About half the wells start in stratified drift, although that material covers but a small part of the town. The average depth of all dug wells is 20 feet; the deepest one is No. 52, on the James Hull place, 38 feet deep. Several others exceed 30 feet in depth. Out of 67 dug wells in Durham 13 are reported to fail regularly and 2 rarely; 2 others very nearly fail. The percentage of failures is the highest recorded in the New Haven area. (See table.) The pulley and hand windlass are about equally popular as lifting devices, there being 19 of the former and 18 of the latter. Hand pumps are less common. Two sweeps were found. Only one gasoline engine was found in use for pumping.

There are only a few drilled wells in Durham, and most of them are at locations where bedrock is near the surface and water can not be obtained in the drift. Two reported yields are 22 and 11 gallons a minute. One of the curiosities of Durham is a flowing well (No. 82) on the Albert Eick place, at the west edge of Durham Meadows. It was drilled in 1888 with a diamond core drill to a depth of 980 feet in an effort to find coal in the Triassic. It penetrates sandstone, the posterior trap sheet, and more sandstone. A strong flow of water was obtained and has continued uninterrupted. The well now delivers about half a gallon a minute through a pipe line 500 feet long to a point 15 feet higher than the mouth of the well. Although the water is highly mineralized it is used for domestic purposes and stock. (For analysis see Durham, No. 82, p. 36.) The water comes from the Triassic sandstone and doubtless gets its head from confinement between shaly beds of that formation that dip down from the high ridges to the west. It is not improbable that other flowing wells could be obtained in the very low land of this vicinity, but the demand is not sufficient to justify the expense of constructing them. The subject of artesian water in the New Haven area is treated on page 33. An analysis of a sample of water from the 200-foot drilled well of Willis Parmellee (No. 84) is given on page 36. The water is moderate in mineral content and hardness and except for the formation of scale in boilers is satisfactory for most purposes.

Springs.—Springs have an unusual importance as a source of water supply in Durham, constituting about one-fourth of all the individual supplies. About 10 of the springs are seepages from till, and 4 or 5 from stratified drift. The rest are fed by circulation through joints in bedrock. The yields range from about 1 gallon to 10 gallons a minute. There are 10 gravity pipe lines and 4 hydraulic rams in use. Analyses of samples of water from two springs in Durham (Nos. 5 and 41) are given on page 36. The waters represented are moderately low in mineral content and hardness and are satisfactory for most purposes.

Suggestions for development.—The surface water of Durham probably will satisfy the town's industrial and civic needs for a long time to come. There are several good locations for the development of ground water, however. One is the little valley filled with stratified drift east of Durham and Durham Center. Driven wells would yield a large quantity of water there. An ideal site for the development of water is a little valley in stratified drift east of Mount Pisgah, where shallow wells, either dug or driven, would yield a large quantity of good water, but as the intake area is only about 1 square mile in extent the supply would not be unlimited. The valley stands about 350 feet above sea level and 150 feet above Durham Center, and the water could be distributed by a gravity system to the village. In developing water in the stratified drift of Durham it should be remembered that the patches of this material that lie in exposed positions on hillsides contain little water.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Durham

[Observations made Oct. 13 and 14, 1919. a before number of well indicates that well is abandoned]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
2	A. F. Otte	200	Slope	22	15	Till		No.
3	A. H. Banks	210	do	28	11	Till and sandstone	Hand windlass	Rarely.
4	Rush	220	do	21	16	Till and probably rock.	Chain pump	No.
7	Roberts	210	do	34	17	Stratified drift 15 feet, sandstone 19 feet.	Pulley	Almost.
8	F. E. Stevens	240	Valley	10	4	Stratified drift	Hand pump	No.
9	N. Burr	230	Slope	17	7	Stratified drift and probably rock.	do	No.
10	E. M. Hubbard	280	Valley	10	7	Stratified drift and sandstone.	do	No.
14	Downs	235	Slope	17	15	Stratified drift and probably rock.	do	Yes.
a15	Wilcox	270	do	13	6	Till and sandstone	do	Rarely.
16	Nelson	300	Terrace	34	17	Stratified drift 12 feet, sandstone 22 feet.	Pulley	Yes.
18	J. D. Newton	300	Slope	20	5	Till (?) and probably rock.	Hand pump	No.
20	Nelson	280	Hill	18	15	Stratified drift and sandstone.	None	Yes.
21	W. A. Sennet	290	Slope	23	16	Till 8 feet, sandstone 15 feet.	Sweep	No.
22	Hannan	500	do	17	10	Chiefly bedrock	Pulley	Almost.
23	Joe Suippe	500	do	15	7	Till and bedrock	Hand pump	No.
24		260	Terrace	10	8	Stratified drift	do	
27		240	Slope	13	5	Stratified drift and probably rock.	Hand windlass	(?).
28	H. W. Bailey	260	do	17	8	Stratified drift and sandstone.	do	No.
30	Anthony Nork	250	do	24	14	Stratified drift, probably to rock.	Hand pump	Yes.
32	Merwin	210	Valley	13	10	Stratified drift	Hand bucket	No.
33	W. F. Griff	200	do	9	7	do	Hand windlass	No.
35	L. A. Stevens	225	Hill	25	19	Chiefly sandstone	Pulley	No.
36	C. Newton	215	Terrace	28	20	Stratified drift 13 feet, sandstone 15 feet.	do	No.
37	Stevens	220	Slope	15	10	Stratified drift and sandstone.	do	No.
38	C. E. Burr	225	Hill	29	22	Chiefly sandstone	do	No.

a A drilled well 200 feet deep goes down inside dug well, and water in casing stands 1 foot above that in outside well. The water of the drilled well was too hard to use and it was abandoned.

Records of wells and springs in Durham—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
39	Hall	200	Slope	13	8	Stratified drift and sandstone.	Pulley	No.
42	Mrs. Johnson	220	Hill	32	26	Stratified drift and probably sandstone	Hand windlass	No.
43	Albert Bros.	200	Slope	20	12	Till and probably sandstone.	Pulley	
44	Rockwell	220	Hill	26	19	do	Hand windlass	(?).
45	Hall	220	do	21	10	do	Pulley	No.
[a]46	Fair	230	do	16	8	Till	Hand windlass	No.
47	Henry Davis	220	do	25	20	Till 3 feet, sandstone 22 feet.	do	No.
48	Wilcox	225	do	19	5	Till and sandstone (?)	do	No.
49	Atkins	230	do	18	8	Till	Hand pump	No.
50	A. W. Otte	220	do	28	22	Stratified drift	Hand windlass	No.
51	Powers	230	do	22	15	Till	Pulley	Yes.
52	James Hull	225	do	38	11	do	Chain pump	No.
53		250	Terrace	14	11	Stratified drift	Hand pump	No.
54		250	Valley	13	11	do	Hand windlass	No.
55	Molzahn	220	Slope	31	9	Till	Pulley	No.
58	Gale	230	Hill	21	9	do	Hand bucket	No.
59	Mush	240	do	20	13	Till and bedrock (?)	Hand pump	Yes.
60	J. Frances	240	Slope	25	17	Chiefly bedrock	Hand windlass	Yes.
61	do	210	Valley	9	3	Stratified drift	Gasoline engine.	No.
62	Holder	180	Slope	10	3	Bedrock	Hand pump	No.
63	do	200	do	18	12	Stratified drift 4 feet, bedrock 14 feet.	Hand windlass	Yes.
64	George Spencer	180	do	15	13	Stratified drift and bedrock.	Pulley	Yes.
65	A. J. Bailey	160	Terrace	16	10	Stratified drift	Chain pump	No.
[a]66	Birdsey	175	do	34	33	do	Hand windlass	Yes.
68	Williams	240	Hill	15	10	Stratified drift and bedrock.	Pulley	No.
69		190	Terrace	27	25	Stratified drift and rock (?).	do	
70	Fred Brown	260	Slope	18	13	do	do	No.
71	Frances	280	do	20	15	Till and bedrock	Hand windlass	Yes.
72	E. L. Bailey	280	Terrace	13	10	Stratified drift	Sweep	Yes.
73	Mrs. Johnson	375	do	23	15	do	Pulley	No.
74	Lovelain	390	Slope	21	18	Chiefly bedrock	Hand windlass	Yes.
75	do	380	Terrace	18	13	Stratified drift	do	No.
76	Davis	380	do	20	15	do	Chain pump	No.
77	Blake	220	Valley	20	12	do	Hand pump	No.
78	Fred Wimler	200	do	10	5	do	Hand bucket	No.
81	Cornall	175	Terrace	18	15	do		No.
83	Clark	200	Slope	22?	11?	Till (?)	Hand pump	No.
88		200	Terrace	21	15	Stratified drift (?)	Pulley	No.
90	J. H. Stevens	325	do	10	6	Till	Hand bucket	No.
95	Hodgson	280	Hill	19	15	Stratified drift and bedrock.	Hand windlass	Yes.
96	Tony Pezzini	280	Slope	14?	10?	Stratified drift	Hand pump	No.
97	John Rogers	275	Terrace	20	18	do	Pulley	No.

