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VOLUME TEN

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LETTER OF TRANSMITTAL

To His Excellency Emerson C. Harrington,

Governor of Maryland and President of the Geological Survey Commission.

Sir:—I have the honor to present herewith the tenth of the general reports of the Maryland Geological Survey which contains the results of extensive studies on two subjects of the widest interest and greatest importance to the people of the State. The detailed investigations and part of the writing of the report were conducted under the direction of the late Dr. Wm. Bullock Clark, but the final work of the investigations and the completion of the manuscripts were carried on after his death. The State of Maryland has received much from Dr. Clark's participation in its activities, and it is eminently fitting that this volume should include a summary statement of the vast amount of information accumulated through his energy and administrative ability. I am,

Yours very respectfully,

Edward Bennett Mathews,

State Geologist.

Johns Hopkins University,
Baltimore, *February 16, 1918.*

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PREFACE

The present volume consists essentially of two general papers covering subjects of universal interest to the people of the state preceded by an introductory tribute to the work and character of the late Wm. Bullock Clark, State Geologist, to whom the Geological Survey owes much of its usefulness and the successful presentation of scientific studies from its inception more than twenty years ago.

The *Geography of Maryland,* which constitutes Part 1 of the volume, was prepared by Wm. Bullock Clark as a summary of the knowledge of the physical features of Maryland which would be of widespread service throughout the state. Parts of the information had been presented in former editions of the Physical Features of Maryland by W. B. Clark and E. B. Mathews, but the present paper has been entirely rewritten with the aim of presenting the same facts in a simple and more popular form. In order that this part might be of greater service to the teachers of the state, arrangements were made for the inserting of an abbreviated statement as a supplement to one of the well-known school geographies. An analysis and order of treatment in the school textbook conform closely with this larger work, and it is hoped that the teachers throughout the state who use the school geography may find in the present publication a helpful amplification of the subject. To that end arrangements were made with the educational authorities in the several counties by which a special edition was run, which will enable the county authorities to supply the Geography of Maryland to the libraries of the schools under their jurisdiction.

In illustrating this subject the author was greatly assisted by the cordial cooperation on the part of the various official state bureaus, especially the

Conservation Commission and the Board of Forestry, and by the transportation agencies, especially the Baltimore and Ohio and Pennsylvania railroads systems. The larger industries also assisted by furnishing illustrative materials. The help of all of these various agencies is gratefully acknowledged.

The *Report on the Surface and Underground Water Resources* of Maryland including Delaware and the District of Columbia, by Wm. Bullock Clark, Edward B. Mathews, and Edward W. Berry, represents the accumulation of information dealing with this subject from a time antecedent to the organization of the Geological Survey. Before the organization of the State Survey a certain amount of information on the subject had been gathered by the U. S. Geological Survey and published as one of its bulletins. The present report was planned and most of the field work was done under the direction of the late Wm. Bullock Clark, but the manuscript was not prepared until after his death. The major part of the report has been written by Edward W. Berry, while the parts relating to Delaware and the character of the waters have been prepared by Edward B. Mathews. Under a cooperative agreement with the U. S. Geological Survey, George C. Matson, of the latter organization, and Eugene H. Sapp, of the Maryland Geological Survey, extended, during the year 1909, the investigation previously made by N. H. Darton and made an extensive study of the underground waters of the Coastal Plain portion of the state. The data collected by them have been utilized whenever possible. During the summer of 1916 additional field studies were made to bring the records up to date. Stanley Worden collected the material from the Coastal Plain, and Eugene H. Sapp, assisted by H. Insley and D. G. Thompson, those of the Piedmont and Appalachian Region. Throughout the work much assistance has been rendered by the well diggers and individuals throughout the state, to whom acknowledgments are gratefully given. Special credit is due the Sanitary Division of the State Department of Health for the use of their records of water analyses, and to Messrs. Penniman and

Browne for their analysis of more than one hundred samples of water residue, and to the Baltimore City Water Department for the loan of illustrations forming figures 91 to 96.

The Survey, as in former years, is indebted to the directors of the various federal bureaus, who through their chiefs of divisions have cooperated at many points with the state organization. This is especially true in the present report with respect to the Division of Hydrography of the U. S. Geological Survey.

WILLIAM BULLOCK CLARK
STATE GEOLOGIST
1896-1917

3A

WM. BULLOCK CLARK, PH. D., LL. D.

STATE GEOLOGIST 1896-1917

The State of Maryland has suffered a great loss through the death of Dr. Wm. Bullock Clark, State Geologist, which occurred unexpectedly at Stonecrop, his summer home at North Haven, Maine, on July 27, 1917.

Wm. Bullock Clark was born at Brattleboro, Vermont, December 15, 1860. His parents were Barna A. and Helen (Bullock) Clark. Among his early ancestors were Thomas Clark, who came to Plymouth, Mass., in the ship *Ann* in 1623 and who was several times elected deputy to the general court of Plymouth Colony; Richard Bullock, who came to Salem, Mass., in 1643; John Howland, a member of council, assistant to the governor, and several times deputy to the general court of Plymouth Colony, who came to Plymouth in the *Mayflower* in 1620; John Tilly who likewise came in the *Mayflower;* and John Gorham, captain of Massachusetts troops in King Philip's War. Among the later ancestors were William Bullock, colonel of Massachusetts troops in the French and Indian War; and Daniel Stewart, a minuteman at the battle of Lexington in 1775.

