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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

WATER-SUPPLY PAPER 223

UNDERGROUND WATERS OF SOUTHERN MAINE

BY

FREDERICK G. CLAPP

WITH

RECORDS OF DEEP WELLS

BY

W. S. BAYLEY

WASHINGTON
GOVERNMENT PRINTING OFFICE
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INTRODUCTION.

LOCATION AND AREA.

The area covered by this report is roughly triangular and includes all of southern Maine, from the coast northward beyond Calais, Oldtown, Skowhegan, and Rangeley. Its northern boundary may be said to follow very nearly the line of the forty-fifth parallel, but a few towns situated a short distance north of the line have, for special reasons, been included in the discussion. Fig. 1 shows the relation of this area to the rest of the State. Its greatest extent east and west is 210 miles, and north and south, along the New Hampshire line, about 130 miles.

CHARACTER OF REPORT.

It was originally intended that the entire State should be covered by a single report, but field investigations showed that the subject was much broader than at first supposed. Although there are large areas which are settled either sparsely or not at all, where little information regarding underground waters can be obtained and little is yet needed, there are wide areas where the water problem is very important and extensive well drilling is going on. This is true of the summer-resort regions, and of the great farming region covering the larger part of Aroostook County. It was found impracticable, therefore, to include the entire State in a single report, and it was decided to confine this report to the region south of the forty-fifth parallel, and to cover the northern part of the State by a special investigation.[a]

In order to meet the needs of all classes of readers the report is so subdivided as first to describe the general water resources of the region, the dependence of quality and quantity on character of rocks,

[a] The report for the northern part of the State is in preparation.

the location and type of wells, etc., and then to discuss in detail the conditions in the various counties, for the benefit of persons needing

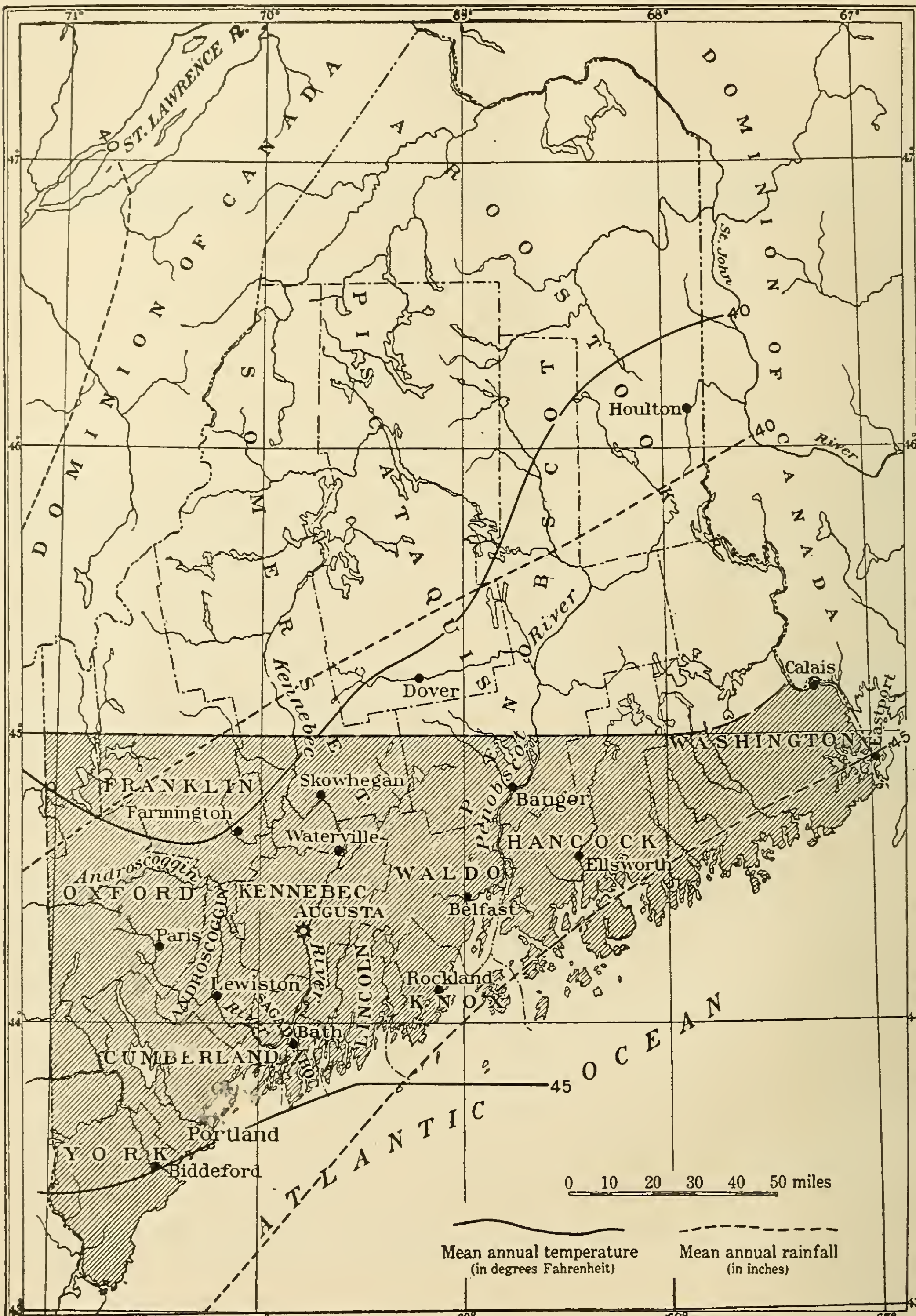

FIG. 1.—Index map showing area described in this report; also mean annual temperature and mean annual rainfall for Maine.

local information. The table of deep wells, compiled by Professor Bayley, is appended for the benefit of persons desiring to drill wells.

NEED OF INVESTIGATION.

The available knowledge regarding the underground-water resources of Maine has heretofore been rather scant. Surface waters and open wells have been largely used, and where deep wells have been resorted to they have been drilled at random, without a scientific forecast of the amount or the quality of the water available at that particular point or with that particular type of well. People are now beginning to realize that well drilling, like other prospecting, in order to be economical to the owners and drillers, must be conducted in accordance with certain scientific rules, which point out the source, depth, amount, and quality of water in different types of rock and different localities. Hence a comprehensive investigation is necessary throughout the State.

The Geological Survey frequently gets requests for information regarding the occurrence or the quality of water in certain towns. In sections of the State where water is scarce, as on the islands and along the coast, especially in the summer-resort region, it is necessary that people should be informed whether it is possible to obtain water by drilling, and if so, at what depth it may be procured. Many towns in the State are searching for a public supply, and some towns have poor supplies and wish to improve them. This report aims to help in solving such problems. Another object in view is the securing of proper well construction. In some parts of the State and by some drillers the most modern methods of drilling and casing wells are used; elsewhere, however, and by other drillers, wells are improperly constructed and some are dangerous to the public health. A comparison of the various methods of construction ought to teach valuable lessons.

SOURCES OF INFORMATION.

Previous literature.—The first lists of deep wells and springs in Maine were published in 1904.[a] A few additional wells were recorded in 1905.[b] A brief account of the underground-water conditions, with lists of important springs, was also given in 1905,[c] and in the same year the conditions in the Kittery-York district, in the extreme southwest corner of the State, were described.[d] A short paper in the same report described a possible water supply from glacial gravels in the vicinity of Augusta.[e]

Correspondence.—Much of the data contained in the first three of the above-mentioned reports was gathered by correspondence, but whenever records could subsequently be obtained in the field they

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[a] Bayley, W. S., Water-Supply Paper U. S. Geol. Survey No. 102, pp. 27–47.
[b] Darton N. H., Water-Supply Paper U. S. Geol. Survey No. 149, p. 63.
[c] Bayley, W. S., Water-Supply Paper U. S. Geol. Survey No. 114, pp. 41–56.
[d] Smith, G. O., Water-Supply Paper U. S. Geol. Survey No. 145, pp. 120–128.
[e] Smith, G. O., op. cit., pp. 156–160.

were added to the list. In obtaining records blanks were sent out containing questions to be answered by well owners or drillers. Considerable information regarding mineral springs has also been obtained by correspondence since the field work was finished.

Field work.—The field work for the present report was done during four months in the summer of 1906. The author was assisted by George C. Matson and B. L. Johnson, and many of the data here given are taken from their notes. It was impossible to visit every town, but all the larger places and those localities which present special problems were visited, and the conditions of occurrence and the quality of well and spring waters were investigated. All public water supplies from underground sources were seen, the important mineral springs were visited, and interviews were held with professional well drillers in order to get authoritative information regarding conditions of drilling.

ACKNOWLEDGMENTS.

The accuracy and completeness of this report have necessarily been dependent to a considerable extent upon the work of other persons besides the author. George C. Matson and B. L. Johnson have assisted in both field and office work. A number of years ago Prof. W. S. Bayley was requested to prepare a table of deep-well records of Maine, which were obtained by correspondence extending over a considerable period of time. These records as submitted by Professor Bayley contained some additional descriptive matter, which has been added to this report. The table has been revised and brought up to September, 1906, and appears on pages 242–259. Several pages of the report, bearing on occurrence and methods of obtaining water in general, have been compiled from notes furnished by M. L. Fuller. Some of the geologic descriptions are taken from reports by George Otis Smith and E. S. Bastin. A large number of the chemical analyses were made by Prof. F. C. Robinson, the samples being collected by A. C. Robinson. Analyses made by other chemists which were not originally expressed according to the uniform system adopted by the United States Geological Survey for use in its publications were submitted to R. B. Dole, of the Survey, for recomputation. C. E. Shute, C. H. Scribner, Fred Foster, Lester Maxwell, and the Poland Brothers, all prominent well drillers, have taken an interest in the investigation and furnished much valuable information. Other drillers have assisted in gathering data.

A comprehensive report on water supplies is manifestly impossible without the assistance of persons in the region which is to be benefited by the report, and in compiling the facts here presented it has been necessary to interview hundreds of residents of the State and to

correspond with several hundred more. To all who have assisted, directly or indirectly, the author wishes to express his thanks. In furnishing information to the Survey they have performed a valuable public service.

RESULTS OF INVESTIGATION.

The investigations thus far conducted in Maine have shown that there is an abundance of water beneath the surface in granite, slate, and other rocks, but as the water occurs in crevices which are not regularly distributed through the rocks, the amount which will be found at any given location or depth is uncertain and can never be definitely predicted. Water in the rocks is usually of good quality, but in some districts it has a large mineral content. Water in surface deposits is generally abundant except in dry weather, but the quality can not be depended upon. It has been found that drilled wells are the most satisfactory and that dug wells and combinations of dug and drilled wells are to be avoided, especially in villages. Most of the commercial mineral springs of the State are safely situated, and their water is of excellent quality. Only a few springs were seen which should be condemned. The public water supplies are mostly satisfactory, but in a few of them, owned by private parties or corporations, the water is badly polluted. In such cases the abandonment of present sources is recommended. No special investigation of surface supplies was made, but it is known that some of these are not satisfactory and that changes should be made.

SETTLEMENT AND DEVELOPMENT AS RELATED TO WATER UTILIZATION.

With the exception of Florida, Maine is the least densely populated of all the Eastern States (23.2 per square mile). Because of this fact and the abundance of lakes and streams, its people have until recently felt little necessity for seeking sources of water supply below the surface. Consequently the underground waters of the State have been, on the whole, but slightly utilized, except in certain restricted areas, where for one reason or another the surface waters have not been suitable for domestic or manufacturing purposes.

Until very recently the rivers and lakes have afforded excellent water for nearly all purposes. With the increase in the number of factories established on the main waterways the rivers have become less and less valuable as sources of water supply, partly because of the waste products poured into them from the factories and partly because of the increased amount of sewage which they must carry in consequence of the growth of the manufacturing communities on their banks.

The drift of the population toward centers is well shown by the census of 1900. The number of cities and villages separately enumerated in this year was 43, as against 25 in 1890, and their population was 258,431, as against 184,821 in 1890, or 37.2 per cent of the total population in 1900, as against 28 per cent in 1890.

The natural result of the two tendencies above mentioned has been pollution of the principal watercourses, with the consequence that communities drawing their public supplies from streams are beginning to complain of the quality of the water furnished them and are turning toward lakes or wells for relief.

Along the coast, where the larger rivers are tidal, communities are dependent on lakes and small brooks for their public supplies. On the islands the principal sources of drinkable water are springs and drilled wells, but as there are only a few island settlements of any considerable size the question of large public supplies for the islands is not of great moment. The rapid growth of summer-resort communities has brought about a demand for information regarding deep-well prospects in such places. In the interior of the State many villages that are not situated near large lakes or spring-fed brooks have taken advantage of the good springs and have obtained through pipes a supply of spring water.

SURFACE FEATURES.

GENERAL STATEMENT.

Water is found in some amount in all formations below the earth's surface from the loosest and most porous sands and gravels to the hardest slate and granite. The amount varies from the merest trace chemically combined in the molecules of the rocks to immense reservoirs which supply wells flowing hundreds of gallons per minute. Some waters are so pure that a refined chemical analysis shows only minute traces of organic and mineral matter; others are so heavily charged with minerals or other impurities as to be unsuitable for use.

The slope of the surface at any point is one factor determining the amount of water absorbed by the ground. The direction and amount of slope also determine the form of the water table—that is, of the upper limit of saturation. Except where the surface is flat the water table is generally not parallel with the surface; it is almost invariably farthest from the surface on the summits of hills and mountains and nearest to it in valleys and along the coast, reaching the surface in swamps and along rivers, lakes, and beaches. The surface of the water table is always in motion, its higher portions flowing toward the lowest outlets along rivers or the sea. This direction of flow explains why fresh water is usually found when a well is dug in a sandy beach.

PRINCIPAL SURFACE FEATURES OF SOUTHERN MAINE.

Altitudes in Maine range from sea level to about 5,200 feet, the highest summit being Mount Katahdin. In some of the central portions of the State the land is very mountainous, but in parts of Aroostook County it is nearly flat. The surface may be said to consist essentially of an extensive southward-facing slope draining directly into the Atlantic Ocean and a smaller northward-facing slope draining into St. John River. The latter area is a great plain with numerous swamps, above which rise a few hills. The surface of the southern slope is much more broken. Its western portion is crossed by ridges of low mountains trending east or northeast, some of which rise several thousand feet above the surrounding country. These are separated by wide areas of plain, on which are many small hills and ridges. Near the coast much of the surface is rough. Rocky ridges and low, bare hills stretch from the shore line some miles inland, but few of these hills are lofty and the valleys between them are not deep. The coast is in most places rocky, but at some points there are sandy beaches, several of which are among the finest in the country.

DRAINAGE.

GENERAL DESCRIPTION.

No other tract of country of the same extent on the continent is so well watered as Maine. The State contains five principal lake systems—that is, large lakes connected by rivers and discharging into main channels which convey their accumulated waters to the ocean.

These systems are, beginning on the western boundary, (1) the Umbagog-Rangeley series, with an area of 90 or more square miles, drained by Androscoggin River; (2) the Moosehead series, forming the headwaters of Kennebec River, the main lake of which is 120 square miles in area and is the largest inland body of water in New England; (3) the Penobscot series, consisting of Chesuncook and its surronding lakes on the West Branch of the Penobscot; Alleguash, Chamberlain, and others on the East Branch, and the Seboeis and others connected with it still farther east but flowing into the East Branch of the Penobscot; (4) the Schoodic Lakes, in the southeastern part of the State, drained by St. Croix River; and (5) the many lakes forming the headwaters of St. John River and its tributaries. There are many other lakes in every county, which, though of small area, in the aggregate hold an immense amount of storage water and add much to the importance of the lake systems of the State. The total number of lakes, not including small ponds tributary to the rivers, is 1,620, and their total area 2,300 square miles, making one lake to each 20 square miles of territory and one square mile of lake surface to each 14.3 square miles of land surface.[a]

DETAILED DESCRIPTIONS.

The main drainage systems within the area covered by this report are described below, the descriptions being taken from the paper by Pressey just cited.

[a] Pressey, H. A., Water powers of the State of Maine: Water-Supply Paper U. S. Geol. Survey No. 69, 1902, p. 16.

Saco River system.—Saco River rises in the White Mountain region of New Hampshire at an elevation of about 1,900 feet above the sea, and has a general southeasterly course to the Atlantic Ocean. The greatest length of the basin from Mount Washington to the sea is about 75 miles; the greatest width about 30 miles. The total drainage area is 1,750 square miles, about equally divided between Maine and New Hampshire. The general elevation of the basin is greater than that of any of the larger streams of Maine except the Androscoggin. The headwaters are in one of the highest and roughest mountain regions in the eastern part of the United States, with steep, wooded slopes and narrow river valleys and with heavy falls to the mountain streams. The mountains grow gradually lower, however, as the ocean is approached, becoming undulating hills in the central part of the basin and comparatively flat land near the sea. The northern part of the basin is still largely wooded, while in the southern part practically all of the forests have been cut, so that more than half the entire basin has been cleared.

Presumpscot River system.—This is one of the most interesting as well as one of the best water-power streams of its size in the United States. It is the outlet of Sebago Lake, which lies about 17 miles northwest of Portland. The lake is fed by Crooked River, a stream heading 35 miles farther north and within 3 miles of the Androscoggin. The area of the lake is 50 square miles, the area of its drainage basin at the outlet of the lake is 470 square miles, and the total drainage area of the river at its mouth is 700 square miles. The northern part of the basin is mountainous and wooded, while the southern part is moderately hilly and cleared of trees.

Androscoggin River system.—The Androscoggin River is formed by the junction of Magalloway River and the outlet of the Umbagog-Rangeley lakes near the Maine-New Hampshire boundary line. For about 35 miles it flows southward into the State of New Hampshire, then turns abruptly to the east and flows into the State of Maine, then turns to the south and joins the Kennebec in Merrymeeting Bay. The total drainage area above Brunswick, where is the last fall, is 3,700 square miles, about 80 per cent of which is in Maine. The greatest length of the basin is 110 miles, the greatest width 70 miles, while the river itself measures about 200 miles in length from the sources of Magalloway River to the coast. * * * The lower part of the basin is hilly and moderately wooded, while the upper two-thirds is very broken and mountainous and heavily timbered.

Kennebec River system.—The Kennebec River basin lies between those of the Androscoggin and the Penobscot, and extends from the Canada line to the ocean. The basin measures 150 miles in length and varies in width from 50 to 80 miles in the main portion, embracing a total area of 6,330 square miles. Of this area 1,250 square miles are tributary to Moosehead Lake. The general elevation is less than that of the Androscoggin basin, though near the center of the area Saddleback, Abraham, and Bigelow mountains rise as isolated peaks to elevations higher than any [other] mountains in the State except Katahdin. The river rises in Moosehead Lake, though its headwaters are collected by * * * a number of small streams rising in the hilly forested areas lying to the east and west of that lake. Near Moosehead the hills and highlands are well back from the lake, leaving a great open plain. The northern part of the drainage basin is broken by offsets from the White Mountains. Nearly the whole of the upper portion of the drainage area is forest covered and in its original wild state.

Penobscot River system.—The Penobscot has the largest drainage basin of all the rivers in Maine, comprising about 8,500 square miles, or more than one-quarter of the entire State. Its greatest length from north to south is 160 miles, its greatest width 115 miles, all within the State. Eight hundred square miles of the basin discharge their waters into the main river below its lowest water power at Bangor. The basin is at a lower elevation above the sea than the basins of the Kennebec and the Androscoggin, as would be expected from the general southeasterly slope of the country toward the Atlantic Ocean. The northern portion, however, is rather elevated, having a mean height of about 1,000 feet. The highest portion of the basin is at the headwaters of the main river, where the elevation is from 1,600 to 2,000 feet. Taken as a whole, the basin is rather uniform in its topographic features. Hills and low mountains stretch from near the sea above Bangor; farther north is an undulating plain, while to the west the surface becomes more broken and greatly diversified by hills, detached peaks, lakes, ponds, and swamps. At the south the basin merges into that of Kennebec, and at the north into that of the Alleguash. * * * A large part of the basin is what is known as "wild land," being heavily timbered and known only to the lumberman and the sportsman.

St. Croix River system.—St. Croix River is formed by two branches, known as the Upper St. Croix or Chiputneticook River, the outlet of the Schoodic Lakes, and Kennebasis River, the outlet of the western lakes of the area, known as the Kennebasis Lakes. The Upper St. Croix, with its tributary lakes, forms nearly half of the eastern boundary of Maine, separating that State from New Brunswick. The total drainage area of the main stream is about 1,630 square miles, of which 960 square miles are tributary to the great reservoir systems controlled by dams at Vanceboro and Princeton. The length of the stream from the headwaters to the mouth is 100 miles. The basin is, in general, lower than that of any of the larger streams of the State flowing into the Atlantic, its headwaters having an elevation of about 540 feet. * * * The lake system of the St. Croix is the largest in the State in proportion to the drainage basin, except that of the Presumpscot. * * * The lake system of the Upper St. Croix comprises approximately 50 square miles of lake surface, and that of the West Branch 70 square miles, considering only the principal lakes and ponds. Indeed, above Vanceboro and Princeton each branch of the river is simply a succession of lakes to almost the extreme headwaters. The total lake surface of the St. Croix is estimated as not less than 150 square miles, or nearly one-tenth of the total drainage area.

Coastal streams.—Between the St. Croix and the Penobscot are Dennys, East Machias, West Machias, Narraguagus, Union, and other rivers, and between the Penobscot and the Kennebec are the St. George, the Pemaquan, and others, while at the southwestern extremity are the Mousam and the Piscataqua, the latter forming a part of the western boundary of the State. These streams are all comparatively small, but their importance is greater than their size would indicate, from the fact that they are in a more thickly populated part of the State and are nearer the coast, where transportation facilities are much better than in the interior, and that they have considerable fall and regular flow, due to the lakes and ponds tributary to them.

RELATION OF CLIMATE TO UNDERGROUND-WATER CONDITIONS.

The climate of Maine is healthful. Although the winters are long and severe the summers are pleasant and warm. The mean annual temperature ranges from 37° at Fort Kent to 46° at Portland.[a]

The mean annual precipitation ranges from 35.3 inches at Fairfield to 52 inches at Mayfield, Somerset County, there being 11 climatological stations in the State, as shown by the accompanying table. Fig. 1 shows the isothermal and isobaric lines for the State.

[a] Boardman, S. L., Special Rept. U. S. Dept. Agr. No. 4 1884, pp. 16–20. Henry, A. J., Bull. Q, U. S. Weather Bur., 1906, pp. 122–134.

Climate and rainfall statistics at stations in southern Maine.[a]

	Fairfield.	Mayfield.	Orono.	Rumford Falls.	Eastport.	North Bridgton.	Lewiston.	Gardiner.	Bar Harbor.	Cornish.	Portland.
PRECIPITATION.											
Spring . . . inches. .	8.4	12.2	10.1	10.8	11.3	12.9	11.6	11.5	12.2	11.4	10.6
Summer . . . do. . .	9.1	16.8	10.2	11.5	10.0	11.8	10.6	9.4	9.3	12.6	10.2
Autumn . . . do. . .	8.9	11.8	10.4	9.7	11.1	11.2	11.5	10.4	12.9	12.2	11.0
Winter . . . do. . .	8.9	11.2	11.9	10.1	11.0	11.7	12.5	11.7	14.5	11.7	11.0
Annual . . . do. . .	35.3	52.0	42.6	42.1	43.4	47.6	46.2	43.0	48.9	47.9	42.8
TEMPERATURE.											
Maximum . . . degrees F. .	97	96	100	101	93	100	100	101	96	97	97
Mean maximum . . . do. . .	53	54	53	52	49	55	54	56	53	52	53
Minimum . . . do. . .	−37	−22	−36	−29	−21	−26	−24	−30	−17	−19	−17
Mean minimum . . . do. . .	32	32	33	33	35	34	34	35	35	37	38
Mean annual . . . do. . .	43	42	43	43	42	44	44	45	44	44	46
Average number of days over 90° . . .	2	2	2	3	1	3	5	8	1	3	3
Average number of days under 32° . . .	172	168	156	151	133	153	150	152	151	140	127
FROST (AVERAGE).											
Latest killing frost in spring . . .	May 13	May 17	May 11	May 15	Apr. 28	May 15	May 5	May 6	May 18	May 23	Apr. 14
Earliest killing frost in autumn . . .	Sept. 24	Sept. 22	Sept. 24	Sept. 20	Oct. 12	Sept. 15	Oct. 2	Oct. 1	Oct. 12	Sept. 12	Oct. 18

[a] Henry, A. J., Bull. Q., U. S. Weather Bureau, 1906, p. 714.

As a rule, the rainfall is fairly well distributed throughout the year, some of it occurring in every season. Thus a large part of the precipitation occurs when the ground is unfrozen, and much of the rain penetrates the ground and goes to increase the underground water supply.

The winters often begin in November, but the climax of the season is not reached till February, and the winter generally ends in April. The summers are, as a rule, short, generally beginning abruptly in June. Fair weather predominates. In July and August there are frequently several successive days of muggy weather, followed by cooler spells, generally with east winds, during which the contrast in temperature is striking. The coldest place in winter is Fort Kent, and the coolest place in summer is probably Eastport, which has a summer mean temperature of 59°. Summer generally terminates gradually in the latter part of September.

UNDERGROUND WATERS.

SOURCE OF UNDERGROUND WATERS.

Rainfall.—Practically all the water utilized for domestic purposes is supplied by rain. The 35 to 52 inches of rainfall disappears from the surface principally in three ways—(1) by evaporation; (2) by run-off through the streams; and (3) by absorption into the rocks and unconsolidated deposits. It is with the last-mentioned portion of the rainfall that an underground-water report is concerned.

Evaporation.—Evaporation, although far less conspicuous than the other methods of removal of the water from the surface, is nevertheless one of the most important. The quantity thus removed commonly amounts to one-half or more of the total water falling as rain. This water never enters the ground, and therefore does not become a source of supply for domestic or other purposes.

Run-off.—The run-off includes the water that flows over the surface into streams and lakes and is carried seaward through definite channels. The quantity disposed of in this way is dependent partly on evaporation and partly on the nature of the materials on which the rain falls. The amount of run-off or discharge in the drainage areas of the two principal river systems of the State is as follows: Kennebec, 22.4 inches; Androscoggin, 24.2 inches.

Absorption.—The rainfall that is not removed by evaporation or by run-off into surface streams is absorbed by the soil or rocks with which it comes in contact, either directly or after being gathered into streams. In the first case the rain falls on the surface of the rocks or on the loose unconsolidated deposits lying upon them, and is either soaked into their pores or passes into the fissures and cavities which may be present in the harder materials. In the second case the water flows into the streams, and from these it may seep into the rocks in which their channels lie, but this seldom occurs in Maine. In either case the unconsolidated materials lying upon the rock surface are saturated to a certain level, and the rocks upon which they lie are in this way kept in contact with water, which is continually being absorbed.

When water enters sands and gravels the direction of movement in moderately moist regions like southern Maine is generally toward the river rather than away from it, but in arid regions, where the rainfall is slight, waters are often absorbed by the gravels in the beds of streams which have come from regions of greater rainfall.

MODE OF OCCURRENCE.

Water occurring in sands, gravels, and other surface deposits is generally held in the pores, or spaces between the pebbles or smaller particles. In certain types of solid rocks, as some sandstones, conglomerates, and very porous limestones, water occurs in the same way, saturating the entire rock below the level of the water table. Most rocks found in Maine, however, are so hard, compact, and close grained that the amount of water contained in the pores is very small. In such rocks practically all the water is held in various forms of crevices, cavities, and fissures. In the slates and argillaceous schists which underlie a large part of the area under discussion, considerable water is held in the bedding and cleavage planes. In granite, gneiss, slate, schist, and most other hard rocks the largest amounts are contained in joint cracks—fissures which cut the rocks in various directions. Where rocks have been faulted—that is, where one wall of a fissure has been moved up or down or horizontally with reference to the other wall—lines of springs sometimes follow the fault where it cuts the surface. In limestones large amounts of water occur in solution cavities which have been dissolved by slow water percolation.

AMOUNT OF GROUND WATER.

General statement.—The amount of water held in the rocks or other materials composing the earth varies greatly, owing to many causes. The amount absorbed depends on the porosity of the material, the slope of the surface, and the size and abundance of joint cracks, fissures, and cavities. The amount of water in drift or surface materials is dependent to some extent on the nature of the underlying rock, and the amount which finds its way into the solid rocks is dependent on the thickness of the overlying surface deposits.

Amount of absorption.—The amount of water absorbed is dependent chiefly on the nature of the materials. The more porous beds of sand and gravel that occur as drift deposits along stream valleys, lake shores, and the coast absorb very large amounts. Next to these unconsolidated deposits, the rocks which present the conditions most favorable for direct absorption are sandstones and certain porous limestones. The direct absorption by granites, slates, and other massive rocks is very slight. In a general way porosity is determined by the amount of water which the rock is capable of absorbing. A cubic foot of sand will absorb on an average about 10 quarts of water, and certain porous sandstones will absorb 2 to 6 quarts.

Upper and lower limits.—In general it is necessary to dig only a few feet to reach a zone saturated with water. The upper limit of this zone is known as the water table, and the water saturating the materials is known as ground water. The general relations of water table and ground water are shown in fig. 2. The depth to the water

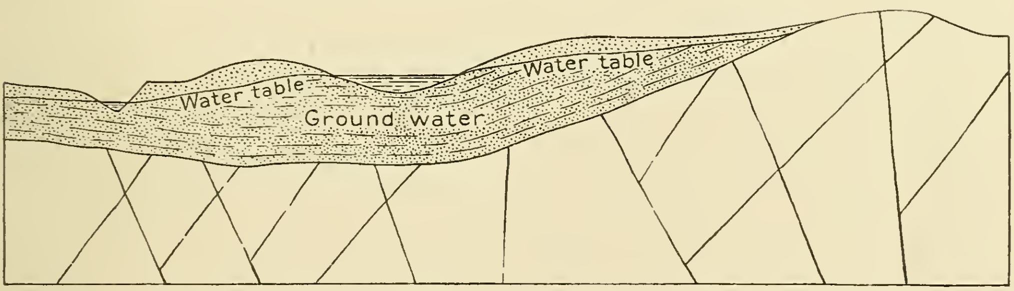


Fig. 2.—Diagram showing relation of ground water and water table to outcrop and bed rock.

table is dependent principally on the amount of precipitation, being least in regions of much rainfall and greatest in arid regions. While there is no definite lower limit to the penetration of water, it is probable that little surface water penetrates more than 3 miles below the surface, and most of the pores and crevices in rocks are closed below the depth of a few hundred feet.

Total amount of ground water.—The total amount of water contained in the earth's crust has been estimated by different writers with widely different results. The most recent estimate is given by Fuller,[a] who concludes that the total amount of free water in the earth's crust would be equivalent to a uniform sheet over the entire surface of the earth with a depth of about 100 feet. This is but a small fraction of the estimate made by other writers.

ULTIMATE DISPOSITION OF GROUND WATER.

The water held in the rocks of the earth's crust disappears in a number of ways. A small portion enters into the chemical composition of the rocks. Small amounts are absorbed by forests and other vegetation. Some of the water reaches the air through capillarity and is evaporated. The largest amounts reach the surface by

[a] Fuller, M. L., Total amount of free water in the earth's crust: Water Supply Paper U. S. Geol. Survey No. 160, 1906, pp. 59-72.

hillside springs and through seepage to neighboring streams. In settled regions large amounts serve as contributions to wells. It is the two last-mentioned portions and the portion still remaining below ground with which we are concerned in this report.

TEMPERATURE OF UNDERGROUND WATERS.

In all wells there is a certain depth, which differs in different localities but is commonly from 50 to 60 feet below the surface, at which there is practically no variation in the temperature of the water from season to season or from year to year. The temperature at this depth is known as the normal temperature of the water for a given locality, and it agrees very closely with the mean annual temperature of the same locality.

In southern Maine the normal water temperature is 40° to 47°. Waters occurring nearer to the surface than the zone of uniform temperature vary in temperature according to season, being warmer than the normal in summer months and colder in winter months. Below the depth of normal temperature the temperature increases, owing to the internal heat of the earth, the average increase being about 1° in every 50 feet. A temperature higher than that which would be expected at a given depth may be due to the derivation of the water from a deep source, but as no thermal springs are known in Maine this cause is not believed to prevail. Where an abnormally high temperature is found in summer it is generally due to the mixture of surface water with the deep-well water, either by leakage along the casing or by penetration downward through joint cracks.

Many determinations of deep-well temperatures have been made throughout Maine, and are found to vary from 45° to 54°, being commonly somewhat higher than the normal. The most common temperature was 47°. In this State the temperature seems to hold no definite relation to the depth of the well, as would be expected; the reason is supposed to be that water in most rock wells in Maine is derived from more than one vein, and the principal supply is not invariably at the bottom of the well. In any well not properly cased surface water may enter and raise the temperature above the normal. The true temperature of a well water can be found only by pumping several minutes before taking the measurement, to exhaust the water which has become either heated (in summer) or cooled (in winter) in the piping.

The temperature of a well water is frequently a factor of considerable importance to the users. In a number of pulp mills in Maine well waters are used for cooling acid. They are also used in creameries for cooling cream, and for ordinary drinking purposes it is more pleasant to have a cool water. Practically all rock waters in Maine are cool enough for drinking, but in some dug wells the water is warmer than the average. Deep-well water whose temperature is higher than 50° is open to suspicion; it is probably in part surface water.

QUALITY OF UNDERGROUND WATERS.

General statement.—Rain water falling near the close of a storm, after the impurities have been dissolved out of the air, is very nearly pure H_2O. As it finds its way below the surface, however, into the soils and surface deposits it dissolves and holds in solution small quantities of organic and mineral matter. Normally in the country districts, where the ground water does not come into contact with polluting materials in its downward passage, it dissolves only a small amount of organic matter, but takes into solution some mineral matter. As the water moves downward still farther and enters the underlying solid rocks large quantities of mineral matter may be taken into solution. In Maine the quantity of mineral matter is seldom more than 200 to 500 parts per million, and this does not affect the safety of the water for drinking purposes. In towns, however, and in the vicinity of houses, barns, refuse heaps, privies, and cesspools, considerable amounts of polluting organic matter are dissolved by the ground water, and such water is dangerous for domestic supply.

Source of mineral matter.—Polluting organic matter always comes, directly or indirectly, from the surface. Mineral matter, however, may enter the water in a number of ways. In most parts of the State it is practically all dissolved from the rocks or other materials in which the water is found or through which it has passed. For this reason water in limestone and calcareous slate, the materials of which are easily soluble, contains large amounts of mineral matter, whereas water in such rocks as granite and ordinary clay slate contains less amounts. Certain mineral constituents, as nitrites, nitrates, and chlorine, are frequently derived from organic matter, and therefore their presence in abnormal quantities is an indication of pollution. In some wells on islands or near the ocean the amount of mineral matter is found to be very high, frequently running up to several thousand parts per million. Such proportions are sometimes due to a mixture of salt water which has entered from the sea.

Normal chlorine lines.—One of the best indications of the source of water, especially of surface water, is chlorine. This element, a constituent of common salt, is present in nearly all natural waters. Its original sources are certain mineral deposits and finely divided salt spray from the sea. This sea spray, which is of most importance as a source of chlorine in Maine, is carried inland with dust particles and precipitated with the rain. The chlorine decreases as waters farther and farther inland are tested, and hence it has been possible to make determinations and prepare a map giving lines of equal chlorine which represent the normal percentages throughout the State.[a] All salt found in water not derived from mineral deposits or from the sea comes from domestic drainage and indicates that the water either is at the present time polluted or was polluted and has since been purified. For surface waters the normal chlorine lines hold with great accuracy. For most underground waters, however, owing to the occasional presence of chlorine in rocks and to the frequent circulation of water to localities of different normal chlorine, the map is of little value, and should not be depended on except when considered together with other evidence.

WATER-BEARING ROCKS OF MAINE.

PRINCIPAL TYPES.

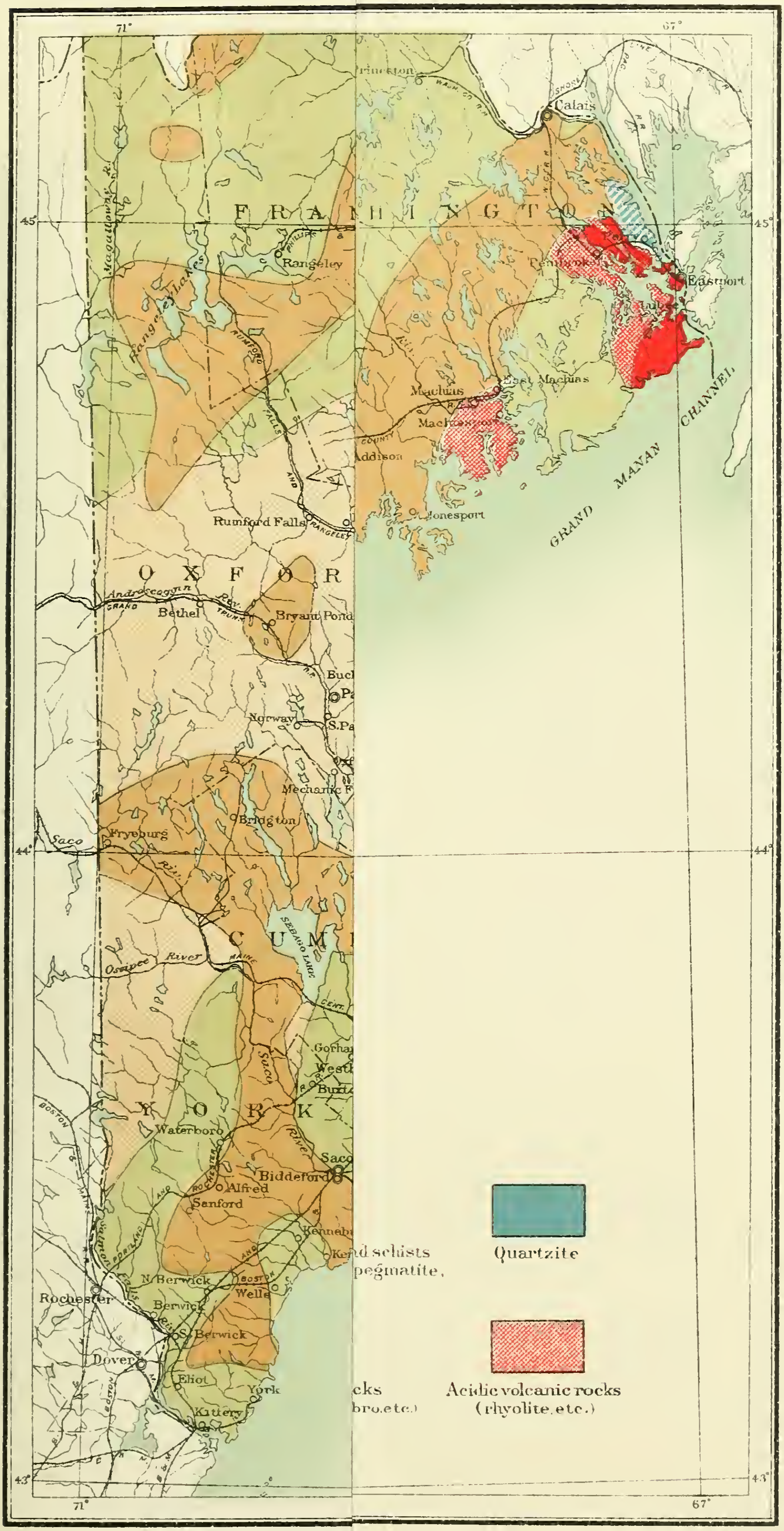
General statement.—All formations contain more or less water, which, as has been pointed out, occupies cavities or crevices in the rock or is held between the pores. The principal rocks in southern and eastern Maine are granites, gneiss, slate, schists, and surface volcanic rocks, with a few small areas of limestone, quartzite, and other rocks. Overlying these are usually surface deposits, consisting of sand, gravel, glacial till, and marine clays.

Relation to underground waters.—The amount and the nature of the water occurring at any locality are dependent on the kind of material in which it occurs. The distribution and character of water in various materials are summarized in the following table:

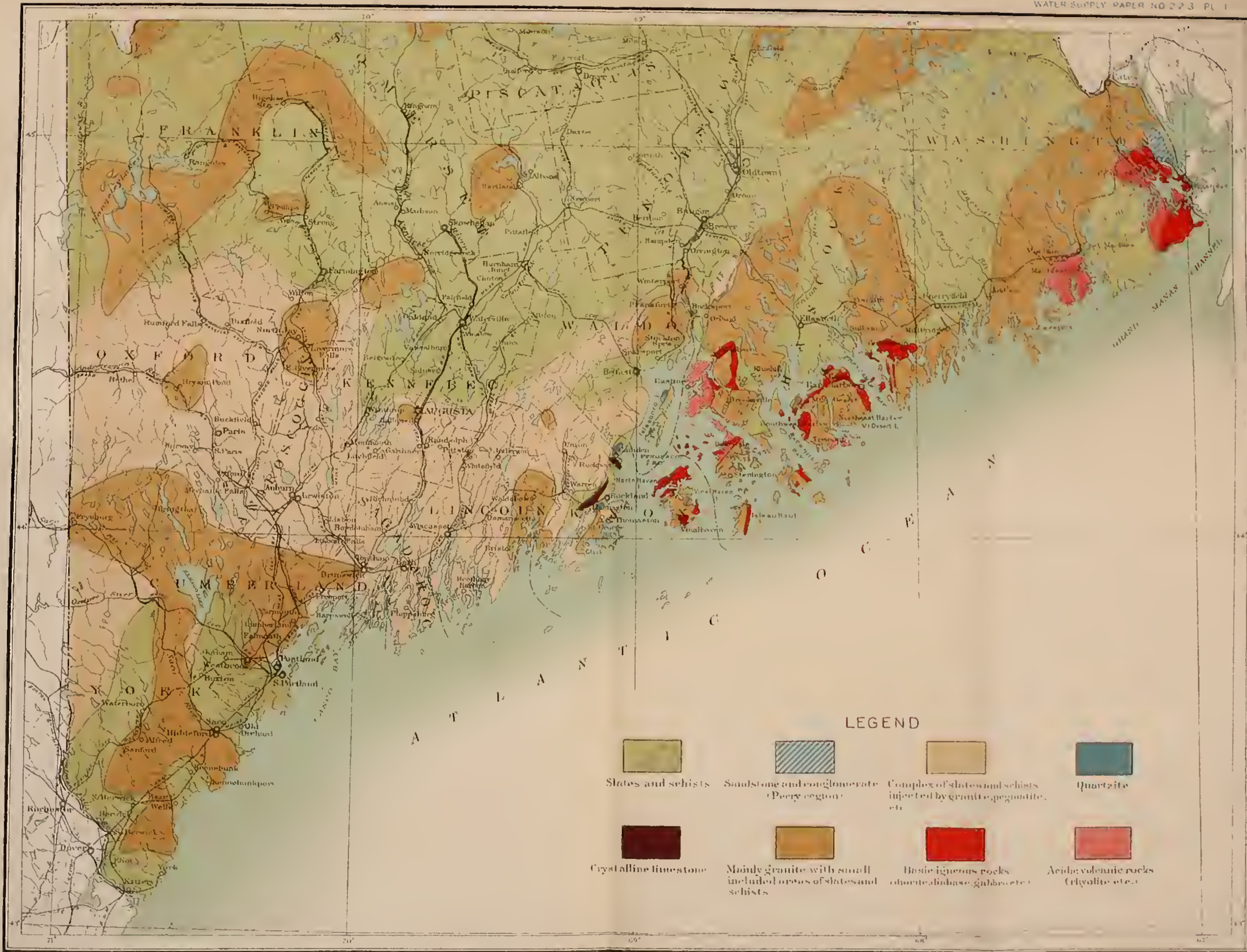
Summary of occurrence of water in rocks and surface deposits of southern Maine.

Material.	Distribution.	Water supply.
Granite	Irregularly distributed over large areas.	Plenty of good water at moderate depths, but held entirely in irregular joint cracks at variable distances apart.
Gneiss	....do	Do.
Slate	Forms more than one-third of the area.	Generally plenty of good water. Occurs in irregular joint cracks, and to a moderate extent along highly inclined cleavage and stratification planes.
Schist	Irregularly distributed in slate and gneiss areas.	Do.
Limestone or marble	Chiefly in Knox County, but existing also as thin bands in slate areas generally.	Abundance of hard water, chiefly in solution cavities.
Trap and volcanic rocks	Occur in several relatively small areas.	Small amounts of water, which are mostly rather high in mineral matter, but in some wells are as good as granite waters.
Unmetamorphosed sedimentary rocks.	Perry Basin, eastern Washington County, and other small areas.	Not tested, but probably contains plenty of water of good quality.
Gravel and sand	Widely distributed, especially in the valleys, 1 to 100 feet thick.	Large amounts of water. Of good quality where not polluted.
Till or bowlder clay	Covers the bed rock nearly everywhere; in many places underlies gravel and sand.	Water of variable amount and quality.
Clay	Locally distributed in the valleys and along the coast.	Contains little available water.

[a] Jackson, D. D., Water Supply Paper U. S. Geol. Survey No. 144, 1905, Pl. II.



ANDREW B. GRAHAM CO. PHOTO-LITHOGRAPHERS WASHINGTON D. C.



ANDREW B. GRAHAM CO. PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

MAP SHOWING DISTRIBUTION OF ROCKS IN SOUTHERN MAINE, SO FAR AS KNOWN

Based on reconnaissance and detailed maps by Geo. Otis Smith, E. S. Bastin, F. G. Clapp, G. C. Matson, and C. W. Brown.

Scale

10 5 0 10 20 30 40 miles

1906

DETAILED DESCRIPTIONS.

GRANITE AND GNEISS.

Description.—The granites and gneisses are very hard, dense, coarsely crystalline acidic rocks, and possess as a rule only microscopic pores. Granite being one of the hardest of rocks, drilling in it is difficult. Commonly a well in this rock is not deepened more than 3 to 5 feet a day, and sometimes not more than a few inches a day.

Distribution.—These rocks are widely distributed in Maine. Their boundaries are so irregular that their limits are best defined on a map rather than in a general description. The granite is represented by the brown color on Pl. I. There is some granite in nearly every part of southern and eastern Maine, but the largest areas are in Washington, Oxford, Cumberland, and York counties. As stated in the legend, areas covered by the granite symbol on the map include some small masses of a somewhat more basic rock, similar to granite, but of a darker color, known as diorite, and also moderate areas of gneiss, a somewhat banded type of granite, and of pegmatite, a rock of granitic composition but of very irregular and coarse texture.

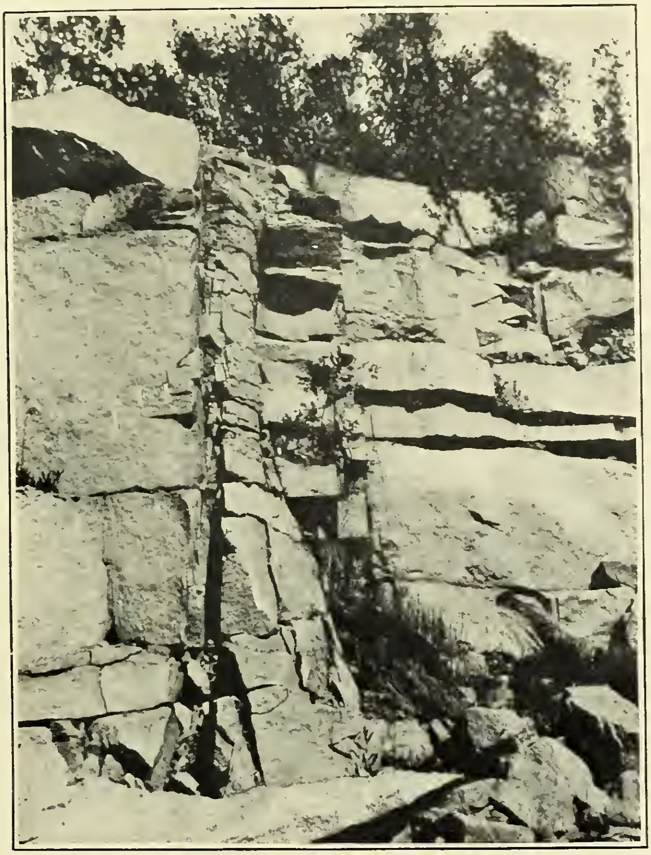
Relations to other rocks.—Where the granite occurs in large areas it extends downward to an unknown depth. In late Silurian or Devonian time the granites and gneisses, in a molten condition, were intruded into the sedimentary rocks which existed at that period. In many localities, as in York and Cumberland counties, the granite can be seen cutting across and inclosing masses of slate. An instance of this relation is seen in Pl. X, *B*, which shows a thin band of granite parallel with the stratification of the slate, the whole rock being much metamorphosed.

Joint cracks.—Practically all the water found in granite occurs in joint cracks. These joints generally form complex systems of intersecting planes (figs. 2 and 4). In southern Maine there are two principal systems. One of these—the horizontal joints, sheet joints, or "beds"—is approximately parallel with the surface of the ledge. Near the surface these joints are only a few inches apart, but they become many feet apart with increasing depth. In the J. C. Rogers well No. 1, near Stonington, 27 distinct "beds" of rock were penetrated in a depth of 94 feet. These ranged in thickness from a few inches to 14 feet. The thickest bed was passed through about midway from top to bottom in the well. The joints that are not sheet joints run in all directions, but in southern Maine the great majority of them, including the most persistent series, strike between N. 70° E. and S. 50° E. The hade of the joints, or the angle which they make with the vertical, varies, but except in the sheet joints it is generally small—from 0° to 30°. A zone of these vertical joints is illustrated in Pl. II, *A*.

Structural relations of granite.—The structure of the granite in Hancock County, where it is extensively quarried, is typical of Maine granites, and its peculiarities will therefore be discussed in some detail. A number of quarries were visited with a view of obtaining information regarding the relations of rock structure to occurrence of water. In the quarries at Brooksville the principal system of joint cracks strikes S. 80° E. These joints are very numerous and persistent and are nearly vertical. They are, however, not open except near the surface. The second system, consisting of a few joints only, strikes S. 10° W. The sheet joints slope with the hill and the beds are in general from 1 to 5 feet in thickness. These conditions would seem to afford a good opportunity for water to penetrate downward parallel with the slope of the hill. In all the quarries there are some joints which do not seem to belong to either regular series, and some which are more open and would give a better opportunity for the downward penetration of water. One joint belonging to the principal series exposes an inch of decomposed granite that has been much iron-stained by percolating water. This crack was very wet, owing to water which is now penetrating along it. In some places granite along joint cracks is decomposed for a distance of 2 inches or more from the crack.

In another quarry in the same town the principal system of joints strikes approximately N. 20° W. and hades 25° W. This system is continuous from the top to the bottom of the quarry, which is 20 feet or more in depth. The principal crack is one-fourth inch wide in places. When seen it was a little wet, but not iron stained or decomposed. In this system the joints are from 20 to 40 feet apart. A smaller system runs about east-west and hades nearly vertical. Other vertical joints do not belong to any of the regular systems. These irregular joints are much stained and tightly closed. They are generally from 2 to 10 feet apart and die out as they run against the more persistent joints of the principal series.

At Stonington a great deal of quarrying has been done and the conditions here are fairly typical of the granite on the Maine coast. The general strike and hade of the joints average the same as in other towns. Some cracks are, however, as much as an inch in width. One crack was found filled with a soft, greasy-looking mineral having a cleavage resembling that of calcite. As most of the quarries are on small islands, and some of them extend more than 100 feet below the sea, the sea water seeps in along the general system of joints and collects in the bottom of the quarries, whence it has to be pumped by windmill or engine. The sheet joints in the quarries at Stonington are nearly always dry. They slope toward the sea from the center of the hill, generally being 1 to 2 feet apart at the surface. Some of them are one-fourth to one-half inch in width and are filled with earth and rotten granite.



A. ZONE OF NEARLY VERTICAL JOINT CRACKS IN GRANITE QUARRY.

B. CONCENTRIC WEATHERING IN DIORITE AT PLEASANT RIVER GRANITE QUARRIES, DALOTVILLE.

Showing mode of entrance and storage of water along decomposition planes.

Water supplies.—Fig. 4 gives an example of the general arrangement of joint cracks. It will be seen that it is possible for water occurring in surface deposits to find its way downward to great depths, and that it will be tapped by any well which chances to strike a joint sufficiently open to form a part of the reservoir. The nearly vertical joints (Pl. II, *A*) and decomposition planes (Pl. II, *B*) generally serve as channels for the admission of water; the sheet joints serve as part of the reservoirs in which it is stored. As most of the joints are rather narrow, the amount of water yielded by them is likely to be only moderate, as a rule not more than 10 gallons a minute. Occasionally, however, as much as 30 gallons a minute has been obtained with a steam pump. The occurrence of water in granite is well illustrated by Pl. III, which shows water flowing from sheet joints in quarries at North Sullivan and Jonesboro. Similar flows have been observed at numerous quarries in Maine. In the R. A. Small well at Lisbon Falls a hand mirror was used to examine the bottom and sides of the well at frequent intervals during drilling, and water was seen to enter from all the sheet joints. In a few granite wells no water has been found.

On account of the extreme irregularity of joints in granite it will be seen that the success of any well in this rock is largely a matter of chance, dependent on whether the location is a fortunate one with reference to the arrangement of the joints. Fig. 4 shows how a well may (*a*) strike plenty of water within a few feet or (*b*) go to a great depth without success. Where the joints are numerous an increased amount of water may be found by deeper drilling, but in some places such continued drilling has found open cracks through which the water ran away.

As joints are most common near the surface and diminish in number as the depth increases, and as the pressure tends to make them close up with depth, the water supplies in granite are generally found within 100 or 200 feet of the surface. In an investigation of water in the crystalline rocks of Connecticut, Ellis[a] concluded that as a rule it does not pay to drill below 200 feet. A prominent well driller of Maine who has drilled many wells in granite, in a calculation based on his experience, found that the average depth of the principal vein of water was 185 feet. While successful wells in which the principal vein is at a greater depth are often found, the probability of success by drilling below 250 feet seems to be less than it is by "pulling up" and starting a new well a few feet away. On account of the irregularity of the joints the new well is no less likely to be successful because a drilling near by has proved unsuccessful. One well drilled in gneiss at Auburn went to a depth of 654 feet without encountering any water. Few wells are complete failures, however.

[a] Ellis, E. E., Water-Supply Paper U. S. Geol. Survey No. 160, 1906, pp. 19–28.

A few wells in granite yield natural flows of water. Usually, however, the water stands some distance below the surface.

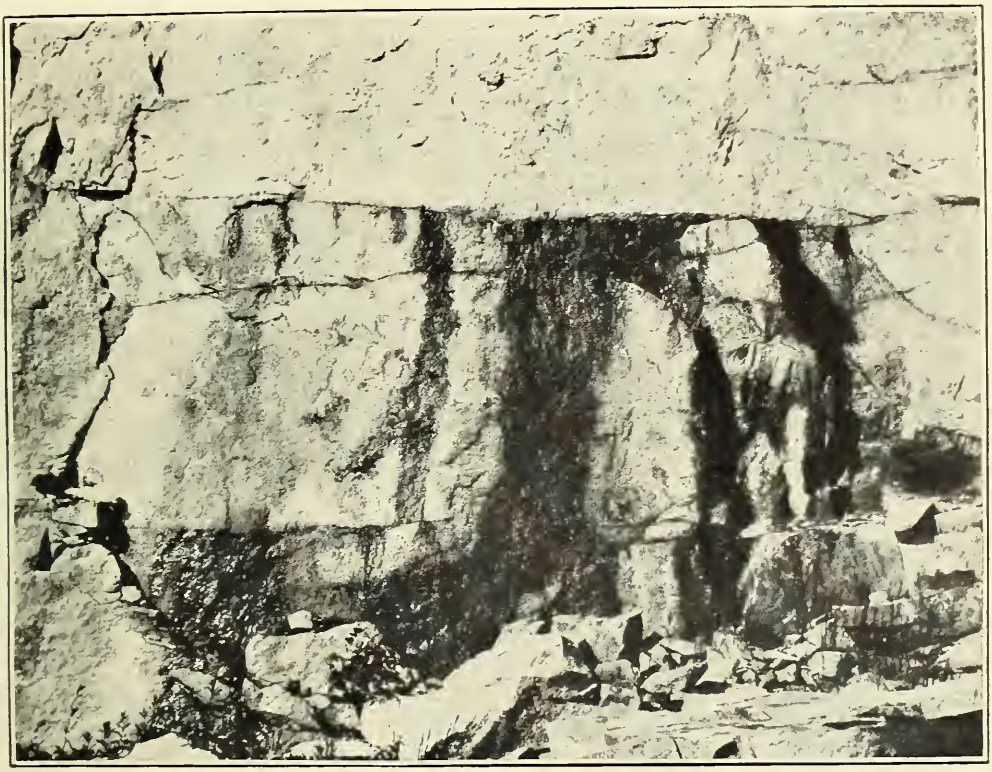
Quality of water.—In quality granite water is as good as the best. The analyses on page 77 show that the total solids range in general from 40 to 200 parts per million, with occasional higher records. Analyses of granite waters from several wells along the coast have shown total solids running up to several thousand parts per million, but these proportions are mostly due to the inward penetration of sea water along open joints. In a few wells the amount of chlorine in granite harmonizes with the normal chlorine for the locality, but in most it is much higher. When this discrepancy can not be accounted for by pollution or by entrance of sea water it is believed that sodium or calcium chlorides exist in the rock. The calcium, magnesium, and sodium in granite are generally low, none of them being known to exceed 70 parts per million, and they are nearly everywhere below 30 parts. The carbonates may run as high as 150 parts, but are here and there as low as 10. Sulphates, if present, range up to 40, and silica from 5 to 30; potassium is not recorded above 10 parts. The general composition of granite water, as illustrated by analyses made in southern Maine, is represented by Pl. IV.

SLATE AND SCHIST.

Description.—The slate found in southern and eastern Maine is exceedingly diverse in character. Most commonly it is a fine-grained, moderately hard, dark-gray to greenish or black rock produced by the consolidation and metamorphosis of clay. In places it grades into true schist. In Aroostook County, southern Penobscot County, and a few other localities the slate is locally slightly calcareous. Practically all the slate in this State is highly folded, and the stratification and cleavage planes stand on edge. Near the coast the strike is variable, but in Kennebec and Penobscot counties it is very constant, being about N. 60° E. over broad areas. The dip is not so uniform, but is nearly everywhere high. As these rocks range from very hard to very soft, the speed of well drilling varies proportionately. Generally 2 to 10 feet a day can be accomplished, but one well is reported to have been sunk 35 feet in a single night.

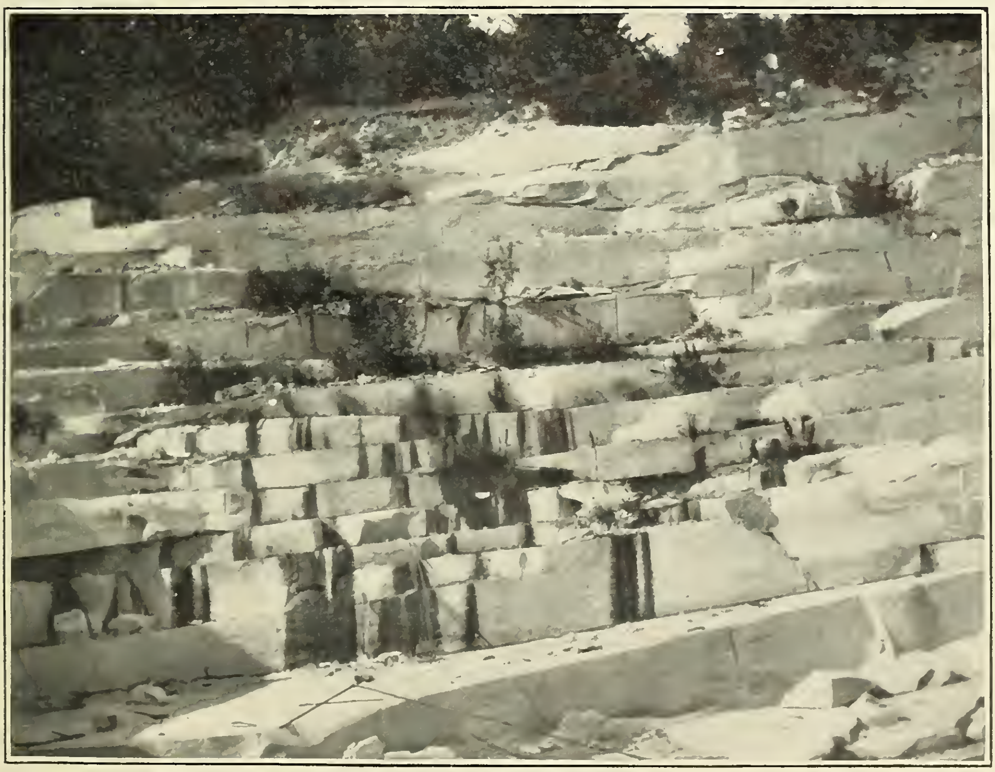
Distribution.—Nearly half the area covered by this report is underlain by slate and schists. The areas are so irregular that they can not be well described, but they are shown on Pl. I by the green color. Slate is much more abundant in the northern part of the area than in the southern part, and north of the forty-fifth parallel it is still more predominant.

Relation to other rocks.—At many points in York and Cumberland counties and elsewhere the slate and schist can be seen to be cut by granite, proving that the sedimentary rocks in that part of the State



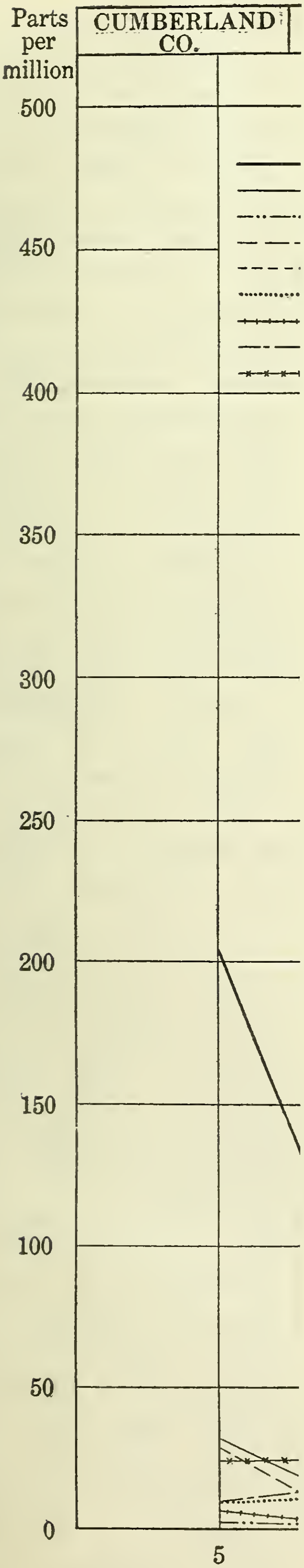
A. SECTION OF GRANITE QUARRY AT JONESBORO.

Showing water issuing from sheet joints.



B. VIEW IN CRABTREE & HAVEY'S GRANITE QUARRY, AT NORTH SULLIVAN.

Showing occurrence of water in sheet joints.



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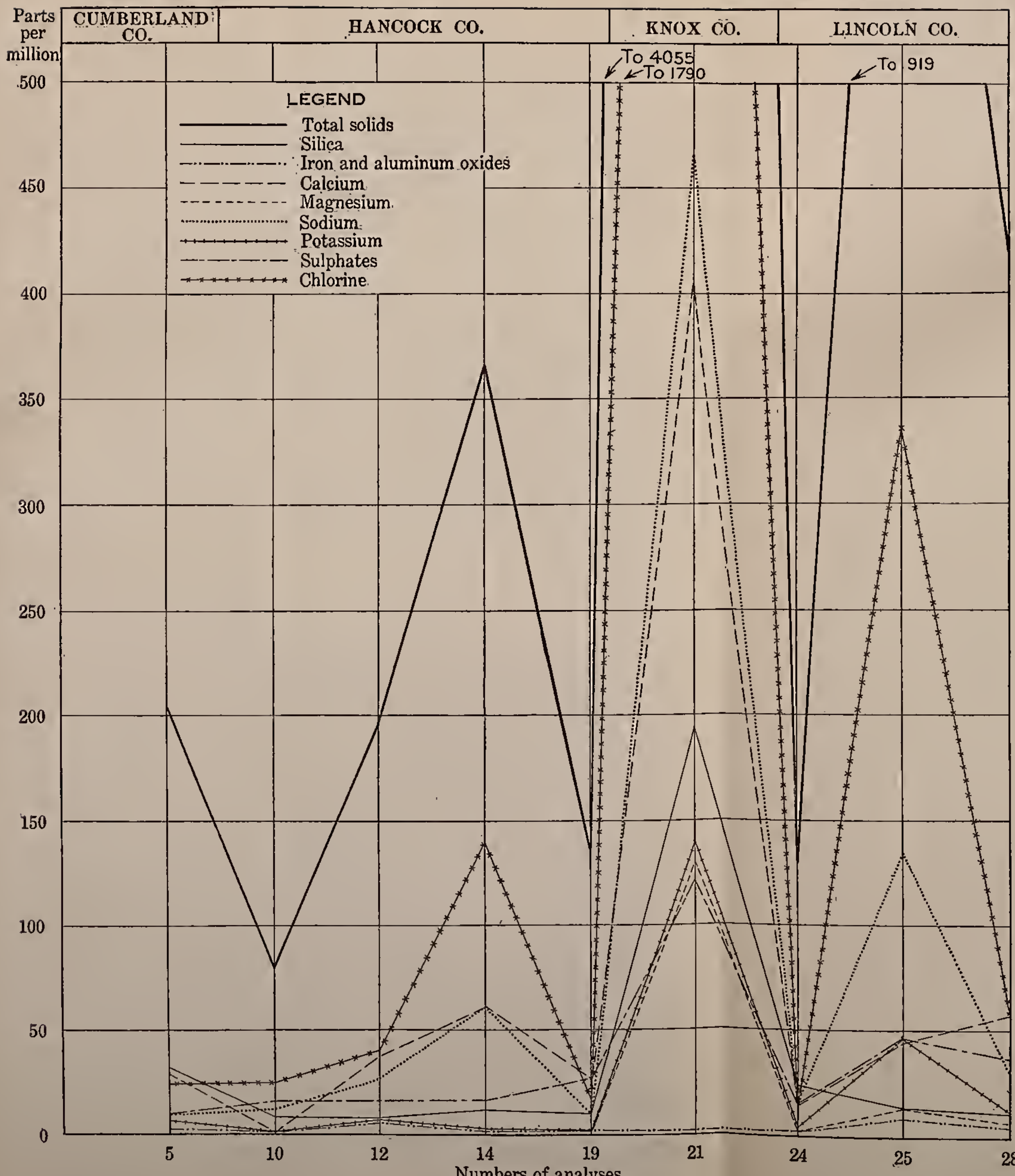


DIAGRAM ILLUSTRATING RELATIVE COMPOSITION OF GRANITE WATERS IN SOUTHERN MAINE.

are older than the principal granite masses. In the Penobscot Bay quadrangle the slate and schist (Penobscot formation) have been shown to be probably of Cambrian age, and most of the similar rocks of southwestern Maine are believed to be of the same age. The Ellsworth schist is slightly older, but may also be Cambrian. All the regionally metamorphosed rocks are Ordovician or older, as the movements which produced metamorphism took place about the close of Ordovician time. The high folding and extensive metamorphism of these rocks over wide areas make them all of the same class so far as the underground-water conditions are concerned.

Stratification, cleavage, and fissility.—The slates over most of Maine show clear evidences of stratification, but have been subjected to so great pressure that the dip is everywhere at a high angle, generally within 30° of the vertical. The strike along the coast is somewhat variable, but throughout most of Kennebec and Penobscot counties it is rather constant, in few places departing much from N. 60° E. Most of the slate and schist is rather easily cleavable, and as a rule the cleavage and foliation planes correspond in strike with the stratification, but vary somewhat in dip. The cleavage, foliation, and stratification planes are generally tightly closed at considerable depths, but rather open near the surface, and in many regions they allow passage for small quantities of water.

Joint cracks.—What has been said regarding joints under the description of granite will also apply in a general way to slate and schist, except that in these rocks the cracks are more irregular in direction, extent, and characteristics. On account of the difference in structure of slate, its joints are not conspicuous, but they can be depended on for water supplies. Where they are flat, they have little effect on drilling, but in numerous places the slate is much cut up by joints, many of which are inclined. These often work havoc with drilling tools. If an inclined joint plane is hard and smooth, the drill may glance off and give a crooked hole. If the joint plane is soft, the drill may get stuck, and sometimes many days are required to remove it, or the hole may have to be abandoned altogether.

Water supplies.—Slate is generally supposed not to contain much water, but in Maine it has proved to be the most productive rock. As in granite areas, the water is first stored largely in superficial deposits of gravel and bowlder clay. In the slates and schists, however, the water penetrates downward not only through joint systems but also along small fissures which follow the stratification and cleavage planes. An illustration of the way water may find its way below the surface from overlying drift is given in Pl. V, *A*, and Pl. VII, *A*, the first view showing the effect of stratification planes and the second of joint cracks.

On account of the more numerous means of admission of water larger quantities are generally expected and found in slate than in granite. Few wells drilled in slate in southern Maine have met with absolute failure. Instances in which only a gallon or two of water a minute has been found are due generally to the insufficient depth of the well.

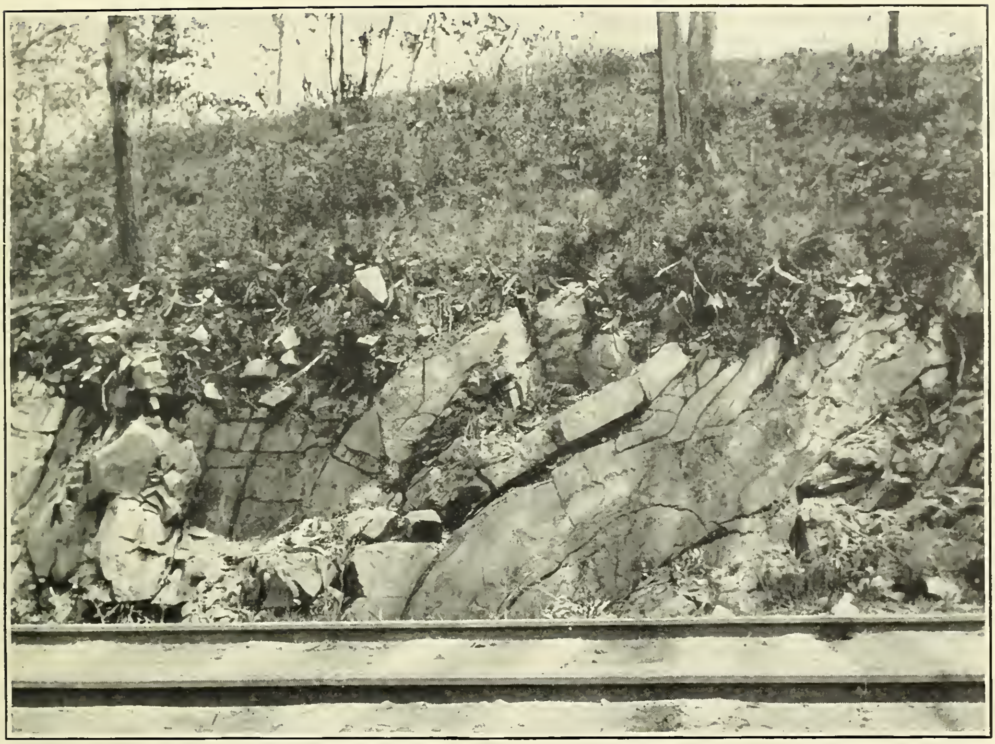
The depth to which it is advisable to drill in slate differs somewhat in various parts of the State. In some places along the coast and near the areas of intruded igneous rocks, where the slate has evidently been under great pressure, the statement made with regard to granite. that it is not desirable to drill deeper than 250 feet, seems to hold true. In the large slate areas of the interior, however, wells drilled much deeper than that seem to afford supplies which increase with depth. Some of the best wells in the State are more than 300 feet deep, and so far as known there have been no failures among these deep holes. Hence in the large slate areas it is well to drill as deep as 400 or 500 feet unless sufficient supplies are obtained nearer the surface. In general, the water in slate is not all obtained in any one vein, but small supplies are found in a number of veins, and it is by the repeated tapping of new veins that a sufficient supply is finally obtained. The amount of water supplied by most slate wells less than 100 feet in depth is between 1 and 10 gallons a minute. In many of the wells of greater depth, however, the supplies run up to 30 gallons a minute, and in a few localities, as at Searsport, wells pumped by steam pump have been reported to yield more than 50 gallons a minute.

A prominent well driller of Aroostook County calculates that in that part of Maine the average depth of wells is 81 feet. In Bangor and vicinity drilling frequently has not been successful at first, but rather than go deeper the driller has moved the machine 5 to 10 feet and a good supply of water has been obtained. Such cases resemble the occurrence of water in granite.

That large open cracks exist in slate is proved at Sorrento, where two salt-water wells were obtained on a peninsula, indicating the penetration of sea water inward from the ocean. In Islesboro cracks and cavities are numerous. These are most common 30 to 40 feet from the surface, and few occur below 100 feet. They are supposed to be due to the solution of beds of limestone, and the permanent supplies from this source are only 2 to 3 gallons a minute.

The best and largest supplies in southern Maine are obtained in slate and schist below 100 feet.

The head of water in slate is very uncertain, depending on the topographic situation of the well and the arrangement of the systems of water passages in the rock. The water level may stand anywhere between the bottom and top of the well, but is commonly a few feet below the surface.



A. OUTCROP OF SLATE IN RAILROAD CUT AT KITTERY JUNCTION.

Showing fracture of rock along bedding and possibility of water entering from overlying drift.

B. COMPLETED WELL BELONGING TO CRABTREE & HAVEY, AT NORTH SULLIVAN.

Showing proper mode of protection of well drilled in granite.

Strange as it may seem to those who know the structure of slate, a few flowing wells have been struck in this rock. Such wells do not appear to have any regular distribution, and there are in general not more than one or two in a town. Two of them are in Westbrook, two in York, two in Islesboro, one at Bangor, and several elsewhere in the region. The flow seldom exceeds 3 gallons a minute. It is generally caused by the pressure of water following downward along systems of joint cracks from neighboring hills (see fig. 4), and the water rarely, if ever, in this region comes from a distance. The best flowing wells in Maine are at Greenville, Piscataquis County, where there are several from which the water will rise 10 to 14 feet above the surface. These will be described in the report on the underground waters of northern Maine.[a]

Quality of water.—In quality the slate water of southern Maine may be said to be the best for drinking purposes, and except in Waldo and Penobscot counties it is seldom hard. According to the analyses which have been made (see pp. 78–80), the total solids run from 25 to more than 800 parts per million. In order to show graphically the general character of slate water Pl. VI has been prepared. A separate line is given for each constituent of the water, and it will be seen that there is some similarity in the composition of the water from different localities.

Occasionally the water found in slate contains small quantities of iron, but these are rarely sufficient to be objectionable. In Waldo and Penobscot counties the amount of calcium and magnesium carbonates is high and produces some scale in boilers. Waters in these counties are generally called "hard," but are only of moderate hardness when compared with many waters in the Central States that are used for a great variety of purposes.

LIMESTONE.

Character and distribution.—In southern Maine the limestones are restricted to a type of dense crystalline limestone which is found practically only in Knox County, in the towns of Rockland, Rockport, Camden, Thomaston, and Warren. The rocks consist of a number of bands of limestone associated with slate, schist, and quartzite. (See Pl. I.) These bands are not more than a mile in greatest width and extend in a general northeast-southwest direction. In Islesboro there are local beds of similar limestone, all very thin and interstratified between vertical slates. These thin limestones of Islesboro are unimportant, except as they furnish a large proportion of calcium carbonate in the water and interfere with well drilling. The distribution of the limestones of Knox and Waldo counties is

[a] The report for the northern part of the State is in preparation.

shown in detail in the Rockland folio.[a] These limestones are believed to be all a part of the same geologic series, and were formed at the same period as most of the slates of central Maine and of Waldo and Knox counties.

Solution cavities and channels.—The waters in limestone occur mainly in open channels, caverns, etc., dissolved in the rock by the water itself. The water probably originally followed joint or bedding planes, which were gradually enlarged by solution and formed the cavities that we now find. One of these channels, exposed in the side of an abandoned quarry, is illustrated in Pl. VII, *B*. The occurrence of these channels within the limestone is very irregular and their location can seldom be predicted. Most deep wells drilled in the limestone, however, will probably encounter one or more such passages.

Water supplies.—The waters in limestone are hard but are not commonly mineralized in other respects. There is a considerable likelihood of pollution, owing to the fact that much of the underground water occurring in limestone has found its way downward through definite channels and has carried with it more or less surface wash. A single analysis of limestone water is given in the table on page 86 (No. 255). This water was collected from a spring in the bottom of a deep quarry near Rockland. No other analyses were made, as no wells have been drilled in limestone (except wells on Islesboro, which are largely in slate but pass through thin layers of limestone). The large amount of water pumped daily from these quarries and the common occurrence of springs in them indicate the probable existence of considerable quantities of water in these rocks.

At Islesboro the drillers report numerous cracks below 50 feet in depth, and occasionally pockets 3 to 4 feet in size are found. These generally supply abundant water for a few minutes or hours, but the supply soon gives out, so drilling is never stopped at a pocket. Although these wells are in a slate region, the pockets are supposed to occur in thin beds of limestone which have been partly dissolved.

VOLCANIC AND OTHER IGNEOUS ROCKS.

Character and distribution.—In the extreme western part of Hancock County, on many of the islands in Penobscot Bay, on the southern edge of Mount Desert Island, and in eastern Washington County, there is a class of rocks represented on the map (Pl. I) by the red color. These rocks are principally volcanic in origin and consist of flows of andesite, rhyolite, diabase, etc., and of beds of tuff or volcanic ash. On a map of this scale it is not possible to represent all the various types of these rocks, even if the limits of all the areas were definitely known. In Hancock and Knox counties the mapping

[a] Geologic Atlas U. S., folio 158, U. S. Geol. Survey, 1908.

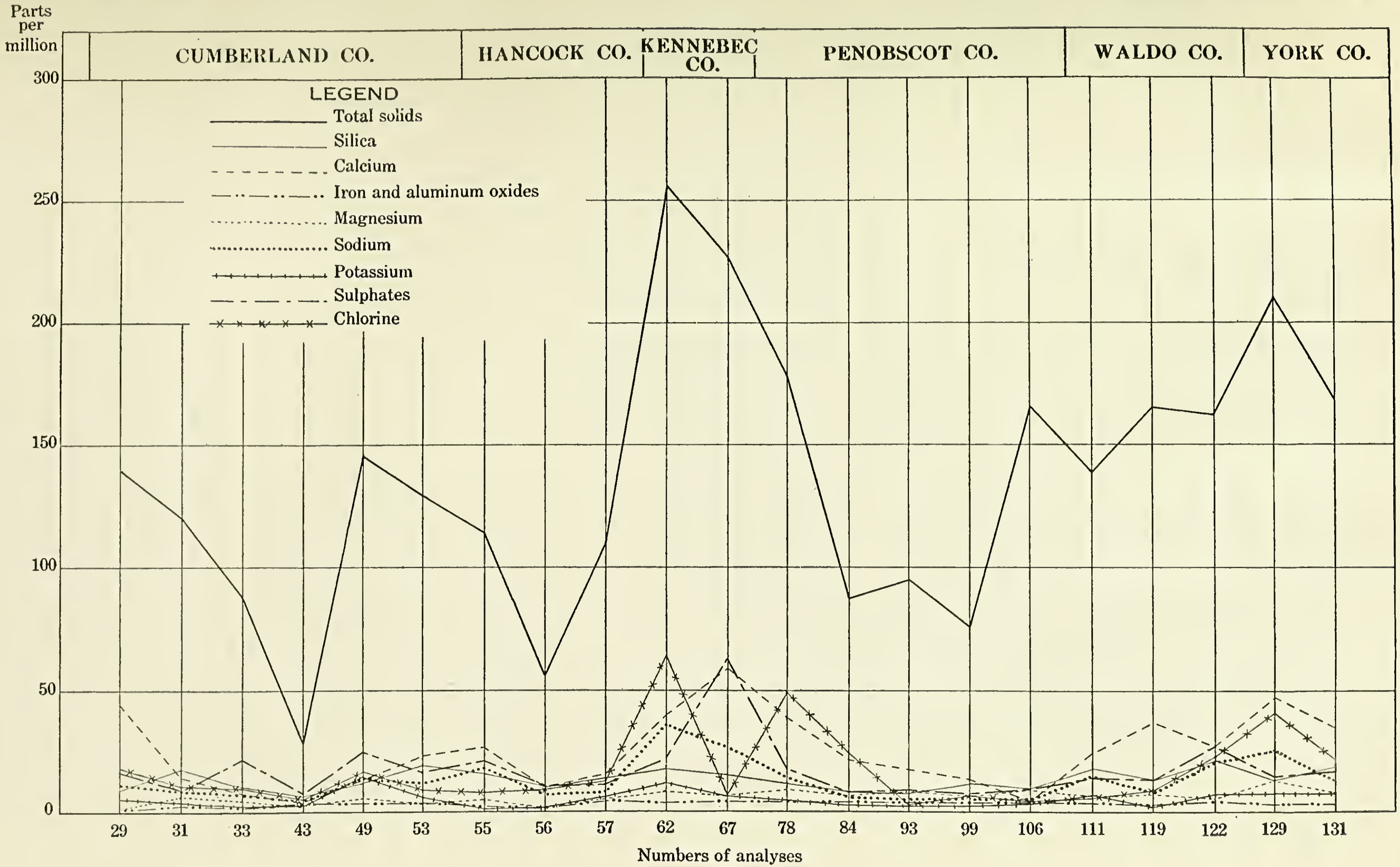
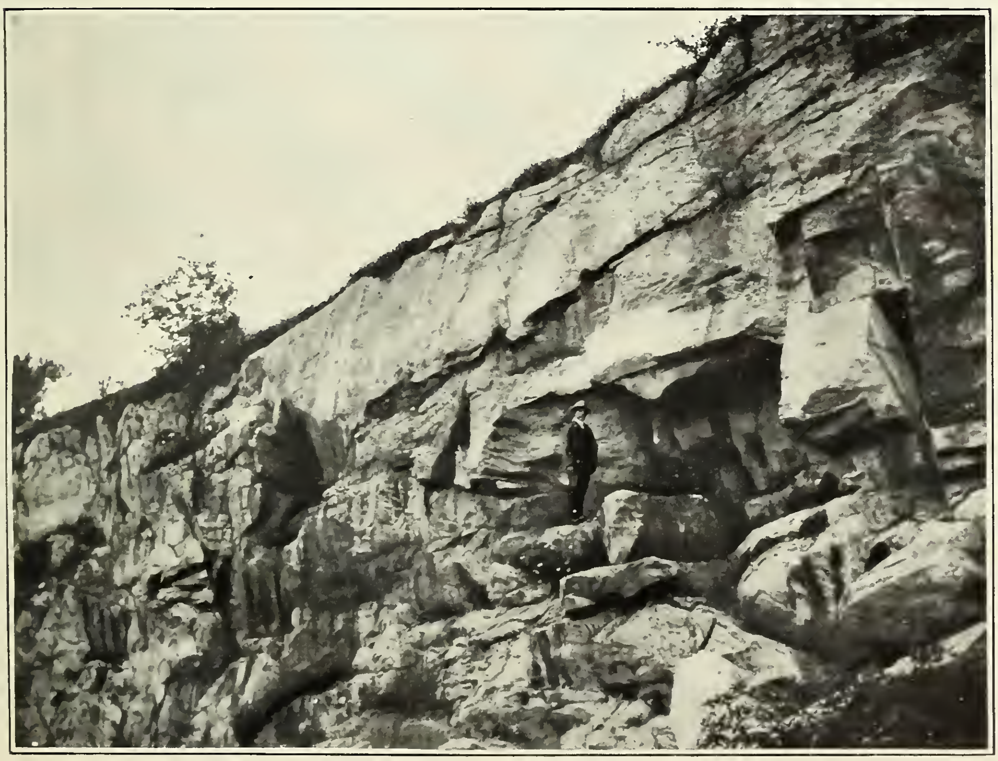


DIAGRAM ILLUSTRATING CHEMICAL COMPOSITION OF WATER FROM SLATE IN SOUTHERN MAINE.