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
[b]25	Banta	245	Valley			Stratified drift	Hand pump	
29	Mrs. Tucker	260	Slope			Chiefly sandstone	do	
34	Camp	220	Hill	80	C. L. Wright	do	do	22
40	White	180	Slope		do	do	do	
[c]82	Albert Eick	180	Valley	980		Sandstone, trap, and sandstone.	Pipe line to house.	Flows.
84	Willis Parmellee	260	Hill	200	Hammond	Trap 113 feet, sandstone 87 feet.	Hand pump	−11
86	Burton	240	Slope			Stratified drift and sandstone.	do	
92	Willis Parmellee	270	do	113		Sandstone	do	

[b] Driven well 10 or 15 feet deep, 2 inches in diameter.

[c] See description in text, p. 182.

Records of wells and springs in Durham—Continued

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
1	Gessler	300	Slope	Till	Barrel sunk in till; gravity pipe line.	------
5	William Artger	260	Nose of ridge	Probably from bedrock below stratified drift. "Boils up" through sand.	Small stoned pit; gravity pipe line.	−1
6	Fred Eick	220	Small ravine on slope.	Marshy seep from till	Stone-walled pit 8 feet deep.	2–3
11	E. M. Hubbard	300	-----do	-----do	Two pits 3 to 4 feet deep in sand; gravity pipe lines.	4–5
12	Merwin	280	Side of marshy valley.	Probably till	Two covered pits 2 to 3 feet deep; gravity pipe lines.	------
13	Wilcox	270	Small break in hillside slope.	Marshy seep from till	Stone-walled pit 2 feet deep.	------
17	Nelson	320	Slope	Till	Stone-walled pit 5 feet deep; gravity pipe line.	1–5
19	-----do	290	Foot of bench	Probably till and sandstone contact.	Barrel in earth; hydraulic ram.	([d])
26	Banta	245	Base of terrace bluff.	Stratified drift.	Well-like pit 5 feet deep, with hand pump.	2–3
31	Ball	240	Edge of marsh	-----do	Two pits 4 to 5 feet deep; gravity pipe lines.	−10
41	White	160	Base of slope	Joints in sandstone above shaly layer.	Open pit 1 foot deep	−1
56	Umber	275	Slope	Till	Pit 1 foot deep; gravity pipe line.	------
57	Gale	300	Slope near top of hill.	-----do	Pit 5 feet deep; gravity pipe line.	------
67	Aragone	180	Valley, side of brook.	Fractures in bedrock (gneiss).	Open pit 2 feet deep	±1
79	Siphon	200	Swampy valley	Stratified drift	Board-walled pit 2 by 2 by 3 feet; gravity pipe line.	------
80	Wilbur Clark	200	Side of brook in ravine.	Fractures in bedrock	Open pit 2 feet deep	------
85	Willis Parmellee	230	Valley, base of small ridge.	Probably from sandstone or trap rock.	Pit 5 by 5 by 3 feet; feeds hydraulic ram.	5–10
87	Seward	280	Base of bluff beside stream.	Joints in sandstone	Open pit 2 feet deep	------
89	Parmellee	220	Base of low terrace bluff.	Stratified drift	Spring house over small pit; hydraulic ram.	4–5
91	C. A. Gessler	280	Ravine	Joints in sandstone	Spring house over shallow excavation.	10
93	John B. Clark	240	Hillside	Till or till-sandstone contact.	Spring house over large excavation; hydraulic ram.	+10
94	M. E. Stevens	240	Bank of ravine	Seep from stratified drift or sandstone.	Open pit feeds hydraulic ram.	------
98	Foote	330	Hillside	Probably till	Gravity pipe line	([e])

[d] Sometimes fails. [e] Fails rarely.

HADDAM

AREA, POPULATION, AND INDUSTRIES

Haddam was incorporated in 1668. It comprises a belt of country about 5 miles wide and 7 miles long lying southwest of Connecticut River between Chester and Middletown, also a small triangular area northeast of the river. The total area of the town is 29,375 acres, or 45.9 square miles. Its population in 1920 was 1,736. The approximate area of the part southwest of the river is 23,000 acres, or 36 square miles, and this report deals only with that part. The population of the town is concentrated in the narrow valley of Connecticut River, particularly in the villages of Higganum, Haddam, Shailerville and Tylerville. At Higganum there are three or four small factories which make farm machinery. The factories are run by water power, which is available in considerable quantity in the town. Quarrying was once an important industry at Haddam but is now nearly abandoned. The other settlements are purely residential or agricultural. Agriculture and lumbering are the only industries of the interior, which is very sparsely settled. Probably more than 75 per cent of the town is woodland. The rural population is decreasing rather than increasing, and vacant houses are common. The Valley division of the New York, New Haven & Hartford Railroad follows Connecticut River across the town and is closely paralleled by a State highway. Because of its unusually attractive scenery and its accessibility this part of the Connecticut Valley is growing in popularity as a summer residence section.

TOPOGRAPHY AND DRAINAGE

Connecticut River in Haddam is tidal and occupies a narrow valley in a dissected plateau that rises 500 to 600 feet above sea level. The highest altitude in the town is on Candlewood Hill, in the northwestern part, about 660 feet above sea level. Most of the drainage flows northeastward through small streams into Connecticut River. These tributaries of the Connecticut tumble down the sides of its valley, over steep beds, with many rapids, and furnish the abundant water power of the town. On the uplands the small streams have not sufficient fall to drain the many swamps that were created by the irregular distribution of glacial drift.

GEOLOGY

Bedrock.—The pre-Triassic crystalline rocks constitute all the bedrock in Haddam, with the exception of one or two dikes of Triassic trap rock. Most of the town is underlain by the Haddam granite gneiss. In the southeast corner a narrow belt of the Middletown gneiss extends from the village of Haddam southward. In the extreme southeast corner is a small area of the Hebron gneiss. In the northwest corner are narrow bands of the Middletown gneiss and Bolton schist. At Higganum and near Little City and possibly at other places are outcrops of a trap dike, probably of Triassic age.

Drift.—Till forms the surface of Haddam, except for a strip a quarter of a mile to half a mile wide along Connecticut River and a few small areas along some tributary streams. It covers probably 90 per cent of the town. It is more sandy than the till in most other towns. The till cover is thin on the slopes and in the valleys, but on the broad hilltops it attains a measured thickness of 30 to 40 feet and probably is as much as 50 feet thick at some places. The deepest wells in till are Nos. 5, 143, and 145, which are 36 feet, 38 feet, and 36 feet deep, respectively.

Stratified drift occurs mainly along the valley of Connecticut River, where it forms narrow terraces bordering the river. The stratified drift is very irregular in thickness. In the small valleys, such as that of Poneset Brook, it has been so cut away as to expose the underlying till at many places, and the remaining patches are very thin. Even near Connecticut River the deposit is not thick everywhere, and bedrock is exposed at many places in the beds of the small streams that cross the terraces. Locally, however, the deposit is deep. In well 28 a depth of 31 feet is recorded, and in one drilled well (No. 74) on the highest terrace 90 feet of stratified drift is reported above the bedrock. This is probably very near the maximum thickness.

WATER SUPPLY

Haddam has an abundance of surface water of good quality for factory and civic uses, but ground water is used almost entirely for domestic supply. There is no public water system in the town, although in Higganum and Haddam there are two or three places where several families have a common supply drawn by gravity from conveniently situated wells or springs. The factories at Higganum depend mainly on Poneset Brook, although one or two of them are reported to have drilled wells that supply drinking water. The individual water supplies examined comprise 148 dug wells, 6 drilled wells, and 19 springs. The location of these supplies is given on Plate 5, and their description in the appended table.

Wells.—The dug wells of Haddam derive most of their water from the drift or from the contact between drift and bedrock. About 44 wells are in stratified drift and the rest in till. Of the total 61 go to or into rock. The average depth of dug wells in Haddam is 18 feet and the average depth to water 12 feet. There are 16 wells which are said to fail regularly and 10 rarely. This is a high percentage of failure. (See table.) Drilled wells are uncommon in Haddam. The six recorded average 111 feet in depth. One yield of 15 gallons a minute is reported.

Springs.—Springs are a more important source of water supply than appears from the number recorded (19), because several of the springs are connected with gravity pipe lines that supply more than one family. The springs are located mainly along small ravines on steep hillsides and derive their water from the till or from the contact of till with the underlying bedrock. None of the yields are unusually large.

Equipment.—There are two unusual facts to be noted with respect to the equipment used on wells and springs. One is the preponderance of the hand windlass as a means of raising water from dug wells (see table), there being 66 hand windlasses in comparison with only 32 hand pumps and 21 rope and pulley installations. The second noteworthy fact is the popularity of gravity water systems, of which 18 are recorded and several more are in use. (See table.) Along the Connecticut Valley at some places this is practically the only type of supply. The main reason for the development of such supplies is that springs are abundant on the hillsides, and most of the houses are in the valleys.

Suggestions for development.—Although there is not much need at present for large quantities of ground water in Haddam, a great deal could be obtained by shallow wells on the lower terraces along Connecticut River or in the large interior swamps, such as that near Poneset. For domestic supplies dug wells are satisfactory, and a further utilization of the hillside well and spring adapted to gravity supply is desirable.

There are some difficulties in obtaining water on the terraces of the Connecticut River valley, particularly the upper terrace. (See pp. 23.) The stratified drift of the 80 to 100 foot terrace rests upon a steeply inclined bedrock floor that slopes down toward the river. Wells on this terrace usually reach rock within 25 or 30 feet—much above the river level—and the only water they receive is that seeping down the bedrock floor toward the river (see fig. 5), a quantity which is often inadequate. On the other hand, most wells sunk on the edge of the terrace nearest the river, where the stratified drift is deepest, must penetrate 50 to 100 feet of stratified drift to reach water, as the water table falls practically to the river level wherever bedrock is deep enough below the surface to permit. The Shailer drilled well (No. 74) is an example of the second condition. It penetrated 90 feet of stratified drift before reaching rock, and the water level was far below the surface. An exception to this general rule is found at Tylerville, where a few wells far out on the terrace reach water at a depth of 25 or 30 feet. This water table is local and probably is supported by an underlying ridge of till or bedrock, as is very plainly true at certain wells in Chester, not far to the south. For the reasons given, wells on the terraces should be sunk as far from the river as possible, at places where bedrock is not too far below the surface yet is overlain by drift of sufficient thickness to yield an adequate supply of water.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Haddam

[Observations made Oct. 15 to 24, 1919]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
1		480	Valley	15	2	Till	Pulley	No.
2	John Politi	400	Slope	24	9	Till and probably bedrock.	Hand windlass	Almost.
3	Edward Rich	160	do	15	11	Till	do	No.
4	A. L. Hubbard	160	do	21	11	Till and bedrock		Rarely.
5	Stevens & Bailey	180	Hill	36	18	Till	Hand windlass	No.
6	Tanner	180	do	25	15	do	do	No.
7	T. Monica	140	Slope	8	1	do	Gravity pipe line.	No.
8	Spencer	140	do	25	15	do	Hand windlass	No.
9	Ryan	120	do	18	4	do	do	No.
10	Burr	100	Terrace	16	8	do	do	No.
11	Joseph Clark	120	Slope	13	4	Till and bedrock (?)	do	Rarely.
12	Public well	120	do	24	4	Till	do	(?).
13	Clark	120	do	25	7	do	do	(?).
14	S. E. Lawson	140	Hill	19	9	Till and bedrock	do	No.
15	Ernest Skinner	160	do	16	10	Till	do	No.
16	C. H. Bailey	160	do	30?	10?	do		No.
17	Gene Burr	160	Slope	21	13	do	Hand windlass	No.
18	Watley	160	Flat	19	7	do	do	No.
19	Wm. Neff	260	Hill	22	16	do	Hand pump	No.
20	John Kingslen	240	Slope	17	5	Till and bedrock	do	Rarely.
21	Jacob Johnson	140	Hill	23	15	Till	Hand windlass	No.
22	Goff	150	do	18	10	do	do	No.
23	Portner (?)	150	do	20	14	do	do	(?).
25	Kahrman (?)	160	do	24	11	do	Hand pump	(?).
26	Burr	240	Slope	24	13	do	Hand windlass	No.
28	Brainerd	50	Terrace	31	28	Stratified drift	do	No.
29		60	do	23		Stratified drift and probably bedrock.		No.
30		20	Valley	9	5	Stratified drift	Hand windlass	No.
31		15	Slope	20	17	do	do	No.
32		50	do	35	33	Stratified drift and bedrock.	do	Yes.
33	Johnson	20	do	20	18	Stratified drift	do	No.
34	Emmons	20	do	22	20	do	do	No.
35	A. M. Brainerd	100	Terrace	18	15	Stratified drift 14 feet, bedrock 4 feet.	do	No.
36	Stanton	100	Hill	13	10	Chiefly bedrock	Pulley	(?).
37	Gilbert	100	Slope	24	19	Stratified drift (?) and bedrock.	Chain pump	No.
38	H. N. Kelsey	90	Terrace	22	16	Stratified drift	Pulley	No.
39	Loewe	100	do	18	12	Stratified drift and bedrock (?).	Hand windlass	Rarely.
40	R. T. Shailer	120	Slope	11?		Till	Hand pump	No.
41	Usher	100	Terrace	14	7	Stratified drift and bedrock (?).	Pulley	No.
42	Mrs. Barry	75	do	14	10	Stratified drift	Hand windlass	Yes.
43	Miller	60	Slope	19	9	Stratified drift and bedrock (?).	do	No.
44	Edward Stone	80	Terrace	17	9	Stratified drift	do	No.
45	John Anderson	80	Slope	15	11	do	do	No.
47		120	Terrace	19	14	do	do	(?).
48		120	do	9	4	Till (?)	Hand pump	(?).
55	David Clark	120	Slope	17	13	Stratified drift (?)	Hand windlass	No.
56	Walkley	110	Valley	8	5	Till and bedrock	Windmill	No.
57	F. D. Butler	140	Slope	20	14	do	Hand windlass	No.
58	Crooks	175	do	17	13	Till	do	No.
59	Dayton	140	do	12	6	Till and bedrock	Pulley	No.
60	Latshaw	140	Valley	15	5	Till	Gravity pipe line.	No.
61		120	Slope	13	10	Till and bedrock	Hand windlass	Yes.
63	Brainerd	120	do	8	4	Till	Gravity pipe line.	No.
64	Kelsey	120	do	12	8	Till and bedrock	Pulley	No.
65	Dickinson	80	Terrace	15	10	Stratified drift	Hand pump	No.
66	Hazen	80	do	25	20	Stratified drift and bedrock (?).	Hand windlass	No.
[a] 67	do	110	Slope	12	9	Till	Electric pump	No.

[a] Pumped through pipe line system to supply 4 or 5 houses.