A. OUTCROP OF SLATE BELOW TILL IN RAILROAD CUT AT KITTERY JUNCTION.

Showing vertical joint cracks and overlying cover of till in which water is held.



B. SMALL CAVE AND SOLUTION CHANNELS IN LIMESTONE.

Showing old water passages, Rockland.

is based on the detailed maps of the Penobscot Bay folio.[a] In Washington County the limits of the volcanic rocks are not so accurately known.

Besides the areas of volcanic rocks represented on the map, there are small dikes of trap rarely more than a few feet in width. These are intrusive in the slate and granite throughout the coast region, and are geologically among the most recent rocks in the State.

Water supplies.—On account of the manifold nature of the volcanic rocks, no comprehensive statements can be made concerning the water supplies they contain. Wells in these rocks are, however, much less sure of success than those in granite. In Castine several wells drilled in acidic volcanic tuff obtained moderate supplies, but one was an entire failure. In a 625-foot well at this place no water was found below 425 feet. At North Haven several wells drilled in basic lava flows get fair amounts of water, but some wells here were but partially successful. On Suttons Island, off Mount Desert, a well in trap is reported to yield 26 gallons a minute when pumped with a gasoline engine, but wells on neighboring islands were either unsuccessful or obtained only from 1 to 5 gallons a minute. At Eastport and Lubec several wells sunk in greenstone seem to give moderate amounts. One well at Eastport was a flowing well.

Quality of water.—On account of the small areas covered by these rocks in Maine only half a dozen analyses have been made. These are given in the table on page 81 and are represented graphically in Pl. VIII. It will be seen that the one greenstone water analyzed showed 413 parts per million of total solids, of which 108 were calcium, 42 were organic and volatile matter, and 71 were sulphates. A field assay of the same water showed 214 parts of bicarbonates, this being about as hard as the average of the slate waters in Penobscot County. The first analysis of trap water (No. 155) is so high in mineral matter that it is supposed to be partly sea water, and should not be considered as typical of trap waters in general. The second analysis of trap water is more moderate, showing only 90 parts of total solids. The proportions of the various elements in this water are very low for a well water. When trap waters are used they seem to be fairly good for both drinking and washing.

UNMETAMORPHOSED SEDIMENTARY ROCKS.

A few small areas in eastern Maine are occupied by unmetamorphosed sedimentary rocks, but only one of these—Perry Basin, in eastern Washington County—is of sufficient size to be mapped. (Pl. I.) This area is described by Smith.[b] The rocks were found to be conglomerates, sandstones, and some interbedded rhyolitic

[a] Geologic Atlas U. S., folio 149, U. S. Geol. Survey, 1908.
[b] Smith, G. O., Prof. Paper U. S. Geol. Survey No. 35, 1905.

lavas. They are of Devonian age, and were named the Perry formation. No drilled wells are known to have been sunk in these rocks, and hence little is known of the underground water conditions. To judge from similar rocks in other localities, they ought to hold plenty of water of good quality. In the same region are considerable areas of Silurian shales.

AREAS OF COMPLEX.

Character and distribution.—On Pl. I large areas in Oxford, Androscoggin, Sagadahoc, Lincoln, Knox, and Waldo counties and portions of adjacent counties are represented by a buff color. These areas are occupied by what is known as a complex, consisting of slates and schists intimately intruded by granites, gneisses, and basic volcanic rocks. The rocks in eastern areas, or those lying east of Brunswick and Augusta, are more slaty, and those in the western areas are more granitic, but they can not be differentiated on the map.

Water supplies.—As a rule water from areas of complex that are of notable size is more uncertain in quantity and quality than that from either granite or slate. Some good wells have been obtained in these areas. In many wells in Lincoln county the water has a peculiar taste, which sometimes makes it unfit for use. The water is known to have a bad effect on the well casing, frequently eating holes through it in a surprisingly short time, and the solution of the galvanized iron may possibly be a factor in the taste of the water. In some wells the taste may be due to iron, but as iron is absent in the greater number of these waters, this is not the chief cause. A review of the analyses of waters from the complex (p. 81) shows that they average higher in sulphates than those from either granite or slate. This indicates that they may contain free sulphuric acid. The sulphates range from a trace up to 77 parts per million. One field assay reports 286 parts per million. The total solids run from 95 to 301 parts per million in samples which were tested for them. As a rule the waters in the more granitic portion of the complex area are rather poor in quality, containing considerable iron and other minerals, whereas that from the more slaty portion is better.

SURFACE DEPOSITS OF SOUTHERN MAINE.

PRINCIPAL TYPES.

The surface deposits in Maine consist of stratified and unstratified clay, sand, and gravel and of till or bowlder clay. With the exception of some modern beaches, these surface deposits, which are known collectively as "drift," were laid down directly or indirectly through the agency of vast continental glaciers that covered New England at several periods during the last million years. Materials

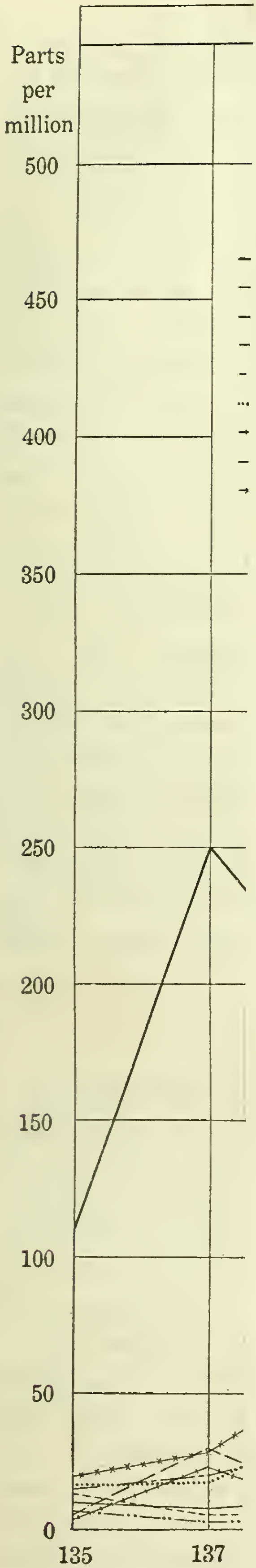

Parts
per
million
500
450
400
350
300
250
200
150
100
50
0
135
137

DIAGRAM ILL(

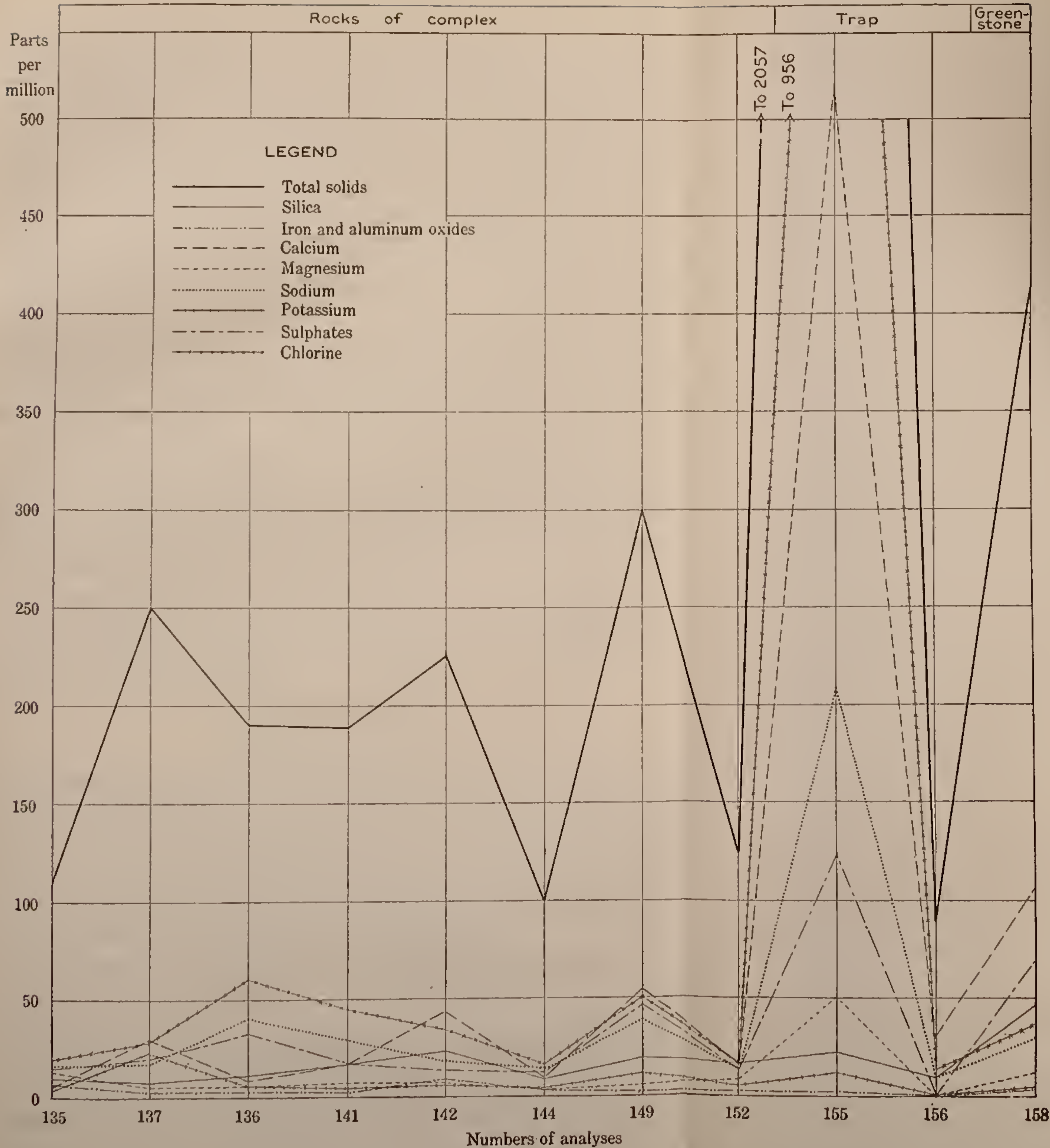


DIAGRAM ILLUSTRATING RELATIVE COMPOSITION OF WATERS IN AREAS OF COMPLEX, TRAP, AND GREENSTONE IN SOUTHERN MAINE.

formed by the grinding action of the ice in passing over the rocks and former surface deposits were, when the ice retreated, left as the heterogeneous deposits of till or bowlder clay which now cover large areas in both the uplands and the valleys. During the occupation of the region by ice, glacial rivers laden with sand and gravel flowed upon or under the ice, and the deposits made in their channels now appear as long, winding gravel ridges, known as "eskers." During the times when the ice was stationary great quantities of sand and gravel were often discharged into the sea, into glacial lakes, or onto the land surface to form deltas and sand plains. Irregular water-laid deposits, formed in connection with the ice, are known as "kames." When the ice finally melted it did not retreat steadily, but often halted, perhaps for years at a time, and during such halts a ridge or a succession of hills of sand, gravel, till, and bowlders was sometimes formed at the ice front, of material pushed up by the glacier or deposited by glacial waters. Such deposits are known as "moraines."

The writer has found evidence that since the first glaciation there have been interglacial periods.[a] During such an interglacial stage the land seems to have stood at a lower level than at present, and there was deposited in the sea a widespread bed of stratified clay, which now extends for great distances along the coast and more than 100 miles up the larger valleys. This has been known as the *Leda* clay, from a species of fossil shell which it contains.

In order that the occurrence of water in the surface formations may be well understood, they will be described in some detail, in the order in which they originated.

DETAILED DESCRIPTIONS.

BOWLDER CLAY, OR TILL.

Character and distribution.—Bowlder clay, or till, is the principal drift deposit of Maine. It consists mainly of a heterogeneous deposit of clay, sand, gravel, and bowlders, showing as a rule no trace of stratification and containing bowlders up to several feet in diameter. Its thickness ranges from a few inches to more than 100 feet. Usually it is very hard and tough, and is called "hardpan," though this term is also applied by well drillers to other formations.

This material is probably the most widespread deposit in Maine, overlying the bed rock nearly everywhere, and generally underlying the surface sand, gravel, and clay deposits, where the latter are present. In places in southwestern Maine till occurs segregated in the form of lenticular hills, known as "drumlins." These are often from one-fourth mile to a mile in greatest length and 100 to 200 feet in height, and are composed entirely of the hardpan type of bowlder clay.

[a] Complexity of the glacial period in northeastern New England: Bull. Geol. Soc. America, vol. 18, 1908, pp. 505-556.

Water supplies.—Where typical and occurring in thick deposits, as in drumlins, bowlder clay can not be said to yield a large amount of water. Wells dug in drumlins are generally dependent on surface water and frequently run dry in summer. The scantiness of the supply in drumlins is due to the large proportion of clay in this type of till, rendering it impervious. Where the till fills depressions and covers gentle slopes, however, it is in many places of more variable character, locally containing gravelly and sandy layers, and here and there having openings which form rather definite water channels. For this reason the degree of success with wells in till varies greatly, but in the aggregate the till yields a large amount of water. Generally wells of large diameter are most successful, as they offer a better opportunity for intercepting a "vein." Water obtained from till is generally of good quality for all uses, unless situated within the range of contamination from surface drainage. If the water once becomes polluted it may retain its dangerous character for a long time and for a considerable distance.

Water occurring in till is generally found within a few feet of the surface. As a rule it is not under pressure, however, and will not rise above the point at which it is encountered. The volume at any one time is not generally large, but there is a constant slow inflow. Water is abundant in a wet season or after a rain, but a large proportion of wells in till run dry in summer.

SAND AND GRAVEL.

Character and distribution.—Sand and gravel deposits are known collectively as "modified drift," for the reason that they are composed of till which has been reworked and assorted by water. Such deposits occurring in the form of flat or gently sloping plains are known as sand plains, deltas, or outwash deposits; those formed in long ridges on or under the ice are known as eskers; and those deposited as irregular hills near the ice front are known as kames or moraines. Many of these deposits are of great thickness. They all consist of pebbles and grains of sand, derived from a great variety of rocks.

Sands and gravels are widely distributed throughout the State. Moraine, kame, and esker deposits may occur in nearly all situations, though most commonly in the lowlands. Sand plains and outwash deposits are situated mostly along the valleys and lakes and within a few miles of the coast. Some of these plains are very extensive, covering many square miles of surface.

Relation to other deposits.—Most of these deposits overlie the principal body of till, although local beds of gravel are found underneath the till and in a few places gravelly layers occur in the till itself.

Gravel is also variable in its relations to clay deposits. Along the coast and in the valleys of Androscoggin, Kennebec, Penobscot, and other large rivers many extensive deposits of coarse gravels underlie the clays, and in such places the upper surface of the gravel is likely to be undulating. In other places sand and gravel overlie the clay.

Water supplies.—Sands and gravels are very porous; in many of them 30 per cent of the volume is made up of free space between the grains. In such materials the whole mass is saturated below the water level, and when penetrated by wells copious supplies are quickly yielded. The waters are generally of good quality, and in Maine they contain less mineral matter than waters from most other types of deposits.

In passing downward through the sands surface waters are subjected to natural filtration and the substances with which they may have originally been polluted are frequently changed to harmless chemical compounds. In gravel and in the coarser types of sand the water moves more rapidly and the conditions are less favorable for filtration, so the waters may remain polluted. In general, however, waters from sands and gravels, if taken from a considerable distance below the surface, are safe to use. Plenty of water may generally be found at 10 to 20 feet, but supplies from greater depth are much safer.

In the sands and finer gravels the cheapest and best method of obtaining water is by driven wells, which can be sunk quickly and at very slight cost. In the very fine sands or quicksands, however, it is very difficult to exclude the material from the pipes, the quicksand frequently penetrating the well and clogging the pipe or ruining the pump. Because of the readiness with which sands and gravels yield their water, wells located close together frequently affect one another, some wells drawing water away from others. The ease of movement of the water is also the cause of great fluctuations in the level of the surface of the saturated zone, which falls rapidly after wet seasons. To procure permanent supplies the wells should penetrate to the level which the water surface occupies in the driest seasons.

CLAY.

Character and distribution.—The clay deposits of Maine differ greatly in composition and in origin. The most common type, however—a widespread formation of rather uniform character—is a light-gray or brownish, fine-grained, thin-bedded deposit, ranging from plastic to tough, but so dense as to be almost impervious to water. It is of marine origin, as shown by fossil shells which it contains in many places. In some localities there are thin layers of sand stratified with the clay. The thickness of this principal clay bed is generally not more than 20 to 30 feet, but in some of the deeper valleys and along the coast it may be as much as 100 feet.

Clay is widely scattered, but in general it occurs near the coast or in the valleys within 100 miles of it. Near the sea it occurs as flat or gently sloping plains rising from 15 to 80 feet above tide. That these plains have been deposited in comparatively recent time is shown by their flat surface and the slight erosion they exhibit. Farther back from the coast, and in the valleys of Piscataqua, Saco, Presumpscot, Androscoggin, Kennebec, Penobscot, and other rivers, there are clays at higher levels, in some places above 200 feet, and in a few reaching 300 feet. The highest elevations are found in the Kennebec Valley, but in general the upper limit is little more than 200 feet. These high-level clays are best preserved in situations more or less protected from erosion, and when they occur in the main valleys they are much eroded, suggesting that they may be older than the coastal clays.

Relation to other deposits.—Where clay occurs it nearly always overlies the principal till deposit. In many localities, however, 3 to 5 feet or more of gravelly till rests on the clay. Gravel may overlie or underlie clay, or both. The clay is generally, but not invariably, unconformable with both the underlying and the overlying deposits.

Water supplies.—Clay is so impervious that in itself it contains little or no water which can be utilized as a source of supply Water is frequently reported in clays, but it usually occurs in more or less sandy layers. In some places sand which approaches clay in fineness and which is sometimes mistaken for clay yields considerable water.

Clay is of greatest importance, not as a water bearer, but as a confining layer to porous sands, the water in which it prevents from escaping. In large areas it is overlain by sand which contains much water, resting on the impervious clay and moving slowly riverward or seaward.

The waters of clays, because of the fineness of the material, come into contact with relatively large amounts of mineral matter and frequently become mineralized, lime and salt being the most common substances dissolved. These waters are, as a rule, free from contamination. When, because of the absence of other sources, it is necessary to obtain supplies from clay, a well should be sunk with as large a diameter as practicable and be continued beneath the point at which the water is obtained to a sufficient depth to furnish ample storage capacity, as clay waters are slight in amount and are yielded very slowly. Dug wells are usually most satisfactory where the clay is near the surface, but such wells should be carefully covered and guarded from all sources of pollution.

OUTLINE OF GEOLOGIC HISTORY.

In order to make clear the relations of the various water-bearing and impervious formations of Maine a brief summary of the history of these formations is given. As a complete geologic investigation of the State has never been made, little can be said regarding the rocks, but the sequence in which they were formed will be briefly reviewed.

The oldest formation in the southern part of the State is probably the Ellsworth schist,[a] of Cambrian age. Muddy sediments that subsequently became slates were deposited over large areas originally, but at the close of Ordovician time there was a long period of dynamic metamorphism in which these slates were turned on edge, cracked and broken, and intruded by molten granite, which now fills cracks in the slate and constitutes the surface over wide areas. The volcanic action may have extended into Devonian time. In some later age the trap dikes which penetrate the slate were formed by intrusion of a basic type of molten lava. Some slates, sandstones, and other rocks may have been formed after the intrusion of the dikes.

After the formation of all the solid rocks of Maine and their metamorphism and folding there were long ages during which few deposits were made in this part of the country, and the land was eroded into hills and valleys and brought into substantially its present relief. Then came the series of great glacial invasions which covered the State with a thick coating of drift. After the deposition of till and gravels and the retreat of the ice of the first invasion there was a long interglacial stage during which erosion removed the greater part of the glacial deposits, so that they are now found only in patches beneath the more recent till sheets.

The next glacial invasion of which we have any record is the one during which the greater part of the Maine bowlder clay was formed. During the subsequent disappearance of the ice coarse gravels were deposited in the valleys and along the coast, after which the widespread formation of marine clay took place. Later the land was elevated and the clay was deeply eroded. Still later the ice advanced again, depositing a few feet of a more gravelly type of till over some of the clay deposits. During the retreat of this final ice sheet immense deposits of sand and gravel were formed in most of the valleys and fresh marine clays were laid down along the coast. By subsequent uplift these clays have now reached an elevation of 20 to 80 feet above the sea, and form extensive plains in some localities.

RECOVERY OF UNDERGROUND WATER.

GENERAL STATEMENT.

Underground water can be obtained naturally, as it emerges from the ground in the form of springs, or artificially, by means of wells or collecting galleries. These methods and their bearing on the underground-water problems of Maine will be discussed separately.

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[a] The Ellsworth schist is described by G. O. Smith and E. S. Bastin in the Penobscot Bay folio (No. 149) of the Geologic Atlas of the United States, published by the United States Geological Survey.

SPRINGS.

Classification and emergence.—Wherever the water table or a water-bearing bed intercepts the surface of the ground a spring is formed. Springs are of various types. The waters may percolate through pores in the surface deposit or through passages in sand and clay, and these are known as seepage springs. They may traverse limestone or other soluble strata, dissolving passages for themselves, and finally emerge on a hillside, or they may flow out of fissures along joint cracks or fault or contact planes and be known as fissure springs. The term "fissure springs" is used rather comprehensively to include the springs issuing along bedding, joint, cleavage, or fault planes. The distinguishing feature is a break in the rocks along which the waters can pass, it being immaterial whether any considerable open space exists. Springs may occur in almost any topographic situation, even on a plain, but they are most common on steep hillsides.

The common method of classifying springs is by their predominating mineral constituents. Since the days of Aristotle many different classifications have been invented, and at the present time several are in use. The classification most commonly accepted in the United States is that of Peale,[a] who divides all mineral springs into two great groups—nonthermal or cold, and thermal—and into five classes with reference to chemical ingredients, viz, alkaline, alkaline-saline, saline, acid, and neutral or indifferent. Some writers use the term "chalybeate" for the fourth class instead of acid. This classification is easily subdivided, according to the predominant solid constituents of the water, which may be sodic, lithic, potassic, magnesic, salicic, iodic, bromic, arsenical, siliceous, manganic, aluminous, etc. The terms "nongaseous," "carbonated," and "sulphureted" designate the existence or nonexistence of gaseous contents.

The majority of mineral springs in Maine are either neutral or light alkaline-calcic or alkaline-chalybeate; only a few springs would fall in the other classes. They are not classified in this report, as the analyses (pp. 84–87) give a much better idea of their character.

Number and importance in Maine.—Springs are abundant in Maine, especially in the interior of the State. Very many are situated on hillsides, from which the water can be distributed by gravity to residences and farms. In places several families have combined and have distributed the water of the larger springs through their dwellings by pipes. Here and there the water is raised by windmills.

The water is very cool, temperatures as low as 45° being common and temperatures over 50° seldom reported. The spring waters are therefore valuable for dairy and creamery purposes.

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[a] Peale, A. C., Natural mineral waters of the United States: Fourteenth Ann. Rept. U. S. Geol. Survey, pt. 2, 1894, p. 66.

Springs are more generally utilized in those parts of the State where the well water is hard than where it is soft. In a few places, where the quality of water in the neighboring streams is poor, springs supply manufacturing establishments.

Information previously published.—The earliest publication regarding the mineral springs of Maine was made by Goodale in 1861.[a] The data contained in this report, consisting of a few analyses, temperatures, etc., were recompiled by Peale[b] in 1886. A few springs were described in 1899 by Crook.[c] Otherwise no information has been published regarding Maine springs except the reports of sales given in the Geological Survey's annual reports on the mineral resources of the United States.

Commercial springs.—A group of springs of great economic value to the State comprises those which are designated commercial springs, or those of which the waters are sold by measure. In this group there are two subclasses. The first includes springs that furnish table water to consumers in their vicinity at regular intervals. The second subclass comprises springs the waters of which are bottled and shipped to distant points, including the mineral springs whose waters are commonly supposed to possess medicinal properties, and also certain other springs the water of which is exceptionally pure. The sales of water from these two classes amount annually to more than $100,000, not including the sales of water from Poland Spring, the proprietors of which decline to make any statement as to the quantity or the value of the water supplied by them. It is believed, however, that the aggregate value of the water shipped from this spring is greater than that of the water from all the other springs in the State.

Altogether the springs reporting sales in southern Maine at the time this investigation was made (1906) were 44 in number, as follows:

Addison Mineral Spring, Addison, Washington County.
Arctic Spring, Bangor, Penobscot County.
Baker Puritan Spring, Old Orchard, York County.
Bluehill Mineral Spring, Bluehill, Hancock County.
Carrabasset Mineral Spring, Carrabasset, Franklin County.
Chapman's Spring, Brewer, Penobscot County.
Cold Bowling Spring, Steep Falls, Limington, York County.
Crystal Mineral Spring, Auburn, Androscoggin County.
Forest Spring, Litchfield, Kennebec County.
Glenrock Mineral Spring, Greene, Androscoggin County.
Glenwood Spring, St. Albans, Somerset County.
Highland Spring, Holden, Penobscot County.
Highland Mineral Spring, Lewiston, Androscoggin County.
Hillside Spring, Bangor, Penobscot County.
Indian Hermit Mineral Spring, Wells, York County.

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[a] Goodale, G. L., Report on the mineral waters of Maine: Sixth Ann. Rept. Maine Board of Agr., 1861.
[b] Peale, A. C., Mineral waters of the United States: Bull. U. S. Geol. Survey No. 32, 1886, pp. 13-16.
[c] Crook, J. K., Mineral waters of the United States and Canada.

Ishka Springs, West Hancock, Hancock County.
Katagudos Spring, Eastbrook, Hancock County.
Keystone Mineral Spring, East Poland, Androscoggin County.
Knowlton's Soda Spring, South Strong, Franklin County.
Mount Desert Spring, Bar Harbor, Hancock County.
Mount Hartford Mineral Spring, Hartford, Oxford County.
Mount Oxford Spring, Sumner, Oxford County.
Mount Zircon Spring, Milton Plantation, Oxford County.
Oak Grove Spring, Brewer, Penobscot County.
Olde Yorke Spring, Old Orchard, York County.
Oxford Spring Home, Oxford, Oxford County.
Paradise Spring, Brunswick, Cumberland County.
Pejepscot Spring, Auburn, Androscoggin County.
Pine Spring, Topsham, Sagadahoc County.
Pine Grove Spring, Pittsfield, Somerset County.
Poland Spring, Poland, Androscoggin County.
Pownal Spring, New Gloucester, Cumberland County.
Pure Water Spring, Waterville, Kennebec County.
Raymond Spring, North Raymond, Cumberland County.
Rocky Hill Spring, Fairfield, Somerset County.
Sabattus Mineral Spring, Wales, Androscoggin County.
Seal Rock Spring, Saco, York County.
Sparkling Spring, Orrington, Penobscot County.
Switzer Spring, Prospect, Waldo County.
Thorndike Mineral Spring, Thorndike, Waldo County.
Ticonic Spring, Winslow, Kennebec County.
Underwood Spring, Falmouth Foreside, Cumberland County.
Wawa Lithia Spring, Ogunquit, York County.
White Sand Spring, Springvale, York County.

In addition to the springs given above, the following springs were reported by Peale,[a] with analyses that were made at various dates between 1861 and 1879. It is not known whether all these springs are still in use, but none of them report sales.

American Chalybeate Spring, South Auburn, Androscoggin County.
Auburn Mineral Spring, South Auburn, Androscoggin County.
Boothbay Medicinal Spring, East Boothbay, Lincoln County.
Ebeeme Spring.
Fryeburg Spring, Fryeburg, Oxford County.
Lake Auburn Mineral Spring, North Auburn, Androscoggin County.
Lubec Saline Springs, head of Lubec Bay, Washington County.
North Waterford Springs, northwest of Waterford village, Oxford County.
Poland Silica Springs, South Poland, Androscoggin County.
Rosicrucian Springs, Rosicrucian, Lincoln County.
Samoset Mineral Springs, Nobleboro, Lincoln County.
Scarboro Spring, Scarboro, Cumberland County.
Summit Mineral Spring, Harrison, Cumberland County.
West Bethel Spring, West Bethel station, Oxford County.

Analyses of some of the above were taken by Peale from Goodale's report.

[a] Op. cit., pp. 15-16.

Origin of spring waters.—A common belief regarding the origin of spring waters is that most of them are derived from a distant source. Several spring owners have told the writer, with perfectly truthful intent, that the water in their springs came from the White Mountains, at least 40 or 50 miles away. Owners of flowing wells in Islesboro have stated their belief that the water of the wells has its source in mountains on the coast, several miles distant.

In some regions springs may have such an origin. Many of the waters of mineral springs in the West come long distances underground. In Maine, however, it is not known that a single spring or well obtains its supply at a distance of more than a mile from the place where the water emerges. The majority of spring waters enter gravel deposits on the surface of a hill and pass downward along the top of the bed rock or "hardpan" deposits until they find an easy point of emergence on the slope. In a few mineral springs the waters issue from joint cracks or from fissures in rock. These waters may come from a considerable depth, but as their temperature is generally about the normal temperature of the region, they are not believed to come from a greater depth than 100 feet below the surface.

Curative properties of spring waters.—Most owners of commercial springs publish numerous testimonials of wonderful cures wrought by the waters. From some advertisements it would appear that the water would cure nearly every known disease. It is not within the province of this report to discuss the medicinal value of waters, but a word of caution should be given. There are many reliable spring companies whose waters are all that is claimed for them. There are other companies who claim manifold cures which have never been made. It would be folly to expect any natural water to be a cure-all; but a few spring waters may be valuable for curative properties, which depend on the presence of certain elements or compounds. A summary of the medicinal value of mineral waters is given in a recent bulletin of the Bureau of Chemistry.[a] Few of the Maine spring waters contain large amounts of dissolved solids, and therefore few can be called mineral waters in the true sense of the term. Most of them are merely pure natural waters, which are of value chiefly on account of the small amount of solid matter dissolved in them. It is by their purity and by their buoyant effect on the general health that they build up the system, rather than on account of any wonderful specific property inherent in the water.

[a] Haywood, J. K., Mineral waters of the United States: Bull. Bur. Chemistry, No. 91, U. S. Dept. Agr., 1905, pp. 12-16. Compiled from Crook's Mineral waters of the United States and Canada, Schweitzer's Mineral waters of Missouri, Cohen's System of physiologic therapeutics, and other publications.

COLLECTING GALLERIES AND TUNNELS.

In many places, where a large amount of water is needed, infiltration or collecting galleries are constructed, generally in flood plains of rivers, where the water which saturates the deposits can be collected and pumped out. This method is especially adapted to public supplies for fair-sized towns. It has not been used in Maine, but there are a number of communities where it could probably be used to advantage.

WELLS.

GENERAL TYPES.

Open wells.—Open wells are ordinarily used for domestic purposes throughout the State. Wells of this type are generally 3 to 6 feet in diameter and from 10 to 50 feet in depth, the most common depth being about 30 feet. The depth is dependent on the distance to the water table and on the character of the material penetrated. Such wells are dug by hand if in surface deposits, or blasted if in rock. Dug wells are curbed with stone or bricks, generally uncemented. Sometimes open wells under 2 feet in diameter are bored with an auger; such wells are curbed with wooden curbs. Open wells are adapted principally to localities where the water is near the surface, especially where it occurs in small seeps, in clayey materials, and requires extensive storage space. Open wells should never be situated near sources of pollution.

Tubular wells.—This term is used in a general sense to describe all types of wells cased with iron pipe, or drilled in solid rock where casing is not necessary. In diameter they vary from 1¼ inches in some shallow driven wells to 15 inches or more in the largest tubular wells sunk for city water supplies. In soft unconsolidated deposits of sand and gravel which carry considerable water at shallow depths small pipes 1¼ to 4 inches in diameter, provided with points and screens, may be driven by hand or power. Such tubular wells are termed driven wells. In localities where the upper soil contains polluting matter driven wells are much safer than open wells, for, when driven some distance below the water table, they draw only from the lower part of the reservoir. Shallow tubular wells may be bored, or in soft deposits they may be sunk by the "jet process," which consists in forcing water down a small iron "jet pipe" inside the casing, the water and drillings rising between the two pipes. The casing sinks by its own weight or is forced down. Such wells are generally 2 to 4 inches in diameter. Tubular wells in rock or other hard material are commonly "drilled wells," sunk by lifting and dropping a heavy drill run by power. Tubular wells are cased with iron pipe in soft material and generally not cased in rock.

Connected wells.—Frequently two or more drilled wells are located near together and connected by exploding a charge of dynamite near the bottom of the shallower one. Thus it is possible to pump several wells with a single pump. In a few places neighboring wells are connected naturally by joint cracks.

Combination wells.—A common form of well is the combination of dug and drilled or dug and driven well. Frequently when dug wells run dry the owner sinks a tubular well in the bottom, running the casing only to the bottom of the old open well, or only part way to the surface. As stated on page 54, such a combination well is unsafe.

METHODS OF OBTAINING WELL WATER.

Pumping.—In Maine there are few flowing wells, and in most wells the water must be raised artificially. The old-fashioned method of raising water is by the windlass, and in some parts of the State well sweeps are in common use. Such simple contrivances are only suitable for shallow open wells; in deep wells it is necessary to install a pump. This is also recommended in shallow wells, as it is easier of operation and the well can be covered to prevent entrance of animals, dust, organic matter, etc.

By far the great majority of wells in Maine are pumped by hand, and this method is in general fairly satisfactory when only a small

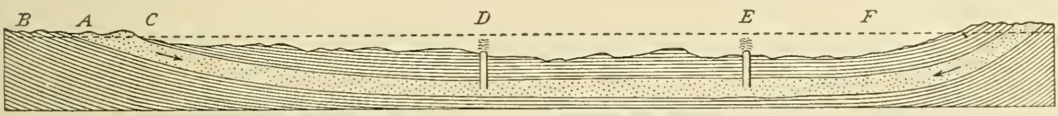


FIG. 3.—Diagram showing conditions under which flowing wells are commonly obtained in favorable regions. (After Chamberlin.) This sketch shows the contrast to conditions in Maine, illustrated in fig. 4. *A*, Porous stratum; *B*, *C*, impervious beds below and above *A*, acting as confining strata; *F*, height of water level in porous beds, or "head" of water; *D*, *E*, flowing wells supplied by water-filled bed *A*.

amount of water is required for domestic use. Hand pumps are either ordinary suction pumps, chain pumps, rotary pumps, or deep-well pumps. In the farming and summer-resort sections, however, windmills are common. They are inexpensive in comparison with the sums generally spent in drilling the well, and they save a great deal of manual labor, especially when the water is desired for stock. For public water supplies it is necessary to resort to some kind of power. Steam, hot air, and gasoline engines are in use. Many persons who own cottages on the coast or islands have these kinds of power, which give excellent service. There are in southern Maine about 30 wells pumped by steam, about 17 by gasoline engines, and about 20 by hot air. Several electric power pumps and two or three air lifts have been installed.

Artesian wells.—In many wells the water is under the pressure of a considerable head, forcing it to rise. Such wells are known as artesian wells. If the water rises enough to reach the surface, the wells are known as flowing artesian wells. The conditions under which flows are normally obtained are described by Fuller,[a] and the cause of the flow is illustrated in fig. 3. The pressure is due to the confinement of the water in inclosed beds beneath an impervious layer. The water enters the porous beds where they outcrop on the surface and flows downward beneath the impervious covering. When the latter is pierced by the well the water rises in consequence of the pressure due to the superincumbent water. Only a few flows of this type occur in Maine, however, and these are generally from surface deposits in very local basins.

Bayley, in his notes on the underground waters of Maine,[b] gives the location of a few flowing wells in Maine, and several more were mentioned by Smith,[c] in his Kittery-York report. A few more have been found by the writer. Most of these belong to the type illustrated in fig. 4, where the pressure is derived from systems of joint

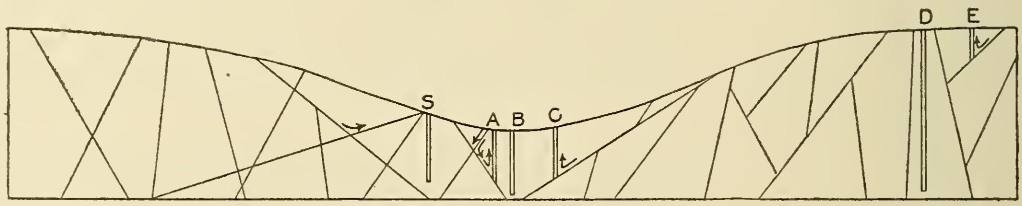


Fig. 4.—Diagram showing various conditions in drilled wells in Maine. *A*, *C*, conditions under which flowing wells may be obtained; *B*, *D*, *S*, conditions under which no water may be found; *E*, normal condition of obtaining water in drilled wells; *A*, conditions under which well may be polluted by surface drainage entering joint cracks near mouth of well.

cracks sloping from higher levels. A superficial coating of till or bowlder clay generally prevents the water from reaching the surface by springs at higher points on the hill. The water penetrates downward along joint cracks and is tapped by a well lower down on the slope or near the bottom of the valley.

In all, 34 flowing wells are known in southern Maine. These are distributed as follows:

Flowing wells in southern Maine.

Androscoggin County	2
Cumberland County	11
Hancock County	3
Knox County	1
Penobscot County	2
Sagadahoc County	2
Somerset County	1
Waldo County	4
Washington County	1
York County	7

It will be noticed that flowing wells are most abundant in the southwest corner of the State. In the town of Greenville, several miles north of the area considered in this report, there is a group of

[a] Fuller, M. L., Bull. U. S. Geol. Survey No. 319, 1908.
[b] Bayley, W. S., Water-Supply Paper, U. S. Geol. Survey No. 114, 1905, p. 49.
[c] Smith, G. O., Water-Supply Paper U. S. Geol. Survey No. 145, 1905, pp. 122–123.

flowing wells which are better than any elsewhere in Maine. These will be described in the forthcoming report on the underground waters of northern Maine. The highest flow due to artesian pressure in southern Maine is about 5 feet above the surface. In one well at Greenville, however, the water rises 20 feet above the surface.

LOCATION OF WELLS.[a]

Factors to be considered.—The chief factors to be considered in choosing the best location for a well are (1) position of the water table, (2) accessibility and convenience, (3) direction of movement of ground water, (4) direction and movement of sewage, (5) points of most abundant water, and (6) possible sources of pollution.

Position of the water table.—The first factor is generally not important except in open or driven wells. These are generally shallow, because of the nature of their construction, and their cost is small. "On passing downward in porous or semiporous materials, such as those in which most open wells are located, a level is soon reached below which the ground is saturated with water (at least down to the first impervious stratum). This water body, or ground water, as it is called, has a definite upper surface, known as the water table, which conforms in general with the broader surface irregularities, but with the difference that the surface of the water table is flatter than that of the ground, being far below the ground on hilltops and cutting the surface in valleys." At a stream or swamp the water table reaches the surface, and the nearer to such natural features the well is situated the less will be its cost. The places where the water table is nearest the surface, however, are the most subject to pollution, and cheapness is often gained at the expense of safety.

Accessibility and convenience.—The location of any well is necessarily determined to a large extent by its nearness to the place where the water is to be used. Convenience often demands that open wells should be situated under houses or in barnyards, near privies or cesspools, or in other situations where they are subject to pollution, but it is always better to locate the well a few hundred feet away than to take such a risk.

Points of most abundant water.—In many places, especially on the uplands covered with bowlder clay, it is necessary to choose the location of open wells with reference to the relative abundance of water. In bowlder-clay deposits the best situation can not always be told in advance, as water in them occurs most commonly in somewhat porous channels not visible from the surface. When there is a choice between digging in bowlder clay or in gravel the latter should be chosen, especially if the gravel is underlain by bowlder clay, as

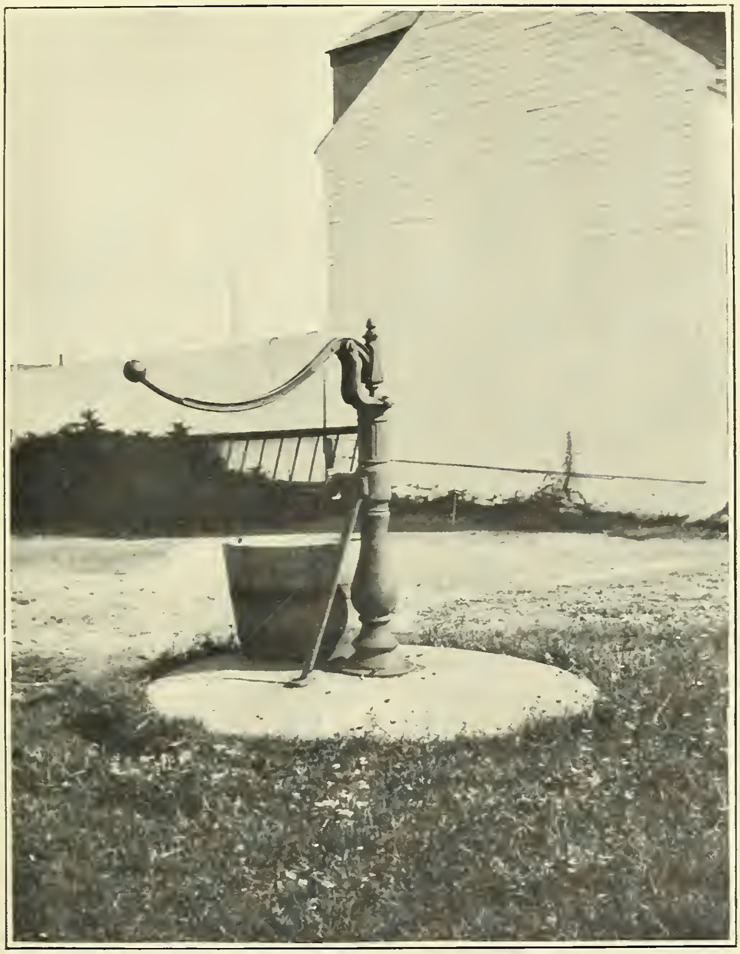
[a] Considerable portions of this and the succeeding section are taken by permission from unpublished notes of M. L. Fuller. Literal excerpts are inclosed in quotation marks.

the water will penetrate downward until stopped by the more impervious bed, and will then be held in a sort of reservoir until tapped by a well or drained off laterally. On slopes the most abundant water is near the base of the slope. Generally there is abundant water in valley drift, but on the hills it occurs in smaller quantities.

Direction of movement of ground water.—"The motion of ground water is always in the direction of steepest slope of the water table, and as this is likely to correspond with the direction of the surface slope the direction of motion of the ground water generally approximates that of the surface drainage." In drift deposits water moves from higher to lower levels. On hills it will move downward through the drift, along the top of the underlying rock. Exceptions are where till, clay, rock, or other relatively impervious formations dip in the opposite direction from the surface. In such cases the water will move downward from the surface along the top of the impervious bed. Wells which are intended to tap the reservoir of ground water should be situated at points toward which the water is moving, and these points must be determined by a study of the surrounding formations.

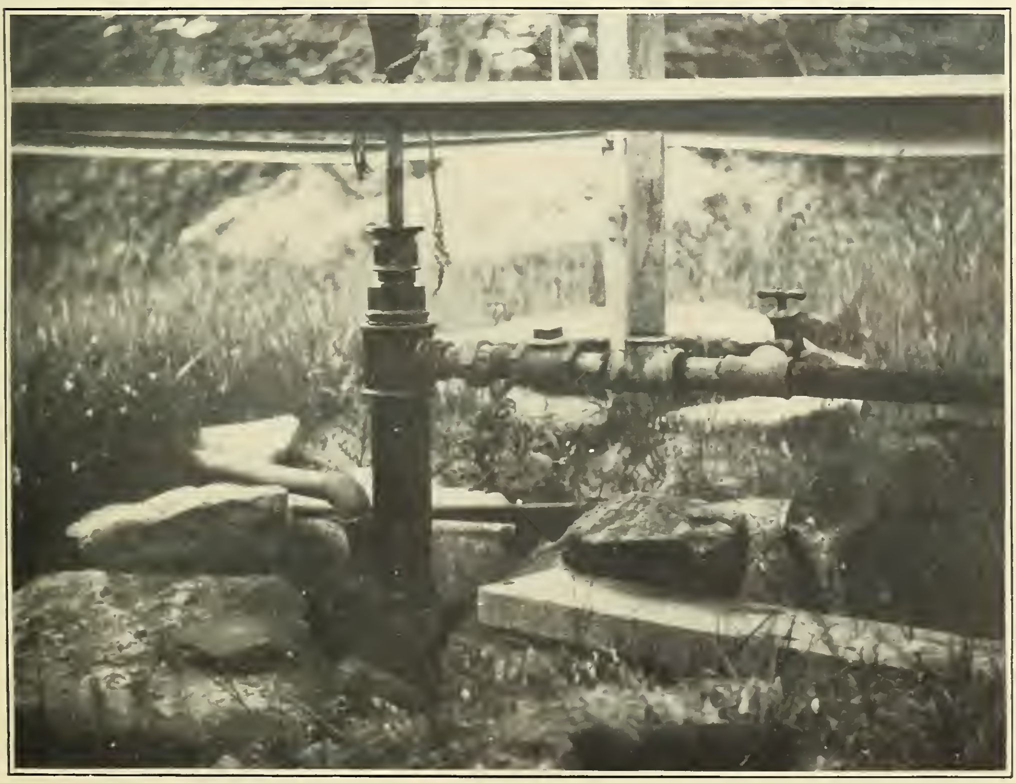
Sources of possible pollution.—Next to the question of abundance of water that of pollution is most important in a consideration of the location of wells. Purity or impurity of underground water is dependent on several factors. If porous drift extends downward indefinitely from the surface, opportunity is afforded for the downward penetration of polluting substances, but the water may sometimes be purified by filtering through sand. If the water-bearing bed is overlain by a covering of impervious rock or clay it is protected from pollution. The purity of water, even in deep wells, may be dependent on the tightness of the casing, both at the joints and at the connection with the pump. Some deep wells in Maine have been rendered dangerous by leaving the casing open at the top, thus affording entrance for surface drainage, small animals, etc. (See Pl. IX, *B*.) When wells are drilled into rock it is customary to drive the casing through the drift and a few feet into the ledge for the sake of protection, but where poor connection with the rock is made contamination often results. The purity of water is also dependent on the depth and kind of casing, as is explained on page 66.

"No well should be located where polluting matter has access to it. Such matter usually comes from cesspools or privies, slops thrown on the surface, backings from hen yards, pigpens, and barnyards, from manured fields, animals falling into the water, and filth thrown in through the open top or washed in through the plank coverings or leaky casings. The matter entering through the top can be kept out by cement, iron, or other impervious curbings. The entrance of material at the bottom of shallow wells can be prevented only



A. WELL AT COUNTY JAIL, WISCASSET.

Showing best method of protection from surface drainage.



B. WELL AT HERON ISLAND, SHOWING OPEN CASING.

PROTECTED AND UNPROTECTED WELLS.

by locating them beyond the reach of contamination. Where any of the polluting agents are present care should be taken to see that the well is located at least 100 feet away and on distinctly higher ground, so that both the surface drainage and the underground drainage—which generally moves in the same direction—will be away from it. On flat sands the wells should be at least 150 feet from any source of pollution. The importance of choosing a location safe from polluting influences is almost universally underestimated. Laying aside considerations of comfort and health, a safe well is nearly always, in the long run, the cheapest. Safety should invariably be made the first consideration instead of the last."

Location of deep wells.—The chief consideration in locating deep wells is to obtain a supply, slight differences in location seldom greatly affecting cost; moreover, owing to the prevailing use of casing in soft deposits, safety from ordinary pollution is insured. The occurrence of deep waters depends on the character and structure of the rocks far below the surface, and the well may usually be located independently of surface relief. In crystalline rocks and highly folded slates, such as are found in Maine, it is impossible to predict with certainty where a well should be drilled in order to be successful, although a study of the rocks by a geologist should afford some information regarding the probability of obtaining successful wells in various situations.

CHOICE OF A TYPE OF WELL.[a]

Factors to be considered.—"The type of well is the first and perhaps the most important point to be decided when sinking for water is contemplated. Of the many types in use, including bored and driven wells, those sunk by the jet process, and those drilled by a rotary or percussion rig, each possesses one or more points especially qualifying it for use in some of the varying conditions encountered in drilling; on the other hand, each has some disadvantage which may disqualify it for use under certain circumstances. The chief factors which govern the selection of a type are usually the amount of water needed, the character of the materials to be penetrated, the depth to which the well must be sunk, the cost of sinking, and the safety of the resulting supply."

Amount of water obtained by different types.—Where the amount of water entering the well is small, it is obviously a distinct advantage to have a well of sufficient size to store water during the times when it is not in use. Open wells are best for this purpose, and this type also has the advantage of cutting a larger cross section

[a] Considerable portions of this section are taken by permission from unpublished notes of M. L. Fuller.

of the water-bearing bed, and thus intercepting more water. In sands and other soft porous materials, which contain considerable water at slight depths, a driven well is desirable. Where water occurs in joint cracks, as in granite and slate, a well of large diameter offers greater chance of striking a seam of water than a well of small diameter. For all deep wells and for shallow wells in all but the softest materials drilled wells are recommended, as they are cheaper, more quickly put down, and safer than wells of the old-fashioned types.

Safety of different types.—Polluting matter finds entrance to a well in a number of ways. In dug wells it may enter through the crevices in the stone, brick, or wood curbing, or even through the pores of the brick itself; in bored wells it may enter through the uncemented joints of the tiling or cracks between the staves of the wooden curbing; and in drilled or driven wells it may enter through leaky joints or holes eaten in the iron casing by corrosive waters. In all types of open and curbed wells there is particular danger of surface wash. Open wells can be protected from this danger by proper curbing, but shallow wells of all kinds can be protected from underground pollution only by safe location. In a town or village, and even in close proximity to a farmhouse, few locations are safe, and hence drilled wells are almost universally the most desirable. These wells may become dangerous through leaky joints in a casing, through poor connection with the bed rock, through corroded casings, and through open tops. Where tiling is used for casing it may become so broken as to render the well dangerous. The danger of pollution in drilled wells can be remedied by proper construction.

"A particularly dangerous type of well—the more so because it is fancied to be secure—is a combination of the dug and drilled types. Because of the slight saving in expense, drilled wells are frequently sunk in the bottom of old dug wells, the casing often beginning at the bottom of the latter. Although the water encountered by the deep well may be perfectly pure at the start, contamination may take place almost immediately by the entrance, especially after rains, of seepage water into the open well and thence into the casing of the drilled well. The remedies are obvious. Either the casing should be carried to the surface of the outside ground, or at least above the highest level ever reached by the water, or the open well should be converted into a water-tight system by the application of a thick coating of cement over both sides and bottom."

Types in use in Maine.—In this State dug wells greatly predominate in number over wells of all other types. Such wells are, however, relatively shallow; few of them exceed 50 feet in depth. For that reason few dug wells are listed in Professor Bayley's table (pp. 242–259). Next to dug wells the most numerous are those sunk with an ordinary churn drill. Most of the wells described in this report are of this type, as they are by far the most practicable in regions of hard rock. Driven wells are abundant in Maine, but are of necessity confined to shallow depths and to valleys in which the sand and gravel deposits are very soft and easily penetrated by the well point. On account of their shallowness few of them are included in the table mentioned. There are very few bored wells in Maine, and these are all rather shallow.

DEPTH OF WELL.

OBJECT OF DEEP WELLS.

The depth to which a well is to be sunk is one of the chief questions to be decided, for on the depth are dependent both the type and the location. There may be at least three reasons why an owner should sink a deep well instead of a shallow one, viz, (1) to obtain an adequate supply, (2) to get a higher head, and (3) to get purer water.

RELATION OF ADEQUATE SUPPLIES TO DEPTH OF WELL.

Erroneous beliefs.—There seems to be a general belief that the amount of water increases with the depth, and that water may be found anywhere if only the well be drilled deep enough. Nothing, however, could be much farther from the truth. In surface deposits it is true that more water may be found with increasing depth as far as the gravel extends, but in the bed rock the occurrence of water follows different laws. The greater part of the water found in the earth came originally in the form of rain, and, as would be expected, the amount of water actually decreases rather than increases with great depth. Many rocks encountered by deep mines and wells, especially at depths below 1,000 feet, are entirely devoid of water.[a]

Limiting depth of abundant water.—In an investigation of underground waters in crystalline rocks in Connecticut it was found that, although down to a depth of 200 feet the chances of striking water by deeper drilling are good, below 200 feet the chances decrease. The difference is due to the closeness of the joint cracks below that depth.[b] Substantially the same conclusion has been reached for many rocks in Maine. Several wells more than 500 feet in depth, drilled in granite and gneiss, have obtained practically no water. One of the most experienced well drillers in Maine states that the

[a] Fuller, M. L., Total amount of free water in the earth's crust: Water-Supply Paper U. S. Geol. Survey No. 160, 1906, pp. 64–70.

[b] Ellis, E. E., Occurrence of water in crystalline rocks: Water-Supply Paper U. S. Geol. Survey No. 160, 1906, pp. 22–23.

average depth to which it is desirable to drill in granite is 185 feet, below which the chances decrease.

In many of the slate areas of the State, on the other hand, the maximum desirable depth seems not to have been reached, as wells 300 and even 400 feet deep report increasing supplies with increasing depth. As few slate wells more than 400 feet deep have been drilled, no statement can be made for greater depths, but it is believed that the cracks tend to close below 600 feet. As the occurrence of water in this State is uncertain the depth at which wells strike a sufficient volume of water is extremely variable and can not be predicted.

Conditions of greater abundance at depths.—It is true that under certain conditions the volume of water found may increase with the depth. Sand, gravel, and bowlder clay, for instance, are dry down to the level of the water table, but below this level the amount of water increases until rock or some other impervious bed is reached. In some parts of Maine the surface deposit is clay, which contains very little water, but when this is penetrated gravels that contain an abundance of water are frequently found. Again, in rocks where the joints are open to great depths water may descend several hundred feet. Such is the case in some of the slate areas of Maine, where the deeper wells are the best.

Conditions of greater abundance near surface.—On the other hand, the quantity of water held in thick sand and gravel deposits is generally more than that in the rock or till below them. Water is more abundant in valley deposits than it is in the underlying rock. Where water-bearing sand rests upon clay the amount of water generally decreases as the clay is entered. Investigations have shown that in most rock wells the joint cracks are likely to be open near the surface and to diminish in size with increasing depth, and that if a depth of 200 to 500 feet or so, differing with the kind of rock, is reached without striking water it is generally cheaper and more satisfactory in all respects to start a new well. Usually the greater abundance of water in deep wells than in shallow ones is due to the fact that a greater number of water-bearing seams are encountered, and for this reason it is advisable to drill at least 200 feet if a sufficient supply is not obtained nearer the surface.

RELATION OF HEAD TO DEPTH OF WELL.

There is a general belief that the head as well as the volume increases with increase of depth. In a few wells such an increase was noted, for example, in the flowing wells at Greenville and in scattered wells elsewhere; but such cases are rare and are always due to chance local conditions which do not prevail over any wide area. In Maine flowing wells are exceptional and should not be hoped for. . Sometimes the level of water in the well is raised by going deeper, but this too is an accident. Most wells are drilled a few feet deeper than the water vein in order to form a reservoir for the water and whatever sediment it may contain.

RELATION OF PURITY OF WATER TO DEPTH OF WELL.

The prevailing idea in regard to purity, as in regard to volume and head, is that deep waters are best. This is generally true, for the reason that shallow waters are usually in unconsolidated deposits, and not being protected by impervious rocks or clay they are more likely to be polluted by surface drainage. A deep rock well is nearly always to be recommended where pure drinking water is desired.

When water is needed for industrial purposes the problem is somewhat different. While water from a depth is generally free from surface pollution, it often contains considerably more mineral matter in the form of incrusting constituents and is generally harder than most surface waters. In Maine, however, few waters are so hard as to prevent their use for laundries and boilers.

DEPTH OF WELLS IN SOUTHERN MAINE.

In the region covered by this report the drilled wells range in depth from 20 to more than 800 feet. Only a few, however, are more than 500 feet deep. Out of 500 wells in Professor Bayley's list (see pp. 242–259) which are more than 50 feet deep only six exceed 500 feet. In order to show the common depth of wells in various parts of southern Maine the following table has been prepared. Only drilled wells more than 50 feet deep are here considered.

Number of wells of different depths in southern Maine.

County.	Between 50 and 100 feet.	Between 100 and 200 feet.	Between 200 and 300 feet.	Between 300 and 400 feet.	Between 400 and 500 feet.	More than 500 feet.	Total number reported more than 50 feet.
Androscoggin	5	4	1	....	....	1	11
Cumberland	44	30	22	5	....	2	103
Franklin	2	....	....	....	....	....	2
Hancock	47	15	6	1	1	1	71
Kennebec	16	15	3	1	....	1	38
Knox	7	15	7	3	....	1	33
Lincoln	31	20	2	1	....	....	54
Oxford	4	4	....	....	....	....	8
Penobscot	39	13	4	1	1	....	58
Somerset	5	1	....	....	....	....	6
Waldo	26	19	10	4	....	....	59
Washington	8	2	....	1	1	....	12
York	29	9	3	2	....	....	45
	263	147	58	19	3	6	500

DEPTH TO PRINCIPAL WATER SUPPLY.

In parts of the country where water occurs in definite beds it is possible to predict the depth at which it will be found by calculation from knowledge of the lay of the rocks and the altitude of the surface. In Maine, however, the water occurs at no definite depth, and all statements as to the distance below the surface at which it will be found must be expressed only as probabilities. Professor Bayley, in compiling the well records, made an effort to obtain figures giving the depth of the principal water supply below the well mouth. It was possible to obtain these figures for more than half the wells; in the rest the depth to the water vein was not known by the owners.

In order to make comparison of the depths at which the principal supply was found in various parts of the State the following table has been prepared, giving the depths of the principal water bed as found in the several counties:

Number of wells in southern Maine obtaining principal water supply at stated depths.

County.	Between surface and 50 feet.	Between 50 and 100 feet.	Between 100 and 200 feet.	Between 200 and 300 feet.	Between 300 and 400 feet.	Below 400 feet.	Total number reported.
Androscoggin	1	3	1				5
Cumberland	6	19	14	9		1	49
Franklin		1					1
Hancock	11	35	7	1		1	55
Kennebec	4	7	6	1	1		19
Knox	1	10	11	1			23
Lincoln	6	20	8				34
Oxford	2	2					4
Penobscot	11	22	2	3		1	39
Sagadahoc	1	7	1	2			11
Somerset		2					2
Waldo	10	10	6	7	3		36
Washington	1	2			1		4
York	3	12	5	2	1		23
	57	152	61	26	6	3	305

By reference to the table it will be seen that nearly three times as many wells drilled more than 50 feet obtain their principal vein of water between 50 and 100 feet from the surface as those which obtain it within 50 feet of the surface. More wells obtain water between 100 and 200 feet than obtain it within 50 feet of the surface. The number encountering their principal water vein deeper than 200 feet, however, diminishes rapidly with each 100 feet of depth. Hence it can be said that the principal water vein may in the greater number of wells be looked for between 50 and 100 feet below the surface; but no one prospecting for water should begin to get discouraged unless he drills more than 200 feet without finding water.

Several exceptions can be made to the statements regarding the occurrence of the greatest number of water seams between 50 and 100 feet from the surface. For instance, it will be noticed that in Waldo County as many wells obtain water at depths less than 50 feet as between 50 and 100 feet, but that at the same time an equal number obtain their largest supplies between 200 and 400 feet from the surface. Waldo County is largely made up of slate, which seems to hold plenty of water, and in that section the principal supply is just as likely as not to be obtained at depths greater than elsewhere. The statement is believed to hold true for Penobscot County also, although in that county shallow wells have met with such success that few have been drilled much below 100 feet. A further discussion of the probable maximum depth of water is given under the descriptions of the different rocks. (See pp. 29–38.)

DIAMETER OF WELL.

By far the most common diameter for drilled wells in this part of the country is 6 inches. Most drillers prefer to sink 6-inch holes, and the prices which they quote and those given in this report are for this size. For domestic use a sufficient supply of water can generally be obtained from a 6-inch well, and it does not seem desirable, except in particular cases, to go to the additional expense of sinking an 8-inch or 10-inch well. A 4-inch well is likely to be too small to give satisfaction, but a few of that diameter have been drilled.

Where a larger amount of water is needed, as in creameries, factories, hotels, etc., an 8-inch well is frequently sunk. Most of the wells drilled for the United States Government at forts along the coast are 8 inches in diameter, although a few of them are 6 inches. For a number of city water supplies, large hotels, etc., 10-inch or 12-inch wells have been drilled. These are expensive and ordinarily not desirable. Although theoretically they will yield a larger volume of water, it is not supposed that the amount of water stored in rocks in this State is sufficient to warrant many wells of this size. It is generally preferable to sink two or more smaller wells. In the early days of well drilling in Maine the business was not such an established one, and the wells were generally of odd sizes. For that reason many wells of 5-inch, 7-inch, 9-inch, and other diameters are reported.

Driven wells sunk for domestic purposes are generally from $1\frac{1}{4}$ to $2\frac{1}{2}$ inches in diameter, and this size suffices for most purposes. Larger wells are sometimes driven, however. In some of the city waterworks batteries of 30 or more $2\frac{1}{2}$-inch driven wells are used.

UNCERTAINTY OF RESULTS.[a]

"The discovery of water by a given well in rocks of this State does not necessarily indicate that other wells drilled in the same neighborhood will likewise yield water. As a matter of fact, in several places dry wells and fairly successful wells are situated side by side. At North Haven, in Penobscot Bay, a well was drilled to a depth of 300

[a] The three paragraphs within quotation marks are from notes of Prof. W. S. Bayley.

feet without finding water; while a second well, less than 50 feet distant, encountered water at 60 feet under sufficient pressure to raise it within 14 feet of the surface. This well yields about 350 gallons a day.

"Again, at Palmyra, in Somerset County, three wells were drilled in slate. One was dry to a depth of 157 feet, at which depth the well was abandoned. A second, 70 feet distant, was drilled 80 feet, when it suddenly filled within 4 feet of the surface. It yields, however, but 25 to 50 gallons daily. A third well, 170 feet from the second one, struck water at 60 feet and now yields about 200 gallons daily.

"In the Kittery-York district a well on the road between York Harbor and York Beach yields 100 gallons an hour, the water vein at a depth of 25 feet giving a pressure sufficient to drive the water 2 feet above the surface. Near by, on Cape Neddick, only a few hundred yards from the flowing well, is another that was drilled to a considerable depth without encountering any water. A third well, at a slightly greater distance from the first, was drilled 87 feet, at which depth salt water was struck."

Fortunately, however, the risk of missing water is not great. The number of dry wells reported is small. The rocks in the southern part of the State (where most of the drilled wells are situated) are nearly all slaty, schistose, and much jointed rocks cut by granite and other igneous rocks. The foliation planes and joint cracks are numerous and closely spaced, so that a drill hole of even moderate length can scarcely avoid intersecting many of them. They afford abundant space for the storage of large quantities of water, but they yield it comparatively slowly.

An important consequence of the manner of storage of water in schistose and jointed rocks is that prophecies regarding the depth at which the water is to be found are valueless. In a gently folded region like Minnesota or Kansas an approximate estimate of the position of the porous water-bearing bed is usually possible. In areas of crystalline or metamorphic rocks like Maine, on the other hand, each well is an independent problem. The hole is sunk until it strikes a crevice or a group of crevices yielding sufficient water for the purpose needed, and the depth to which it must be sunk can not be foretold. In some wells water is encountered within 50 feet of the surface; in others only at much greater depths.

PROPORTION OF SUCCESSFUL WELLS.

An earnest effort has been made to obtain accurate information regarding the proportion of wells drilled which are successful. Such an estimate is difficult to obtain for several reasons. In the first place, most well drillers are naturally inclined to be optimistic and report few if any failures. Second, real failures are likely to be forgotten by residents of a community, and it is hard to get track of them. Third, there is no agreement between underground-water experts, well drillers, and owners as to what really constitutes a successful well. In several instances the United States Government has been known to abandon a well for the reason that its supply was only 10 to 20 gallons a minute. Large hotels have abandoned wells for the same reason. For ordinary domestic purposes, however, a well with this capacity is called very successful, and even 1 or 2 gallons a minute will usually suffice for a single family. If less water than this is obtained, the well is generally ranked as a failure.

As stated above, most well drillers report no failures. A few of the most experienced drillers report one or two wells in a hundred that do not yield sufficient water. In many instances there is a disagreement between the driller and the owner, owing to the fact that the well produced a fair amount of water when the vein was first pierced, but by the time the bill had been paid and the driller had moved to some other town the water gave out. Cases like this are due to the water occurring in pockets. For this reason some of the more experienced and reliable drillers will not leave a well until after waiting a sufficient time to determine whether the supply is likely to be permanent.

In the following table a successful well is considered as one that supplies enough water for ordinary domestic use, generally a gallon a minute. In compiling the table all wells more than 50 feet in depth in which the type of rock was known were considered. The unsuccessful wells include both those in which little water was found and those in which the water was of very inferior quality.

Proportion of successful wells in southern Maine.

Type of rock.	Number of successful wells.	Number of unsuccessful wells.	Total number of wells considered.	Percentage successful.
Granite	51	8	59	86
Gneiss	12	2	14	86
Slate	191	[a] 23	214	88
Schist	34	3	37	92
Trap and greenstone	10	3	13	77
Complex	42	[b] 6	48	87
	340	45	385	88

[a] Including six wells ruined by entrance of sea water.
[b] Including one well ruined by entrance of sea water.

It will be seen that, aside from the trap and greenstone wells, the percentage of successful wells was from 86 to 92, the average being 88. On account of the factors mentioned in the preceding paragraph, however, this is possibly somewhat overestimated. It is evident that trap and greenstone are the poorest rocks in this State in which to drill. If the six slate wells ruined by salt water should be included with the successful wells, the percentage of probable success by drilling in slate would become 93, agreeing very well with the percentage for schist.

CAPACITY OF WELLS.

As very few wells in Maine are pumped by power, and as fewer of these are operated continuously or more than several hours at a time, it is difficult to make any definite generalization regarding the amount of water which they will yield. The best that can be done is to state the maximum and minimum amounts obtained and the most common reports of the yield in gallons a minute. Some of these reports are based on only a few minutes' pumping; in other cases the wells have been operated as a test for several hours or days continuously. Probably the majority of wells in Maine yield less than 5 gallons of water a minute. There are, however, many reports of yields as high as 10 or 20 gallons a minute, and a number of wells where more than 50 gallons a minute have been obtained for several hours continuously. A few yields of 100 to 200 gallons a minute are reported, but such high amounts can not be vouched for, as the exact conditions under which the test was made are unknown. One of the greatest factors in the reported capacity of the well is obviously the capacity of the pump used.

INCREASE IN YIELD.

In some wells the capacity increases with age. This is due to the fact that a newly drilled well contains at its bottom much fine material derived from the drilling, which tends to clog up the pores and water veins in the rock. As time passes this material is washed out, and the yield of the well becomes larger. Instances of such increases in yield are the well of the Penobscot Coal and Wharf Company at Searsport, that of the Maine Insane Hospital at Widows Island, and some wells in the town of Standish. In one well in Standish, drilled ten years ago, not more than half a gallon a minute could be obtained at first, but it has now increased in yield so that it can not be pumped dry.

DECREASE IN YIELD.

It is not uncommon for wells to decrease in yield some time after they are drilled. The change may begin to take place shortly after the well is first used, or it may not begin for years. In the former case it is generally due to the fact that pockets of water were struck, rather than permanent veins. In the latter case it may be due to several causes. Sometimes, when a drilled well is supplied largely by surface water, a single dry season will have a great effect on its yield. Some shallow drilled wells vary greatly according to the month of the year, but the best deep wells are supplied from sources which can not be affected by changes in a single season, though sometimes a series of years in which the rainfall is below normal will affect these wells. In other wells the decrease in volume of water may be due simply to the gradual draining of the subterranean reservoir, and some such wells may never recover their original capacity. Usually when a newly drilled well has been carefully tested by the drillers and reported to yield several gallons of water a minute, and this capacity continues for several days, it is safe to regard the well as a success. It is never wise to let the driller depart until it is reasonably certain that the water does not come from pockets.

INTEREFFECT OF WELLS.

An interesting study could be made of the effect of neighboring wells upon one another, and such a study would be of great benefit to the inhabitants of a region and would increase the knowledge of conditions under which underground waters occur. The well at Foster's dyehouse at Portland is 140 feet deep in slate, and several water beds were penetrated. When a second well was drilled about 600 feet distant the water level in the dyehouse well was depressed about 3 feet.

In J. C. Rogers's granite quarry near Stonington two wells were drilled to depths of 94 and 279 feet. These wells are naturally connected by a joint crack about 60 feet from the surface. By pumping the 94-foot well water can be drawn from both. The capacity is 60 gallons a minute. The wells of the Southwest Harbor Water Company are situated 36 feet apart and are connected 90 feet from the surface.

At Dark Harbor, in the town of Islesboro, Charles Pendelton sunk a well to a depth of 88 feet. At a later date a well was sunk 16 feet distant, on the Allen property, and in half an hour from the time water was struck in the Allen well the yield of the Pendelton well diminished to such an extent that it would pump down so as to suck air. The Pendelton well was then deepened to 140 feet and encountered a large volume of water which supplied both wells. Water will now rise within 5 feet of the surface in both, but the greater part of the water in Allen's well is supplied from Pendelton's. The rock is much broken up at this place, and in the Pendelton well the drill was very nearly lost in a crack at a depth of about 80 feet.

USES OF UNDERGROUND WATER.

The prevailing use of both well and spring waters in Maine is for drinking and other domestic purposes and for watering stock. Spring and well waters are used for the public supplies of many villages, and well water is used in boilers of locomotives or manufacturing establishments, there being little water in Maine that gives too much scale for this purpose. Several creameries use water for cooling cream, and pulp mills use it for cooling acid. In granite quarries, especially on the islands, the water problem is an important one, and in several places well drilling has met with success. In addition to the ordinary uses of water, certain spring waters have value as "mineral waters." They are put on the market and shipped to distant centers, or the springs are made sites for summer hotels, thus contributing to the health of the country and to the wealth of the State.

COST OF WELL DRILLING.

The cost is necessarily an important factor in the sinking of wells. It varies with the locality, the kind of rock, and other conditions. For a rock well under 30 feet in depth the cost of drilled and open wells is about the same. A shallow well in drift may be cheaper if dug than if drilled, but in general drilled wells are the cheapest if they are carried down more than a few feet. Of all types the cheapest is the driven well, and this type is recommended wherever practicable. Such wells can be sunk to moderate depths through sand, fine gravel, and clay for $10 to $20.

The cost of drilled wells is very variable, depending on the locality and the kind of rock. In Aroostook County, where the rocks are rather soft slate, the cost is only $2 a foot in surface deposits and $1 in ledge, cased to rock and the casing furnished. Near Bangor, where the rock is slate, the charge is $3 per foot for the first 50 feet, $4 for the second 50 feet, and $5 for every foot below 100. This price includes the casing. A well 247 feet deep at Bangor cost $940: the windmill cost $66 and the pump $45. At other places in Penobscot County the price is $3 a foot straight, and in some towns it is less. In Lincoln County, in the area of complex, the common charge is $3.50 a foot, but some wells have been drilled for less. On account of the expense of drilling, it is possible that the price in this section may be raised. At Bucksport, in Hancock County, a well 308 feet in depth cost $1,540 and a steam pumping plant cost $360.

Wells on the islands cost more than those on the mainland. In Lincoln County island wells cost $6 a foot. In Hancock County, where the rock is largely granite, the cost is generally $4 on the mainland and $5 on the islands. Most drillers charge $6 in granite. Blasted wells, only a few feet deep, are $4 a foot. On Widows Island, near North Haven, a well 109 feet deep cost $525; and a gasoline engine and pump $177. In Islesboro, where more drilling has been done than in any town in Maine, the charge is $3 a foot, but drillers will not set up their machines without an agreement to drill at least 50 feet.

In Washington County, where little drilling has been done, the cost is $6 a foot. At Portland and vicintiy it is $4 a foot in drift and

$4 to $6 in rock. A 151-foot well on Cape Elizabeth cost $752, the pump $246, and a 40,000-gallon tank $900. A well 120 feet deep on Peaks Island cost $450 and a hot-air engine and deep-well pump $400. On Diamond Island a 96-foot well cost $500. In York County the price is generally about $6 a foot. In the vicinity of Winthrop, Kennebec County, where the rock is slate, the price has been raised from $3 to $5 a foot. The lower price ought to be sufficient here, as it is in most of the slate areas.

NOTES ON WELL DRILLING IN MAINE.

GENERAL STATEMENT.

As drilled wells are becoming more and more necessary in Maine, and as well drilling constitutes a considerable industry, which benefits the community at large, it seems important to include here a brief discussion of certain aspects of drilling that are not understood or appreciated by everyone.

RELATION TO KIND OF ROCK.

Speed of drilling.—The speed of drilling in Maine varies from a few inches to 30 feet a day, depending on the kind of machine, character of rock, abundance of joint cracks, etc.

With a good machine an experienced man can drill a 6-inch hole an average distance of 5 feet a day. In granite, however, 5 feet is usually the maximum daily performance, and sometimes a very hard, fine-grained phase of the rock is struck in which the drill will not go more than 1 foot a day. These hard portions of the rock are generally aplite dikes. In the slates of southern Maine the speed of drilling varies with the nature of the rock, ranging as a rule from 2 to 14 feet a day, though in southern Aroostook County, where the slate is softer, it averages 20 feet. One driller claims to have sunk a slate well 44 feet deep in eight hours, but this record is exceptional. Quartz seams in slate retard the speed of the drill.

A well on House Island, near Portland, drilled in metamorphic slate or schist, is said to have been deepened 35 feet in one night. In the 196-foot well of the Warren Water Company the average speed was 3 feet and the fastest 9 feet a day. As a rule, the finer the grain of the rock the harder it is to drill. In schist and metamorphic slates the drilling is much slower where they stand on edge than where they are flat. Pl. X, *B*, shows a dike of granite in slate, illustrating how differences in type of rock may affect the speed of drilling.

Effect of joint cracks.—Where joint cracks are parallel to the surface, or nearly so, they seldom affect the ease of drilling. Where they dip at a high angle, especially in the harder rocks, drilling becomes less easy. Frequently tools become stuck in the rock and much time and labor are wasted in recovering them. At other times the bit will strike the hard, smooth surface of the rock and glance off to one side, making a crooked hole. In such cases stones and occasionally scraps of soft iron are thrown into the hole and blasted with dynamite, breaking up the rock so as to give the drill a hold on it. Sometimes it is necessary to abandon such wells and make a second attempt. The slates of Penobscot County have few troublesome joints, and in them drilling is relatively easy. Most of the crooked holes have been sunk by inexperienced drillers. In some wells in granite and other hard rock the drilling is reported to "sharpen the drill." Other types of rocks cut the drill to pieces.

CASING FOR DRILLED WELLS.

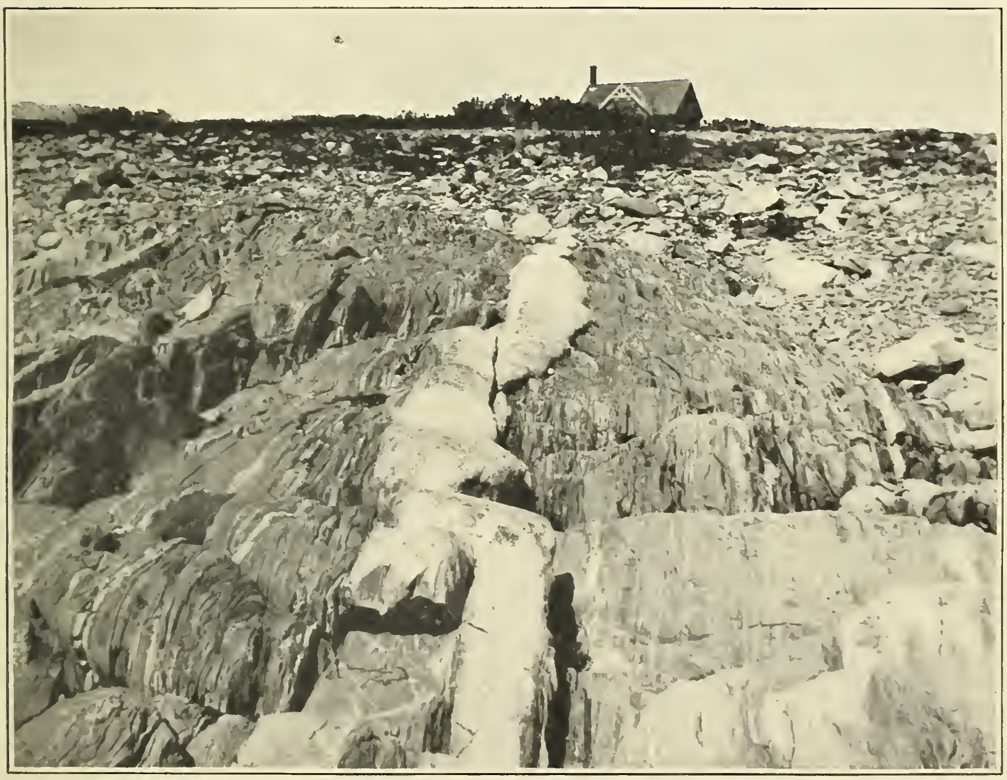
Methods of casing.—Properly constructed drilled wells are so cased that absolutely no surface water can enter the well. It is rarely necessary or desirable to case rock wells far into the rock, but the casing should always be driven through the surface deposits and several feet into the bed rock. If a tight joint is not made with the bed rock an opportunity is furnished for polluted surface water to enter between the casing and the rock. In Government wells the casing is generally driven 12 feet into the ledge. If the bed rock is within a few feet of the surface, it is well to dig around the outside of the casing and cement it firmly to the rock.

Pl. IX, *B*, shows a type of well which is seen far too often. The top of the casing is not even attached firmly to the pump or covered over, but is open in such a way that surface drainage or small animals might easily enter it. The owners of such unprotected wells are advised to close the pipes at the surface. Pls. V, *B*, and IX, *A*, show the proper method of protecting the well by a coating of cement.

Kind of casing.—Galvanized iron pipe is commonly used for casing wells, and as a rule is serviceable. In some places in Maine, however, the galvanized iron imparts a very disagreeable taste to the water, making it unfit for drinking. The water, through some acid property, attacks the pipe, eating pin holes through it, and the well has to be abandoned or recased. Generally ordinary iron pipe is free from this disadvantage, but in places trouble is experienced with this also. Block-tin pipe, though expensive, is as a rule little acted on by water. A well at New Harbor, in Lincoln County, was first cased with galvanized iron, but the taste of the water was too strong. A change was then made to a block-tin pipe, but the water ate pin holes in it and finally wooden pipe had to be put in. An example of the trouble caused by the use of galvanized iron is furnished by the experience of the Rumford Falls Water and Power Company. (See p. 184.)

A. SLATY ROCK ALONG THE COAST, CHRISTMAS COVE.

Showing nature of rock in which poor water of that vicinity is found.



B. OUTCROP OF ROCK ALONG COAST, FORTUNE ROCK, BIDDEFORD.

Showing alternation of hard and soft layers.

INJURY TO WELLS BY SEA WATER.

At a number of places along the Maine coast, especially on the islands, ocean water has entered through crevices in the rock and mingled with the well water to such an extent that the well has had to be abandoned. As a rule trouble with salt water occurs where the rock is slate. In a few places, however, salt-water wells have been obtained in granite. A well owned by Mrs. Kiesel in the town of Islesboro obtained good water at 181 feet from the surface, but drilling was continued, and at 220 feet salt water was encountered. The well was filled with Portland cement to a depth of about 200 feet from the top, the sea water being thus shut out, and the water was reported of good quality in 1906.

In other wells fresh water is first obtained, but after continued pumping the water becomes salt. Such was the case in the Thorp well on Greenings Island, off Mount Desert, which rises and falls with the tide. The water in the R. A. Foss well in Scarboro, 200 feet deep and situated 200 or 300 feet from salt water, was good for a month, but then became salty.

An interesting well is that of the Consolidated Electric Light Company of Maine, at Portland. In 1887 this well was drilled 136 feet and obtained good water. Like the Kiesel well, it was deepened in the hope of getting a larger supply, and salt water was encountered. The total depth of the well was 204 feet. In 1890 it was plugged. The plugging shut off much of the magnesium carbonate and calcium carbonate content of the water and increased the sodium chloride considerably.

An example of the entrance of sea water occurs in the town of Sorrento, which lies on a small neck jutting out from the mainland opposite Sullivan. The slate on this neck is very hard, dense, and fine grained and breaks up on the weathered outcrop into small angular blocks a few inches square. The strike and dip of the strata are variable. In some places the cleavage agrees with the stratification, but in others it does not. Clay 5 to 10 feet thick overlies the slate along the shore, and it is probable that this would prevent the accumulation of much water on the surface of the peninsula. The outcrops along the coast show that the rock is deeply fissured by wave action, some vertical cracks a foot or more across running in for a distance of several feet. As some of the fissures are inclined toward the south, it is probable that the sea water enters the rock on the north side of the peninsula and makes its way far below the surface into wells. This will explain why the only two wells drilled on the peninsula were failures, so far as finding fresh water was concerned. Pl. X, *A*, gives an idea of the character of rock along the coast in which salt water is sometimes found.

SHOOTING WELLS.

In many parts of the country, and particularly in the oil regions, it has been the custom for many years to explode heavy charges of nitroglycerin in the bottom of deep rock wells. This practice increases the yield of many of the wells enormously, greater amounts either of oil or of water being obtained. The increase in yield is due to the fracturing of the rock by the force of the explosion, cracks being formed in which the liquid can move more freely through the rock toward the well.

In many regions water wells have been "shot" with success, and this leads to the question whether that method might not be used in Maine. A few experiments have been tried by certain drillers, who have exploded charges at the bottom of deep wells. It is found that in a hard rock like granite the explosion will form small cracks, and in a few instances water has entered from a near-by seam and supplied the well. Softer rocks, however, like slate and schist, are little broken up, and definite cracks are not formed; hence it is hardly worth while to shoot wells in these rocks. A crooked well drilled at Bath, 90 feet in depth, was shot with 75 pounds of dynamite, but it did no good. This well is situated in the area of complex.

Dr. Charles G. Weld, of North Haven, has two successful wells 12 feet apart, 114 and 140 feet deep. These wells were connected by exploding torpedoes at a depth of 114 feet in both of them.

A number of crooked holes have been straightened by shooting. A prominent well driller has informed the writer that an explosion of dynamite in a crooked hole is frequently much better than reaming it. Generally 75 to 150 pounds of dynamite are used. The explosion makes very little shock, but sometimes scatters water and pebbles several hundred feet from the well.

DATE OF DRILLING.

Study of the well records given in Professor Bayley's table (pp. 242–259) shows that nearly half the wells in southern Maine have been sunk within the last decade. In the farming regions of the State drilling has been largely a necessity, and for that reason considerable was done as early as the eighties, and the number of wells drilled annually does not seem to have increased materially since then. But in the summer-resort regions, which are mostly situated on or near the coast, the greater part of the drilling has been done since 1899. There was some drilling in these sections as early as 1890, but during the early nineties few wells were put down on account of the general industrial depression of the country. The following table has been compiled from the well records in order to give an idea of the relative number of wells drilled in each decade:

Number of wells drilled in southern Maine, by decades.

Before 1880	2
1880–1889	72
1890–1899	133
1900–1906	183
	390

The total is less than the number of drilled wells reported in the table, for the reason that many owners or drillers have failed to report the year in which their wells were drilled.

PUBLIC SUPPLIES.

GENERAL STATEMENT.