Records of wells and springs in Haddam—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
68	R. Hayden	140	Slope	15	5	Till and bedrock	Gravity pipe line.	No.
69	Spencer	180	Hill	19	16	do		Yes.
70	Dickinson	120	Slope	8	6	Till	Gravity pipe line.	No.
[a] 71	Arnold estate	200	Valley	7	2	do	do	No.
72	Haddam	100	Terrace	20	14	Stratified drift and bedrock (?).	Pulley	No.
73	Clark	90	do	15	11	Stratified drift and bedrock.	do	Yes.
75	Middlesex County jail.	140	Slope	14	5	Till	Gravity pipe line.	No.
76	Mrs. Williams	90	Terrace	20	17	Stratified drift and bedrock (?).	Hand windlass	No.
77	A. M. Clark	100	do	11	8	Till and bedrock	do	Yes.
78	Mrs. Williams	80	do	17	13	Stratified drift	do	No.
79	Public well	100	do	11	3	Till	do	No.
80	Philip Arnold	100	Slope	24	15	do	do	No.
81	G. Erickson	100	Terrace	23	20	Stratified drift 18 feet, bedrock 5 feet.	Pulley	Yes.
82	Mrs. Shailer	60	do	18	13	Stratified drift and probably bedrock.	Hand windlass	Yes.
83	H. P. Pierce	50	do	16	13	Stratified drift and bedrock.	do	No.
84	Mrs. Shailer	70	do	22	12	Stratified drift	Hand pump	No.
85	Faartoft	80	do	21	13	do	Hand windlass	No.
86	John Shailer	60	do	28?	22?	Stratified drift and bedrock.		No.
87		70	do	15	11	do (?)	Hand windlass	(?).
88	Buell	70	do	11	6	do	do	No.
89	Ely	60	do	28?		do	Hand pump	No.
90	Emil Schutte	60	Slope	17	10	do	do	No.
91	Mrs. Arnold	70	Terrace	29	26	do	Pulley	Rarely.
93	G. G. Hamlet	80	do	15	13	do	Sweep	Yes.
94	Delmar	40	Valley	25	22	do	Hand windlass	No.
95	Shailer	120	Slope	15	9	Till and bedrock	Gravity pipe line.	No.
97		90	Terrace	38	28	Stratified drift and probably bedrock.	Pulley	No.
98	Roth	80	do	15	9	Stratified drift and bedrock.	do	No.
99	O. B. Cohen	60	do	18	13	Stratified drift	Hand windlass	No.
100	Dietrichs	60	do	24	20	do	do	(?).
101	Weissburn	40	Valley	11	6	Stratified drift and probably till.	Pulley	(?).
102	M. LeMay	65	Terrace	20	15	Stratified drift	Chain pump	No.
103		65	do	21	17	do	Pulley	Rarely.
104	Matthewson	20	do	17	15	do	Hand pump	No.
106	A. Newcombe	20	Slope	14	8	Stratified drift and bedrock.	Hand windlass	No.
107	Patterson	20	do	15	7	Stratified drift and probably bedrock.	Hand pump	No.
108	M. Waterhouse	80	do	21	15	Stratified drift and bedrock.	Pulley	Yes.
111	Soran	440	Bench	12	5	Till	Hand windlass	No.
112	Berger	450	do	14	5	Till and bedrock	do	Yes.
113	Soran	420	Valley	10	4	Till	Sweep	No.
114	Tyler	400	Slope	11	5	do	Hand windlass	Rarely.
115	C. Dickinson	480	Hill	20	12	do	Pulley	Yes.
117	do	480	do	17	13	Till and bedrock	Hand windlass	Yes.
119	Poucher	350	Terrace	27	23	Stratified drift	Pulley	No.
120	Joe Farina	565	Hill	16	6	Till	Sweep	No.
121	John Marconi	565	do	14	7	do	Pulley	No.
122	Emma Burr	565	do	16	5	do	Hand pump	No.
123	Shum	570	do	18	9	do	Chain pump	No.
124		520	Bench	15	11	do	do	No.
125	Charles Wilcox	520	Hill	18	12	Till and bedrock	Hand pump	Yes.
126	Viner	580	do	13	7	Till	Hand windlass	No.
127	Vichel (?)	580	do	12	5	do	do	No.
128	Ittala (?)	600	Flat	12	2	do	Hand bucket	No.
129	Plattman	580	Valley	12	6	do	Chain pump	No.
130	Rogan	600	Slope	22	14	do	Hand pulley	No.
131	Robbins	600	do	15	11	Till and probably bedrock.	Hand pump	No.

[a] Furnishes supply for several houses and for town hall, library, and church in Haddam.

Records of wells and springs in Haddam—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
132	A. Roctar	620	Hill	25	13	Till	Hand pump	No.
133		600	do	10	5	Till and bedrock	None	(?).
134		540	Valley	11	6	Till	Hand windlass	No.
135	Public road	540	Flat	9	2	do	do	No.
136	David Long	600	Hill	9	5	do	Hand bucket	Yes.
137		625	do	18	11	do		(?).
138	Camp	620	do	13	5	do	Chain pump	No.
139	P. C. Mann	560	do	20	9	do	Pulley	No.
140	Frank Pocone	430	Slope	17	13	do	Hand pump	No.
141	Nocar & Loma	400	do	14	10	do	Hand windlass	No.
142	Wm. Penkara	380	do	15	11	do	Chain pump	No.
143	Oscar Richards	420	Hill	36	15	do	Hand windlass	No.
144	W. C. Knowles	400	do	24	15	do	Hand pump	Rarely.
145	J. B. Panetta	425	do	38	30	do	Pulley	No.
146	Joseph Kelwet	380	Valley	12	7	do	Hand bucket	No.
147		400	Bench	21	13	Till and probably bedrock.	Hand windlass	(?).
148	Kroe	400	Slope	29	20	Till and bedrock	Hand pump	No.
149	Borg	500	Valley	15	11	do	Hand windlass	No.
150		580	Hill	12	6	do	None	(?).
151	Cima	540	Bench	16	5	do	Hand bucket	No.
152	Joseph Strum	580	Hill	22	12	do	Hand windlass	Yes.
153	A. Kollom	580	Slope	23	14	do	Chain pump	No.
155	Hijack	580	Hill	13	10	do	Hand bucket	Yes.
156	Slattery	590	do	12	6	do	Pulley	Yes.
157	Hort	600	Slope	14	7	Till and bedrock (?)	Hand pump	Yes.
158	Oktarice	480	do	15	9	Till and bedrock	Hand bucket	Yes.
161	Chiswski	250	Hill	23	18	Till	Hand windlass	No.
162	Eldred Spencer	240	Slope	15		Till and bedrock	Hand pump	No.
164	W. F. Smith	250	do	25		Till 8 feet, bedrock 17 feet.	do	Yes.
168	Jacoby	275	do	17	11	Till	do	No.
169	J. A. Bennet	300	do		15	Till and bedrock	Hand windlass	No.
170	Peck	240	do	17	11	Till and probably bedrock.	do	No.
171	A. Lundgren	220	do	14	7	Till	Windmill	Rarely.
172	Mrs. Clark	215	Valley	8	5	Till (?) and bedrock	Chain pump	No.
173	L. Gladwin	230	Slope		10	Till	Hand pump	No.

Drilled wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth (feet)	Driller	Kind of rock	Equipment	Yield (gallons per minute)
24	W. S. Porter	150	Hill	128		Till 20 feet, bedrock 108 feet.	Hand pump	
27	Burr	100	Slope	158		Bedrock	Gasoline engine.	15
74	Shailer	80	Terrace	150	Murray Bros.	Stratified drift 90 feet, bedrock 60 feet.	Windmill	
96	Tyler	80	do	102		Stratified drift, probably to bedrock.	Hand pump	
[a]118	Arthur Dean	475	Slope	80	Murray Bros.	Till 25 feet, bedrock 55 feet.	do	
165	S. E. Spencer	300	do	50	do	Chiefly bedrock	Gravity pipe line.	

[a] Drilled in bottom of dug well about 25 feet deep.

Records of wells and springs in Haddam—Continued

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
46	Andeen	130	Hillside	Till	Well-like pit 7 feet deep; gravity pipe line.	
49	Halsey	200	do	do	Board-covered pit; gravity pipe line.	
[a]50	Undina Beverages Co.	300	do	do	Excavation 12 feet in diameter and 8 feet deep; gravity pipe line.	2-3
51	Bresmith & Johnson.	300	do	do	Gravity pipe line.	
52	Lilgren	160	do	Till and bedrock contact.	2 pits 2 to 3 feet deep; gravity pipe line.	
53	John F. Roberts	110	do	Till (?)	Covered well-like pit; piped to stock trough.	
54	Pelton	220	do	Till	Spring house over shallow pit; gravity pipe line.	
62	Waters	110	Valley	do	Tile sunk 3 feet in earth.	
92	Arnold	100	Base of hill	Fractures in bedrock.	None; open seep.	2-3
105	Public road	40	Hillside ravine	Stratified drift and bedrock contact.	Open pit	
109	Waterhouse	120	Hillside	Till-bedrock contact and bedrock fractures.	Open pool; gravity pipe line.	Fails.
110		100	Valley, edge of brook.	Fractures in bedrock.	Shallow open pool	1
116	C. Dickinson	465	Bench on hillside	Till	Barrel sunk in till	
154	Hijack	560	Base of hill	Probably from bedrock beneath till.	do	2-3
159	John Clark	340	Ravine on side of valley.	Till	None	4-5
160	Priest	260	Swampy valley	do	Tile; gravity pipe line ½ mile long.	
163	Wilbur Smith	220	Ravine, foot of bluff.	Fractures in bedrock.	Open pool	
166	W. P. Skinner	275	Ravine	Till, or till-bedrock contact.	do	
167	Brooks	300	Hillside	Till	2 barrels sunk in till; gravity pipe line.	2-4

[a] Water is piped to 3 or 4 houses and is also bottled and sold as a beverage under the name "Granite Rock Spring Water."

CHESTER

AREA, POPULATION, AND INDUSTRIES

Chester was formed from Saybrook in 1836. It lies west of Connecticut River between Saybrook and Haddam and east of Killingworth. Its shape is roughly rectangular, and its width from north to south is about 3 miles and its length about 5 miles. The total area of the town is 10,338 acres or 16.2 square miles. The population in 1920 was 1,675. Most of the people live in the village of Chester, in the eastern part of the town. The village is built in the converging valleys of two brooks, the larger of which is called Chester River. There are several factories that utilize the water power of the two streams. The products manufactured include steel bits and brass and wire goods, also ivory goods and allied toilet articles, which are a local specialty. Outside the village agriculture is the only important industry. Most of the town is rough and wooded, probably less than one-third being cultivated. The Valley division of the New York, New Haven & Hartford Railroad follows Connecticut River across the eastern part of Chester, passing about a mile east of the center of the village. A State highway connects the village with points north and south.

TOPOGRAPHY AND DRAINAGE

The eastern boundary of Chester is at sea level on Connecticut River, which is tidal. West of the river the surface rises rapidly into a dissected plateau whose summit is 400 to 600 feet above sea level. The highest hill in the town, between Water House Pond and Deep Hollows Reservoir, is slightly more than 600 feet above sea level. Along Connecticut River lies a narrow terraced valley less than a mile wide, which contains some fairly level land. The other valleys are narrow with steep slopes and numerous low bluffs. Some of the hilltops are broad and rolling. The relief usually exceeds 200 feet. Most of the drainage goes east through Chester River into Connecticut River. In the western part of town there is a deep north-south valley occupied by Cedar Lake and Cedar Swamp, both of which drain eastward through Chester River.

GEOLOGY

Bedrock.—Crystalline rocks underlie the drift throughout Chester. Most of the western part of the town is underlain by the Haddam granite gneiss and the eastern part by the Hebron gneiss. There are also smaller bodies of other gneisses. Rock outcrops are common over the town, particularly on the sides of valleys.

Drift.—Till forms the surface of three-fourths or more of Chester, and stratified drift the remainder. The till covers all the slopes and hilltops. It is sandy, like that of Haddam, and in some localities it strongly resembles stratified drift. The thickness of till is variable, but well records at a few places show a thickness of 30 to 40 feet, probably very near the maximum.

Stratified drift occurs in the Connecticut River valley, where it forms a fairly level belt of land somewhat less than a mile in width. The valley is terraced, as it is in Haddam. A set of very narrow stratified-drift terraces borders the small streams in Chester village. The stratified drift of Chester River extends irregularly upstream in a more or less discontinuous band that gradually rises in altitude. About the borders of Cedar Lake and Cedar Swamp are narrow strips of stratified drift, and there is a considerable deposit in a tributary valley just west of Cedar Lake along the road to Killingworth. The maximum thickness of stratified drift recorded in wells is 36 feet, but it is probably 75 feet or more at a few localities in the Connecticut River valley. At most places, however, the stratified drift is thin, like the till. The following table shows the greatest thicknesses of drift in wells for which records were obtained.

Depth of drift penetrated by wells in Chester

Wells in till		Wells in stratified drift	
No.	Depth (feet)	No.	Depth (feet)
21	40	69	36
49	37	134	28
50	33		

WATER SUPPLY

Water from a reservoir in Killingworth is supplied to the village of Chester by the Guilford-Chester Water Co. Although the mains reach most of the village, there are still a great many dug wells in use. Outside the village wells are almost the sole dependence for water for domestic use. The appended table gives the records of 138 dug wells and 3 springs used as individual water supplies. Their locations are shown on Plate 5 and Figure 19.

Wells.—Dug wells are practically the only type of well used in Chester. About 70 of the dug wells, slightly more than half the number examined, start in stratified drift. Of the total number about 50 penetrate to or into bedrock. The dug wells are generally reliable, but 12 are reported to fail regularly each year and 6 occasionally. The average depth of all dug wells is 16 feet, and the average depth to water in them 10 feet, a low figure compared with that in other towns.

Springs.—Three of the factories at Chester use small springs (not shown on the maps or in the tables), which supply a small quantity of drinking water for employees. The springs issue on slopes at the base of the stratified-drift terraces that extend through the town. For other purposes all the factories use brook water or the public supply.

Suggestions for development.—There is at present no particular need for much ground water in Chester. The lower levels of stratified drift in the Connecticut River valley would yield large quantities of ground water. On high-level terraces stratified drift which occurs as thin patches over an irregular bedrock floor is not a favorable source for water, as was noted under Haddam. Many of the domestic wells obtain water in such circumstances, but the supply is small and the wells are likely to fail. An exception may be made of a part of the 60-foot terrace in the Connecticut River valley along the highway west of Hadlyme station. A large supply of ground water could be

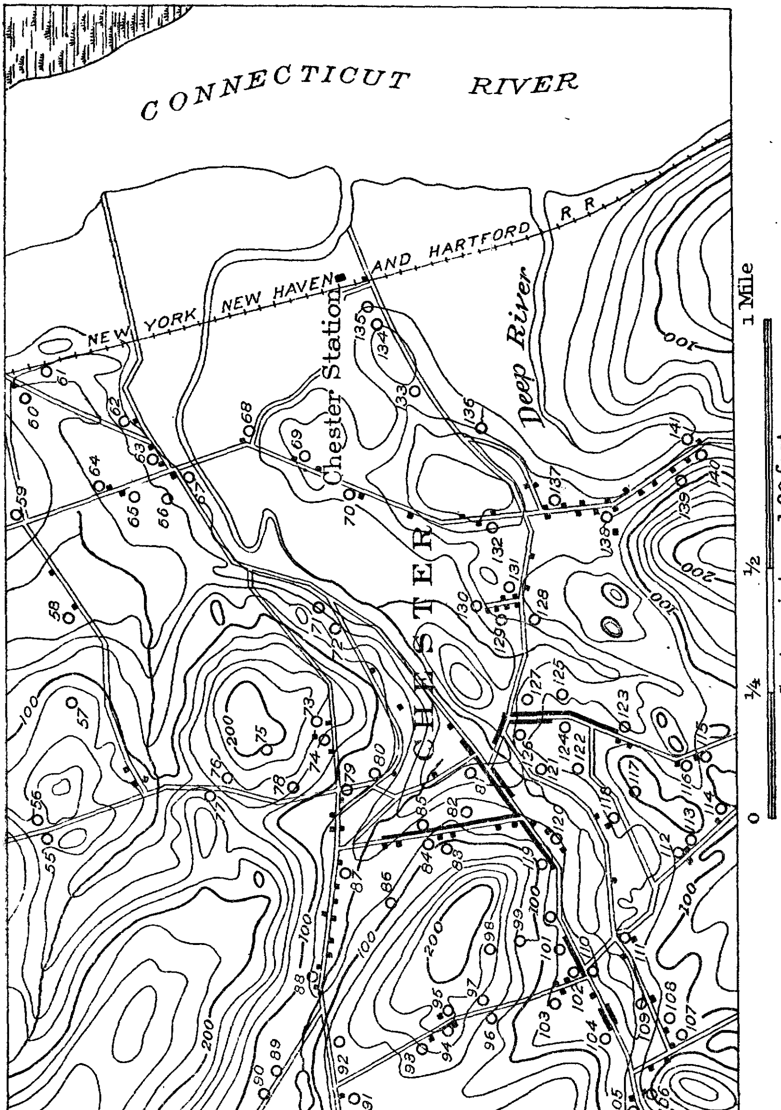

FIGURE 19.—Map of Chester and vicinity showing location of wells and springs. (Base from map of Saybrook quadrangle, surveyed in 1890)

obtained in the small valley there by wells 10 to 20 feet in depth, as the ground-water level is maintained near the surface by a ridge of bedrock which crops out along the railway west of Hadlyme station.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Chester