Classification of sources.—Public water supplies in Maine are drawn in part from surface sources, including rivers, streams, and ponds, and in part from springs and wells. Some of the surface sources are so situated that the water is of good quality. Springs are good when they are properly situated, and wells are always desirable if they are deep and properly cased. Several towns use more than one of these sources, and some communities have changed from surface to underground supplies or vice versa.

Ownership of public water systems.—A preliminary list of the cities and villages possessing water-supply systems was given by W. S. Bayley in 1905,[a] the lists being obtained through correspondence. During the summer of 1906 several months of field work was done by the writer, and the lists were enlarged considerably. The following paragraphs in quotation marks are from the notes of Professor Bayley:

"As a result of the investigations, the water systems of the State fall into three groups with reference to ownership. The first and most numerous group is that owned by incorporated stock companies; a second group embraces those owned by private parties; and a third group includes those owned by cities or town corporations or by water districts. The third group embraces the smallest number of systems, but they are the largest, since they include the systems supplying the largest communities. As a rule the service is managed directly by the corporate officers in villages, or by water commissioners in cities.

"In recent years another method of management has come into vogue. When a community has reached the limit of its borrowing capacity, or is too small to warrant the construction of an independent system, a water district is formed, usually embracing two or more distinct municipalities, but perhaps including only a portion of a single

[a] Water-Supply Paper U. S. Geol. Survey No. 114, 1905, pp. 40–47.

one. The affairs of the district are managed by a board of trustees chosen by the officers of the municipalities interested. The water rates are established by these trustees, and the profits arising from the operation of the plant, after paying running expenses and providing a certain sum for the maintenance of a sinking fund, are turned into the treasuries of the municipalities.

History.—"Until recently nearly all the public supplies of Maine were obtained from surface sources, such as lakes and streams. In recent years, however, because of the increasing difficulty of finding uncontaminated surface supplies, there has been a tendency to utilize the underground resources wherever possible. Many villages situated in the rural districts have always used spring water, which is conveyed to them in pipes, and in many places small groups of houses are supplied in the same way, but these systems have usually been owned by private parties and not by public corporations. In late years there has been a rapid increase in the number of public systems furnishing spring water. It is plain, however, that since springs are limited in capacity, the size and number of communities which can depend on them for their public supply must likewise be limited. When this limit is reached recourse must be had to wells, if an underground supply is desired, or to lakes if suitable ones are within reach."

Comparative use of various sources.—With reference to their sources of supply the communities have been grouped under three heads—those obtaining water from springs, those using wells, and those supplied by rivers, streams, and lakes. Nearly all the large cities use lake water, as this is found to be more satisfactory than river water, because the great quantity of waste matter discharged into the streams from factories and the numerous settlements along their banks often renders them unfit for domestic use. Of the larger communities, only Bangor, Biddeford, and Saco continue to draw their supplies from streams. Augusta, Waterville, and Rumford Falls have recently changed from rivers to lakes, and Brunswick from a lake to wells. Several others of the smaller communities are agitating a change from rivers to lakes or wells, and the trend of opinion in Bangor is to the effect that Penobscot River must soon be abandoned.

The accompanying lists contain 151 names of communities that are receiving water distributed through pipes and delivered in houses. Of these, 29 obtain their supply from springs, 13 from wells, and 109 from surface sources. The names of several of these communities are duplicated, as a few receive their water from two sources, and others are at present changing from one source to another. Exclusive of duplicates, the number of communities purchasing water distributed through pipes is 148. The lists give the most important data that have been collected with respect to the water-supply systems in the southern part of the State. They are believed to contain the names of practically all the communities enjoying water service, but a few communities may have been overlooked.

Relative merits of sources.—The choice between a surface and an underground source of supply for any community must be controlled by several factors. In the first place, not all communities are so situated that the most desirable source of supply is near at hand. In certain districts it is almost impossible to obtain a good water supply. In others it is necessary to use streams which are contaminated by sewage and manufacturing wastes from towns situated farther upstream. Many of these communities may be situated in places where no adequate underground supply can be obtained, and such is especially the case with large cities for the reason that the yield of wells always has a maximum limit. Where the quantity of water from wells is not sufficient it is generally necessary to resort to surface sources, even though the water may not be as pure as desired. In all cases the quality of the water should be considered first, as on this depends the health of the people who drink it. Another feature which must be considered in certain districts is the amount of mineral matter contained in the water. Where the supply is desired largely for boilers or manufacturing purposes the amount of contained lime and other dissolved matter should be small, but in Maine this factor is generally not high enough to render the water detrimental.

COMMUNITIES USING WELL SUPPLIES.

There are 13 communities in southern Maine which obtain their public water supplies from driven or drilled wells. All these supplies are believed to be of excellent quality. The communities are enumerated in the following table, and the owners, sources, and methods of distribution are given for convenience of reference. A full description of these water supplies is given under the county headings.

Water systems in southern Maine using wells as sources of public supply.

No.	Community.	County.	Population.	Owner.
1	Brunswick	Cumberland	5,210	Brunswick and Topsham water district.
2	Castine	Hancock	936	Castine Water Co.
3	Cushing Island	Cumberland		Francis Cushing.
4	Great Diamond Island	do	450	Diamond Island Association.
5	East Northport	Waldo	150	Mountain Spring Water Co.
6	Hancock Point	Hancock	100	Village corporation.
7	Peaks Island	Cumberland	500	C. E. Rounds Water Co.
8	Rumford Falls	Oxford	2,595	Rumford Falls Light & Water Co.
9	Sanford	York	2,000	Sanford Light and Water Co.
10	Southwest Harbor	Hancock	720	Southwest Harbor Water Co.
11	Topsham	Sagadahoc		Brunswick and Topsham water district.
12	Warren	Knox	2,069	Warren Water Co.
13	Winthrop	Kennebec		Winthrop Cold Spring Water Co.

Water systems in southern Maine using wells as sources of public supply—Continued.

No.	Source.	Quality.	Method of distribution.
1	50 driven wells	Soft	Pumped into reservoir.
2	Drilled wells	do	Reservoir.
3	do	do	Tank on hill.
4	do	Hard	Pumped into reservoir.
5	Drilled well and springs	Soft	Do.
6	Old mine shaft	do	
7	Drilled wells		Do.
8	75 driven wells	Soft	Pumped to standpipe.
9	Dug and driven well		Reservoir.
10	2 drilled wells	Soft	Pumped to standpipe.
11	50 driven wells	do	Pumped to reservoir.
12	Drilled well	do	Pumped by windmill and gasoline engine to reservoir.
13	Drilled wells	Hard	Pumped to reservoir by windmills.

COMMUNITIES USING SPRING SUPPLIES.

More than twice as many villages draw their water supply from springs as from wells. These, 29 in number, are enumerated in the following table, and the owners, sources, and methods of distribution of water are given for convenience of reference. A full description of these supplies will be found under the appropriate county descriptions.

Water systems in southern Maine obtaining public supplies from springs.

No.	Community	County.	Population.	Owner.
1	Addison Point	Washington	150	Addison Point Aqueduct Co.
2	Bingham	Somerset	800	J. J. Lander et al.
3	Bolsters Mills	Cumberland		Alfred R. Clark.
4	Brooks	Waldo	300	Consolidated Water Co., of New Hampshire.
5	Casco	Cumberland	100	S. O. Hancock.
6	Cherryfield	Washington		Several small systems.
7	East Northport	Waldo	3,000	Norton Spring Water Co.
8	Farmington Falls	Franklin	200	Stock company.
9	Friendship	Knox	300	Friendship Water Co.
10	Hallowell	Kennebec	2,714	City of Hallowell.
11	Harrington	Washington	1,200	Two aqueduct companies.
12	Lamoine	Hancock		Cold Spring Water Co.
13	Lisbon Center	Androscoggin	100	
14	Lisbon Falls	do	1,585	Sylvester Aqueduct Co.
15	Lubec	Washington		Town of Lubec.
16	Milbridge	do		Milbridge Water Co.
17	North New Portland	Somerset	360	
18	North Waterboro	York	230	Chase & Johnson.
19	Orrington	Penobscot		
20	Paris Hill	Oxford	251	Paris Hill Water Co.
21	Ridlonville	do	143	Shaw-Ridlon Land Co.
22	Searsmont	Waldo		L. B. Cobb & Son.
23	Skowhegan	Somerset	6,000	Several aqueduct companies.
24	Stratton	Franklin		
25	Union	Knox	1,000	Union Water Co.
26	Vienna	Kennebec		
27	Winthrop	do		Several well systems.
28	Yarmouth	Cumberland		Town of Yarmouth.
29	Yarmouthville	do	1,000	Do.

Water systems in southern Maine obtaining public supplies from springs—Continued.

No.	Source.	Quality.	Method of distribution.
1	Spring 1 mile distant	Soft	Direct pressure.
2	Several springs	do	Do.
3	2 springs near by		Do.
4	Spring 2 miles distant	"Hard"	Do.
5		Soft	
6	Springs near by	do	Do.
7	Well and springs	do	Reservoir.
8	Springs near by	do	Direct pressure.
9	Springs	do	From tank pumped by windmill.
10	Springs on Winthrop Hill	do	Direct pressure.
11	Springs not far from town	do	Do.
12	Springs	do	Pumped to reservoir by windmill.
13	do		
14	2 springs	Soft	Direct pressure.
15	Marston's spring	do	Direct to standpipe.
16	2 springs	do	Direct pressure.
17	Springs		
18		Soft	Do.
19	Whidden Jpring		
20	Crocker Hill Springs	Soft	Do.
21	Springs		
22	Dyer's spring		Do.
23	Springs	Soft	Do.
24	do		
25	2 springs 1½ miles distant	Soft	Do.
26	Springs		
27	Springs and wells	Soft	Do.
28	Forest Paper Co.'s spring	do	Standpipe.
29	do	do	Do.

COMMUNITIES USING SURFACE SUPPLIES.

Of the 148 communities having public water supplies in the southern part of the State, 109 use water from lakes, ponds, rivers, or brooks. In a description of underground-water supplies it is important for purposes of comparison to record what communities are using surface sources. Moreover, towns sometimes change from surface to underground sources or vice versa. For these reasons a table of the communities using surface sources is appended.

Water systems in southern Maine obtaining public supplies from surface sources.

No.	Community.	County.	Population.	Owner.	Source.
1	Asticon	Hancock	50		Jordans Pond.
2	Auburn	Androscoggin	12,951	Auburn Aqueduct Co	Lake Auburn.
3	Augusta	Kennebec	11,683		Lake Cobbosseecontee.
4	Bangor	Penobscot	21,850	Public Works Co	Penobscot River.
5	Bar Harbor	Hancock	2,500	Bar Harbor Water Co	Eagle Lake.
6	Bath	Sagadahoc	10,477	Maine Water Co	Lake Nequasset.
7	Bayville	Lincoln	57		Adams Pond.
8	Belfast	Waldo	4,615	Belfast Water Co	Little River.
9	Belgrade	Kennebec		Belgrade Water Co	Belgrade Lake.
10	Benton	do		Kennebec water district	China Lake.
11	Bethel	Oxford	722	Bethel Water Co	Chapman Brook.
12	Biddeford	York	16,145	Biddeford and Saco Water Co.	Saco River.
13	Boothbay Harbor	Lincoln	2,000		Adams Pond.
14	Brewer	Penobscot	4,835	Public Works Co., Bangor	Penobscot River.
15	Buckfield	Oxford	379		South Pond.
16	Bucksport	Hancock		Bucksport Water Co	Silver Lake.
17	Camden	Knox		Camden and Rockland Water Co.	Mirror Lake.
18	Cape Elizabeth	Cumberland		Portland water commissioners.	Sebago Lake.

Water systems in southern Maine obtaining public supplies from surface sources—Cont'd.

No.	Community.	County.	Population.	Owner	Source.
19	Cape Neddick	York	164	York Shore Water Co	Chase Pond.
20	Cape Porpoise	do	420	Mousam Water Co	Monson River.
21	Chisholms Mills	Franklin	800	Livermore Falls Water Co.	Moose Hill Lake.
22	Damariscotta	Lincoln		Twin Village Water Co	Little Pond.
23	Dexter	Penobscot			Dexter Pond.
24	East Lamoine	Hancock	170		Blunts Pond.
25	Eastport	Washington	5,311	Eastport Water Co	Boydens Pond.
26	Ellsworth	Hancock	4,297	Ellsworth Water Co	Branch Pond Stream.
27	Ellsworth Falls	do	400	do	Do.
28	Fairfield	Somerset	3,800	Kennebec water district	China Lake.
29	Falmouth Foreside.	Cumberland	175		Sebago Lake.
30	Farmingdale	Kennebec		Gardiner water district	Cobbosseecontee Stream.
31	Farmington	Franklin	1,200		Varnum Pond.
32	Freeport	Cumberland	759	Freeport waterworks	Frost Galley Brook.
33	Fryeburg	Oxford	550	Fryeburg Water Co	Two brooks in Conway, N. H.
34	Gardiner	Kennebec	5,501	Gardiner water district	Cobbosseecontee Stream.
35	Glencove	Knox	117		Mirror Lake.
36	Gorham	Cumberland		Gorham Water Co	Sebago Lake.
37	Great Works	Penobscot			Penobscot River.
38	Hallowell	Kennebec	2,714		Cobbosseecontee Stream.
39	Hartland	Somerset		Linn Woolen Co	Sebasticook River.
40	Hastings	Oxford	200		Brook.
41	Hebron	do	500	Hebron Water Co	Halls Pond.
42	Hulls Cove	Hancock	177	Bar Harbor Water Co	Eagle Lake.
43	Kennebunkport	York	2,100	Mousam Water Co	Branch Brook.
44	Kennebunk	do		do	Do.
45	Kennebunk Beach	do	170	do	Do.
46	Kennebunk Landing.	do		do	Do.
47	Kittery	do	1,500	Agamenticus Water Co	Folly Pond.
48	Kittery Point	do	400		Do.
49	Kingfield	Franklin	700	Kingfield Water Co	Outlet Tuffs Pond.
50	Lamoine Beach		100		Blunts Pond.
51	Lewiston	Androscoggin	23,760	Lewiston water commissioners.	Lake Auburn.
52	Livermore Falls	do	1,250	Livermore Falls Water Co.	Moose Hill Lake.
53	Machias	Washington		Machias Water Co	Machias River.
54	Madison	Somerset	1,850	Madison Water Co	Kennebec River.
55	Mechanic Falls	Androscoggin	1,500	Mechanic Falls Water Co	Waterhouse Brook.
56	Milford	Penobscot		Public Works Co., Bangor.	Penobscot River.
57	New Castle	Lincoln		Twin Village Water Co	Little Pond.
58	North Berwick	York			Stream supplied by springs.
59	Newport	Penobscot		Newport Water Co	Pillsbury Pond.
60	North Vassalboro.	Kennebec	850		China Lake.
61	Northeast Harbor.	Hancock	350		Hodlock's Lower Pond.
62	Norway	Oxford	2,034	Norway Water Co	Norway Lake.
63	Oakland	Kennebec	2,500	Oakland Water Co	Messalonskee Lake.
64	Ocean Bluff	York	375	Mousam Water Co	Branch Brook.
65	Ogunquit	do		do	Do.
66	Old Orchard	do	1,000	Biddeford and Saco Water Co.	Saco River.
67	Oldtown	Penobscot	5,763	Public Works Co., Bangor.	Penobscot River.
68	Orono	do	3,257	do	Do.
69	Perry	Washington		Eastport Water Co	Boydens Lake.
70	Phillips	Franklin	674	Moore & Gaming	Mount Blue Pond.
71	Pittsfield	Somerset	2,208	Pittsfield waterworks	Sebasticook River.
72	Portland	Cumberland	50,145	Portland water commissioners.	Sebago Lake.
73	Rangeley	Franklin	563		Cascade Brook.
74	Randolph	Kennebec		Gardiner water district	Cobbosseecontee Stream.
75	Richmond	Sagadahoc		Richmond waterworks	Kennebec River.
76	Rockland	Knox	8,150	Camden and Rockland Water Co.	Mirror Lake.
77	Do	do	8,150	Rockland Water Co	Lake Chickawaukee.
78	Rockport	do	2,314	Camden and Rockland Water Co.	Mirror Lake.
79	Rockville	do	150		Do.
80	Saco	York	6,122	Biddeford and Saco Water Co.	Saco River.
81	Seal Harbor	Hancock	250	Seal Harbor Water Supply Co.	Jordans Pond.

Water systems in southern Maine obtaining public supplies from surface sources—Cont'd.

No.	Community.	County.	Population.	Owner.	Source.
82	Searsport	Waldo			Half Moon Pond.
83	Sorrento	Hancock	100	Estate of Frank Jones	Long Pond.
84	South Paris	Oxford	1,457	Norway Water Co	Norway Lake.
85	South Portland	Cumberland	6,287	Portland water commissioners.	Sebago Lake.
86	South West Harbor	Hancock	720	South West Harbor Water Co.	Long Pond.
87	South Berwick	York	1,000	South Berwick Water Co	Two Brooks.
88	Skowhegan	Somerset	4,266	Skowhegan waterworks	Brook 1 mile from village (in part).
89	Southport	Lincoln			Adams Pond.
90	Springvale	York	2,000	Springvale Aqueduct Co	Littlefields Pond.
91	Squirrel Island	Lincoln	50		Adams Pond.
92	Stockton Springs	Waldo			Half Moon Pond.
93	Strong	Franklin	600	Strong Water Co	Outlet of Day Mountain Pond.
94	Sullivan	Hancock			Long Pond.
95	Thomaston	Knox	2,600	Camden and Rockland Water Co.	Mirror Lake.
96	Veazie	Penobscot		Public Works Co., Bangor.	Penobscot River.
97	Waterville	Kennebec	10,000	Kennebec water district	China Lake.
98	Westbrook	Cumberland	7,283	Portland water commissioners.	Sebago Lake.
99	Wells Beach	York		Mousam Water Co	Branch Brook.
100	West Kennebunk	do	350	do	Do.
101	Wilton	Franklin	2,000		Varnums Pond.
102	Winnegance	Sagadahoc	156		Lake Nequasset.
103	Winslow	Kennebec		Kennebec water district	China Lake.
104	Winter Harbor	Hancock	600	Grindstone Neck Water Co.	Birch Harbor Pond.
105	Winterport	Waldo			West Branch Lowes Brook.
106	Woolwich	Sagadahoc		Maine Water Co	Lake Nequasset.
107	York	York		York Shore Water Co	Chase Lake.
108	York Corner	do	250		Do.
109	York Beach	do	500	York Shore Water Co	Do.

COMPOSITION OF THE UNDERGROUND WATERS.

GENERAL EXPLANATIONS.

Classes of analyses.—The analyses reported in the table on pages 77–87 include all chemical analyses (mineral analyses) of Maine well and spring waters that could be obtained. They may be grouped in four classes:

(1) "Field assays," or approximate analyses of half-pint samples made in the field by F. G. Clapp, G. C. Matson, and B. L. Johnson, of the United States Geological Survey.

(2) Analyses of 1-gallon samples shipped to Prof. F. C. Robinson, at Bowdoin College, Brunswick, Me., and analyzed by him.

(3) Analyses made by W. W. Skinner, of the United States Department of Agriculture, in connection with cooperative work between the Geological Survey and the Bureau of Chemistry.

(4) Analyses made by other persons.

The first group of analyses are designated "assays" for the reason that they were made with a field outfit to obtain a general idea of the character of the water.[a] They do not pretend to be refined analyses, and are published only because it was impracticable, on account of

[a] Leighton, M. O., Field assay of water: Water-Supply Paper U. S. Geol. Survey No. 151, 1905.

expense, to make more than 70 analyses of the second group, and only 10 of the third group had been made.

In order that the reader may form a graphic idea of the proportions of the different ions in various rocks and localities, the analyses of the second group have been plotted on Pls. IV, VI, and VIII.

Recomputation of analyses.—The analyses made by the United States Geological Survey are uniformly reported in ionic form and parts per million. Analyses obtained from miscellaneous sources, however, were originally given as parts per million, parts per 100,000, or grains per gallon, and were mostly reported in the form of the chemical compounds in which the minerals are supposed to exist. Chemical research shows that there is no certainty that the elements are combined in this form, the compounds given in most analyses being mainly theoretical. For this reason all analyses which were not expressed according to the standard method when received by the writer were recomputed into ions and parts per million, and they are expressed in this form in the table.

Omission of sanitary analyses.—Few sanitary analyses are included in this report, although hundreds of them have been made by the state board of health and other analysts. The reason for this omission is that sanitary analyses record only those constituents of a water which may be present by reason of its pollution or the entrance of organic matter in other ways. The substances reported in a mineral analysis of water, however, are with few exceptions, derived from materials dissolved from rocks or surface deposits, and are at all times nearly the same for a given well or spring, varying only with the amount of rainfall, the height of the water level, or, in the case of a well, with the age of the well. The substances reported in a sanitary analysis are chlorine, ammonia, nitrites, and nitrates—substances that are formed during the decay of organic matter, and consequently are present in soils, sewage, and other wastes. The amount of these impurities varies from time to time according to local conditions.

Much has been written in scientific journals regarding the value or worthlessness of a sanitary analysis. The best chemists of the world now agree that it is of value only when considered in connection with other matters, such as the location of the well or spring with reference to sources of pollution. As the present paper is designed for permanent reference, and as sanitary analyses of any water vary from time to time, only a few such analyses are given here. Others may be found in the annual reports of the state board of health, to which interested persons are referred.

DETAILS.

Tables.—The following tables contain nearly 300 analyses of well and spring waters. The well table is subdivided according to the kind of rock penetrated.

Analyses of well waters in southern Maine.

[Parts per million.]

WELLS IN GRANITE.

No.	Locality.	Owner.	Type.	Depth (feet).	Color.	Total solids.	Organic and volatile matter.	Silica (SiO_2).	Iron and aluminum oxides ($Fe_2O_3 + Al_2O_3$).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Chlorine (Cl.)	Total hardness as $CaCO_3$.	Analyst.[a]
	Androscoggin County:																		
1	Lisbon	R. A. Small	Drilled	(?)	4					0					107	tr.	14		F
2	South Poland	Chas. Gould and W. F. Trask	do			[b]98		18.17		0.51	19	2.2	7.9	0.5		13			H
	Cumberland County:																		
3	Bridgton	F. H. Abbott	(?)	(?)	2					0					73	0	9.6		F
4	Do	F. P. Bennett	Drilled	(?)	0					0					21	0	36		F
5	Do	J. K. Martin	do	125		206	74	31.1	2.8		29	7.6	9.6	6.9		9.6	24		R
6	Do	Granville Morrison	do	72	11					0					44	tr.	4.7		F
7	Do	Unknown	do	125	45					0					45	tr.	9.6		F
8	South Freeport	J. H. Lea	do	108	39					tr.					118	(c)	9		F
	Hancock County:																		
9	Eden	Edw. Morrell	do	87	6					0					99	tr.	14		F
10	Greening's Island, Northeast Harbor.	J. G. Thorp	do	88		81	5.2	8.5	1.1		1.1	1.8	11	1.7		15	23		R
11	North Sullivan	C. H. Abbot	do	37	0					0					9	tr.	24		F
12	Do	John M. Blaisdell	do	25	0	196	27	8.3	4.7		37	4.3	26	5.6		15	41		R
13	Do	Crabtree & Haney	do	51	23					0.5					50	tr.	102		F
14	Do	do	do	51		364	67	12.5	2.1		62	3.4	62	3.7		16	140		R
15	Stonington	Samuel W. Goss	do	67	26					1					98	tr	58		F
16	Do	R. B. Judkins	do	67		156	48										32	53	H
17	Crotch Island, Stonington	Ryan-Parker Construction Co.	do	300	4					1					15	125	70		F
18	The Settlement, Stonington	J. C. Rogers	do	93⅔	0					0					27	(c)	14		F
19	Do	do	do	279		136	19	11.2	2.0		29	3.4	13	1.9		26	17		R
20	Kennebec County: Augusta	Chas. F. Tittetts	Blasted	30		42	18										4	30	H
21	Knox County: Vinalhaven	Glue factory	Drilled	230		4,056	1,046	194.7	1.4		404	131	465	140		122	1,790		R
	Lincoln County:																		
22	Bristol	J. W. P. Gowdy	do	52	0					0					33	tr.	22		F
23	Damariscotta	Mrs. G. C. Chapman	do	87	0					0					123	(c)	58		F
24	Damariscotta Mills	G. W. Waltz	do	64		129	29	23.8	2.5		18	2.9	13	5.8		14	15		R
25	Pemaquid Beach	C. A. Sproul	do	45		919	272	13.7	7.1		45	14	134	49		46	334		R
26	Pemaquid Harbor	C. A. Farrin	Blasted	25	22					5					6	(c)	32		F
27	Waldoboro	R. L. Benner	Drilled							0					143	(c)	4.3		F
28	Do	Miss E. F. Genthner	do	56		419	100	10.9	3.5		57	9.0	30	13		36	57		R

[a] F, Field assay by F. G. Clapp, G. C. Matson, or B. L. Johnson; R, F. C. Robinson, analyst; H, Sanitary analysis by state board of health.
[b] Includes lithium (Li), trace; carbonate radicle (CO_3), 36. ("Apollo water.")
[c] SO_4 less than 35 parts per million.

Analyses of well waters in southern Maine—Continued.

WELLS IN SLATE.

No.	Locality.	Owner.	Type.	Depth (feet).	Color.	Total solids.	Organic and volatile matter.	Silica (SiO_2).	Iron and aluminum oxides (Fe_2O_3+Al_2O_3).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Chlorine (Cl.)	Total hardness as $CaCO_3$.	Analyst.
	Cumberland County:																		
29	Cape Cottage	Amos Miller	Drilled	115		140	22	9.0	0.9		43	2.4	11	3.8		15	18		R
30	Gorham	Dan Cressey	do	66	20					0					765	(m)	39		F
31	Great Diamond Island	Diamond Island Ass'n	do	120		120	14	16	.8		15	6.4	10	3.0		9.2	11		R
32	Portland	do	do	96	0					0					45	tr.	10		F
33	Mere Point	W. D. Pennell	do	67		88	30	8.8	2.0		7.0	4.5	7.3	1.5		22	10		R
34	Portland	Beacon Hill Water Co	do	70	0					0					61	tr.	18		F
35	Peaks Island	C. W. T. Goding	do	135		183	40		4.7		27	0.4	18			25	27	(a)	
36	Do	Mrs. E. Lefavor	do	40		52	22										1	17	H
37	Portland	Jas. P. Baxter	do	164	8					0					170	64	185	163	F
38	Do	Chas. A. Brown	do	60		160	48										38	67	
39	Do	E. T. Burrows	do	106	9					0					160	83	106	176	F
40	Do	Consolidated Electric Light Co.	do	b204		2,008													
41	Do	James Cunningham	do	35		142	26										24	81	
44	Do	M. R. Griffith	do	178		644	192										212	172	
45	Do	Maine General Hospital	do	505		177	0.5	11		2.5	13	4.3	38	11		6.8	4.5	(c)	(d)
46	Do	John T. Palmer	do	161		610	54										162	81	
47	Do	G. F. Thurston	do	40		140	90										14	46	
48	Scarboro	H. J. Libby estate	do	200	7					0					76	38	15		F
49	Do	do	do	200		145	13	12.1	2.6		12	4.7	12	17		24	13		R
50	Standish	R. W. E. Shaw	do	86	0					tr.					101	tr.	7.1		F
51	Westbrook	Haskell Silk Co	do			344	60	135	tr.		24	7.8				32		60	
52	Do	Rufus Jordan	do	216	6					0					76	(m)	8		F
53	Do	do	do	216		129	18	19	2.6		24	3.0	10	3.7		16	7.5		R
54	Do	J. H. Rines	do	307	5					0					98	36	13		F
	Hancock County:																		
55	Bucksport	Eastern Maine Conference Seminary.	do	308		116	9.6	15	1.8		26	3.6	18	2.2		22	6.5		R
56	Do	do	Open	Few		53	5.6	8.9	1.1		9	1.4	7.6	1.4		9	9.2		R
57	Hancock	Jeremiah Stratton	Drilled	65		109	10	15	1.0		15	2.9	6.7	2.3		11	12		R
58	Orland	Mrs. A. W. Emerson	do	42	9					0.1					28	10	4		F
59	Do	Mrs. A. W. Hutchins	do	77	12					high					32	10	5.4		F
	Kennebec County:																		
60	Farmingdale	H. M. Hodgdon	do	107		170	66										32	103	
61	Do	Tibbetts & Sawyer	do	80	33					1.7					37	20	46		F
62	Gardiner	Chas. Hopkins	do	34		258	40	20	1.4		39	6.9	36	11		21	64		R

63	Sidney	G. F. Bowman	do	96	6					0					37	tr.	121		F
64	Winslow	J. L. Dean	do	65	4					0					153	tr.	7.5		F
65	Do	Will Glidden		30	11					0					49		1.9		F
66	Do	J. F. Howard	Open	(?)	60										135	(m)	10		F
67	Winthrop	C. M. Bailey Sons & Co	Drilled	307½		227	20	16	2.0		57	6.3	27	5		63	7.5		R
68	Do	do	do	307½	0					0					95		13		F
69	Do	Frank S. Wood	do	175		217				0.35							4.7	67	(e)
70	Winthrop Center	Mrs. H. J. Bailey	do	200	0					0					99	tr.	11		F
	Knox County:																		
71	Rockport	The Roxmont	Open	16											35	tr.	14		F
	Penobscot County:																		
72	Bangor	Bangor House	Drilled	290	4					0					519	52	55		F
73	Do	do	do	290		834	150	17	1.0		214	32	46		(f)	63	58		
74	Do	Jos. E. Buckley	do	30	0	150											12	60	(g)
75	Do	Eastern Maine Insane Hospital.	do	425	0					0					146	tr.	15		F
76	Do	High School	do	217		491	124			0.02							46	260	(h)
77	Do	do	do	217	0					0					224	42	46		F
78	Do	do	do	217		180	37	10	1.1		46	7.4	12	1.3		18	50		R
79	Do	do	do	217		441	62	[i] 7	[j] tr.	10	82	15	33				102	258	(g)
80	Do	H. F. Hanson	do	35		436	190										76	229	
81	Do	F. L. Jones	do	247½	0					0						20	72		F
82	Do	Maine Creamery Co	do	120	0					0					121	145	22		F
83	Do	do	do	120			11										2.7	(k)	
84	Do	do	do	180		86	21	6.7	0.7		20.1	5.7	4.0	0.8		5.9	21		R
85	Do	Morse & Co	do	255	0					0					160	(m)	16		F
86	Do	Palm Street School	do	72		256	61			0.2							24	185	(h)
87	Do	do	do	72		233	58	[l] 8.1	[j] tr.	8.4	44	11	11				38	200	(g)
88	Do	Penobscot County courthouse.	do	200½	0	242	40										46		(g)
89	Do	do	do	200½	0					0					221	(m)	76		F
90	Do	Union Square School	do	203		439	103			tr.							54	298	(a)
91	Do	do	do	203	0					0					266	(m)	50		F
92	Charleston	A. A. Dority	do	38	0										157	tr.	5.7		F
93	Do	J. H. Higgins	do	33		93	16	7	1.2		18	6.8	3.1	1.6		6.6	1.4		R
94	Do	C. H. Scribner		16	0										199	tr.	14		F
95	Corinna	Wm. Pitcher			27					tr.					317	tr.	32		F
96	East Newport	L. D. Babb	Drilled	71½	67					0.5					104	tr.	11		F
97	Do	J. P. Chadbourne	do	63		424	92										64	188	
98	Do	J. B. Chadbourne	do	57		474	158										80	320	
99	Do	R. C. Chadbourne	do			74	11	12	1.5		14	4.0	3.5	1.4		4.6	6		R
100	Hampden	Mrs. A. J. Bragg	do	103	69					tr.					35	(m)	10		F
101	Do	Cyrus Moulton	do	75+	20					0					109	(m)	25		F
102	Do	C. L. Philbrick	do	50	15					0					56	0	20		F
103	Hampden Corners	Town well	Blasted	28	2					0					110	(m)	52		F
104	North Dixmont	S. E. Harris	Drilled	55	44					tr.					316	40	112		F
105	Orrington	Archie Harding	do	50	4					0					73	tr.	8.7		F
106	Stetson	F. P. Abbott				165	37	8.3	2.1		4.2	8.2	4.5	3.1		7.1	8		R

[a] Carbonate radicle (CO_3), 40.
[b] Well plugged at 145 feet; salt water.
[c] Carbonate radicle (CO_3), 84.
[d] E. L. Robinson.
[e] Chas. Harrington.
[f] Carbonate radicle (CO_3), 140.
[g] Ora W. Knight.
[h] H. D. Evans.
[i] Includes some suspended clay.
[j] Al_2O_3.
[k] When drilled hardness 140.
[l] With suspended clay.
[m] SO_4 less than 35 parts per million.

Analyses of well waters in southern Maine—Continued.

WELLS IN SLATE—Continued.

No.	Locality.	Owner.	Type.	Depth (feet).	Color.	Total solids.	Organic and volatile matter.	Silica (SiO_2).	Iron and aluminum oxides ($Fe_2O_3+Al_2O_3$).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Chlorine (Cl).	Total hardness as $CaCO_3$.	Analyst.
	Sagadahoc County:																		
107	Bowdoinham	E. C. McFarlane			45					0					134	(a)	35		
	Somerset County:																		
108	Norridgewock	G. C. Haynes	Drilled	26	0					0					35	tr.	3.5		F
109	Pittsfield	W. R. Hunnewell	Dug	47		56	16										5	35	
110	Do	F. J. Taylor	do	26		408	74										48	188	
	Waldo County:																		
111	Belmont	Horace Chenery	Drilled	187		138	9.5	17	2.5		23	6.4	15	6.1		14	5		R
112	Cape Jellison	Northern Maine Seaport R. R. Co.	do			104	25	12	*b* tr.	10	18	6.2				tr.	7	(c)	(d)
113	Islesboro	R. A. Boit	do	398	0					0					149	tr.	33		F
114	Do	Islesboro Land and Improvement Co.	do	149	0					0					155	tr.	22		F
115	Do	M. E. Lewis	do	150		145											11	85	
116	Do	H. T. Sloan	do	198	0					0					104	tr.	7.7		F
117	Jackson	E. E. Morton	do	45	22					tr.					75	0	30		J
118	Kidders Point	Northern Maine Seaport R. R. Co.	do			146	24	16	*e* tr.	10	20	4.2				0	8	(f)	(d)
119	Monroe	Nathan Stearns	do	60		164	50	13	1.2		37	6.3	7	2.7		14	8.5		R
120	Do	do	do	60	22					0.5					95	(a)	8.7		F
121	Searsport	Northern Maine Seaport R. R. Co.	do	329½	102					2					62	(a)	65		F
122	Do	W. E. Grinnell	do	100		162	11	21	3		28.4	5.1	21	6.2		28	22		R
123	Do	Northern Maine Seaport R. R. Co.				101	13	21	*e* tr.	5.2	8.5	2.7				tr.	7	(g)	(d)
124	Troy	Chas. Harmon	Drilled	40	22					0.5					112	(a)	20		F
125	Winterport	S. Chase	do	57	17					tr.					40	0	14		F
126	Do	J. K. Downs	do	40	17					tr.					90	tr.	7.4		F
127	Stockton Springs	Northern Maine Seaport R. R. Co.	do			104	25	9.5	*e* tr.	9.1	10	1.5				tr.	10	(h)	(d)
	York County:																		
128	Cutts Island, Kittery	Roland Thaxter	do	75	80					1.5					39		29		F
129	Do	do	do	75		209	15	11	3.2		46.8	13	27	8.7		14	40		R
130	Kittery Point	Horace Mitchell	do	60	6					0					63	tr.	44		F
131	Ogunquit	Chas. C. Hoyt estate	do	65		169	11	19	3.2		34.1	6.7	13	7.9		18	20		R

WELLS IN AREAS OF COMPLEX.

	Knox County:																		
132	North Haven	Nelson Mullen	Drilled		10					0					217	(a)	20		F
133	Vinalhaven	Rev. G. A. Strong	do		4					0					88	(a)	40		F
134	Warren	Warren Water Co	do	200	14					0					42	tr.	3.3		F
	Lincoln County:																		
135	Christmas Cove	Everett Wescott	do	100		107	13	10	6.6		4.4	12	17	4.0		14	17		R
136	Do	E. F. Wilder	do			189	22	12	1.9		9.1	5.2	41	5.2		33	61		R
137	Coopers Mills	Chas. H. Ashford	do	65		249	48	7.3	2.6		31	4.9	18	24		21	28		R
138	Do	S. E. Hopkins	do	46	13					¼					96	tr.	24		F
139	East Boothbay	Hodgdon Bros	do	120	25					0					102	15	21		F
140	Do	Frank Rice	do	75	13					0					65	tr.	42		F
141	Do	do	do	75		188	26	17	2.7		16	6.7	29	4.0		17	43		R
142	Heron Island	Wm. C. Damon	do	119		225	34	25	8.5		44	7.6	19	6.5		12	33		R
143	Ocean Point	L. J. Crooker	do	360	25					0					48	tr.	12		F
144	Do	do	do	360		96	9.3	8.8	2.1		9.3	2.6	13	2.5		11	14		R
145	Pemaquid Point	W. A. Elliott	do	51	0					1					148	tr.	33		F
145a	Do	M. B. Macdonald	do	23		115				tr.							34	44	
146	Wiscasset	Customs House	do	79	5					0					238	49	77		F
147	Do	W. G. Hubbard	do	70	7					0					329	77	220		F
148	Do	J. P. Tucker	do	68	8					0					138	25	31		F
149	Do	Wiscasset Jail	do	154		301	18	21	1.3		54	4.7	39	12		46	52		R
	Sagadahoc County:																		
150	Bath	H. Langdon	do		26					0					105	tr.	40		F
151	Do	Roller Bushing Works	do	180	69					0					98	286	918		F
152	Woolwich	F. W. Carleton	do	98		123	28	16	1.9		16	8.3	12	4.0		13	17		R
	Waldo County:																		
153	East Northport	Northport Mountain Spring Co.	do	162	0	145	39			tr.							6.4	88	H
154	Do	Mrs. Mark Maudall	do	64		234	82										58	126	H

WELLS IN IGNEOUS ROCKS OTHER THAN GRANITE.[i]

	Knox County:																		
155	North Haven	F. S. Mead	Drilled	126		2,057	355	22	2.2		515	52	209	7.2		125	956		R
156	Do	G. W. Wheelwright	do	180		90	6.8	10	0		30	1.2	8.9	0.7		4.9	13		R
	Washington County:																		
157	Eastport	Seacoast Canning Co	do	408	25					0					214	70	30		F
158	Do	do	do	408		414	42	48	1.9		108	11	30	3.9		71	36		R
159	Jonesport	do	do	384	22					0.5					28	47	47		F
160	York County: Cutts Island, Kittery.	John Thaxter	Open	6	22					0					70	tr.	19		F

[a] SO_4 less than 35 parts per million.
[b] Al_2O_3.
[c] Temporary, 34; total, 89.
[d] Ora W. Knight.
[e] Al.
[f] Temporary, 35.
[g] Temporary, 25; total, 59.
[h] Temporary 25; total, 55.
[i] Wells 155, 156, 160 are in trap; 157, 158 in greenstone; 159 in diorite.

Analyses of well waters in southern Maine—Continued.

WELLS IN CLAY.

No.	Locality.	Owner.	Type.	Depth (feet).	Color.	Total solids.	Organic and volatile matter.	Silica (SiO_2).	Iron and aluminum oxides ($Fe_2O_3+Al_2O_3$).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Chlorine (Cl).	Total hardness as $CaCO_3$.	Analyst.
161	Cumberland County: Scarboro.	Jno. H. Leavitt	Dug	19½	0	......	......	......	......	0	......	......	......	......	58	(*a*)	27	......	F
162	Franklin County: Farmington.	Warren Ladd	...do	58	30	......	......	......	......	0	......	......	......	......	27	tr.	40	......	F
	Hancock County:																		
163	Brooksville	......	...do	16	100	......	......	......	......	0	......	......	......	......	43	0	5.2	......	F
164	Do	......	...do	14±	7	......	......	......	......	0	......	......	......	......	116	53	85	......	F
165	Kennebec County: Vassalboro.	Geo. C. Gardner	...do	16	2	......	......	......	......	0	......	......	......	......	70 67	(*a*)	12	......	F
166	Washington County: Lubec.	......	...do	30±	148	......	......	......	......	0	......	......	......	......	127	47	14	......	F
167	York County: North Kennebunkport.	Edwin Dennett	...do	......	5	......	......	......	......	0	......	......	......	......		tr.	40	......	F

WELLS IN TILL (BOWLDER CLAY).

No.	Locality.	Owner.	Type.	Depth (feet).	Color.	Total solids.	Organic and volatile matter.	Silica (SiO_2).	Iron and aluminum oxides ($Fe_2O_3+Al_2O_3$).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Chlorine (Cl).	Total hardness as $CaCO_3$.	Analyst.
168	Cumberland County: Portland.	Unknown	Dug	12	33	......	......	......	......	tr.	......	......	......	......	40	0	8.6	......	F
	Hancock County:																		
169	Eden	...do	...do	16	0	......	......	......	......	0	......	......	......	......	16	tr.	10	......	F
170	Orland	...do	...do	22	0	......	......	......	......	0	......	......	......	......	29	(*a*)	19	......	F
171	Sorrento	T. N. Nickerson	...do	8	38	......	......	......	......	0	......	......	......	......	29	......	11	......	F
173	Penobscot County: Orono	N. W. Page	...do	54	0	......	......	......	......	0	......	......	......	......	77	tr.	34	......	F
174	Washington County: Jonesboro.	......	...do	7	....	......	......	......	......	0	......	......	......	......	34	tr.	16	......	F

WELLS IN SAND AND GRAVEL.

No.	Locality.	Owner.	Type.	Depth (feet).	Color.	Total solids.	Organic and volatile matter.	Silica (SiO_2).	Iron and aluminum oxides ($Fe_2O_3+Al_2O_3$).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Chlorine (Cl).	Total hardness as $CaCO_3$.	Analyst.
	Androscoggin County:																		
175	Auburn	E. H. Libby	Open	27	0	......	......	......	......	0	......	......	......	......	31	tr.	4.9	......	F
176	Mechanic Falls	......	Driven	35	0	......	......	......	......	0	......	......	......	......	10	tr.	3.2	......	F
	Cumberland County:																		
177	Brunswick	Brunswick and Topsham Water District.	...do	25	....	55	......	12	0.2	......	4.2	1.8	8.9	......	......	6.5	4.0	26	

178	Do	do	do			55		11	0.2		3.9	2.3	7.3			11	4.0	26	
179	Do	do	do			42											16	22	
180	Do	Public supply	do		5					0					23	tr.	5.3		F
181	Scarboro	West Boothbay	Open	5	0					0					36	(a)	14		F
182	Do		do	20	0					0					29	tr.	18		F
183	Windham	Geo. E. Dow	do	10	0					tr.					29	tr.	3.3		F
	Hancock County:																		
184	East Orland	Tom Mason	Driven	87½		66	13	16	1.0		6.5	4.1	6.2	1.6		3.7	3.7		F
185	Hancock	Public well	Bored	30½	0					0					32	tr.	11		F
186	Kennebec County: Gardiner.	Mrs. S. R. Hayes	Open	22	20					0.5					33	20	17		F
	Oxford County:																		
187	Rumford Falls	Rumford Falls Light and Water Co.	Driven			36	6	14		0.7	3.3		0.9		(b)	1.8	3.0		R
188	Do	do	do			58	6.6	14		2.2	3.3		0.9		(c)	1.8	3.0		R
189	Do	do	do			37	6.2	14		1.5	3.3		0.9		(d)	1.8	3.0		R
	Washington County:																		
190	Calais	W. A. Rideout	Bored	44	30					0					90	tr.	9.2		F
191	Do	do	do	44		138	16	13	1.7		4.1	5.4	18	3.0		11	12		R
192	Machias	Joseph Smith	Open	21	97					0					128	10	16		
193	Millbridge	Millbridge Water Co	Bored	17	0					0					34	0	8.4		
	York County:																		
194	Berwick	Berwick Water Co			30					1					21	74	8.8		F
195	York	York Harbor Brick Co	Open	10	30					0					190	tr.	9.2		F

MISCELLANEOUS WELLS.[e]

196	Androscoggin County: Auburn.	C. M. Goff				112	5.1	14		0.2	14	1.6	0.1	0.8	(f)	5.3	9.7		
	Hancock County:																		
197	Bluehill	Mrs. Ethelbert Nevin	Drilled		16					0					134	tr.	21		F
198	Do	Dr. A. M. Thomas	do		352					0					112	tr.	15		F
199	Sagadahoc County: Bowdoinham.			140	30					0					93	tr.	31		F
200	Cumberland County: Cushing Island, Portland.	S. W. Thaxter	Dug	72	68	30											8.0	32	H
201	Waldo County: Searsmont	D. B. Cobb	Open	33	0					0					76	0	5.0		F
202	Washington County: Perry	R. R. Newcomb	Dug	22	22					0					81	tr.	20		

[a] SO_4 less than 35 parts per million.
[b] Sample from pumping station; carbonate radicle (CO_3), 5.7.
[c] Sample from end of long galvanized-iron main; carbonate radicle (CO_3), 16.
[d] Sample from Hotel Rumford; carbonate radicle (CO_3), 6.8.
[e] Wells 197, 198, 200 are in gneiss; 201 in till and slate; 202 in sandstone.
[f] Carbonate radicle (CO_3), 41.

Analyses of spring waters in southern Maine.

[Parts per million.]

No.	Locality.	Owner.	Name of spring.	Total solids.	Organic and volatile matter.	Silica (SiO_2).	Iron and aluminum oxides ($Fe_2O_3+Al_2O_3$).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Chlorine (Cl).	Carbonate radicle (CO_3).	Total hardness as $CaCO_3$.	Analyst.[a]
	Androscoggin County:																	
203	Auburn		Auburn Diamond.	79			3.4		6.6	14			2.7					R. C. Stanley.
203a	Do	Samoar Carbonating Co.	Crystal Mineral	74		12	3.1		7.7	3.6				8.3	5.3	23		L. G. Jordan.
204	Do	Pejepscot Spring Water Co.	Pejepscot	[b] 86	3.1	19	1.1		14	2.6	3.8	1.6		11	2.2	27		Stillwell and Gladding.
205	Durham		Sylvan	29		5.1	2.2		1.5	1.4	3.8	1.1		4.1	6.0	4.0		E. G. Jordan.
206	East Poland	S. M. Pratt	Keystone Mineral.	51	tr.	(c)		6.7		3.2	5.3			2.9	2.6	15		R. C. Stanley.[d]
206a	Do	do	do	104		12			15	3.1	4.2	0.8	60	3.4	5.2			W. W. Skinner.[e]
206b	Greene	A. B. Parker & Sons	Glenrock Mineral.	67		5.6	(f)	2.2	12	1.8	5.1	3.2		4.0	5.0	26		L. G. Jordan.
207	East Turner		Cliff	30		5.6	1.9		2.6	1.3	2.4			5.2	3.9	7.6		Do.
208	Lewiston	Windsor Mineral Spring Co.	Windsor Mineral.	154		18		0.7	42	1.9	5.8			29	5.1			S. P. Sharples.
208a	South Auburn		American Chalybeate.	174	38	11		8.3	27	5.5	2.2	6.3		11	3.5	61		F. L. Bartlett. C. F. Chandler.
209	Lewiston	Highland Mineral Spring Water Co.	Highland Mineral.	84		11			15	2.6	3.1	8.0		10	5	29		Do.
210	Do	do	do	82		13				6.0	15			3.6	10	33		R. C. Stanley.
210a	Do	do	do	52		11			5.9	0.9	2.8	1.2	23	4.6	2.2			W. W. Skinner.[g]
211	North Auburn		Auburn	65		0.2	tr.	tr.	1.8	0.8	16	1.3	2.1	1.8	2.7			S. D. Hayes.
211a	South Poland		Fountain Head	68		16			5.9	tr.	10	0.8	18	1.1	16			F. L. Bartlett.
212	Do	Hiram Ricker & Sons.	Poland	63	4.0	19	tr.		8.3	2.7	2.7	1.2		1.4	2.7	21		C. F. Chandler.
213	Do	do	do			19			8.4	2.7	2.9	1.2		1.5	2.7	21		
214	Do	do	do			24	0.4		14	2.1	6.9	2.4	48.4	3.6	5.0			U. S. Dept. Agriculture.[h]
214a	Do	do	do	109		15			14	2.4	6.3	0.9	56	3.3	5.9			W. W. Skinner.[i]
214b	Do		Star	242	38	9.9	(j)		16	4.0	33	6.7		8.3	50	54		F. L. Bartlett.
	Cumberland County:																	
215	Bolsters Mills	Alfred C. Clark						0					23	0	2.3			F
216	Brunswick							0					5	tr.				F
217	Do		Paradise	17		0.6		0.05	0.8	0.3	2.7	0.3		7.1	0.6	4.9		Henry Carmichael.
218	Do		do	18	0.3	6.6		0.09	0.7	0.3	0.3			1.0	1.6	4.2		F. C. Robinson.
219	Falmouth Foreside.	Underwood Spring Corporation.	Underwood	36	0	8.6			3.2	0.7	5.9	0.9		1.1	9.1	6.8		F. L. Bartlett.

220	Harrison		Summit	.....	4.1	17	tr.	tr.	6.8	1.2	11		.....	7.4	1.9	27	.....	Do.
221	New Gloucester	Pownal Spring Hotel Co.		20	0.2	7.0	.....	0.3	2.2	0.1	2.0	0.2	.....	8.2	1.6	5.0	.....	F. C. Robinson.
222	North Raymond	Raymond Spring Co.	Raymond	k 34	tr.	7.2	.....	0.03	6.8	1.1	1.6	0.6	0.1	0.8	2.4	13	.....	W. F. Haines.
223	Saco		Cascade	·30	22	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.0	.....	9.5	State board of health.
224	Scarboro			.....	.....	.....	.....	0	.....	.....	.....	.....	49	(l)	14	.....	.....	F
225	South Freeport	G. W. Soule		.....	2.2	.....	.....	tr.	tr.	.....	.....	.....	.....	tr.	0.5	.....	1.7	Ohler.
	Franklin County:																	
229	Carrabassett	Carrabassett Mineral Spring Co.	Carrabassett	.....	.....	12	.....	0.42	5.7	1.7	1.0	0.8	.....	4.1	1.7	11	.....	S. P. Sharples.
230	Do.	do.	do.	72	.....	14	5.3	3.7	8.2	4.3	2.8	1.6	.....	1.6	4.4	15	.....	Salvatore La Bua.
231	Do.	do.	do.	26	.....	1.0	5.7	.....	2.5	1.3	1.4	1.0	.....	5.7	3.3	3.6	.....	Do.
232	Do.	do.	do.	38	.....	12	0.6	.....	6.0	1.6	1.0	0.5	.....	4.1	1.7	10	.....	S. P. Sharples.
233	Farmington Falls	Farmington Falls Aqueduct Co.		.....	.....	.....	.....	0	.....	.....	.....	.....	9	tr.	.....	.....	.....	F
234	Rangeley	Rangeley Lakes Hotel Co.	Rangeley Mineral	58	12	12	tr.	.....	7.8	2.0	1.2	.....	.....	12	1.9	9.3	.....	F. R. Stillman.
235	South Strong	R. W. Knowlton	Knowlton's Soda	42	.....	16	m tr.	tr.	2.1	0.7	4.3	3.4	.....	4.3	2.7	8.6	.....	H. L. Bowker.
	Hancock County:																	
236	Bluehill	Bluehill Mineral Spring Co.	Bluehill Mineral	n 79	.....	21	m 1.0	3.1	12	1.7	3.9	0.51	.....	7.6	3.1	23	.....	
237	Do.	do.	do.	(o)	.....	21	m 1.0	3.2	12	1.8	10		.....	7.6	6.7	3.6	.....	W. P. Mason.
238	Eastbrook	R. B. Lowrie	Katagudos	20	.....	7.3	0.2	.....	1.6	0.5	1.8	.....	.....	.....	2.7	.....	.....	J. W. Baird.
239	Mount Desert		Mount Desert	64	20	9.4	tr.	.....	10	1.6	.....	.....	.....	1.6	10	.....	32	Davenport & Williams.
240	Stonington			.....	.....	.....	.....	0	.....	.....	.....	.....	29	0	13	.....	.....	F
241	Tremont			.....	.....	.....	.....	.....	.....	.....	.....	.....	22	tr.	95	.....	.....	F
242	West Hancock		Ishka	16	.....	6.4	.....	0.1	1.2	0.5	1.4		.....	1.4	2.4	2.2	.....	H. Carmichael.
	Kennebec County:																	
243	Augusta	C. O. Cony		.....	.....	.....	.....	0	.....	.....	.....	.....	5.0	tr.	21	.....	.....	
244	Chelsea	W. H. Austin		.....	.....	.....	.....	0	.....	.....	.....	79	.....	tr.	59	.....	.....	
245	Do.			.....	.....	8.8	.....	.....	2.3	0.5	3.3	1.8	.....	1.1	4.4	4.7	.....	
246	Clinton (Morrison Corner).	H. E. Kendall		33	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	41.23	

a F, field assay by F. G. Clapp, G. C. Matson, or B. L. Johnson.
b At 120° C. Include phosphate radicle, 0.95. Lithium, none; bromine, none; iodine, none.
c Silica and alumina, 15.
d Analysis probably incorrect.
e For full analysis see p. 99.
f Al, 2.4.
g For full analysis see p. 97.
h Also nitric acid radicle (NO_3), 5.89; nitrous acid radicle (NO_2), 0.0032; PO_4, trace; metaboric acid radicle (BO_2), 0; arsenic acid radicle (AsO_4), 0; Br, 0; iodine, 0; Mn, 0; L, minute traces; ammonia (NH_3), 0.008; gases (cubic centimeters per 1,000 grams at 0° C. and 760 millimeters pressure) free CO_2, 5.6; CO_2 (set free from bicarbonates on evaporation to dryness), 8.8.
i For full analysis see p. 101.
j Al, 22.0.
k Include aluminum (Al), 0.02; phosphate radicle (PO_4), 0.04; borate radicle (BO_4), 0.10.
l SO_4 less than 35 parts per million.
m Al.
n Include nitrate radicle (NO_3), 0.58; manganese (Mn), 0.25.
o Include nitrate radicle (NO_3), 0.66; manganese (Mn), 0.22.

Analyses of spring waters in southern Maine—Continued.

No.	Locality.	Owner.	Name of spring.	Total solids.	Organic and volatile matter.	Silica (SiO_2).	Iron and aluminum oxides ($Fe_2O_3+Al_2O_3$).	Iron (Fe).	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Bicarbonate radicle (HCO_3).	Sulphate radicle (SO_4).	Chlorine (Cl).	Carbonate radicle (CO_3).	Total hardness as $CaCO_3$.	Analyst.
	Kennebec County—Continued.																	
247	Litchfield	Forest Springs Water Co.	Forest No. 1	*a*100	3.0	14		tr.	22	1.6	5.3	2.7		9.0	3.0	38		
248	Do	do	Forest No. 2	*a* 55	3.3	14			8.8	1.5	3.8	0.8			2.8	18		
249	Do	do	Forest No. 3	*a* 28	3.0	9.5			2.1	0.5	2.7	0.6		1.1	2.2	6.1		
250	Togas		Hallowell		6.3	15												
251	Vienna		Vienna Sparkling	51	0	8.2	0.9		13	1.5	0.1	1.9		2.4	0.2	23		C. F. Chandler.
252	Do		do	*a* 43	0	15	tr.		4.4	1.0	5.3	0.4		0.6	0.1	16		S. D. Hayes.
253	Winslow		Ticonic Mineral	185		11	tr.	5.8	42	9.9	19	5.0		2.2	5.6	70		S. K. Hitchings.
254	Do							0					43	(*b*)	9.4			F
255	Knox County: Rockland, in bottom of limestone quarry.			234	28	15	8.9		29	22	20	4.7		29	6.1			F. C. Robinson.
	Lincoln County:																	
256	East Boothbay		Boothbay Medicinal.	212		11	*c* tr.	20	14	2.9	13	15	89	28	19			F. L. Bartlett.
257	Jefferson			86		16		0.3	14	3.4	5.0	3.6		7.1	5.5	31		F C. Robinson.
258	Nobleboro		Samoset Mineral	425	tr.	12		19	23	1.9	13			37	11	192		H. C. Carmichael.
	Oxford County:																	
259	Hartford	Consolidated General Mineral Water Co.	Mount Hartford Mineral.	*d* 36		8.5	*c* 0.1	0.4	3.2	0.7	4.2	0.6		4.0	1.1	9.6		J. W. Mallett.
259a	Do	do	do	46		9.0			4.4	1.0	4.0	0.8	20	1.6	4.0			W. W. Skinner.[e]
260	Milton plantation	Mount Zircon Spring Co.	Mount Zircon	33	2.2	9.7	*c* tr.	0.7	2.3		1.0	9.8		5.4	1.5			F. L. Bartlett.
261	Paris	Paris Hill Water Co.	Crocker Hill (public supply)[f] No. 1.	*a* 11	3.7	1.2	0.3		0.5	tr.	1.8				3.9			
	Do	do	Crocker Hill (public supply)[f] No. 2.	*a* 13	2.1	1.7	0.4		0.5	0.1	2.3				3.6			
	Do	do	Crocker Hill (public supply)[f] No. 3.	*a* 14	2.7	1.8	0.5		0.6	0.2	2.5				3.9			
262	Do		Mount Mica Mineral.					0	0				10		2.2			F
263	Rumford Falls	Rumford Falls Power Co.	Cataract										22	tr.	4.9			F
264	Sumner	United Mineral Springs Co.	Mount Oxford	3.4		8.0		2.1	6.6	0.3	1.5			1.4	2.5	11		E. E. Calder.

265	Zircon		Zircon Moon Tide	26		9.0	0.1		2.1	0.6	3.1			3.9	0.8	6.1		S. P. Sharples.
	Penobscot County:																	
266	Brewer	A. H. Farrington	Highland	16		tr.	tr.	tr.	0.8	1.2	4.0			tr.	6.0	4.4	15	O. W. Knight.
267	Do	M. W. Staples						0					157	tr.	7.3			F
267a	Do	Miss Jennie Farrington	Oak Grove	136		16			18	3.5	7.0	1.1	73	4.9	5.6			W. W. Skinner.[g]
268	Orrington	A. G. Dole	Sparkling	194	16	[h]11		0	14	1.5	41	12		29	60	17		Richard Pfliffar.
	Sagadahoc County:																	
269	Topsham	Pine Spring Water Co.	Pine	13		4.6		0.33	1	0.03	2			0.2	2.3	3.1		F. C. Robinson.
270	Do	do	do	33		7.4			2.1	0.8	3.5	0.6	13	1	4.2			W. W. Skinner.[o]
	Somerset County:																	
271	Fairfield	W. N. Osborne	Rocky Hill	63	54	11			11	3.7	2.1	0.4		2.9	2.5	24		F. C. Robinson.
271a	Do	do	do	106		11			13	4.3	4.6	.8	64	3.7	2.8			W. W. Skinner.[i]
272	St. Albans	C. A. Moulton	Glenwood	67		3	[c]1	1.4	10	10						40		S. S. Bradford.
272a	Do	do	do	94		11			13	2.5	3.9	.9	55	3.6	1.8			W. W. Skinner.[j]
273	Skowhegan	West Skowhegan Aqueduct Co.						0					10	0	10			F
	Waldo County:																	
274	Prospect	Switzer Water Co.	Switzer	376	tr.										50		([k])	F. C. Robinson.
	Washington County:																	
275	Addison	Addison Mineral Spring Co.	Addison Mineral	139		tr.		8.9	14	2.2	9.6	4.6	76	15	9.2			S. D. Hayes.
276	Do	do	do	135		tr.	[c]tr.	8.9	14	3.2	9.5	2.6	75	13	9.2			Do.
277	Calais							0					16	tr.	6.3			F
278	Columbia	Quantabacook Water Co.	Harrington (public supply).	70	12	13	1.2		17	1.8	6	1.1		6.5	9			F. C. Robinson.
279	East Machias	Estate of Peter Talbot.						0	0				18	0	4.6			F
280	Eastbrook	R. B. Lowrie	Katagudos															
281	Lubec	Lubec waterworks	Lubec (public supply).					0					66	([b])	13			F
282	Do	Town of Lubec	do	102	7	11		0.4	20	3.2						39		F. C. Robinson.
282a	Head of Lubec Bay		Lubec Saline	4,609	[l]181			17	83	228	1,250			390	2,388	72		C. T. Jackson.
283	Millbridge	Millbridge Water Co.						0					11	([b])	8.8			F
284	Terry							0					111	([b])	23			F
	York County:																	
285	Kennebunk	Heirs of Chas. Parsons.						0					24	([b])	19			F
286	Kennebunk Beach		Kennebunk Beach Mineral.	189														S. H. Hitchings.
287	Limington	G. P. and Frank Anderson.	Cold Bowling	27	11	3.2			1.4	0.2	3.5			1.1	0.9	5.9		
288	Ogunquit	C. W. Dunyon	Wawa Lithia	([m])		2		tr.	3.7	1.1	1.8	1.6		3.2	12	12		A. E. Austin.
289	Old Orchard	Olde Yorke Springs Co	Olde Yorke	94		4.2		0.6	14	3.5	11	5.8		8.2	12	34		F. C. Robinson.
289a	Scarboro		Scarboro Mineral	[n]3,190	18				30	114	1,025	27		72	1,763	141		Geo. L. Goodale.
290	Springvale	Geo. G. Plummer	White Sand	42	12			0.01							0.2		20	

[a] Include lithium (Li), trace.
[b] SO_4 less than 35 parts per million.
[c] Al.
[d] Include manganese (Mn), trace; strontium (Sr), trace; rubidium (Rb), trace; lithium (Li), 0.01; phosphate radicle, 0.02.
[e] For full analysis see p. 181.
[f] Nos. 1 and 2 from reservoir, No. 3 from residence of Geo. M. Atwood, at Paris.
[g] For full analysis see p. 195.
[h] With Al_2O_3.
[i] For full analysis see p. 208.
[j] For full analysis see p. 207.
[k] Temporary, 25.9; permanent, 16.
[l] Includes $CaCl_2$.
[m] Include lithium (Li), 3.
[n] Include Br, trace.
[o] For full analysis see p. 201.

Total solids.—The total solids constitute the residue left on evaporation of a water sample. Those reported in southern Maine well and spring waters range from 13 parts per million in a spring at Naples to 4,055 parts in a well at North Haven. The high percentage of mineral matter in the North Haven water and in several other wells near the sea which show abnormally high solids is generally due to an admixture of ocean water that penetrates inward along joint cracks in the rocks. With one exception, the highest amounts of total solids in southern Maine which are believed to be due to the natural composition of the water are somewhat under 500 parts per million and are found in several widely scattered wells drilled in slate in Penobscot and Somerset counties. The minimum of total solids in slate is 52 in a well at Portland. The figures in Aroostook County slates (and "slated limestones") in northern Maine are higher, ranging between 200 and 800 parts per million. A single well at Bangor reports 834 parts per million.

In granite one well at North Sullivan reports 364 parts per million, and one in Waldoboro 419 parts. These figures are high for granite, as the total solids in granite waters generally run below 200. Most springs issuing from sand and gravel give low figures, many running below 30. One spring, at South Freeport, reported only 2.8 parts per million of total solids, but this figure is probably wrong.

The reports of the State board of health contain many sanitary analyses which show the amount of total solids in spring waters, but as the springs are mostly private ones, and as the material from which they issue is not known, or known only through correspondence, the analyses would be of little value in this report, and only two or three are given.

Organic and volatile matter.—Organic and volatile materials are much greater in amount in the waters analyzed than might be expected in deep-well and spring waters. It should be noted, however, that some of the highest figures occur in analyses for which the name of the chemist is not known, and hence their accuracy is open to doubt. Normally, with a few exceptions, the organic and volatile matter ranges from 5 to 100 parts per million in wells, and from 0 to 30 parts in springs. An exceptionally large amount of "organic and volatile matter" may be due to pollution of the water, to water of crystallization, or to volatile mineral components..

Silica.—The amount of silica in Maine waters is always low. As shown by the diagrams, it ranges from 7 to 25 parts per million for well waters, exclusive of the wells where it can be attributed to sea water. In spring waters the silica runs from 0.24 part to 21 parts. The highest amount, 21 parts, occurs in the Blue Hill Mineral Spring.

Iron and aluminum oxides.—The figures for iron and aluminum oxides are much more constant than those for any other ion or group of ions. With the exception of iron when reported alone, they are the lowest of all the materials commonly estimated. (See lowest line in Pls. IV, VI, and VIII.) In well waters from granite and similar rocks these minerals run from 1 to 8 parts per million; in those from sand and gravel, 1 to 2 parts; in spring waters, 0.2 to 9 parts. The highest amounts occur in spring water from a limestone quarry at Rockland.

Iron.—Most of the analyses reporting iron separately from aluminum are field assays, and in them iron is generally found to be absent. Most Maine waters are destitute of iron in appreciable quantities. As half a part per million of this mineral is recognizable to the taste, it will be seen that much iron would make the waters unusable. The greatest amount reported, 5 to 10 parts per million, is in the wells of the Northern Maine Seaport Railroad Company in Waldo County. This amount of iron in a water would make it undrinkable; hence it is probable that the figures given for iron in these wells may include alumina.

A number of mineral springs also report high iron, and to some of these the statement just made may possibly apply. As a rule, the amount of iron in springs of this State runs below 1 part per million. The Blue Hill Mineral Spring, which is said to issue from a rock containing a large quantity of iron, contains only 3.2 parts per million of this mineral.

Calcium.—Calcium, a constituent of lime, is one of the most abundant ingredients. It is generally highest in limestone, and runs from 40 to 160 parts in the areas of calcareous slates. Exceptional figures are much higher. The lowest known figure for calcium in slate water is 4. In granite it ranges from 1 part per million in a well on Greenings Island to 62 parts in a North Sullivan well. In gravel waters the amount is from 3 to 6 parts. In springs it ranges from a mere trace to 42 parts.

Magnesium.—In waters where calcium occurs magnesium also is found, but generally in much smaller quantities. In granite waters it ranges from 2 to 10 parts per million, in slate from 1 to 30, and in sand and gravel from 1 to 5. In calcareous slates in northern Maine the amount of magnesium runs from 15 to 40 parts. In spring waters the amount of this element is very uncertain, running as high as 14 parts, but being in most springs below 3. The analysis of limestone water from Rockland shows 22 parts of magnesium, nearly as many as of calcium—29. In two analyses, those of the Highland Mineral Spring at Lewiston and the Keystone Mineral Spring at Auburn, magnesium without calcium is reported. This is evidently a mistake, and it is possible that part of the solid matter reported as magnesium is in reality calcium.

Sodium.—Sodium is one of the constituents of common salt and of sea water, which explains why it is so high in certain analyses. Normally it runs from 7 to 60 parts per million in granite, from 3 to 30 parts in slate, and from 1 to 10 parts in gravel. In spring waters it is variable, but seldom exceeds 20 parts. In most Maine waters sodium is much lower than calcium, as shown by the diagrams. In sea water, however, sodium far exceeds calcium and magnesium in amount. The fact that in analysis No. 155 calcium is much in excess of sodium indicates that perhaps the high total solids may not be due entirely to sea water, as would appear at first inspection of the diagram.

Potassium.—Smaller quantities of potassium than of sodium are found in most waters. The element is usually in equilibrium with chlorine, as is sodium, and it is also found in sea water. In granite the amount ranges from 0.5 to 13 parts per million, in slate from 0.8 to 17, and in sand and gravel it is below 3. In two well waters the amount of potassium is reported greater than that of sodium. In spring waters it runs from 0.2 to 15 parts.

Bicarbonate radicle.—All carbonates occurring in Maine well and spring waters are believed to exist in the bicarbonate or acid-carbonate form, as several hundred tests for the normal or alkaline carbonate resulted negatively. The figures in the bicarbonate radicle column are mostly the results of field assays made according to the standard method of the United States Geological Survey,[a] and are approximate only. The tests made show the amount of bicarbonates to range from 9 to 143 parts per million in granite, 20 to more than 500 in slate, 40 to 167 in clay, 16 to 80 in bowlder clay, and 10 to 128 in sand and gravel. One report from a well in slate gives 765 parts per million. The higher figures, while somewhat scattering in distribution, are mostly from the northeastern quarter of the State. In Aroostook County none of them are under 100 and many exceed 300 parts per million. In spring waters the bicarbonate radicle is generally low, one refined analysis showing only 0.14 part. In a few springs the bicarbonates exceed 100 parts per million.

Carbonate radicle.—Most of the analyses of spring waters and a few analyses of well waters made by chemists not connected with the United States Geological Survey report calcium, sodium, and other carbonates. There is no way of determining from these analyses what proportion of the carbonates exist in the form of the normal carbonate radicle and what proportion in the bicarbonate form. In recomputing the results, therefore, it has been necessary to express them simply as "carbonate radicle" (CO_3), though these are probably all bicarbonates (HCO_3). Although normal carbonates are not known

[a] Leighton, M. O., Field assay of water: Water-Supply Paper U. S. Geol. Survey No. 151, 1905, pp. 66–69.

to have been found in Maine waters, they can not be said with certainty to be absent.

Sulphate radicle.—All sulphates occurring in Maine waters have been recomputed to the sulphate radicle (SO_4). Small amounts of this compound occur in most waters, and in some they are high. In granite they range from a mere trace to 36 parts per million, in clay from 0 to 53 parts, and in gravel and sand from 0 to 11 parts. In spring waters the sulphates range from 0 to 37 parts, but are generally below 10.

Chlorine.—Chlorine, a constituent of common salt, is one of the most variable components of natural waters. It ranges in the Maine waters analyzed from less than 1 part per million to as high as 1,790 parts in one well which was invaded by sea water. The highest chlorine that is believed to be due to the composition of the rock is somewhat under 200 parts. In some portions of the country (as in places in New York State), where the rocks contain salt, however, the waters are high in chlorine. Normal chlorine lines and the limitations of their use are explained on pages 27–28. In the majority of well waters the chlorine is above the normal as given for the local surface waters. In most deep wells which are properly cased this is due to chlorine dissolved from the rocks and in open wells to the entrance of surface waters.

Hardness.—The hardness of waters may be classed as temporary, due to the carbonates and bicarbonates of calcium and magnesium; or permanent, due to sulphates, chlorides, or nitrates of the alkali earths. A large part of the hardness in Maine waters is temporary and can generally be removed by boiling, which precipitates the hardening constituents. Aside from the analyses made by the state board of health, few tests for hardness have been made. In general the waters outside of Aroostook County and parts of Penobscot and Somerset counties are soft; and when they are described by residents or in the table at the end of the report as "hard" the term is used only relatively, with reference to softer waters in the same region. The total hardness of waters in southern Maine ranges up to 300 parts per million, the highest figures being shown in Penobscot County, where the rocks are slightly calcareous. The hardness of spring waters, however, seldom exceeds 20 parts. The reports of the state board of health include several hundred analyses of spring waters which give the hardness. Few of these are published here, as the material from which the spring issues is known only through correspondence.

Lithium.—Few tests for lithium in Maine waters have been made. One or two well waters which issue from granite report traces of this element, and amounts up to 0.01 part per million are reported to have been found in spring waters issuing from granite and gneiss.

Other substances.—In a few analyses tests have been made for other elements. Manganese, strontium, rubidium, phosphates, arsenates, and borates have been found as mere traces. Tests for bromine and iodine have resulted negatively. None of the substances mentioned have been found in quantities large enough to give the water medicinal properties. The most complete analyses, showing something in respect to the probability of finding the rarer elements in spring waters, are those made by the Bureau of Chemistry, United States Department of Agriculture.

DESCRIPTION OF UNDERGROUND WATERS BY COUNTIES.

ANDROSCOGGIN COUNTY.

GENERAL DESCRIPTION.

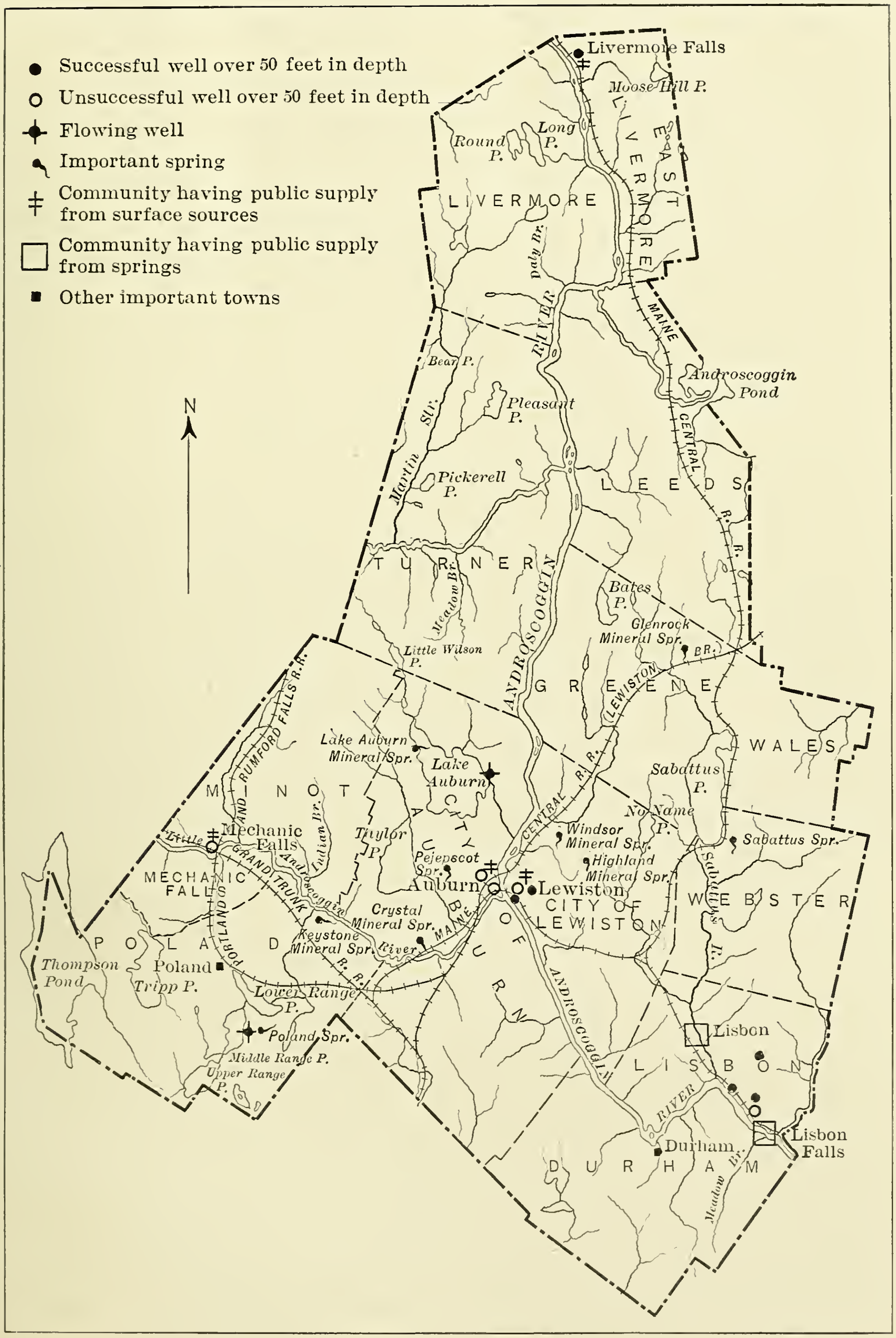
Androscoggin County is situated in the southwestern part of Maine, on both sides of Androscoggin River. It is one of the smallest counties in Maine, having a length of 40 miles, an extreme breadth of 25 miles, and a total area of only 480 square miles. The population, according to the census of 1900, was 54,242. Lewiston is the largest city, having a population of 24,997. Auburn, the county seat, on the opposite side of the river from Lewiston, contained 13,971 inhabitants. This county is moderately hilly, ranging in altitude from 100 to more than 800 feet.

UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Distribution of rock types.—The rocks of Androscoggin County consist for the most part of complex intrusions of granite and gneiss in schist, but a strip along the eastern border of the county, north of Lisbon, is underlain by slate. In the vicinity of Lewiston and Auburn the rocks consist mostly of hard gneissic schist or granitic gneiss, cut by small granite dikes. In most places within this strip the rock is distinctly bedded, but the strike and dip are extremely variable, the strata being much contorted in places. In some localities the joints are open and the rock is decomposed, allowing penetration of water downward; in other places the rock is dense, and all the cracks are tightly closed. This probably accounts for the failure of several deep wells at Auburn and Lewiston. Farther away from the boundary of the slate area, and in some places near its border the rock is true granite. A map of Androscoggin County showing the distribution of deep wells, important springs, and communities having public water supplies forms Pl. XI.

Surface deposits.—The greater part of the uplands of the county is covered by bowlder clay and irregular gravel deposits, locally of



MAP OF ANDROSCOGGIN COUNTY.

Showing distribution of deep wells, important springs, and communities having public supplies.

considerable thickness. Along the rivers, however, rather extensive lowlands consist of clay rising to a maximum elevation of about 200 feet. At Lewiston a number of brickyards make use of this clay. At Lewiston Upper Station the clay is 20 feet thick and in places is overlain conformably by stratified sand and underlain by coarse gravel. In other parts of Lewiston the clay is more than 30 feet in thickness. Gravel underlies the clay in the vicinity of Lisbon Falls and Lewiston, and probably nearly everywhere in the Androscoggin Valley. Many flat sand and gravel deposits extend along the valley of Little Androscoggin and other rivers and surround the principal lakes and ponds. The total thickness of these deposits varies greatly, but in extreme cases along the valleys it is as much as 60 feet. On the highlands the drift is thinner, generally not more than 5 to 15 feet thick.

WELLS.

GENERAL DESCRIPTION.

Types of wells.—The majority of the wells of Androscoggin County are open surface wells, but some driven wells are used, and in Lewiston, Auburn, and Lisbon Falls there are a few drilled wells. The open and driven wells vary in depth from 10 to 35 feet, and in the valleys they are generally successful, so far as the quantity of water is concerned, although some have been dug to rock without success, and the water in many of them becomes very low or gives out in a dry season. In general dug wells are the only type of shallow wells which can be used on the hills, but driven wells are more satisfactory in the sands and clays of the valleys.

Drilled wells.—In parts of the county where it is not possible to obtain water of suitable quality or in sufficient quantity from surface wells drilling should be adopted. Little drilling has been done as yet, but the method will be used more and more in future. Some hesitation may be felt in regard to it at Lewiston and Auburn because several of the wells, including one 654-foot well, have been failures. It is possible that in this vicinity open joint cracks containing water are so rare and superficial that successful wells can not be obtained; but the region has hardly been fairly tested, and it is possible that in some parts of these cities there may be plenty of water in the rocks. If tests are made, it will probably not pay to drill below 300 feet. Most of the wells already sunk have been 6-inch wells, but one 8-inch well was drilled. The depths range from 50 to 654 feet.

Quality of water.—Little can be said in regard to the quality of water in Androscoggin County, as few analyses have been made. Field assays of the water from dug wells at Auburn and one at Mechanic Falls show a very low mineral content. A drilled well in granite at South Poland gave 98 parts per million of total solids. A well in Auburn, location not known, reports 112 parts per million of total solids. Throughout the county the water is soft, but in drilled wells it is less so than in the surface wells. In nine springs, the waters of which have been analyzed, the total solids range between 29 and 154 parts per million. In one driven well and one drilled well the water is said to overflow the surface.

Uses.—In all parts of the county the chief use of well water is for domestic and farm purposes, and it is seldom used for anything else. At Lewiston, however, water from gravel is used in Bates's mill for bleaching purposes.

DETAILED DESCRIPTION.

Lewiston and Auburn.—At Lewiston and Auburn wells drilled in the solid rock have generally been failures. A well of the Standard Dry Plate Company, corner of Bates and Pine streets, Lewiston, found very little water. A well belonging to Mr. John Picket, now deceased, on Highland street, Auburn, got water, but is now abandoned. One of the most conspicuous failures in Maine is a well belonging to the Turner Center Creamery in Auburn. This well was drilled by an experienced driller to a depth of 654 feet, but absolutely no water was found below 8 feet from the surface. The first 90 feet was through gravel and clay, the rest in gneiss. The quality of water, where found, is generally good. Analyses of well waters in Auburn are given in the table on pages 82, 83 (Nos. 175 and 196).

The plant at Bates's mill, Lewiston, consists of 15 driven wells ranging in depth from 30 to 40 feet. The formation at the mill consists of 20 feet of gravel ("made ground") resting on about 5 feet of clay, below which lies 2 feet of gravel containing a plentiful supply of water. The gravel bed slopes to the south and appears at the bottom of all these wells and also at the bottom of a 65-foot well owned by the same company, situated 200 feet beyond the last well of the system. The water tastes strongly of iron. It is used in bleaching, and the pumps are run fifteen hours a day, pumping an average volume of 350 gallons a minute.

Dug wells are far more common than driven wells in this vicinity, and, except in the clay areas, are generally of moderate depth and are fairly satisfactory if protected from pollution. In the clay areas wells should be driven or drilled through the clay into the underlying sand and gravels, which generally contain plenty of water. Some open wells are blasted in rock, the chief value of this method being to furnish a reservoir for the water of the overlying drift. At North Auburn there are a few dug wells 40 to 60 feet in depth, most of them many years old. Several drilled wells are reported within the town limits. A few dug wells and springs are pumped by windmills. In the southern part of the town there are considerable areas of sand plain in which water can be easily obtained at shallow depths. Dug wells have been used mostly thus far, but some persons are now using driven wells. Several commercial mineral springs are situated in these towns and will be described under the appropriate heading. (See pp. 96–99, 103.) The public supply of Auburn and Lewiston is taken from Lake Auburn. This would be excellent water if properly protected, but unless the building of cottages and pleasure resorts on the lake shores is regulated and boating is stopped the supply will soon become dangerous for drinking.

Poland.—The conditions in the town of Poland vary greatly. Considerable areas in the eastern part of the town and in the vicinity of the ponds consist of sand and clay plains, but a large part of the town is hilly. Open wells are the rule, being generally dug to bed rock, and some of them are blasted into the rock itself as much as 4 to 10 feet. Only one drilled well is known. This is situated 700 yards from Poland Spring and was drilled in granite in the hope of tapping the spring supply. Needless to say, the attempt failed. The analysis of water from this well is given in the table (No. 2).

Mechanic Falls.—A number of years ago test wells were sunk at Mechanic Falls to depths of 30 to 60 feet through clay and fine sand, in order to get a public supply. A little water overflowed the surface, but the amount was too small, so the wells were abandoned. As the village lies on broad clay and sand plains bordering Little Androscoggin River, the water is here abundant and is easily obtained by dug and driven wells. The water is obtained on top of the clay, but if this is penetrated a more abundant supply of better quality will be found. It is possible, even, that flowing wells may be obtained in places. Driven wells are recommended in preference to dug wells wherever practicable, but all forms of wells should be sunk through the clay.

Lisbon.—Along the river at Lisbon water is found in shallow wells in sand resting on clay. Several wells drilled in granite at Lisbon Falls were sunk to depths ranging from 50 to 187 feet, and all but one were successful as regards quality of water. Only one field assay (No. 1 of the table) is available to show the mineral content of the water here.

East Livermore.—At Livermore Falls one or more shallow drilled wells have been sunk, but no information is at hand regarding them.

Other towns.—In the towns of Danville, Minor, Webster, Wales, Greene, Turner, Leeds, and Livermore no wells are known to have been drilled, the type generally in use being the ordinary open wells used at most farmhouses.

SPRINGS.

General statement.—Commercial mineral springs are more abundant in this county than in any other county of Maine, no fewer than seven springs reporting sales of water being situated within its borders. These are as follows:

Crystal Mineral Spring, Auburn.
Highland Mineral Spring, Lewiston.
Keystone Mineral Spring, East Poland.
Pejepscot Spring, Auburn.
Poland Spring, South Poland.
Sabattus Springs, Sabattus.
Windsor Mineral Spring, Lewiston.

In addition to these there are several other springs of interest, the water of which is not sold.