[Observations made Oct. 20 to 24, 1919. a before number of well indicates that well is abandoned]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
1	Agnelli	140	Valley	12	5	Till and probably bedrock.	Pulley	No.
2		140	do	21	14	Chiefly bedrock	do	(?).
3	Capellini	100	do	21	10	Stratified drift and bedrock.	Hand pump	No.
4	Mrs. Alander	100	Slope	15	9	Stratified drift	None	Yes.
5	C. S. Priest	100	Terrace	14	7	Stratified drift and probably bedrock.		(?).
6	Montana	20	do	20?	18?	Stratified drift	Hand pump	No.
7		60	do	26	17	Stratified drift and bedrock (?).	Pulley	
8	Costello	60	do	15	11	Stratified drift	Hand pump	No.
9	do	70	do	25	17	do	Pulley	No.
10	Robbins	40	do	17	7	Till 13 feet, bedrock 4 feet.	Chain pump	No.
11	Varaselli	50	do	12	5	Stratified drift	do	No.
12	Kirtland	55	do	13	5	do	Pulley	No.
13	Johnson	140	Slope	13	10	Till	Hand windlass	No.
14		280	do	16	6	do	Hand pump	(?).
15	A. H. Douce	410	do	14	7	do	Pulley	Yes.
16	A. E. Post	420	Hill	15	6	Till and bedrock	Hand pump	No.
17	O. Johnson	200	Slope	14	5	do	Pulley	No.
18	C. O. Lyon	120	do	15	11	do	do	Yes.
19	Fargo	180	Terrace	20	15	Stratified drift	do	No.
20	B. Harwood	170	Valley	10	5	do	do	No.
21	C. R. Gladding	200	Slope	40	12	Till	do	No.
22	F. Goen	240	do	16	8	do	do	No.
23	L. A. Kelsey	175	Valley	13?	10?	Stratified drift	Hand pump	Rarely.
24	Epperi (?)	180	do	14	9	do	Pulley	No.
25	Benta	240	Slope	15	10	Till	do	No.
26	Strodt	210	Valley	10	8	Stratified drift	Chain pump	No.
27	Stahl	210	do	8	2	Stratified drift and bedrock.	Hand pump	No.
28	Buena	210	do	11	7	Stratified drift (?)	Chain pump	No.
29		280	do	10	1	Till	Hand windlass	(?).
31	Bergunzie	400	Hill	15	10	do	Pulley	No.
32	Colomari (?)	450	Slope	18	8	Till and probably bedrock.	Chain pump	No.
33	Misnik	470	do	22	12	do	Pulley	No.
34		470	do	21	8	Till	do	No.
35		500	Hill	10	3	do	Sweep	(?).
36	Markham	510	do	21	8	do	Chain pump	No.
37	do	510	do	18	6	do	Hand pump	No.
38	A. Swann	500	do	20	12	do	Pulley	No.
39	Beckley	300	Terrace	17	10	Stratified drift	do	No.
40	Miska	300	do	25	23	do	do	No.
41	Cole	290	do	24	22	do	Hand windlass	No.
42	Neighbor	275	do	17	14	do	Hand pump	No.
43		280	do	15	8	do	Pulley	No.
44		270	do	13	9	do	Chain pump	No.
45	Chalny	280	do	16	9	do	Pulley	No.
46		280	do	13	8	do	Hand pump	No.
47	Briest	300	do	12	5	Till	Hand windlass	(?).
48	Westcott	300	do	12	5	do	Hand bucket	No.
49	A. Jaegger	360	Hill	37	27	do	Hand windlass	No.
50	Public well	380	do	33	19	do	do	No.
51	do	360	Valley	13	2	do	None	No.
52	Seifert	320	Terrace	15	13	Stratified drift and bedrock.	Chain pump	No.
53	Lantree	350	Slope	12	2	Till	Gravity pipe line.	No.
54	John Paul	400	Hill	18	8	do	Chain pump	No.
55	Frank Koski	150	do	15	5	do	do	(?).
56		150	do	18	8	do	Pulley	No.
57	Ott	130	do	25?	(?)	Till and bedrock	Gravity pipe line.	No.
58	J. A. Smith	40	Valley	12	7	Stratified drift and bedrock.	Chain pump	Rarely.
59	Warner	50	Terrace	14	8	Stratified drift	do	No.
60	do	40	do	14	6	Till (?)	do	No.
61	do	40	Valley	13	5	Till 8 feet, bedrock 5 feet.	Hand pump	No.
62	Phil. Monte	10	do	9	5	Stratified drift	Pulley	No.

[a] Water reported to be softest when well is very full.

Records of wells and springs in Chester—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
63	David Peroti	10	Vally	10	5	Stratified drift	Chain pump	No.
64	Stager	40	Terrace	15	11	Stratified drift and probably bedrock.	Hand pump	(?).
65		40	do	23	18	Stratified drift	Pulley	(?).
66	Bartman	10	Valley	7	4	do	Hand pump	No.
67	Holmes	5	do	7	5	do	Pulley	No.
68	Kay	10	do	10	6	do	Hand pump	No.
69	Foster	40	Terrace	36	33	do	Pulley	Rarely.
70		30	do	15	12	Stratified drift and bedrock.	do	Rarely.
71	Herrel	60	do	25	15	Stratified drift and probably bedrock.	do	No.
72	Cohen	60	do	26	15	Stratified drift	Hand windlass	Yes.
73	Regar	160	Slope	15	11	Till	Hand pump	No.
74	Simpson	160	do	17	9	do	Hand windlass	No.
75	Montana	175	do	18	6	do	Gravity pipe line.	No.
76		140	Hill	19	12	do	Chain pump	No.
77		150	Slope	20	13	do	do	No.
78	J. W. Williams	130	do	10	5	do	Gravity pipe line.	(?).
79	C. Watrous	60	Terrace	21	18	Stratified drift and probably bedrock.	Rope and pulley.	(?).
80	C. N. Silliman	80	Slope	10	5	Till and bedrock	Hand bucket	No.
81	Louis Tisso	40	Terrace	13	10	Stratified drift	Hand pump	No
82		80	do	14	7	Stratified drift and bedrock (?).	Pulley	(?).
83	Joiner	100	Slope	20	10	Till and bedrock	do	Yes.
84	Slater	100	do	15	9	do	Gravity pipe line.	No.
85	A. Wilcox	60	Terrace	19	10	Stratified drift and bedrock.	Pulley	Rarely.
86	Slater	100	Slope	18	15	Till and bedrock	Gravity pipe line.	No.
87	D. H. Gilbert	60	Valley	14	10	Stratified drift	Chain pump	No.
88	Mrs. Gaylord	80	Slope	18	15	Till and probably bedrock.	do	No.
89	Carini	100	Valley	10	6	Stratified drift	do	No.
90	Colimini	100	do	18	13	do	do	No.
91	M. F. Perry	130	Terrace	11	8	Till	Pulley	No.
92	Carini	140	Slope	12	5	do	do	No.
93		170	Hill	16	10	do	Chain pump	No.
94	E. C. Watrous	170	do	13	9	Chiefly bedrock	Pulley	No.
95	Wilcox	180	Slope	13	8	Till and bedrock	do	Rarely.
96	Ayres	140	do	13	8	do	do	Yes.
97	Crook	160	do	13	8	do	do	No.
98	Hunt	150	do	21	16	do	Gravity pipe line.	No.
100	Arnold	80	Terrace	20	17	Stratified drift and bedrock.	Pulley	Yes.
a101	Hunt	80	do	21	16	do	None	Yes.
102	H. Norton	60	do	24	19	Stratified drift	Pulley	No.
103	C. G. Bennet	80	Valley	17	12	do	do	No.
104	Mamorse	80	Terrace	23	19	do	do	No.
105	Mrs. Jones	80	do	19	14	do	Chain pump	No.
106	W. H. Stevens	100	Slope	22	15	Till and probably bedrock.	Pulley	(?).
107	Anna Fargo	95	Terrace	13	7	Stratified drift and bedrock.	do	No.
108	do	90	do	11	6	Stratified drift	do	No.
109	A. Smith	80	do	13	5	do	Hand pump	No.
110	Clement Bailey	60	do			do	Windmill	No.
111	Leete	80	do	19	15	do	Chain pump	No.
112	Adams	90	do	13	10	Till and bedrock	Pulley	No.
113	McNamara	100	Valley	11	5	do	do	Yes.
114	Daly	90	do	12	5	Till	do	No.
115		90	Terrace	15	10	Till and bedrock	Hand bucket	(?).
116		80	do	10	5	do	Pulley	(?).
117	F. E. Parker	100	Hill	22	12	Till 4 feet, bedrock 18 feet.	do	Yes.
118		70	Terrace	11	6	Stratified drift	do	(?).
119	Marelli	100	Slope	26	24	Till and probably bedrock.	do	(?).
a120	Mrs. Wright	60	do	14	9	Stratified drift and probably bedrock.	Chain pump	Yes.
121		50	Terrace	12	5	do	Hand pump	(?).
122	Barry	70	do	20	15	Stratified drift and bedrock.	Pulley	Yes.