Crystal Mineral Spring.—The Crystal Mineral Spring is owned by the Samoar Carbonating Company, of Lewiston. It is situated on a sloping hillside 3 miles southwest of Auburn depot, and the water issues from undulating deposits of stratified sand, known as kames, which rest on a bed of clay. The water is collected in a cement-lined and glass-covered masonry tank, about 8 feet square and 4 feet deep, inclosed in a spring house where the water was formerly bottled. It is now hauled to Lewiston and bottled there, being mostly carbonated for soda water and ginger ale, and sold under the trade name Samoar water. The temperature of this water at the spring is 47° and the measured overflow is 6 gallons a minute. The water has no color, odor, or taste, and on account of its situation distant from houses there is no chance for pollution. The analysis, recomputed from that given in the circular issued by the owner, is given in the table (No. 203a).

Glenrock Mineral Spring.—The Glenrock Mineral Spring is situated in the town of Greene, 2½ miles south of the post-office. It is owned by A. B. Parker & Sons, of Greene. The water issues from gravel deposits on a gentle slope in an open field. The spring is incased in granite curbing cemented to an impervious stratum, and is reported to flow 18 gallons a minute, not varying according to season. The temperature is 47½°. The water is colorless, odorless, and tasteless, and is of excellent quality. It is used as a table and medicinal water by many families in Lewiston and Auburn. The analysis of the water is given in the table (No. 206b), the composition being taken from the circular issued by the owners and recomputed according to the standard method.

Highland Mineral Spring.—The Highland Mineral Spring is situated on a southward-sloping hillside in the city of Lewiston, about 3 miles northeast of the post-office. It is owned by the Highland Spring Water Company, of New York. The hill on which the spring is situated is composed of gneiss and schist cut by pegmatite dikes, and a covering of 1 to 5 feet of bowlder clay overlies the rock. The water occurs in a vertical 6-inch crack parallel with the stratification of the gneiss, entering from the direction of the summit of the hill on the north side of the spring. The water is believed to be derived from the rain and snow falling on the hillside within a few hundred feet of the spring, being held in the drift and the upper crevices of the rock until it emerges at the spring. The spring is reported to flow 20 gallons a minute in a wet season, but diminishes somewhat during the summer. The temperature averages 42°, varying a little during the year.

The spring is inclosed with a granite curbing, and the whole is covered with a small spring house. The bottling house is 50 feet away. The situation is almost ideal for a mineral spring, as the hill rises 100 feet or so above it and is covered mostly by thick woods. There are no houses on the hill except two cottages on the summit, several hundred yards from the spring, separated from it by a small ravine. These are occupied for a month in summer by the treasurer of the company—a prominent New York physician—and as every precaution is taken in respect to drainage, there is practically no danger of the spring water becoming polluted. The water is bottled near by and shipped to New York and other cities. Valuable medicinal properties are claimed for it by the owners. The water retails in New York for $2 a 5-gallon carboy, or the same rate for a case of 12 quarts. This is colorless, odorless, and tasteless.

Several analyses have been made of this water (Nos. 209, 210, and 210a of the table), but the most complete is that made by W. W. Skinner, of the Bureau of Chemistry, United States Department of Agriculture, in connection with cooperative work on mineral waters conducted by the Geological Survey and the Bureau of Chemistry. The proportions of the various constituents are as follows:

Analysis of water from Highland Mineral Spring.

[W. W. Skinner, analyst.]

Gases (cubic centimeters per 1,000 grams at 0° C. and 760 mm. pressure):	
Carbon dioxide (CO_2), free	38.2
Carbon dioxide (CO_2), set free from bicarbonates on evaporating to dryness	4.2
	Parts per million.
Phosphoric acid radicle (PO_4)	None.
Metaboric acid radicle (BO_2)	None.
Arsenic acid radicle (AsO_4)	None.
Silica (SiO_2)	11.40
Sulphuric acid radicle (SO_4)	4.65
Bicarbonic acid radicle (HCO_3)	22.90
Nitric acid radicle (NO_3)	None.

	Parts per million.
Nitrous acid radicle (NO_2)	None.
Chlorine (Cl)	2.20
Bromine (Br)	None.
Iodine (I)	None.
Iron and aluminum (Fe and Al)	.35
Manganese (Mn)	None.
Calcium (Ca)	5.86
Magnesium (Mg)	.94
Potassium (K)	1.21
Sodium (Na)	2.79
Lithium (Li)	None.
Ammonium (NH_4)	.021
Oxygen to form Fe_2O_3 and Al_2O_3	......
	52.321
Free ammonia	.02
Albuminoid ammonia	.05
Nitrogen as nitrates	Traces.
Nitrogen as nitrites	None.
Oxygen consumed	1.50

Keystone Mineral Spring.—The Keystone Mineral Spring is owned by E. H. Pratt, of East Poland. The spring is situated on a gently sloping hillside in the eastern part of the town of Poland, about a mile north of Empire Road station on the Grand Trunk Railway. The water issues from a nearly horizontal seam 4 feet or so from the surface, overlain by a bed of granite and underlain by gneiss. The beds of the gneiss strike N. 30° to 40° W. and dip 35° NE. The hill rises 10 feet higher within 100 feet southwest of the spring and 25 feet higher 200 feet north of the spring. To the east is a little valley; to the southwest lies an undulating sand plain a quarter of a mile in extent. The water apparently comes from the southwest, where it is caught on this sand plain, sinks into the underlying rock, and finds its way along the contact plane between the granite and the gneiss.

This spring is walled with a granite curb and inclosed in a bottling house, and is well protected from pollution. The temperature in the basin is 50°, the water being probably warmed somewhat by contact with the air. There is no color or odor and little, if any, taste. The measured overflow is a trifle over 3 gallons a minute and is reported to fluctuate very little with the weather or the season. The water has been analyzed, and the composition reported by the owners and recalculated into ions and parts per million according to the standard rules is given in the table (No. 206).

The best analysis of this water is one made by W. W. Skinner, of the Bureau of Chemistry, United States Department of Agriculture, in connection with cooperative work on mineral waters conducted by the Geological Survey and the Bureau of Chemistry. This analysis is as follows:

Analysis of water from Keystone Mineral Spring.

[W. W. Skinner, analyst.]

Gases (cubic centimeters per 1,000 grams at 0° C. and 760 mm. pressure:
- Carbon dioxide (CO_2), free 9.2
- Carbon dioxide (CO_2), set free from bicarbonates on evaporating to dryness 10.9

	Parts per million.
Phosphoric acid radicle (PO_4)	None.
Metaboric acid radicle (BO_2)	None.
Arsenic acid radicle (AsO_4)	None.
Silica (SiO_2)	11.60
Sulphuric acid radicle (SO_4)	3.43
Bicarbonic acid radicle (HCO_3)	59.53
Nitric acid radicle (NO_3)	.88
Nitrous acid radicle (NO_2)	None.
Chlorine (Cl)	5.20
Bromine (Br)	None.
Iodine (I)	None.
Iron (Fe) and aluminum (Al)	.39
Manganese (Mn)	None.
Calcium (Ca)	14.72
Magnesium (Mg)	3.11
Potassium (K)	.84
Sodium (Na.)	4.23
Lithium (Li)	None.
Ammonium (NH_4)	......
Oxygen to form Fe_2O_3 and Al_2O_3	......
	103.93
Free ammonia	None.
Albuminoid ammonia	None.
Nitrogen as nitrates	.20
Nitrogen as nitrites	None.
Oxygen consumed	6.50

Keystone Spring water is bottled and mostly peddled in Lewiston and Auburn, but some is shipped by rail. Examination of the spring shows it to be probably secure from danger of pollution.

Pejepscot Spring.—Pejepscot Spring is situated on Golf Hill in Auburn, about 1½ miles northwest of the post-office. The water is reported by the owners to issue from a bed of sand near the base of the hillside. It is colorless, tasteless, and odorless, and is reported to flow about half a gallon a minute. It is put on the market for medicinal and table use. The analysis given in the table (No. 204) is recomputed from that furnished by the owners.

Poland Spring.—Poland Spring is the best-known spring in Maine. It is owned by Hiram Ricker & Sons (Incorporated) and is situated on Ricker Hill at South Poland. This is a hill of considerable size, rising 300 feet above the surrounding valley and consisting almost entirely of granite and granite gneiss, covered only by 1 to 30 feet of hardpan or bowlder clay. On top of the hill stands the Poland Spring House, a famous summer resort.

On the north and east sides of the hill the formation is typical granite, but on the south and west slopes it is much more gneissic in character. The spring is situated on the east slope of the hill, 84 feet below the summit. In the immediate vicinity of the spring the rock is in few places more than 3 feet below the surface, and much of the surface is bare rock which slopes with the hill. The water issues from cracks in a dike of porphyry which is about 10 feet wide at the spring and strikes about N. 80° W., as nearly as can be estimated. This dike has been traced by the owners of the spring for a distance of 200 feet and its width diminishes at the southeast end to about 1 foot. Its other relations can not be determined without excavation, but it is reported to hade slightly into the hill. The spring itself is covered by a glass case and protected from too close intrusion by a marble wall surmounted by an iron grating. By looking down through the glass cover a number of narrow cracks a small fraction of an inch in width can be seen running parallel with the sides of the dike. The surface of the dike is weathered rather whitish and is somewhat decomposed. It is from this part of the dike that the water emerges.

No pains or expense have been spared by the owners of the Poland Spring to collect every available gallon of the water which emerges, and to protect the spring from all possible pollution. A trench was once excavated along the dike for many feet, and the dike covered with cement, to prevent the exit of water anywhere except in the spring. The curbing has been carefully cemented to the rock to prevent all surface wash, and over the spring has been built an elaborate and expensive marble spring house. The hotel stands on the summit of the hill several hundred feet distant, and all drainage from the hotel and stables is carried in tightly jointed pipes down the opposite slopes.

Poland water has no color, odor, or taste, and is very low in mineral matter, as shown by the analyses given in the table (Nos. 212, 213, 214, and 214a). The first and second analyses are reported by the owners of the spring and the various constituents have been recalculated into the ionic form and parts per million, according to the standard method.

The best analyses of the Poland Spring water were made by W. W. Skinner, of the Bureau of Chemistry, United States Department of Agriculture, in connection with cooperative work on mineral waters conducted by the Geological Survey and the Bureau of Chemistry. One of these, made in 1905, has been published,[a] but is repeated here.

[a] Haywood, J. K., Mineral waters of the United States: Bull. No. 91, U. S. Dept. Agr., Bur. Chemistry, 1905, pp. 32–33.

Analysis of Poland Spring water.

[W. W. Skinner, analyst.]

Gases (cubic centimeters per 1,000 grams at 0° C. and 760 mm. pressure):	
Carbon dioxide (CO_2), free	5.6
Carbon dioxide (CO_2), set free from bicarbonates on evaporating to dryness	8.8
	Parts per million.
Silica (SiO_2)	24.1
Sulphuric acid radicle (SO_4)	3.6
Bicarbonic acid radicle (HCO_3)	48.4
Carbonic acid radicle (CO_3)	......
Nitric acid radicle (NO_3)	5.89
Nitrous acid radicle (NO_2)	.0032
Phosphoric acid radicle (PO_4)	Trace.
Metaboric acid radicle (BO_2)	None.
Arsenic acid radicle (AsO_4)	None.
Chlorine (Cl)	5.0
Bromine (Br)	None.
Iodine (I)	None.
Iron (Fe) and aluminum (Al)	.4
Manganese (Mn)	None.
Calcium (Ca)	13.9
Magnesium (Mg)	2.1
Potassium (K)	2.4
Sodium (Na)	6.9
Lithium (Li)	Minute trace.
Ammonium (NH_4)	.008
Oxygen to form SiO_3 and Fe_2O_3	1.2
	133.9012
Free ammonia	.008
Albuminoid ammonia	.051
Nitrogen as nitrates	1.33
Nitrogen as nitrites	.001
Oxygen required	.45

HYPOTHETICAL FORM OF COMBINATION.

	Parts per million.
Ammonium chloride (NH_4Cl)	0.024
Lithium chloride (LiCl)	Minute trace.
Potassium chloride (KCl)	4.6
Sodium chloride (NaCl)	4.6
Sodium sulphate (Na_2SO_4)	5.3
Calcium phosphate ($Ca_3(PO_4)_2$)	Trace.
Sodium nitrate ($NaNO_3$)	8.07
Sodium nitrite ($NaNO_2$)	.0048
Sodium bicarbonate ($Na(HCO_3)$)	4.4
Magnesium bicarbonate ($Mg(HCO_3)_2$)	12.6
Calcium bicarbonate ($Ca(HCO_3)_2$)	46.1
Ferric oxide (Fe_2O_3) and alumina (Al_2O_3)	.6
Calcium silicate ($CaSiO_3$)	7.3
Silica (SiO_2)	20.3
	115.8988

The second analysis by the Bureau of Chemistry was made at a later date and has not been previously published. The various constituents are as follows:

Analysis of Poland Spring water.

[W. W. Skinner, analyst.]

Gases (cubic centimeters per 1,000 grams at 0° C. and 760 mm. pressure):	
Carbon dioxide (CO_2), free	2.10
Carbon dioxide (CO_2), set free from bicarbonates on evaporating to dryness	10.20
	Parts per million.
Phosphoric acid radicle (PO_4)	Traces.
Metaboric acid radicle (BO_2)	None.
Arsenic acid radicle (AsO_4)	None.
Silica (SiO_2)	15.40
Sulphuric acid radicle (SO_4)	3.29
Bicarbonic acid radicle (HCO_3)	55.63
Nitric acid radicle (NO_3)	3.98
Nitrous acid radicle (NO_2)	None.
Chlorine (Cl)	5.90
Bromine (Br)	None.
Iodine (I)	None.
Iron (Fe) and aluminum (Al)	.32
Manganese (Mn)	None.
Calcium (Ca)	14.37
Magnesium (Mg)	2.38
Potassium (K)	.90
Sodium (Na)	6.34
Lithium (Li)	None.
Ammonium (NH_4)	.011
Oxygen to form Fe_2O_3 and Al_2O_3	.130
	108.651
Free ammonia	.01
Albuminoid ammonia	.005
Nitrogen as nitrates	.900
Nitrogen as nitrites	None.
Oxygen consumed	4.00

The volume of flow of the Poland Spring is reported to be about 8 gallons a minute. The temperature averages 42° and rarely varies 2° the year round. It is little affected by rain, and then only after the lapse of considerable time. The spring water is used for drinking at the Poland Spring House and the Mansion House near by and is bottled and shipped.

The Poland Spring is said to have been accidentally discovered in 1845. The hotel was built in 1876. In 1906 a fine plant, consisting of a spring house and bottling works, was installed at a cost of more than $100,000. In the vicinity of the Poland Spring are situated a number of other springs from which some water has been sold. One of these waters, sold near by, went for a while by the name of "Poliska water." Some years ago a well was sunk on the west side of the hill in an attempt to tap the Poland Spring, but without success.

Cliff Spring.—The Cliff Spring is situated one-fourth mile west of East Turner, and the water is sold in Lewiston. The flow is reported to be 1½ gallons a minute.

Windsor Mineral Spring.—The Windsor Mineral Spring, owned by the Windsor Mineral Spring Company, of Boston, is situated 3 miles northeast of Lewiston post-office, on the slope of a rock hill which rises 100 feet or more behind the spring. The surface deposits consist of several feet of bowlder clay. The water is said by the owners to issue from rock. The formation is pegmatite, gneiss, and schist. The slope of the hill is grassed over and covered in part by an orchard. The only buildings in the vicinity are a house and barn, situated 500 feet horizontally along the hillside, thus giving no opportunity for pollution by drainage. The flow is reported to be 5 or 10 gallons a minute and to be invariable. The temperature is said to vary 2° or 3°.

The water is sold in Boston, New York, and other cities for table and medicinal purposes. Some of it is carbonated. The charge for still water is $1.50 a 5-gallon carboy. The spring is well protected by a cement curbing and is covered by a small spring house.

This water contains 154 parts per million of total solids. The complete analysis, recomputed according to the standard system, from the analysis reported in the company's circular, is given in the table (No. 208).

Lake Auburn Mineral Spring.—An important spring is situated on the northwest shore of Lake Auburn, at the foot of a gentle bowlder clay and gravel slope, near the lake. Formerly the site of this spring was used for a summer resort and there was a large hotel here, but a few years ago the hotel was destroyed by fire and it has not been rebuilt. The spring is still covered with a small spring house, and many people from the village of North Auburn come here for drinking water.

PUBLIC SUPPLIES.

Several communities in Androscoggin County—Lewiston, Auburn, Mechanic Falls, Livermore Falls, Lisbon Falls, and Lisbon Center—have public water supplies. The last two mentioned are, however, the only ones using underground sources.

The village of Lisbon Center has a public supply owned by Mr. Herbert G. Spear, the water being derived from springs. The supply is distributed from a tank through galvanized-iron pipe, and the water is called good. The amount used per day is reported to be

1,500 gallons. The pressure is 15 pounds. The water mains are about 1 mile in length, and there are 30 taps. There is no fire service.

Lisbon Falls obtains its supply by direct pressure from two springs owned by the Sylvester Aqueduct Company.

CUMBERLAND COUNTY.

GENERAL DESCRIPTION.

Cumberland County lies in the southwestern part of the State, bordering on Casco Bay and extending inland toward the New Hampshire line. It has a length north and south of about 45 miles and a breadth east and west of about the same distance, and covers a total area of 1,014 square miles. The population according to the census of 1900 was 100,689. This county contains Portland, the largest city of Maine, which in 1900 had a population of 55,167. The county includes many large lakes, especially in the western part, the largest being Sebago and Long lakes and Thompson Pond. It contains nearly the whole of the Presumpscot River system, Saco River follows the western edge for 16 miles, and Androscoggin River near its mouth borders the eastern corner for a similar distance. The county is relatively hilly, ranging in altitude from sea level to more than 1,300 feet above sea level in the northwestern part. Along the coast are scores of islands, large and small, which are utilized extensively as summer resorts. A map of Cumberland County, showing the distribution of deep wells, important springs, and communities having public supplies, forms Pl. XII.

In the interior districts of Cumberland County the prevailing type of well is the old-fashioned dug well, but in the vicinity of Portland and on the various islands of Casco Bay drilled wells are abundant and are generally successful. The range in depth is from 30 feet to more than 800 feet, the most common depth being between 50 and 100 feet. A few drilled wells in the vicinity of Portland and a number of driven wells on the flood plain of Androscoggin River near Brunswick overflow.

UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Character and distribution of rock types.—As in Androscoggin County, the prevailing type of rock is granite. Only the region in the southern part of the county, lying between Sebago Lake and the sea, and small areas along the coast and on the islands, consist of slate and schist. These areas include Portland, Cape Elizabeth, Scarboro, South Portland, Gorham, parts of Windham, Westbrook, Deering, Freeport, and the island portions of Cumberland and Yarmouth. In the extreme northeastern part of the county, in much of Harpswell and in the eastern half of Brunswick, is an area of "complex" in which

U. S

MAP OF CUMBERLAND COUNTY.

Showing distribution of deep wells, important springs, and communities having public supplies.

granites and gneisses alternate with slates, schists, and other rocks. which can not be subdivided in mapping.

Along the coast between Cape Elizabeth and Brunswick the rock varies in nature from hard, gneissic, and locally almost granitic rock to a very soft and schistose formation. The prevailing strike is northeastward, and this peculiarity accounts for the northeast-southwest elongation of the islands in Casco Bay. In general, the stratification and cleavage coincide rather closely in strike, although they may vary considerably in dip. Here and there the strata are much contorted, but the cleavage is generally rather uniform and for the most part nearly vertical, although in places it is considerably inclined. On Peaks Island the strike averages N. 40° to 60° E., and the dip ranges from 30° to 60° NW. The cleavage there is parallel to the dip. In many places the cleavage planes are open and would seem to allow opportunity for considerable water to penetrate downward into the rocks.

The mainland of Portland and parts of Deering and Westbrook differ considerably from the coast and islands, being composed of nearly pure slate which shows little trace of schistosity. This is the general type of slate found farther inland in Maine. In Portland and vicinity the slates are cut by intruded trap and granite dikes. At many places near its borders the granite contains masses of slate, and, like the slate, it is cut by dikes of trap. This indicates that the slate was the first rock formed, that is was intruded by great masses of molten granite, and that later both slate and granite were intruded by small masses of basic rock in the form of dikes which may now be seen cutting those rocks.

The joint cracks in the vicinity of Portland correspond in trend to those developed in other parts of the State. On the other harbor islands the main joints trend approximately N. 30° E., and N. 70° W. At Woodfords they are irregular. Some are nearly vertical, and the most persistent hade is toward the northwest, but a few vertical joints run in an east-west direction. One of the best exposures of this slate can be seen in a large ledge at Fish Point, in the Grand Trunk Railway yards at Portland.

On the islands in Casco Bay the cleavage is inclined at a high angle with the stratification, the latter being much contorted. In places the cleavage and stratification correspond, but such agreement is generally accidental. The strike of the cleavage is N. 40° E., and the hade is from 30° to 90° NW. In places the rock is very shaly. The joint cracks at these places are very irregular, but one system runs between N. 20° W. and N. 50° W. These joints are rather numerous, but not persistent. The rock contains a great many quartz veins.

The structure of the slate and its adaptability for holding water are shown by phenomena recorded in the drilling of wells at Portland.

In one well the drill dropped several inches when water was struck at a depth of 288 feet.

Surface deposits.—The surface deposits of Cumberland County are very diversified in nature. In the towns bordering the coast there are large areas covered by clay, which in many places is in turn overlain by flat sand deposits. The upper surface of the clay is not flat but undulating, so that the overlying sand is not everywhere of the same thickness. Along the coast the clay does not in general rise more than 60 feet above tide, but in the valleys of Presumpscot and other rivers it is in places as high as 150 feet. The clay and sand plains are several square miles in extent. The clay is also underlain in many places by sand and gravel in which water may generally be found. A typical section showing the relations of the clay to the other deposits is exposed at Portland.

Typical section of drift at Portland.

	Feet.
Dark-brown clay with a few bowlders	10
Fine stratified sand	8
	18

Another type of section is as follows:

Section of drift near Westbrook.

	Feet.
Coarse heterogeneous gravel	5
Stratified dark-brown clay	6
Fine horizontally-stratified sand	3
Coarse semistratified gravel	5
	19

The following section is exposed in a cut in Munjoy Hill on Washington street, Portland:

Section on Munjoy Hill, Portland.

	Feet.
1. Coarse gravel	3
2. Stratified gravel	10
3. Stratified, contorted, and eroded clay	5
4. Hard blue bowlder clay	10+
	28+

On top of No. 3 in this section a large amount of water can be seen seeping out of the hill. On the east side of the hill there are great gullies from which springs issue, apparently on top of the same bed. As a reservoir is situated on the summit, it is possible that the water has its source in leakage.

A few exposures in the city of Portland show that the upper part of both hills on which the city is built consists of gravel, while rock forms the core at depths of 100 feet or so below the summit. Considerable areas in Portland outside the peninsula consist of clay rising to a maximum height of 100 feet above tide. Generally these clays are underlain by sand or gravel which may contain water. In some of the brickyards considerable water seeps out of the clay near its base. The top of Bramhall Hill is reported to have once been a swamp, and the water which seeps out around both sides of the hill probably comes from this source. Springs are reported to have once been abundant on this hill.

Away from the coast the drift is thinner. On the highlands it is generally of the ordinary type of bowlder clay, from 1 to 10 feet or more thick. About Sebago Lake, however, and in some of the broader valleys there are flat sand deposits of considerable thickness. Some undulating sand and gravel deposits are found on the highlands.

Buried valleys.—In most places the stratified drift deposits are underlain by rock at no considerable depth. Elsewhere, however, along ancient buried river valleys, the clay is of great thickness. Such a structure is found underneath Fore River between Portland and South Portland, where borings made during the construction of Vaughan's bridge showed the bed rock descending with a fairly regular drop from sea level at Portland to 110 feet below tide on the South Portland shore. A short distance south of this place the rock reaches the surface again and outcrops near Cape Elizabeth depot. In the construction of Vaughan's bridge two rows of 13 borings each were put down as tests. A sample record of the strata passed through is as follows:

Record of boring at Vaughan's bridge, Fore River, Portland.

	Feet.
1. Water	11.9
2. Soft black silt	21.4
3. Soft silty sand and peat	21.0
4. Very soft blue clay with silt	52.8
5. Coarse gravel and sand, hard	2.4
6. Slate.	
	109.5

No. 3 is nearly pure peat in some borings; in others it is made up largely of sand. It is reported in only 10 out of the 26 borings, and when mixed with sand has a thickness of 5 to 30 feet, rising within 33 feet of mean low water. No. 4 is typical blue clay, and its surface rises from 55 feet below tide at South Portland to low-water level at Portland. No. 5 is a stony bowlder clay.

The two kinds of buried valleys, those in the clay surface and those in the underlying bed rock, indicate that Fore River was the outlet for a stream of some size both before and after the deposition of the clay. It is probable that rock valleys of this kind extend many miles inland at several points along the coast, although they can not be traced on the surface owing to the great thickness of glacial drift. It may be expected that water supplies will be found by drilling wells in these filled valleys at some distance back from the coast.

WELLS.

GENERAL DESCRIPTION.

Types of wells used.—In Cumberland County, as nearly everywhere else in Maine, open wells are by far the most abundant type. The most common depth is probably 25 feet, and the wells are usually dug in bowlder clay or gravel. As a rule they are fairly successful, but the quality, volume, head, and persistence of the water vary greatly. A few wells, such as some of those driven on the flood plain of Androscoggin River for the towns of Brunswick and Topsham, obtain flows of water from a depth of 25 to 35 feet. This is possible only in a few favored localities. In some localities wells driven through soft clay into the underlying sands and gravels obtain water of good quality. Drilled wells are generally successful.

Drilled wells.—In Cumberland County there are no deep wells sunk exclusively in drift; however, the borings for Vaughan's bridge in Portland go to a depth of 110 feet below tide before striking rock. This suggests the possibility of getting water along similar buried valleys. It may be worth while to mention the case of the Merrimac Valley in Massachusetts, where a number of wells were drilled into the gravels underlying the clays at considerable depths and a few flowing wells were obtained. Although there is no certainty that similar wells could be obtained in Maine, it is probable that wells sunk at any point along the old valleys would obtain plenty of water.

In Cumberland County the number of drilled wells which have been sunk is somewhat over 120. The diameter of these wells varies from 4 to 8 inches according to the situation and the quantity of water desired, but the common diameter is 6 inches. The depth ranges from 40 feet in a few wells to 830 feet in an unsuccessful well drilled at the Maine General Hospital.

Quantity of water.—The most common depth of well is 50 to 100 feet, and the depth to the principal vein of water is generally within the same limits. Some wells, however, find the principal water vein as deep as 200 feet. The wells are most closely grouped at Portland and on some of the islands in Casco Bay and in the town of Standish. Most of them are successful, although in a few no water was obtained, and a few wells are reported along the coast in which the only result was salt water which had probably penetrated inward from the sea. The quantity of water found varies greatly, from less than a gallon to 60 gallons a minute. The common capacity is not more than 10 gallons a minute. The best wells known in the county are at Portland. Generally the wells are permanent, but it has been necessary to drill a few of them deeper, and some have been abandoned because of decrease in supply.

Quality of water.—As elsewhere in Maine, the quality of the water is dependent largely on the kind of rock in which the well is drilled. It is found that the lowest amount of total solids is generally obtained from granite, although typical hard blue slate of the type found on the mainland at Portland generally gives water of moderate mineral content. Where the rocks are more schistose, however, and especially where they are mixed with trap and granite, approaching the type known as "complex," the water is of poorer quality, generally being higher in sulphates and carbonates and more commonly containing iron. There is probably no place in Cumberland County where the water is so highly charged with mineral matter as to be unsuitable for use in boilers, but sea water has penetrated and ruined a few wells. Generally the well waters of this county are low in mineral matter, and where kept safe from pollution by organic matter they are perfectly satisfactory for drinking. The table of analyses on pages 77–83 shows that the total solids in rock wells in this county run from 25 to more than 600 parts per million, with one higher report (2,008) due to sea water. The ordinary amount of total solids is from 100 to 150 parts, and the hardness from 16 to 176.

Uses.—Most of the wells in Cumberland County are used for domestic supplies. In Portland, however, they are used in several office buildings for both drinking and boilers and in a number of factories. On the islands of Casco Bay they are used to supply summer cottages. Several of these islands have installed public supplies from rock sources. Brunswick has a supply from deep wells in gravel and sand. Most of the wells of the county are pumped by hand or by windmill, but those used for public supply and some private wells are pumped by power. Several of the forts in Casco Bay are supplied by wells.

Flowing wells.—In Cumberland County 10 flowing wells are reported, exclusive of the wells of the Brunswick and Topsham water district, which flow at times. Most of these are situated on the islands of Casco Bay, but one of them is in Gorham and one in Westbrook. The greatest head is about 3 feet above the surface, and the greatest yield is about 2 gallons a minute. With few exceptions the water is suitable for any use.

DETAILED DESCRIPTIONS.

City of Portland.—The drinking-water problem is not pressing in the city of Portland, for the reason that an excellent supply is obtained from Sebago Lake, a body of water so large that it is little affected by any polluting influence. However, the number of summer cottages and hotels situated on the lake and its tributaries is increasing rapidly, and several steamboat lines are run regularly on the lake. It is feared, therefore, that the water may in time become dangerous if no precautions are taken to stop the increase of contaminating influences. (See p. 125.) But at present the water supply of the mainland portions of the city is excellent, and the advantage of wells lies principally in a saving of water bills. Several companies and individuals have drilled deep wells for that reason, and on the islands of the harbor a number have been sunk for supplying summer cottages. In all, more than 30 drilled wells have been sunk within the city limits.

The deepest well known to have been drilled in the State of Maine was sunk in 1902 at the Maine General Hospital, on Western Promenade, overlooking the union station. This well was sunk to a depth of 830 feet. It was drilled by an experienced driller, who contracted to supply 16 gallons of water a minute, the price of the well being $2,000. Only 3 gallons a minute were obtained, and this was not sufficient for the hospital needs. The driller requested permission to "shoot" the well with 200 pounds of dynamite, but his request was refused and the well was abandoned.

This well was situated 150 feet distant from a successful well 505 feet in depth at the same hospital, which obtained 13 gallons of water a minute and cost $3,290, including the engine and pump. This well was sunk in 1902 to a depth of 100 feet. A year later it was deepened to 505 feet, its present depth. The first 24 feet of this well is through gravel, the next 76 feet through clay, and the rest through slate. It yields more than 21,000 gallons of water a day, and the water is of very good quality. The analysis (No. 45) shows 177 parts per million of dissolved solids. The sanitary analysis showed the water to be perfectly safe.

In the well drilled for Mr. D. F. Emory the following strata were encountered:

Record of D. F. Emory well, Portland.

	Feet.
Fine sand	12
Gravel and sand	30
Hard "sandstone"	10
Rock	76
	128

In a 298½-foot well belonging to Burgess, Forbes & Co. the strata were as follows:

Section of Burgess, Forbes & Co. well, Portland.

	Feet.
Gravel	14
Clay	65
Clay and gravel	18
Clay	52
Slate	61
"Granite"	88½
	298½

If the "granite" is really granite, it indicates the extreme irregularity in distribution of this rock beneath Cumberland County.

One of the best wells in the city is that belonging to Mrs. Mary J. Frazer, at the corner of Franklin and Fore streets. This is a flowing well 210 feet deep, in slate. It is pumped by a windmill and is reported to yield 25 gallons of water a minute and to supply drinking water for a large number of tenements in the vicinity. Water was obtained at a number of different depths, but the best vein was tapped at the bottom of the well. The owner reports the use of this well as a great saving in expense over city water. It is a fine, clear water, and contains 25 parts per million of total solids, a lower amount than exists in the water of any other deep well in the city. An interesting feature regarding this well is that although it is situated but a few hundred feet from the sea, where the normal amount of chlorine is over 6 parts per million, only 1.4 parts of chlorine were found in this water. This may mean that the water comes from a source some distance inland.

An unsuccessful well was drilled in 1887 for the Consolidated Electric Light Company of Maine, on Plum street. This well is 8 inches in diameter. Salt water was struck at 140 feet from the surface, and the well was drilled to 204 feet in the hope of getting water of better quality. It yielded 65 gallons a minute, and the well could not be pumped dry, but the water was too salty for use. The well was then plugged at a depth of 145 feet. An analysis was made, and the result showed the total solids to amount to 2,008 parts per million, of which 1,912 were readily soluble and 96 insoluble by heating. The water was rather alkaline and contained a trace of iron. The analyses showed that there was less calcium carbonate than before plugging and that nearly all the magnesium carbonate was shut off; the sodium chloride increased considerably. The water has great tendency to scale and corrode the boilers. As the total solids in this water do not approach the amount in sea water, it can not be pure ocean water, but is considerably diluted with rock water.

Another unusual well is the one belonging to Mr. James P. Baxter, at Baxter Block. Mr. Baxter reports his well water to be better than Sebago water, because the latter will show a slight sediment on standing, whereas that from his well will not. This well nearly flows. It is said that when the drilling had reached a depth of 76 feet no water had been found, but at that depth the drill suddenly dropped for a distance of more than 80 feet through a cavernous space. If this report is accurate, it is probable that a vertical joint crack of considerable size was encountered.

The well drilled for E. T. Burrowes & Co. is 106 feet deep and becomes a flowing well in the spring. Analysis of this water showed pollution by sewage, and it is not used for drinking.

On account of the general use of Sebago water in Portland there are few dug wells within the city limits. The former town of Deering now belongs to Portland and has for years used the city supply. There are a few dug wells in the vicinity of Woodfords, but these are not used for drinking water, as the population has become too dense to make water from shallow wells safe. In quality the Portland water is very good, as regards both purity from pollution and low mineral content. The analyses of waters from 11 deep wells in the city are given in the table (Nos. 37 to 47).

Peaks Island, Portland.—The shore of Peaks Island consists almost entirely of bare rock and bowlder clay, but the interior, rising at points to a height of more than 80 feet above tide, is covered in places by sand and clay which are locally 20 feet or more in thickness. The rock consists of slate and sandy schist striking northeast and having a nearly vertical dip. In hardness the rock varies greatly, as it is cut by a great many small veins of quartz.

There are many open wells on the island, the most common depth of which is 15 feet, and these generally afford plenty of water. The capacity of some of them has been increased by blasting a few feet in ledge. On account of the increasing summer population of the island surface wells are no longer safe. Wherever practicable their use should be discontinued and deep wells or the public supply be substituted.

Drilling on the island is comparatively easy, and a number of deep wells have been sunk. Their depth ranges from 45 to more than 200 feet. The best wells on the island are the two drilled for the Peaks Island Water and Light Company, which are 202 feet deep. These wells are connected by a natural fissure below the surface and together will yield 85 gallons a minute with the pumps running twenty-four hours a day.

On Peaks Island there is one flowing well, belonging to Mr. C. W. T. Goding, of the Casco Bay Steamship Company. The mouth is only a few feet above tide. This is an 8-inch well, 135 feet deep. By pumping, it yields 52 gallons of water a minute. No failures are known on the island, but two or more wells obtain only 2 or 3 gallons a minute each. A few people have used springs, but these are now abandoned. Two analyses of deep-well waters on this island are given in the table (Nos. 35 and 36).

Great Diamond Island, Portland.—The surface of Great Diamond Island is mostly bowlder clay, with slaty ledge outcropping in a few places. The west side of the island is low; the east side is high and rocky. The rock is similar to that on Peaks Island, but is more slate than schist. Many wells here, even including two of those belonging to the water company, are only open wells a few feet in depth, some of them blasted 2 or 3 feet into the ledge. Two wells drilled on the western shore for the Diamond Island Association were successful; they yield 12 and 15 gallons a minute and now supply about 60 buildings, mostly cottages. The water is found at a depth of about 100 feet in gneiss. Analysis No. 31 gives the composition of water in one of these wells, and No. 32 is a field assay from the other.

At Fort McKinley, on the north end of Great Diamond Island, seven wells have been drilled at various times for the United States Government. They range from 95 to 302 feet in depth, and water is found at depths of 80 to 100 feet. Two or more of them were abandoned because of insufficient supplies, but the rest yield a maximum amount of 4 to 40 gallons a minute. The detailed description of these wells may be of benefit in future deep drilling on neighboring islands.

Well No. 1, 97½ feet deep, overflowed the surface before pumping. The test showed 25 gallons a minute. Well No. 2, 95 feet deep, situated 150 feet east of No. 1, taps the same vein, and before pumping the water overflowed the surface. In the test it showed 30 gallons a minute by pumping, and when pumped with No. 1 it will supply 48 gallons a minute. Well No. 3, situated 150 feet south of No. 1, is 265 feet deep. The test showed 15 gallons a minute. Well No. 4, situated 300 feet northwest of No. 1, is 302 feet deep and supplied 14 gallons a minute in the test. In wells Nos. 3 and 4 the water stands at 15 to 20 feet below the surface. The pumps are down 125 feet and 150 feet, respectively. In these wells 15 to 18 feet of drift was penetrated on top of the rock; the remainder is schist, much of which contains pyrites. The total capacity of all four wells during the wet season of 1902 and 1903 was 84 gallons a minute. The total capacity during the dry season of 1904 and 1905 was 30 gallons a minute. In dry seasons wells Nos. 1 and 2 can be exhausted.

Little Diamond Island, Portland.—Little Diamond Island is situated just south of Great Diamond and is connected with it at low tide by a sand bar. So far as the structure of the rocks is concerned, it is but a continuation of Great Diamond Island. On Little Diamond one well has been drilled to a depth of 170 feet and obtains 4 gallons a minute from 160 feet below the surface. Most of the wells on this island are dug wells less than 20 feet in depth. These are perfectly safe if situated on the uphill side of all houses. At the east end of Little Diamond Island is a light-house at which the Government has a well 171 feet deep. The water in this well is salty and contains total solids amounting to 460 parts per million, the chlorine being 397 parts, carbonates 80 parts, and sulphates also high. The unusual composition is due probably to a considerable admixture of sea water.

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House Island, Portland.—House Island consists of solid rock round the sides, but there is some drift on top. On this island a single well was sunk to a depth of 170 feet. It is reported to supply 15 gallons a minute.

Cushing Island, Portland.—Cushing Island is the most southerly of the group of islands in Portland Harbor, and is about a mile in length. The cover, of till, is 1 to 5 feet or more in thickness, and the underlying rock is schistose gneiss of varying degrees of hardness. This island is a better collector of water than some of the others, because it has a few depressions in the surface and less bare rock. The principal system of joint cracks here strikes N. 40° to 50° W. and hades N. 25° from the vertical, the joints being from 3 to 10 feet apart. A second system strikes N. 80° W. to N. 70° E. and hades N. 10°. The third system, probably sheet joints, strikes north and south and dips toward the west at 20° to 30° from the horizontal. Along the shore a great many irregular joints can be seen.

On this island there are several private wells which strike water at depths of 80 to 275 feet, and the United States Government has drilled four or more wells at Fort Levett. There are a few dug wells on the island, but most of the residents use water from a drilled well belonging to Mr. Cushing.

The most extensive drilling on the island was for Fort Levett. Here several wells have been sunk and abandoned. Official records have been kept of only the three most recent ones. Well No. 1 struck rock at 18 feet and was cased to 28 feet. Its total depth is 277.2 feet. A forty-eight hour test on January 4, 1906, showed 30 gallons of water a minute. The rock resembles hard mica schist or quartzite. The pump barrel is down 150 feet. When pumped the water falls below this level. Well No. 2, drilled in 1906, is 326 feet deep. It penetrates 11 feet of soil and clay and is cased to a depth of 74 feet. The water level before pumping stands within 20 feet of the surface, but while pumped it stands 300 feet lower. On the test this well supplied 10 gallons of water a minute, but this was not considered enough, and a new well was drilled. Such a well should not be abandoned, as 10 gallons a minute is a good yield in Maine. Well No. 3 struck rock at 15 feet and is cased to 27 feet. The water stands 20 feet below the surface. On January 3, 1907, it was 176 feet deep, but no report has been obtained since it was completed.

Long Island, Portland.—The rock on Long Island is mostly schist, which splits easily along the bedding planes, standing nearly vertical The island contains a great many cottages, but no public supply is used. The only wells are of the old-fashioned open type.

Cow Island, Portland.—A flowing well is reported to have been drilled at Fort Lyon, on Cow Island, in 1906. The natural flow was 6 gallons a minute, and the capacity by pumping is reported to be 40 gallons a minute.

Gorham.—A number of drilled wells have been sunk in the town of Gorham, and so far as known they have been successful, as regards both quality and quantity of water. The deepest well is that of Mr. J. H. Rines, in the eastern corner of the town. This well was drilled all the way in solid rock. The drilled wells are about a dozen in number, and range in depth from 40 to 307 feet, generally supplying enough water for domestic purposes from a formation which is mostly slate. In the eastern part of the town the dug wells average 15 feet in depth and contain, as a rule, 5 or 6 feet of water in the dry spell, though some of them dry up. One dug well is more than 60 feet deep, in till, and for fifty years has never been known to be dry. The analysis of water from a 66-foot rock well is given in the table (No. 30).

Westbrook.—The formation at Westbrook is for the most part slate, but the northern part of the town is underlain by granite. The bed rock is only a few feet below the surface. In that section the wells are open wells, only 10 to 20 feet in depth. Many wells go dry during the summer, but those blasted a few feet in ledge give plenty of water.

In the vicinity of Saccarappa there are two flowing wells, one owned by Mr. Rufus Jordan, the other by the Haskell Silk Company. These wells are both 216 feet in depth and obtain their flows near the bottom of the well. The surface rock is slate, but one or both wells are reported to enter granite. It is possible that the flow may be caused by the penetration of water downward from the hills along the contact between the granite and the slate, but this conclusion has not been definitely proved. The composition of the water in the flowing wells is given in the table (Nos. 51 and 53).

Chebeague Island, Cumberland.—Chebeague Island is the largest of the islands in Casco Bay, being more than 3 miles in length. Like other islands of the bay, it consists mostly of schist, but the surface of the interior is made up in part of sand. It is easy to get water from shallow wells, and for that reason only one drilled well has been sunk on the island. The depths of the dug wells are only 6 to 20 feet. The water is mostly safe for drinking. The abundance of water on this island is due to the thickness of the drift covering and to a swampy depression which lies on the high land of the interior. The only drilled well is owned by Mr. E. A. Ballard. This well was drilled to a depth of 52 feet and obtained plenty of water. Later it was sunk to 80 feet, and still later to 301 feet. The latter extension was unsuccessful, not increasing the supply. The water is good and clear, and the supply has increased in volume through natural causes since the well was drilled. The amount is small, but is sufficient for domestic purposes at the cottage.

Little Chebeague Island, Cumberland.—Little Chebeague Island bears the same relation to Chebeague Island that Little Diamond Island bears to Great Diamond. Little Chebeague is connected with the main island at low water by a sand bar. All over the island the drift is thick, 40 feet or more of it being exposed in a nearly vertical cliff on the north side. On top of this bluff, not many feet from the edge, a well was drilled to a depth of 197 feet. Rock was struck at about 100 feet. The water is good and was at first plentiful, but the supply has diminished until now there is not enough to supply one family. Another well should be drilled to the east of this, and it is believed that there is an even chance of obtaining a better well. On this island a dozen or more cottages use open wells.

Windham.—The town of Windham is rather hilly, and the rock consists mostly of slate and schist. The wells are nearly all open wells, 10 to 40 feet in depth, but at South Windham two drilled wells have been sunk. One of these was a failure owing to improper casing; the other well supplies plenty of water for three or four families. Most of the people in the village use Sebago Lake water, as the Portland aqueduct runs near the village. A few springs emerging from gravel have been used in the vicinity, and the mills obtain water from this source. There is plenty of water in the gravel, and its quality seems to be very good. Some of the dug wells run dry during the summer.

Scarboro.—The greater part of the town of Scarboro consists of broad sand and clay plains rising from sea level to 100 feet or more above tide. On these plains the water level is only a few feet below the surface and excellent soft water can generally be obtained by driven wells, at a cost of only $12 to $15. The size of pipe commonly used is 1¼ inches.

In this town drilled wells are generally unnecessary, but on the hills and in some localities where the rock approaches the surface it is necessary to drill. On the road running from West Scarboro to Portland several wells have been drilled, which range in depth from 50 to 200 feet. They generally yield plenty of water for a house and farm. One of them, on the H. J. Libbey estate, gave 3½ gallons a minute for three and one-half hours in the test. In this part of town there are a number of dug wells 15 to 20 feet in depth. The formation on the hills and underneath the drift is slate.

In West Scarboro the deep wells are good, but most of them are less than 50 feet in depth. A number of springs in the vicinity are used to supply houses in the village. Some wells are bored in clay, and a few of these have been unsuccessful. Most wells here, however, supply enough water for a family from a depth of 30 to 35 feet. The best water is obtained by penetrating the clay.

At Pine Point Beach the wells are only 10 to 15 feet deep, driven in sand. On Blue Point Hill the wells are all dug, and some of them fail in summer. On Prouts Neck the formation is all rock. Conditions there have not been investigated, but it is probable that water can be obtained by deep drilling.

Cape Elizabeth.—The coast of Cape Elizabeth is very high and rocky and is greatly appreciated as a summer resort. The few wells that have been drilled along the coast range in depth from 60 to 120 feet, supplying summer cottages. The Shore Acres Land Company, however, has a well 151½ feet deep, which supplies a number of houses with good water. Away from the coast the wells are mostly shallow and are driven or dug in sand and gravel. In quality the rock water is generally good. An analysis of water from a 115-foot well at Cape Cottage reports 140 parts per million of total solids. The calcium here is 43 parts per million, which is high for southwestern Maine.

South Portland.—The coast of South Portland is mostly bold and rocky, like that of Cape Elizabeth. The surface varies from rocky hills to plains of clay overlain by sand. Nearly the whole town uses Portland water, and there is little demand felt for drilled wells. Several shallow wells on the clay plain penetrate the underlying gravel and obtain water of good quality. No drilled wells are reported. An interesting set of borings made for Vaughans Bridge is described under Portland (p. 107).

Falmouth.—The surface of Falmouth is made up of clay and sand plains rising to an altitude of 100 feet, broken by low hills of schist and granite. Throughout the town the wells are shallow and the conditions are variable. Part of the town is now using Sebago Lake water. In the southern part a number of drilled wells have been sunk, some of them more than 100 feet, and the chances for water have been found to be fairly good.

At Falmouth Foreside the Underwood Mineral Spring is situated.

Clapboard Island, Falmouth.—On Clapboard Island a single well has been drilled by Mr. S. F. Houston. It reached a depth of 210 feet. No information regarding this well has been received.

Standish.—In the town of Standish much drilling has been done, 18 wells having been put down by a single driller. The wells range in depth from 40 to 90 feet. The drilled wells are mostly open wells which have been deepened because of previous insufficient supply. The volume of water is still small, but is sufficient for all farm purposes, in some wells amounting to 10 gallons a minute. Some of these wells can not be pumped dry, but most of them are exhausted in a short time.

The well of Mr. Frank H. Rand was originally a 30-foot open well, blasted 22 feet in ledge. There was little water, and the owner drilled to a depth of 60 feet, striking a pocket of water, which soon gave out. The well was afterwards deepened to 79 feet and obtained 10 gallons a minute. Most of the wells have been drilled in rock, but several near the village of Sebago Lake penetrate nearly 40 feet of sand. As a rule the water comes from crevices in a schistose rock. One shallow drilled well in Standish contained so much iron that it was not used. The only evidence of the composition of water in this town is derived from a field assay (No. 50).

Bridgton.—The town of Bridgton is believed to be entirely underlain by granite. In the village and town much drilling has been done at various times, 14 wells having been sunk by one driller. The depths range from 40 to 290 feet. So far as known, the wells of moderate depth have been successful, and a 200-foot well seems also to have been satisfactory. A well 290 feet in depth, however, was drilled for the Bridgton Aqueduct Company and yielded very little water. This is one of many examples showing the uselessness of sinking wells below 200 feet or so in granite. At North Bridgton and elsewhere wells are dug and seem to be mostly satisfactory. Several field assays (Nos. 3, 4, 6, and 7) of water from Bridgton wells have been made, but only one complete analysis (No. 5).

Harrison.—Several wells have been drilled at various times in the town of Harrison, one of them, high on a hill, being 90 feet deep and successful. Other wells—as several at Bolsters Mills—were only about 40 feet deep and obtained water, but were abandoned in favor of a spring supply which is now used by that village. On the hills many people use excellent springs which issue from bowlder clay and are pumped by windmills to houses higher up.

Otisfield.—Several drilled wells have been sunk in Otisfield, and the conditions seem to be favorable for obtaining underground-water supplies, but no data are at hand.

Brunswick.—Brunswick is an example of a city with a good water supply, taken from driven wells on the flood plain of Androscoggin River, as explained under the heading "Public supplies." Formerly the river water was used and typhoid fever was epidemic; later the water was purchased from Bath. So far as safety is concerned private wells are now unnecessary. In case individuals or companies desire to sink wells, they will probably succeed in getting sufficient water, either from shallow wells sunk through the surface sands and clays into underlying gravel or by drilling into rock. The former source is recommended for manufacturing establishments in situations where the surface deposits are of sufficient thickness.

Harpswell.—This part of the Maine coast is so uniformly rocky, and it is so difficult to get water from dug wells, that many people at their summer cottages have resorted to the ancient custom of using cisterns and rain water. Few people in Harpswell use drilled wells.

At the extreme end of Mere Point is one well 67 feet deep, in schist, which furnishes enough water for all the families—a dozen or more—having cottages on the end of the point. An analysis of the water from this well is given in the table (No. 33).

Freeport.—The public supply of Freeport village comes from Frost Gulley Brook. In the town a number of wells have been drilled to depths varying from 100 to 200 feet. They could not be pumped dry during a twenty-four-hour test and were used for some time, but were abandoned when the public supply was instituted. The well water is obtained in gneiss. Several wells at South Freeport, about 100 feet deep, obtain enough water for domestic uses from granite. Casco Castle at South Freeport obtains its supply from a spring situated 2 miles south of the hotel. Otherwise South Freeport uses shallow wells.

Other towns.—In the towns of Baldwin, Sebago, Naples, and New Gloucester some drilled wells have been sunk, but they are rare and scattered. In Casco, Raymond, Pownal, Gray, and North Yarmouth no drilling is known to have been done, and only open wells, with perhaps a few driven wells, are used.

SPRINGS.

General statement.—In Cumberland County springs are abundant. The topography is varied, the covering of drift is in many places thick, and springs seep out along the bowlder-clay hillsides. In the country districts water is pumped from some of these springs by windmills or hydraulic rams to houses on the hills above. Where springs are not situated within limits of pollution from neighboring houses the water is generally of good quality. One small village—Bolsters Mills—uses springs for a public supply. In many parts of the region covered by clay and sand plains it is common to find springs emerging from sand overlying clay. Some of these springs contain surprisingly small amounts of mineral matter and many are entirely free from organic matter.

The commercial mineral springs in Cumberland County which report sales are as follows:

Paradise Spring, Brunswick.
Pownal Spring, New Gloucester.
Raymond Spring, North Raymond.
Underwood Spring, Falmouth Foreside.

Paradise Spring.—Paradise Spring is situated in the eastern part of the town of Brunswick and is owned by D. D. Gilman & Bro., of Brunswick. It is renowned as having been a favorite resort of Nathaniel Hawthorne. The spring lies at the foot of a steep sand bluff, rising above the flood plain of Androscoggin River, not far from the waterworks of the Brunswick and Topsham water district. It is supposed that the spring water percolates out of the sand above its contact with the clay, as seen in a number of roadside springs in the vicinity. The water is colorless, odorless, and tasteless. It has a temperature of 43° in winter and 45° in summer, and the stream coming out of the small pipe in the bank is reported by the owners to supply about 8 gallons a minute. This yield is said never to vary. The surroundings are wooded, and there are no buildings in the vicinity, so the spring is perfectly free from danger of pollution. The chemical composition is reported in analyses 217 and 218, recomputed from those reported in a circular issued by the owners. The total solids are only 18 parts per million.

Formerly Paradise Spring water was sold in Brunswick, but since the new city water system was installed there has been no demand for mineral water and the owners have gone out of the business. The price at which it was marketed was 75 cents a 5-gallon carboy. There is no spring house or other improvement at the spring.

Pownal Spring.—The so-called Pownal Spring is situated at New Gloucester, on rather high land, and there is believed to be no chance for pollution. The water is reported to flow from solid rock. Some years ago the Pownal Spring Hotel Company was incorporated and the water was analyzed with a view to establishing a hotel near the spring. The analysis, as recomputed from that reported in the company's circular, is given in the table (No. 221). The total solids amount to only 20 parts per million. The owners claim valuable medicinal properties for the water.

Raymond Spring.—Raymond Spring, situated at North Raymond, about one-eighth mile northwest of North Raymond post-office, was for twenty years prior to 1905 known as Wilson Spring. It is reported to issue from a fissure in granite about 100 feet below the summit of a hill. Formerly there was a hotel here, but some years ago it was burned. The flow is large and is said to diminish only slightly in dry seasons. The water is clear and sparkling, odorless, and tasteless. As there are no houses near by, it seems to be perfectly safe. It is used for drinking and medicinal purposes and is shipped and sold at 30 cents a gallon. The owners claim medicinal properties for it. An analysis of the water reported in a statement issued by the owners, recomputed into ions and parts per million, is given in the table (No. 222).

Underwood Mineral Spring.—Underwood Spring is situated at Falmouth Foreside, a few feet above sea level and only a short distance from the shore in a gully, the sides of which consist of clay. It is owned by the Underwood Mineral Spring Company, of Portland. The water is believed to issue from sand directly on top of the clay. The spring is bricked up, and the upper of its two openings is covered by a large glass pyramid. The water is colorless, odorless, and tasteless. The flow is reported by the owners to be 140 gallons a minute, and the measured temperature is 46°. A large hotel is situated on the sand plain above the spring, several hundred yards distant from it. The locality is used as a resort, and the water is bottled and shipped for medicinal and table use. A 5-gallon carboy delivered on the train or in Portland sells for 75 cents. "Soft" drinks are also made. The bottling house is situated on the shore of the bay and the water flows directly from the spring to this place. The mineral analysis of the water, recalculated from the analysis of the water reported by the owners, is given in the table (No. 219).

Summit Spring.—Summit Spring is situated on very high land in the northern part of the town of Harrison. It is the site of a hotel, and formerly was extensively used. The yield is reported to be 38 gallons a minute and the temperature 46°. The analysis shows the total solids to amount to 68.9 parts per million.

PUBLIC SUPPLIES.

General statement.—The largest water supply in Cumberland County comes from Sebago Lake, whence it is carried by an aqueduct to the city of Portland. The surrounding towns also use this water where the Portland aqueduct lines are conveniently situated. Of the 15 communities in Cumberland County which have public water supplies 7 are supplied from surface sources, 4 from wells, and 4 from springs. Six of the communities having surface supplies use Sebago Lake water. These are Portland, South Portland, Cape Elizabeth, Westbrook, Gorham, and Falmouth Foreside. Freeport obtains its water from a brook.

The most important underground-water supply in the county is that of Brunswick, which has combined with Topsham, in Sagadahoc County, to install a supply obtained from driven wells on the flood plain of Androscoggin River. Peaks Island, Great Diamond Island, and Cushing Island, in Portland Harbor, have public supplies from drilled wells. The communities using spring supplies are Yarmouth, Yarmouthville, Bolsters Mills, and Casco. All these supplies are described in detail below.

Brunswick and Topsham.—Formerly the public supply of Brunswick was taken from Androscoggin River, and typhoid fever was prevalent in the village. That system was abandoned, and until recently water was purchased from the Woolwich Water Company, which supplies Woolwich and Bath from Lake Nequasset, in Woolwich. This supply was regarded as unsatisfactory; consequently, in 1904 a water district was established, embracing the towns of Brunswick and Topsham, with a population of about 7,300 persons to be served, and a new source of supply was sought in driven wells.

A test well, driven to hardpan on the flood plain of Androscoggin River 1⅓ miles east of the Brunswick post-office, yielded an abundance of good water. Thereupon a number of other wells were driven in the same vicinity, 50 of which constitute the source from which the supply is taken. These wells are situated along a straight line extending a distance of about half a mile on the flood plain, not more than 10 feet above the river. Back of them rise several terraces, the highest of which is about 60 feet above the surface on which the wells are situated. At the base and along the sides of these terraces are many springs, the best known being the Paradise Spring, described on pages 119–120. The flood plain is composed of recent river deposits and is in places marshy. The upper terraces are composed of marine clays overlain by sand. The water seems to follow the upper surface of the clay beneath the sands and gravels, seeping out wherever the covering is thin or broken and saturating the sands and gravels to such an extent that they form practically an exhaustless reservoir. The facts that the water surface in the wells is considerably higher than the surface of the river and that its analysis is different from that of the river water show that the latter is not its source.

The wells are all of about the same character. They are 2½ inches in diameter, with a depth of 25 to 35 feet, depending on the height of the surface above the river. The principal water bed is very coarse sand from 5 to 10 feet thick, overlain by 15 to 20 feet of finer sand and 3 to 6 feet of sand and clay. Underlying the water bed is a considerable depth of "hardpan," consisting of clay and sand. A test well was driven 155 feet, when bed rock was apparently encountered, as it was impossible to drive farther. Under normal conditions the water in the wells rises within a foot of the surface, but in the spring and after heavy rains some of the wells flow, yielding about 5 gallons a minute. In order to estimate the capacity of the wells a test was undertaken, beginning September 21, 1904, and continuing night and day for thirty days. Nine wells were connected with a fire pump having a 10-inch cylinder and a 12-inch stroke. The result of the tests showed an average yield of 1,003,732 gallons daily. The total yield from the entire series of wells is estimated at about 5,000,000 gallons daily.

The water supplied by the wells is as soft and excellent in quality as any other public supply in Maine. Analyses, recomputed into ions and parts per million from those reported by the company, are given in the table (Nos. 177–179).

From the wells the water is pumped to a standpipe, 145 feet above the town, having a capacity of 650,000 gallons. The mains are 13¾ miles in length. There are 80 fire hydrants in Brunswick. The average pressure is 60 pounds. About 5,000 people are supplied with water.

Peaks Island, Portland.—A large part of Peaks Island is supplied by a water system owned by the Peaks Island Water and Light Company. The water is obtained from two drilled wells situated close together near the south end of the island, not far from the village. The wells are sunk in solid rock and are unusually satisfactory for drilled wells, as explained under the description of wells on Peaks Island (p. 112). They are pumped by two steam pumps. The test showed that 50 gallons a minute could be obtained from the older of the two wells, this being the full capacity of the pump. During the test the water surface was lowered 35 feet. The test of the newer well showed 110 gallons a minute for seven hours, when the water gave out. There is, however, a plentiful supply of water in the two wells, and they can be pumped together at the rate of 75 gallons a minute day and night. The water mains belonging to this company are about 7 miles in length. Two miles of these are "under frost," or buried deep enough so that they can be used during the winter. The other 5 miles are "above frost" and for the most part on the surface. The pipes used are 8, 6, and 4 inches in diameter. The owner, Mr. E. E. Rounds, reports that 255 takers are on his books. Most of these people are cottage holders, and they have unlimited use of the water at $10 a year. Seven hotels are on the system, and some of these pay as much as $100 a year. The water of the company has been analyzed, but the analysis has not been received by the Survey. From a sanitary standpoint the water is believed to be as pure as could be desired. The pressure on the main street is 60 pounds.

At the north end of Peaks Island there is a smaller system of waterworks, owned by the Beacon Hill Water Company, which has a drilled well 70 feet in depth pumped by a hot-air pump. More than 30 buildings are reported to be supplied by this system.

Great Diamond Island, Portland.—Great Diamond Island is largely supplied by a water system owned by the Diamond Island Association. The water is obtained from wells, 2 of them being ordinary dug wells and 3 others being drilled to a considerable depth in solid rock. The dug wells are little used, as the water has been found not very good. The drilled wells are pumped by hot-air engines and windmills. The supply is adequate for the island except sometimes in the summer season, when it is necessary to resort to private wells or to the surface wells owned by the company. It is supposed that about 60 cottages are supplied with water from these sources. The supply is satisfactory except that in summer the water becomes so warm, owing to the pipes being laid on the surface of the ground, that it is not used for drinking. In consequence of the position of the pipes the supply has to be discontinued during the winter. An analysis of water from one of the drilled wells is given in the table

(No. 31). Other data relative to the wells will be found on pages 112–113. From the wells the water is pumped to a tank situated on the hill in the center of the island, the capacity of the tank being 60,000 gallons and the pressure 30 pounds. A smaller tank is situated near by. There is no fire service. About 10,000 gallons a day are used.

Cushing Island, Portland.—A hotel, stable, and about a dozen cottages on Cushing Island are supplied by a 275-foot well owned by Mr. Francis Cushing. The water is pumped by a deep-well steam pump through $2\frac{1}{2}$-inch pipe to three tanks on top of the hill. The well and pump are inclosed in a pump house, and the pump is operated eight to nine hours a day. At one time it was tested five days continuously without failure, and the yield was variously reported at 40 to 70 gallons a minute. The water is fine and clear and has a measured temperature of 52°.

Yarmouth and Yarmouthville.—These villages have a public water supply from springs belonging to the Forest Paper Company, but the system is owned by the town. The springs are reported to issue from sand at the base of a rocky hill at a rate of 100 gallons a minute. The water is distributed from a standpipe 100 feet in height and 50 feet in diameter, its capacity being 265,000 gallons. The pressure is 60 pounds. The water is good, and 130,000 gallons a day are used for farm and domestic purposes. There are 8 miles of mains, 800 taps, and 57 fire hydrants, and the system supplies 2,000 people. So far as known the supply is satisfactory. Royal River furnishes an emergency supply.

Bolsters Mills.—More than 20 families and the stores at Bolsters Mills are supplied by two springs situated just east of the village. The springs issue from bowlder clay a few rods distant from the base of a high gravel moraine. The springs proper are dug holes, 3 by 3 feet in size and 2 feet deep, with an outlet pipe and strainer in the bottom. They are owned by Mr. Alfred R. Clark. The water is reported to be of very good quality; and as there are no buildings above, there is no chance of pollution. The springs are covered with protecting sheds.

There is plenty of water here for all purposes, but some care is necessary not to waste it in dry seasons. Water rates are $6 a year for either one or two faucets. About two-thirds of the houses in the village use the public supply.

PREDICTIONS AND RECOMMENDATIONS.

In an investigation like that of the underground waters of Maine it is gratifying to see that in some districts the value of drilled wells is appreciated. In the vicinity of Portland a number of manufacturing establishments and tenement owners are using drilled wells and thereby saving water bills. On the neighboring coasts and islands of the harbor there is a large summer population, and these people are using a great many drilled wells. Such is also the case in a few summer-resort districts away from the coast. In general excellent supplies of pure water are obtained, and very few failures have been encountered. The proportion of successful wells shows that there is plenty of water for domestic use in the rocks, although the supply is not always sufficient for hotels. As might be expected, there have been a number of failures, but the chance of success in any locality is far greater than the chance of failure. Drilled wells are so much safer and so much more satisfactory when an adequate supply is found that it would seem desirable to search for water in this way much more extensively than has been done.

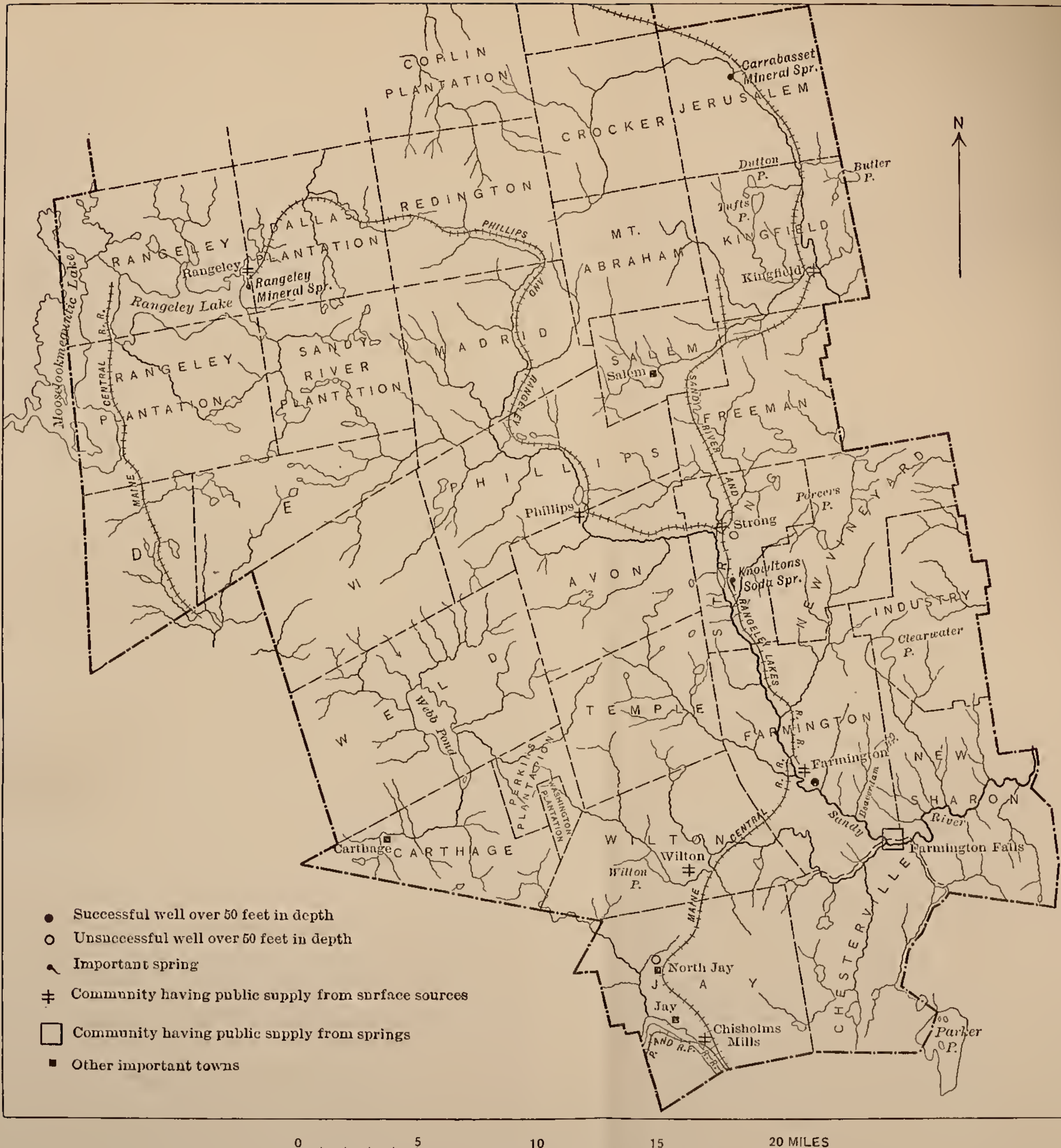
The success of well drilling in the vicinity of Portland has been so marked that it seems safe to recommend sinking wells on islands of the harbor where as yet they have not been drilled. For example, on Long Island the residents are using the common open wells, as of old. A number of people on Peaks Island and some of the other islands use wells of the same type. These may be safe in the country, but are hardly safe in a summer-resort island having a large population. A public water system could be installed on other islands at a comparatively small cost, as has been done on Peaks Island and Great Diamond Island. The water obtained by deep wells will be safe for drinking, and three or four wells will probably give a sufficient supply for any of the largest islands.

It may not be amiss to emphasize in this connection a precaution regarding Sebago Lake water, to which reference was made on pages 109–110. This lake has for years been supplying the city of Portland and several adjacent towns, and the water has been found to be one of the best surface supplies in the State. There is more water than can ever be utilized, and the lake is so large that contaminated water now entering any particular part of it would be so diluted as to cause little danger to the inhabitants of the city. It must be remembered, however, that there are already a number of cottages and hotels along the shores of Sebago Lake and its tributaries, and that these are springing up more thickly every year. At least two steamboat lines run on the lake regularly, and it is used for fishing and bathing. Every precaution should therefore be taken to keep the lake in a sanitary condition and to prevent the increase of cottages and hotels along the shores. The best plan would be for the city or the State to acquire and hold the lake as a public reservation in care of a park commission, as has been done with several large reservoirs in Massachusetts and other States.

SOUTHERN FRANKLIN COUNTY.

GENERAL DESCRIPTION.

Franklin County is situated in western Maine, its north end bordering on the Canadian line and its west end separated from New Hampshire by a distance of about 12 miles. The county has a length from north to south of about 85 miles and an extreme width of 30 miles. Its total area is 1,764 square miles, and its population, according to the census of 1900, was 18,444, the least next to Piscataquis County. This county contains no cities or large towns; Farmington, the county seat, has a population of 1,251. Less than two-thirds of the county is situated in the territory covered by this report, but the region farther north contains few features of importance to a report of this nature. The county is one of the hilliest in Maine, and contains numerous lakes and ponds, of which the largest situated entirely within the borders of the county is Rangeley or Oquossoc Lake. A large lake, Mooselookmeguntic, lies on the boundary between Franklin and Oxford counties. A stretch of Androscoggin River, less than 5 miles in length, cuts across the southern corner of the county, and Rangeley and Mooselookmeguntic lakes lie near the headwaters of the same river, but with these exceptions there is no large stream within the borders of the county. Sandy River, a tributary to the Kennebec, flows through the south-central part of the county, and Dead River, with its numerous lakes and small tributaries, is a conspicuous feature of the north end of the county, which is far famed for its fishing grounds. In altitude Franklin County ranges from 355 feet on Androscoggin River near Chisholms Mills to 3,388 feet at the summit of Mount Abraham. The central part of the county is very mountainous, and contains few villages and few lines of transportation. The Maine Central Railroad extends as far as Farmington, through a fairly settled district, but the region north of Farmington is reached only by the Sandy River, Phillips and Rangeley, and Franklin and Megantic railroads, narrow-gage lines, which extend north as far as Carrabasset and northwest as far as Rangeley and several summer camps, the latter of which are reached by unimportant branches. Rangeley and Mooselookmeguntic lakes are also reached by the Portland and Rumford Falls Railway, which runs northward from Rumford Falls, in Oxford County, as far as Oquossoc, on the western edge of Franklin County. A map of this county showing the distribution of deep wells, important springs, and communities having public supplies forms Pl. XIII. This report considers only the region south of the forty-fifth parallel.



0 5 10 15 20 MILES

MAP OF SOUTHERN FRANKLIN COUNTY.

Showing distribution of deep wells, important springs, and communities having public supplies.

UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Distribution of rock types.—The rock formations of Franklin County are not well known, but are supposed to consist almost entirely of granite and slate, with slate predominating. An area of granite enters the southwest corner and crosses the county in a northeast direction, the band having a width averaging less than 10 miles. This granite is quarried at Jay, on the Maine Central Railroad. It does not extend north of Dryden. A small granite area enters New Sharon from the east and heads for the area in which Jay is situated, indicating that these two areas may be connected at no great depth below the surface.

The known distribution of the rocks in this county can probably be best described by stating the areas in which they cross the several lines of transportation. North of the most northern outcrop at Dryden, on the Maine Central Railroad, the formation is entirely slate as far as Strong, on the Phillips and Rangeley Railroad. In the vicinity of Phillips, however, there is a patch of granite several miles across. Beyond Phillips no more granite is encountered until the railroad turns west, just north of East Madrid, in the mountain region. An area of granite is crossed here for about 10 miles, beyond which the rocks are slaty as far as Rangeley. Rangeley Lake is situated entirely within the slate area, but from this lake southward, along the Portland and Rumford Falls Railway, the formation is granite as far as Houghton, just beyond the borders of this county. On the Franklin and Megantic Railway the formation is supposed to be entirely slate from Strong—the junction of the Phillips and Rangeley and Sandy River railroads—northward as far as Carrabasset. Here, however, an area of granite is entered and continues to the end of the railroad at Bigelow. The village of Stratton, 7 miles northwest of Bigelow, is situated in the granite area. West of Stratton, however, the rocks are believed to be slaty in nature. In the extreme northern part of Franklin County, extending from a point near Beaverpond as far as the Canadian border and westward to the Oxford County line, is another area of granite. As a great part of Franklin County consists of wilderness, the detailed geology of this county is unknown.

Surface deposits.—In Franklin County the drift deposits are generally thick in the valleys and very thin in the hills. On Sandy River and some of the smaller streams there are extensive sand plains of unknown depth. In the vicinity of Farmington these are underlain at a few feet by clay, probably an extension of the same clay deposit which follows Kennebec River for so many miles. Irregular sand and gravel deposits are widespread over the county and are generally underlain by bowlder clay, which also forms the surface over much of the uplands.

WELLS.

GENERAL DESCRIPTION.

Franklin County is so well provided with springs that wells are less numerous than in other parts of Maine. Dug wells are, however, common in the valleys, especially in the southeastern part of the county. The general depth of the dug wells is from 10 to 30 feet, though a few are more than 40 feet in depth. They are mostly sunk in drift, but a few wells have been blasted in rock. Most of the wells in this county give plentiful supplies of water, and, as the population is not large, few wells are contaminated. No drilled wells are known to have been sunk in the county.

DETAILED DESCRIPTION.

Farmington.—The town of Farmington, the county seat of Franklin County, is situated on a sand plain bordering Sandy River and high above it. It formerly had a public supply from an infiltration well situated 30 feet from the river. As this did not furnish sufficient water for the village, a portion of the supply was drawn from the river. Most of the inhabitants used this water until recently, and few people in the village have wells. The supply is now derived from Varnum Pond. On the outskirts of the village are situated many dug wells, one of which reaches a depth of 58 feet. This well is reported to pass through 10 or 15 feet of sand, underlain by clay, which extends to the bottom of the well. It contains about 50 feet of water the year round. That the clay underlying the sand is very irregular in elevation is shown by a road section southeast of town in which the clay rises sharply through a height of 15 feet or so and reaches the general level of the plain. Between Farmington and Farmington Falls attempts have been made to drive wells in the clay, but all trials have failed, owing to clogging of the screens by fine clay particles.

With the foregoing exception the wells at Farmington are mostly less than 25 feet in depth and few exceed 35 feet. They are dug in sand and gravel and generally rest on clay. The rock in the vicinity is a dense slate, striking northeast and southwest and having a vertical dip. Between Farmington and Strong the supplies are derived mostly from springs, as the hillsides are steep and spring water is generally easily obtainable.

SPRINGS.

General statement.—As Franklin County is very hilly, it has numerous springs, and it is not likely that there will ever be any serious lack of water except locally. Springs are used by many families in the country districts for domestic supply, and at least two villages use them for public supplies. Within the county are at least three so-called mineral springs, one of which ships water regularly by railroad, and a second has done so in the past. These springs are as follows:

Carrabasset Mineral Spring, Carrabasset.
Knowlton Soda Spring, Strong.
Rangeley Mineral Spring, Rangeley.

Carrabasset Mineral Spring.—Carrabasset Spring, belonging to the Carrabasset Mineral Spring Water Company, of Boston, is situated on the bank of a small stream 10 feet above water level, on the Franklin and Megantic Railway, a short distance south of Carrabasset station. It issues near the base of a sand plain which rises only 10 feet higher at its central point, about 250 feet away. The spring was formed by digging a well 15 feet deep to a soft, shalelike rock. The water is reported to come from the rock. It is colorless, odorless, and tasteless, and has a temperature reported to be 46° in summer and 42° in winter. The flow is 5 gallons a minute after a storm and 2½ gallons a minute during a dry spell. It is said that after a heavy rain an hour or so elapses before the spring is affected. The water is used for drinking at a farm and two cottages situated near by and is bottled and shipped to Boston as a table and medicinal water. The price is 25 cents a gallon, or $1 for a 5-gallon bottle. A part of the water is carbonated. The company runs a bottling establishment on the spot, and the spring is well protected by curbing on all sides. An analysis of the water, recalculated from that published in the company's circular, is reported in the table (No. 230).

Carrabasset Spring No. 2.—Not far from the Carrabasset Mineral Spring, on the opposite side of the river, is a spring, owned by the same company, which issues from the side of a high eskerlike ridge. The analysis of this water is given in the table (No. 231). No water is yet shipped.

Knowlton Soda Spring.—The mineral spring belonging to Mr. R. W. Knowlton is situated in South Strong, 7 miles north of Farmington. According to the owner, the spring emerges from a rocky hillside at the rate of 8 gallons a minute. It is reported by the owner to have valuable curative properties. The spring is covered by a three-story building, where the water is bottled. An analysis, recalculated from an analysis furnished by the owner, is given as No. 235 in the table.

Rangeley Mineral Spring.—The Rangeley Mineral Spring is owned by the Rangeley Lake Hotel Company, and is situated a short distance from the Rangeley Lake House, on a gentle bowlder-clay slope at least 50 feet above the highest part of the town of Rangeley and 60 feet or more below the crest of the hill. The water seeps out of the hillside in a small stream. It has no color, odor, or taste and is very cold. As the spring house is always closed, the volume of flow could not be measured. The water is piped through a 1½-inch pipe to the Rangeley Lake House, where it is used for all drinking and cooking purposes. It has sometimes been shipped to Boston. No improvements have been made, with the exception of digging out the spring to a depth of about 8 feet, stoning it up with bowlders from the field, and building a small spring house over it. The water has been used since the hotel was started in 1896. It is probable that many other springs of good quality could be obtained on the same hillside. The analysis reported by the owners of the spring, recalculated into ions and parts per million, is given in the table (No. 234).

PUBLIC SUPPLIES.

General statement.—In Franklin County public water supplies are not common. Several towns, including Farmington, Phillips, Rangeley, Strong, and Kingfield, use water from surface sources. Farmington Falls has a supply from springs.

Farmington Falls.—The water system of Farmington Falls is a gravity supply from springs situated in sand and gravel hills near the town. These springs have been in use for about thirty years. No pumping is necessary, and the water is brought to town in a 1-inch pipe, which is lead except where it crosses the river, that portion being made of iron. The system is owned by the Farmington Falls Aqueduct Company, consisting of thirteen shareholders, who paid $100 each at the time of its establishment. These persons and four other families use the water for domestic purposes, the four outside families paying $8 a year each. The water is of excellent quality and never gives out, but in dry seasons it is occasionally rather low. A field assay resulted as shown in analysis No. 233 of the table.

Strong.—The Strong Water Company was installed in 1905 to supply the village. The wells in town had been satisfactory, but it was thought advisable to put in this supply for the sake of the additional conveniences. The water is taken from a small pond a few acres in extent situated on the slope of the mountain west-southwest of Strong. There are 75 faucets and 12 fire hydrants in the village, and seven-eighths of the people are said to use the public supply. The pond is reported to be 600 feet above the village. It gave at first a pressure of 200 pounds, but now it has been regulated to 80 pounds, which is sufficient. This water, from a high source on the mountain, is excellent in quality.

Rangeley.—Rangeley has a public water supply from Cascade Brook, on the flanks of Saddleback Mountain. The water is good; but, notwithstanding this fact, about half the inhabitants use dug wells 10 to 30 feet in depth. The Rangeley Lake House has a fine supply piped to the hotel from a spring on the hill. Other springs could be obtained and used if desired, but the present public supply seems entirely satisfactory.

Kingfield.—Previous to 1898 the village of Kingfield used dug wells 10 to 25 feet in depth, and typhoid fever was prevalent. In that year a public supply was installed from Tufts Pond Brook, and the typhoid suddenly disappeared. The water is now excellent and few wells are used.

PREDICTIONS AND RECOMMENDATIONS.

The water supplies of Franklin County are so uniformly excellent that suggestions regarding their improvement may be considered unnecessary. Several villages, however, of which the largest is Rangeley, draw water largely from dug wells situated within their limits. In all such villages no time should be lost in installing a system of waterworks, either from some mountain brook of which the water is perfectly safe from pollution, or from springs, or drilled wells, or other safe wells. As yet no deep wells have been drilled in Franklin County. The reason is obvious—they have been unnecessary in most places. In towns like Rangeley and Farmington, however, which have not entirely satisfactory systems of waterworks, it would be possible to obtain water by drilling wells through the gravels and underlying clays into the bed rock, and such supplies would be safer for drinking than the ordinary dug wells situated within the town limits.

HANCOCK COUNTY.

GENERAL DESCRIPTION.

Hancock County lies in southeastern Maine, bordering on Penobscot, Bluehill, and Frenchman bays and including a large number of islands. Its western edge is formed by Penobscot River. This county is about 90 miles in extreme length from north to south, about 50 miles in greatest breadth, and has a total area of 1,390 square miles. According to the census of 1900 its population was 37,241. The largest city is Ellsworth, with 4,297 inhabitants, but Bar Harbor has a large summer population and is an important place during a few months of the year.

Hancock County can be said to consist of three sections—the island region and the adjacent inhabited region, which together comprise about one-half of the area, and the wild lands, which make up the other half. The wild lands are confined to the area lying north of the Maine Central and Washington County railroads, which cross the center of the county. The only other transportation line on land is a branch of the Maine Central Railroad which enters Bucksport, the northwesternmost town in the county, from the north. The surface configuration of Hancock County is very diverse. Much of the coast is low and consists of gently sloping rock ledges or of clay or bowlder-clay plains, but on Mount Desert Island many of the cliffs are precipitous, and there are mountains that rise to an extreme altitude of about 1,500 feet. Inland from the coast, especially in the region situated north of the railroads, there are many mountains, some of which reach elevations as high as 1,200 feet. Throughout the county are scattered numerous lakes and ponds. A map of this county showing distribution of deep wells, important springs, and communities having public supplies forms Pl. XIV.

The water conditions of Hancock County vary greatly. Away from the coast most of the wells are dug wells, which give fair supplies. On the coast and on many of the islands, however, water is harder to obtain and drilled wells are the rule, especially in the summer resorts.

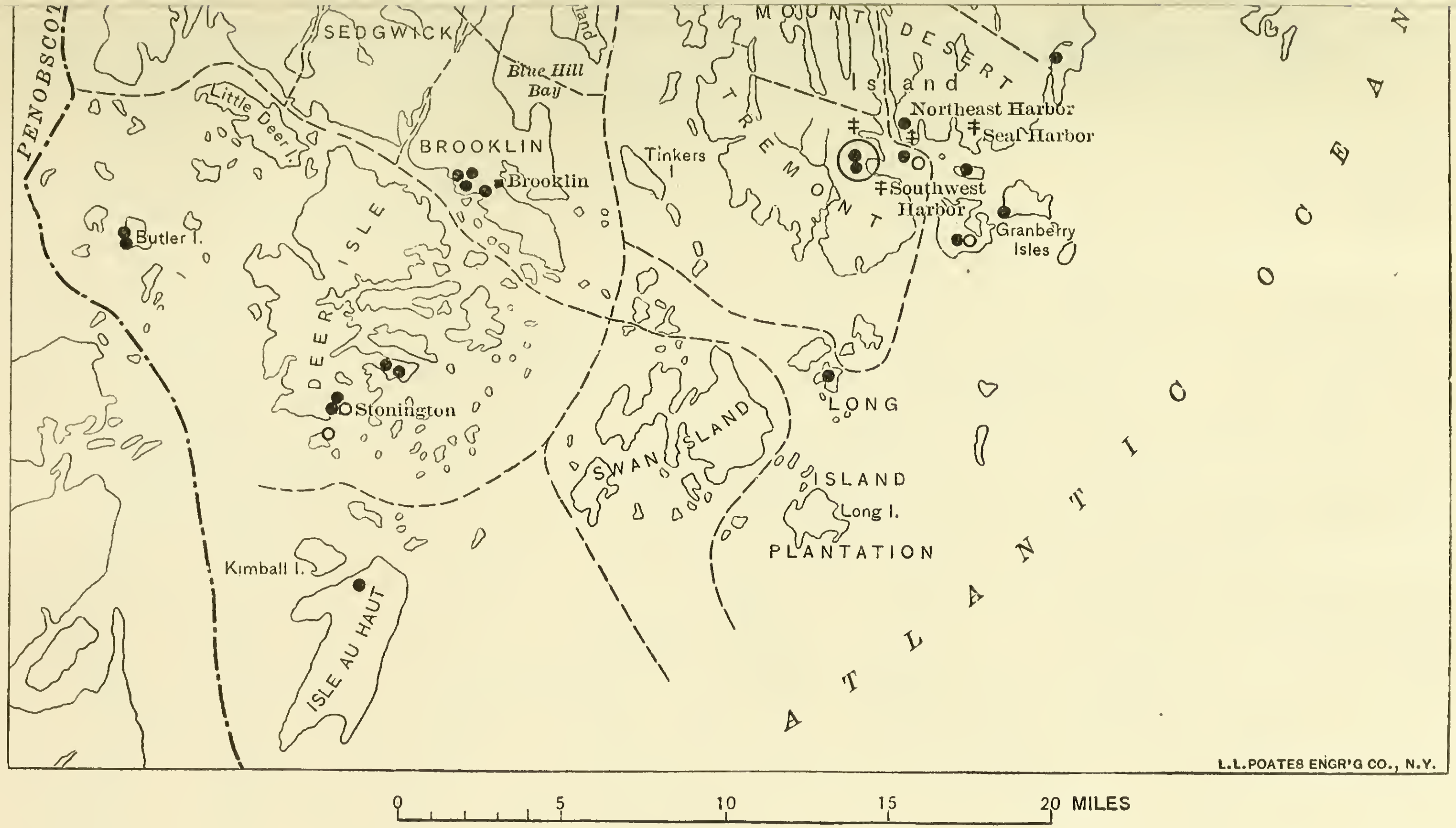
UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Distribution of rock types.—The prevailing rock in Hancock County is granite, which, however, is irregularly distributed. It forms the greater part of the islands, although the northwestern part of Deer Isle, the coasts of Mount Desert, and many smaller islands are composed of other rocks. Castine, Brooksville, Sedgwick, and Penobscot are underlain in part by volcanic rocks. With the foregoing exceptions the area west of Ellsworth is granite. The towns of Ellsworth, Hancock, Lamoine, and Trenton, and a strip extending northward with an average breadth of 5 to 10 miles, supposedly as far as Amherst and Aurora, are underlain by slate and schist. Another small patch of slaty rock lies in Sorrento and the southern part of Sullivan and Township VII, in the southeast corner of the county. North of this area and covering the two eastern tiers of towns in the county an area of granite extends to an unknown distance, probably nearly to Great Pond. The north end of the county, within the area under consideration, is known to consist of slate, but north of the forty-fifth parallel lies another area of granite.