Records of wells and springs in Chester—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
123	Lynch	60	Valley	13	6	Stratified drift	Pulley	No.
124	Champlain	70	Terrace	18	14	Stratified drift and probably bedrock.	Hand windlass	No.
125		60	do	21	12	do	Pulley	No.
126	Moore	60	Slope	20	11	do	do	No.
127	Stewart	60	do	14	6	Chiefly bedrock	Hand pump	No.
128	Wilcox	40	Valley	10	5	Stratified drift	Pulley	No.
129	Chas. Shipman	60	Slope	19	7	Till	Chain pump	No.
130	Bertelli	30	do	15	9	do	do	No.
a131	DeForrest	60	do	15	5	do	do	No.
132	J. S. Nobb	60	do	19	12	Till and bedrock	do	No.
133	Ott	40	Terrace	12	7	Till	do	No.
134	A. Monte	20	do	28	17	Stratified drift	Pulley	No.
135	Vyborny	10	do	16	8	do	do	No.
137	St. Joseph's Church.	40	do	20	15	do	Chain pump	No.
138	Myers	60	do	15	12	Stratified drift and bedrock.	Pulley	No.
a139	Pine Tree Hotel	60	do	11	6	Till and probably bedrock.	None	(?).
140	R. D. Gilbert	60	do	15	10	Till	Chain pump	No.
141	Baker	30	Slope	15	10	Stratified drift and probably bedrock.	do	No.

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
30	Bergonzie	380	Ravine	Till and bedrock	Excavation 4 feet deep and spring house.	2-3
99	Fanning	120	Hillside	do	Gravity pipe line	2-3
136	L. Zanelli	10	Foot of bank	Cleavage planes in bedrock; old quarry face.	Piped to tub	1-2

a Water reported to be hardest when well is very full.

KILLINGWORTH

AREA, POPULATION, AND INDUSTRIES

Killingworth is an interior town lying just north of Clinton and east of Madison. It was formed in 1667 and at that time included the town of Clinton. The entire western boundary is formed by Hammonasset River. The shape of the town is irregular, its greatest length from north to south being about 8 miles and its width 3 to 5 miles. Its area is 23,791 acres, or 37.2 square miles. The population was 531 in 1920 and is decreasing rather than increasing. The town is of a purely rural character and lacks public utilities of any kind. Its only industries, with the exception of one small cotton mill, are agriculture and lumbering.

TOPOGRAPHY AND DRAINAGE

The extremes of altitude are about 20 feet above sea level on Hammonasset River in the southwest corner of the town and 600 feet on certain hills on the northern boundary. Most of the town lies between 200 and 500 feet above sea level. Killingworth is much dissected and unusually rugged. It has a relief averaging 100 feet in most parts of the town and 200 feet in places. The hills are rough and rocky. The northern part of the town contains a number of large swamps created by glacial disturbance of the drainage. The general slope of the land is southward, and the streams all flow in that direction. More than half the town is drained by Hammonasset River and most of the remainder by Menunketesuck River.

GEOLOGY

Bedrock.—The bedrock under nearly all of Killingworth is the Haddam granite gneiss, which ranges from light gray to nearly black. It is exposed at many places all over the town, but especially in the western half, where the slopes are steepest. In the southwest corner of the town there is a small area of the Middletown gneiss, which is exposed along the Killingworth-Clinton road.

Drift.—Stratified drift is found in a few valleys, but till covers about 95 per cent of Killingworth. (See pl. 7, *B*.) The till of Killingworth is inclined to be sandy, like that of Haddam and Chester. The following are the greatest depths of till recorded in wells:

Depth of till penetrated by wells in Killingworth

	Feet		Feet
Well 139	38	Well 63	37
145	33	128	38

Stratified drift is found in several localities in very narrow belts, usually terraces bordering stream valleys. Its thickness is generally not great, although in the district near Southwest School it probably exceeds 50 feet, and in well 156 a thickness of 39 feet is recorded.

WATER SUPPLY

Wells.—Wells are almost the sole dependence for water supply in Killingworth. The houses are mostly on the uplands, where springs are not convenient for use. The table gives the records of 153 dug wells and 4 springs which were examined in the town. Their location is shown on Plate 5. The only type of well in use is the dug well. There are very few areas where driven wells could be used.

Most of the Killingworth wells are in till or till and bedrock. Only about 20 start in stratified drift. About 40 wells reach or penetrate bedrock. Twenty wells are reported to fail regularly and 4 rarely. The average depth of all dug wells is 19 feet. The deepest wells are those of Schuritcel and Couts (143 and 144), on Chestnut Hill, 51 feet and 42 feet, respectively. Both penetrate some rock beneath the till.

Suggestions for development.—Presumably it will not be necessary to develop much ground water in Killingworth. The largest supplies, though possibly not the best quality of water, could be obtained from shallow dug wells in the swamps. Many marshy areas and springs probably could be made to yield considerable water. Shallow wells in the stratified drift at many places will yield a large quantity of water. In the principal area of stratified drift, in the southwestern part of town, however, the drift lies on a sloping bedrock floor high above the adjacent river, and most of its water drains away, so that only at the contact with bedrock is any water obtained, and even there the supply is generally small and unreliable. This condition is well illustrated by wells 149 and 150, which are near the border of the stratified-drift terrace. Both penetrate stratified drift to bedrock. No. 149, which is nearest the hill slope above the terrace, is 20 feet deep, and its water level is only 10 feet below the surface. This well probably penetrates several feet of till or bedrock. No. 150, about 200 feet farther out on the terrace, is 29 feet deep, and the depth to water is 25 feet.

RECORDS OF WELLS AND SPRINGS

Records of wells and springs in Killingworth

[Observations made Oct. 16 to 29, 1919, except well 73, which was examined June 6, 1919. a before number of well indicates that well is abandoned]

Dug wells

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
1	Vulk	300	Valley	10	8	Stratified drift	Hand pump	No.
2	Nuetzel	300	do	10	7	do	Pulley	No.
3	Kuever	300	do	16	13	do	do	No.
4		500	Hill	26	5	Till	None	No.
5		500	do	26	12	do	do	No.
6	E. H. Budde	620	do	14	5	do	Chain pump	Yes.
7	Miller	620	do	13	9	Till and bedrock	do	Yes.
8	Joseph Nogar	580	do	14	10	do	Hand windlass	No.
9	Miller	600	Slope	11	5	Chiefly bedrock		No.
10	Beyrodt	580	Valley	13	3	Till and bedrock	Hand bucket	No.
11	Charles Piersig	560	Hill	20	14	Till	Pulley	No.
12	Stone House School.	480	Terrace	17	14	Stratified drift	Chain pump	No.
14		400	Slope	20	11	Till 14 feet, bedrock 6 feet.	Hand bucket	Yes.
15		400	do	16	13	Till and probably bedrock.	None	(?).
16	W. R. Hotchkiss	400	do	19	12	Till and rock	Hand pump	No.
17	Rockbauer	420	Hill	15	8	Till	Pulley	No.
18	Charles Blatchley	310	Terrace	15	10	Stratified drift	do	No.
19	Hofrichter	420	Hill	17	11	Till and bedrock	Hand bucket	Yes.
20	Rullman	500	do	29	17	Till	do	No.
21	do	500	do	25	16	do	Pulley	No.
22	Joseph Millacey	510	do	16	8	do	do	No.
23	Myers	480	Slope	19	13	Till and bedrock	do	Yes.
24	W. J. Bearies	420	Hill	20	8	do	do	Yes.
25		300	Terrace	17	14	Stratified drift	Hand windlass	No.
26		280	do	20	16	do	do	No.
27		280	do	16	13	do	Pulley	No.
28		450	Hill	15	5	Till	None	(?).
29	Pyne	460	do	19	13	do	Hand windlass	No.
31	Melacarne	400	Valley	15	10	Till and bedrock	Pulley	No.
32	Joseph Polassus	530	Slope	21	10	Till	do	No.
33	Thode	500	do	16	8	do	do	No.
34	Joseph Dunnock	500	Hill	22	12	do	Hand windlass	No.
35		500	do	27	19	do	Pulley	No.
36	Meyer	500	Flat	12	6	do	do	No.
37	Polimos	500	Hill	20	10	do	do	No.