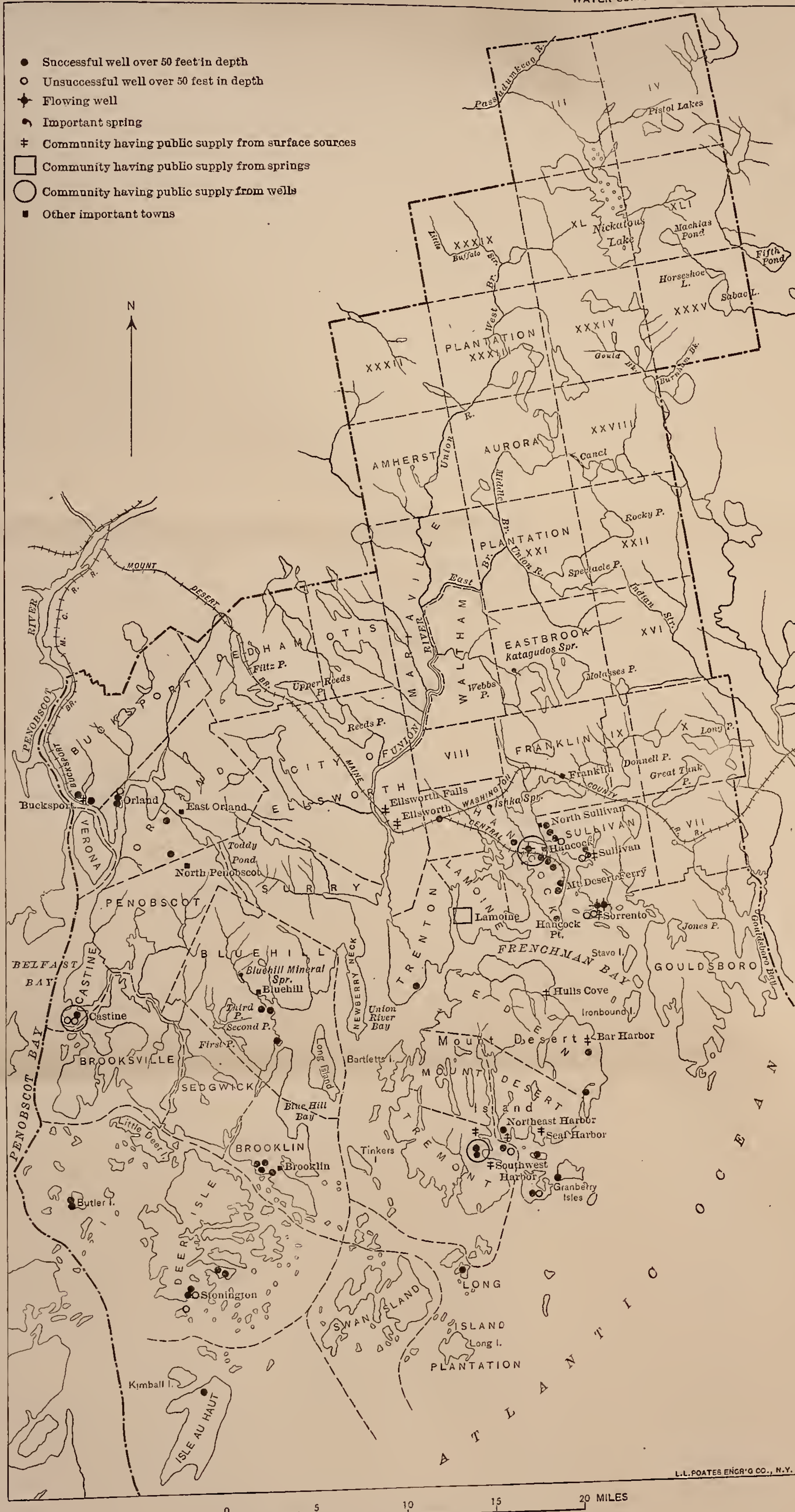
The structure of the granite of Hancock County is typical of Maine granite in general, as described on pages 29–32. The area mapped and described as granite in this part of Maine includes, however, small areas of diorite ("black granite") and similar rocks.

At Hall's quarry on Mount Desert, at Stonington, at Sullivan, and at Vinalhaven the granite is extensively quarried, and numerous exposures at these places show water seeping out of the sheet joints, as explained on page 31 and illustrated in Pl. III. At one place, near Stonington, a good spring issues from a vertical joint crack on



MAP OF HANCOCK COUNTY.

Showing distribution of aeep wells, important springs, and communities having public water supplies.



MAP OF HANCOCK COUNTY.

Showing distribution of aeep wells, important springs, and communities having public water supplies.

the hillside. The direction of the joints is variable, but the majority of them trend between N. 75° E. and S. 50° E. Their size is small, but they seem to hold plenty of water in places.

The slate in Hancock County is extremely variable in character, at some places being hard and blue and at others consisting of a very metamorphic schist, much contorted and containing locally a large amount of iron and other minerals. In places, as at Bucksport, the slate becomes very hard, dense, and quartzitic.

The detailed distribution of the rocks in a small section of southern Hancock County has been worked out by G. O. Smith, E. S. Bastin, and C. W. Brown, of the United States Geological Survey, and hence it is possible to describe the formations of this region somewhat more fully than those of others. A considerable part of the area is granite, but the intervening regions are occupied by other igneous and stratified rocks distributed very irregularly. The distribution of the formations that have been mapped by the geologists in detail is described under the various townships.

Surface deposits.—The surface deposits of Hancock County are extremely variable in character and thickness. In Penobscot, Bluehill, and Frenchman bays the coast of the mainland and islands consists mostly of bare rock and the smaller islands are covered only with a thin coating of drift. In a few areas protected from wave action along the coast low clay plains are found, and in several places in Bluehill and vicinity low drumlin-like deposits of bowlder clay occur. On the larger islands and on the mainland away from the coast the drift is of considerable thickness. The bowlder clay is generally 5 to 50 feet or more thick, and in the valleys it is commonly overlain by sands, gravels, and clays. At Orland a cliff of bowlder clay rises 100 feet vertically above tide water of the river. In exceptional cases bowlder clay is underlain by sand, as in the well of Mr. Tom Mason, near East Orland.

WELLS.

GENERAL DESCRIPTION.

Types of wells used.—Certain parts of Hancock County are abundantly supplied with water from springs, but wells are generally more abundant on the coast and on the islands. Old-fashioned dug wells are common, and in many of the country districts are preferred by the inhabitants on account of the large amount of water contained in the drift. A few driven wells have been sunk through sand and clay in certain localities, and some of these have discovered small artesian supplies.

Drilled wells.—Along the coast and on the islands the most popular and best type is the drilled well, of which more than 170 have been sunk to depths exceeding 50 feet. The prevailing size used is 6 inches and the depth varies from 30 to 675 feet. Most of the drilled wells in the county have been successful in obtaining fair amounts of potable water. A few have been failures owing to the absence of sufficient water or to the penetration of salt water into the wells. The failures have been commonly in schist and metamorphic rocks, seldom in granite. Where little water is found the difficulty is probably due to the fact that the wells did not chance to strike a fissure containing water. Another well near by might meet with success. As the greatest amount of water in the rocks is held comparatively near the surface, it is seldom advisable to drill below 200 feet or so. Instead, if a well reaches that depth without obtaining water, a second attempt should be made 50 to 100 feet away.

Quality of water.—The quality of water in Hancock County is extremely variable, owing largely to differences in the character of the formations. An example of the nature of waters which are generally obtained from deep wells in sand is shown in No. 184 of the table (p. 83), where the total solids are seen to be only 66 parts per million. Several dug wells in till have been tested by field assays in Orland, Eden, and Sorrento, and are low in mineral content. The amount of chlorine in some of these wells indicates possible pollution.

The wells in granite, of which four laboratory analyses have been made, give total solids from 81 to 364 parts, the lowest amount being found in a well on Greenings Island near Southwest Harbor, and the highest in the Crabtree & Havey well at North Sullivan. The chlorine in these four wells varies from 17 parts in a well at The Settlement, Stonington, to 140 parts in the Crabtree & Havey well. As these are deep drilled wells, not subject to pollution, the chlorine is probably a natural constituent of the rock. Sulphates range from a trace up to 25 parts per million, with one report of 104 parts. Carbonates run from 8 to 70 parts, and calcium, magnesium, sodium, and potassium are present in moderate amounts. In several analyses a little iron is reported, but this is not generally found in granite. The analyses of granite waters in Hancock County are tabulated on page 77, Nos. 9 to 19.

Three complete analyses have been made of waters in slate in Hancock County (Nos. 55, 56, and 57). One is from a 308-foot well in the village of Bucksport, the second is from an open well a few feet distant, and the third from a well in Hancock. The first two of these analyses show 116 and 53 parts per million of total solids, respectively. An interesting feature regarding these wells is that while the water of the deeper one is more than twice as high in total solids as that of the open well, the chlorine is the only constituent which is highest in the latter. This feature is strong evidence of pollution in the open well. Water from a slate well in the village of

Orland contains a little iron, and much iron is known to be contained in schists in some parts of the county. Near North Penobscot a well so situated is so strong in iron as to be almost useless.

Many wells along the coast have been ruined by the entrance of salt water from the sea. This occasionally happens in granite, but is much more common in slate. An example in the town of Sorrento is described on page 67.

Quantity of water.—Although it is unsafe to depend on the figures given by well drillers and owners as a guide to the amount of water likely to be furnished by a well, they are of some use as a general guide to the amount which may be expected. Wells in this county report all yields up to 100 gallons a minute, those commonly reported being only 3 to 5 gallons a minute, which, however, is plenty for all domestic purposes. A few wells gave too little water to be used. Most of the drilled wells hold out from year to year, when sunk deep enough, but dug wells often run dry. In a drought several years ago many of them gave out.

Uses.—The water of wells in Hancock County is used mainly for domestic supplies, and drilled wells are fairly common at summer cottages. In Castine, Southwest Harbor, Sorrento, and Stonington, however, they have been sunk for public supplies. At Sorrento a driven-well system has been abandoned for a surface supply, and the Stonington well was never used. At Hancock Point an abandoned mine shaft is used for public supply. At Brooklin a canning company has a drilled well; at Stonington granite quarries use them. The wells of Hancock County are commonly operated by hand pump, but many are rigged with windmills and a few are pumped by steam, gasoline, or hot air.

Flowing wells.—Several flowing rock wells are known in Hancock County. A number at Hancock flow from a bed of gravel confined underneath clay, and a similar local basin is situated near the village of Sorrento.

DETAILED DESCRIPTIONS.

Ellsworth.—As Ellsworth has a satisfactory public supply from a pond, very few wells are now in existence in the city. There are no drilled wells. The rock formation is slate and schist, and as drilled wells in these rocks are generally successful elsewhere it is probable that here too they would meet with success. At Ellsworth Falls water can be seen seeping out of joint cracks in slate, and this indicates the availability of water for wells in these rocks.

Bluehill.—The part of the town of Bluehill lying northeast of the village and extending nearly as far as North Bluehill, the region lying southwest of Bluehill Falls and extending eastward to South Pond, and a small section in the extreme northwest corner of the town are underlain by granite. A strip just east of the granite area, in the western part of the town, consists of diorite, diabase, and gabbro. Long Island is made up of granite as far north as Deep Cove; otherwise this town, including the north end of Long Island, the whole of Bluehill Neck, the vicinity of Bluehill village, and North Bluehill, is composed of schist.

Several deep wells have been drilled in this town to supply summer cottages along the shore. Dr. A. M. Thomas has a well 140 feet in depth, in gneiss. Unfortunately the water is very turbid, owing to the entrance of clay through crevices in the rock. The supply is sufficient, as the water can not be lowered by pumping and yields 2,500 gallons in three or four hours per day, but on account of its quality it can be used only for the stable. The well belonging to Mrs. Ethelbert Nevin at Bluehill Falls is reported to yield 7½ gallons of water a minute. On account of the great amount of iron contained in the rocks over large areas in the town of Bluehill, it is probable that some wells here will fail to get water. Analyses made of the two above-mentioned wells did not, however, show any iron. The amount of carbonates was high for Hancock County, being 92 and 110 parts per million, respectively. Where the rock consists of granite, gneiss, or hard, compact slate the water will generally be of good quality. In the vicinity of Bluehill village most of the wells are dug to ledge and some are blasted, getting good water. Bluehill Mineral Spring is situated in this town.

Sedgwick.—The town of Sedgwick is nearly all underlain by granite. In the southern part of the town, extending from Benjamin River westward along the coast to the Punchbowl, is a strip of volcanic rocks. Between the villages of Sedgwick and North Sedgwick stretches another strip, which consists of schists. In the vicinity of Bluff Head is a small area of schist, and between Bluff Head and the northern corner of the town lies a small area of diorite.

No drilled wells are known in Sedgwick. The dug wells are 8 to 20 feet in depth, and most of them get plenty of water in drift. A few run dry in summer. The water is commonly of good quality.

Brooklin.—The portions of Brooklin lying south of Brooklin village, and including the end of Flye Point and the islands of the town, are granite. North of Brooklin village the town is entirely underlain by schist.

Several deep wells have been drilled in the vicinity of the little settlement known as Haven. These are from 50 to 112 feet in depth and find plenty of water that is reported to be of good quality for domestic purposes. One of the wells here, owned by Noah V. Tibbitts, is reported to supply 20 cottages. This well is 87 feet deep, and a number of veins of water were found. A drilled well of the Brooklin Packing Company supplies a sardine factory and near-by houses.

Castine.—The rocks of the peninsula of Castine are entirely volcanic, and consist mostly of a stratified variety known as tuff. The village of Castine is supplied with water chiefly from deep drilled wells, but in part by springs. Many people continue to use dug wells, which generally yield plenty of water, but which, being situated in the heart of the village, are clearly subject to contamination. The Castine Water Company has four wells, 58, 70, 80, and 110 feet deep, situated on one of the highest hilltops of the peninsula. On another hilltop a well 675 feet in depth was drilled by the same company. This is an 8-inch well and one of the deepest in Maine. The first water was found at 425 feet and rose within 25 feet of the well mouth. The well is reported to yield about 13 gallons a minute through the day, but is not very satisfactory on account of its poor construction. Further data regarding these wells are given under "Public supplies" (pp. 147–148). The fact that the last-mentioned well was sunk to a depth of 425 feet without striking water indicates that wells in this section will probably not all be successful. This statement is emphasized by the result of the well drilled for the Acadian Hotel Company on the hillside on which Castine is built. In July, 1906, this well was down 227 feet and the test with the hand pump showed a yield of only about 1 gallon of water a minute. As the owner did not consider the yield sufficient, he was advised to discontinue this well and start a new one a short distance away.

Bucksport.—At the Eastern Maine Conference Seminary, Bucksport, a well was drilled to a depth of 308 feet. Water was struck at about 100 feet and a second seam at about 300 feet. In the spring of the year when it was drilled water overflowed the surface, and the well supplied several gallons a day of excellent water. It is pumped by a 3-horsepower gasoline engine. Analyses of water from this well and from an open well a few feet distant are given in the table (Nos. 55 and 56). It is interesting to note that all the constituents are higher in the deep-well water than in that from the shallow well, with the exception of chlorine, which is higher in the open well. This indicates the probability of contamination in the open well. In another part of Bucksport two wells, 30 and 80 feet deep, were drilled only 3 feet apart, in quartzite, and connected by blasting. Only one of these is pumped. The supply is not large, but is sufficient for domestic purposes.

Orland.—In the town of Orland several drilled wells have been sunk, with varying results. The best well in town was that drilled for Mr. Tom Mason at East Orland. This well started on a gently sloping hillside consisting at the surface of bowlder clay containing numerous large bowlders. Instead of striking rock at a few feet, as might have been expected, the drill went through 87 feet of sand and gravel and then struck an excellent supply of water directly on top of a bed of clay. The water is clear and cold, and 8 gallons a minute can be pumped. The well is very low in mineral matter, as shown by analysis No. 184 in the appended table.

A well drilled for Mrs. A. W. Hutchins, near North Penobscot, was not so successful. The rock is here a hard, traplike formation containing a considerable quantity of iron. This well was dug 12 feet in bowlder clay, blasted 8 feet through ledge, and then drilled 57 feet, making a total of 77 feet, striking water at 67 feet. The water tastes very strongly of iron. (See analysis No. 59.) It can not be used for washing because it stains everything with which it comes into contact, and iron is precipitated from the water when it is left standing for some time.

At the village of Orland three wells have been drilled to depths varying from 40 to 70 feet. One of these was abandoned because of the large amount of iron contained in solution and the supposed connection of the well with the river. A second well gives plenty of water, which has a slight iron taste, but not enough to interfere with domestic use of the water. The quantity of iron is not more than half a part per million, and the other minerals are low, as shown by a field assay (No. 58). That the water is highly prized is shown by the fact that eight families use it in seasons when the surrounding dug wells run low. The water is reported to be softer than when the well was first drilled, seventeen years ago. This well is situated on a point of rock which projects into the river and on which a number of cottages have been built. Across the river the formation is quite different, a steep bluff of bowlder clay being exposed for a height of about 100 feet. It is improbable that much water could be obtained from this material. Throughout the town of Orland dug wells are the prevailing type. They do not often give out, but frequently get very low. Where not polluted the water is of good quality. An example of the quality of water in till is given by a field assay (No. 170). The well from which this water was taken supplies six to eight families during a drought. Generally, however, water is not so abundant in till.

Stonington.—The wells of Deer Isle are all open wells except in the vicinity of Stonington, where a number of drilled wells have been sunk. At Stonington the sanitary conditions are very poor, only five wells having been drilled; the rest of the people use dug wells and springs, the water of which is polluted and dangerous. The town is thickly settled, is growing rapidly, and has no sewerage system. The formation is entirely granite, and hence the results obtained in drilling here have a rather important bearing on the occurrence of water in granite in general.

Two of the most successful wells in the region were drilled in 1906 at Mr. J. C. Rogers's quarry at "The Settlement" to supply water for quarrying operations. The first well was 93 feet 8 inches in depth, passing through 27 distinct "beds" of rock. The thickest mass of rock uninterrupted by joints measured 14 feet, but some were only a few inches in thickness. The thickest bed was encountered about midway from top to bottom of the well. This well supplied 62 gallons of water in seven minutes, but the supply was not considered sufficient and a second well was drilled 50 feet distant. It was sunk to a depth of 279 feet and intercepted the same water-bearing fissures as those found in the first well, as was proved by the fact that pumping the second well lowered the water in the first. A week's test was made on these wells. They are said to connect 60 feet below the surface, and will yield 60 gallons a minute. A field assay of the water of the first well and a laboratory analysis of that of the second are given in the table (Nos. 18 and 19).

In the village of Stonington Mr. Samuel Goss has a well 67 feet in depth, also drilled in granite, which supplies his hotel. A field analysis of this has been made (No. 15). The Goss well supplies also fifteen or twenty families, and the water is used for watering lawns, etc. Ten years ago the Pine Lake Water Company sunk a well on the summit of Thurlow Hill, near the village, for the purpose of procuring a public supply for the village. The well was drilled to a depth of 183 feet, and is reported to have yielded 18 gallons of water a minute, but was plugged and has never been used. The Guyer & Torey well was drilled to a depth of 67 feet to supply two families, and a windmill and tank were installed and pipes run to the houses before it was discovered that the supply was too small to be used. The Sunset House, Acadian House, and a dozen residences are supplied by a good spring situated on a hill outside the village. The result of a field assay of this water is given in the table (No. 240).

In one quarry at Stonington the approximate amount of water issuing from the granite can be calculated from the amount pumped out of the quarry. The writer was informed by the foreman that more than 3,000 gallons accumulate daily in the bottom of the quarry from the joints. Near this quarry a good spring issues from a vertical joint which is said to be as wide as a common pencil. The crack is situated on the hillside below the quarry, but as it was covered it could not be seen.

One of the difficulties in quarrying granite on the smaller islands near Stonington is lack of water. On Moose Island there is a small catchment area consisting of a swamp, and water is obtained from a dug well near by. On Crotch Island the quarry of the Ryan-Parker Construction Company is 130 feet in depth, mostly below sea level, and is nearly dry. In a search for water another well was drilled to a depth of 300 feet, but without success, except that salt water was encountered. The chlorine in this well was 70 parts per million and the sulphates 104 parts. (See analysis No. 17.) In 1907 a second attempt was being made for water on the opposite side of the island. No other drilled wells have been sunk in the vicinity of Stonington.

On Deer Isle there is a good chance of getting water at moderate depth. On the smaller islands, however, conditions are less favorable and as a rule drilling will probably not pay. In the vicinity of Stonington there is very little drift overlying the granite, and this circumstance probably explains why so little water is found by drilling on the smaller islands.

Deer Isle.—About half of Deer Isle, comprising the area lying east of a line drawn from Smalls Cove through Deer Isle village and Torry Pond to Eggemoggin Reach, consists of granite. This area also includes the islands lying in that part of the town. West of the above-described line the major portion of the island consists of acidic volcanic rocks. There are one or two small patches of schist in the northern part of the island and several areas of greenstone west of Deer Isle village. The wells on this island are dug in bowlder clay and the depth of the deepest is 28 feet. The amount of water is extremely variable.

Little Deer Island consists of volcanic rocks and small areas of associated formations. The other islands of the town of Deer Isle in Penobscot Bay are made up almost entirely of volcanic rocks and greenstone. No drilled wells have been sunk. From the variability of the rocks a broad range may be expected in the character of the well waters.

Swans Island Plantation.—Swans Island consists entirely of granite. No drilled wells are known to have been sunk.

Long Island Plantation.—There are several islands in Long Island Plantation, but the only one on which a well is known to have been drilled is Black Island. This well was sunk to supply the granite quarries, but the water is also used for domestic purposes. The depth is 78 feet, and it is reported to be a good well.

Eden, Mount Desert Island.—Mount Desert Island consists of three towns—Tremont, Mount Desert, and Eden. Bar Harbor is situated in Eden, Northeast Harbor is situated in the town of Mount Desert, and Southwest Harbor is in Tremont. The coasts of the island are generally high and rocky and much wave worn. The water supply of Bar Harbor and Hulls Cove is derived from Eagle Lake and is one of the best supplies in the State. At the fair grounds near Bar Harbor a well belonging to Gen. Edward Morrell obtained an abundant supply of pure water at a depth of 87½ feet, in granite. A large number of cattle are watered every day, but the supply never gives out. A field assay of this water is reported in the table (No. 9). As Bar Harbor has one of the best lake supplies and filter galleries in the

State, there is little need for sinking wells in this village. A number of cottages at Schooner Head and vicinity have a supply brought in pipe from The Bowl, high up on Newport Mountain. Near Bar Harbor is a mineral spring known as Red Rock Spring.

At the village of Otter Creek, 5 miles south of Bar Harbor, two wells were drilled to depths of 25 and 37 feet, obtaining small amounts of water, in granite. If they had been sunk 50 to 100 feet deeper the supply might have been sufficient. The first of these wells was drilled to a depth of 25 feet, striking a vein sufficient in quantity for drinking but not for other purposes.. An attempt to deepen the well was made by an inexperienced driller, who filled it with loose stones and afterwards lost the drill, and the hole had to be abandoned. A well dug in till in the southwestern part of the town gave the field analysis shown in No. 169. Many fine springs occur in this town.

Tremont, Mount Desert Island.—At Southwest Harbor two wells have been sunk by the Southwest Harbor Water Company. The first successful well was drilled in 1891 to a depth of 125 feet. The second well, 36 feet distant, was drilled in 1899 to a depth of 297 feet. These wells communicate at a depth of 90 feet. They could not be lowered by pumping, but enough water could not be obtained, owing to the insufficient capacity of the pumps in use and possibly also to the inadequacy of the supply, and Long Pond was resorted to as a supplementary supply. A full description of the waterworks is given on pages 148–149.

Many people in Southwest Harbor still use dug wells less than 30 feet in depth. The water is of variable quality. The field assay of a spring which issues from the clay along the shore near the village is given in the table (No. 241). This water flows 3 gallons a minute out of gravel beneath clay, and is highly prized by the owners. The spring is said to be sometimes covered by water at high tide. In the northern part of town is a historic spring, made famous by Indian legends, and the water is highly prized by the residents and visitors. The spring has never been improved. In the villages of Tremont, Bass Harbor, and McKinley only dug wells are used. It is probable that deep wells here would be successful.

Greenings Island, Tremont.—On Greenings Island a well was drilled in 1893 for Mr. J. G. Thorp to a depth of 88 feet, in granite. This well is located only 100 feet from high-tide mark and 20 feet above it. The supply is reported sufficient. The water is pumped to a 5,000-gallon tank for use in the house. (See analysis No. 10.) At the north end of the island the cottages are now supplied by pipes laid under the sound from Southwest Harbor.

Quite different in results from the above is a well drilled at the opposite end of the island about 1903 for Mr. Colton. It is 110 feet deep and salt water was encountered at a depth of 90 feet, where the drill struck ledge. The water is so salty that it is not used. The drill stuck once or twice in crevices. The occurrence of salt water on this island is not confined to any particular part of the island, but is believed to be largely a matter of chance. A well near this one might be fresh, and, conversely, a well might happen to strike salt water at the north end of the island.

Town of Mount Desert.—Mr. L. E. Kimball, of Northeast Harbor, had a well drilled several years ago for the cottages there and the well was later bought by the water company. It was sunk to a depth of 189 feet. At 90 feet from the surface water commenced to enter the well. Several soft places in the ledge were encountered, and at one place the drill dropped as much as a foot. The water increased in volume with depth, and when the well was finished the test showed 60 gallons a minute for twelve hours, and it could not be pumped dry. The water is good, but somewhat irony. The well was abandoned when the public supply was installed. The rugged character of the town of Mount Desert makes springs very numerous. In the vicinity of Hall's quarry a number of good ones issue from the base of granite cliffs several feet in height. In that quarry considerable water can be seen issuing from sheet joints. At one time enough water for drinking was obtained near the bottom of the quarry.

Cranberry Isles.—On Sutton Island a well was sunk to a depth of 199 feet. This well will yield 20 gallons of water a minute and the water is of good quality. It supplies seven houses on the island.

On Great Cranberry Island a well was drilled in 1904 by Mr. Moorfield Storey to a depth of 201 feet, but it was abandoned, as only a very little water was found. In 1906 a second well was drilled, but the data regarding it have not been received.

On Little Cranberry Island a well 50 feet in depth was sunk for Miss Frothingham. The supply is reported to be 5 gallons a minute.

Hancock.—The village of Hancock is situated on a neck of land which is rather flat and low. A creek flows nearly across the neck and on the lowland lies an area of blue clay ("flat's mud"), below which is sand and gravel. In the square at Hancock, in 1904, a hole was bored with a 2-inch auger, and a strainer was attached to the bottom of the pipe. Below the soil was found a hard blue clay containing fossil shells; below this was a 6-inch bed of fine sand, underlain by coarse gravel containing excellent water, which flowed 9 feet above the surface of the ground. The water will still sometimes rise to a height of 5 feet, but the head is somewhat less than this in dry weather. A dug well near by is not quite so deep, but overflows the surface the year round. The town well averages half a gallon a minute. There are a few other good flowing wells in the vicinity, and most of them are bored. This area is a local artesian basin, only a few hundred feet across, and the head of the water is caused by the inclination of the gravel bed, which holds the water underneath the clay. The gravel bed reaches the surface east of the wells and is inclined downward toward the west. The wells drilled into the clay but not through it are less satisfactory.

The deepest water supply in the town of Hancock is the village supply of Hancock Point. The source is an old shaft sunk about 1880 for a silver mine. It is 8 feet in diameter at the top and 98 feet in depth. The mine was unsuccessful and was abandoned, and later it filled with water within 4 feet of the surface. The water is said to be of fine quality for drinking purposes until the middle of August in every year, when it is reported to take on a brackish or mineral taste. The water is used only during the summer season.

In the vicinity of Hancock several wells have been drilled and reach depths of 30 to 70 feet. An analysis of the Jeremiah Stratton well, 65 feet in depth, is given in the table (No. 57). A few families use springs. Most of the wells in the vicinity are dug.

Many wells in North and South Hancock are reported to have run dry during the summer following the earthquake shock in March, 1903, while others which were then dry became filled with good water. In a few cases where wet and dry wells stood side by side the one containing water dried up and the other filled with water. Some wells that went dry are reported never to have recovered. Similar instances are reported in the town of Ellsworth. It is probable that the reports regarding these phenomena are correct, but it may be fairly questioned whether the cause was not a dry season rather than the light earthquake shock. The filling up of certain wells may be explained by the slow natural infiltration of water after they have been abandoned for some time.

The supply of the Maine Central Railroad at Mount Desert Ferry is from a spring 2 miles north of the village of Hancock. The Ishka Mineral Spring is situated in this town.

Sullivan.—The village of Sullivan, or Sullivan Harbor, has used water from Long Pond since the spring of 1905. It is good, clear water, but sometimes tastes of algæ. In the past most of the people have used wells or springs, but they are rapidly giving them up for the pond water, which is supposed to be of better quality. Open wells here obtain water in part from drift and in part from rock, and the supply is of variable quality and quantity. Mr. Dwight Braman has a 10-inch well drilled to a depth of 89 feet in granite. The water rises within 8 feet of the surface. It is used for drinking at the Manor House and is reported to have been sold. On the same estate is an abandoned silver-mine shaft, 120 feet deep and 20 by 15 feet in diameter, which is now full of water.

In the same village Capt. S. V. Bennis once had a well drilled 180 feet in depth. This well was 6 inches in diameter at the top and 5 inches at the bottom. The supply of water was small and the well has not been used for thirteen years. The owner reported that the well is drilled in slate which is very dense and contains a great many quartz veins. The Bennis well is situated less than 1,000 feet from the Braman well, and the smaller amount of water encountered in the former may be due in part to the fact that the slate in this locality, as is often the case near granite areas, is very dense, containing few joints, and holds little water, whereas the granite, in which the Braman well was drilled, contains a great many water-bearing joints.

In the vicinity of West Sullivan several shafts of abandoned mines have been transformed into wells. One at West Sullivan was drilled 40 feet and obtained good water, but on continuing it to 61½ feet water which is too highly charged with mineral matter to be used was obtained and the well was abandoned. The surface wells in this vicinity, however, give good supplies of soft water. The public supply of West Sullivan comes from a spring.

At North Sullivan the conditions seem to be much better. The formation is of granite, and a number of wells 50 feet in depth obtained plentiful supplies of as good water as can be found in the State. Some of these wells have been blasted in rock; others were drilled. A comparison of the two types of wells here indicates that for shallow wells in granite the cost of both is about the same, but for deep wells the drilled type is cheaper. For both shallow and deep wells the drilled type is safer.

One of the best wells is that of Mr. C. H. Abbott. This well, after going through 3 feet of drift, struck granite and went to a depth of 136½ feet without obtaining water. On drilling 10 inches deeper a seam of water was struck and a two-hour test was made; in that time 2,000 two-gallon pailfuls were pumped and the water was lowered only 11 inches. In the construction of the well hard galvanized-iron tubing was put down to rock, driven as hard as possible, and cemented to the ledge. With this construction it is impossible for surface water to pollute the well. The assay of this water is given in the table (No. 11). This granite water is a delightful-tasting, clear, cold water. Complete analyses of the Crabtree & Havey well (No. 14) and of the John M. Blaisdell well (No. 13) are given in the table. In the Crabtree & Havey well the amount of mineral matter is very high, being 364 parts per million. A view of the Crabtree & Havey well is given in Pl. V, *B*.

Sorrento.—The summer resort of Sorrento, situated on a peninsula at the southwest end of the town of Sullivan, has a gravity water supply from Long Pond, taking the water from the end of the pond opposite to that from which it is taken by Sullivan. Sorrento formerly had 14 driven wells, installed a dozen years ago, consisting of 2-inch pipes sunk from 50 to 65 feet in depth in gravel deposits a mile northeast of Sorrento. They are reported to have been nearly all flowing wells. They were situated in a low, swampy area a few hundred feet in extent, bordered on the north and south by rock hills and on the east by hills of gravelly till, and a small brook drained out to sea at the west end. Small gravel hills surround the valley, giving a head to the water, which is confined in quicksand below a bed of clay. The wells stretched along an east-west line and were 100 feet or so apart, ranging as much as 50 feet on either side of the center line.

At Sorrento two wells, 92 and 61 feet deep, were drilled in rock about fifteen years ago. Both gave salty water, but one of them was used for a short time. In the rock along the shore are a number of cracks as much as one-half inch in diameter which might allow passage for water into the hill and downward into the wells. The dip is toward the south, and it is probable that the salt water enters the cracks parallel with the stratification of the rock on the north side of the peninsula. Drilled wells are not recommended on this smaller peninsula, but on the major peninsula which juts out from Sullivan they may meet with success. A dug well in till in the northern part of the major peninsula was tested by field assay (No. 171).

Penobscot.—The rocks of the town of Penobscot are also very diverse in character. In the vicinity of South Penobscot, extending northward beyond Wight Pond and southward as far as North Brooksville, the formation is granite, as it also is north of Pierce Pond. Between Pierce Pond and the village of Penobscot, and along a narrow strip just east of Wight Pond, is a band of diorite which encircles the South Penobscot granite area. East of Wight Pond, with the exception of the narrow strip of diorite, the rocks are schist as far as the Bluehill line. West of Northern Bay and south of Wallamatogus Mountain the rocks are volcanic. As in Deer Isle, great difference may be expected in the character and amount of well waters.

Surry.—A strip of granite of variable width extends along the southwestern edge of Surry, but with this exception the region southwest of the village is made up of schist. No drilled wells are known. It is probable, however, that in both the granite and the schist areas drilling will be successful.

SPRINGS.

General statement.—Away from the coast Hancock County is well provided with springs, many of them supplying farmhouses, and some are pumped by windmills. At Greens Pond, in the town of

Dedham, a spring supplies the hatchery and nursery of the United States Fish Commission, and the spring water is piped through the buildings. Within the limits of the county there are at least four important mineral springs, as follows:

Bluehill Mineral Spring, Bluehill.
Ishka Spring, West Hancock.
Katagudos Spring, Eastbrook.
Mount Desert Spring, Bar Harbor.

Bluehill Mineral Spring.—Two springs owned by Greely & Hagarthy, of Ellsworth, are situated in a valley about 3 miles north of Bluehill post-office. The water is reported to issue from a ferruginous rock with a volume of 5 gallons a minute. It is colorless and odorless, but contains some sediment. It is highly charged with iron and other minerals and has deposited iron about its mouth. The analyses reported by the owners and recomputed into ions and parts per million are given in the table (Nos. 236 and 237). The total amounts of solids in the two springs are reported as 79 and 49 parts per million. The water is used for medicinal purposes. The existence of this spring was noticed by Jackson as early as 1838.[a]

Ishka Spring.—The Ishka spring is situated near a hilltop 4 miles north of the village of Hancock. The total solids are reported as 19 parts per million (analysis No. 242). The spring is covered with a house and the water is bottled for shipment.

Katagudos Spring.—The spring known as the Katagudos is situated in the town of Eastbrook, 8 miles northeast of Franklin post-office. The water is said to seep out of a hillside formed of surface deposits, with a volume estimated by the owner as about 8 gallons a minute. The water is said to be colorless and odorless and to have a pleasant taste. It is used for drinking and medicinal purposes and a small hotel is situated there. The owner is Mr. R. B. Lowrie. The analysis of this water is reported in the appended table (No. 238), the composition being recalculated from the analysis reported by the owner.

Mount Desert Spring.—Mount Desert Spring water comes from a spring owned by Messrs. J. H. Souris and C. A. Waters. The water is said by the owners to issue from a fissure in granite. The flow is reported to vary slightly, but to average 12 gallons a minute. Much water is sold in the vicinity and some is shipped to a distance. An analysis, reported by the owners and recalculated from the original into ions and parts per million, is given in the table (No. 239). The water is reported to have medicinal value. The price is 12 cents a gallon.

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[a] Jackson, Charles J., Report on the geology of the State of Maine, 1838.

PUBLIC SUPPLIES.

General statement.—In Hancock County very few villages have public supplies. The following, however, use surface water: Bucksport, Northeast Harbor, Ellsworth, Sullivan, and Sorrento. One town in the county, Castine, gets its water from wells and springs, and Southwest Harbor gets it from wells and a pond. Lamoine has a supply from springs, and Hancock Point uses an abandoned mine shaft. A deep well was sunk at Stonington some years ago for a public supply, but it was never used.

Castine.—The village of Castine is supplied by two private water systems. The larger of these is owned by Mr. A. M. Deveraux, who has several deep drilled wells situated on the summits of the hills occupying the center of the peninsula. In addition to the wells a number of springs are used.

The first well was put down by a driller who promised water at a depth of 60 feet. The well was drilled 57 feet 8 inches, and the tools stuck, making it necessary to abandon the hole. It was filled with stones to prevent any other driller from making use of it, and a second hole was drilled 2 feet away. This one went 62½ feet, got a good supply of water, and continued 3 feet deeper for a reservoir. A third hole, 12½ feet distant, was drilled to a depth of 70 feet. By pumping the two successful wells it was found that they communicated and that it was only necessary to put a pump in one of them. The water level stands 25 feet from the surface. Another well was drilled 10 feet away from No. 3, to a depth of 80 feet, water being found at the same depth, 62½ feet, and rising to the same level as in the others, 25 feet from the surface. Later, hole No. 2 was deepened to 110 feet.

On another hilltop a well 675 feet in depth was drilled for the same water company. This is an 8-inch well and is one of the deepest in Maine. The first water was found at 425 feet, and filled the well within 27 feet of the surface. The cost was $3,500, and much trouble was caused by losing the drill, obtaining a crooked hole, etc., due to inexperienced drilling. The well is reported to yield about 13 gallons of water a minute through the day, but is not very satisfactory on account of its poor construction.

The three principal wells belonging to this system are now pumped by a windmill into a cement-lined tank situated on the hilltop near by. The maximum capacity of the three wells is reported to be about 27 gallons a minute. The capacity of the tank is more than 25,000 gallons, but the supply from the wells is seldom sufficient to fill it. The other well belonging to the system is situated about a mile from these and is also pumped by a windmill into a tank having a capacity of more than 30,000 gallons. The supply from this well also is insufficient, and the tank is never full.

As a temporary supply, to make up the deficiency of water in the wells, the owner has installed a system of springs. These are situated on low land in the eastern part of the peninsula, in sand and gravel. A system of tiling several hundred feet in length was put in, extending 6 to 10 feet from the surface downward into the clay on which the sand rests. This system catches the water held in the sand by the impervious clay below and is reported to give 10,000 to 20,000 gallons of water a day. The water is pumped by steam to a reservoir or tank near by, and thence to a reservoir on the hill near the deepest well.

Mr. Deveraux reports that 150 water takers are on his system. This includes two hotels, one of which recently put down a drilled well for the purpose of obtaining its own supply. Unfortunately this well was a failure. With the wells and springs constituting the public supply there seems to be plenty of water to meet the demand for it. The spring system, however, is reported to be only temporary, and the owner contemplates installing a system of driven wells instead. Mr. Deveraux's company is sometimes known as the Castine Water Company.

The other company in Castine is known as the Castine Aqueduct Company. The water is taken from springs in gravel, and is used by a few persons. A number of people in the village prefer the use of dug wells, as of old. Many of these wells are in poor locations and unsafe. They should be abandoned.

The price charged for water in Castine by the Castine Water Company has recently been raised from $7.50 to $10 a year. On account of this increase many people have given up the public supply and are depending on the dug wells. The price charged by the Castine Aqueduct Company to its patrons in the lower part of the town is $6 a faucet.

Southwest Harbor.—The village of Southwest Harbor has a water supply taken from two sources, both owned by the Southwest Harbor Water Company. Until recently most of the water was taken from two drilled wells situated on the summit of the hill just west of the village. These wells and the conditions of water in them are described on page 141. The first well used was 136 feet deep and pumped 45 gallons a minute. The second, 20 or 30 feet from it, was sunk to a depth of 297 feet. The windmill was first situated over the old well, and an 8-horsepower gasoline engine was also established to pump both wells. As both the windmill and the engine were insufficient to pump the two wells to their fullest capacity, a secondary water supply was installed from Long Pond. Another well, 125 feet deep, was never used.

The water from the wells and pond is pumped to a standpipe 225 feet above tide, the capacity of which is 107,000 gallons, and it can be pumped full in seven hours of continuous pumping by means of a windmill. The pressure is reported to be 90 pounds on the main street. The length of pipe connecting the village of Southwest Harbor with Long Pond is about 2½ miles. In addition to this the company has 1 mile of pipe extending to the steamboat landing and probably half a mile in the village. All these pipes are underground. The mains extending to Long Pond are 2 inches in diameter and the rest are one-half inch. Surface pipes extend to the village of Manset and to a great many cottages in the vicinity of Southwest Harbor. A 1-inch pipe runs below the sound to Greenings Island. Five fire hydrants are reported in the village of Southwest Harbor, but there are none in the outlying villages.

The majority of the people in Southwest Harbor use the water supplied by the company. A few, however, use dug wells. There are estimated to be 150 consumers, over 50 of whom, however, are summer residents. The rates are $10 a faucet in private houses and $7 in stores. During the winter all inhabitants except those on the lines which are buried use well and spring waters. The chief reason given for having so much pipe above ground is that ledge at many places lies close to the surface and to lay pipe in it would be very expensive. The water has been analyzed and is considered of excellent quality. The amount of sickness in town seems to have decreased since the waterworks were installed.

Lamoine.—Twenty families in the village of Lamoine are supplied by the Cold Spring Water Company. The water seeps out of sand deposits, and is pumped by windmill into a reservoir.

PREDICTIONS AND RECOMMENDATIONS.

Most of the towns in Hancock County seem to appreciate the value of pure water supplies. Stonington, however, while growing rapidly, has as yet no such supply. The people of this town use dug wells and springs almost entirely, and many of these are in situations where they are sure to be polluted from surface drainage. There are no sewers in the town, and altogether conditions are insanitary. It seems important that the dug wells and springs should be abandoned as rapidly as possible and a public water supply installed. This might be obtained from any one of several sources, among which are Burntland Pond and other ponds on the south end of the island. If none of these supplies are satisfactory it seems probable that a number of wells drilled in granite at a safe distance outside the village, away from the shore, would furnish plenty of water. There is always an uncertainty whether rock wells will obtain sufficient water for a village, however, and a pond supply should be obtained if practicable. There is plenty of water in the granite of Deer Isle for ordinary domestic purposes, and even for small manufacturing and other establishments. Individuals or companies that can afford to do so will be wise to sink wells for drinking water.

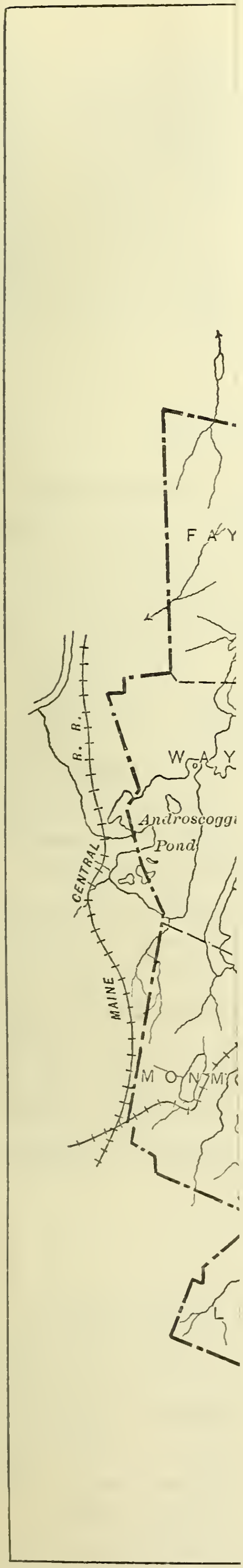
In most of the summer-resort districts of the county, especially on the islands, drilled wells are rather commonly used. Although some have been failures, there have been, on the other hand, a surprising number of successful wells drilled on islands where it would seem that the supply of water in the rocks must be small. In most localities the best method of obtaining water for cottages is by drilled wells. These should not go to a depth of more than 200 feet, as deeper drilling is generally of little avail.

A number of wells situated near the coast, and especially on the small islands, have been unsuccessful, owing to the entrance of sea water, which has ruined the wells. In certain wells fresh water has first been encountered, and by continued drilling to obtain a greater supply salt water has been struck; in others salt water has been struck first, the fresh-water seams existing at greater depths. Sometimes the water of the well is fresh, but by long-continued pumping becomes salt. In any of these cases, where both salt and fresh water veins are struck, it is possible for experienced drillers, by proper manipulation, as described on page 67, to close off the salt water and redeem the well.

KENNEBEC COUNTY.

GENERAL DESCRIPTION.

Kennebec County lies in the south-central part of Maine, on both sides of Kennebec River and directly east of Androscoggin and Franklin counties. It has a length from northeast to southwest of 50 miles and a maximum breadth from east to west of 35 miles. Its area is 880 square miles, and its population according to the census of 1900 was 59,117. The chief cities are Augusta—the state capital—with 12,379 inhabitants; Waterville, with 10,899; and Gardiner, with 5,501. The county is well provided with railroads, being crossed by a line of the Maine Central Railroad along Kennebec River and another line 5 to 15 miles west of the river, meeting the river line at Waterville. From Waterville the railroad runs northeastward to Burnham, and a branch extends north as far as Skowhegan, in Somerset County. The Somerset Railroad extends from its terminus at Oakland northward to Moosehead Lake, in Somerset and Piscataquis counties. A narrow-gage railroad—the Wiscasset, Waterville and Farmington—runs southeastward from Winslow to Wiscasset, in Lincoln County, and a branch of this railroad runs from Weeks Mills to Albion. The surface of Kennebec County is rather hilly, but is not so much so as some of the other counties in the State. The elevation ranges from sea level along Kennebec


F A Y
W A Y
Androscoggi
Pond
R. R.
CENTRAL
MAINE
M O N M

MAP OF KENNEBEC COUNTY.

Showing distribution of deep wells, important springs, and communities having public water supplies.

River to more than 700 feet on some of the hills. The tide on Kennebec River penetrates as far inland as Augusta. Within the county are a great many lakes, which are mostly utilized for summer resorts. The largest body of water in the county is Great Pond, in Rome and Belgrade. Throughout the county the open well is the prevailing type, but some drilling has been done. A map of this county showing distribution of deep wells, important springs, and communities having public supplies forms Pl. XV.

UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Distribution of rock types.—A large part of the county is underlain by slate. There is, however, a small patch of granite, about 5 miles in breadth, lying in the common corner of Manchester, Hallowell, and Augusta, and most of the area south of Gardiner consists of a complex of slate, schist, and gneiss, which can not be separated on any map.

Structural relation of the rocks.—Throughout nearly the entire county the slate strikes very uniformly northeast, and the dip of the strata and that of the cleavage are nearly vertical. The rock ranges from very shaly, or even fissile, to hard and dense, and in some places it is schistose.

Surface deposits.—The surface deposits of Kennebec County differ greatly in character and thickness. Along Kennebec River and up many of the side valleys there is considerable clay, which rises to elevations of more than 200 feet. In places this clay is underlain by gravels from a few inches to 50 feet or more in thickness. Elsewhere the clay is overlain by sand. On the hills the deposits are mostly till from 1 to 50 feet in thickness. In places, however, rather extensive morainal deposits are found on the hills, as in the vicinity of Augusta.

WELLS.

GENERAL DESCRIPTION.

Types of wells used.—The most common type of well in Kennebec County is the old-fashioned open well. These wells range in depth from 5 to 50 feet, and are dug in gravel or bowlder clay. They are generally successful, but often run dry in summer. The water is generally of good quality except where the wells are so situated as to become polluted.

Drilled wells.—About 35 drilled wells have been sunk in the county, ranging in depth from 30 to 560 feet, the most common depth being about 100 feet. The wells are mostly 6 inches in diameter, but three or more 8-inch wells have been sunk. In general the shallower of the deep wells have been successful, but a greater number of water veins and consequent larger supplies are obtained by going 100 to 200 feet. It happens that the largest supply reported was obtained from a well which went down more than 300 feet. This well got 50 gallons a minute at that depth. It seems worth the expense to drill as deep as this if sufficient water is not obtained nearer the surface. The deeper supplies in the slate have not been prospected, for the reason that plenty of water is obtained at shallower depths, but it would be well to drill a few test wells when more water is needed.

Quality of water.—Where unpolluted the well waters of Kennebec County are mostly good. The total solids as reported in four analyses range from 170 to 258 parts per million, but the amount of lime is never great enough to cause serious trouble in boilers. The only two complete analyses of slate waters in this county are given in the appended table (Nos. 62 and 67), but a number of field assays and other tests have been made (Nos. 60 to 70). Analyses 243 to 254 give the composition of several commercial spring waters.

DETAILED DESCRIPTIONS.

Augusta.—The city of Augusta is supplied with plenty of water of good quality from Cobbosseecontee Pond, and there is little necessity of using well water. One well 560 feet in depth, belonging to Mr. G. P. Sanborn, has been used for supplying a greenhouse. The amount of water is not large, and the well overflowed in rainy weather, indicating that the water may come from a surface source. Wells drilled in the neighboring town of Winthrop indicate that plenty of water may also be expected in the slate areas of Augusta, and wells drilled in granite at numerous places in Hancock, Lincoln, and Washington counties indicate that water may be expected in the granite areas in this city as well.

Hallowell.—Like Augusta, Hallowell has a surface water supply and is little in need of drilled wells. The only well known to have been drilled in the village is reported to have been sunk at Johnson Brothers' shoe factory. A well was drilled in 1880 on the farm of Mr. H. G. Vaughan to a depth of 70 feet, and enough water for drinking and farm purposes was obtained.

Farmingdale.—In the town of Farmingdale a number of wells have been drilled to depths of 50 to 110 feet. The water is generally of good quality, and there is plenty for ordinary domestic purposes. Assays have been made of two well waters in this town (Nos. 60 and 61).

Gardiner.—The water supply of Gardiner is taken from Cobbosseecontee Stream, just below the bridge at the upper end of the village of Gardiner. The water is reported good, but on account of the large number of farms situated along the banks of Cobbosseecontee Stream and its tributaries and the proximity of the pumping station to the village the supply must be considered as of questionable safety for the future.

Formerly, dug wells were abundant in the village, but they are now nearly all abandoned for the city water. Some dug wells penetrate the clay and get plenty of water which never gives out and which is cold and has an excellent taste. One 20-foot well goes through clay and gravel and rests on ledge. This well is in the heart of the city and so situated that the water probably enters the gravel bed within the limits of the populated district, yet nine families use the water. A number of similar wells were seen, some of which use chain pumps. On account of the extreme danger of pollution of dug wells situated in a thickly populated village these can not be considered safe. They are probably even more dangerous than the river water. The bed of gravel underlying the clay seems irregular in thickness, in some places reaching 15 feet and in others being entirely missing. A few wells only have given out. The solution of the water problem at Gardiner seems to lie in the abandonment of the present system and the installation of a supply from a point higher up on Cobbosseecontee Stream or its tributaries, where the water is safe.

Gardiner is situated entirely in the area of the complex consisting of alternating slate, schist, gneiss, and granite. Little well drilling has been done; but in the southern part of the town there are two drilled wells, 34 and 36 feet in depth, which are interesting as showing what should and what should not be done in the location of wells. Mr. Joseph Douglas has a well drilled to the depth of 36 feet entirely in rock. A deep-well hand pump was installed with the intention of using the water for drinking. The well stands only 15 feet from the barnyard, however, and the water is colored brown and has a bad odor, indicating the existence of open cracks in the rock extending under the barnyard, and consequent pollution of the well water. A dug well 15 feet in depth on the opposite side of the road and in a safe location is used for drinking water.

As a contrast, an example of a well-kept well is that of Mr. Charles Hopkins in the same part of the town. This well is 34 feet deep, and was drilled fifteen years ago, striking schist at 5 feet from the surface. The well is pumped by a windmill and gives an abundant supply of water. By looking down the well with a hand glass after pumping it as nearly dry as possible the water can be seen issuing from a crevice as large as a man's hand. This well has obtained more water than was found by farmers in the vicinity who have blasted in rock. The blasted wells here cost much more than Mr. Hopkins's well, and thus furnish an argument in favor of the drilled type.

Waterville.—The city of Waterville, together with other towns of the Kennebec water district, obtains its supply from China Lake.

Formerly it was obtained from Messalonskee Stream, which was badly polluted and caused a great deal of typhoid fever. At present, however, there is little need of drilled wells in the city, as the China Lake water is satisfactory. It is possible that drilled wells may have been sunk in the town, but inquiry during the investigation disclosed none. If rock water supplies are desired, they can probably be obtained by drilling at nearly any point, as few unsuccessful wells have been drilled in neighboring towns.

Winslow.—In 1899 the Hollingsworth & Whitney Company had a series of seven wells drilled 60 feet from the bank of Kennebec River and 20 feet above water level. The wells are 110 to 125 feet deep and extend along a line 90 feet in length. The water was used for cooling acid in the manufacture of paper. The wells were pumped by compressed air, thereby obtaining 200 to 300 per cent of the amount obtained by an ordinary steam pump. Now, after seven years, the wells are said to have filled with sand until they are only about 90 feet in depth. While they were used, pumping one of them would lower the rest. They are now abandoned because of insufficient supply for the purpose desired, and river water is used instead. A 67-foot well belonging to the same company is still used to supply drinking water.

On the terrace above these wells a number of persons have drilled wells to depths of 30 to 65 feet. These have met with varying degrees of success, some of them having plenty of water, while others give out in dry weather. It is probable that they would be more successful if drilled to 100 feet or deeper, as a greater number of water veins would be tapped. On the terrace between Kennebec and Sebasticook rivers there are flat areas of considerable clay which are worked in places for the manufacture of brick. In places the clay is overlain by sand, and at the village of Winslow a spring issues from the sand on top of the clay and is piped to four houses for domestic use.

A rather interesting well is that of Mr. Will Glidden, which is 30 feet in depth, drilled in slate. The water rises from the slate by artesian pressure into a dug well, from which it is pumped by a windmill. The pressure of water here is derived from a 15-foot rise in the hill 400 feet back from the well. A number of wells in Winslow have been blasted in rock. The water from one well on a hill is siphoned to a house on the hillside below. Field assays have been made of water from three wells in this town (Nos. 64–66).

Chelsea.—No drilled wells are known in Chelsea, but some wells have been driven and some bored to depths of 20 or 30 feet. The dug wells are generally of similar depths and the water is almost always of good quality. It usually issues from sand. Many farms in the town and the Maine Insane Hospital obtain supplies from springs.

Oakland.—Oakland has a public supply from Lake Messalonskee. This lake does not seem to be entirely safe from pollution, but the water is considered of very good quality. Drilled wells are unknown in the town.

Pittston.—In Pittston several drilled wells have been sunk, which range in depth from 56 to 135 feet. The water seems to be good, and is used for domestic and farm purposes. The yield is 8 to 10 gallons a minute.

Winthrop.—Winthrop is the only town in Kennebec County where drilled wells have been sunk extensively, and the almost unfailing success here is an index of the supplies which may be expected to be found by drilling elsewhere in the county. No fewer than a dozen successful wells have been drilled, mostly pumping 12 to 50 gallons of water a minute.

The principal wells in the village of Winthrop are owned by C. M. Bailey Sons & Co., H. P. Hood & Son, and Charles H. Gale. The public supply of the village comes from a spring belonging to the Winthrop Aqueduct Company, from springs and drilled wells belonging to Charles H. Gale, and from springs belonging to Levi Jones. The principal water system is that of Mr. Gale, whose wells and springs are situated on the hill directly west of the village. The wells are three in number, and are 90, 96, and 65 feet deep. They give a fair amount of good water and can not easily be pumped dry. Probably half the people of the town use this supply. These wells and the associated springs are described in detail under the heading "Public supplies" (pp. 157, 158).

The best well in Winthrop was drilled in 1906 for C. M. Bailey, Sons & Co. at their factory. This was sunk to a depth of 307½ feet. At 300 feet from the surface a supply of fine water was struck, which when tested yielded 50 gallons a minute. The pump is generally run three hours a day, but has been run eight hours continuously without exhausting the supply. The water is used for boilers, but is also excellent for drinking. The analysis is given in the table (No. 67). The well of H. P. Hood & Son was drilled in 1903 to a depth of 172 feet. It was cased with 8-inch casing to ledge, a distance of 18 feet, and 6-inch pipe was then run down to 140 feet. It is reported to yield 25 gallons of water a minute and can not be pumped dry. In these two wells the water stands about 8 feet from the surface.

At Winthrop the rock is slate; at Baileyville (Winthrop Center) it is schist, but the water seems to be just as abundant. The well of Mrs. Hannah J. Bailey, drilled 200 feet through rock, obtained 15 gallons of fine water a minute and now supplies four families and a boarding house. The water is piped to the houses from a windmill. Messrs. C. I. Bailey and J. Briggs own a well together, and the depth and quality of the water were similar to those of Mrs. Bailey's well.

The yield is reported as 30 gallons a minute. All the wells at Baileyville have been successful, and the water is of good quality and has no iron taste. The marked success of wells in this vicinity is a strong indication that similar wells can be obtained in other parts of the slate area of Kennebec County.

Other towns.—In the towns of Litchfield, Albion, and Sidney there are scattering drilled wells. In the following towns no drilled wells are known to have ever been sunk, and the supplies are obtained entirely, so far as known, from open wells: Vienna, Rome, Mount Vernon, Fayette, Belgrade, Readfield, Monmouth, West Gardiner, Manchester, Oakland, Waterville, Clinton, Benton, Unity Plantation, China, Windsor, Chelsea, and Randolph.

SPRINGS.

General statement.—Springs are very common on the hillsides of Kennebec County. They usually issue from bowlder clay or sand and at many places are used for domestic and farm supplies. In Augusta the Maine Insane Hospital draws its supplies from a spring situated back in the hills. At the village of Winthrop several small aqueduct systems take their water from springs situated on the hills west of the village. These are described under the heading "Public supplies" (pp. 157, 158). Within the limits of the county are the Forest Springs, at Litchfield; Pure Water Spring, in Waterville; and Ticonic Mineral Spring, at Winslow.

Forest Springs.—The Forest Springs Water Company was organized in 1900 for the purpose of marketing the water which comes from the Forest Springs, in the town of Litchfield, 1½ miles northeast of Litchfield Plains. The springs have been renowned for their purity for more than a hundred years and are said to have been much frequented by the aborigines.

There are three springs. The first is 450 feet from the second and about a quarter of a mile from the third. The two principal springs are situated at the base of a gentle sandy slope, not far from a small brook; the third spring is farther back in the woods. The principal spring is in reality a well 6 feet in depth. At this place were encountered the following strata, from the surface downward:

Section of drift at Forest Spring.

	Feet.
Gravel loam	2
Clay	1
Fine gravel	28
	31

The spring was curbed down 6 feet and has a sandy bottom. It is situated in the woods far from any house, and the water is of excellent quality, with no chance of pollution. The analyses of the three springs, reported in a circular issued by the company, are given in the table (Nos. 247 to 249), recalculated according to the standard method. The company has built an up-to-date bottling plant near the springs, and the water is carefully bottled and shipped in half-gallon and quart bottles and 5-gallon carboys. The flow of the principal spring is 100 gallons an hour.

Pure Water Spring.—The Pure Water Spring is situated 1½ miles north of Waterville. The water is carbonated and sold in Waterville. The hardness is given by the owners as 41.5 parts per million.

Ticonic Mineral Spring.—About 2 miles northeast of Waterville is the Ticonic Mineral Spring, the product of which is sold in Waterville. The flow is reported as 5½ gallons a minute. The analysis of this water is given in the table (No. 253), recalculated from the figures reported by the owners.

PUBLIC SUPPLIES.

General statement.—Eleven villages in Kennebec County—Augusta, Hallowell, Farmingdale, Gardiner, Randolph, Oakland, Waterville, Benton, Belgrade, North Vasselboro, and Winslow—have public supplies drawn from surface sources. The only important underground-water supply is that of Winthrop, which uses wells and springs. Hallowell, Augusta, and Vienna are reported, however, to have small spring supplies.

Winthrop.—The village of Winthrop has no regular municipal supply. There are, however, a number of aqueduct companies, and these furnish water to a majority of the population. Most of the water is supplied by Charles H. Gale, the Winthrop Aqueduct Company, and Levi Jones. The largest system is that owned by Mr. Gale, which consists of wells and springs situated on the hillside just west of the village. The wells are about 100 feet above the village and are sunk to depths ranging from 65 to 120 feet. The springs are near by, in a swampy depression in the hillsides. The water is collected in a reservoir.

At first consideration the swampy source of the springs would seem to be an argument against the use of this water. It can be said, however, that there may be no great danger of this water being contaminated by surface drainage. One house is situated on the hillside above, but it is so far away as probably to have no effect on the water supply. From the reservoir the water is piped to the town in galvanized-iron pipes, which are badly rusted by the water. As the system is a gravity system the water has a good pressure. There are reported to be about 150 patrons of the system, and this probably represents about half the village population. The wells are pumped by windmills. The owner reports that when the wells are used there is plenty of water to supply all needs. Without the wells, however, the amount is not sufficient. No analyses of the water have been made except a sanitary analysis made some years ago.

An interesting feature was brought out in connection with this analysis. The water was sent to a chemist by a resident of the town, as it was supposed to be polluted. At the same time a sample taken from a dug well in the village was sent—a well extensively used by the residents and believed to be excellent. On receipt of the returns it was found that the water of the dug well was badly polluted and that the public supply was of excellent quality. This is a strong argument against the use of dug wells in a thickly settled village and in favor of the installation of deep-well supplies wherever practicable. There is some question in this case about the use of the springs. They are certainly not as good as the drilled wells, but they are probably safe.

The other water systems have their source in springs situated on surrounding hillsides, but the number of takers is smaller. The supply belonging to Levi Jones issues from a bowlder-clay hillside and is conveyed by gravity in galvanized-iron pipes to the village. About 35 families are reported to use the water, which is believed to be of good quality.

The water rates in Winthrop are $6 a year. The fire hydrants are supplied from an entirely separate source, pumped by the Winthrop Mill Company from another well.

Vienna.—A few persons, probably fewer than a dozen, in Vienna village are supplied by water from a large spring piped through a main three-fourths of a mile in length.

Hallowell.—In the town of Hallowell there is a supply owned by the city, reported to be derived from springs on Winthrop Hill. The water is obtained by direct pressure, and the pressure is 40 to 110 pounds. About 120,000 gallons are consumed daily.

PREDICTIONS AND RECOMMENDATIONS.

In Kennebec County few failures in well drilling have been recorded. The underlying rock of the county consists almost entirely of slate, and the almost uniform success of wells in rock of this type is contrasted to the frequent failures of wells in some other regions. So far as known, the public water supplies are at present all of good quality, although in the past there has been some trouble from water taken from Messalonskee Stream in the vicinity of Waterville. This supply is no longer used. No public supplies are known to be of poor quality. In Oakland and Gardiner, however, it would seem that the supplies are only temporarily safe; they are so situated that they may in time become polluted unless proper precautions are taken. Drilled wells in these towns would be a safeguard in case the condition of the water should cause trouble.

KNOX COUNTY.

GENERAL DESCRIPTION.

Knox County occupies a nearly central position on the Maine coast. Its length from north to south, including the outer islands, is 35 miles, and its breadth is about 20 miles. It has an area of 327 square miles, being, with the exception of Sagadahoc, the smallest county in Maine. Its population, according to the census of 1900, was 30,406. Rockland, the chief city, contained 8,150 persons, Camden had 2,825, and Thomaston 2,688. The only railroads in the county are a branch of the Maine Central which crosses from Warren to Rockland, and the Georges Valley Railroad, a short line running from Warren to Union. The surface of the county is gently undulating in the southern part, but rather mountainous in the northern part. The altitude ranges from sea level to more than 1,450 feet, the highest elevation being in the town of Camden; and its surface is covered with a considerable number of ponds and small lakes. A map of Knox County showing the distribution of deep wells, important springs, and communities having public supplies forms Pl. XVI.

UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Distribution of rock types.—The rocks of Knox County consist largely of a complex of granite, diorite, slate, schist, etc. In the southeastern part of the county, extending from Rockport southwestward across Rockland, Thomaston, and Warren, are small bands of limestone rock, from a few hundred feet to about a mile in breadth, bordered by slates, schists, and quartzites. The limestone strata are much contorted, the rock is very hard, white to blue and gray in color, and is extensively quarried. In the eastern part of South Thomaston and St. George and covering the adjacent islands is a small granite area. The continuation of this area covers the greater part of Vinalhaven. A small area in the northern part of the same island and the entire island of North Haven consist of trap, slates, and acidic volcanic rocks.

The detailed geology of considerable portions of the county has been worked out by E. S. Bastin, of the United States Geological Survey, and will be given later under the names of the various towns.

Surface deposits.—The surface deposits of Knox County are irregular in thickness. Along the coast and in the lowlands the sands and clays locally run up to 100 feet in thickness, though usually much thinner, and their upper surfaces form flat plains near the coast and in the larger valleys. In the vicinity of Thomaston the clays are rather extensive. In some parts of the county there are small morainic deposits, which are in places as much as 100 feet thick, consisting of sand, gravel, and till. Over the greater part of the uplands the surface is bowlder clay, ranging from 1 to 10 feet in thickness. In places this is absent and the hills consist of bare rock. Most of the water from dug wells in Knox County is derived from the surface deposits.

WELLS.

GENERAL DESCRIPTION.

Types of wells used.—The wells of Knox County are mostly dug wells, but on the coast and islands a considerable number of drilled wells have been sunk. The dug wells range from 5 to 30 feet in depth and are mostly sunk in bowlder clay or gravel. They contain plenty of water in the wet season, but in summer they often run dry.

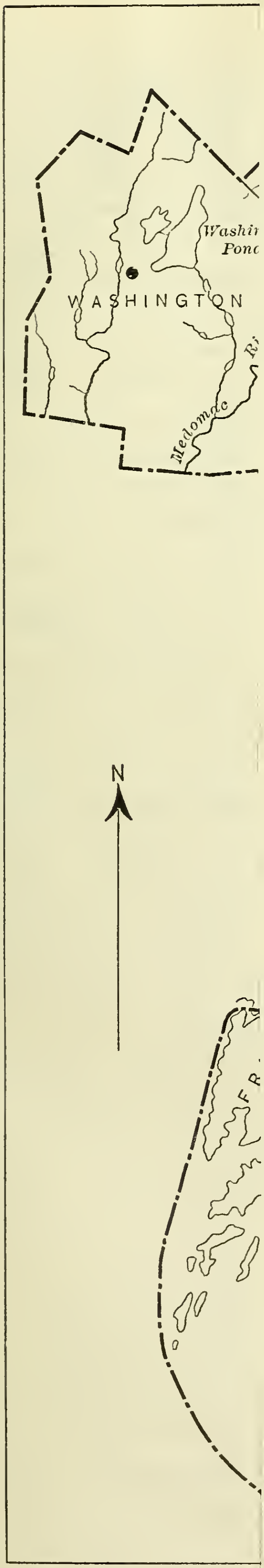
Drilled wells.—The drilled wells in this county are about 40 in number. They are from 50 to 640 feet in depth, and the yield ranges up to 25 gallons a minute. Most of the wells in the county have been successful, but several have failed. At North Haven a 300-foot well was dry, while a 200-foot well near it contained a small quantity of water. In the vicinity of Rockland one well was abandoned because the water was not sufficient to supply a large hotel, and a second well was salty. The county contains one flowing well which supplies the town of Warren. The wells between 100 and 200 feet in depth obtain the largest amount of water. Of the seven wells sunk below 200 feet, only one got an appreciable increase in the supply. These rocks probably do not contain much water below that depth.

Quality of water.—The quality of water in the wells of Knox County ranges from very soft to very hard, the hardness being dependent on the amount of lime in the rocks in which the wells are sunk. The only analysis of water from solid limestone is that of a sample from the bottom of one of the Rockland limestone quarries (No. 255). It will be noticed that neither the total solids nor the calcium is as high as in some waters from rocks that do not contain as much lime. The magnesium, however, is very high—22 parts per million.

The only other complete analyses of Knox County waters are those made from two trap wells at North Haven. The total solids in these wells are 90 and 2,057 parts per million. The excessive amount in the latter well is due to an admixture of sea water.

DETAILED DESCRIPTIONS.

Rockland.—The Rockland region is occupied largely by slate, schist, and limestone with minor areas of quartzite. In the northwest corner of the town the slates are broken up and are intruded by granites, gneisses, and similar rocks. West of the city proper is a narrow belt of crystalline limestone extending in an easterly direction from Thomaston toward Chickawaukie Pond. It is bordered



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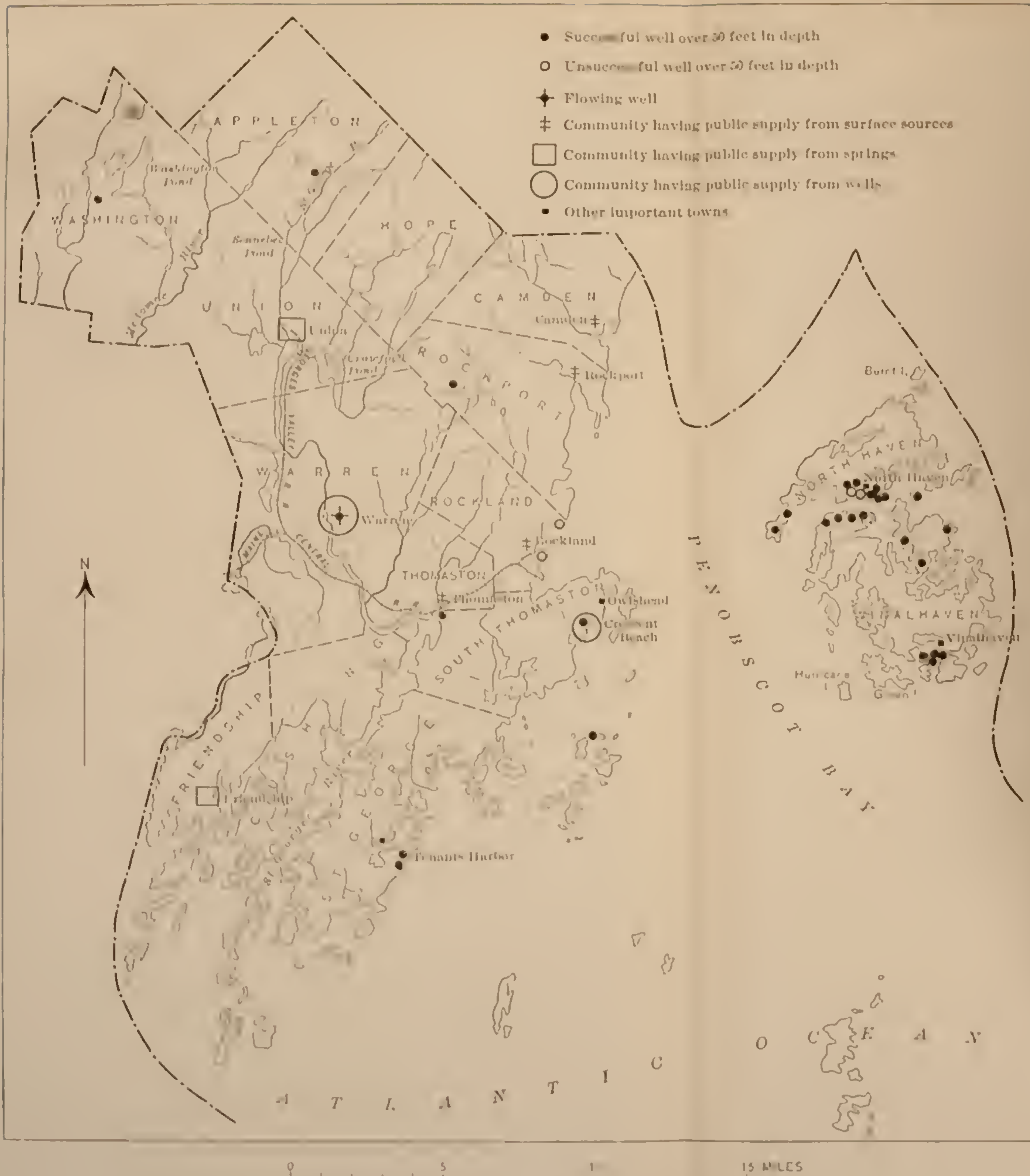


MAP OF KNOX COUNTY.

Showing distribution of deep wells, important springs, and communities having public water supplies.

on the southeast by a number of smaller limestone bands. This limestone is extensively quarried, some of the quarries being several hundred feet deep. Those which are abandoned are filled with water. Associated with this limestone are a few narrow bands of quartzite.

Few dug wells remain in Rockland, but along the limestone region are a number which are dug to rock, striking it at depths of 15 to 20 feet. The water here is uniformly hard. There is plenty of it in winter, but it gives out in summer. In dug wells in the immediate vicinity of the quarries the water gave out, owing to the drainage of the surface deposits by the quarrying operations.

The limestone quarries in the vicinity of Rockland, Thomaston, and Warren are the only quarries in this kind of rock in Maine, and as they throw some light on the occurrence of water in limestone, they deserve special consideration. In Rockland several quarries extend to a depth of more than 300 feet below the surface. Some of them are now abandoned and filled with water within a few feet of the surface. Where they are being worked water can be seen entering from the joint cracks below a depth of about 80 feet from the surface. An example of the amount of water entering these quarries per day is furnished by a quarry 300 feet long, 70 feet wide, and 180 feet deep. In the bottom of this quarry is a hole 25 by 30 feet across and 4 feet deep which fills in about twelve hours during the night. This is at the rate of about 10 gallons a minute. The water is pumped out in about an hour and a half in the morning. It can be seen dripping into the quarry along the joint cracks, and in one or two places springs of considerable size are found. The most water enters along the ends of the quarries parallel with the stratification of the rock, but much of it comes in on the horizontal joints.

A number of quarries show caves in limestone, due to the solution of this rock by the water. One or two caves of considerable size were found. (See Pl. VII, *B*.) The largest are 5 feet across and extend more than 5 feet inward from the side of the quarry. In one place where the drift has been stripped from the surface a former water channel about 2 feet in diameter was seen running downward into the rock. A few solution channels are seen following the horizontal joints, and in places these are 2 to 4 inches in diameter. The occurrence of water in solution channels in limestone is a common feature in such rocks throughout the country, and the drillers frequently find that the drill drops several feet when a vein of water is struck. There is plenty of water in this rock at Rockland, but it is very hard.

The city of Rockland has an excellent supply of water from Oyster River Pond, with Chickawaukie Pond as an auxiliary supply. Not more than three wells are known to have been drilled in Rockland, and these have been abandoned. One was drilled on Crockett Point in 1900 to a depth of 22 feet, striking rock at 3 feet from the surface, but was abandoned because the water was salty. In 1906 an 8-inch well was drilled at Hotel Samoset, Rockland Breakwater. The surface was clay rising a few feet above tide, but rock was struck at 14 feet and the well was sunk to a depth of 640 feet. At 185 feet 10 to 12 gallons of water a minute was struck, but below that no water was found. This supply was not sufficient for a large hotel and the well was plugged. However, the water would have been enough for several private families. No information can be obtained regarding the other well at Rockland.

Thomaston.—Northwest of a line drawn from the western edge of Thomaston village to Mount Battux in Rockland the rocks of this town consist of slate and schist. There is also a small area of slate crossing the village of Thomaston. The most conspicuous rock east of the slate area is a band of limestone, more than a mile in breadth, extending from the southern border of the town northeastward to Chickawaukie Pond, in Rockland. South of this limestone area are a number of alternating bands of quartzite, schist, and limestone which are too complicated for description. In a limestone quarry is a spring which is reported to give a good flow of water. As in Rockland, the dug wells overlying the limestone are from 10 to 20 feet in depth, and the water is very hard. Some of the wells rest on ledge. They sometimes run dry in summer.

Only one drilled well has been sunk in the town—that of the Thomaston Brick Company. It was drilled 46 feet through marine clay, then in limestone for 340 feet, making a total depth of 386 feet. The water is hard and the supply is only about 3 to 5 gallons a minute.

South Thomaston.—The eastern and southern parts of South Thomaston are composed mostly of granite and much associated gneiss and basic rocks. Between Weskeag River and Rockland Harbor is a band of slate and schist more than half a mile broad. West of this band the area consists of the same succession of quartzite, limestone, and slate which is found in the southeast corner of Thomaston. Most of the wells in this town are dug. At Crescent Beach a well was drilled in 1906 for Mr. F. M. Smith to supply cottages at that place. The depth was 75 feet, and the well furnished 5 or 6 gallons of water a minute, which was reported to rise within 2 or 3 feet of the surface in the wet season. The well can be pumped down 30 or 40 feet, but can not be exhausted. Other data regarding it are given in the section on "Public supplies" (p. 167).

Several wells are reported to have been drilled at Owlshead and Hendrickson Point, but information regarding them has not been received.

St. George.—The town of St. George consists almost entirely of granite. There are, however, in the western half of the town considerable areas of diorite. The wells of this town are for the most part dug wells, but on Harts Neck, south of Tenants Harbor, at least three drilled wells have been sunk to supply summer cottages. Those of Mr. William S. Richardson and Mr. J. B. Aldrich are rather interesting. While these wells are situated so near the houses that windmills could not be built over them, the windmills were built a few feet distant and the wells are pumped by means of a connecting rotating horizontal rod. The wells are drilled 67 and 54 feet deep, in a very hard gneissic rock. The Richardson well is reported to yield only 2 gallons of water a minute. Another well near by was also successful. At Port Clyde a well is reported to have been drilled, but no information regarding it is at hand.

Warren.—The town of Warren is almost entirely underlain by granites, gneisses, diorites, and schists, mixed in the form of a complex. There are, however, small areas of other rocks. One of these extends as a narrow strip from the southern border of the town in the vicinity of Thomaston northward along the Thomaston and Rockland line beyond the head of Oyster River. Northwest of Warren village is a small area of limestone which is quarried. Most houses in the village of Warren have dug wells, but these are abandoned and the people use the public supply. This comes from a deep drilled well situated on the high hill east of the village. It is 196 feet deep and is reported to flow 5 feet above the surface without pumping. The volume is reported to be 8 gallons a minute, and in a test the well pumped 100 gallons a minute for five days continuously. The country rock is complex, and as no rock shows within half a mile it can not be said certainly from what material the water comes. For full information regarding this system of waterworks see page 166.

Rockport.—The entire western part of Rockport, including all the area lying west of the village of West Rockport, is occupied by a complex of granite, gneiss, diorite, schist, and other rocks. The area east of this line is composed almost entirely of schist, with some slate. There are, however, a few small areas—one in the vicinity of Oakland Park, a second just south of Rockport village, a third crossing the village itself, and a fourth between Rockport village and Simonton Corners—which consist of quartzite, and smaller areas in the village of Rockport and north of Simonton Corners consist of limestone. Rockport draws its water from Oyster River Pond, and hence wells might be considered unnecessary in the village. As the rock is near the surface, however, and it is hard to pipe the streets, many dug wells are still used. They should be abandoned as rapidly as practicable. Through the country the wells are mostly dug. One drilled well of moderate depth and fair success has been sunk for Mr. Oscar Gould near West Rockport.

North Haven.—North Haven and the outlying islands included within the town are composed principally of basic lavas or greenstone. A small area in the vicinity of North Haven village, however, stretching eastward across Stimpson, Babbage, Calderwood, and Burnt islands and Indian Point, is formed of volcanic rock. On the main island of North Haven considerable drilling has been done, especially near North Haven village. Messrs. C. S. Staples and J. M. Howe put down two wells in 1902 to depths of 200 and 300 feet. The deeper well was dry and the other obtained only 1½ quarts of water a minute at 68 feet. Eighteen pounds of dynamite were exploded at that depth and the supply of water increased to 3 quarts a minute, but no more than this could be obtained. In 1893 Mr. Nelson Mullin had a well drilled 121 feet in trap in the same village. The water is called a little irony, but the supply is 5 gallons a minute and is considered satisfactory for a hotel and five cottages which are supplied from it. (See field assay, analysis No. 132.) Mr. F. S. Mead also drilled in trap and obtained 10 gallons a minute. The well belonging to Mr. F. H. Smith is 118 feet deep and supplies a store, three dwellings, a fish market, and a livery stable.

On the point a mile east of the village Dr. C. G. Wells had three wells drilled in 1891, 1895, and 1903 to depths of 122, 142, and 282 feet, getting 2, 20, and 6 gallons of water a minute, respectively. The water is found at various depths, is pumped by windmills and a hot-air engine, and is used for supplying cottages and a steam yacht. A short distance north of the wells belonging to Doctor Wells is one belonging to Mr. William A. Gaston, 57 feet in depth. One well at North Haven was ruined by the accidental admission of calcium carbide into it from an acetylene-gas generator. Analyses of two wells drilled in trap at North Haven are given in the table (Nos. 155 and 156). One of these was salty.

Vinalhaven.—The major portion of Vinalhaven is composed of granite. In the vicinity of Barley Hill and Coombs Hill and at several places near Vinalhaven village there are small areas of diorite. Zeke Point is made up of lava, but the northern half of Calderwood Neck is schist. The part of the island northwest of Seal Cove and Long Cove is largely lava, but a number of patches of diorite lie along the coast, and there are several small areas of schist and lava.

On the main island of Vinalhaven six or more wells have been drilled to depths ranging from 120 to 225 feet. Four of them are situated at the village of Vinalhaven, where sometimes as much as 20 gallons of water a minute is obtained from granite. The well of the Bodwell Granite Company, 125 feet in depth, is pumped by a gasoline engine and the water is used in dressing granite. Some veins of salt water were encountered below a depth of 50 feet in this well. The well of the Vinalhaven Fish Company, 225 feet in depth, is pumped in the same way, gives 20 gallons of water a minute, and is used to supply a canning factory.

At the north end of the island the rock is mostly trap. There are a number of wells here, and these are from 100 to 200 feet in depth, obtaining from 10 to 25 gallons of water a minute by windmills. The well of Mr. J. M. Howe here supplies four cottages, and that of Rev. G. A. Strong supplies three cottages. (See field assay, analysis No. 133.) Mr. Howe owns several wells on the island.

The conditions observed in the granite quarries at Vinalhaven are as follows: No seepage of water from the joints was noticed, but they are somewhat stained by iron. One east-west joint, due largely to weathering, is 4 inches wide. Both systems of joints are well developed in places. In some parts of the quarries they are only 1 to 4 feet apart, but elsewhere they may be 10 or 20 feet apart. Near the bottom of a neighboring quarry four small seepages were seen from horizontal joint cracks. All the water obtained from these cracks is used for engines in the quarry and polishing house.

On Widow Island a 109-foot well drilled in granite for the Maine Insane Hospital yields 2 gallons of water a minute. The well is pumped by a gasoline engine and the water is used for domestic purposes by 70 persons. It is considered of excellent quality.

Camden.—About half the town of Camden, including the entire area lying west of a line drawn from Melvin Heights northeast to the Waldo County line, is composed of a complex of granite, gneiss, diorite, and schist. The region east of this line is occupied by slate and schist, with the exception of an area extending from the extreme west end of the village of Camden northeastward to the saddle between Mount Battie and Mount Megunticook, which is composed of quartzite, and of a small patch south of the village and extending into Rockport which is composed of limestone. There are also a few small patches of quartzite, limestone, and other rocks scattered promiscuously through the town.

Camden has a good surface water supply from Mirror Lake, and the village is not in need of wells. On its borders and in the country districts people still use dug wells, which give water of variable quality. No drilled wells are known to have been sunk.

Other towns.—In the towns of Washington, Hope, Union, Friendship, and Cushing no drilled wells are known. The conditions are as usual in the country districts and supplies can be obtained by dug wells, but these are of variable quality and sometimes run dry in the summer.

SPRINGS.

Knox County is well provided with springs. In the town of Camden Mr. Frank Alexander has a spring consisting of a well-like hole, 2 feet in depth, dug in the bottom of the cellar, 6 feet below the surface of the ground. The material is hard "pin gravel." Mr. Alexander has a waste pipe 2 feet below the cellar and the spring overflows to a near-by valley. This spring was installed before the town had a public supply. It is described here as an example, for the reason that spring waters coming from under dwelling houses are not safe. When springs have their origin in sands and gravels at a distance from houses they are generally preferable, but they can not be recommended when they are so situated as to be influenced by surface drainage from surrounding buildings.

PUBLIC SUPPLIES.

General statement.—The towns of Rockland, Camden, Rockport, and Thomaston have an excellent public water supply furnished by the Camden and Rockland Water Company and drawn from Mirror Lake, in the town of Camden. Two communities in this county—Warren and Crescent Beach—use deep wells for their public supplies, and two villages—Union and Friendship—have spring supplies.

Warren.—The village of Warren is supplied by the Warren Water Company, which has an artesian well situated on the hillside about one-half mile east of the village. The well is 196 feet in depth and is a drilled well 6 inches in diameter. It was sunk 54 feet in 1900 and to its present depth in 1903. The flow began at 165 feet and increased to 185 feet. The well is reported to flow 5 feet above the surface without pumping and to give a volume of 12 to 15 gallons a minute, but is fitted with a windmill and a gasoline engine for use when necessary. When tested for five days and five nights it averaged 100 gallons a minute. The hill on which the well is situated consists of a gentle bowlder-clay slope rising toward the east, and the well is about 100 feet above the highest part of the village. The water is pumped to a reservoir situated some 800 feet distant. It is in the midst of pasture land, but is surrounded by a barbed-wire fence 10 feet from the nearest point of the reservoir. The pressure is 85 pounds. An 8-inch main carries the water to 10 fire hydrants and most of the residences in town.

This water company is said to have been formerly conducted by Mr. White, who had a shallower well on the same site as the present one. On account of failure the present company was formed. The well seems to give a plentiful supply of water, as evinced by one occasion when there was a fire and two lines of hose were run to the burning building without the water being exhausted. The rate is $7 a year for family use for one faucet, but an extra charge is made for other faucets. The water is said to be of excellent quality. The principal constituents shown by a field assay are given in analysis No. 134.

Crescent Beach.—Crescent Beach, in the town of South Thomaston, is supplied by a drilled well belonging to Mr. F. M. Smith. The well is situated on a gentle gneissic slope at some distance from the village. It is 75 feet deep and was guaranteed by the drillers to give 6 gallons a minute. It is pumped by a windmill which has been run steadily a week at a time. Sometimes a gasoline engine is used. The water can not be pumped out, but can be lowered 30 feet. When not pumped it often stands only 2 feet below the surface. The water has been considered good by the users, but sometimes gives a bad odor. An examination of the well disclosed the probable cause. The casing is open at the surface, thus giving a chance for mice, snakes, or other small animals to fall in. This is a good example of how a well should not be kept. The top of the casing should always be closed. The well has supplied about 25 cottages at the beach, also the stable and hotel buildings.

Union.—The village of Union is supplied by the Union Water Company through a gravity system from springs on the hillside east of the village. There are two springs, reported to flow 2 gallons a minute each, which seep out of bowlder clay. About 80 families are said to use this water. The pressure is 50 to 80 pounds.

Friendship.—The village of Friendship is supplied by a spring system owned by the Friendship Water Company, of Warren. The water boils up through sand at a reported rate of 20 gallons a minute. It is pumped into a tank by a windmill. It is good soft water and seems to be entirely satisfactory for domestic use. The system is said to supply 60 families.

PREDICTIONS AND RECOMMENDATIONS.

The public water supplies of the larger villages of Knox County are all of good quality, so far as known, and there seems to be little necessity for their improvement. In view of the fact that most wells drilled within the county have been successful, it is suggested that drilled wells be used more extensively. They will be found especially satisfactory on the islands and rocky coasts of summer resorts, where it is difficult to get an adequate supply from open wells.

LINCOLN COUNTY.

GENERAL DESCRIPTION.

Lincoln County lies a little southwest of the center of the Maine coast. It is 40 miles in length from north to south and 20 miles from east to west. Its area is 520 square miles, and its population in 1900 was 19,669. Wiscasset, the county seat and largest town, contained only 1,273 inhabitants. About 7 miles of the western border of the county fronts on Kennebec River. The county is crossed by the

Maine Central Railroad from Wiscasset to Waldoboro and by the Wiscasset, Waterville and Farmington Railroad, a narrow-gage line running north from Wiscasset to Winslow in Kennebec County. The surface of the county is much broken up by indentations from the sea projecting many miles inland, and the coast is lined by a great many islands. The altitude ranges from sea level up to about 500 feet on a few of the hills. Along the coast considerable well drilling has been done. The distribution of deep wells, important springs, and communities having public supplies is shown in Pl. XVII.

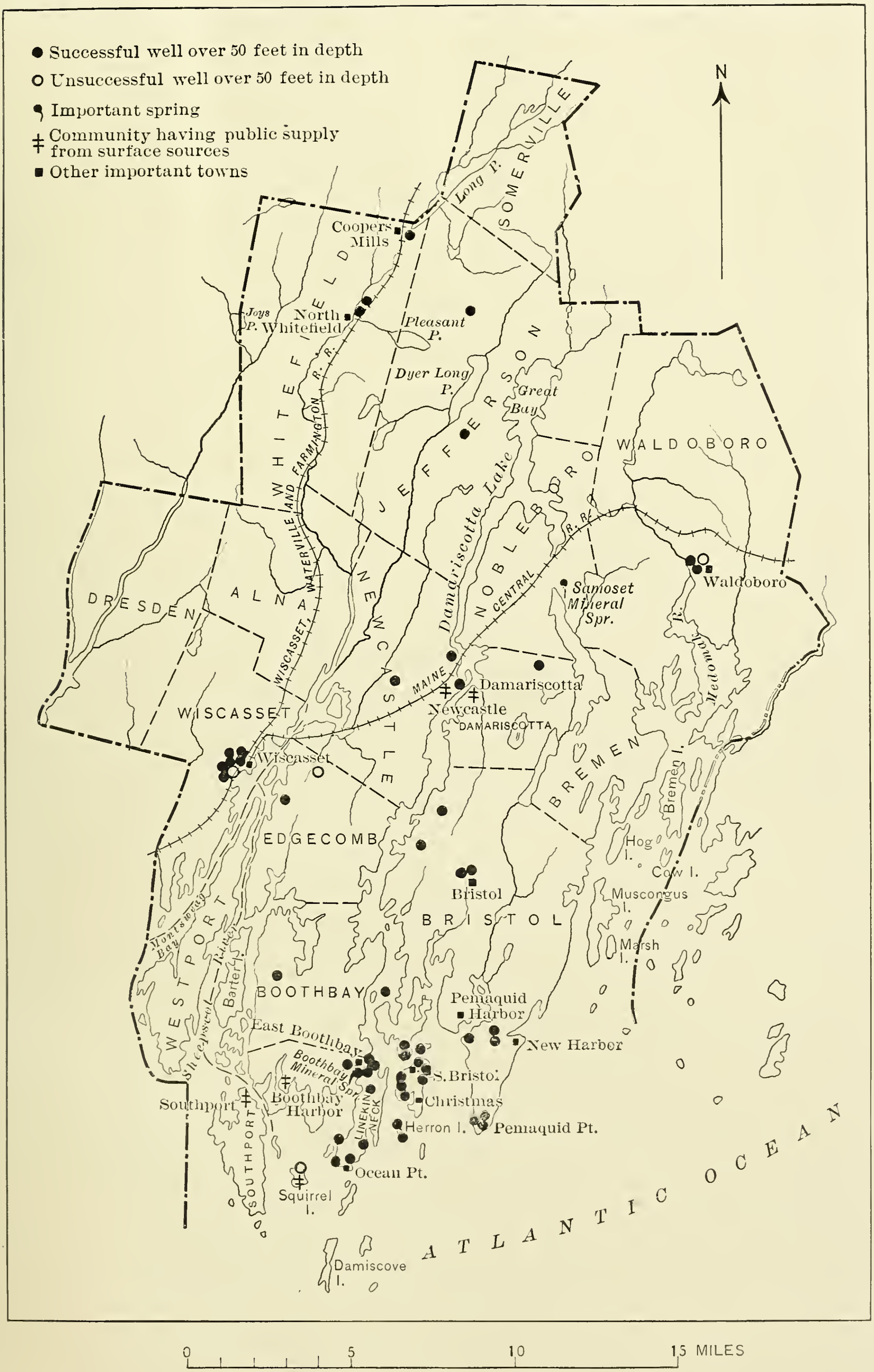
UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Distribution of rock types.—Nearly the entire area of Lincoln County is composed of a complex of slate, schist, gneiss, pegmatite, etc. The greater part of the towns of Waldoboro and Bremen is, however, occupied by granite. Smaller granite areas exist within the limits of the complex, but they are for the most part not large enough to be mapped.

Character of rocks.—The rock complex of which most of Lincoln County is composed is similar to the areas of complex in other counties. Where outcrops are seen they may consist of dense schist, striking in a northeast-southwest direction and having a nearly vertical dip, or of granite or gneiss or pegmatite. In most places the exposures consist of a mixture of these types, perhaps with gradations between them. Here and there these rocks are intruded by masses of trap, diorite, or other igneous rocks. There are no quarries in the area of complex in this county or elsewhere in the State, and for that reason the actual conditions in which the water is held in the rocks are not well known. A few railroad cuts show water seeping out of horizontal joint cracks or along the contact between various types of rock. In some sections along the railroad the water is seen in cracks which have been opened by blasting. This would seem to indicate the desirability of "shooting" wells where no water is obtained. In general the occurrence of water in the area of complex is likely to be less abundant than in areas of granite or of slate. This is presumably due to the fact that the changes in character of the rock interfere with the circulation of water through definite joint cracks extending for long distances.

Surface deposits.—The surface deposits of this county are as a rule not of great thickness. The coasts are rocky, and the islands contain only a few feet of drift. Some exposures of clay are found along the valleys, and these may be expected in protected areas anywhere up to an elevation of 200 feet or so. Small areas of stratified sand and gravel also rise to the same altitude. Most of the uplands



MAP OF LINCOLN COUNTY.

Showing distribution of deep wells, important springs, and communities having public water supplies.

of the county are covered by till, which varies in thickness from 1 to 20 feet or more. The thickest deposits of drift are probably in the vicinity of Waldoboro, where there are large moraines.

WELLS.

GENERAL DESCRIPTION.

The wells of Lincoln County consist of both dug and drilled types, the former being by far the most numerous, as in other regions. There are, however, more than 80 drilled wells within the limits of the county. These range in depth from 30 to 360 feet, and the usual size is 6 inches. The most common depth of wells in this region is somewhat less than 100 feet, and probably not more than 70 feet. There are, however, a few wells as much as 150 feet deep and three wells have been sunk more than 200 feet. In general the deeper wells are not so successful as those of moderate depth. The 360-foot well on Ocean Point is an exception to this rule, and in that well a large portion of the water was obtained near the bottom.

The quality of the water from deep wells in Lincoln County should probably be ranked lower than that of any other county in Maine. The most common defect is the large proportion of iron which it contains. This is shown in few analyses; it is in reality but a few parts per million, but is sufficient to give a distinct mineral taste to the water and sometimes makes the water too rusty to be used for washing. The mineral matter ranges from 95 to 419 parts per million, as shown by analyses Nos. 135 to 149 and 22 to 28 in the table. The water is generally called hard by the residents. Analyses of three mineral springs are given also (Nos. 256 to 258). No flowing wells are known within the limits of the county.

DETAILED DESCRIPTIONS.

Wiscasset.—As Wiscasset has not yet a public water supply, a considerable number of drilled wells have been sunk in the village. More than fifteen years ago a well was drilled for Mr. W. G. Hubbard at the Hilton House to a depth of 70 feet. At 68 feet a fine supply of water was struck, which can not be exhausted when pumped at the rate of 35 strokes a minute, and after eight or ten hours' pumping the well contains just as much water. It is supposed to yield about 15 gallons a minute. When first struck the water would fill the well at the rate of 15 feet in five minutes. It can be lowered 50 feet by pumping. A gasoline engine was installed and a well house and tank were built at a total cost of about $1,000.

Another good well was drilled in 1905 at the custom-house to a depth of 75 feet, and water was struck at 72 feet, increasing in volume near the bottom of the well. It supplies the custom-house and half a dozen families for drinking and cooking purposes. This well was cased 6 feet into rock, and at the surface of the ground a cement floor was put in as a preventive of contamination by infiltration of surface drainage. The water can be lowered, but it will return to its former level in ten minutes. Four hours' pumping will not exhaust it.

In the 48-foot well of Mr. S. B. Cromwell, at Wiscasset, the drill dropped 3 or 4 inches when water was struck, indicating the occurrence of joint cracks. Several wells between 30 and 50 feet in depth in this village have good supplies. Most of them can not be pumped dry. The water sometimes has a bad taste, which is believed to be due to its action on the galvanized-iron pipe, but may be due to the iron naturally contained in the water.

Two wells in Wiscasset, both situated at the Turner Center Creamery, only a block from tide water on Sheepscot River and 5 feet above tide, have been spoiled by the entrance of salt water. One of them, 64 feet in depth, was drilled in 1890 for Mr. John Budd, who had a gristmill on the spot. After being used a couple of years the water became too brackish for use. A second well was drilled at the creamery to a depth of 103 feet. This is too brackish for drinking, but is used for cooling cream.

A well drilled for Mr. A. R. Smith is an example of a correct method of construction where rock lies near the surface. In this well the depth to rock is 6 feet. The surface materials were dug out and the casing was driven 3 feet into the rock and cemented firmly to the ledge, thus preventing all entrance of surface drainage.

The deepest well at Wiscasset is 154 feet deep, sunk at the county jail. This is another example of good construction. Rock reaches the surface here, and a pipe was put in and the rock coated with cement for several feet around the pipe. A laboratory analysis of the water from this well is given in the table (No. 149). Field assays of three other wells are also given (Nos. 146 to 148).

In brief, well drilling in Wiscasset seems to have met with marked success. Most of the families in town use dug wells, which give plenty of water the year round and have never seriously interfered with the public health. Many of these wells are in poor situations, however, and as the use of dug wells is always dangerous in a village, they should be abandoned and a public water system established without delay. Meanwhile drilled wells are highly recommended.

Edgecombe.—At South Newcastle, in 1901, Mrs. C. A. McMichael drilled a well 56 feet in depth. Water struck at that depth rose to within 1½ feet of the surface, but the supply was small and the well was abandoned. No other drilled wells are known in town.

Newcastle.—The villages of Newcastle and Damariscotta are supplied with water by the Twin Village Water Company, obtaining its supply from Little Pond. The water seems to be of good quality. Throughout the town of Newcastle dug wells prevail, but several drilled wells have been sunk. The two Glidden wells, 85 and 88½ feet in depth, struck water near the bottom and obtain 7 gallons a minute. They are pumped by a hot-air engine for domestic use. At Damariscotta Mills a well was drilled 64 feet deep for Mr. S. W. Waltz, and plenty of water was found for all ordinary purposes. An analysis of this water is given in the appended table (No. 24).

Damariscotta.—Damariscotta is situated just across the river from Newcastle, and the two villages have a joint supply from Little Pond. The supply seems to be good, and no wells have been drilled in the village. In the northeastern part of town a well was sunk for Mrs. S. G. Chapman to a depth of 87½ feet, and the principal water supply was obtained at 57 feet. The amount is said not to be large, but there is plenty for two houses and two barns, and it is reported to have increased during the course of years. A field assay is appended (No. 23). The water is said to become softer every year. The well is fitted up with a model type of windmill and tank, and the water runs by direct pressure to the house.

Bristol.—The town of Bristol covers a large area, and many drilled wells have been sunk within its borders. At Bristol Mills most people use dug wells and obtain fair supplies of water. A few persons have springs, one of which supplies three families. Wells have been drilled here for Dr. J. W. P. Goudy and Mr. J. C. Hyson, 52 and 62½ feet deep, respectively. Doctor Goudy's well obtains a plentiful supply of good water (analysis No. 22). It is pumped by a force pump situated inside the house, although the well is 10 feet away. There is a tank in the top of the house, and the owner has installed all modern improvements. The water at Bristol Mills is reported to be much better in quality than that at South Bristol.

In the northwestern part of the town Rev. H. E. Cotton has a well 72 feet in depth, but he obtained only about 1 gallon a minute.

At Pemaquid a well was drilled in 1901 for Mr. C. A. Sprowl to a depth of 45 feet. The principal water was struck at 30 feet, but it has a poor taste. The same trouble was experienced with the well of Mr. M. B. Macdonald. At this place nearly every house has a cistern. The well water is poor and very irony. On Pemaquid Point Mr. W. A. Elliott had a well drilled in 1901 to a depth of 51 feet, getting a good supply of water at that depth. The well supplies the hotel and probably 90 people during the summer. Two complete analyses of well waters from Pemaquid Point are given in the table (Nos. 145 and 145a). An analysis of water from granite at Pemaquid Beach is given also (No. 25).

At New Harbor there are several wells, 30 to 140 feet deep. The water is highly charged with mineral matter, has a bad taste, and is very destructive to the well casings. Mr. E. W. Fossett drilled a well 33 feet deep and put in galvanized-iron pipe. The water was not fit to drink, and he changed to block-tin pipe. The water ate pinholes through this pipe, and it was necessary to resort to a wooden pipe. The water is still very irony, showing that the mineral taste did not come entirely from the casing.

At South Bristol several wells have been drilled, the water in most of which is very irony. In the well at Mr. N. W. Gammage's hotel rather bad conditions were encountered, and they are described for the reason that they have an important bearing on the purity of water in deep wells in general. At a depth of 2 feet from the surface a small slanting crack was encountered, which reaches the surface 5 feet from the well. The surface of the rock here was thoroughly covered by cement, but afterwards grass and worms were found in the well water, and an analysis by the State board of health showed a large amount of organic matter. It is supposed that these must have entered through an extension of the crack or through an intersecting crack on the other side of the well. On account of the poor quality of the water the well was temporarily abandoned for cistern water. In this well a small quantity of water was found at 30 feet, but the largest volume was encountered at 100 feet. The well was drilled 3 feet deeper to furnish a reservoir.

The largest group of wells in Bristol is found at Christmas Cove, on the south end of Rutherford Island. Here there are 13 drilled wells, ranging from 25 to 125 feet in depth. Several of these have an abundant supply of water and have never been pumped dry. One of the largest wells in Lincoln County is that of Mr. W. E. Little. The others range from 1 to 3 gallons a minute. The water is mostly of good quality, but rather hard, and some of it is a little irony. Two laboratory analyses are given in the table (Nos. 135 and 136). The well drilled for Mr. W. E. Little at the Christmas Cove House was sunk to a depth of 106 feet, rock lying about 22 feet from the surface. The water was obtained at 50 feet, but it was not sufficient in quantity, so the next year the hole was deepened and 2 gallons a minute were obtained. Most of the wells at Christmas Cove are ordinary open wells, some of which are blasted in rock.

On Heron Island, just off the point of Christmas Cove, are two wells, one of which, belonging to Mr. William C. Damon, is 115 feet deep. It can be pumped dry, but furnishes plenty of water for the use of a single cottage. A complete analysis of water from this well is given in the table (No. 142). On the north end of the island a well was drilled for the Heron Island Company to a depth of 162½ feet, and got plenty of water in wet weather, but not enough in a dry spell. This well is used to supply the hotel near by. It stands in a small depression in the surrounding rock, and the top of the casing is open, with nothing to prevent the entrance of dirt, stones, or small animals. (See p. 66.)

Boothbay Harbor.—The villages of Boothbay Harbor and Bayville are supplied by an excellent water system owned by the town and obtained from Adams Pond. No drilled wells are known to have been sunk in the town, but if it should become necessary to use well water it is probable that drilled wells would be successful so far as the quantity of water is concerned. As indicated by the conditions in neighboring towns, the water would probably be found to be somewhat irony.

Boothbay.—Most of the wells in the town of Boothbay have been drilled at East Boothbay. The Hodgton Brothers' well is 120 feet deep, but got most of the water at 47 feet from the surface. By looking down the well with a hand mirror water can be seen issuing from fissures in the rock. In quality it is called very good, and people from a number of houses use water from it. It is also used to supply a blacksmith shop here. Mr. Frank Rice, near by, has a well 75 feet in depth, which was first drilled 34 feet in 1905, but the amount of water was not sufficient, and the next year it was sunk to 75 feet, and a plentiful supply was obtained. The water has, however, a bad "vitriol-like" taste. An analysis is given in the table (No. 141). The water is sufficient to supply a dozen families. Mr. Frank Weston had a well drilled 75 feet deep, which obtained water at a depth of 65 feet from the surface. The well can not be pumped dry, but the water has the same bad taste. Capt. J. L. Race drilled only 35 feet, and his well yields plenty of water, but has the same defect. Field assays of two of these wells are given in the table (Nos. 139 and 140).

On Ocean Point three wells have been drilled, the deepest being that of Mr. L. J. Crooker. This well was first drilled only 60 feet, but the supply gave out in a dry summer; for that reason it was drilled the next year to 360 feet, and now there is plenty of water. The cylinder of this pump is down only to 120 feet, indicating that the head of the water sustains itself well. It is pumped by a gasoline engine and windmill. Most of the water is reported to come in near the bottom of the well. An analysis is given in the table (No. 144).

The well of Mr. John A. Royal, situated 1 mile northeast of Ocean Point, is 90 or 100 feet in depth and obtains its principal water supply at 85 feet. It is pumped by a hot-air engine and can not be exhausted. The owner has installed a 600-gallon tank and has all modern improvements in his house. On Lincoln Neck, about 1 mile east of East Boothbay, is a well belonging to Miss F. C. Lowden. This is about 250 feet in depth and obtains 10 gallons of water a minute, supplying two cottages. Two wells near together, 154 and 157 feet deep, situated near East Boothbay, were formerly used for manufacturing purposes, but were abandoned. The supply is variously reported as 3 to 27 gallons a minute, but the water was highly charged with mineral.

To summarize the conditions in the town of Boothbay, it can be said that the water as a rule is rather poor, having a strong mineral taste, which is probably for the most part iron, but which may come in certain wells from the zinc in the galvanized-iron casing dissolved by the water. In locations where the taste is not objectionable it will be advisable to sink wells, as the quantity of water is in general sufficient for ordinary purposes.

Southport.—The only drilled well known in the town of Southport was sunk on Squirrel Island for the hotel. It was drilled to a depth of 200 feet in granite, obtaining one-half gallon of water a minute at 40 feet from the surface. The supply was insufficient for the hotel, and the well has never been used. Water mains are now laid across the bay from Spruce Point, and the Boothbay Harbor supply is used for the hotel and cottages.

Waldoboro.—Two wells in the village of Waldoboro, belonging to Mr. R. L. Benner and Miss E. F. Genthner, are 56 and 88½ feet deep, respectively, in granite. The supply is about 5 gallons a minute in each, obtained from a depth of 48 and 84 feet, and the water is of excellent quality. Miss Genthner's well had a good supply of water at 30 feet, and the water level rose within 7 feet of the well mouth. On drilling 20 feet deeper, however, another crevice was struck, and the water level dropped 8 feet. The marked contrast in the quality of water here to that at East Boothbay and Bristol shows the superiority of water in granite to that in the region of complex. A laboratory analysis was made of one of these waters (No. 28) and a field assay of the other (No. 27). Mr. Benner has the pipe of his well cemented to ledge.

In 1904 a company was chartered in Waldoboro to sink a well for public supply on top of the moraine-like gravel hill east of the village. The well reached a depth of 200 feet, of which 176 feet were in rock, and yielded 10 gallons of water a minute. The funds of the company then gave out and the well was never completed. Most of the people in Waldoboro use dug wells, many of which give water of poor quality. The town is in great need of a public supply. Wells similar to the one drilled by the old company might be put down and a satisfactory supply obtained. The citizens have become discouraged in regard to well drilling, however, and are suspicious of putting money into any new scheme. It is possible that a satisfactory supply could be obtained from Storer Pond or some other pond at a distance from the village.

Whitefield.—At Coopers Mills, in the northeast corner of Whitefield, three wells have been drilled to depths of 46, 65, and 28 feet. In the well of Mr. S. E. Hopkins water was found near the surface and drilling was stopped. This well can be pumped dry in twenty minutes, but will fill again rapidly. The water is excellent for drinking, but contains a little iron. A field assay is given in the table (No. 138). The wells of Mr. Charles H. Ashford and Mr. Newell Avery obtained sufficient water for domestic purposes, but the iron taste is noticeable; consequently Mr. Ashford uses his water only for drinking. A laboratory analysis was made of this water (No. 137).

At North Whitefield at least three wells have been sunk, that of Dr. A. R. G. Smith reaching 114 feet. All the wells here are of good quality except for the slight taste of iron.

Jefferson.—In the northwestern part of Jefferson Mr. Abram Brann had a well drilled to a depth of 91 feet, obtaining water at 25 feet from the surface, which is excellent for drinking, but a little irony. At Bunker Hill a well belonging to Mr. L. R. Hodgkins was drilled to a depth of 119 feet. This water also contains iron.

Other towns.—In the town of Alna at least one drilled well has been sunk, but no information regarding it could be obtained. In Somerville, Nobleboro, Bremen, and Dresden no drilled wells are known, and the conditions are such as are ordinarily found through the country districts. It is probable that supplies in these towns will be of similar quality to those found in other sections. On the island of Monhegan, situated several miles from the mainland, drilled wells are not known, but it would seem desirable to sink them, as supplies of fresh water could probably be obtained.

SPRINGS.

General statement.—Springs are fairly abundant in Lincoln County and are used by a number of farmers for private supplies. They can generally be obtained on steep hillsides, and most of them issue from deposits of bowlder clay. There are no commercial mineral springs within the limits of the county, but reports have been received of two springs which are of some interest.

Boothbay Medicinal Spring.—At East Boothbay is a spring which is rather interesting, as the water is chalybeate, containing 20 parts per million of iron. The total solids amount to 212, and the constituents are given in the table (No. 256), recalculated from the owner's report of the analysis. The flow of this spring is reported to be 2½ gallons a minute. The water is sometimes carbonated.

Samoset Mineral Spring.—The Samoset Mineral Spring is situated one-half mile east of Nobleboro. The water is interesting, in view of the fact that it contains 425 parts per million of total solids—more than any other spring in Maine of which the water has been analyzed. (See analysis No. 258.) Of this, sodium constitutes 127 parts. As the chlorine is low, it is possible that there is considerable sodium carbonate in this water. This spring also contains 19 parts of iron, making it highly chalybeate. The flow is reported to be 2½ gallons a minute. The water is carbonated.

PUBLIC SUPPLIES.

The towns of Lincoln County are so small that few have public supplies. The villages of Newcastle and Damariscotta have united to obtain a supply, brought from Little Pond by the Twin Village Water Company. Boothbay Harbor and Bayville have a supply from Adams Pond, and this is also piped under the bay to Southport and Squirrel Island. The town of Waldoboro once attempted to obtain a supply for the village by sinking a deep well, but there was financial trouble and the company was dissolved. Wiscasset has no public supply, but is greatly in need of one. Conditions in these towns are described under the various town headings.

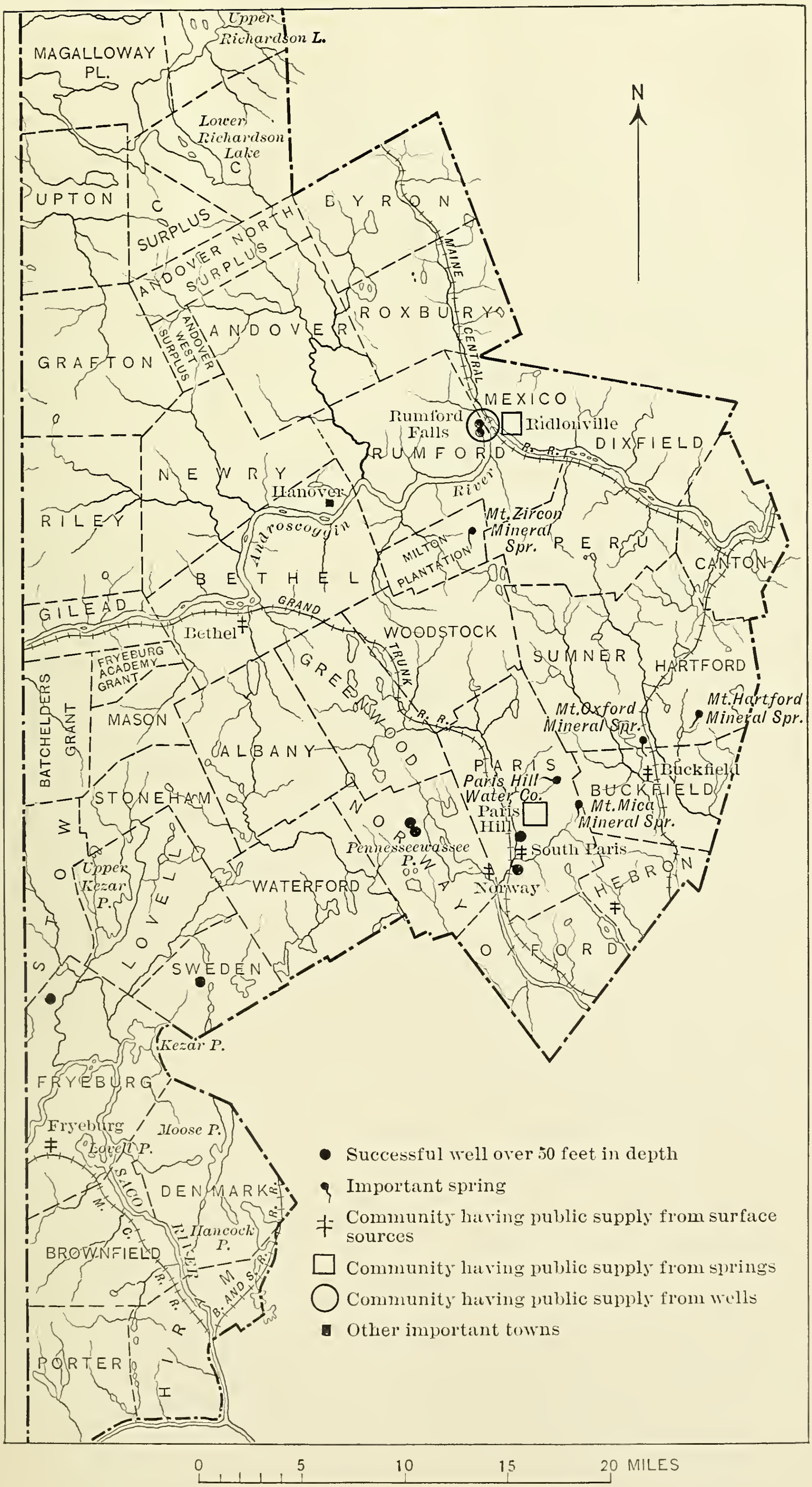
PREDICTIONS AND RECOMMENDATIONS.

The villages of Lincoln County are so small that public supplies are less necessary than in some other counties. However, as already noted, Wiscasset and Waldoboro should install water systems as soon as practicable. As explained above, the supplies are poorer in this county than in any other part of Maine. This is due principally to the fact that the water comes from an area of complex in which the rocks are very irony, and it is inevitable that some of this iron content should be dissolved by the water. There are, however, within the complex area small patches of granite, ranging from a few feet up to several miles in extent. It has been found that water in these patches is excellent, in marked contrast to that in the areas of mixed rocks. Hence the principal recommendation to make for Lincoln County is that whenever possible a well be sunk in granite in preference to shale, schist, or any other metamorphic rock. The waters from granite have been found by analyses to be of high quality.

SOUTHERN OXFORD COUNTY.

GENERAL DESCRIPTION.

Oxford County is situated in western Maine, bordering on the New Hampshire line; it is bounded on the north by Canada, on the south by York County, and on the east by Franklin, Androscoggin, and Cumberland counties. Its length from north to south is 110 miles, and its extreme breadth is about 40 miles. The area of the county is 1,981 square miles, and the population according to the census of 1900 was 32,238. Rumford Falls is the largest town, containing 2,595 inhabitants. This county is very hilly and in parts it is very mountainous. The elevation of the surface ranges from 300 feet on Saco River and 350 feet on Androscoggin River to 3,125 feet at the summit of Mount East Royce. Androscoggin River crosses the county from west to east near its center, and this river has its source in the same county farther north. Saco River crosses the southwest corner of the county. A large number of



MAP OF SOUTHERN OXFORD COUNTY.

Showing distribution of deep wells, important springs, and communities having public water supplies.

lakes and ponds are scattered throughout the area, but the largest are situated near its north end. Welokennebacook and Molechunkamunk lakes lie entirely within the county, and Umbagog and Mooselookmeguntic are largely included within its limits.

The county is comparatively well served by transportation lines. The Grand Trunk Railway crosses it in a general northwesterly direction from Lewiston in Androscoggin County to Androscoggin River on the boundary between Oxford County and the State of New Hampshire. The Maine Central Railroad crosses the southwest corner of the county, along Saco River from Fryeburg to Hiram. The Portland and Rumford Falls Railway extends northward from Mechanic Falls in Androscoggin County to Canton on Androscoggin River; it follows this river northwestward to Rumford Falls, and then extends northward into the wilderness. A small portion of the north end of the county, lying entirely in the wild lands, is outside the area considered in this report.

The deep wells, important springs, and communities having public supplies are represented in Pl. XVIII.

UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Distribution of rock types.—The rocks of Oxford County fall naturally into two groups. In the first group belong the granites and associated gneisses and schists of the complex; in the second group belong the slates. West of a line drawn from a point near North Fryeburg northwestward to Locke Mills, and northward beyond Roxbury on the Portland and Rumford Falls Railway, the area is mostly a mixture of slate, granite, gneiss, etc., with the exception of a solid granite area entering from the vicinity of Rangeley Lakes and extending southward to the vicinity of Grafton, and one or two smaller granite areas. Southeast of the above-mentioned line the rocks are largely granite. They include, however, areas of gneisses, schists, and possibly other rocks which can not be differentiated on the map and which have not been studied in detail.

Structure and relations of rocks.—These rocks are similar to those of Androscoggin County. The granite is of diverse character, ranging from a very coarse grained typical granite to a fine-grained rock which is more in the nature of aplite. These rocks are cut by beds of gneiss and schist, and here and there mineral springs issue along the contact. Pegmatite, a very coarse grained granitic rock, which in places contains rare minerals, is abundant in Oxford County, but is found only in small bodies. This is the type of rock occurring at Mount Mica, in the town of Paris. The characteristics of the slate of Oxford County have not been studied.

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Surface deposits.—The surface deposits of Oxford County consist largely of bowlder clay, which ranges in thickness from a few inches on many rugged hills to more than 50 feet in other places. There are large deposits of gravel in the county, but, as might be expected, these occur mostly along the valleys. Clay in this county is rare. In the surface materials water is generally abundant, but is likely to give out in the dry season.

WELLS.

GENERAL DESCRIPTION.

Types of wells used.—Open wells are the most abundant type in Oxford County. These range in depth from 5 to 50 feet and are generally successful. Frequently, however, the supply of water is not sufficient in a dry season and it is necessary to resort to springs. In some parts of the county, where the surface deposits are soft enough, driven wells have been sunk a few feet, and many of these are successful.

Drilled wells.—Drilled wells are not abundant, and so far as known only about a dozen have been sunk within the limits of the county. Most of them are in Norway, Rumford Falls, and South Paris, but there are several in other towns. The most common size is 6 inches, but one 8-inch and one 12-inch well were reported. The depth ranges from 50 to 125 feet. Generally these wells have been successful in obtaining plenty of water for ordinary domestic use. Three of them, however—one in Rumford Falls, a second in South Paris, and a third in Sweden—are not used on account of insufficient supply. One of these three was the deepest well in the county. The wells are used mostly for domestic purposes, but at South Paris one well has been sunk to supply a factory with drinking water. The supplies are obtained mostly by hand pumps or windmills.

Quality of water.—One well was abandoned on account of a strong taste in the water, presumably coming from the galvanized-iron pipe used for casing. Otherwise the quality of water from the wells of Oxford County is as good as the average. Few analyses of Oxford County well water have been made. The most important, which were of water from driven wells at Rumford Falls, will be found in the table (Nos. 187 to 189) and are discussed on pages 183–185. Waters from several of the springs of Oxford County have been analyzed and the compositions are given in the table (Nos. 259 to 265).

DETAILED DESCRIPTIONS.

Rumford.—The village of Rumford Falls has a fair water supply from driven wells situated on the flood plain of Androscoggin River at the upper end of the village. (See pp. 184–185 and analyses 187 to 189.) With this exception few wells are in use in the village, and only three drilled wells were found. The wells of the public waterworks are from 20 to 35 feet in depth and are mostly in sand. The system is described in detail under the heading "Public supplies."

Dr. C. M. Bisbie once sunk a well in the upper part of the village to a depth of 73 feet. A little water was found at 25 feet from the surface, just below the top of the bed rock. The amount was considered insufficient and the well was abandoned. Other wells have been drilled, but no information regarding them could be obtained. At one time a well was started at a livery stable, but when the hole was down 6 feet the driller was required to give an expensive bond before proceeding, and this resulted in the abandonment of the work. Such requirements discourage well drilling, and it should be remembered that deep wells are a decided advantage to any community. It is probable that small amounts of water can be obtained by drilled wells in the rocks at Rumford Falls and vicinity. The upper part of the village of Rumford Falls, known as Virginia, is supplied by springs issuing from drift and piped to the houses. Mexico, across the river, is supplied by several aqueducts from springs on the hills, which supply 10 to 20 houses each.

A field assay of the water from a spring near the cataract is given in the table (No. 263). A few miles from Rumford Falls, in Milton Plantation, is the Mount Zircon Mineral Spring, described on page 182 (analysis No. 260).

Paris.—Paris Hill, the county seat of Oxford County, is supplied by springs, and wells are not much used. These springs are described on page 185 and the analyses are given in the table (No. 261). At South Paris several driven wells have been sunk. The best of these is probably the one drilled in 1906 for the Mason Manufacturing Company. It was sunk to a depth of 117 feet, 40 feet of which was drilled in sand and the rest in granite. The test showed 250 gallons of water an hour, and the quality was good. A well sunk for Mr. John H. Howland went to a depth of 122 feet in granite, but obtained little water. The well was "shot" with 90 pounds of dynamite without success. On the sand plain in the village of South Paris a number of driven wells have been sunk to depths of 10 to 30 feet. Some of these reach ledge. The wells got plenty of water and can not be exhausted. The public supply of South Paris is taken from Norway Lake and is used by a large number of people.

Buckfield.—The village of Buckfield has recently installed a good water supply, which is piped from South Paris. Formerly dug wells were extensively used in the village, but these are being abandoned, as the water is not as satisfactory for domestic purposes as the town water. Within a few miles of Buckfield, near the edge of the adjacent towns of Hartford and Sumner, are the Mount Hartford Mineral Spring and the Mount Oxford Spring, described below and analyzed as reported in the table (Nos. 259, 259a, and 264).

Norway.—The water supply of the village of Norway, like that of Paris, is drawn from Norway Lake, and most of the people use it. A few persons use driven wells, and as the village is situated on the flat sand deposit only a few feet above the lake and river plenty of water can generally be obtained in this manner. Driven wells are better than dug wells and are advised outside the village. The desirability of their use in the village, however, is questionable, as, so far as known, the lake supply is satisfactory.

Sweden.—In the northern part of Sweden a well was once sunk to a depth of 189 feet on the farm of Mr. Walter Evans. It is reported to be drilled in "trap," and yielded 8 gallons of water a minute. As the farm is now abandoned, the well is not used, and no other information regarding it could be obtained. With this exception the wells are mostly less than 30 feet in depth and are ordinary open wells. The supplies are small, but there is enough water for farms, except in very dry weather.

Fryeburg.—In 1890 a well was sunk for Mr. L. W. Atkinson at North Fryeburg to a depth of 115 feet. There are some driven wells here, but most wells in the town are dug. Some families use cisterns to catch rain water.

Other towns.—With the exception of the towns described above, no localities in Oxford County are known to use wells of other than the ordinary open and driven types, which are mostly less than 40 feet in depth. These wells differ somewhat with the kind of material, but as a rule plenty of water can be obtained in wet weather, and smaller supplies, or none at all, in a dry spell.

SPRINGS.

General statement.—The springs of Oxford County are very numerous, occurring on steep hillsides, along the valleys, and even on gentle slopes. A great many of them are utilized by farmers for drinking. The water from others is bottled and sold in Boston and New York. The commercial mineral springs of the county are as follows:

Mount Hartford Mineral Spring, Hartford.
Mount Oxford Mineral Spring, Sumner.
Mount Zircon Spring, Milton Plantation.

Mount Hartford Mineral Spring.—The Mount Hartford Mineral Spring is situated in the southern part of the town of Hartford, about 4 miles northeast of Buckfield village, high up on the slopes of a granite hill. The spring is owned by the Mount Hartford Mineral Water Company, but is now leased for ninety-nine years to the Consolidated General Mineral Spring Company, of Philadelphia. The water seeps out of a bowlder-clay hillside and is caught in a granite-walled tank and piped to a bottling house lower on the hillside. The water is shipped to Philadelphia and sold as the "Mount Hartford natural mineral water." It is colorless and odorless and is said to flow more than 40 gallons a minute. A large proportion of it is carbonated and made into ginger ale.

The water is low in mineral matter, as shown by the analyses (Nos. 259 and 259a). Analysis 259 is recomputed from the analysis given in the circular issued by the company. Analysis 259a is part of the following complete analysis, which was made by W. W. Skinner, of the Bureau of Chemistry, United States Department of Agriculture, in connection with cooperative work on mineral waters conducted by the Geological Survey and the Bureau of Chemistry.

Analysis of water from Mount Hartford Mineral Spring.

[W. W. Skinner, analyst.]

Gases (cubic centimeters per 1,000 grams at 0° C. and 760 mm. pressure):	
Carbon dioxide (CO_2), free	.....
Carbon dioxide (CO_2), set free from bicarbonates on evaporating to dryness	3.80
	Parts per million by weight.
Phosphoric acid radicle (PO_4)	None.
Metaboric acid radicle (BO_2)	None.
Arsenic acid radicle (AsO_4)	None.
Silica (SiO_2)	9.00
Sulphuric acid radicle (SO_4)	1.62
Bicarbonic acid radicle (HCO_3)	20.47
Nitric acid radicle (NO_3)	.88
Nitrous acid radicle (NO_2)	None.
Chlorine (Cl)	4.00
Bromine (Br.)	None.
Iodine (I)	None.
Iron (Fe) and aluminum (Al)	Trace.
Manganese (Mn)	None.
Calcium (Ca)	4.43
Magnesium (Mg)	1.03
Potassium (K)	.76
Sodium (Na)	3.95
Lithium (Li)	None.
Ammonium (NH_4)	Trace.
Oxygen to form Fe_2O_3 and Al_2O_3	.....
	46.14
Free ammonia	Traces.
Albuminoid ammonia	Traces.
Nitrogen as nitrates	200
Nitrogen as nitrites	None.
Oxygen consumed	8.00

Mount Oxford Mineral Spring.—Mount Oxford Mineral Spring is situated in the town of Sumner, about midway between the villages of East Sumner and Buckfield, on the line of the Portland and Rumford Falls Railway. It is owned by the United Mineral Springs Company, of New York. The water issues from a steep bowlder-clay hillside, far from all sources of pollution. The hillside above is wooded. There is no color or odor, and only a slight taste. The flow is estimated as 8 gallons a minute. From the granite tank in which it is caught, and which is covered with a glass case, it is piped down the hillside to a bottling house on the railroad at Saunders Crossing, whence it is shipped. The storage tank is 40 feet below the spring and holds 4,000 gallons. Most of the water thus far (1906) is shipped to Providence, R. I., but some of it is sent to Philadelphia. The pipe used in carrying the water from the spring to the bottling house, a distance of 80 rods, is of wrought iron, this kind of pipe having been recommended by the State chemist of Massachusetts as the best for this water. The water has been analyzed and is low in mineral matter. The composition recomputed from that reported in the circular issued by the company is given in the table (No. 264).

Mount Zircon Spring.—The Mount Zircon Spring is owned by the Mount Zircon Spring Company, of Boston. It is situated in the eastern part of Milton Plantation, high up on the western slope of Mount Zircon. It seeps out of bowlder clay on a gentle, wooded hillside, somewhat higher than the only house in the vicinity. The water has no color, odor, or taste, and is reported to flow 14 gallons a minute. It is bottled on the spot and shipped to the city. A 5-gallon carboy of it retails in Boston for $1.50. This is a very old spring, and is said to have been a popular resort long before the Poland Spring was known. There was formerly a large hotel here, which was well patronized until it was burned. The spring is inclosed in a small house, in which is a glass-covered porcelain-lined tank with a sand bottom, out of which the water bubbles. This water contains 33 parts per million of mineral matter, as shown in the analysis (No. 260), which was recalculated from the analysis reported in the circular issued by the company.

Cataract Spring.—On the west side of the cataract at Rumford Falls is an excellent spring, issuing from a flat crevice one-fourth inch in size in a pegmatite ledge, about 2 feet below the surface. The spring is situated just below the highway, above which the hill rises very steeply. The country rock is a complex. This spring is owned by the Rumford Falls Power Company, which does not use it, but many of the inhabitants haul the water for drinking, preferring it to the city water. The flow is about 3 gallons a minute. The highest temperature at the point of emergence in August was 45½°.

The spring is surrounded with granite curbing 10 feet across, cemented to the rock, and a small house protects it. The only analysis available is a field assay given in the table (No. 263).

Mount Mica Mineral Spring.—The Mount Mica Mineral Spring is situated on the southern slope of Mount Mica, near the boundary between the towns of Paris and Buckfield. The water bubbles out of sandy bowlder clay at an estimated rate of 1 or 2 gallons a minute. It has no color, odor, or taste. It is not sold, but people frequently carry it away in bottles for their own use. The water is reported to have been analyzed, but the analysis has not been received by the Survey. A field assay is given in the table (No. 262).

"*Magnesia Spring,*" *Buckfield.*—In the western part of Buckfield there is a spring which is reported to contain a large amount of magnesia. The water is not sold, but is carried away in bottles by a number of residents in the vicinity and is said to have medicinal properties. It is reported to have been analyzed, but no analysis has been obtained by the Geological Survey.

Jones's Spring.—About one-half mile west of Norway is Jones's Spring, the water of which is sold in Norway. The flow is small, being reported as only one-half gallon a minute.

PUBLIC SUPPLIES.

General statement.—The towns of Buckfield, Bethel, Fryeburg, Hebron, South Paris, and Norway have public supplies taken from surface sources. Paris Hill and the little town of Ridlonville use springs situated much higher up on a neighboring hillside, and Rumford Falls has a system of driven wells. The underground supplies will be described in detail.

Rumford Falls.—The water supply of Rumford Falls was formerly taken from Androscoggin River, but two years ago a system of 2½-inch driven wells was sunk at the upper end of the village, below the settlement known as Virginia. The wells are 68 in number and range from 22 to 35 feet in depth. They are about 30 feet apart, in sand and gravel that form the plain bordering the river, and are situated along a line 300 feet from the river. The system is owned by the Rumford Falls Water and Light Company. From the pumping station the water is pumped to a standpipe on the hill, with a capacity of 500,000 gallons and an elevation above the surface of 75 feet. The water is carried in cast-iron pipes and distributed by gravity from the standpipe. There are said to be 440 connections, which include most of the houses in town. Water to the amount of 1,164 gallons a minute can be pumped by the present plant, and this rate is continued twenty-four hours a day. There seems to be an abundant supply of water and as yet there has been no trouble about obtaining it.

The principal problem connected with the supply is its quality. Androscoggin River, situated close by, is of course polluted by drainage from the mills and towns farther up the stream. In addition to this factor, there is a swampy depression situated 50 feet east of the eastern line of the wells, and this depression lies downhill from the village of Virginia, in which the drainage conditions are poor. The water has a "mucky taste" and sometimes a little color in summer, and these defects have been supposed by residents of the city to be due to this depression.

An interesting case connected with this supply was reported by the manager of the water company. The inhabitants of the village objected to the water from time to time for the reason that it was supposed to be contaminated. In 1905 a series of samples were collected and submitted for analysis to Prof. F. C. Robinson, of Bowdoin College. The results of these analyses are given in the table (Nos. 187 to 189), in which sample 1 was taken from the pumping station, sample 2 from the end of a long galvanized-iron main, and sample 3 from Hotel Rumford. These analyses show that the total solids are rather low. In sample 2 there were 20 parts per million more than in 1 or 3. The chlorine, silica, calcium carbonate, sulphates of sodium and potassium, and sodium chloride are the same or very nearly so in all three analyses, but the carbonate of iron differs. The one surprising discrepancy in the analyses is that the amount of carbonate of zinc reported is 1.084 parts in sample 2, which was taken from the galvanized-iron main, while samples 1 and 3 showed no zinc. It is also noticeable that the carbonate of iron is greatest in the same sample and next greatest in the sample taken from Hotel Rumford, while the iron in the water at the pumping station is small. This seems to indicate, as stated by Professor Robinson, that the water in traveling through a galvanized-iron main dissolves a considerable quantity of the zinc, owing to the carbon dioxide in the water. This gas is more often present in well water than in river or lake water and is a desirable constituent, but it seems to have a bad effect on the water by dissolving the zinc. The iron causes a deposit when the water stands. The zinc renders the water unfit for domestic use and is probably the cause of some of the taste which is reported. For this reason Professor Robinson recommended that galvanized-iron connections be taken out and connections of tin-lined or brass pipe be substituted. The brass pipe is probably the best, but is more expensive. The bacteria in the water are all harmless. As seen by the analyses, they were most numerous at the pumping station and decreased rapidly toward the points where the water was used. The results of these analyses seem to indicate strongly that the taste complained of was due to the use of galvanized-iron connections.

Another recommendation made by Professor Robinson was that the swampy depression back of the wells should be filled up, as it affords a reservoir for stagnant water, and in the future may cause pollution of the wells. This recommendation is here reiterated, and it can not be too strongly urged that the conditions in the village of Virginia be kept as sanitary as possible in order to prevent any possible contamination of the public water supply. The pipes connecting with the mains in the streets are 16 inches in diameter, but in the distant parts of town the mains are as small as 6 inches. There is 1 mile of 16-inch pipe, and in all there are about 5 miles of pipe. Black iron pipe is used at present, and it seems to give satisfaction. There is now a regulation of the company which does not allow plain iron, lead, or galvanized-iron pipe as connections. Water rates are $8 a year for ordinary faucets. The pressure on the main street is reported as 70 pounds. A test made of the pumping plant showed that 300,000 gallons of water could be pumped by it. This calls for only 25 gallons a minute from each of the 68 wells.

The strata found in the wells consist of 18 to 25 feet of fine sand at the top, below which is 10 feet of fine gravel, in which the water occurs; below this is another layer of fine sand. The water in the wells stands higher than in the river, indicating that it is not derived from that source, but comes from back in the hills.

Paris Hill.—The Paris Hill Water Company was incorporated and a gravity system of waterworks from Crocker Hill Springs was installed in 1899. The springs are situated on the side of a high hill about 2 miles east of the village. The water flows through a 2-inch cast-iron pipe to a reservoir 100 feet below the springs and 210 feet above the village. The pressure is 90 pounds. Water mains 6, 4, and 2 inches and service pipes three-fourths inch and one-half inch in size are used, and the total length of the mains is nearly 3 miles. There are no fire hydrants, but there are 70 taps, and about 350 persons, or approximately 95 per cent of the population of the village, use the public supply. It has been estimated that 5,000 to 15,000 gallons of water are used daily. The supply is sufficient for all present needs.

The Crocker Hill Springs seep out of gravel far removed from any source of pollution. The water is of as good quality as any other in Maine. Analyses made in 1901 for the owners by a New York chemist (name unknown) and recalculated by the United States Geological Survey are given in the table (No. 261). The amount of total solids—11, 13, and 14 parts per million—is extremely low. Samples 1 and 2 were taken from the reservoir and sample 3 at the residence of Mr. George M. Atwood, at Paris.

Ridlonville.—The Shaw-Ridlon Land Company, of Ridlonville, owns a water supply derived from springs. The water is used only for domestic purposes and is satisfactory, but fire protection is needed.

SOUTHERN PENOBSCOT COUNTY.

GENERAL DESCRIPTION.

Penobscot County lies somewhat east of the center of Maine and has a length of 120 miles, extending from near the head of Penobscot Bay northward into the wilderness. Its greatest breadth east and west is about 70 miles, and its area is 3,254 square miles. Only the southern portion is covered by the present report. The northern border of this area lies near Oldtown and Charleston. The population of Penobscot County according to the census of 1900 was 76,246. The largest city is Bangor, with a population of 23,500, and Oldtown comes next with 5,763 inhabitants. This county is moderately hilly. Its elevation ranges from sea level to nearly 5,000 feet on the eastern slopes of Mount Katahdin, many miles north of the area covered by this report. In the area under consideration the greatest elevation is only about 1,000 feet, in the southeast corner of the county, on the edge of the mountains. Scattered throughout the county are a great many lakes, of which the largest are Newport Pond, Pushaw Lake, and Nichols Pond. Penobscot River flows through the center of the county from north to south, and on it are situated Bangor, Oldtown, and a number of the other principal towns. The Maine Central Railroad crosses from west to east between Dover and Bangor and then runs northward along Penobscot River. This railroad has a branch running from Bangor southeastward to Ellsworth, in Hancock county, a second branch running southward along Kennebec River to Bucksport, in Hancock County, and a third extending northward from Newport to Dover, in Piscataquis County. The Bangor and Aroostook Railroad runs northward from Waldo County, and crosses the center of Penobscot County to South Lagrange, where it joins a branch of the same road which connects with the Maine Central Railroad at Oldtown. The locations of deep wells, important springs, and communities having public supplies are shown in Pl. XIX.

UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Character and distribution of rocks.—Nearly the entire portion of Penobscot County included within this report is composed of slate. The only exception is a patch of granite which lies in the extreme southeast corner of the county, entering it for only a few miles in the mountain region. The slates which cover the county are typical of the class of slates which cover large areas in central Maine. They are fine grained and split parallel with the stratification, which is nearly vertical and strikes very uniformly in a direction about N. 30° E. Here and there dips of as much as 60° toward the southeast or northwest are found. In places numerous quartz veins are seen parallel with the stratifica-

MAP OF SOUTHERN PENOBSCOT COUNTY.

Showing distribution of deep wells, important springs, and communities having public water supplies.

tion, and these indicate that in past geologic ages a great deal of water has circulated in the rock. The fact that many bedding and cleavage planes are rather open near the surface indicates the possibility that a large proportion of the abundant water now found in these slates is held in these planes. Some of the water, however, occurs in joint cracks, an examination of the rock where it is quarried showing that there are abundant cracks in other directions than the cleavage planes which might hold water.

At Brewer the direction of the principal system of joints is northeast and the hade about 50° SE. A second system strikes southeast and hades about 30° SW. A road cut at this place shows considerable water seeping down along the cleavage planes. The general structure of the rock can also be well seen at a number of quarries along Kenduskeag Stream at Bangor.

Surface deposits.—The surface deposits of Penobscot County differ greatly in thickness and character. Along Penobscot River the sands and gravels are locally as much as 100 feet in thickness, and some rather extensive areas of clay extend up the side valleys for several miles. Away from the river the gravels may be as much as 50 to 100 feet thick in exceptional cases, but they generally occur in the form of eskers, morainic deposits, and irregular patches of gravel.

Underlying the sands, gravels, and clays and overlying the bed rock almost everywhere is the regular bowlder-clay deposit which is found nearly everywhere in Maine. This ranges in thickness from a foot to more than 50 feet. Along Penobscot River in the vicinity of Veazie are long sections showing nothing but bowlder clay. Some of these are as much as 60 feet in height above the river. The upper part of this section is of a buff color for about 10 feet from the surface, and below that is the ordinary hard blue bowlder clay. There are a great many bowlders in the deposits, some of them up to 3 feet in diameter. No stratification can be seen in this type of deposit.

On a hill in the southern part of Orono a well was once dug for Mr. N. W. Page to a depth of 54 feet. This well passed through nothing but hard bowlder clay and found no water until near the bottom.

WELLS.

GENERAL DESCRIPTION.

Types of wells used.—Although the old-fashioned type of dug well is very abundant in this county, as elsewhere in Maine, and far predominates in number over all other types, drilled wells are more widely scattered and are used by a larger number of people than in any other county in southern Maine. In the area under consideration there are supposed to be only two or three towns which contain no drilled wells, and in these towns there is no reason why drilled wells should not be successful.

Drilled wells.—The drilled wells which have been sunk in Penobscot County are mostly 6 inches in diameter, this being the most common size used in Maine. There are a few, however, which are reported as small as 4 and 5 inches. Several 7-inch wells have been drilled, and a well in Stetson, one of the oldest drilled wells in the State, is said to be 12 inches in diameter. A few wells are larger at the top than at the bottom, and a number are drilled in the bottom of dug wells, but this type is not recommended. The proportion of successful wells in Penobscot County is probably larger than in any other county in Maine. Altogether more than 85 wells have been drilled to depths greater than 50 feet, and it is not supposed that more than half a dozen of them have been abandoned for want of sufficient water.

Quality of water.—Only one well is known in Penobscot County with the mineral content so high that the water can not be used. A number of wells are reported, however, that have been contaminated by surface drainage and thereby rendered dangerous. As more analyses have been made of water from slate wells in Penobscot County than in any other slate area in Maine, a fair knowledge of the quality of water is available. Of 35 analyses which have been made, 8 are nearly complete laboratory analyses, the rest being field assays and tests for only a few constituents. All analyses will be found in the table (Nos. 72 to 106). As will be seen, the total solids range from 74 to 834 parts per million, depending largely on the proportions of lime, sulphates, and carbonates in the water. The highest lime recorded is 214 parts per million in the well at the Bangor House, but no other reports exceed 82 parts. Several wells report 5 to 10 parts per million of iron, but this is believed to be an error, as no iron can be tasted in these waters, and these figures should possibly be placed under "iron and alumina." Analyses of several spring waters are given in the table (Nos. 266 to 268). The waters of Penobscot County are as hard as any others in southern Maine, the hardness being in many waters from 100 to 300 parts per million.

DETAILED DESCRIPTIONS.

Bangor.—As the present water supply of Bangor is taken from Penobscot River it is badly contaminated by sewage and manufacturing wastes from Oldtown and other villages. Hence the problem of obtaining water from wells in the city is very important. Some persons still use dug wells, but the most popular type and the type advised in nearly every case is the drilled well. Within the city limits 13 drilled wells have been sunk; they range in depth from 30 to 425 feet.

The deepest well in Bangor, one of the deepest successful wells in Maine, is situated at the Eastern Maine Insane Hospital, 1 mile east of the city proper. This well was drilled in 1896 to a depth of 425 feet. A little water was struck at 50 feet, but the principal supply was found at the very bottom of the well when all hope of success had been given up. The drill made a perceptible drop at the time the principal seam of water was struck. The water does not stand within 200 feet of the surface, but notwithstanding this fact 30 gallons a minute, the full capacity of the pump, can be obtained. Three hundred or more people are supplied for drinking and laundry purposes. Analysis No. 75 is a field assay of water from this well. When used in the laundry the water has to be softened.

Some of the best wells in Bangor were drilled during 1906 at the various schoolhouses in the city. The contract between the city and the drillers specified in every case that they must get at least 2,000 gallons of water a day. Wells are situated at the high school, the Palm street school, the Larkin street school, and the Union square school, and all have been successful in getting an inexhaustible supply of fine water. The depths vary from 72 to 217 feet, the deepest wells being generally the best. The water is not only used for drinking every day by the school children and by hundreds of passers-by, but, in the case of the high-school well at least, it has been used extensively by several hotels and numerous residences in the vicinity for their tables. On hot summer days this well is pumped almost continuously from morning till night without exhaustion. At Palm street, in a test, the well was pumped continuously ten hours a day for three days, and the water level was not affected. Careful sanitary analyses have been made of the schoolhouse wells, with the result that they were found to be perfectly safe for drinking. Mineral analyses have been made which show considerable discrepancy in certain wells, but are a good index to the character of the water beneath Bangor. (See Nos. 76–79, 86–87, and 90–91 of the table.)

Another excellent well, sunk in 1905, is that of Mr. F. L. Jones, on Center street. This well is 247½ feet deep; at this depth the drill dropped several inches and obtained water. The supply is so large that scores of neighbors use the well almost continuously. (See analysis No. 81.) The well at the court-house, which was the first well drilled in the city proper, and that of the Bangor House also furnish abundant supplies. In the latter well the drill penetrated 30 feet of clay, 15 feet of "rock," 5 feet of sand, and 240 feet of rock. As sand is very seldom found below solid rock, it is probable that the material below the clay is either an overhanging ledge or a large bowlder. The Bangor House well is said to yield 27 gallons a minute. Analyses of water from this well (No. 73) and from the court-house well (No. 88) are given in the table. Water from the well of the Maine Creamery Company is sold in Bangor under the name of Hopkins Artesian Spring water. It is believed to be excellent water. (See analysis No. 84.) The amount of total solids is only 86 parts per million, the lowest reported in analyses of Bangor wells.

One flowing well has been obtained in Bangor. This was drilled in 1906 for Morse & Co., to supply drinking water for the men at their mill. The well is situated in the valley, only a few feet from a steep, rocky hillside. The water is pumped, but will rise 2 feet above the surface without pumping. It is of excellent quality and appears to be inexhaustible. It can be pumped down 75 feet in half an hour.

The conditions in the country districts of Bangor have not been extensively investigated. Some drilled wells less than 50 feet in depth are known, and it is probable that there are some of greater depth. At any rate, conditions are very favorable for getting deep supplies.

There is a persistent belief among residents of Bangor that a limestone formation underlies the city and is encountered by certain deep wells. This is presumably due to the fact that the well waters are mostly very hard, ranging in many wells between 100 and 300 parts per million. The hardness is due in these cases, however, to the solution of small amounts of calcareous material scattered through the slates and not to any regular bed of limestone.

Brewer.—Several drilled wells have been sunk in the town of Brewer, but only two of them are deep. These were drilled in 1899 for the Eastern Manufacturing Company, at South Brewer, and reached depths of 250 and 350 feet. The water is used for cooling acid at a pulp mill. The joint supply of the two wells is reported to be only 50 gallons an hour. The wells are situated not far from Penobscot River and the 350-foot well fluctuates with the tide and is reported to yield salty water. No drilled wells more than 30 feet in depth are known in this town, but as all wells in Bangor have been successful, drilling on this side of the river is likely also to be rewarded with success.

At South Brewer a number of springs are used for supplying houses. Some of these springs are in bowlder clay, others issue from hard gravel underneath clay. One dug well in the valley of Sedgeunkedunk Stream was dug through 19 feet of clay and 3 feet of gravel, and the water rose to the surface and overflowed, thus being truly artesian. A pipe was inserted below the surface and the water carried to houses in the valley. Where good spring water can be obtained from uncontaminated sources it should by all means be used in preference to river water. Dug wells or springs in the villages are not advised, but drilled wells will obtain water which is pure and safe. Oak Grove Spring is situated in this town.

Veazie.—The people of Veazie, except those who have the public supply from Bangor, use dug wells. It is probable, however, that plenty of good water can be obtained by drilling into the underlying rocks.

Orono.—Near the southern corner of Orono a well was once dug, for Mr. N. W. Page, to the unusual depth of 54 feet. The well is situated on a round hill of bowlder clay 200 feet above the river. The material is all hard, stony bowlder clay, similar to that exposed in the section on the opposite bank of Penobscot River. On account of the tough nature of the material, it was necessary to blast with dynamite. The principal water bed was found at 30 feet, and the water seeps in everywhere lower down. The bottom of the bowlder clay was not reached. A field assay of this water is given in the table (No. 173).

The village of Orono is supplied from Penobscot River, the water-works having been only recently installed. Several drilled wells supply moderate amounts of water from depths of 50 to 60 feet. One of these is situated at the University of Maine. It seems probable that larger supplies may be expected by sinking 100 to 200 feet deeper.

Oldtown.—Oldtown lies on the northern border of the area covered by this report, and its water supplies have not yet been investigated. No wells have been reported by correspondence, but as the rock conditions are similar to those of Bangor, where abundant and excellent supplies are found, it seems probable that like success will attend deep drilling at Oldtown.

Orrington.—Several shallow drilled wells have been sunk in the town of Orrington, getting water at about 50 feet, in slate. The best example is the well of Mr. Archie Harding, in the southern part of the town. When the well was sunk a large stream of water is reported to have gushed into it and rose 40 feet from the bottom. This well was pumped with two pumps and could not be lowered appreciably. The quality of the water is excellent. A field assay is given in the table (No. 105). Every evidence seems to favor well drilling in this town.

Hampden.—At scattering points in the town of Hampden a number of wells have been drilled, ranging in depth from 50 to 103 feet. There seems to be plenty of water for all domestic and farm purposes. In water from one of these wells a small amount of iron is reported. Four field assays (Nos. 100–103) were made in this town. In the square at Hampden Corner is a well 28 feet deep, belonging to the town. It was blasted in slate. As many as 20 families are said to use it, but it is exhausted during a drought.

Newburg.—No well reports from Newburg are at hand. The town is situated in rocks similar in nature to those at Bangor, however, and deep drilling here may be expected to be generally successful.

Hermon.—In Hermon the wells are mostly between 10 and 25 feet in depth, and they yield a fair amount and quality of water. Drilled wells are not known, but they will probably be successful if drilled deep enough.

Carmel.—In the town of Carmel a number of drilled wells have been sunk, from 45 to 75 feet in depth. The supplies are small, being generally only 2 or 3 gallons a minute, but there is generally enough water for domestic purposes. In one well it was reported irony, but otherwise it is good.

Dixmont.—At North Dixmont a number of drilled wells have been sunk, from 50 to 120 feet in depth, mostly of which yield sufficient water for domestic purposes. A single field assay was made (No. 104). In this part of the county the level of water in many shallow drilled wells varies with the season.

Etna.—A number of wells are reported in Etna from 40 to 100 feet in depth. Water is obtained at two or more levels, but the most abundant supplies occur near the bottom of the wells. In one well, 54 feet in depth, the principal seam of water was struck at 50 feet, a minor seam at 20 feet, and the yield is reported to be 15 gallons a minute. There is generally plenty of water for domestic and farm purposes. One well reports a little iron in the water.

Plymouth.—Conditions in Plymouth are similar. Well records are lacking, but it is known that water can usually be obtained in slate at depths of 50 to 100 feet. The supplies are generally sufficient for domestic and farm purposes, and the water is of good quality.

Newport.—Drilled wells are also used in Newport. They range in depth from 50 to 100 feet. Some of them are drilled in the bottoms of open wells, but this is a poor construction. (See p. 54.) The principal seams of water are encountered at all depths from 15 to 70 feet. One well, 79 feet in depth, struck the principal seam at 70 feet and a minor seam at 35 feet, and the total yield was 30 gallons a minute, but this is exceptionally large. In general there is enough water for a house and farm. Some data regarding the character of the water in East Newport are afforded by a laboratory analysis (No. 99), two partial analyses (Nos. 97 and 98), and one field assay (No. 96). The hardness and total solids are extremely high for Maine.

Stetson.—Several drilled wells have been sunk in Stetson. One of these is rather exceptional in being 12 inches in diameter. It is 74 feet deep and was sunk in 1878, getting water at the bottom. Another well, 100 feet in depth, was drilled in the bottom of a dug well and found no water. One complete analysis has been made of water from this town (No. 106).

Levant.—The wells in Levant are reported to be all dug, and the depths run from 8 to 25 feet. The quality of the water is as good as is usual in dug wells.

Glenburn.—No drilled wells are reported in Glenburn, but it is possible that one or more of them may exist. The proximity of this town to Bangor and the similarity of the slate make it probable that water of like quantity and quality will be found.

Kenduskeag.—A number of wells have been drilled in the town of Kenduskeag, and at least one of them is more than 100 feet in depth. This was sunk for Mr. Chester Weld and was dug 9 feet, blasted 13 feet, and drilled 86 feet in rock, the drilling being done in instalments, as the well repeatedly went dry. At the depth of 109 feet drilling was stopped, the supply being then 1 gallon a minute. Particulars regarding other wells in this town are not known, but it would seem probable that more water can generally be obtained by drilling deeper.

Corinna.—Drilled wells in Corinna are from 60 to 110 feet in depth. As a rule, sufficient water is obtained for domestic uses, and the quality is good. One well, however, 108 feet in depth, obtained water which was reported to be "salty," and was so poor that it could not be used. A field assay of one sample of well water is given in the table (No. 95).

About ten families in the village of Corinna are supplied by springs owned by Mr. F. F. Burrill. The supply was installed in 1897 and the water flows by gravity to the houses.

Corinth.—A few drilled wells are known in Corinth. They run from 35 to 70 feet in depth and supply plenty of water for domestic purposes. One well at East Corinth, drilled years ago, was a failure, but there is no reason why deep drilled wells should not generally be successful in this town.

Hudson.—A single well is reported in Hudson. It was drilled to a depth of 66 feet and gives enough water for ordinary domestic and farm purposes. Deep drilling in this town ought to meet with success.

Charleston.—Drilled wells in Charleston range from 16 to 190 feet in depth. Some of the shallower ones get plenty of water, but the deeper ones are the best. In this vicinity the water stands at 4 to 12 feet from the surface. Some wells can be pumped dry by continued pumping, but most of them can be lowered very little. One well, situated on the hill north of the village and 100 feet or so above the houses, was sunk for the Higgins Classical Institute to 105 feet, and the water stands 8 feet from the surface. It is siphoned down the hill to several houses in the village. There is abundant water and it can be lowered only 20 feet or so by pumping. The table includes a laboratory analysis of this water (No. 93) and field assays of the other well waters (Nos. 92 and 94).

Garland.—No information is at hand with respect to wells in Garland. The rock formation being similar, it seems probable that the conditions for obtaining water will be like those found in Charleston and that the supplies will be both abundant and good.

Dexter.—The village water supply of Dexter is taken from Dexter Pond. One drilled well is reported here 58 feet deep, but only a small amount of water was obtained. Conditions ought to be favorable for getting plenty of water by drilling 100 to 200 feet in the slate.

Other towns.—In towns east of the river, with the exception of Brewer and Orrington, there are no drilled wells. For a number of miles north of the area included in this report there are scattering drilled wells, and they generally obtain plenty of water. Northeast of the area the region of abundant water supply continues into Aroostook County.

SPRINGS.

The springs of Penobscot County are fairly numerous, although not so thickly distributed as in some parts of Maine. In the vicinity of Bangor are several mineral springs which supply water for many of the inhabitants. The commercial springs of the county are as follows:

Arctic Spring, Bangor.
Chapman's Spring, Orrington.
Highland Spring, Holden Center.
Hillside Spring, Bangor.
Oak Grove Spring, Brewer.
Sparkling Spring, Orrington.

Arctic Spring.—The Arctic Spring is situated 1½ miles north of Bangor, and the water is sold in Bangor. The flow is reported as 8 gallons a minute and the temperature 44°. The hardness is 60 parts per million.

Chapman's Spring.—About one-quarter mile north of East Orrington is another spring the water of which is sold in Brewer. No information regarding it has been received.

Highland Spring.—The Highland Spring is situated on a hillside in the town of Holden, 5 miles east of Brewer. It is owned by Mr. C. B. Robinson, but is leased to Mr. A. H. Farrington. The water is said by the owners to issue from a crevice in the rock, and the spring is protected by a small house built over it. The water is bottled and shipped under the name "Highland Spring water." The analysis given in the table shows it to contain 16 parts per million of total solids. Owing to a misprint in the circular issued by the owners there are several errors in the composition reported. This water has been used in Bangor for sixteen years. The price of a 3-gallon bottle is 12 cents. This spring should not be confused with the Highland Mineral Spring in the city of Lewiston.

Oak Grove Spring.—The Oak Grove Spring is owned by Miss Jennie Farrington, of Brewer. It is situated on the eastern bank of Penobscot River, about one-half mile above the village of Brewer. The water issues from a steep slope of bowlder clay about 20 feet above the ordinary river level. In its exact geologic occurrence it issues from a bed of gravelly bowlder clay and is said to come from a vertical crack one-eighth of an inch in width in the ledge below this deposit. No houses are situated within 500 feet of the spring. The fields above the spring are cultivated with grain, potatoes, etc. There seems to be little opportunity for pollution of the water, and it is probably perfectly safe for drinking. A small spring house has been built over the spring and the water is hauled to Bangor, where it is sold. It is colorless, odorless, and tasteless. The flow is about 1½ gallons a minute and its measured temperature is 48°. The water sells at 12 cents a 3-gallon bottle. The spring has been operated for five years by the present management, but was run several years earlier by other parties. The water is highly appreciated by the people of Bangor.

In 1906, in connection with cooperative work on mineral waters by the United States Geological Survey and the Bureau of Chemistry in the Department of Agriculture, a complete analysis of this water was made. The various constituents found are as follows:

Analysis of water from Oak Grove Spring.

[W. W. Skinner, analyst.]

Gases (cubic centimeters per 1,000 grams at 0° C. and 760 mm. pressure):	
Carbon dioxide (CO_2), free	9.00
Carbon dioxide (CO_2), set free from bicarbonates on evaporating to dryness	13.40
	Parts per million by weight.
Phosphoric acid radicle (PO_4)	None.
Metaboric acid radicle (BO_2)	None.
Arsenic acid radicle (AsO_4)	None.
Silica (SiO_2)	15.50
Sulphuric acid radicle (SO_4)	4.94
Bicarbonic acid radicle (HCO_3)	73.03
Nitric acid radicle (NO_3)	5.30
Nitrous acid radicle (NO_2)	Faint traces.
Chlorine (Cl)	5.60
Bromine (Br)	None.
Iodine (I)	None.
Iron and aluminum (Fe and Al)	.250
Manganese (Mn)	None.
Calcium (Ca)	18.58
Magnesium (Mg)	3.50
Potassium (K)	1.10
Sodium (Na)	6.95
Lithium (Li)	None.
Ammonium (NH_4)	Traces.
Oxygen to form Fe_2O_3 and Al_2O_3	.100
	135.850
Free ammonia	Traces.
Albuminoid ammonia	Traces.
Nitrogen as nitrates	1.20
Nitrogen as nitrites	Faint traces.
Oxygen consumed	4.00

A good recommendation for this water is that a Bangor photographer uses it entirely for his photographic work in preference to all other water.

Sparkling Spring, Orrington.—The Sparkling Spring is situated in the town of Orrington, about 1½ miles from the Brewer line and one-half mile east of Penobscot River. It consists of a hole dug 6 to 10 feet deep in a hollow beside a little brook flowing over a gravel terrace. The water is reported to issue from three cracks in the ledge below, and it is said by the owners that a pole can be stuck down 10 feet in one of these cracks. This statement has not been verified. The water is sold in bottles in Bangor at the rate of 12 cents a 3-gallon bottle. The analysis shows 194 parts per million of total solids, distributed as in analysis No. 268, recalculated from the company's advertisement. "There is considerable free carbon dioxide in solution." The spring is owned by Mr. Albert G. Dole and is leased by Mr. E. H. Homestead.

PUBLIC SUPPLIES.

The public water supplies of Penobscot County are taken entirely from surface sources. The city of Bangor and the villages of Brewer, Veazie, Orono, Oldtown, and Milford use water taken directly from Penobscot River. The villages of Newport and Dexter obtain water from lakes near by. There are no well or spring supplies of any consequence.

PREDICTIONS AND RECOMMENDATIONS.

The most important water question in Penobscot County arises in connection with the public supply of Bangor and several surrounding towns. These now obtain their supply entirely from Penobscot River. This water is badly polluted by sewage and manufacturing wastes from towns farther up the river, and is therefore dangerous to the public health. The people of Bangor realize this and many of them have been agitating for a safer source of supply. In 1906 the late Freeman C. Coffin, of Boston, was employed by the city council to make a thorough investigation of the Bangor water problem, for the purpose of deciding on the best source for a new supply. In his report[a] Mr. Coffin suggested four possible sources, as follows: (1) Ground-water supply; (2) Phillips Lake; (3) Felts and Eaton brooks; (4) Cold Stream Pond.

All the sources were found to be of excellent quality, but no definite decision was made between them. In regard to the ground-water supply, which was seriously discussed, two sources were considered, one in the broad flats west of Penobscot River and south of Pushaw Pond, the other east of Penobscot River and opposite the

[a] Bangor Daily Commercial, March 13, 1906.

pumping station. Either of the sources ought to yield a satisfactory supply, the chief doubt being in regard to the amount of water which can be obtained. The surface water supplies mentioned above seemed to be of equal worth, but perhaps more expensive.

It may be some time before a pure water system is installed. Meanwhile it is desirable that as many individuals and companies as can afford it should drill wells for their own private supplies. So far as known, there have been no failures in deep wells within the city, and the deeper such wells are drilled the better and larger the supplies seem to have become. For that reason it is advised that well drilling be continued at least until the supply shows signs of diminution. Elsewhere in southern Penobscot County the conditions are very similar as regards the kind of rock, and there is no reason why wells 100 to 400 feet deep should not be just as successful as in the vicinity of Bangor.

SAGADAHOC COUNTY.

GENERAL DESCRIPTION.

Sagadahoc County is the smallest county in Maine. It is situated on the eastern border of Casco Bay and extends a few miles inland, having a length from north to south of 32 miles and an extreme width from east to west of 17 miles. Its area is only 259 square miles. The population of this county according to the census of 1900 was 20,330. Bath, the largest city, had a population of 11,527, more than one-half of the population of the county. Kennebec River flows from north to south across the center of the county and follows the eastern border for a short distance north of Bath. In Merrymeeting Bay it is joined by Androscoggin River, which separates this county from Cumberland. South of Bath, Sagadahoc County is cut up by many indentations of the sea and enlargements of the river. The altitude ranges from sea level to nearly 500 feet. The principal transportation line is the main line of the Maine Central Railroad, which extends from Brunswick along the west bank of Kennebec River, a branch of the same railroad which runs eastward beyond Bath, and a second branch which extends northwestward along the eastern border of Androscoggin River to Lewiston in Androscoggin County.

A map of Sagadahoc County showing distribution of deep wells, important springs, and communities having public supplies forms Pl. XX.

UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

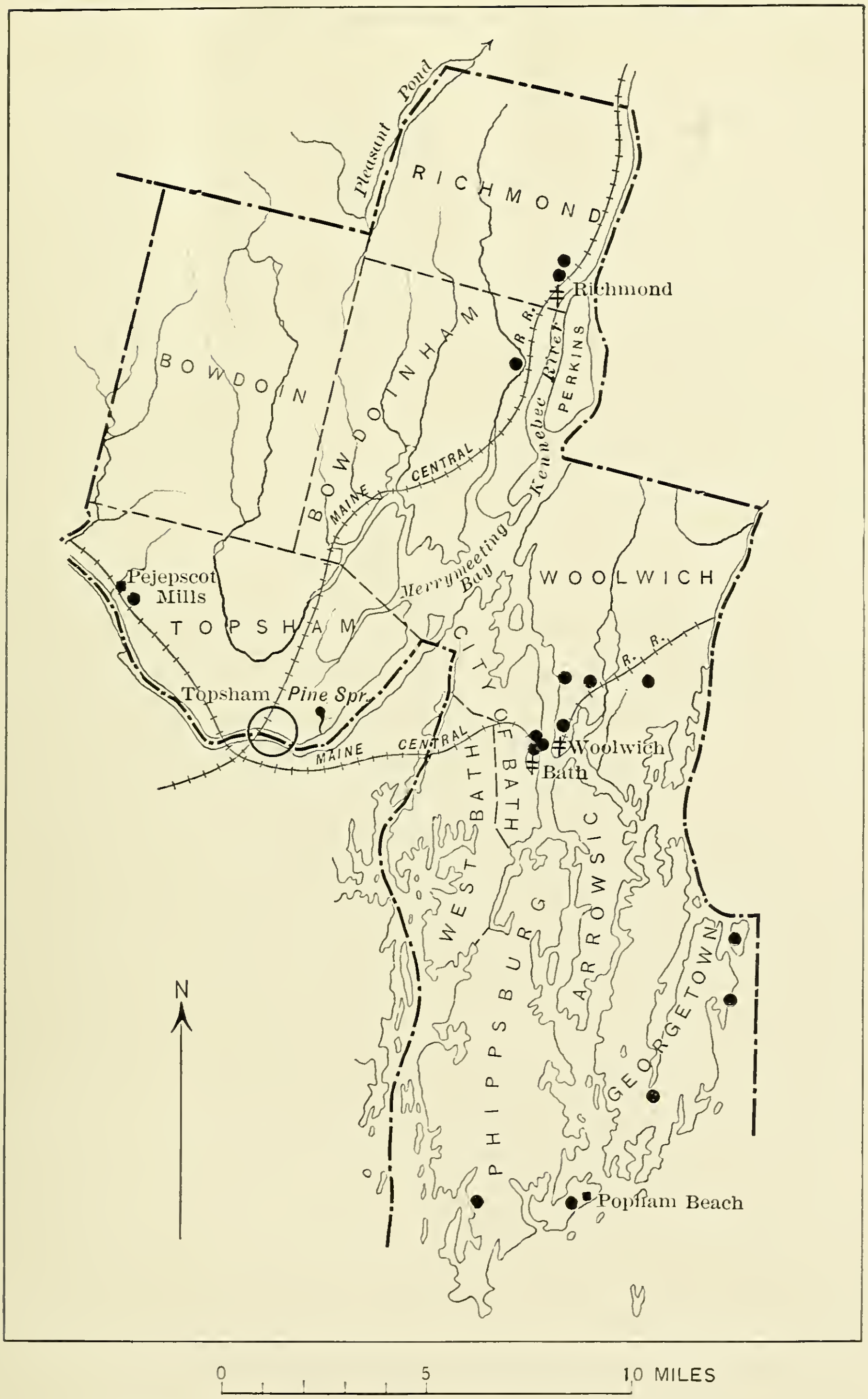
Distribution of rock types.—The rocks of Sagadahoc County must all be grouped as complex, which consists of granites, gneisses, slates, schists, and diorites, so rapidly alternating with one another that they can not be differentiated on any map. So far as observed in the field, the western portion of the county seems to be more gneissic and granitic than the eastern part, which is more schistose. The irregular proportions of the different rocks seem to have some effect on the quality of the water in various parts of this county and in adjacent counties.