Records of wells and springs in Killingworth—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
38	Schnoor	410	Hill	19	13	Till	Pulley	No.
39	do	410	do	15	10	do	None	No.
40	do	400	Valley	11	6	do	Pulley	No.
41	Clepprodt	440	Hill	22	14	do	do	No.
42	do	460	do	12	10	Till and bedrock	do	Yes.
43	H. G. Nettleton	450	Flat	15	10	Till	Chain pump	No.
44	Griswold	460	do	14	9	do	Sweep	No.
45	Charles Nettleton	460	do	14	5	do	Chain pump	No.
46	Wall	480	Hill	15	16	Till 11 feet, bedrock 4 feet.	Hand windlass	No.
47	Adamatz	480	do	21	10	Till	do	No.
48	Anderson	460	Slope	14	10	do	Pulley	No.
49	C. Deckerman	480	Hill	20	9	Till and bedrock at bottom.	Hand windlass	No.
50	O. Melacarne	480	do	21	8	Till	Sweep	Yes.
51	do	480	do	23	11	do	Pulley	No.
52	Machold	460	do	24	10	do	do	No.
53	Plattenberg	450	do	23	9	do	do	No.
54	Hatch	400	do	13	8	do	Chain pump	No.
56	Parmelee	480	Slope	12	5	do	do	No.
57	Jones	420	Hill	20	10	Till and bedrock	Hand pump	No.
58	Svivoec	400	do	12	5	Till	Pulley	No.
59	Croper	370	Flat	14	8	do	do	No.
60	Liska	280	Hill	17	13	Till and bedrock		No.
61	Schubert	360	Slope	15	8	Till	Hand pump	No.
62	Holle	360	Hill	13	5	do	Pulley	Yes.
63	LeGary	380	do	37	27	Probably till	do	No.
64	Holle	340	Slope	12	8	Till	None	(?).
65	Ordney	305	Flat	19	12	do	Chain pump	No.
66	Rehm	300	do	23	10	do	do	No.
67	Peterson	300	do	15	8	do	Pulley	No.
68	Nelson	300	do	21	7	do	do	No.
69	W. H. Stevens	310	do	15	7	do	Chain pump	No.
70	Parmelee	300	do		5	do	Pulley	No.
71	I. B. Harris	300	do	13	10	Till and bedrock	do	Yes.
72	Mrs. Harris	300	do	12	7	Till	do	No.
73	McFord	300	Hill	14	11	Till and bedrock	None	Yes.
74	Sherwood	300	do	16	9	do	Pulley	Rarely.
75	Joseph Marcinek	310	do	10	6	Till	do	No.
76	Wulfert	300	Flat	15	5	do	Hand pump	No.
77	Steve Pamula	310	do	24	15	do	Hand windlass	No.
78	E. E. Lord	280	do	15	13	do	Sweep	Yes.
79	do	280	do	12	8	do	do	No.
80	do	280	do	20	15	do	Chain pump	No.
81	Marcinek	280	do	18	12	Till and bedrock	do	Rarely.
82	Charles Gessick	280	Hill	21	17	Till	do	No.
83	Mrs. Stone	280	Flat	17	10	do	Pulley	No.
84	F. T. Doolittle	300	do	17	9	do	Hand pump	No.
85	Moore	300	Slope	11	2	do	Sweep	No.
86		300	Hill	18	12	Till (?)	None	(?).
87		380	Slope	15	10	do	Hand windlass	No.
88	F. Adamatz	460	Hill	12	3	Till and bedrock	Hand bucket	Yes.
89	C. F. Dowd	460	do	17	9	Till	Hand windlass	No.
90	Joseph Tippi	460	do	17	12	do	Pulley	No.
91	Parrelka	470	do	15	8	do	Hand windlass	No.
92	N. L. Parmelee	460	do	16	8	Till and bedrock	Pulley	No.
93	L. D. Parmelee	460	do	21	15	Till	do	No.
94		360	Terrace	19	17	Stratified drift (?)	None	No.
95		360	Slope	12	9	Till	do	(?).
96	Charles Frent	380	do	20	11	do	Hand windlass	No.
97	Frent	370	do	22	13	do	do	No.
98	Pinney	360	do	26	14	do	Pulley	No.
99	Skelnirk (?)	360	do	10	2	do	Hand windlass	No.
100	M. A. Bitzer	370	do	14	7	Till and bedrock	Pulley	Yes.
101	Kaplan	350	do	18?	10?	Till	Hand pump	No.
102	Parmelee	380	do	26	17	do	Hand windlass	No.
103	Fabiszac	380	Flat	14	7	do	Pulley	No.
104	A. Lower	440	Hill	15	9	do	do	No.
105	Adamatz	420	Slope	22	13	do	do	Yes.
106	do	480	Hill	30	20	do	do	No.
107	Nettleton	460	do	25?	8?	do		No.
108	H. Hesser	445	do	28	17	Till and probably bedrock.	Pulley	No.
109	H. C. Marsh	430	do	15	9	Till	do	Yes.
110	Buhrer	420	do	22	9	Till and bedrock	do	No.
111	H. S. Markham	420	do	18	7	Till	do	No.

Records of wells and springs in Killingworth—Continued

Dug wells—Continued

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Depth of well (feet)	Depth to water (feet)	Kind of rock	Equipment	Does well fail?
112	H. S. Markham	420	Hill	10	3	Till	Hand bucket	No.
113		420	do	14	7	do	Hand pump	No.
114	Church	420	do	19	9	do	do	No.
115	Yunker	380	Slope	23	15	Till (?)	do	No.
116	Schretzeel	380	Hill	11	8	Till and bedrock	Chain pump	Almost.
117		380	do	16	8	Till	do	(?).
118	F. E. Winkel	365	Flat	15	6	do	do	No.
119	Warner	310	do	16	8	Till and bedrock	do	No.
120	Markwick	310	do	14	8	Till and bedrock (?)	Pulley	No.
121	Public road	340	do	11	5	Till	Chain pump	No.
122	Chittenden	320	Slope	4	1	Chiefly rock	Hand pump	Yes.
123	Wood	340	Hill	18	10	Till and bedrock	None	No.
124		300	do	20	12	Till	Hand pump	No.
125	Chittenden	300	do	16	12	do	Pulley	Yes.
126	do	280	do	24	15	do	do	No.
127	John Mako	240	do	16	10	do	Chain pump	No.
128	Zimmerman	265	do	38	25	Till and probably bedrock.	Pulley	No.
129	do	240	Valley	12	3	Till	do	(?).
130	Van Normand	260	Hill	35	28	do	do	No.
131	Coe	200	do	30	19	do	do	No.
132	C. N. Davis	120	Valley	11	5	do	Chain pump	No.
a133		130	do	13	8	Stratified drift	None	No.
134	Mike Gott	325	Hill	22	14	Till	Pulley	No.
135	Dowd	325	do	25	15	Till and bedrock	do	No.
136	S. Kelsey	325	do	21	10	do	do	No.
137	George Redford	330	do	24	8	Till	None	No.
138	Bergman	320	do	27	17	Till and bedrock	Pulley	No.
a139	A. Hull	330	do	38	27	Till	None	No.
141	D. W. Evarts	340	do	21	12	do	Pulley	Yes.
142	Knapp	290	Flat	14	7	do	Hand pump	No.
143	G. P. Schuritcel	300	Hill	51	20	Till 20 feet, bedrock 31 feet.	Pulley	No.
144	Couts	320	do	42	21	Till and bedrock	do	No.
145	Dahlberg	280	do	33	16	Till	do	No.
146	do	260	Slope	12	6	do	do	No.
147	Ott	100	Terrace	21	15	Stratified drift	do	No.
148	Yeshore	100	do	28	25	Stratified drift and bedrock.	do	No.
149	Pitrof	105	do	20	10	Stratified drift and probably bedrock.	Hand windlass	Yes.
150	do	100	do	29	25	Stratified drift and bedrock.	Pulley	No.
a151	M. Nettleton	80	do	24	21	Stratified drift	None	No.
152	P. E. Parmelee	80	do	22	20	do	Pulley	No.
153	Myer	90	do	22	17	Stratified drift and bedrock.	Hand pump	No.
154	Nettleton	100	do	24?	(?)	do	do	Rarely.
155	Snyder	60	do	24	21	Stratified drift and probably bedrock.	Pulley	No.
156	Daly	60	do	39	30	Stratified drift	do	No.
157	Wise	60	Slope	14	12	Stratified drift and probably bedrock.	do	No.

Springs

No. on map	Owner	Altitude above sea level (feet)	Topographic position	Source	Improvements	Yield (gallons per minute)
13	Hammonasset Club	400	Hillside	Small excavation	Gravity pipe line	
30		400	Slope	Till and bedrock	Open stone-walled pit 1½ feet deep.	
55	Public road	470	Small break in slope.	Till	Tile sunk 11 feet in earth.	
140	Hall	260	Foot of hill (drumlin).	do	None	1-2

INDEX

Topography by U. S. Geological Survey
Surveyed in 1889 and 1890

Geology by J. S. Brown

GEOLOGIC MAP OF THE NEW HAVEN AREA SHOWING LOCATION OF WELLS AND SPRINGS

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

Contour interval 20 feet.
Datum is mean sea level.

1928