Surface deposits.—The surface deposits of Sagadahoc County are not as thick as those in most other counties in Maine, owing largely to the fact that the county is cut up by many indentations of the sea and much opportunity has been given for the removal of the deposits by erosion. Along Kennebec River, up many of the small side valleys, and in a few sheltered places along the coast are small areas of clay, some of them 100 feet above sea level. These may be underlain by gravel. They are of considerable extent in the county and are overlain in many places by sand and gravel. Overlying the bed rock, as elsewhere in the State, is a thin coating of till, which in extreme cases is 20 feet or more in thickness. Borings in the valley of Androscoggin River in Topsham show that there the bed-rock floor of the valley is at least 155 feet below sea level, indicating a deep filling of gravel and an old gorge extending some distance back into the State.

WELLS.

GENERAL DESCRIPTION.

Only about 20 wells are known to have been drilled in Sagadahoc County. These are widely distributed, but are most numerous in Bath and Woolwich. They are mostly 6 inches in size, but a few 4-inch wells were sunk years ago. In depth they range from 40 to 335 feet, the deepest well in the county being that of the Pejepscot Paper Company, at Pejepscot Mills. An interesting fact is that although this well obtains only a small quantity of water a 40-foot well drilled for the same company a few feet distant obtained an inexhaustible supply, showing that the conditions are very uncertain. So far as can be learned from a study of the wells and records, it would not seem advisable to drill to great depths in this county. The limit should probably be about 200 feet. If a well reaches that depth without obtaining a sufficient supply the most economical procedure will be to drill a second well a short distance away. In the city of Bath most of the wells which were drilled years ago have been abandoned owing to the installation of a good city water supply. The abandonment has not been due in every case to the quality of the wells or the water. It can be stated, however, that the supplies in this county are not as good as in many counties of the State, and it is probable that not more than half the wells which have been drilled



● Successful well over 50 feet in depth

Important spring

‡ Community having public supply from surface sources

◯ Community having public supply from wells

▪ Other important towns

MAP OF SAGADAHOC COUNTY.

Showing distribution of deep wells, important springs, and communities having public water supplies.

are in use at present. Four field assays (Nos. 150, 151, 107, and 199) and one laboratory analysis (No. 152) are given in the table. One mineral spring has been analyzed (Nos. 269–270a).

DETAILED DESCRIPTIONS.

Bath.—The city of Bath has an excellent water supply, piped under Kennebec River from Nequasset Pond, in Woolwich. For this reason no drilled wells have recently been sunk in the city. Some drilling was done years ago, mostly between 1883 and 1895. Eight or more wells were sunk to depths of 50 to 100 feet, and the yield ranged from 2 to 30 gallons a minute. Some of the water was used for boilers, but most of it was for ordinary domestic purposes. A few wells are still in use. The C. A. Hooker well is 100 feet deep and the water will rise to the surface at times. A considerable number of people in Bath use shallow dug wells. Many of them are in poor locations where they might easily be contaminated by surface drainage. It is advised that all such wells be abandoned. Two field assays of waters from Bath have been made (Nos. 150 and 151).

Woolwich.—Next to Bath, Woolwich has the greatest number of wells in the county. Most of these are about 100 feet in depth. They yield several gallons of water a minute and seem to be fairly satisfactory as sources of supply. A laboratory analysis of water from one of them is given in the appended table (No. 152).

Georgetown.—On McMahans Island a well of the Sheepscot Land Company was drilled to a depth of 246½ feet and obtained a good supply of water. At Five Islands Mr. George E. Hughes sunk a well to 242 feet. This is pumped by an electric motor and seems to be satisfactory. No other drilled wells are known in Georgetown.

Phippsburg.—Only one drilled well is known to have been sunk in the town of Phippsburg. This is a 96-foot well at Fort Popham, but no data regarding it have been received. Most of the wells in town are dug from 6 to 30 feet. At Popham Beach many driven wells have been sunk, getting fresh water from 6 to 15 feet below the surface, in sand. Below that depth salt water is encountered. The level of fresh water in these wells rises with the tide. Among the sand dunes are a number of small ponds, which indicate the level of water in the dunes. At Popham Beach several years ago a boring was made to a depth of 962 feet for coal, but without success.

Topsham.—The village of Topsham has combined with Brunswick in the Brunswick and Topsham Water District to install a supply of water from driven wells situated on the flood plain of Androscoggin River. The supply is so excellent that wells are unnecessary in these villages. At Pejepscot Mills a well 335 feet in depth gave only enough water for two families. A well was later drilled near by to a depth of 40 feet and obtained plenty of water. This is an example of the extreme irregularity in the occurrence of rock water in this part of Maine. The formation here is mostly gneiss. In case any individuals or private companies in the village of Topsham desire water from wells in order to save water bills, it is probable that supplies can be obtained with success equal to that at Lisbon and Bath, a few miles to the northwest and east, respectively, of Topsham. The Pine Spring is situated in this town.

Bowdoinham.—The only drilled well known in Bowdoinham was sunk for Mrs. George L. Hinckley to a depth of 124 feet. This seems to have been a good well, but is not used on account of a broken pump. A dug well 40 feet in depth, 35 feet of which is in gravel and 5 feet in ledge, supplies 20 families. The rest of the wells here are less than 40 feet in depth. Two field assays (Nos. 107 and 109) have been made of well waters in this town.

Richmond.—A number of drilled wells have been sunk in Richmond in the past, but most of them are less than 50 feet in depth. One well 100 feet and one 65 feet deep are reported. Most wells in the village are abandoned, however, as there is a public supply from Kennebec River.

Other towns.—In the towns of Bowdoin, West Bath, and Arrowsic no drilled wells are known to have been sunk. While conditions are not as favorable as they are in Kennebec County, they seem to be better than in Lincoln County, and it is probable that drilling will be successful if the owner is willing to take the risk of possibly having to sink 2 wells before getting water.

SPRINGS.

General statement.—Springs are not especially abundant in Sagadahoc County, but some excellent ones are known. At Pejepscot Mills, in Topsham, the paper company owns an excellent spring which issues from sand and gravel in the bank of the river. The water is fine and cold and the rate of flow never varies. It is in such a situation that there seems to be no chance of pollution, and the water is highly prized by the people at the mill and by the inhabitants of the small village. A little spring house has been built and the water is pumped by means of a hand pump. One commercial spring is situated in the county.

Pine Spring.—As has been said, the Pine Spring is situated in the town of Topsham, 2 miles east of the village. It is owned by the Pine Spring Water Company, of Brunswick. The spring is situated in a small ravine in a sand plain. It is entirely surrounded by woods and as the only house in the vicinity is 500 feet distant, on the opposite side of the ravine, there is no chance for the water to become polluted. The water is colorless, odorless, and tasteless. The flow is 5 gallons a minute and the measured temperature is 44°. The water is sold as "Pine Spring water" and is bottled for ginger ale and "soda." It is not called a mineral water. A crate of six half-gallon bottles retails for $1.50. Formerly a spring house was built over the spring, but it is now in disrepair. Such a house is unnecessary, as the spring is situated far from all buildings. The analysis of the water is given in the table (No. 269), having been recalculated from the analysis published by the company. Another analysis of the water made by W. W. Skinner, of the Bureau of Chemistry, United States Department of Agriculture, in connection with cooperative work on mineral waters conducted by the Geological Survey and the Bureau of Chemistry, is as follows:

Analysis of Pine Spring mineral water.

[W. W. Skinner, analyst.]

Gases (number of cubic centimeters per 1,000 grams at 0° C. and 760 mm. pressure):	
Carbon dioxide (CO_2), free	8.2
Carbon dioxide (CO_2), set free from bicarbonates on evaporating to dryness	2.4
	Parts per million by weight.
Phosphoric acid radicle (PO_4)	None.
Metaboric acid radicle (BO_2)	None.
Arsenic acid radicle (AsO_4)	None.
Silica (SiO_2)	7.4
Sulphuric acid radicle (SO_4)	1.05
Bicarbonic acid radicle (HCO_3)	12.86
Nitric acid radicle (NO_3)	None.
Nitrous acid radicle (NO_2)	Faint traces.
Chlorine (Cl)	4.20
Bromine (Br)	None.
Iodine (I)	None.
Iron and aluminum (Fe & Al)	.32
Manganese (Mn)	None.
Calcium (Ca)	2.14
Magnesium (Mg)	.79
Potassium (K)	.60
Sodium (Na)	3.49
Lithium (Li)	None.
Ammonium (NH_4)	.026
Oxygen to form Fe_2O_3 and Al_2O_3	......
	32.876
Free ammonia	.025
Albuminoid ammonia	.005
Nitrogen as nitrates	Traces
Nitrogen as nitrites	Faint traces.
Oxygen consumed	6.00

PUBLIC SUPPLIES.

The city of Bath and the village of Richmond are supplied with water from surface sources, the former from Kennebec River and the latter from Nequasset Pond. Formerly the Bath supply was taken from 83 wells driven in sand, the average depth of which was about 20 feet. These wells were abandoned for the present supply. The village of Topsham has combined with Brunswick to obtain a system of water supply from driven wells on the flood plain of Androscoggin River, a short distance below the villages. This supply is described in connection with Cumberland County.

SOUTHERN SOMERSET COUNTY.

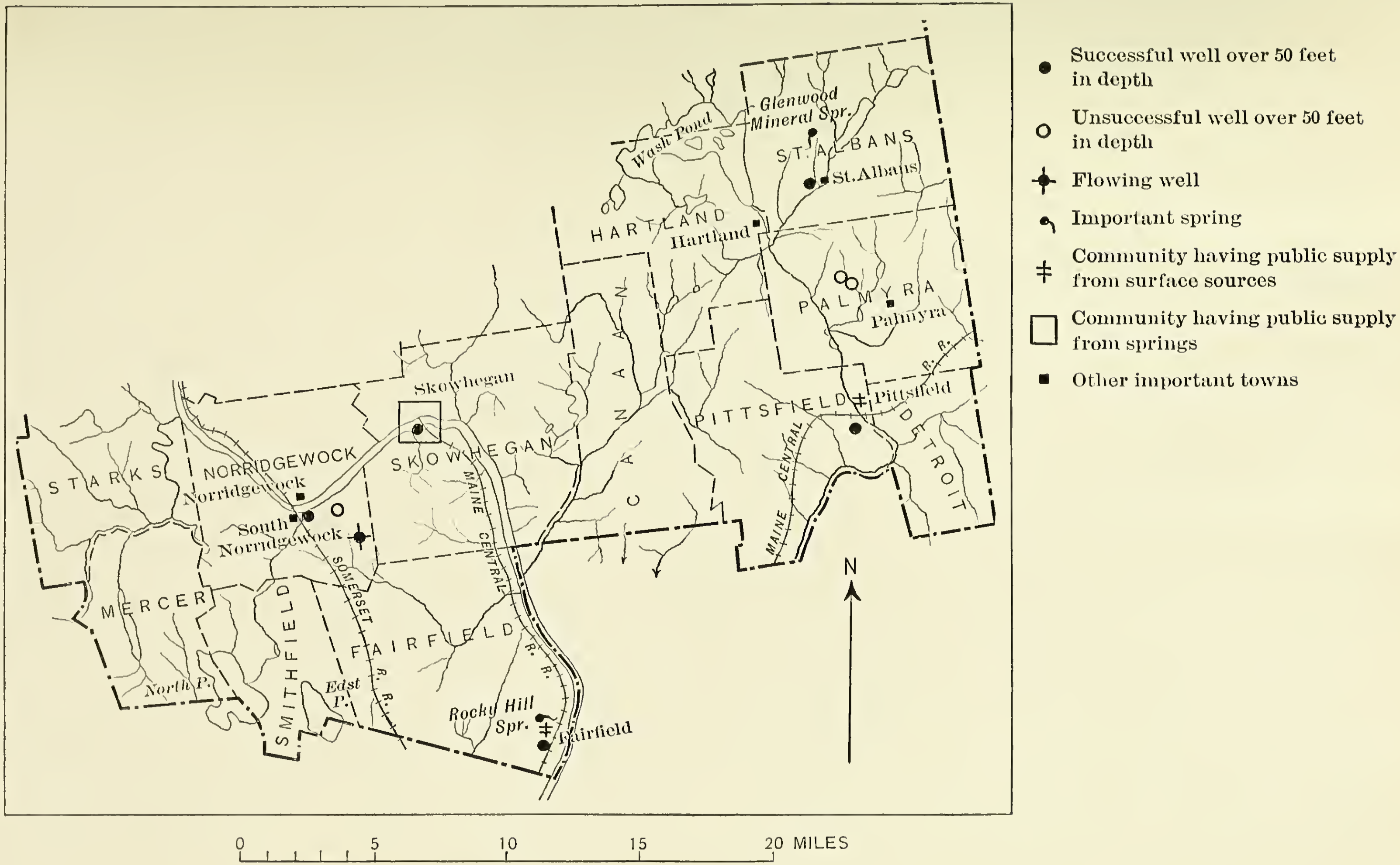
GENERAL DESCRIPTION.

Somerset County lies somewhat west of central Maine and extends north and south about half the length of the State, a distance of about 140 miles. The maximum breadth of the county is 45 miles and its area is 3,831 square miles. In this report only the southern part of the county is included. The population of the whole county according to the census of 1900 was 33,849. The largest town is Skowhegan, with a population of 4,266. The county is rather mountainous, its altitude ranging from 150 feet above the sea along Kennebec River to 3,600 feet at the summit of Mount Bigelow, but the highest point in the area here discussed is probably not over 2,000 feet high. Kennebec River is the principal stream, and flows through the center of the county in a southerly direction, except in the vicinity of Skowhegan, where it makes a marked bend. There are no important tributaries to the river in this part of the county, although Sandy River enters from the west in the vicinity of Madison, and Sebasticook River rises in the eastern part of the county and flows southward. Scattered throughout the county are a great many large and small lakes, of which Moose Pond is the largest within the area covered by this report. The only lines of transportation are the Maine Central Railroad, which runs southward from Skowhegan along the west bank of Kennebec River, and the Somerset Railway, which runs northward from Oakland through the center of the county to Moosehead Lake, outside the limits of the area here considered. A map showing the distribution of deep wells, important springs, and communities having public supplies forms Pl. XXI.

UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Distribution of rock types.—The predominant rock formation of Somerset County is slate, and the whole northern part of the county is formed of this rock, with three important exceptions. These are



MAP OF SOUTHERN SOMERSET COUNTY.

Showing distribution of deep wells, important springs, and communities having public water supplies.

areas of granite. The first lies just west of Hartland and St. Albans and covers the southern part of Harmon, the western part of Hartland, the northeast corner of Cornville, and the southwest corner of Athens. The second granite area lies in the extreme southwest corner of the county and covers nearly the whole of Mercer, the portion of Norridgewock southeast of the village, and the west corner of Smithfield. The third granite area extends from Embden Pond, in Embden, northwestward beyond the limits of the area included in this report, and covers the northern part of New Portland, the northwestern part of Embden, the western edge of Concord, and probably the whole of Lexington and Highland plantations. Moderate amounts of water are found in granite, but the supplies are irregularly distributed. The granite is quarried in the vicinity of South Norridgewock.

The slate of this part of Somerset County is typical of the slate making up a large part of central Maine. It is a very fine-grained drab to black slate and splits parallel with the stratification. The strike is in general about N. 60° E. and the dip is as a rule nearly vertical, although in some places it is inclined. Locally this slate is slightly calcareous. Considerable water is found in this rock.

Surface deposits.—Along Kennebec River and in other sections where the land is rather low the surface is covered with sand and gravel and some clay, which form flat plains extending backward from the river in places for a mile or more. These plains are well developed in the vicinity of Skowhegan. One of these broad gravel-filled valleys lies between Norridgewock and North Fairfield. In these deposits good water is abundant and issues in the form of springs around the sides of the plains. The county contains also irregular gravel deposits. On the uplands the surface consists mostly of bowlder clay, which ranges from a few inches to 20 feet or more in thickness. In some of the mountain regions the surface is nearly bare of drift.

WELLS.

GENERAL DESCRIPTION.

Types of wells used.—The prevailing type of well in Somerset County is the old-fashioned open well, such as is common throughout the State. These wells are, as a rule, sunk in bowlder clay and gravel, although some of them are blasted a few feet into the rock. They range in depth from 5 to 40 feet. Generally they are successful in times of abundant rainfall, but are likely to run dry in summer.

Drilled wells.—Only about a dozen drilled wells have been sunk in Somerset County. In diameter they vary from 5 to 8 inches, but 6 inches is the prevailing size. The depth ranges from 26 to 157 feet, the most common depth being about 80 feet. They strike rock at 1 to 50 feet below the surface, and the greatest supply of water may be found anywhere between the top and the bottom of the well. So far as known all the drilled wells have been sunk in slate, but there is no reason why they should not be successful in granite, as they are elsewhere in Maine. In one well the water rises to the surface of the ground.

Quality of water.—As few analyses have been made of waters from wells in Somerset County, not a very good idea can be given of the quality of water here. The total solids found in a well which was dug in drift and blasted in the underlying rock were 408 parts per million, and the hardness was 188. The amount of total solids in a drilled well was 56, and the hardness was 35. Another drilled well, 26 feet in depth, in slate and situated high up on a hillside, contained 29 parts of carbonates, a trace of sulphates, and 3.5 parts of chlorine. The details of these analyses are given in the table (Nos. 108 to 110). A good idea of the character of water which may be found in slate in this part of Maine may be had by consulting the analyses given in the table in connection with western Penobscot and northern Kennebec counties, on pages 78–79. The analyses of waters in granite in other parts of Maine are given on page 77. Analyses of several mineral springs are also given in the table (Nos. 271 to 273).

Quantity of water.—In general in Somerset County there seems to be plenty of water in the slates. Of the dozen wells drilled four have been failures, but three of these were situated on a barren hilltop where there was little soil and where there would seem to be little probability of finding water. The other well reported only a small fraction of a gallon per minute. One well was abandoned on account of poor water, and several have not been used since waterworks were installed in their respective towns. As the rock of Somerset County, with the exception of that in the granite areas, is similar to that of southern Penobscot County, where water is abundant, good supplies may also be expected in Somerset County.

Flowing wells.—A 25-foot well drilled on a slate hillside in the eastern part of Norridgewock obtained water which overflows the surface except in times of dry weather. With this exception no flowing wells are known in the county.

DETAILED DESCRIPTIONS.

Skowhegan.—Skowhegan, the county seat and largest town in Somerset County, is largely supplied with water by several aqueduct companies that obtain water from springs situated on the slopes of a sand plain bordering the village. The supplies are believed to be very good at present, but care should be taken to prevent their contamination by surface drainage. A full description of the public supplies of Skowhegan is given under the appropriate heading (pp. 209–210). The only drilled well in the village was sunk more than twenty years ago for Mr. Levi P. Weston, on an island in the middle of the river. This well was pumped by a windmill, but was abandoned when the city waterworks were installed in 1888. On the sand plains surrounding the town there are a number of driven wells which seem to obtain adequate supplies of good water, and similar supplies may be obtained almost anywhere on the sand plains along Kennebec River.

Norridgewock.—On the sand plain south of the river in Norridgewock a large amount of water can be obtained by driven wells 10 or 15 feet in depth. The wells in the village are shallow. On the highlands east of the village of South Norridgewock are two drilled wells. One of these is 77 feet in depth and probably contains water, but has not been used because the owner had no deep-well pump. The other drilled well is situated in the eastern part of the town. It is only 26 feet in depth and overflows except in dry weather. It is siphoned down the hill to a farmhouse on the slope below and supplies water for domestic and farm purposes. It would seem that siphons might be more widely used in Maine. A field assay made of the water in this well is given in the table (No. 108).

Fairfield.—The village of Fairfield forms a part of the Kennebec water district, which obtains water from China Lake. In Fairfield an 8-inch well was drilled in 1884 to a depth of 91 feet. It is still used, and the water seems to be of good quality. As this town lies in the slate area in which abundant water supplies are found in neighboring parts of Penobscot County, it would seem that equally successful wells might be obtained here. The Rocky Hill Spring is situated in this town.

Pittsfield.—Pittsfield is supplied from the Sebasticook River. The water is reported as rather poor. In the village are a great many dug wells, 12 to 50 feet in depth, which are somewhat suspicious, as they are subject to contamination from surface drainage. One spring is situated near a number of houses and is probably not safe. Two or more drilled wells have been sunk in this village to a depth of less than 50 feet. The water is only of fair quality and is called hard. It is probable that more water could be obtained by sinking deeper, and it may be of better quality, although this can not be stated with certainty. An open well for Dr. F. J. Taylor was dug 20 feet and blasted 6 feet. The water has a fine taste and never gives out. A field assay of this water is given in the table (No. 110). A well drilled 47 feet for Mr. W. R. Hunnewell is reported to have a hardness of 35 parts (No. 109) while that of the Taylor well is 188. The total solids of the former were 56 and of the latter 408. In the Taylor well 48 parts of chlorine per million were found.

Palmyra.—Several drilled wells in Palmyra have attained fair success; several others, however, have not. An example of unsuccessful drilling is found on the estate of Mr. Perry Furbush, whose farm is situated on top or a hill where the rock reaches the surface. Three wells were sunk. The first was dug and blasted 43 feet; then a horizontal gallery was run at right angles to the strike of the slate for a distance of 24 feet, but no water was found. This well was then drilled to 157 feet from the surface, when the tools became stuck and work was stopped. No water was found. Well No. 2 was drilled 80 feet through ledge and now supplies 20 to 30 gallons of water a day, summer and winter. Well No. 3 was also drilled 80 feet in ledge. The tools stuck at 80 feet, and the well had to be abandoned. This well was situated only 130 feet from the first. By pumping it dry every four hours 125 gallons of water a day could be obtained, which was not enough. As all the wells on this estate have proved to be practically failures, a spring some distance away on the hillside is used for watering the cattle. This spring is reported to issue from a vertical crack on a rotten seam parallel with the bedding of the slate. In other parts of town several drilled wells are supposed to have attained greater success, but these were not visited.

St. Albans.—At least one well is known to have been drilled in the town of St. Albans. The depth is reported to be 49 feet, and the yield is only a fraction of a gallon a minute. Deeper drilling in this town might meet with greater success in both the granite and the slate areas. The Glenwood Mineral Spring is situated in this town.

Hartland.—One or more wells less than 50 feet in depth have been drilled in the town of Hartland. The water was poor and they are not used. It would seem that by sinking to a greater depth water ought to be obtained in both the granite and the slate areas.

Madison, Anson, and Solon.—These three towns, although lying a little south of the northern extremity of the area considered in this report, have not been studied. They will be included in the report on the underground waters of northern Maine.

Other towns.—Other towns in this area obtain supplies entirely from dug wells and from springs. Where the wells are favorably situated the conditions are supposed to be good. In many places springs are of good quality and are much better and cheaper than wells.

SPRINGS.

General statement.—As stated above, springs are very abundant in Somerset County and are used for both public and private supplies, especially along Kennebec River. North of Madison several town supplies come from this source. Skowhegan and Fairfield also have spring supplies in part. Three mineral springs reporting sales are situated within the limits of Somerset County. These are the Glenwood Spring at St. Albans, the Pine Grove Spring near Pittsfield, and the Rocky Hill Spring at Fairfield.

Glenwood Spring.—In the town of St. Albans, about 2 miles north from the post-office, is the Glenwood Spring. The water is reported by the owner, Mr. C. A. Moulton, to issue from sand with a volume of 30 gallons a minute. It has no color, odor, or taste, and the temperature is said to be 48°. The water is shipped for table and medicinal use. An analysis, reported by the owner, has been recalculated into ions and parts per million and is given in the table (No. 272). The total solids amount to 67 parts. The following analysis, which gives the full composition of the water, was made by W. W. Skinner, of the Bureau of Chemistry, United States Department of Agriculture, in connection with cooperative work on mineral waters conducted by the Geological Survey and the Bureau of Chemistry.

Analysis of water from Glenwood Mineral Spring.

[W. W. Skinner, analyst.]

Gases (cubic centimeters per 1,000 grams at 0° C. and 760 mm. pressure):	
Carbon dioxide (CO_2), free	7. 30
Carbon dioxide (CO_2), set free from bicarbonates on evaporating to dryness	10. 00
	Parts per million by weight.
Phosphoric acid radicle (PO_4)	None.
Metaboric acid radicle (BO_2)	None.
Arsenic acid radicle (AsO_4)	None.
Silica (SiO_2)	11. 00
Sulphuric acid radicle (SO_4)	3. 62
Bicarbonic acid radicle (HCO_3)	54. 71
Nitric acid radicle (NO_3)	1. 55
Nitrous acid radicle (NO_2)	None.
Chlorine (Cl)	1. 80
Bromine (Br)	None.
Iodine (I)	None.
Iron and aluminum (Fe and Al)	. 35
Manganese (Mn)	None.
Calcium (Ca)	13. 01
Magnesium (Mg)	2. 49
Potassium (K)	. 93
Sodium (Na)	3. 92
Lithium (Li)	None.
Ammonium (NH_4)	. 011
Oxygen to form Fe_2O_3 and Al_2O_3	. 150
	93. 541
Free ammonia	. 01
Albuminoid ammonia	. 01
Nitrogen as nitrates	. 35
Nitrogen as nitrites	None.
Oxygen consumed	5. 00

Pine Grove Spring.—About 5 miles southeast of Pittsfield is a spring known as the Pine Grove Spring. The flow is reported large, and the temperature is given as 48°. The water is sold in Pittsfield and vicinity.

Rocky Hill Spring.—The Rocky Hill Spring, owned by Mr. W. N. Osborne, is situated 1½ miles north of the village of Fairfield. The spring is said to flow 18 gallons an hour and to issue from slate. The flow diminishes somewhat in a severe drought. The temperature is reported as 46°. The water is colorless and tasteless. It is sold in Waterville and Fairfield. A sanitary anlaysis made in 1896 showed it to be of excellent quality. The mineral analysis, from the analysis advertised by the owner, is given in the table (No. 271). A more complete analysis was made by W. W. Skinner, of the Bureau of Chemistry, United States Department of Agriculture, in connection with cooperative work on mineral waters conducted by the Geological Survey and the Bureau of Chemistry. This is as follows:

Analysis of water from Rocky Hill Spring.

[W. W. Skinner, analyst.]

Gases (cubic centimeters per 1,000 grams at 0° C. and 760 mm. pressure):	
Carbon dioxide (CO_2 free),	7.20
Carbon dioxide (CO_2), set free from bicarbonates on evaporating to dryness	11.60
	Parts per million by weight.
Phosphoric acid radicle (PO_4)	None.
Metaboric acid radicle (BO_2)	None.
Arsenic acid radicle (AsO_4)	None.
Silica (SiO_2)	10.60
Sulphuric acid radicle (SO_4)	3.66
Bicarbonic acid radicle (HCO_3)	63.57
Nitric acid radicle (NO_3)	2.20
Nitrous acid radicle (NO_2)	None.
Chlorine (Cl)	2.80
Bromine (Br)	None.
Iodine (I)	None.
Iron and aluminum (Fe and Al)	.140
Manganese (Mn)	None.
Calcium (Ca)	13.29
Magnesium (Mg)	4.34
Potassium (K)	.85
Sodium (Na)	4.60
Lithium (Li)	None.
Ammonium (NH_4)	Traces.
Oxygen to form Fe_2O_3 and Al_2O_3	.060
	106.110
Free ammonia	Traces.
Albuminoid ammonia	Traces.
Nitrogen as nitrates	.50
Nitrogen as nitrites	None.
Oxygen consumed	3.50

PUBLIC SUPPLIES.

Skowhegan.—About half the inhabitants of Skowhegan obtain water from what is known as the "city water" system. This system is, however, owned by the Skowhegan Water Company, which has a contract to provide the village with fire protection. The water comes from a ponded brook in a valley on the eastern edge of the village and is believed to be of fair quality. There are also four aqueduct systems drawing water from springs situated in ravines in the sand plains which surround the village. These are the West Aqueduct Company, the Coburn Aqueduct Company, the Skowhegan Aqueduct Company, and the Niel Aqueduct Company. All these supply the part of the village situated north of the river. On the south side of the river there are a number of private systems.

The springs of the West Aqueduct Company are two in number and issue from the base of a sand and gravel plain on the northern and western edges of town. The plain is underlain by clay. One of these springs is situated 300 feet from the nearest house built on the plain above; this is probably safe. The other spring is 50 feet or less below a stable on the edge of the plain; this spring would seem to be dangerous and ought to be abandoned. The water is collected in two tanks built over these springs and runs by gravity to the houses where it is used. Most of West Skowhegan gets water from this system. The water is called excellent by the users. This is the largest aqueduct system, and supplies about 150 families. A field assay of tap water is given in the table (No. 273).

The spring of the Coburn Aqueduct Company is situated within a few hundred feet of the West Aqueduct springs, in another ravine. This water is of excellent quality and appears to be safe. The system is reported to supply about 100 families.

The Skowhegan Aqueduct Company's system is smaller, deriving its supply from a well and a spring situated on the edge of the plain on North street. The well is a large dug well, probably 15 feet in depth, on top of the plain and not 50 feet distant from two houses. The water is in sand, on top of clay. The company is reported to have 36 takers. The spring is situated not 20 feet from a house and on the slope below it. This situation appears rather dangerous and it would be advisable to abandon the spring.

The Neil Aqueduct Company obtains its supply from an old brick-yard some distance down the ravine from the springs of the West Aqueduct Company.

All these supplies are gravity systems, and as the sources lie on the edge of the sand plain they can not reach the people living on the higher land. These families are supplied by "city water." Most of the patrons of the aqueduct water use spigots, which flow a constant stream through a hole about one-twentieth of an inch in diameter through a glass tube. The rates are $6 a year.

The first aqueduct line is reported to have been laid in this village as long ago as 1830.

Other towns.—A part of Fairfield has a spring supply. Pittsfield and the rest of Fairfield use surface water.

PREDICTIONS AND RECOMMENDATIONS.

In Somerset County the conditions for obtaining underground-water supplies seem to be fairly good, but as yet they have not been fully developed. In a few places, as in some of the villages, water is obtained from dug wells which are evidently polluted by surface drainage and are unsafe. Where there is any suspicion about the quality of the water the dug wells should be abandoned for the public supplies or drilled wells. The latter are suitable for use nearly everywhere and are in many places better than the public supplies. Some springs have been seen which should not be used, but as a rule the springs in the county are well situated and are safe for drinking.

WALDO COUNTY.

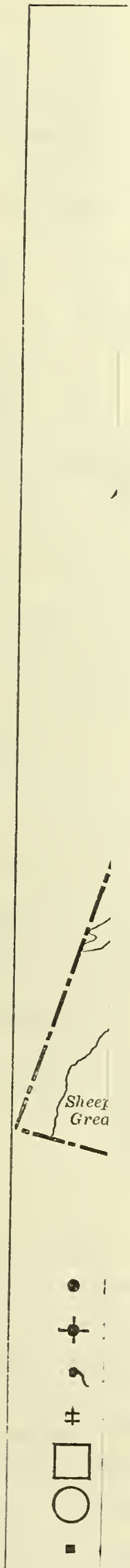
GENERAL DESCRIPTION.

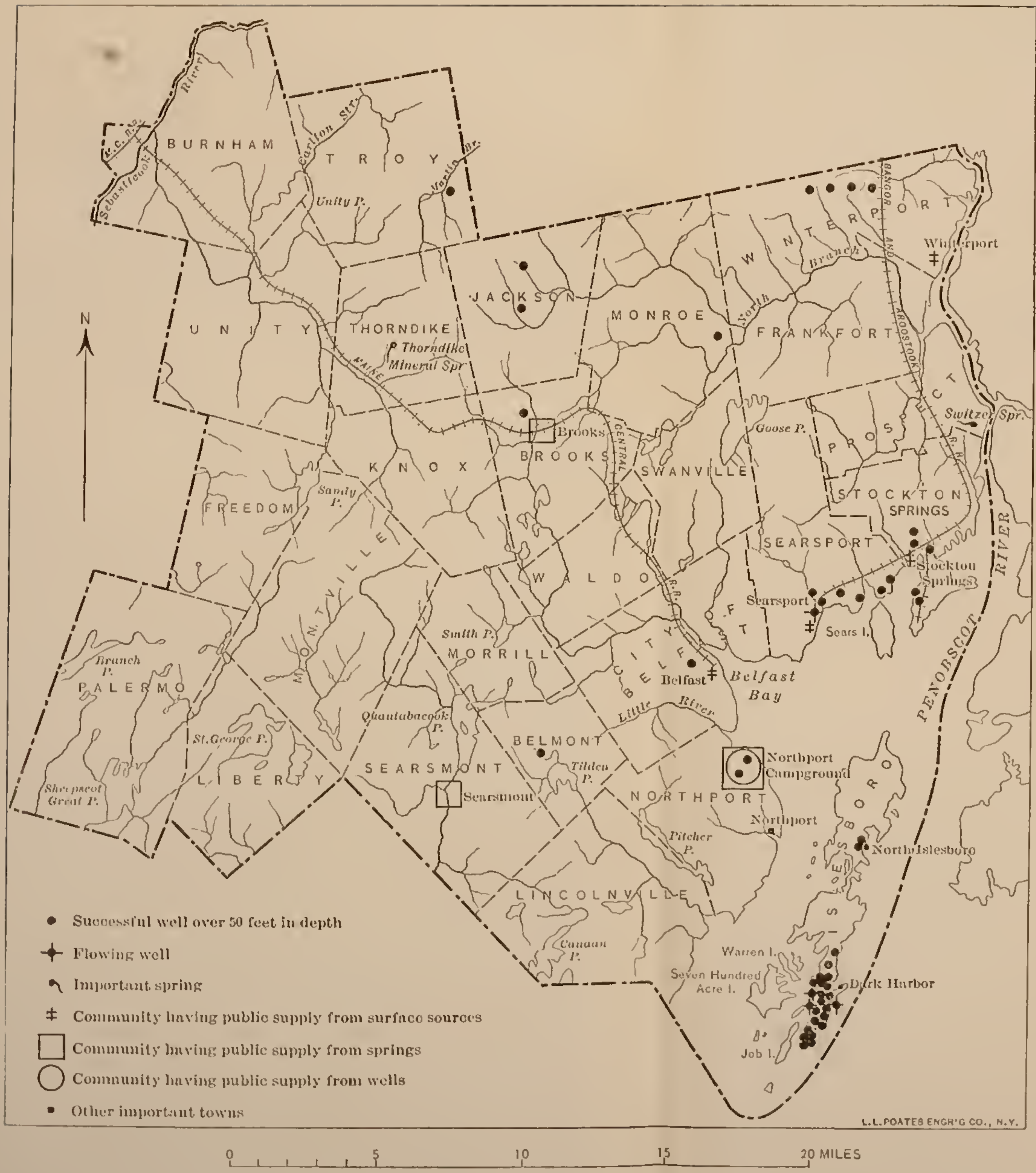
Waldo County lies in southern Maine, just west of Penobscot River and Penobscot Bay. It is a small county, having a total extent north and south of only about 35 miles, and the same east and west. Its area is 748 square miles, and the population according to the census of 1900 was 24,185. Belfast, the principal town, contains 4,615 inhabitants. This county is moderately hilly and ranges in elevation from sea level to nearly 1,100 feet. It has no large streams except the Penobscot, on which it borders, but contains a few small lakes. Its transportation lines are the Maine Central Railroad, running northwestward from Belfast across the county, and the Bangor and Aroostook Railroad, which runs northward from Searsport. A map of Waldo County showing the distribution of deep wells, important springs, and communities having public supplies forms Pl. XXII.

UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Distribution of rock types.—Probably about half of Waldo County is composed of slate. The area occupied by this rock lies northwest of a line drawn roughly from the southwest corner of the county northeastward to Penobscot River, on the border of Penobscot County. There is also a considerable patch of slate and slaty rocks southwest of Stockton Springs, which covers the greater part of the





MAP OF WALDO COUNTY.

Showing distribution of deep wells, important springs, and communities having public water supplies.

towns of Searsport, Belfast, and Belmont and smaller parts of Searsmont and other towns. Islesboro is also mostly slate, although thin and unimportant bands of limestone are reported to cross this island.

The principal granite area in Waldo County lies in the southeastern part of Winterport, the eastern part of Frankfort, in Prospect, northern Searsport, and eastern Swanville. Parts of Swanville, the greater part of Waldo, smaller parts of Brooks, Morrell, western Searsmont, southeastern Montville, Liberty, and southeastern Palermo are underlain by a complex consisting mostly of granite, gneiss, diorite, schists, and other rocks. Another arm of the complex enters the southern edge of the county and covers the greater part of Lincolnville and Northport, but also includes part of Searsmont and probably a corner of Belmont.

As a rule the slate of Waldo County strikes in a northeast direction, and the cleavage has generally about the same trend. The slate is hard and compact and the dip is always high. A small part of eastern Waldo County has been studied thoroughly by the geologists of the United States Geological Survey, and the results have been published in the Penobscot Bay geologic folio.[a] It is therefore possible to say with considerable certainty what kind of rocks are found in the various towns in this region. The distribution of these rocks will be described under the town headings.

Surface deposits.—The unconsolidated deposits forming the surface of Waldo County consist for the most part of bowlder clay, which ranges in thickness from 1 to 20 feet or more, but is commonly thin. This bowlder clay generally forms the surface on the hills where they do not consist of bare rock, but in the lowlands it is in many places overlain by various amounts of stratified sand and gravel, and here and there by clay. These deposits locally form flat plains, but are nowhere of great extent.

WELLS.

GENERAL DESCRIPTION.

Types of wells used.—The predominant type of wells in Waldo County is the open well. They vary in depth from 10 to more than 30 feet and are generally dug in gravel or bowlder clay, although some of them are blasted in rock. These wells are generally successful in wet seasons, but in summer they usually dry up.

Drilled wells.—A greater number of wells have been drilled in Waldo County than in any other county on the Maine coast except Cumberland. There are more than a hundred such wells within the limits of the county. They are mostly 6-inch wells, but a few 7 inches in size are reported, and a number of wells are 8 inches at the top and 6 inches at the bottom. One well was 10 inches at the top and 8

[a] Geologic Atlas U. S., folio 149, U. S. Geol. Survey, 1907.

inches at the bottom. In depth they run from 30 to 329 feet. Most of them have been successful, although a few have been abandoned owing to insufficient supply, and in one or two the quality of the water has not been up to the standard.

Quality of water.—The quality of water in Waldo County is generally good. In all, 14 analyses are known to have been made. Most of them are of slate waters, but a few analyses of water from other rocks have been made. The total solids reported range from 138 to 163 parts per million, and one well reports them as high as 234. The hardness runs from 85 to 152 parts, but is reported in only a few analyses. The carbonates range from none to 28, and the calcium from 8 to 47. Some reports of iron run as high as 10, but these are believed to be erroneous. A better idea of the quality of the water can be had from the table (Nos. 111 to 127, 153, and 154).

Quantity of water.—The quantity of water found in wells in Waldo County is extremely variable, depending on the situation, time of year, kind of rock, and other conditions. In some wells only a trace of water was found. In one of the wells situated at Cape Jellison the supply was 200 gallons a minute, according to the reports of the railroad company. Only a few failures have occurred in the county. In general the water seems to be best in slate. In the complex region indicated on the map (Pl. I) supplies will probably not be found to be quite as large as elsewhere.

Flowing wells.—Several flowing wells have been noted in Waldo County. Two of these are situated in the town of Islesboro and are deep drilled wells, probably deriving their head from near-by hilltops rising a few feet above the surface of the well. A similar well is reported at Searsport, but the hill from which its head is derived seems to be at a distance of several hundred feet. The flowing wells in slate of which these are examples are caused by water pressure due to the inclination of the joint cracks running from hills in the vicinity, and the flows are found where the intervening rocks are overlain by clay and hardpan, which close the joints at the surface.

DETAILED DESCRIPTIONS.

Belfast.—Belfast obtains its public supply from Little River, which enters the sea 2 miles south of the village. The water is poor, being taken from a very swampy reservoir near the mouth of the river. In summer it has a fishy odor. As far as health is concerned it is probably not dangerous, and if taken from a higher point on the same river and confined in a reservoir containing less vegetation the water would probably be satisfactory.

In the upper part of the village a few wells have been dug in clay and bowlder clay. These are situated near houses and are in danger of pollution from drainage. Some persons prefer the wells to the city water, but the public supply is safer. One drilled well in town is 39 feet in depth, and the water is used for domestic purposes. The slate in this town is similar to the slate of Penobscot County and ought to give plenty of water, although its capacity has not yet been thoroughly tested by drilling.

Belmont.—The only drilled well in Belmont is that belonging to Mr. Horace Chenery. It is 187 feet deep, and slate was struck at 12 feet from the surface. The well was cased with 10-inch casing to rock, and 8-inch casing was then placed inside and the space between filled with cement, making it water-tight. The yield is reported as 19 gallons a minute, and the analysis (No. 111) records 138 parts per million of total solids.

Searsmont.—In Searsmont there are no drilled wells. The deepest well is dug 44 feet deep and supplies good water. A field assay (No. 201) shows 16 parts per million of carbonates. The public supply of Searsmont is obtained from springs. The village has a few driven wells, but none have been drilled.

Northport.—The town of Northport is underlain largely by a complex of slates and schists, with considerable granite and diorite and other injected igneous rocks. Northport Camp Ground is supplied by a public system from springs and a drilled well belonging to the Mountain Spring Water Company. The well is 168 feet deep, is situated on the hill in the upper part of the village, and supplies 27 gallons of water a minute. An analysis (No. 153) shows total solids amounting to 145 parts per million and a hardness of 87. Another well, 64 feet in depth, obtained a small amount of water. The total solids and the hardness are 234 and 126 parts per million, respectively. A full description of the deeper well is given under the heading "Public supplies" (p. 217).

Searsport.—Searsport is underlain mostly by slate and schist. There are, however, traces of other rocks in the town. The village until recently was supplied by two springs situated on the hillside 2 miles west of the village, but now buys its water from Stockton Springs, which obtains its supply from Halfmoon Pond.

The best drilled wells in Searsport are those of the Bangor and Aroostook Railroad (Northern Maine Seaport Railroad Company). One of these, situated at the terminal, is 329½ feet deep. This well yields 60 gallons of water a minute with a steam pump. A similar well at Kidders Point is 285 feet deep and yields 130 gallons a minute. The water is sold to supply steamships and is also used for running an electric plant.

In the village of Searsport there are several wells. Some of these are about 100 feet deep and give many gallons of water per minute. The well at the Searsport House is said to overflow the surface in wet weather. The quality of the water is very good. The common constituents are reported in the analyses of the railroad wells (Nos. 118 and 123). As will be seen, the total solids range from 100 to 150. The water is excellent for drinking purposes, but it forms a small scale in locomotive boilers.

Stockton.—The village supply of Stockton Springs is taken from Halfmoon Pond. The railroad has a well at the "Y," one well directly east of the village, and two wells at Cape Jellison. These wells range in depth from 158 to 247 feet and yield from 10 to 200 gallons a minute. Of the wells at Cape Jellison one was drilled 158 feet, giving 12 gallons a minute, but the supply decreased; the other was sunk to 225 feet, and at that depth gave 200 gallons a minute. These wells are pumped by steam and electric pumps. Two analyses of water are given in the table (Nos. 112, 127). In both wells there is much iron, due to the rusting of the pipes, but the water is good. It is excellent for drinking, but some scale forms in boilers. There are several other drilled wells at Stockton Springs.

Prospect.—In the eastern part of the town of Prospect the Switzer Spring is situated. All wells in the town are shallow and none is known to have been drilled.

Frankfort.—Most of the wells in Frankfort are dug wells, but one or more drilled wells are reported. The water in the eastern part of town is mostly granite water; that in the western part is largely slate water. The wells in the western section will probably be somewhat the more successful.

Winterport.—Winterport has a public supply from West Branch of Lowes Brook. There are no drilled wells in the eastern part of the village, but in the western part there are several, the conditions for water being better in that section. The supplies are obtained in slate similar to that at Bangor.

Monroe.—At least one drilled well is situated in the town of Monroe. This is a 7-inch well 61 feet deep. The water contains some iron, but is used for domestic purposes and for stock.

Jackson.—Several drilled wells in Jackson are between 45 and 65 feet in depth. One of them is a 9-inch well. The water from all of them is used for domestic purposes and for stock.

Brooks.—The public supply of Brooks is taken from two springs in the village. A few people use dug wells, some of which have caused sickness in the past. There are a number of drilled wells in town, but no information regarding them is at hand. There ought to be plenty of water in slate at this place.

Thorndike.—Wells have been sunk in the town of Thorndike, but no data have been received regarding them. The conditions ought to be as good as in other towns in the vicinity which derive their water from the slate formation.

Troy.—In Troy most wells are blasted and drilled in rock. The depth ranges from 20 to 70 feet, and plenty of water is obtained for domestic and farm purposes. Most of the wells are of the ordinary size, but in 1876 one 8-inch well was sunk. Conditions in this vicinity are probably good.

Islesboro.—Drilled wells are practically the only kind used in southern Islesboro, and the island contains more of these than any other town in Maine. It is occupied as a summer resort by many wealthy people, who can afford the best type of wells, and more than 40 have been drilled. The depths range from 60 to 398 feet, the common depth being 60 to 120 feet. There is generally plenty of water, and some wells report more than 15 gallons a minute. The 149-foot well of the Islesboro Land and Improvement Company supplies a large summer hotel and sometimes 10 cottages, the yield being 8 gallons a minute. Only two or three failures are reported. The majority of wells lie south of Dark Harbor, but a few are situated farther north. There are several drilled wells at North Islesboro.

In quality the water of the Islesboro deep wells is uniformly good. It varies, however, from hard to soft. One analysis reports total solids as high as 145 parts per million and a hardness of 86. The chlorine in three other wells varies from 7 to 33, and the carbonates, where determined, run between 85 and 127 parts. There is generally a trace of sulphate, but no iron. (See analyses Nos. 113 to 116.)

The predominating rocks on Islesboro are a series of volcanic rocks and interstratified slates, tuffs, etc. There are, however, a few narrow bands of limestone extending in a general north-northeast direction, and just west of Meadow Pond in North Islesboro is a small patch of quartzite. Several small areas of greenstone are found in the southern part of the main island and on some of the smaller islands of the town. The limestone is probably responsible for the hard water which is sometimes reported. The drift on the island is generally very thin, but where it is thick enough some dug wells are used. The water in these is likely to be softer than in the drilled wells. Some of the dug wells can not be pumped dry. The drilled wells are, however, always best for drinking. One drilled well enters a hard, granitic-looking rock at 20 feet from the surface. This is called "granite" locally, but is probably only a more metamorphic portion of sandy slate.

Well drillers report that 75 per cent of the water on Islesboro is found on the western side of the ridge. A popular belief on the island is that the deep-well supplies come from the mountains on the mainland. This is not impossible, but calculation based on the amount of rain water falling annually on Islesboro, and an estimate of the amount which is probably absorbed by the surface deposits, show that there is plenty of water to supply all the dug wells without having to postulate such a distant source.

A well on Bevidges Point obtained salt water at a depth of 220 feet. This well was filled with Portland cement to a depth of about 200 feet, and now the water is excellent. Mr. Edwin Bevidge, on the same point, also obtained salt water, but it was not salty enough to injure the well for domestic purposes.

SPRINGS.

General statement.—Springs are very numerous in Waldo County, and some are used for domestic supplies. At the town of Brooks the public supply is derived from springs, and in Searsport spring water has been used in the past for public supply. The principal commercial springs of the county are the Switzer Spring, in Prospect, and the Thorndike Mineral Spring, in Thorndike.

Switzer Spring.—The Switzer Spring, owned by the Switzer Water Company, of Bangor, is situated in the town of Prospect, half a mile northwest of Prospect Ferry. The water comes from a fissure in granite and flows through about 20 feet of gravel, from which it issues in a good-sized stream. The yield is reported in the company's circular as 150 gallons a minute. The flow is reported to be constant, and pumping by a windmill does not lower it. The temperature is reported as 44°.

The Switzer Spring water is mostly carbonated and used for soft drinks, but a small amount is bottled and shipped as spring water. The water is pumped to the bottling house 100 feet away. Some of the residences in the vicinity use this spring water for drinking.

Thorndike Mineral Spring.—Three miles east of Thorndike post-office is the Thorndike Mineral Spring, owned by Mr. Ross C. Higgins. The water seeps out of a hillside with a volume estimated by the owner as a gallon a minute. The water is very clear, but has a strong odor and taste of sulphur. It does not carry any sediment. A white sulphurous deposit is said to be formed on rocks above the spring. The water is used for drinking and for medicinal purposes and is sold. No analysis is reported.

PUBLIC SUPPLIES.

General statement.—Several villages and towns in Waldo County have public water supplies. Of these Belfast, Searsport, and Winterport use water from surface surfaces. Brooks and Searsmont have spring supplies, and Northport Camp Ground has a supply from a deep drilled well and a spring.

Brooks.—The village of Brooks has been supplied since 1900 by the Ames Spring and the Ginn Spring, which flow by gravity into a 10,000-gallon tank. The system is owned by the Consolidated Water Company of New Hampshire. The Ames Spring is about 75 feet and the Ginn Spring 125 feet above the tank. Forty-three families and business houses, constituting about three-fourths of the village, are supplied, and about 5,000 gallons of water are used daily. The town has 2 miles of 3-inch and 1-inch mains. The Ginn Spring is the larger of the two springs, varying in flow from 3 to 6 gallons a minute. The Ames Spring may flow 1 gallon a minute. There is plenty of water for all present needs. A sanitary analysis made in 1903 shows the water to contain 150 parts per million of total solids and to have a hardness of 113. The chlorine was normal, and nitrites and nitrates were absent.

Searsmont.—The water supply of the village of Searsmont has for over fifteen years consisted of a gravity system from a spring owned by D. B. Cobb & Son. The spring issues from bowlder clay in an open field. In use it gives a head which will raise the water 100 feet above the center of the village. The mains consist of about half a mile of 2-inch iron pipes. Ten families, or about half the village, use the water. The amount is more than sufficient for all immediate needs. The quality of the water appears to be first class, but it contains a little iron. There is a barn about 300 feet distant, along the hillside, but no trouble has been experienced with the water. As a precaution it would seem desirable to change to a spring higher on the hill. The boggy nature of the surface indicates that a spring could be obtained higher up.

Northport Camp Ground.—The village of East Northport, or Northport Camp Ground, has for nearly twenty years been supplied by gravity from a well and a spring owned by the Mountain Spring Water Company. The spring, situated 2½ miles back on the mountain, is used the year round, and the well situated on the hill above the village is used as an additional supply during two months of the summer season. The well was first drilled to a depth of 95 feet, but it could be pumped dry, so drilling was continued. The rock is supposed to be schist, struck at 50 feet from the surface. At about 150 feet the drill dropped 18 inches and all the water was lost. The well was deepened to 168 feet and the water can now be lowered 30 feet by pumping. It has been pumped seventeen hours with no signs of exhaustion. There are about 200 takers and 500 taps, making about 95 per cent of the summer population who use the public supply. The village has no fire hydrants. In the height of the season 20,000 gallons of water are used in twenty-four hours. The mains are reported to be 12 miles in length. They are 6 inches and 2 inches in size.

PREDICTIONS AND RECOMMENDATIONS.

The improvement of the waterworks belonging to the town of Belfast is important. The village now obtains its supply from a rather poor reservoir near the mouth of Little River. The water has a disagreeable fishy odor and its use is at times very unpleasant. It is not supposed to be detrimental to the public health, and in spite of its poor taste it is believed to be better than the water taken from dug wells in the heart of the village. In order to give entire satisfaction, however, the supply should be improved.

It is suggested that if a reservoir were built higher up on the same stream, and if care were taken to remove decaying vegetable matter and other organic materials from the reservoir and banks, the present trouble might be avoided. It is also possible that treatment with a minute quantity of copper sulphate, by a competent engineer, might improve the condition of the water.

Another recommendation to be made in respect to Waldo County is that a larger number of drilled wells be sunk. Many dug wells that do not give proper satisfaction might be replaced by drilled wells with probably good results, as the slates of Waldo County seem to contain plenty of water.

SOUTHERN WASHINGTON COUNTY.

GENERAL DESCRIPTION.

Washington County lies in the southeastern part of Maine, being bounded on the east by New Brunswick and on the south by the ocean. The length of this county is about 90 miles and its maximum breadth about 60 miles. The total area is 2,456 square miles, and the population according to the census of 1900 was 45,232. The largest city is Calais, with a population of 7,655, and the next largest is Eastport, which contains 5,311 inhabitants.

Washington County may be conveniently subdivided into three sections. The southernmost is a narrow strip along the coast, which contains a few small cities and towns. The central section, covering by far the greater part of the county, is an uninhabited wilderness. A few miles of the northern part of the county, near the Maine Central Railroad, also is somewhat settled and contains many farms. The area described includes the coast section and about half the wilderness section. The only railroad in the region covered by the report is the Washington County Railway, which crosses within a few miles of the coast, from Ellsworth, in Hancock County, to Calais and Eastport, on the eastern boundary of Washington County. Calais lies somewhat outside the area of this report as defined in the introduction, but it is included here in order to make a unit in discussion of the southern section of Washington County. Pl. XXIII is a map of southern Washington County showing the distribution of deep wells, important springs, and communities having public supplies.

This county is unusually well supplied with surface water, the principal rivers being the St. Croix, dividing Maine from New Brunswick, the Machias or Kowahskiscook, Pleasant River, and Narra-

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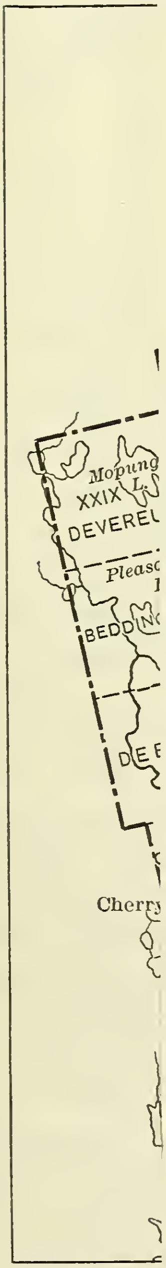


Showing

● Successful well over 50 feet in depth

○ Unsuccessful well over 50 feet in depth

✦ Flowing well

Important spring

‡ Community having public supply from surface sources

□ Community having public supply from springs

MAP OF SOUTHERN WASHINGTON COUNTY.

Showing distribution of deep wells, important springs and communities having public water supplies.

guagus River. Throughout the wilderness there are abundant lakes, some of them 5 to 10 miles in length. The county is fairly hilly away from the coast, but not so rough as the adjacent part of Hancock County.

UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Distribution of rock types.—Probably one-third of the area considered in this county is underlain by granite. A band of this rock which has a width of 10 to 20 miles extends from the southwest corner of the county, in the vicinity of Millbridge, northeastward to the vicinity of Calais. Another granite area extends from Hancock County across the boundary a short distance into Washington County. The areas mapped as granite in Washington County include small areas of diorite, a rock somewhat similar to granite, but darker and more basic.

Between the two principal granite areas, occupying most of the region north of the Washington County Railway, between Cherryfield and Addison, is a large slate area. The region lying southeast of the railway, between Machias and Pembroke, consists to a large extent of slate, but includes also some volcanic rocks. Probably the most extensive of these lie in the extreme southeastern part of the State. Some unmetamorphosed siliceous shales occur in the southeastern portion of the county.

In the towns of Perry and Robbinston is an area known as the Perry Basin, which is composed of rocks of different types from those found elsewhere in Maine. These are mostly conglomerates, sandstones, and some lavas. The sedimentary rocks here contain fossils, and by these their age is known to be Devonian.

Surface deposits.—The surface deposits of Washington County differ greatly in character. In many parts of the county there are areas of several square miles which are made up almost entirely of plains and undulating deposits of gravel and sand, in places 100 feet or more in thickness. One of these areas, situated in the town of Columbia and vicinity, consists of a flat plain 250 feet above the sea and several miles in length. Underneath the gravel deposits and covering a large portion of the bed rock of the county is a thin coating of till. Small areas along the coast and near the mouth of the principal streams consist of clay.

WELLS.

GENERAL DESCRIPTION.

On account of the great abundance of good spring water in Washington County the proportion of wells is not great. Throughout the country districts the use of springs is probably fully as extensive as that of dug wells. The known drilled wells exceeding 40 feet in depth number only 12. These are mostly situated in the extreme east corner of the county, but there is one drilled well on Roque Island and one at Jonesport. Three deep driven wells have been sunk at Columbia Falls.

Little is known of the quality of well water in Washington County. Two laboratory analyses (Nos. 158 and 191), however, are reported, and several field assays (Nos. 190, 192, 193, 157, and 159) have been made. Wells in sand and gravel were found to be low in mineral matter, but those in greenstone were high. For analyses of granite waters persons interested are referred to page 77, where they appear in connection with the descriptions of other counties. The table also contains several analyses and field assays of springs (Nos. 275 to 284), some of which are of great mineral purity.

DETAILED DESCRIPTIONS.

Calais.—The city of Calais has taken its public supply from St. Croix River. The water was poor, however, and it has recently been abandoned for a spring supply brought from St. Stephens, New Brunswick. The wells in the city are mostly shallow. Several drilled wells are not used. There is no reason, however, why plenty of good water may not be obtainable by drilled wells in that region, as good wells have been obtained in the same granite rocks across the river.

In the country districts of Calais springs are largely used. These generally emerge from till or sand; one spring, however, was seen issuing from a crack in diorite. Some wells in town are sunk in clay. The water in these is generally poor. In the vicinity of Red Beach there are many granite quarries. No water was seen in them, but its absence was probably due to the small amount of soil on the hills where the quarries are situated, as granite generally contains water. The only reports of the composition of water in Calais are given by a laboratory analysis and a field assay of water from a 44-foot bored well in sand and gravel (Nos. 190 and 191).

Eastport.—Eastport is underlain largely by basic volcanic rocks which were originally lava flows. The city obtains its public water supply from Boydens Lake, in the town of Perry. The one drilled well in town is owned by the Seacoast Canning Company. It is 408 feet in depth, drilled in the bottom of an old quarry in the basic lavas. The rock is very hard for a depth of 250 feet, and several drills were broken, but below that depth the formation is softer. Most of the water was obtained at 345 feet, but small amounts were found at other levels. At times the water overflows the bottom of the quarry. The water was lowered 28 feet when pumped with an ordinary steam pump, and the amount was found to be too small for use. In 1906 pipes were run down 225 feet and a deep-well pump was installed. An attempt was made to use a force pump, but the rock was found to have been so broken up by blasting in the quarry that the water was forced by the pump into the fissures of the rock instead of out of the mouth of the well. In a test with a 3½-horsepower gas engine the water was lowered 75 feet and 60 gallons a minute were obtained, but it is not believed that the well would yield that amount by continuous pumping. An analysis of this water given in the table (No. 158) shows 413 parts of total solids, 48 parts of silica, and 71 parts of sulphates. This analysis is interesting, as it is the only one available of water from greenstone in Maine.

A large part of the peninsula of Eastport is bare rock, but there is some clay and gravel. A section of a dug well on the outskirts of the city is as follows: Soil, 3 feet; gravel, 5 feet; blue clay, 20 feet.

Some wells situated 50 to 80 feet above tide on the borders of the village obtain plenty of water below the bed of clay. Several of these were abandoned because they contained salt water. At a time when it was desired to supply the city by underground water a 40-foot test well was driven for the waterworks. This well flows at the surface and is used by farmers in the vicinity. The water is somewhat salty.

Lubec.—Lubec has an excellent water supply from springs situated west of the village. This system is described on pages 224-225. In the village of Lubec there are three drilled wells, and at North Lubec there are three more. The latter were drilled for the Seacoast Canning Company and are used and pumped by a windmill. In Lubec a well 100 feet deep was sunk for a hotel owned by Mr. W. J. Mahlman. Water was obtained at 96 feet and was pumped by a windmill. It was good water, but as only 8 gallons a minute were obtained the well was abandoned when the city water was installed. The well of the Lubec Sardine Company was drilled 165 feet and scarcely any water was found.

The rocks at Lubec are slates intruded and metamorphosed by large masses of gabbro. West of the peninsula the drift is generally thick and there is some clay. The field assay of one 30-foot well in clay is given in the table (No. 166).

Perry.—All wells in the town of Perry are open wells. In most of those which are sunk in clay the water is "brackish." The town is reported to be abundantly supplied with springs which issue from volcanic rock, sandstone, and clay. The flow is reported as much as 20 gallons a minute in wet weather and a little less in dry weather. A single field assay of water from a dug well is given in the table (No. 202).

Pembroke.—The general depth of wells in Pembroke is 5 to 30 feet. They are all open wells and are mostly dug in till and gravel.

Machias.—The town of Machias uses Machias River water. There are few wells in the town, and all are open wells. Some of the shallower ones penetrate clay and obtain water in gravel at an average depth of about 20 feet. Many families near the village use spring supplies. Some of the springs flow as much as 5 gallons a minute.

Marshfield.—There are no drilled wells in the town of Marshfield, and water is obtained from dug wells and springs. An analysis has been made of one 21-foot well which penetrates clay and enters gravel. Most of the wells run low or dry up in summer. Some persons haul water by hand from near-by springs.

Whitneyville.—The wells in Whitneyville are not more than 20 feet in depth. Some are in gravel and some in clay, and several rest on rock. The wells run dry during the summer and the owners haul water to their houses. At a few houses springs are used.

Jonesboro.—All wells in the town of Jonesboro are dug. One well is situated 50 feet from a granite ledge and is dug 7 feet in bowlder clay. This well overflows the surface. A field assay is given in the table (No. 174). One of the interesting features at Jonesboro is the granite water which seeps out of the horizontal joints, as shown in Pl. III, *A*. This illustration shows that there is plenty of water in granite at this place. A single field assay (No. 174) of water in bowlder clay has been made.

Machiasport.—The wells of Machiasport are mostly dug wells, 30 to 40 feet in depth, in sand and gravel. There are some springs in the town. The sardine factory obtains its water from a reservoir supplied by springs.

Jonesport.—Most of the inhabitants of Jonesport use shallow wells and springs. One dug well near the shore is reported to rise and fall with the tide, but the water is fresh. The well of the Seacoast Canning Company is 384 feet deep, in diorite. The water is used for drinking and the yield is reported to be 2½ gallons a minute. It is called hard water. A field assay of this water is appended (No. 159).

On Roque Island the water is said to occur at the contact between the volcanic rocks and the underlying sedimentaries. The well of Mr. George A. Gardner is pumped by a gasoline engine and gives enough water for domestic purposes. It can be pumped dry in twenty minutes, but will fill again in about the same length of time.

Addison.—The village of Addison Point has a public supply from springs which are described under the heading "Public supplies;" otherwise, the inhabitants use only dug wells and springs. One well, 21 feet in depth, penetrated two beds of clay and obtained water in gravel. The Addison Mineral Spring is situated 2 miles southeast of Addisonport.

Columbia Falls.—About half the houses in Columbia Falls are supplied by two springs. The water system is described under the heading "Public supplies." The rest of the inhabitants use dug and driven wells. At Logie's canning factory there is a driven well 72 feet in depth, in which the formation consists entirely of sand. Three gallons a minute are obtained near the bottom of the well. Several other deep driven wells are reported in the town. These generally go through the clay into underlying gravel.

Harrington.—The village of Harrington is supplied by two spring systems, one of which is situated one-half mile northeast of the village and the other 2 miles west of the village, in the town of Columbia. These systems are fully described under the appropriate heading (pp. 225-226). A large part of the town consists of clay. The wells are mostly dug, but some are driven. Many of them go through 25 to 30 feet of clay and enter gravel.

Millbridge.—Millbridge has a public supply from springs situated in the hills a mile west of the town. These springs are fully described on pages 226-227. There are a few wells in the village, but these are mostly abandoned, as they enter a clay bed 35 to 40 feet in depth, in which poor water is found. One well was dug 40 feet and entered a layer of "flats mud" and is now brackish. People who do not use the aqueduct water get their supply from cisterns. There are no drilled wells in the town. The field assay of a shallow bored well in gravel is given in the table (No. 193).

Cherryfield.—The village of Cherryfield obtains water from springs by several small aqueduct systems. These are described more fully under "Public supplies." Some springs supply only two or three families. A few persons have cisterns. There are a number of wells 10 to 40 feet deep in gravel. The water of the wells and springs is good and is never exhausted.

Columbia.—The town of Columbia has few inhabitants and nearly everybody uses water from dug wells and cisterns. In the northern part of the town is a flat plain known as Pineo Ridge, or Blueberry Barrens, standing at an elevation of 250 feet above the sea and having a steep northern slope and deep ravines on its southern slope. These ravines contain many springs of excellent water. The public supply of the town of Harrington comes from springs situated in a swampy depression on a sandy slope in the southwest corner of Columbia.

SPRINGS.

General statement.—Springs are very abundant in Washington County. They are used by a large proportion of the inhabitants of the country districts for drinking purposes, and are also used by many communities for public supplies. The towns of Lubec, Harrington, Millbridge, Addison Point, Calais, Columbia Falls, and Cherryfield all have excellent water supplies from springs. There is at least one commercial mineral spring in the county.

Addison Mineral Spring.—Addison Mineral Spring, owned by the Addison Mineral Spring Company, is situated in the town of Addison, about 4 miles from Columbia station on the Washington County Railway. The spring has been known for a great many years. It was bought by White & Nash about twenty-five years ago, and the water was shipped for a time in barrels. Steps are now being taken to shut out the surface water and otherwise improve the spring. A concrete reservoir 12 feet in diameter and 6 feet in depth has been constructed, in the center of which is the spring. The reservoir generally contains about 3½ feet of water. The owners report the flow to be about a barrel a minute. It bubbles up through coarse gravel overlain by about 4 feet of clay. The run-off contains a considerable deposit of iron.

The composition of the water is given in the table (Nos. 275 and 276). It will be seen that the total solids are 139 parts per million, which is high for a Maine spring water. The water is also said to contain gases, "principally nitrogen, oxygen, and carbon dioxide, with a little hydrogen sulphide." A sanitary analysis in 1906 showed it to be suitable for drinking.

PUBLIC SUPPLIES.

General statement.—Notwithstanding the fact that the villages in Washington County are mostly small, several of them have wisely established public water supplies from the best sources. Machias has a supply from Machias River. Eastport obtains water from Boydens Pond. Calais formerly used St. Croix River water, but this was poor and recently a supply has been installed from St. Stevens, New Brunswick, which seems to be excellent. With these exceptions all the towns having public supplies obtain their water from pure springs issuing from sand and gravel deposits. The communities having such supplies are Lubec, Harrington, Millbridge, Addison Point, Columbia Falls, and Cherryfield.

Lubec.—The village of Lubec owns a system of waterworks piped from a spring situated in drift deposits about 2 miles west of the village. The spring issues from the side of a clay plain, but there is probably gravel and sand underneath. The surface behind the spring is composed of bowlder clay and is covered by large bowlders. The rock is said to lie 6 feet below the surface. There are no houses within a distance of more than 1,000 yards back on the hill, and there is no chance of the spring becoming contaminated by surface drainage.

Originally this spring was in private ownership, but five years ago it was bought by the town at a cost of $800, which included a little land about it. This whole hillside appears to be honeycombed with springs, and the water bubbling up out of the sand is very pure and clear and of excellent quality. A small shed has been built over the spring. The flow is reported to be 100 gallons a minute, and an old resident says it has not diminished in volume during his lifetime. An analysis of the water showed 102 parts per million of total solids, the various constituents of which are reported in No. 282 of the appended table. From the spring the water flows by gravity to a 500,000-gallon reservoir dug in stony bowlder clay a few hundred feet distant. From here it is pumped to the village under a pressure of 25 to 45 pounds.

Harrington.—The village of Harrington is supplied by two private companies taking water from springs. The larger one of the two companies is the Quantabacook Water Company, which draws by gravity from a spring situated about 2 miles northwest of the village. This system is owned by several prominent citizens of the town and supplies about 60 families. The waterworks date back to the year 1861, thus being one of the oldest water systems in Maine. In that year wooden pipes were run to town, and some of the original pipes are still in use. In clay their condition deteriorates very little. In gravel, however, it has been necessary to change to iron. The wooden pipes consist of two half logs, put together side by side, with a 2-inch hole bored in the center.

In exact geologic occurrence the water bubbles up out of the sand in a swamp situated near the base of a long, gentle slope of sand and gravel probably underlain by clay. A stick 15 feet long was thrust down into the spring and did not reach the bottom. There are no houses in the vicinity, and the water may be said to be perfectly safe as regards sanitary quality. It is clear and has a fine taste and a measured temperature of only 44°. The flow does not vary with the season. The spring is covered with a small spring house. A fair-sized brook is formed and much more water runs away than can be used. At present about 300 persons are supposed to use the water, and it is said that four times as many people could be supplied. The rates are $8 for a family, without restrictions. The spring is situated 60 feet above the village and therefore gives a good pressure. The head is said to have diminished somewhat owing to the rotting of the wooden pipes. A field assay is given in analysis No. 278.

The eastern half of the village of Harrington is supplied from a spring situated in sand and gravel deposits about one-half mile northeast of town and not far from the railroad. It is owned by various members of the Nash family. The surroundings are thickly wooded and the water bubbles up similarly to that of the spring owned by the Quantabacook Company. It is supposed to issue from sand near the top of the underlying clay. Although the soil is so thick that the spring can not be seen, the water constantly overflows and runs off in the form of a small brook. The water is excellent, is very clear, and has a temperature of 42°. A small spring house is built over the spring.

This company has about 40 takers on its lines. It has no charter, but is a rather old company and still uses wooden pipes. The supply is not as large as that of the Quantabacook Water Company, but there is plenty for all who use it, and the spring is so situated, in the woods and far from any houses, that there is absolutely no danger of its becoming contaminated. The water of this company is similar in quality to that of the Quantabacook Company, being very low in mineral and organic matter. It is said that since these water systems have been installed no case of typhoid fever or diphtheria has originated within the limits of the village.

Millbridge.—The village of Millbridge is supplied by the Millbridge Water Company, which takes water from a spring and a bored well situated in the woods about a mile west of the village. The company was chartered in 1895 and the system was started in 1896. The Millbridge Water Company bought out the old wooden aqueduct company which had been in existence for ten or twelve years and had run a small plant accommodating from 30 to 40 houses.

The spring and the well are situated on the eastern side of a gentle bowlder-clay slope which is believed to be underlain by gravel. There are no houses within a distance of three-quarters of a mile, and the water can be said to be absolutely safe from contaminating influences. The water from the spring is piped to town. The well, however, situated near by, is fitted with a windmill and a kerosene engine, which are used in case of drought. The well was dug in 1898, at a time when the spring was rather low. When the wind blows in summer the well water enters the mains and is mixed with spring water. In winter the well is never used. The well passes through 16 feet of till and enters gravel. It is reported that when it penetrated the clay into underlying gravel the water gushed up 12 feet into the air. When not used it now overflows in a small stream. It is curbed with ordinary glazed sewer pipe. The water of this well can be lowered within 4 feet of the bottom by pumping, but no lower.

There seems to be plenty of water at this place, but if it ever is exhausted it will be a very simple matter to dig out other holes such as the well above mentioned. According to surveys made by the company the spring is situated 69 feet above the drawbridge across Narraguagus River at Millbridge. The well is 38 feet below the level of the spring and is only 17 feet in depth. The pump at the well carries the water to a reservoir 50 by 30 feet in size situated near the spring. The pressure is 48 pounds. The owners report that there is no detectable difference in quality between the water taken from the spring and that taken from the well. Both are fine, clear water with little or no taste. The results of field assays are appended (Nos. 193 and 283). The water mains of the Millbridge Water Company are 6 inches in diameter. The wooden pipes used for years were abandoned and now iron pipe is used.

About 120 water takers are said to be on the lines, including the mills and sardine factories. Probably about 600 people use the water. Nine-tenths of the houses on the south side of the river use it, but none on the north side. The rates are $10 to a family for a single service, with no restrictions as to the use of the water.

Cherryfield.—Cherryfield is supplied in part by water from the West Side Aqueduct and the East Side Aqueduct companies, the water being taken from two springs situated a short distance from the village. The water issues from gravel about 100 feet above the village. The people who do not use these supplies generally have private aqueducts running to springs in the hillsides. A few, however, use dug wells 10 to 40 feet in depth. All this water is found in gravel below clay. The principal system was installed in 1875. The aqueduct companies use wooden logs for piping. These are said to have rotted out in gravel, but answer the purpose very well in clay. The springs are said to yield plenty of water during the winter, but sometimes they are low during the summer.

Addison Point.—The village of Addison Point is supplied by the Addison Point Aqueduct Company, which has a spring in sand 7 miles from the village and distributes the water by direct pressure through logs. The head is about 60 feet.

PREDICTIONS AND RECOMMENDATIONS.

On account of the sparse population of Washington County few recommendations are necessary. All the public water supplies seem to be of excellent quality, and their use is recommended above that of ordinary well water. In few places does it seem necessary or advisable to spend money in drilling deep below the surface. In communities where well water is scarce and people desire to save water bills drilling may perhaps be done to advantage, as it has been done by several of the canning companies; and when the islands along the coast come to be used more extensively as summer resorts it is probable that deep wells will be needed in order to obtain sufficient supply. Deep-well water can be obtained nearly everywhere. In some of the volcanic areas, however, as at Lubec and Eastport, the quality and amount will be rather uncertain. The poorest water supply is that of Eastport, and the sanitary conditions in this town might be much improved.

YORK COUNTY.

GENERAL DESCRIPTION.

York County is the extreme southwestern county of Maine, bordering on the ocean and on the State of New Hampshire. Its greatest length is 50 miles from north to south and its breadth is 30 miles. The total area is 957 square miles, and the population according to the census of 1900 was 64,885. The largest city is Biddeford, containing 17,165 inhabitants; Saco had 6,122 and Sanford 6,078. The principal rivers are the Piscataqua, separating Maine from New Hampshire, and Saco River, which lies in the eastern part of the county.

The principal transportation lines are the Eastern, Western, and Portland and Rochester divisions of the Boston and Maine Railroad, which cross the county from northeast to southwest, and the York Harbor and Beach Railroad, which connects Portsmouth, N. H., with York Beach. In topography the county is very diversified, ranging in altitude from sea level to about 1,300 feet. The coast is in many places very rocky, but it also contains a number of beaches which are among the finest in the country and are used extensively for summer resorts. A map of York County showing the distribution of deep wells, important springs, and public supplies forms Pl. XXIV.

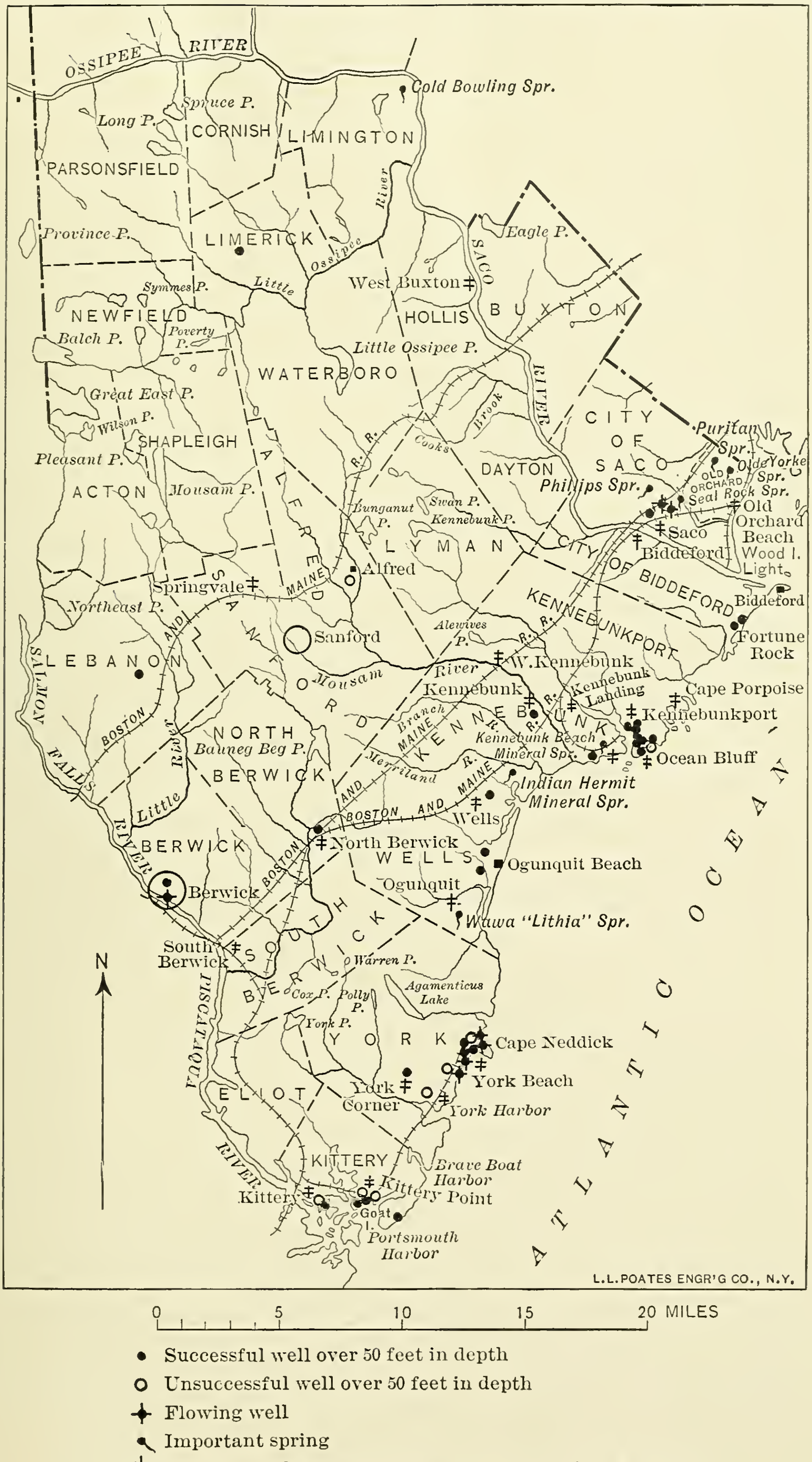
UNDERGROUND WATERS.

RELATION TO ROCKS AND SURFACE DEPOSITS.

Distribution of rock types.—The rocks of York County consist chiefly of slate and granite. They are rather irregularly distributed, but in general the granite can be said to occupy a belt from 5 to 10 miles in width, extending southward from Limington and Hollis to the vicinity of Alfred and Lyman, where it splits into two belts, one of which reaches the coast in the town of Kennebunkport and the other extends as far south as South Berwick and northern York. Outside the granite area the rock is generally slate and schist, which range in character from a rather fissile shaly rock to a hard, dense black slate which is in many places considerably metamorphosed. Much of the rock mapped as slate is in reality schist or quartzite. Both the slate and the granite are cut by a large number of trap dikes.

The prevailing direction of the strike of the slate is from N. 60° to 80° E., and the dip is generally 75° NW. or SE. to vertical. In only a few localities are the dips low. In places the strata are much contorted. The old metamorphic rocks are cut by numerous dikes of basic igneous rock generally known as trap.

All the rocks of York County are very much jointed, but the joint systems are not so definite and regular as in other parts of Maine. An interesting illustration of the way in which water may enter rock and be held in the fissures is given in Pl. V, *A*. In this locality the



- Successful well over 50 feet in depth
- Unsuccessful well over 50 feet in depth
- Flowing well
- Important spring
- Community having public supply from surface sources
- Community having public supply from wells
- Other important towns

MAP OF YORK COUNTY.

Showing distribution of deep wells, important springs, and communities having public water supplies.

water in the overlying surface deposits will seep slowly downward along the cracks parallel with the stratification and bedding of the slate. Pl. VII, *A*, shows how it may penetrate along vertical joints.

Surface deposits.—The surface deposits of York County range in thickness from less than 5 feet on some of the hills to more than 100 feet in places along the coast and in some of the larger valleys. Over broad areas on the lowlands there are plains of sand and gravel rising to 100 or 200 feet above the sea and increasing in elevation inland. These are generally underlain unconformably by extensive clay deposits, which in this county reach a maximum elevation of more than 100 feet above tide. Generally abundant water is found in the sand and gravel on top of the clay, and this may be of good quality outside the villages. In some places sand and gravel underlie the clay, and water in this material can be found by driving or drilling wells through the clay formation.

WELLS.

GENERAL DESCRIPTION.

Types of wells used.—Most of the wells in York County, as elsewhere in Maine, are of the old open type, ranging in depth from 10 to 50 feet. These are going out of use and are generally not so satisfactory as drilled wells.

Drilled wells.—The drilled wells more than 50 feet in depth are about 70 in number. So far as known, the deepest well in the county is that of Mr. E. S. Marshall at York Harbor, which was drilled to a depth of 325 feet. There are several wells more than 200 feet deep. The most common depth at which sufficient water is found seems to be about 60 feet from the surface, but some wells did not reach the principal vein until they had gone down more than 200 feet. The head varies greatly. In a few wells the water overflows, but in some others it does not stand within 30 feet of the surface.

Quantity of water.—One well at the United States navy-yard at Kittery reports 15 gallons of water a minute, while a neighboring well reports almost no water. The well belonging to the Boston and Maine Railroad at Kennebunk reports 24 gallons a minute. A well at Cape Neddick reports 30 gallons. With these exceptions the supply is 10 gallons or less. Many persons are using water for domestic supplies when the amount is only about a gallon a minute. The water is generally obtained by hand pump or windmill, but a few wells in the summer resorts are pumped by hot-air engines. In some of the summer resorts many excellent wells have been abandoned in recent years, owing to the installation of satisfactory public supplies. Not more than half a dozen deep wells in the county are known to have been entire failures.

Quality of water.—In quality the water runs from very soft to slightly hard. A few wells along the coast have been ruined by the entrance of salt water. The general quality of slate waters in York County may be judged from analyses Nos. 128 to 131. Two of these are complete analyses and report 169 and 209 parts per million of total solids. A field assay of water in till (No. 167), two of water in sand and gravel (Nos. 194 and 195), and one of water in trap (No. 160) have been made. Several analyses of mineral springs are reported (Nos. 285 to 290), recalculated from the owners' figures.

DETAILED DESCRIPTIONS.

Biddeford.—The city of Biddeford, in conjunction with Saco, has a public supply taken from Saco River. The depth of the few drilled wells in Biddeford is about 100 feet, but only a small amount of water has been obtained. The water was found in granite, but is thought inferior in quality to the usual granite water. Several fair wells have been abandoned on account of installation of city water.

Many wells in this vicinity are dug to rock and obtain water in surface deposits overlying it. A few dug and bored wells in the thickly settled portions of the city are 40 feet or more in depth and obtain water in gravel underlying clay. In one well the water rose to the surface and overflowed. A few wells get water at 10 or 15 feet in sand and gravel.

At Biddeford Pool and Fortune Rock there are a number of drilled wells. At Fortune Rock several summer residents pump water by a windmill from a small pond situated a few feet above tide. This pond water is poor and not safe for drinking.

Saco.—Saco, in conjunction with Biddeford, obtains its public supply from Saco River. A number of bored wells in this city obtain water in clay at a depth of 40 to 50 feet, and the supply seems to be excellent for domestic purposes. Some wells get water at 10 or 15 feet in sand and gravel.

Two or more wells in Saco were drilled in clay to a depth of 55 to 60 feet and obtain flows from gravel below 50 feet or more of clay. Ferrys Beach has good driven wells 10 to 15 feet in depth. Saco owns a well 250 feet deep, which supplies water for drinking fountains.

Old Orchard.—Formerly the public supply of Old Orchard Beach was obtained by gravity from Phillip's spring in Saco. At the present time the water of the Saco River is used.

The wells on Old Orchard Beach are mostly driven and bored in sand to an average depth of 15 feet, the deepest being about 40 feet. The water is usually good, but it is sometimes brackish. Away from the shore drilled wells ought to be successful if sunk into the underlying rock.

Buxton.—In the town of Buxton several shallow drilled wells obtain enough water for domestic use. No very deep drilled wells have been sunk. The village of West Buxton is now having a public supply installed from Saco River.

Kennebunkport.—The villages of Kennebunkport, Ocean Bluff, and Cape Porpoise are furnished with water by the Mousam Water Company, which obtains its supply from Branch Brook, in Kennebunk. The water is of good quality and for that reason there are not many wells in these villages. A few wells from 10 to 40 feet in depth obtain water in sand on top of clay. A large part of the western part of Kennebunkport consists of a plain of clay sloping seaward and overlain and underlain by sand and gravel. Through this plain the rock reaches the surface in places. Most of the wells are dug. A field assay of water from one well dug in clay at North Kennebunkport is given in the table (No. 167).

In the village of Kennebunkport one drilled well was sunk years ago, but is now abandoned and no information regarding it can be obtained. At Ocean Bluff a number of wells were drilled years ago to depths ranging between 40 and 250 feet. As the public supply has now been installed for several years, all wells have been abandoned and no reliable information about them is at hand.

Kennebunk.—The villages of West Kennebunk, Kennebunk, Kennebunk Landing, and Kennebunk Beach, all situated in the same town, obtain their water supply from the Mousam Water Company, which draws it from Branch Brook. Most houses on the line of the aqueduct outside of the villages also use the town water. There are only a few wells in these villages, and all of these are shallow, being dug or driven to depths of 10 to 30 feet. Plenty of water is obtained from them, but the supply is probably not so safe for drinking as the city water. At Kennebunk Beach a well was once drilled to the depth of 80 feet. The dug and driven wells are mostly sunk in sand and gravel, and some of them rest on clay. At the Mineral Spring House at Kennebunk Beach the Kennebunk Beach Mineral Spring is situated.

Wells.—The villages of Wells, Ogunquit, and Wells Beach obtain their public supply, like the villages in Kennebunk and Kennebunkport, from the Mousam Water Company, the source being Branch Brook. The supply is of good quality. In the village of Wells a few dug and driven wells have been sunk, mostly 12 to 15 feet in depth, in sand and gravel. At Crescent Beach a spring from sand supplies eight cottages. The water is pumped by a windmill to a tank.

Only one or two wells have been drilled here. In the southern part of the town a well was once sunk for Mr. A. P. Littlefield and is reported 100 feet deep in granite, obtaining water at about 50 feet. At Ogunquit two or more wells have been drilled, 60 or 70 feet in depth, and obtain several gallons of water a minute. The water of the well belonging to the Charles C. Hoyt estate at Ogunquit has been analyzed, and the composition is given in the table (No. 131).

York.—At York Harbor a well was drilled for the York Harbor Hotel to a depth of 150 feet, but the supply was small and the well is not much used. At York Beach a well was sunk 60 feet deep in granite and obtained a flow which will rise 2 feet above the surface. Two other wells at this place are reported to overflow the surface from depths of 28 and 60 feet. One of these is said to yield 30 gallons a minute by pumping. Several other wells in town obtain supplies at depths of 40 to 90 feet, and the supply is reported to range between 5 and 10 gallons a minute. The well of Mr. E. S. Marshall, at York Harbor is the deepest in York County. It was drilled 325 feet and was "shot," but let in sea water, and for that reason was abandoned.

Several wells drilled in the town of York have met with failure. Three of these were situated at Cape Neddick, only a few hundred yards from one of the good wells mentioned above. One of these failures was drilled to 87 feet, at which depth salt water was encountered, which rose to about sea level. It is worthy of note that two of the unsuccessful wells were drilled in the trap rock which makes up the greater part of Cape Neddick, and that the third was in schist close to the contact with the trap rock, while the successful wells were in slate and schist. A detailed description of the water resources in the vicinity of York has been given by George Otis Smith.[a]

Some water is found at York in and underneath a bed of clay which forms the surface deposit at many places along York River. A small amount seeps out in springs near the bottom of brickyards. One well in a brickyard near York village is dug 18 feet deep in the bottom of a clay pit 8 feet below the surface. The section of this well is as follows: Gray clay, 6 feet; stratified blue clay with thin sand partings, 6 feet; blue clay not stratified, almost quicksand, 6 feet; gravel containing water, 10 feet. A field assay of the water taken from this well is given in the table (No. 195).

Kittery.—Several wells have been drilled on Cutts Island, some at Kittery Point, and several at the navy-yard. At Kittery Point they range from 35 to 60 feet in depth. Mr. Horace Mitchell has five wells from 6 to 60 feet in depth, which together supply the Hotel Champernowne. One of these is drilled 60 feet. The water is pumped from the wells to two cisterns, which together hold 40,000 gallons. In the best season of the summer 200 or more people are supplied by the five wells. The location of two of them is rather poor. It is said that water supplies in slate in this vicinity often give out in dry weather.

The villages of Kittery and Kittery Point are supplied by water from Folly Pond. On Cutts Island there are two drilled wells, one in slate and one in a trap dike. The slate well, owned by Mr. Roland Thaxter, is 75 feet deep; the trap well, belonging to Mr. John Thaxter,

[a] Water resources of the Portsmouth-York region, New Hampshire and Maine: Water-Supply Paper U. S. Geol. Survey No. 145, 1905, pp. 122–127.

is 125 feet. The slate well was "shot" twice with 10 pounds of dynamite, but this did not increase the amount of water. The well in trap a few hundred feet distant was a failure, although it was "shot" four times with 15 pounds of nitroglycerin. Near the same point is a well, a few feet deep, blasted in trap in a cellar. A field assay of this water is given in the table (No. 160). This well seems to be safe from surface drainage, as it is bricked up and cemented to the cement floor of the cellar.

Most of the wells in this town obtain only 20 to 50 gallons of water an hour. The well on the grounds of the Hotel Pocahontas, on Gerrish Island, was drilled in 1895 to a depth of 40 feet, the principal source of water being at 39 feet, with other veins at about 30 feet. The well is reported to yield only about a gallon a minute. The water is raised by a windmill and partly supplies the hotel, although there is another source consisting of a natural spring 7 feet above high tide. This spring has been excavated in rock to the depth of 8 feet and when not pumped overflows through crevices of the rock.

At the navy-yard a well was drilled to a depth of 200 feet, obtaining very little water. A second one was sunk to the same depth with a similar result. The first was then deepened to 300 feet, and 15 gallons a minute were obtained.

The most important well in this vicinity is just over the State line, at the Hotel Wentworth, on Newcastle Island, in Portsmouth, N. H. This well is situated near Forts Constitution and Stark. It was drilled some years ago and is supposed to be about 275 feet deep. During midsummer the steam pump has been run night and day at the rate of 30 gallons a minute for two weeks with no appreciable diminution of the supply. The water is of excellent quality.

Eliot.—In the town of Eliot the wells are all dug. Those in the lowlands sunk in clay to moderate depths get a small amount of water. It is of irregular occurrence and seems to occupy more or less well-defined channels in more sandy strata. At one place a pipe was driven 35 feet through clay, and water was not found, showing that it can not be depended on with certainty.

Berwick.—The public supply of Berwick is derived from two wells in gravel. At least two other wells are said to have been drilled, but are now abandoned on account of the installation of city water. A field assay of this water is given in the table (No. 194).

North Berwick.—In North Berwick one well 125 feet deep, sunk in granite, obtains a few gallons of water a minute near the bottom. One or two other drilled wells have been sunk, but no information regarding them has been obtained.

Lebanon.—At Center Lebanon a well was sunk fifteen years ago to a depth of 50 feet. It yields less than 1 gallon a minute, and contains some iron. The water is used, however, for domestic purposes.

Alfred.—Alfred has no public supply, and the water is obtained chiefly from dug and bored wells, mostly 35 to 50 feet in depth. Plenty of water can be obtained a few feet from the surface. Years ago a drilled well was sunk 140 feet, but for some reason was abandoned. There is no reason why drilled wells will not succeed here.

Sanford.—The village of Sanford is supplied with water from a driven well and a dug well situated on the flood plain of Mousam River, midway between that village and Springvale. The supply is satisfactory. It is described under the appropriate heading (pp. 237–238). There are no wells in use in Sanford village. Springvale, in the same town, is situated 2 miles from Sanford, and is supplied by Littlefields Pond, 1 mile north of the village. The water is called poor and is said to have caused typhoid fever, but the pond is situated on the hills where there should be little danger of contamination. Many dug wells are in use in the village. Formerly there were two small water systems here, one obtaining water from springs in sand and gravel deposits at the lower end of the village, the other using river water. In 1904 the spring company was bought out by the other company, and about that time a typhoid epidemic broke out, which was supposed to have been caused by mixing river water with spring water. The springs issue from the base of a gravel terrace rising 20 feet above them, on top of which and several hundred feet distant some houses are situated, but the water is not supposed to be polluted. The largest spring is reported to flow 45 gallons a minute, and the smaller one 30 gallons. The springs are inclosed in small sheds and the water is collected in tanks. They are still used by a few tenants of the owner. Wells in the town of Sanford are all shallow.

SPRINGS.

General statement.—York County is well supplied with spring water. Most of the people in the country districts use wells, but a few have springs. Within the county are a considerable number of springs the water of which is sold. These are as follows:

Baker Puritan Spring, Old Orchard.
Cold Bowling Spring, Steep Falls.
Indian Hermit Mineral Spring, Wells Village.
Kennebunk Beach Mineral Spring, Kennebunk Beach.
Olde Yorke Spring, Old Orchard.
Seal Rock Spring, Saco.
Wawa Lithia Spring, Ogunquit.
White Sand Spring, Springvale.

Baker Puritan Spring.—In the town of Old Orchard, about 4 miles west from Pine Point in Cumberland County, is a spring owned by I. C. Baker & Co., of Pine Point. It is situated on a high, dry sandy plain from which the water seeps out of a very fine sand. It is colorless, odorless, tasteless, and very soft. It is reported to flow about 2 gallons a minute, varying slightly in very dry seasons. It is used as a medicinal and table water.

No chemical analysis has been made of this water. A sanitary analysis made in 1895 by H. D. Evans, chemist, reports 2 parts per million of chlorine, 0.2 part of oxygen consumed, 8.1 hardness, 3.5 of soluble organic matter, and 13.5 of residue of evaporation constituting the total solids; nitrites and nitrates are said to be absent.

Cold Bowling Spring.—In the town of Limington, 1 mile south of Steep Falls post-office, is a spring owned by Messrs. George P. and Frank Anderson, of Boston. The spring is known as the Cold Bowling Spring. The water is reported by the owners to issue from gravel overlain by hardpan. The flow is not large, but it is reported not to vary. The surroundings consist of a level wooded plateau. The water is odorless, is exceedingly pleasant to the taste, and is very clear. The temperature is said to be invariable. The water is sold for table and medicinal purposes at 15 cents a gallon. An analysis, recalculated from that of the owners is given in the table (No. 287).

Indian Hermit Mineral Spring.—About three-quarters of a mile east of Wells village is a spring owned by Mr. C. D. Healey, called the Indian Hermit Mineral Spring. The spring is situated on a hillside and the water is said by the owner to issue from ledge with a volume of 5 gallons a minute. The water is colorless and odorless and has a very pleasant taste. It is sold as a table and medicinal water. The water is said to have been analyzed by Rush & Johnstone, chemists, of Philadelphia, who report it to contain lithia, silica, iron, sodium, magnesium, and other elements.

Kennebunk Beach Mineral Spring.—At the Mineral Spring House at Kennebunk Beach there is a spring owned by Mr. H. K. Smith, the water of which has been sold for table use. The spring is said to have been used by the farmers for years. The hotel was built by Mr. W. F. Paul fifteen years ago, being then called the Grove Hill House. The water is used at the hotel for drinking and cooking, and until city water was installed it was used for other purposes. Considerable water is said to be sold to cottages and hotels in the vicinity and in Kennebunk Beach and Kennebunkport. The water is said to have a very peculiar taste. It was analyzed by S. H. Hitchings, chemist, in 1899 and found to contain 189 parts per million of mineral matter. No quantitative determination of the different constituents was made.

The spring is 12 feet across and 2 or 3 feet deep in the center. It is inclosed in a spring house about 15 feet square. The hotel is situated on a ledge on the hillside, 300 feet distant, and 50 feet above the spring. The spring is well walled up and protected by masonry curbing. The water is pumped by a pitcher pump. It is very clear.

The formation is bowlder clay, but hard blue clay outcrops 40 feet distant, across the road. The spring is only 200 feet from the edge of the salt marsh, which may account for the peculiar taste.

Olde Yorke Spring.—The Olde Yorke Spring, owned by the Olde Yorke Springs Company, is situated at Old Orchard. The water is colorless, odorless, tasteless, and excellent for drinking. As shown by the analysis reported in the circular issued by the owners and recomputed as No. 289 in the table, the water contains 94 parts per million of total solids. It is sold at 20 cents a 1-gallon can.

Seal Rock Spring.—In the town of Saco, about 1¼ miles east of the post-office, is the Seal Rock Spring, owned by Mr. M. A. Leavitt. The water is said to boil up from a surface deposit in a valley with a volume of 1½ gallons a minute, which is not supposed to vary with the season. The spring is situated in an open field. The water has no color, odor, or taste, and carries no sediment. No analysis has been made. The water is used for drinking, cooking, and medicinal purposes, and is sold for 5 cents a gallon.

Wawa Lithia Spring.—The Wawa Lithia Spring, owned by Mr. C. W. Dunyon, of Roxbury, Mass., is located 1 mile from Ogunquit, in the town of Wells. The spring is situated in a valley halfway down a hillside, and is said by the owner to issue from a broken granite ledge. It is protected by a small spring house which is kept locked and surrounded by a wire fence. The surroundings are wooded. The water has no color or odor and is very clear. The temperature is low and is said to be variable. The flow is reported to be 1 to 2 gallons a minute with little variation. The water is used for domestic purposes and is sold as a medicinal and table water. The price of a 5-gallon carboy is $1.50. The analysis in the table (No. 288), is recalculated from that given by the company.

White Sand Spring.—The White Sand Spring is situated on a farm near Springvale and the water is sold in Sanford and Springvale. It is owned by Mr. George G. Plummer. The water is reported to issue at the rate of 5 gallons a minute from granite overlain by gravel, on a rather flat slope. It is colorless, odorless, and tasteless, and its temperature varies with the season. It is used for drinking and cooking and is sold in Sanford and Springvale as a medicinal and table water. The total solids reported in an analysis published by the owner are 42 parts per million, and the hardness is 19.5. A sanitary analysis showed practically no nitrates and very little ammonia, which indicates that the water is probably safe for drinking.

PUBLIC SUPPLIES.

General statement.—A number of communities in York County have public supplies, but only two of them are from underground sources. Probably the best water system in the county is owned by the Mousam Water Company. The supply is taken from Branch Brook, in the town of Kennebunk, and is used by the villages of West Kennebunk, Kennebunk Landing, Kennebunkport, Kennebunk Beach, Cape Porpoise, Ocean Bluff, Wells, and Ogunquit. Kittery and Kittery Point are supplied by Folly Pond. North Berwick and South Berwick use small brooks. York, York Harbor, and York Beach are supplied by the York Shore Water Company from Chase Lake. Biddeford and Saco obtain their water from Saco River. Formerly Old Orchard was supplied from Phillip's spring in Saco, but at present Saco River water is used. Berwick has a well supply. Springvale uses water from Littlefields pond, although formerly the village was supplied by springs. Sanford has a dug well and driven wells near Mousam River between Sanford and Springvale.

Sanford.—The Sanford waterworks consist of 16 driven wells and a large dug well situated on the flood plain beside Mousam River between Sanford and Springvale. The water is pumped into a reservoir and the pressure is derived in part from that and in part from the pumps at the pumping station near by. The water mains consist of galvanized-iron, wrought-iron, and cast-iron pipes, from 12 inches down to 1¼ inches in diameter. It has been thought that the galvanized iron seriously affects the condition of the water, and the pipes sometimes rust through. For that reason the galvanized-iron mains are being replaced by others of cast iron. The capacity of the reservoir is 500,000 gallons and it gives a pressure of 90 pounds.

Until a year ago only the dug well was used, but this water was insufficient and for that reason driven wells were installed. These range in depth from 20 to 30 feet. The water is found in a bed of gravel, which slopes in the same direction as the river, and which is overlain by fine sand and silt; 500 gallons a minute can be pumped for eighteen hours at a stretch. The sand furnishes an excellent natural filter bed, and the supply seems to be perfectly satisfactory.

Berwick.—For five years Berwick has had a supply from driven wells situated on the north edge of the village. The waterworks are owned by the Berwick Water Company. The water is distributed from a reservoir having a capacity of 750,000 gallons and giving a fire pressure of 105 pounds and a regular domestic pressure of 68 pounds. The water is soft and is satisfactory. The mains are about 7 miles in length and there are 30 fire hydrants and 200 taps. About one-tenth of the inhabitants use the public supply. The consumption is 40,000 gallons daily. There is plenty of water and it is reported to be excellent, but persons beyond reach of the mains still use dug wells. A field assay is given in the table (No. 194).

West Newfield.—The people of West Newfield are supplied by a spring, which flows with a volume of 2 gallons a minute. The water is excellent. There are about 1,000 feet of mains and 26 taps.

RECORDS OF DEEP WELLS IN SOUTHERN MAINE.

By W. S. Bayley.

The table on the following pages contains the records of 526 wells more than 50 feet in depth obtained to the date of completing the foregoing report. This list was started by correspondence during the years 1903 to 1905, and was completed and revised by field and office work in 1906 and 1907. An effort has been made to include in it all wells, both successful and unsuccessful, more than 50 feet in depth, which have been sunk in southern Maine. In order to make a systematic canvass of the State, blanks were first mailed to the postmasters, asking for the names of well owners and drillers. The majority of postmasters replied to these inquiries, and to the names obtained in that way another blank was sent, requesting full information regarding the locality, owner, year completed, diameter, type, depth of well, depth to rock, depth to principal and secondary water supplies, head of water, quality of water, yield, use, and method of obtaining water from all wells. Replies were received from about half the persons to whom the inquiries were sent. Where the first request met with no reply, a second was sent.

It is probable that a considerable number of wells have been omitted from the list for the reasons, first, that many well owners did not reply to either the first or the second request for information, and, second, that it has been impracticable on account of expense to visit all the wells in the field. Doubtless there are some dug wells more than 50 feet deep which are not included, as all open wells have been dug many years and it is difficult to obtain reliable information concerning them. Some drilled wells are omitted for similar reasons.

It is believed that most of the information given in the table is correct. In preparing such a table, however, inaccuracies are bound to creep in, and it is probable that there have been some mistakes in filling out the blank forms. The list is especially likely to be somewhat in error with respect to the depths at which water was obtained. Few of the local drillers keep accurate records, and in consequence the only data obtainable regarding depth to water are for the most part such as can be recalled by the well owners. The nature of the rock furnishing the supply is seldom reported in correspondence, and many of the reports made are not reliable, for the reason that persons not educated along these lines are unfamiliar with the correct names of rock formations in which water is found. The data in the column headed "Material" are furnished mainly by F. G. Clapp, G. C. Matson, and B. L. Johnson, who investigated the conditions regarding occurrence of water in southern Maine and who have visited most of the wells listed in the table. In the column headed "Quality of water" the terms "hard" and "soft" will be seen to be of frequent occurrence. In only a few parts of southern Maine are there any really "hard" waters, and for that reason the word must be taken only in a relative sense, as comparing the water with some softer water which is familiar to the person making the report.

The compiler wishes to express his thanks and those of the United States Geological Survey to all persons who have assisted in supplying information. They have done a public service to the community.

Records of deep wells in southern Maine.

[Abbreviations: n. r., no rock; +0, just overflows; −0, reaches surface, but does not overflow.]

No.	Locality.	Owner.	Year completed.	Diameter (inches).	Type.	Depth of well (feet).	Depth to rock (feet).
	Androscoggin County.						
1	Auburn	John Picket			Drilled		0
2	do	Turner Center Creamery	1904	8	do	654	90
3	East Auburn	Frank Merrill	1906		Driven	60	n. r.
4	Lewiston	Bates Mill Co		2½	do	65	n. r.
5	do	W. R. Bartlett	1899	6	Drilled	103½	60
6	do	F. P. Stetson	1891	6		60	
7	Lisbon Falls	Hugh Douglas			Drilled		4
8	do	R. A. Small	1889	6	do	50	10
9	do	Worumbo Woolen Mills			do	187	
10	do	do	1904		do	215	0
11	Livermore Falls	W. A. Thompson			do	65	
12	Mechanic Falls	Portland and Rumford Falls Ry.	1892	6	do	120	15
13	Poland	W. F. Trask and C. F. Gould	1895	6	do	140	
	Cumberland County.						
14	Baldwin	Frank Milliken	1884	2½	Drilled	95½	2
15	Bridgton	A. H. Abbott	1891	6	do	200	35
16	do	Bridgton Aqueduct Co		6	do	290	
16a	do	The Bridgton		6	do	70	
17	do	Rufus Gibbs's heirs		6	do	113	40
18	do	J. K. Martin	1890	6	do	125	20
19	do	Granville Morrison	1903	6	do	72	10
20	do	W. Morrison	1896	6	do	52½	12½
21	do	O. G. Plummer	1890	5½	do	52	10
22	do	G. Whitehouse	1905	6	do	70	30
23	Brunswick	Brunswick and Topsham water district.	1904	2½	Driven	25–35	n. r.
24	Cape Elizabeth	Geo. G. Brooks		6	Drilled	75	0
25	do	J. B. Coyle estate		6	do	80	
26	do	Geo. T. Cruft	1899	6,5	do	127	3
27	do	James Cunningham			do	50	4
28	do	Mrs. E. Dennison	1906	6	do	60	0
29	do	—— Goodrich		6	do	55	
30	do	Amos Miller	1894	6	do	115	2
31	do	Geo. F. Morse			do	60	0
32	do	N. W. Morse	1895	6	do	75	0
33	do	Shore Acres Land Co		6	do	151½	3
34	do	U. S. Government (light-house).	1902	6	do	149	1
35	Clapboard Island, Falmouth.	S. F. Houston	1899	6	do	210	6
36	Cow Island	U. S. Government	1905	6	do	390	
37	Cushing Island	Francis Cushing			do	275	40
38	do	S. W. Thaxter et al	1889	6	do	70	10
39	do	do	1892	8,6	do	80	2
40	do	U. S. Government (Fort Levitt).	1902		do	550	
41	do	do	1905	8	do	326	11
42	do	do	1906	8	do	277	18
43	do	do	1907	8	do	482	15
44	East Otisfield	Lester Jilson	1888	7	do	68	62
45	Falmouth	J. M. Brown	1897	6	do	205	
46	do	E. H. Ingalls	1894	6	do	149¾	12
47	do	George Woodward	1900	8	do	200	
48	Freeport	Clark grist mill	1886	6	do	140?	30
49	do	Freeport Granite Co	1886	6	do	160?	40
50	do	Mrs. C. H. Mallett	1888	6	do	180?	
51	do	O. W. Shaw & Co.	1886	6	do	140?	40
52	Gorham	J. H. Carroll	1894	8	do	92	76
53	do	Dan Cressey	1897	8	do	66	5
54	do	A. B. Deering	1906	6	do	80	5
55	do	Gorham Normal School	1892	6	do	96	0
56	do	Melville Johnson	1902	6	do	90	68
57	do	Clarence McMakin			do	80	few
58	do	H. L. Martin	1900	6	do	60	17
59	do	J. H. Rines	1900	6	do	307	0
60	do	Fred Smith	1901	8	do	105	19
61	do	Wm. E. Strout	1895	8,6	do	65	6

Records of deep wells in southern Maine.

[Abbreviations: n. r., no rock; +0, just overflows; −0, reaches surface, but does not overflow.]

Depth to principal water supply (feet).	Depth to other supplies (feet).	Material in which water occurs.	Average height to which water rises (+ above, − below, well mouth).	Quality.	Yield (gallons per minute).	How obtained, where used.	Use, or if not used, the reason why.	No.
		Gneiss				Abandoned		1
		do			0	Not used	No water	2
		Gravel	+ 0	Fair			Drinking	3
63		do		Iron and magnesia.		Steam pump	Bleaching	4
	60	Gneiss		Good	3	Not used	Too little water	5
50			− 20	Hard, iron		Pump	Domestic	6
		Granite						7
47		do	− 15	Hard	2	Hand pump	Domestic	8
		do	few	Sulphur				9
63		Gneiss			35			10
		Granite						11
		do	− 10	Soft		Not used	Too little water	12
135		do	+ 0	Hard	18	do		13
			− 17	Soft		Windmill	Domestic	14
198		Granite	− 12	do	90	do	Domestic and irrigation.	15
		do				Never used	Very little water	16
		do		Good		Abandoned	Water works installed.	16a
		do		do	6	do	Not enough for hotel	17
115		do	− 75	Soft	20	Hand pump	Domestic and stock	18
		do	− 10	do	many	Windmill	Domestic	19
45		do	− 12	do	6	do	Domestic and stock	20
		do	− 30	Hard		Pump	do	21
70		do	− 47	Soft	5	Windmill	do	22
3–10		Sand	−1 to + 0	Hard		Steam pump	Public supply	23
		Schist		Brackish		Abandoned	City water installed	24
		do						25
75	60		− 27	Hard		Windmill	Domestic and stock	26
				Good	many		Domestic	27
		Schist		Hard		Hand pump	do	28
								29
115	90	Schist	− 6	Hard	few	Windmill	Domestic	30
		do						31
		do	− 5	Hard		Windmill	Domestic	32
		Slate	− 30	Good	many	do	Domestic and stock	33
140	60		− 6	Alkaline	32	do	Drinking and stock	34
200	60		− 35	Good		Hot-air engine	Domestic and stock	35
			+ 0		20			36
		Gneiss				Steam pump	Public supply	37
		Schist	− 50	Fair	10	Windmill	Domestic	38
		Gneiss	− 25	Good		do	do	39
		Schist				Not used	Water gave out	40
280	60, 45	do	− 20	Good	10		Supply of fort	41
		do	− 20	Iron	30	Steam pump	do	42
180	464	do	− 18		5		do	43
				Hard		Windmill	Domestic and stock	44
204				Soft	40	do	Domestic	45
				Hard		do	do	46
200	50		− 6			Pump	do	47
			− 40			Not used	City water installed	48
			− 40			do	do	49
160			− 5					50
			− 50			Not used	City water installed	51
92		Slate	− 75			Windmill	Domestic	52
66	few	do	− 4	Hard		Hand pump	do	53
60	80	do	− 30	Good		Pump	Domestic and stock	54
92			+ 1	Hard		Not used		55
85		Slate	− 40		1½	Windmill	Domestic and stock	56
		Schist		Little hard			Domestic	57
		Slate	− 14	Hard	5	Windmill	Farm	58
	30	do	− 30	do		do	Domestic and stock	59
		do	− 18	Soft		do	Domestic	60
63		Schist	− 9	Hard		Hand pump	Domestic and stock	61

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Records of deep wells in southern Maine—Continued.

No.	Locality.	Owner.	Year completed.	Diameter (inches).	Type.	Depth of well (feet).	Depth to rock (feet).
	Cumberland County— Continued.						
62	Great Chebeague Island	Ellis Ames Ballard		6	Drilled	301	
63	Great Diamond Island	Diamond Island Association	1893	6	do	120	8
64	do	do		6	do	96	6
65	do	W. A. Stone	1900	6	do	215	6
66	do	U. S. Government (Fort McKinley).			do	302	
67	do	do	1902	6	do	97½	10
68	do	do	1902	6	do	265½	
69	do	do	1902	6	do	95	8
70	do		1899	6	do	265	16
71	Harrison	Dan Caswell			do	65	20
72	do	Ben Harmon			do	90	
73	House Island, Portland	U. S. Government (quarantine)			do	270	0
74	Little Chebeague Island	J. H. Hamlin			do	197	100±
75	Little Diamond Island	U. S. Government (light-house)	1902	8	do	171	6
76	Mere Point	W. D. Pennell		6	do	67	0
77	Naples	Mrs. A. F. Perly	1895	8	do	210	13
78	New Gloucester	Shaker Society	1895	6	do	150	
79	Otisfield	Lester Jilson			do	100+	
80	Peaks Island	Beacon Hill Water Co		6	do	93	0
81	do	Sue Cole		6	do	75	
82	do	Tom Frothingham, jr	1899	6	do	90	0
83	do	C. W. T. Goding	1900	8	do	135	
84	do	Hillburn estate			do	60	14
85	do	Peaks Island Water and Light Co	1898	8	do	202	0
86	do	do	1905	8	do	203	0
86a	do	do	1907	8	do	201	2
87	do	Harriet M. Skillings's heirs			do	80	
88	do	J. H. Tolman	1896	8, 6	do	97	3
89	Portland	Jas. P. Baxter	1895	6	do	164	0
90	do	Chas. A. Brown				60	
91	do	Burgess-Forbes & Co	1887	6	Drilled	298½	149½
92	do	E. T. Burrows & Co	1891	6	do	106	5
93	do	Consolidated Electric Light Co. of Maine.	1887	8	do	204	8
94	do	D. F. Emory	1906	6	do	128	42
95	do	Foster's dye house	1886	6	do	140	0
96	do	Mary J. Frazer		6	do	210	
97	do	M. R. Griffith	1897		do	178	30
98	do	Maine General Hospital	1892	6	do	505	100+
99	do	do	1901	10, 8	do	830	97
100	do	John T. Palmer	1897		do	161	4
101	do	Y. M. C. A. building	1898	9	do	96	0
102	Scarboro	Walter Briggs			Dug	56	
103	do	Ira C. Foss		6	Drilled	290	
104	do	H. J. Libby estate	1905	7	do	201	19
105	do	S. D. Plummer		8	do	127±	1
106	Sebago Lake	Chas. Dolloff heirs	1895	6	do	60	
107	South Freeport	G. A. Dixon	1888	6	do	100	6
108	do	J. H. Leo	1901	6	do	108	0
109	South Windham	J. L. Robinson	1902	6	do	121	41
110	Standish	Jno. W. Bowers	1902	6	do	60	12
111	do	Mrs. G. W. Granville	1901	6	do	60	50
112	do	Almond Marean	1897	6	do	63	
113	do	Frank H. Rand	1900	6	do	78	8
114	do	R. W. E. Shaw	1897	6	do	86	
115	Westbrook	Haskell Silk Co	1904	6	do	216	6
116	do	do	1904	6	do	200	0
117	do	Rufus Jordon	1903	6	do	216	
	Franklin County.						
118	Farmington	Warren Ladd	1850		Dug	58	
119	North Jay	Leon H. Look	1903	2	Driven	70	n. r.

Records of deep wells in southern Maine—Continued.

Depth to principal water supply (feet).	Depth to other supplies (feet).	Material in which water occurs.	Average height to which water rises (+ above, — below, well mouth).	Quality.	Yield (gallons per minute).	How obtained, where used.	Use, or if not used, the reason why.	No.
55		Schist	− 15	Good	½	Windmill	Domestic	62
		Slate	+ 0	Hard	12	Hot-air engine	Public supply	63
		do	− 15	do	15	do	do	64
		do	+ 0	Soft	8	Steam pump	Domestic	65
		Schist	− 20		14			66
80		Slate	+ 0	Hard	25			67
100		do	− 3	do	15	Not used		68
80		do	+ 0	do	30			69
35		do	− 8	Soft	60	Steam pump	Domestic	70
		Granite		Good				71
		do				Abandoned	House burned	72
		Schist			15	Windmill	Domestic	73
		do				Not used	Water gave out	74
160		Slate	− 6	Salty	4	do	Water too salty	75
		Schist				Hand pump	Domestic	76
			− 24		⅕	Steam pump	Stock and irrigation	77
35			− 35		¼	Not used		78
		Granite						79
23		Schist	− 10		25	Hot-air engine	Public supply	80
		do		Hard, little iron.	few	Hand pump	Domestic	81
90		do	− 10	Little iron	5	do	Domestic and stock	82
		do	+ 0		52	Steam pump	Boilers and hotel	83
60		do			many	Hand pump	Domestic	84
		do		Hard	} 85	{Steam pump	Public supply	85
193		do	− 28	do		do	do	86
140	90	do	− 30	do		do	do	86a
		do				Hand pump		87
84		do		Soft	2	Windmill	Domestic	88
164		Slate	− ½	Hard			Business block	89
60		do	− 10	Soft				90
160	288	do	−160	Soft, alkaline.	14	Steam pump	Boilers and drinking	91
106		do	− 15	Hard		do	Fire service and washing.	92
136	29	do	− 9	Salty	65	Not used	Water too salty	93
120		do	− 42	Soft	1¼	Windmill		94
60		do	− 12	do	30	Pump	Dye house	95
		do	+ 0	do	25	Windmill	Supplies many tenements.	96
		do	− 78	Hard				97
405	505	do	−100	Soft	13	Steam pump	Domestic and boilers	98
97		Gravel	−100	do	3	Not used	Too little water	99
		Slate		Hard				100
38		do		do	26	Abandoned	Sometimes brackish	101
			− 54			Windmill	Domestic	102
275				Salty		Not used	Water salty	103
200	40	Slate	− 14	Hard	8	Windmill	Domestic and stock	104
		do	− 8	do	many	do	do	105
			− 10	Soft		do	do	106
	15		− 4	Medium		Hand pump	Domestic and factory	107
	35	Granite	− 18	Hard	½	Windmill	Domestic	108
		Slate	− 40	Muddy	5	Not used	Poor water	109
59			− 15	Soft		Hand pump	Domestic	110
60		Schist	− 4	do	4	do	do	111
13			− 13	Hard		do	do	112
71	50	Schist	− 4	Soft	9	do	Domestic and stock	113
		do	− 26	Hard	3	do	Farm	114
200	50	Slate and granite.	+ 0	Hard, sulphur.	} 34	{Air lift	Manufacturing	115
200	50	Slate	− 16	do		do	do	116
216		do	+ 8	Hard	2	Natural flow	Domestic	117
58		Clay				Windlass	Domestic	118
						Not used	Too little water	119

Records of deep wells in southern Maine—Continued.

No.	Locality.	Owner.	Year completed.	Diameter (inches).	Type.	Depth of well (feet).	Depth to rock (feet).
	Hancock County.						
120	Bar Harbor	Edw. Morrell	1902	6	Drilled	87½	2
121	Black Island	Brown & McAllister	1893	6	do	74	4
122	Bluehill	A. M. Thomas	1905		do	140	20
123	do	A. S. Thomas			do	208	
124	Bluehill Falls	Mrs. Ethelbert Nevins	1905		do	90	
125	Brooklin	Brooklin Packing Co		6	do		
126	do	Wm. W. Dodge		6	do	112	2
127	do	G. S Stevens	1888	5	do	104	
128	do	Noah V. Tibbetts	1904	4	do	87	4
129	do	Mrs. Wilson			do	55	
130	Bucksport	Melville Chapman	1891	6	do	80	few
131	do	Eastern Maine Conference Seminary.	1902	6	do	308	0
132	Castine	Acadian Hotel Co	1906	6	do	368	43
133	do	Castine Water Co	1893	7	do	58	14
134	do	do	1893	7	do	70	14
135	do	do	1894	8	do	80	14
136	do	do	1896	7	do	110	14
137	do	do	1899	8	do	675	12
138	do	Geo. W. Perkins	1893	7	do	50	7
139	Crotch Island, Stonington.	Ryan-Parker Construction Co	1906		do	303	
140	East Orland	Tom Mason		6	Driven	87½	n. r.
141	Great Cranberry Island	Moorefield Storey	1904	6	Drilled	207	9
142	do	do	1907		do	250	
143	Greening Island	—— Colton	1903		do	110	
144	do	J. G. Thorp	1896	6	do	90½	2
145	Hancock	Hancock Water, Gas and Power Co.	1880	100	Old mine shaft.	98	4
146	do	D. H. Saunders	1888	6	Drilled	65	5
147	do	E. L. Stratton	1904	6	do	50	12±
148	do	Jeremiah Stratton	1905	6	do	65	4
149	do	Town of Hancock	1902	2	Bored	30	n. r.
150	Isle au Haut	Mrs. R. A. Sturtevant	1895	6	Drilled	78	0
151	Little Cranberry Island	Miss Frothingham	1903	6	do	50	0
152	Mount Desert Ferry	F. L. Colby	1888	6	do	60	5
153	do	I. G. Crabtree	1888	6	do	65	
154	North Sullivan	C. H. Abbot	1903	6	do	37	3
155	do	Crabtree & Havey	1902	6	do	51	0
156	Northeast Harbor	L. E. Kimball	1900	6	do	189	0
156a	do	J. G. Thorp	1896	6	do	90	7
157	Orland	A. H. Dresser	1899	6	do	43	
158	do	A. W. Emerson	1890	6	do	42	2
159	do	Mrs. A. W. Hutchins		6	do	77	12
160	do	A. J. Jordan	1887	6	do	65	4
161	Otter Creek	Mrs. Birge	1899	6	do	37	4
162	Sorrento	Frank Jones estate	1896	2	Driven	[a]50–60	n. r.
163	do	do	1891	6	Drilled	92	4
164	do	Isaac Lawrence		6	do	114	
165	do	William Lawrence	1892	7	do	61	0
166	Southwest Harbor	Southwest Harbor Water Co	1891	6	do	136	
167	do	do	1895	6	do	125	
168	do	do	1899	5⅞	do	297	6
169	Stonington	Geyer & Torey	1900	5⅛	do	144	2
170	do	Samuel Goss	1893	5½	do	67½	2½
171	do	Pine Lake Water Co	1896	6	do	183	0
172	do	J. C. Rogers & Co	1906	6	do	94	0
173	do	do	1908	6	do	279	0
174	Sullivan	Dwight Braman	1889	10	do	98	0
175	do	do			Blasted and drilled.	120	0
176	do	S. V. Bennis		6,5	Drilled	108	30
177	Suttons Island	Wm. Burnham	1902	6	do	199	6

[a] 14 wells.

Records of deep wells in southern Maine—Continued.

Depth to principal water supply (feet).	Depth to other supplies (feet).	Material in which water occurs.	Average height to which water rises (+ above, − below, well mouth).	Quality.	Yield (gallons per minute).	How obtained, where used.	Use, or if not used, the reason why.	No.
87½		Granite		Good		Hand pump	Stock	120
70	50	do	− 3	Iron	15	do	Domestic and quarry supply.	121
		Gneiss	− 0	Soft, muddy	many	Hot-air engine	Stock	122
		do		Iron		Hand pump	Domestic	123
		do			7½	Hot-air pump	do	124
		Granite			many		Sardine factory	125
		do	− 26	Good		Windmill	Domestic	126
103	20, 40		− 20		2½	Pump	Domestic and boiler	127
87	20, 60		− 0	Soft	many	Steam pump	Domestic	128
		Granite		Good		Hand pump		129
70	20	Quartzite	− 20	Iron	few	do	Domestic	130
100	300±	Slate	− 8	Hard, iron	many	Gasoline engine	Washing and boilers	131
278		Volcanic tuff	− 15	Hard	10	Hot-air engine	Hotel	132
		do				Not used	Drill stuck	133
62		do	− 25	Soft	27 (134–136)	Windmill and steam pump (134–136)	Public supply	134
62		do	− 25	do		do	do	135
62		do	− 25	do		do	do	136
620		do	− 27	do	13	Windmill	Little used	137
48	40		− 8	do			Dairy	138
		Granite		Salty		Not used	Water salty	139
		Sand	− 40	Good	8	Windmill	Domestic and stock	140
		Felsite			1	Not used	Too little water	141
		do			few			142
90				Salty		Not used	Water salty	143
86	45	Granite	− 9	Soft		Windmill	Domestic	144
			− 3	Little hard		Windmill and gasoline engine.	Public supply	145
62			− 12	Soft	few	Hand pump	Stock	146
30	50	Schist	− 20		many		Domestic	147
50		do	− 45	Little hard			do	148
30		Gravel	+ 5	Soft	½	Natural flow	Drinking fountain	149
72	30		− 4	do	10	Windmill and gasoline engine.	Domestic and stock	150
50			− 6		5	Hand pump	Domestic	151
60			− 30			do	do	152
10			− 10	Soft		Pump	do	153
37		Granite		Good	16	Hand pump	do	154
18		do	− 10	Little iron	many	do	do	155
180			− 83	do	40	Not used	City water installed	156
86	30		− 7	Soft	10	Windmill and gasoline engine.	Domestic and irrigation.	156a
23		Slate	− 20	Hard		Hand pump	House unoccupied	157
42		do	− 20	Hard, good		do	Domestic	158
67			− 59	Iron		do	do	159
60	33, 44	Slate	− 7	Iron, muddy		Not used	Poor water	160
34		Granite	− 3	Good		Hand pump	Domestic	161
50–60		Sand	+ 0	do		Abandoned	Formerly village supply.	162
90		Slate	− 11	Soft	6	Not used	Brackish	163
								164
56		Slate	− 14	Soft	4	Not used	Brackish	165
120		Granite	− 80	Hard	50	do		166
95		do	− 9	Soft	45	Gasoline engine and windmill.	Public supply	167
		do	− 30	Medium	100	do	do	168
144		do	− 7	Soft	1½	Windmill	Domestic	169
65	35	do	− 7	Hard	3	Windmill and gasoline engine.	Supplies 15 families	170
180		do	− 18	Soft	28	Not used	Never connected	171
45	38	do	− 4	Good	60 (172–173)	Steam pump (172–173)	Quarrying	172
210		do				do	do	173
		do	− 8			Hand pump and windmill.	Drinking	174
		do						175
		Slate				Not used	Too little water	176
199	174	Trap	− 6	Soft	20	Gasoline engine	Domestic	177

Records of deep wells in southern Maine—Continued.

No.	Locality.	Owner.	Year completed.	Diameter (inches).	Type.	Depth of well (feet).	Depth to rock (feet).
	Hancock County—Con.						
178	Suttons Island	Church & Burnham	......	5½	Drilled	90	......
179	Trenton	Geo. J. Safford	1904	6	do	54	22
180	Washington Junction	H. B. Phillips	......	....	......	130±	......
181	West Sullivan	J. Clapham	1889	6	Drilled	61	20
182	do	V. B. Gordon	......	....	Old mine shaft.	410	......
	Kennebec County.						
183	Albion	A. S. Besse	1876	7	......	45	......
184	Augusta	G. P. Sanborn	1898	6	Drilled	560	0
185	Farmingdale	H. M. Hodgdon	1889	6	do	108	3
186	do	Tibbetts & Sawyer	1889	6	do	80	2
187	do	Charles Trask	1889	6	do	56	39
188	Gardiner	Chas. Hopkins	1890	6	do	34	5
189	Hallowell	H. G. Vaughan	1880	6	do	70	20
190	Litchfield	Harlan P. King	1891	....	do	77	10
191	Pittston	C. C. Libbie	1890	....	do	56	10
192	do	B. E. Moody	......	5	do	100	......
193	do	do	......	5	do	85	......
194	do	L. E. Moody	1890	5⅝	do	135	4
195	Sidney	J. J. Frye	1886	....	do	230	......
196	do	G. F. Bowman	1902	6	do	92	66
197	Vassalboro	American Woolen Co	1902	....	do	50	......
198	Winslow	J. L. Dean	1904	6	do	65	5
199	do	Hollingsworth & Whitney Co.[a]	1899	6	do	110–125	......
200	do	do	1901	6	do	67	5
201	do	Ralph Simpson	1904	6	do	55	5±
202	do	J. P. Taylor	1880	5	do	65	9
203	do	Chas. Withie	1904	6	do	55	5±
204	Winthrop	C. M. Bailey Sons & Co	1906	6	do	307½	36
205	do	C. H. Gale	1895	6	do	87	0
206	do	do	......	....	do	96	
207	do	do	......	....	do	65	......
208	do	do	1899	6	do	120	50
209	do	H. P. Hood & Son	1903	8	do	172	18
210	do	Frank S. Wood	1905	8	do	176	2
211	Winthrop Center	C. I. Bailey and J. Briggs	1890	5⅞	do	200	9
212	do	C. M. Bailey	1893	5⅞	do	184	12
213	do	E. A. Bailey	1889	5	do	113	4
214	do	Mrs. Hannah J. Bailey	1898	6	do	200	......
	Knox County.						
215	Appleton	F. J. Oakes	1900	6	do	320	......
216	Crescent Beach	F. M. Smith	1906	6	do	75	1
217	High Island	W. Gray & Sons	1905	6	do	230	......
218	North Haven	H. W. Chaplin	1891	6	do	200±	0
219	do	W. A. Gaston	......	....	do	57	......
220	do	Lewis Herzog	1905	6	do	164	......
221	do	Henry Jackson	1904	....	do	150	......
222	do	F. S. Mead	1896	....	do	126	0
223	do	Nelson Mullen	1893	6	do	121	6
224	do	Chas. S. Rackeman	......	....	do	165	......
225	do	F H Smith	1893	6	do	118	3½
226	do	C. S. Staples and J. M. Howe	1902	6	do	300	......
227	do	do	1902	6	do	200	0
228	do	C. G. Wells	1903	5⅞	do	282	2
229	do	do	1895	6⅛	do	142	2½
230	do	do	1891	6	do	122	3½
231	Rockland	Rockland Machine Co	1900	6	do	97	......
232	Rockland Breakwater	Ricker Hotel Co. (Hotel Samoset)	1906	8	do	640	14
233	Tenants Harbor	J. B. Aldrich	1894	5½	do	54	......
234	do	Wm. S. Richardson	1894	6	do	67	10

[a] 7 wells along a 90-foot line.

Records of deep wells in southern Maine—Continued.

Depth to principal water supply (feet).	Depth to other supplies (feet).	Material in which water occurs.	Average height to which water rises (+ above, — below, well mouth).	Quality.	Yield (gallons per minute).	How obtained, where used.	Use, or if not used, the reason why.	No.
85			— 9	Sulphur	14	Not used		178
			— 10	Good	20	Hand pump	Domestic and stock	179
								180
40	61		— 8	Mineral	5	Not used	Bad taste	181
						Siphon	Boilers	182
25	10		— 35	Hard		Windmill	Domestic	183
180		Granite	—400	Soft	few	do	Irrigation	184
104		Slate	— 7	do	5	Pump	Domestic and stock	185
75		do	— 9	do	5½	Hand pump	Milk farm	186
53		do	— 9	do	20	do	Domestic and stock	187
25		Schist		Medium	many	Windmill	do	188
70	20	Slate	— 15	Hard		Not used	Poor water	189
50	30	do				Pump	Domestic	190
53			— 9	Soft	10	Hand pump	Domestic and stock	191
10			— 4			Not used	Drilled for ore	192
						do	do	193
132	77		— 9	Soft	8	Hand pump	Domestic and stock	194
230		Slate						195
70		do	— 30	Soft	1½	Windmill	Domestic	196
			— 14				do	197
		Slate	— 27	Little hard	60	Hand pump	Domestic and irrigation.	198
		do	— 7			Air lift	Cooling acid, but now abandoned.	199
63		do	— 8			Hand pump	Drinking	200
		do						201
		do		Hard, iron	15	Hand pump	Drinking and stock	202
		do			few			203
300		Schist	— 9	Good	50	Steam pump	Boilers	204
25		do	— 12			Windmill	Public supply	205
		do		Good		do	do	206
		do		do		do	do	207
		do	— 20	Hard	many	Siphon	do	208
100		do	— 7	Good	25	Steam pump	Creamery	209
	100	do	— 20	do	4	Electric pump	Domestic	210
	195	do	— 7	do	20	Windmill	Domestic and stock	211
183		do	— 27	do	30	Steam pump	Boilers	212
112	15	do	— 3		12	Windmill	Domestic and stock	213
		do	— 50	Good	15	do	do	214
60			— 10	Soft	15	Not used		215
		Complex	— 2	Variable	6	Windmill and gasoline engine.	Public supply	216
		do			72			217
175			— 25	Little hard	½	Windmill	Domestic	218
								219
				Poor	3½	Abandoned	Ruined by accident	220
				Soft		Gasoline engine	Domestic	221
125		Trap		Hard	10	Windmill	do	222
118	67	do	— 7	Little iron	4½		Hotel and 5 cottages	223
		do		Good				224
116				Soft	4	Windmill	Domestic and stock	225
					dry	Not used	No water	226
64			— 14	Hard	½	do	Too little water	227
68			— 35	Medium	6	Windmill	Domestic	228
140			— 9	Hard	20	Windmill and hot-air engine.	Cottage and yachts	229
112			— 9	Salty	2½	Windmill	do	230
90			— 20	Soft	40	Not used	Too salty	231
185					10	do	Too little water for hotel.	232
50		Gneiss	— 12	Soft		Windmill	Domestic	233
66		do	20	Hard	2	do	do	234

Records of deep wells in southern Maine—Continued.

No.	Locality.	Owner.	Year completed.	Diameter (inches).	Type.	Depth of well (feet).	Depth to rock (feet).
	Knox County—Cont'd.						
235	Thomaston	Thomaston Brick Co	......	....	Drilled	386	......
236	Vinalhaven	Bodwell Granite Co	1880	6	....do	125	......
237	....do	Wm. B. Clark and others	1903	....	....do	220	6
238	....do	H. L. Fransis	......	6	....do	185	12
239	....do	J. M. Howe	1897	5⅝	....do	120	2½
240	....do	Sanborn, Glidden and Raymond	1904	4	....do	203	0
241	....do	Alex. Strong	1897	5⅞	....do	181	5
242	....do	Vinal Haven Fish Co	1903	6	....do	225	0
243	....do	G. W. Wheelwright	1899	6	....do	180	0
244	Warren	Warren Water Co	1903	6	....do	196	4
245	Washington	A. E. Poland	1905	6	....do	95	5
246	West Rockport	Oscar Gould	1885	6	....do	50	3
247	Widows Island	Maine Insane Hospital	1906	6	....do	109	6
	Lincoln County.						
248	Birch Island, South Bristol.	E. A. Means	1901	6	Drilled	75	3
249	Bristol	H. E. Cotton	1905	6	....do	70½	4
250	Bristol Mills	J. W. P. Goudy	1905	6	....do	52	12
251	....do	J. C. Hyson	1906	6	....do	62½	18
252	Cooper Mills	Chas. H. Ashford	1896±	6	....do	65	......
252a	Christmas Cove	D. Y. Comstock	....	....	....	40	......
253	....do	G. K. Dennett	1902	6	Drilled	50	0
254	....do	T. O. Little & Son	1902	6	....do	130	16
255	....do	W. E. Little	1902	6	....do	106	22
256	....do	A. T. Thorpe	1901	6	....do	123½	0
257	....do	A. S. Warner	1903	6	....do	83	0
258	....do	Everett Westcott	1902	6	....do	100	0
259	....do	E. F. Wilder	1902	6	....do	55	......
260	Damariscotta	Mrs. G. C. Chapman	1902	4	....do	87½	25
261	Damariscotta Mills	G. W. Waltz	1905	6	....do	50	12
262	East Boothbay	Ammonia Works	1891	5	....do	157	10 (262–263)
263	....do	....do	1891	6	....do	154	
264	....do	Fred Curtis	1905	6	....do	84	......
265	....do	Hodgdon Bros	1904	6	....do	120	2
266	....do	Captain Race	1904	6	....do	51	......
267	....do	Frank Rice	1904	6	....do	72½	2
268	....do	Frank L. Weston	1904	6	....do	72	0
269	Hodgdons Island, Bristol.	—— Stratton	1905	6	....do	118½	3
270	Inner Heron Island	Wm. C. Damon	1904	6	....do	119	0
271	....do	Heron Island Co	1890	6	....do	62½	10
272	Jefferson	Abram Brann	1884	6	....do	91	......
273	....do	L. R. Hodgkins	1880	6	....do	119	0
274	Linekin Neck	F. C. Lowden	1901	6½	....do	250	0
275	....do	John A. Royal	1904	6	....do	95	0
276	Newcastle	J. M. Glidden	1892	5	....do	85	12
277	....do	W. T. Glidden	1892	5½	....do	88½	9
278	....do	S. D. Wyman	1902	6	....do	76	......
279	New Harbor	E. W. Fossett	1901	6	....do	33	......
280	....do	F. A. Fossett	1901	6	....do	140	3
281	....do	C. T. Poland	......	6	....do	33	......
282	North Boothbay	Paul Conklin	1904	6	....do	142½	......
283	North Edgecomb	F. R. Curtis	1905	4	....do	84	0
284	North Whitefield	John Dowden	1889	6	....do	105	35
285	....do	A. R. G. Smith	1889	6, 5	....do	114	9
286	Ocean Point	L. J. Crooker	1903	6	....do	360	0
287	....do	—— Emerson	1904	6	....do	67½	......
288	Pemaquid Beach	C. A. Sproul	1901	6	....do	42	3
289	Pemaquid Point	Chamberlain & Elliott	1900	6	....do	55	0
290	....do	W. A. Elliott	1901	6	....do	51	0
291	South Bristol	N. W. Gamage	1902	6	....do	102	......
292	South Newcastle	Mrs. C. A. McMichael	1901	6	....do	56	10
293	Squirrel Island	K. H. Richards	......	....	....do	200	0
294	Waldoboro	R. L. Benner	1902	6	....do	41	2

Records of deep wells in southern Maine—Continued.

Depth to principal water supply (feet).	Depth to other supplies (feet).	Material in which water occurs.	Average height to which water rises (+ above, − below, well mouth).	Quality.	Yield (gallons per minute).	How obtained, where used.	Use, or if not used, the reason why.	No.
		Limestone		Hard	4			235
50		Granite	− 3	do		Gasoline engine.	Granite dressing	236
		do		Brackish		Pump	Washing	237
180			−14		10	Windmill	Cottage and yacht	238
115		Trap	−10	Medium	22	do	4 cottages	239
60		Granite	−27	Hard	$\frac{3}{8}$	Hand pump	Domestic	240
175		Trap	− 7	Soft	25		do	241
215	50, 75	Granite	−30	Alkaline	20	Gasoline engine.	Canning factory	242
		Trap	−15	Hard	5	Windmill	Domestic and stock	243
165			+ 5	Soft	100	Windmill and gasoline engine.	Public supply	244
95	40	Complex	−22		8	Hand pump		245
27		do		Soft		do	Domestic and stock	246
70	40, 100		− 5	Hard	3	Gasoline engine.	Domestic	247
73	30	Complex	−12	Soft	2	Hand pump	Domestic	248
		do	−30		1		do	249
52	35	do	−15	Good	1	Hand pump	do	250
50		do	− 9	Iron	5	do	Domestic and stock	251
		Gneiss		do		do	Drinking	252
		Complex						252a
50	35	do	−40	Hard	1½	Hand pump	Domestic	253
128	60	do	− 6	Soft	12	Windmill	Summer hotel	254
86	50	do	−20	do	2	do	do	255
94		do	− 8	Good		Not used	Hotel burned	256
		do	−52	Hard, good		Windmill	Domestic	257
92	40	do	−25	Soft		Hot-air pump	do	258
		do	− 5	Good	many	Hand pump	do	259
57		do	−14	do	1½	Windmill	Domestic and stock	260
47		Granite	−14	Soft	many	Hand pump	Domestic	261
56		Complex	− 6	Mineral	3½	Not used	Works abandoned	{262, 263
							Domestic	264
47		Granite	− 3	Good	many	Hand pump	do	265
							do	266
75	34	Granite	−35	Hard	many	Hand pump	do	267
65		do		Good	many	do	do	268
117		Complex	− 6		5			269
115	85	do	− 4	Iron	many	Hand pump	Domestic	270
60		do	−60	do		Windmill	do	271
25		do		do		Hand pump	do	272
			− 3½	do		do	do	273
248	33, 83		−30	Soft	10	Steam pump	do	274
85		Schist		Good		Hot-air engine	Domestic and stock	275
85		Complex	−11	Soft	7	do	Domestic, stock and irrigation.	276
84		do	−34	Medium	7	do	Domestic	277
40		do	−15	Hard	many	Hand pump	Farm	278
		do	− 6	Iron		do		279
134	16, 85	do	−16	Hard		do	Domestic and stock	280
		do	− 5	Iron				281
								282
84			−20	Hard	8	Hand pump	Domestic	283
90	30		−39	Soft	9	do	Domestic and stock	284
114	39, 77	Complex	− 4	do	21	do	Domestic	285
		do	−15	Good	10	Windmill and gasoline engine.	7 cottages	286
		do					Domestic	287
30	12	do	− 6	Salty	$\frac{1}{5}$	Hand pump	Stock	288
		do	− 4			do	Domestic	289
50	20	Granite	− 4		many	do	Hotel	290
100	36	Complex	−65	Hard, iron		do	Domestic	291
56		do	− 1	Soft	3½	Abandoned		292
40		Granite			½	Not used	Too little water	293
38		do	− 3	Hard		Hand pump	Domestic	294

Records of deep wells in southern Maine—Continued.

No.	Locality.	Owner.	Year completed.	Diameter (inches).	Type.	Depth of well (feet).	Depth to rock (feet).
	Lincoln County—Cont'd.						
295	Waldoboro	E. F. Genthner	1902	6	Drilled	56	4
296	do	Waldoboro Water Co	1902	6	do	156	24
297	Walpole	E. M. Woodman	1905	6	do	110	6
298	Wiscasset	Lincoln Bailey	1905	6	do	100	0
299	do	S. B. Cromwell	1904	6	do	48	
300	do	John Dow		6	do	154	0
301	do	W. G. Hubbard	1890	6	do	70	7
302	do	Lincoln County (jail)		6	do	154	0
303	do	A. R. Smith	1905		do	80	6
304	do	J. P. Tucker	1904	6	do	50	20
305	do	Turner Center Creamery	1890	5	do	64	3
306	do	do	1905	6	do	95	
307	do	U. S. Government (customhouse).	1905	6	do	79	24
	Oxford County.						
308	North Fryeburg	L. W. Atkinson	1890		Drilled	115	17
309	North Norway	Charles A. Merrill			do	62	
310	do	do	1891		do	102	7
311	Rumford Falls	C. M. Bisbee and R. J. Virgin	1901	8, 6	do	73	20
312	do	Rumford Falls Light and Water Co.	1904	2½	Driven	22–35	n. r.
313	South Paris	J. Frank Howland	1890	12	Drilled	122	50
314	do	Mason Manufacturing Co	1906	6	do	117	42
315	do	George R. Morton	1906	6	do	52	0
316	Sweden	Walter Evans			do	89	6
	Penobscot County.						
317	Bangor	H. C. Chapman & Son (Bangor House).	1899	6	Drilled	290	50
318	do	City of Bangor (high school)	1906	6	do	217	
319	do	City of Bangor (Larkin st. school).	1906	6	do	188	
320	do	City of Bangor (Palm st. school).	1906	6	do	72	
321	do	City of Bangor (Union sq. school).	1906	6	do	203	
322	do	Eastern Maine Insane Hospital	1896	6	do	425	0
323	do	Foster & Scribner			do	57	0
324	do	F. L. Jones	1905	6	do	247½	14
325	do	Thomas McAlloan			do	77	
326	do	Maine Creamery Co			do	120	50
327	do	Morse & Co	1906	6	do	255	0
328	do	Penobscot County courthouse	1905	5	do	201	
329	Bradford	W. E. Bailey	1882	8	Bored	54	
330	do	J. J. Reeves	1895	8	Drilled	197	
331	do	H. T. Williams	1885	6	do	61	
332	Brewer	Eastern Manufacturing Co	1899	6	do	350	59
333	do	do	1899	6	do	250	
334	Carmel	H. W. Garland	1902	6	do	66	66
335	do	J. E. Hasey	1902	7	do	58	
336	do	O. A. Stevens	1900	6	Bored	75	
337	Charleston	Charles Elden			Drilled	50	10
338	do	Higgins Classical Institute		6	do	105	0
339	do	A. H. Mitchell			do	190	40
340	Corinna	N. Reed Packard	1904	7, 6	do	61	4
341	do	A. J. Richardson	1884	6	do	59	
342	do	P. H. Simpson	1888		do	108	3
343	Corinth	L. H. Sawyer	1890		do	70	0
344	Dexter	James Cole	1895	6	do	58	24
345	Dixmont	E. D. Rowell	1887	6	do	112	5
346	East Corinth	Northern Maine Packing Co	1899	6	do	465	8
347	East Newport	L. D. Babb	1887	6	do	79	0
348	do	J. B. Chadbourne			do	57	4
349	do	J. P. Chadbourne			do	63	
350	do	C. M. Loud	1883	6	do	55	9
351	Etna	H. L. Grove	1897	6	do	54	6
352	do	G. B. Hibbard	1900	6	do	80	60
353	do	G. A. Sanborn	1890	6	do	57	56

Records of deep wells in southern Maine—Continued.

Depth to principal water supply (feet).	Depth to other supplies (feet).	Material in which water occurs.	Average height to which water rises (+ above, — below, well mouth).	Quality.	Yield (gallons per minute).	How obtained, where used.	Use, or if not used, the reason why.	No.
48	37	Granite	− 27	Soft	5½	Hand pump	Domestic	295
150	17	do	− 26		5	Not used	Never completed	296
106		Complex	− 12	Hard			Drinking and stock	297
90	35	do	− 20	Good		Windmill	Domestic and stock	298
		do	− 8	Little iron	5	Hand pump	do	299
		do				do	Drinking and stock	300
68	18	do	− 20	Hard	15±	Gasolene engine	Domestic and stock	301
		do		do		Hand pump	Drinking and stock	302
	15	do	− 10	Good		do	Domestic	303
		do	− 50	do		do	Domestic and stock	304
56		do	− 8	Salty		Abandoned	Salty water	305
		do	− 3	Brackish		Steam pump	Cooling cream	306
79	72	do	− 12	Hard	8	Hand pump	Domestic	307
			− 17	Hard		Windmill	Domestic and stock	308
					few	Hand pump		309
					few			310
25		Granite	− 20		few	Not used	Too little water	311
[a] 20		Sand and gravel.		Soft		Steam pump	Public supply	312
55		Complex	− 50			Not used	Too little water	313
		Granite	− 60	Good	40		Drinking and boilers	314
40		Complex	− 1	Soft			Domestic	315
79		Trap	− 17	Hard		Not used	Strong taste	316
280	−100	Slate	100	Hard	27	Pump	Hotel	317
		do		Good	many	Hand pump	Drinking	318
		do	− 8	do	30	do	do	319
		do		do	many	do	do	320
		do		do	many	do	do	321
425	50	do	−200	Good, hard	30	Steam pump	Domestic	322
		do		Good	many	Hand pump	Drinking	323
247½		do	− 22	do	many	do	do	324
		do		do	many			325
		do	− 10	do			Cooling cream and sold	326
255	17	do	+ 2	Soft, good		Hand pump	Domestic	327
60	80	do	− 50	Hard		Electric pump	Drinking	328
35		do	− 19	do		Hand pump	Public well	329
20		do	− 20	do	few	do	Domestic	330
58		do	− 15	do	1	do	Domestic and stock	331
21		do	− 21	Salty	} 1	{ Steam pump	Cooling acid	332
50±		do	− 20	Hard		do	do	333
50		do	− 16	do	2	Hand pump	Domestic	334
12		do	− 12	Soft		do		335
50		do	− 25	Hard	3½	do	Domestic	336
		do						337
100		do	− 8		15	Siphon	Domestic for 4 buildings.	338
		do		Good	many			339
61	20, 30	do	− 15	Hard	4	Windmill	Domestic and stock	340
59		do	− 18	do	3	do	Domestic	341
20		do	− 15	Hard, salty		Abandoned	Poor water	342
20	35	do	− 20	Soft		Hand pump	Farm	343
53		do	− 20	Hard	few	do	Domestic	344
112		do	few	Hard, alkaline		do	Domestic and stock	345
450		do	− 6	Sulphur and iron.	20	Steam pump	Drinking and canning.	346
70	35	do	− 15	Soft	30	Windmill	Domestic and stock	347
		do	− 55	Hard			Domestic	348
		do	− 17	do			do	349
		do	− 15	Fair		Hand pump	Domestic and stock	350
50	20	do	− 10	Soft	15	do	do	351
86	50	do	− 20	Hard		do	do	352
50	41	do	− 10	Little iron		do	Farm	353

[a] Average.

Records of deep wells in southern Maine—Continued.

No.	Locality.	Owner.	Year completed.	Diameter (inches).	Type.	Depth of well (feet).	Depth to rock (feet).
	Penobscot County—Con.						
354	Hampden	A. J. Bragg	1898	7	Drilled	103	
355	do	Cyrus Moulton	1901	6	do	85	
356	do	C. L. Philbrick	1899	6	do	50	20
357	do	J. E. Shaw	1889	6	do	100	2
358	do	Village of Hampden	1900	5	do	122	
359	Hampden Corners	J. F. Maddocks		6	do	6 5	52
360	do	J. E. Shaw	1886	6	do	100	0
361	Hudson	Geo. H. Smith	1887	6	do	66	
362	Kenduskeag	Chester Weld			do	109	9
363	Newport	Frank Bennett	1889	6	do	53	
364	do	W. D. Crowell	1891	6	do	75	3
365	do	Edwin W. Trueworthy		6	do	100	
366	North Dixmont	Thos. L. Bragden		6	do	76	52
367	do	S. E. Harris	1896	4½	do	75	4
368	do	do	1897	5½	do	55	10
369	do	Chas. O. Varney	1895	6	do	55	50
370	Orono	N. W. Page	1903		Dug	54	n. r.
371	do	E. W. Mansfield	1890	6	Drilled	53	50
372	do	University of Maine	1886	6	do	54	25
373	Orrington	Archie Harding	1894	7	do	50	
374	Plymouth	H. M. Gage	1896	6	do	66	
375	do	H. W. Stackpole	1893	6	do	73	n. r.
376	Stetson	R. A. Fitts			do	100±	
377	do	F. E. Wiggin	1878	12	do	74	0
	Sagadahoc County.						
378	Bath	Bath Iron Works	1885	4	Drilled	100+	
379	do	George Connell	1887	6	do	57	3
380	do	W. J. Donald	1883	6	do	167	
381	do	J. E. Dunton's heirs	1885	6	do	149	0
382	do	C. A. Hooker	1893	4	do	100	0
383	do	H. Langdon	1883	6	do	200	
384	do	Torrey Roller Bushing Works	1885	4	do	180	0
385	Bowdoinham	Mrs. George L. Hinckley			do	124	27
386	Five Islands	George E. Hughes	1900	6	do	242	0
387	Georgetown	William Wade	1904	6	do	270	1
388	McMahans Island	Sheepscot Land Co		6	do	246½	
389	Pejepscot Mills	Pejepscot Paper Co			do	335	0
390	do	do			do	40	11
391	Popham Beach	—— Tibbetts			do	962	
392	do	Fort Popham			do	91	
393	Richmond	Eugene Rankins	1885	5	do	42	
394	do	Frank Williams	1885		do	65	0
395	Small Point	George O. Curtis	1904	6	do	100	
396	Woolwich	Lincoln Bailey	1905	6	do	98	0
397	do	F. W. Carleton	1892	6	do	98	0
398	do	J. Collins	1887	6	do	53	5
399	do	George G. Hathorn	1897	6	do	96	0
	Somerset County.						
400	Fairfield	F. C. Tobey	1884	8	Drilled	91	7
401	Norridgewock	F. H. Burrell	1901	6	do	77	
402	do	Guy C. Haynes		6	do	26	10
403	Palmyra	Perry Furbush		6	do	157	43
404	do	do			do	80	0
405	do	do		6	do	80	0
406	Pittsfield	W. R. Hunnewell			do	47	
407	St. Albans	J. L. Palmer	1897	8	do	49	8
408	Skowhegan	Levi P. Weston	1880		do	52	0
	Waldo County.						
409	Belfast	W. E. Whitcomb		6	Drilled	81	
410	Belmont	Horace Chenery	1905	10,8	do	187	12
411	Brooks	Jerome Geness				51	

Records of deep wells in southern Maine—Continued.

Depth to principal water supply (feet).	Depth to other supplies (feet).	Material in which water occurs.	Average height to which water rises (+ above, − below, well mouth).	Quality.	Yield (gallons per minute).	How obtained, where used.	Use, or if not used, the reason why.	No.
90	40	Slate	−13	Soft		Hand pump	Domestic	354
78		do	− 5	Hard	1	do	do	355
30		do	−30	Hard, iron		Pump	do	356
95	25	do	−20	Medium		Hand pump	do	357
		do		Hard	5	Not used		358
65		do	−10		$\frac{1}{2}$	Hand pump	Drinking and stock	359
90	25	do				do	Domestic and stock	360
	42	do	−48	Hard		do	do	361
23		do		Iron	1	do	Domestic	362
29		do	−24	Soft		do	do	363
16		do	−16	Hard	many	do		364
70		do	−25	do		do	Domestic and stock	365
		do	−20	do		do	do	366
55		do	−22	do		Windmill	Domestic	367
44		do	−44	Poor		Hand pump	do	368
		do	few	Soft		do	do	369
30		Gravel	−30	Hard, good		Windmill	Domestic and stock	370
		Slate	−15	Hard		Hand pump	Domestic	371
52		do	few	do		Windmill and electric motor.	do	372
50		do		Good	many	Hand pump	Domestic and stock	373
		do	−30	Hard		Windmill	Farm	374
		Sand		Good		do	Domestic and stock	375
					0	Not used	No water	376
74		Slate	−30	Poor	few	Hand pump	Stock	377
						Abandoned	City water installed	378
50		Gneiss	− 3		4	Hand pump	Domestic	379
160		do	− 7	Soft	30	Abandoned	City water installed	380
			−30	Hard		Not used	do	381
60	20	Gneiss	— 0	do	40	Steam pump	Formerly used in boilers.	382
20			−20	Soft	1	Windmill	Domestic and irrigation.	383
50	130	Gneiss	−20	Hard		Steam pump	Bushing works	384
				do		Not used	Pump broken	385
242		Granite	−50	Soft	few	Electric-motor pump.	Domestic	386
					4			387
			−40	Soft				388
		Gneiss		Good	few	Hand pump	Domestic	389
		do	−24	do	many	do	do	390
						Not a well	Prospecting for coal	391
					12			392
16		Complex	−26	Hard, iron	2	Hand pump	Domestic	393
65		do	− 3	do		do	Stock and lawn	394
79					2			395
90	35	Complex	−20	Little hard		Abandoned	Poor water	396
		Gneiss		Hard	8	Hand pump	Domestic and stock	397
50	30		− 7			do	Farm	398
		Gneiss	−30	Hard	6	do	Domestic and stock	399
		Slate	−10	Hard		Hand pump	Domestic	400
70		do	−35			Never used	Never installed; deep-well pump.	401
26		do	− 0			Siphon	Domestic and stock	402
		do			0	Not used	No water	403
					$\frac{1}{60}$	Hand pump	Stock	404
60		do		Hard	$\frac{1}{7}$	do	do	405
			− 7	Soft		Not used		406
41		Slate	− 8	do	$\frac{2}{5}$	Windmill	Dairy and stock	407
		do				Abandoned	City water installed	408
		Slate						409
		do	− 3		19	Steam pump	Domestic and stock	410
		do						411

Records of deep wells in southern Maine—Continued.

No.	Locality.	Owner.	Year completed.	Diameter (inches).	Type.	Depth of well (feet.)	Depth to rock (feet.)
	Waldo County—Cont'd.						
412	Cape Jellison	Northern Maine Seaport R.R. Co.	1905	8, 6	Drilled	225	70±
413	....do	....do	1905	6	....do	158	99
414	East Northport	Mrs. Mark Mandall	......	....	....do	64	4
415	....do	Mountain Spring Water Co	1900	6	....do	168	65
416	East Troy	L. E. Prentiss	1885	8	....do	65	25
417	Islesboro	E. R. Adams	1906	6	....do	100	......
418	....do	John T. Atterbury	......	....	....do	150	......
419	....do	George Bird	1902	6	....do	78	28
420	....do	R. A. Boit	1902	6	....do	398	......
421	....do	F. E. Bond	1901	6	....do	218	4
422	....do	H. E. Bond	1902	5⅞	....do	218	9½
423	....do	J. R. Brackett	1898	6	....do	50+	......
424	....do	Miss Caldwell	1901	6	....do	266	5½
425	....do	Mrs. W. H. Draper	......	6	....do	165	5
426	....do	Mrs. —— Draper	1899	5½	....do	102	10½
427	....do	W. P. Farnsworth	1900	6	....do	70	......
428	....do	J. Murray Forbes	......	....	....do	180	......
429	....do	D. Hatch	1901	6	....do	66	13
430	....do	F. W. Hatch	1902	6	....do	63	0
431	....do	P. D. Hatch	1902	6	....do	60	8½
432	....do	T. B. Homer	1892	....	....do	120	......
433	....do	....do	1897	....	....do	200	......
434	....do	Islesboro Land and Improvement Co.	1890	6	....do	149	5
435	....do	—— Kissel	......	....	....do	220	......
436	....do	H. A. Lewis	1900	....	....do	75	......
437	....do	M. E. Lewis	1903	6	....do	150	......
438	....do	Mrs. Minton	......	....	....do	300±	......
439	....do	H. W. Morse	1901	6	....do	210	130
440	....do	Leighton Parks	1901	5	....do	65	......
441	....do	Charles Pendleton	1901	6	....do	54	4
442	....do	....do	......	....	....do	50	......
443	....do	W. S. Pendleton	1901	6	....do	69	13
444	....do	Pendleton Bros	1890	5⅝	....do	71	12
445	....do	C. S. Pierce	1901	6	....do	225	......
446	....do	Charles Platt	1901	6	....do	125	7
447	....do	Helen L. Pratt	1898	8	....do	101	......
448	....do	E. S. Preble	......	....	....do	70	......
449	....do	F. C. Shattuck	1900	....	....do	90	......
450	....do	H. T. Sloan	1902	7½	....do	198	......
451	....do	David H. Smith	1901	6	....do	134	0
452	....do	Town of Islesboro	1887	5⅞	....do	73	7½
453	....do	J. D. Winsor	1902	5⅝	....do	252	56
454	Jackson	M. S. Hatch	1885	9, 6	....do	53	5
455	....do	E. E. Morton	1885	7	....do	45	6
456	Kidders Point, Searsport	Northern Maine Seaport R.R. Co.	......	....	....do	285	62
457	Monroe	Nathan Stearns	1890	7	....do	61	47
458	Searsport	J. H. Kneeland	1882	6	....do	50	4
459	....do	David Nickels	1904	6	....do	108	17
460	....do	Northern Maine Seaport R.R. Co.	1905	8, 6	....do	329½	105
461	....do	Penobscot Coal and Wharf Co	......	....	....do	301±	80
462	....do	Searsport House	1894	6	....do	97	10
463	....do	Town of Searsport	1886	6	....do	100	6
464	....do	N. W. Staples	1887	6	....do	64	34
465	Stockton Springs	J. C. Lambert	1892	6	....do	50	15
466	....do	Northern Maine Seaport R.R. Co.	1905	8, 6	....do	247	74
467	....do	A. H. Soden	......	....	....do	100±	......
468	Winterport	S. Chase	1888	6	....do	57	6
469	....do	C. W. Nealey	......	6	....do	115	15
	Washington County.						
470	Calais	F. N. Beckett	......	6	....	90	......
471	....do	W. A. Rideout	1882	5	....	49	49
472	Columbia Falls	A. H. Chandler	1905	4	Driven	46	n. r.
473	....do	A. and R. Logie	1904	6	....do	72	n. r.
474	Eastport	Seacoast Canning Co	1903	6	Drilled	408	0

Records of deep wells in southern Maine—Continued.

Depth to principal water supply (feet).	Depth to other supplies (feet).	Material in which water occurs.	Average height to which water rises (+ above, − below, well mouth).	Quality.	Yield (gallons per minute).	How obtained, where used.	Use, or if not used, the reason why.	No.
225		Slate	−20		200	Electric motor	Locomotives and ships	412
158		do			12	Abandoned	Supply insufficient	413
		Schist	− 1	Hard			Domestic	414
112	75, 100	do	−50	Soft	27	Steam pump	Public supply	415
40	52	Slate	−53	do		Hand pump		416
		do			15			417
		do		Good	15			418
35		do	−30	Hard	3	Hot-air engine	Domestic	419
394	200±	do	−15	do	10	do	Domestic and irrigation.	420
218		do	−40	do		Power pump	Domestic	421
218		do	− 4	Medium	16	Steam pump	Domestic and stock	422
		do		Hard	8	Hot-air engine	do	423
260	55	do	− 7	Medium	14	Steam pump	Domestic	424
90		do		Hard		Hand pump	do	425
99		do	−11	Medium	16	Gasoline engine	do	426
20		do	− 0	Hard	3	Hand pump	Stable	427
		do		Good	20		Domestic	428
30		do		Hard	8	Gasoline engine	do	429
57		do	−17	do	4	Hot-air engine	do	430
31		do	− 4	Soft	1½	Pump	do	431
		do	−10	Hard	1	Steam pump	do	432
	50	do	−few	do	1½	Hand pump	do	433
		do		do	8	Hot-air engine	Hotel and 10 cottages	434
		do		Good				435
		do	−20	Hard	4	Hot-air engine	Domestic	436
150		do	− 8	do	12	do	do	437
		do			few			438
		do	−50	Hard		Hot-air engine	Domestic	439
		do	− 3	do	5	do	do	440
24		do	−12	do	4	do	do	441
		do		Salty				442
22		do		Iron	6	Hand pump	Store and mill	443
70		do	− 5	Soft	5	Steam pump	Gristmill	444
		do	− 6	Hard		Hot-air engine	Domestic and stock	445
120	60	do		Soft	14		Domestic	446
20		do	−10	do		Gas engine	do	447
		do			many			448
		do	− 5	Hard			Domestic	449
190		do	+ 0		12	Hot-air engine	do	450
75		do	−20	Hard	10	Hand pump	do	451
73		do	−12	do	3	do	Public well	452
252	125	do	+ 0				Domestic	453
50	25	do	−20	Hard, iron		Windmill	Domestic and stock	454
	13	do	−13	Hard		Hand pump	Farm	455
284	80	do	−16	Soft	75	Electric power pump.	Locomotives and drinking.	456
		do	−41	Hard, iron		Pump	Domestic and stock	457
50	24	do	−20	do		Hand pump	Drinking and stock	458
	60	do	−19	Soft	20	do	Domestic	459
329½		do	−20	do	60	Steam pump	Locomotives	460
300		do	−12		50		Domestic and boilers	461
30		do	+ 0	Good		Windmill	Hotel	463
100		do	− 8	Hard, iron		Pump	Public well	462
64		do	−24		4	Hand pump	Domestic and stock	464
40		do	−25			do	do	465
247	187	do	−32			Steam pump	Locomotives	466
		do						467
53	30	do	−30	Hard, iron		Hand pump	Domestic and stock	468
115		do	−50			do	Stock	469
40			few			Not used		470
49			−20	Soft		Pump	Domestic	471
		Gravel	−12	Hard	4	Windmill	do	472
68	50	do	−20	Soft	3	Steam pump	Canning factory	473
345	408	Green stone	+ 0	Good, hard	60	Gas engine	do	474

Records of deep wells in southern Maine—Continued.

No.	Locality.	Owner.	Year completed.	Diameter (inches).	Type.	Depth of well (feet).	Depth to rock (feet).
	Washington County—Continued.						
475	Jonesport	Seacoast Canning Co	1904	6	Drilled	384	0
476	Lubec	Lubec Sardine Co			do	165	10
477	do	W. J. Mahlman	1893	6	do	100	
478	North Lubec	Seacoast Canning Co. [a]		6	do	60-70	
479	Pembroke	Gardiner Brick Co	1898	6, 5	do	85±	
480	do	Sprague & Wylie		6, 5	do	90±	
481	Roque Island	George A. Gardiner			do	90±	
	York County.						
482	Alfred				Drilled	140	0
483	Berwick	Benjamin Bragdon estate			do	65	18
484	do	C. E. Marshall	1898	6	do	86½	30
485	Buxton	J. M. Hopkinson		6	do	46	0
486	Cape Neddick	C. B. Moseley	1894	6	do	28	
487	do	W. H. Wentworth	1889	6	do	70	16
488	Fortune Rock	J. G. Brackett	1893		do	97	0
489	do	—— Davis	1889	6	do	100	
490	Gerrish Island	S. E. Jennison	1898	6	do	58	4
491	Kennebunk	Boston and Maine R. R	1892	6	do	120	
492	do	Dr. Ross	1893	6	do	100±	
493	Kennebunk Beach	C. W. Arnold		6	do	80	
494	Kennebunkport	John W. Deering		6	do	50	
495	do	—— Giles	1886	6	do	75	
496	do	—— Hall	1886	6	do	75	
497	do	Kennebunkport Seashore Co	1889	6	do	55	
498	do	—— Smith	1885	6	do	60	
499	do	B. S. Thompson	1885	6	do	70	
500	Kittery	U. S. Government (navy-yard)			do	200	
501	do	do			do	300	
502	Kittery Point	Horace Mitchell		6	do	60	
503	do	Pepperell House		6	do	51	10
504	do	John Thaxter	1887	6	do	125	0
505	do	Roland Thaxter			do	75	
506	Lebanon Center	N. B. Shapleigh	1893	6	do	50	20
507	Limerick				do	100	
508	North Berwick	A. P. Littlefield			do	125	5
509	Ocean Bluff	Arlington Hotel			do	50±	
510	do	Sarah Bancroft	1884	6	do	73	2
511	do	Mrs. Samuel H. Jones			do	224	
512	do	Kennebunkport Seashore Co			do	85	0
513	do	Ocean Bluff House			do	102	
514	Ogunquit	Edward Freeman			do	68	15
515	do	Charles C. Hoyt estate	1890	6	do	65	5
516	Saco	City of Saco	1886	6	do	250	
517	do	Mason & Durgin		8		56	n. r.
518	do	W. Warren (?)				61	n. r.
519	Wells	A. P. Littlefield			Drilled	100	
520	York	Hugh Talant		6	do	90	0
521	York Beach	Dr. Clement			do	59	
522	do	C. W. Hildreth		6	do	60	0
523	do	C. B. and W. C. Hildreth	1891		do	60	16
524	do	York Beach Water Co		6	do	60	2
525	York Harbor	E. S. Marshall	1888	6	do	325	0
526	do	York Harbor Hotel	1888	6	do	150	

[a] Three wells.

Records of deep wells in southern Maine—Continued.

Depth to principal water supply (feet).	Depth to other supplies (feet).	Material in which water occurs.	Average height to which water rises (+ above —below, well mouth).	Quality.	Yield (gallons per minute).	How obtained, where used.	Use, or if not used, the reason why.	No.
		Diorite	−7	Hard	2½	Hand pump	Drinking	475
		Greenstone			0	Not used	Very little water	476
96		do	−12	Good	1	Abandoned	City water installed	477
		do	−1	do		Windmill	Canning factory	478
								479
				Good				480
				do		Gasoline engine	Domestic	481
39			−34			Not used		482
65		Slate	−12	Poor	many	Abandoned	City water installed	483
		do	+0			do	do	484
42	30		−24	Hard	few		Domestic	485
27		Slate	+0	Soft	30	Pump	do	486
		do	+2½	do		Windmill	Supplies 25 families	487
97		Granite	−20		⅓	do	Domestic	488
100	95				few		do	489
56	30	Slate	−6	Soft	5		do	490
120			−3		24			491
100±		Granite			10			492
			−20			Not used	City water installed	493
			−10		few	Hand pump	Domestic	494
								495
								496
50				Soft	3	Not used	City water installed	497
					few		Domestic	498
					few		do	499
		Slate			0	Not used	Nearly dry	500
					15			501
		Slate	−7½	Soft	1	Windmill	Hotel	502
15		do	−5	do	½	Not used	Hotel abandoned	503
110		Trap	−14	Hard	½	do	Too little water	504
		Slate		Iron		Hand pump	Domestic and stock	505
45		do	−40	Hard, iron	1	do	Domestic	506
				Surface water				507
122		Granite	−10	Soft	few		Stock	508
		Slate				Abandoned	City water installed	509
					8	do	do	510
224	90	Slate		Iron	few	do	do	511
		do				do	Hotel burned	512
		do				do	Failure	513
65		Granite			few			514
65		Slate	−5	Hard	10+	Hot-air engine	Domestic, stock, and boilers.	515
250		do	−20		10	Windmill	Fountains	516
56		Gravel	+0			Abandoned		517
		do	+0					518
50		Granite						519
89½		Slate		Brackish	5	Not used	City water installed	520
		Granite	+0		40	Pump		521
60		do	−14	Hard	few	Hand pump	Domestic and stock	522
60		Slate	−18	do		Windmill	do	523
60		Granite	+2		84	Abandoned		524
325			−30	Salty	16	Not used	Too salty	525
		Slate				do	Not enough for hotel	526

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