As a youth Mr. Clark received his training under private tutors, and at the Brattleboro High School from which he was graduated in 1879. He entered Amherst College in the autumn of 1880, where he was inspired by Professor Emerson to specialize in geology. Immediately after completing his collegiate course in the spring of 1884 he went to Germany, where he devoted himself to geology and allied subjects under the direction of Professors Zittel, Groth, and Rothpletz. His Doctor's Dissertation on the geology around one of the picturesque lakes of the foothills of the Alps showed characteristics of his later work, especially the use of paleontology as an aid to geology, rather than as an end in itself. Receiving his degree of Doctor of Philosophy in 1887, he supplemented his training by field work with members of the official surveys of Prussia and Great Britain.

Dr. Clark returned from Europe in the fall of 1887 and began his work at the Johns Hopkins University, where he advanced rapidly through the various academic grades to become professor of geology and head of the geological department in 1894. Under his leadership the high standards established by his predecessor, Professor George Huntington Williams, were maintained and the scope of the work greatly broadened by increases in the teaching staff and a co-ordination of the various branches of the rapidly expanding science of geology. As a student he acquired knowledge easily and showed keen discrimination and judgement in selection of the essential elements; as a teacher he inspired his students with high scholastic ideals and broad outlook, and furnished the opportunity for many to carry on extensive investigations under his supervision. At heart he was not a cloistered specialist but a publicist who enjoyed contact with people and was ever ready to place his knowledge as a specialist at the service of the public.

From 1888 when Dr. Clark received an appointment as assistant geologist on the U. S. Geological Survey, he has been more or less closely, though not always officially, connected with the work of that organization in his chosen field, the Coastal Plain of the Atlantic seaboard. Under its auspices he prepared a bulletin on the Eocene Deposits of America and monographs on the Mesozoic and Cenozoic Echinodermata of the United States. He was also associated with the work of all the State Geological Surveys from New York southward, furnishing reports for the volumes of the New Jersey, Maryland, Virginia, and North Carolina organizations. The area of his chief work and that to which he gave most of his interest and energy was Maryland.

Professor Clark began his studies on the physical features of Maryland as soon as he settled in Baltimore in 1887, but his first official connection with the state was his appointment as Director of the State Weather Service in 1892, followed by his election as State Geologist in 1896, Executive Officer of the State Board of Forestry in 1906, and his appointment as a State Roads Commissioner in 1910. All of these positions, except the last, were held continuously until his death. In these several capacities he was instrumental in collecting and disseminating a vast amount of new and accurate knowledge regarding the natural resources of the state and in promoting the present road system which has greatly facilitated their utilization. During Professor Clark's tenure of office as State Geologist the annual mineral production of the state has more than doubled, without any unusual discoveries or unhealthy promotion.

His knowledge, ability, and gracious personality have been frequently utilized by his appointment as representative of the state. In 1900 by act of the general assembly Dr. Clark was appointed to represent the state in the resurvey of the Maryland-Pennsylvania boundary, commonly known as the Mason and Dixon Line. In 1908, he was an adviser to the governor at the White House Conference on Conservation. Among the better known official exhibits of Maryland's mineral resources were those made at the Buffalo, Charleston, St. Louis, and San Francisco expositions. These exhibits, which attracted attention at the time and received a large number of conspicuous awards, are now permanently installed in the State House at Annapolis.

Not the least among the services rendered to the state by Professor Clark are those given to help improve the physical well-being of its sick and dependent. For 16 years Dr. Clark was the president of the Henry Watson Children's Aid Society. He was a member of the Executive Committee of the Maryland Association for the Prevention of Tuberculosis, as well as vice-president and chairman of the Executive Committee of the Alliance of Charitable Agencies of Baltimore City.

The standing of Professor Clark among his scientific colleagues is attested by the character and scope of the societies to which he belonged and in which he held office. Among these are the National Academy of Science, of which he was chairman of the Geological Section, the American Philosophical Society, the Philadelphia Academy of Natural Sciences, the American Academy of Arts and Sciences, the Deutsche Geologische Gesellschaft, the Washington Academy of Science, Paleontologische Gesellschaft, Mining and Metallurgical Society of America, and the American Association for the Advancement of Science. He was councillor and treasurer of the Geological Society of America at the time of his death. In 1904 he was elected a foreign correspondent of the Geological Society of London. He was also President of the Association of American State Geologists. Amherst conferred on him the honorary degree of Doctor of Laws in 1908.

With the outbreak of the war Professor Clark became actively interested in problems of defence and economic preparedness. He was appointed a member of the Geology and Paleontology Committee of the National Research Council, chairman of its subcommittee on road materials and a member of its committee on camp sites and water supplies. He was a member of the Maryland State Council of Defence and chairman of its committees on Research and on Highways and Natural Resources. He was also an active member of the League to Enforce Peace, the National Defence League, and the Chamber of Commerce of the United States.

Professor Clark's administrative ability and professional attainments are largely responsible for the extensive development of Maryland's mineral resources and his loss will be severely felt in all quarters. He was always keenly interested in the educational value of the work of the varions state bureaus which he directed, and had just finished writing a geography of Maryland for school teachers. At the time of his death he was engaged in writing a report on the underground waters of the state and another on the coals.

At the annual meeting of the Maryland Geological and Economic Survey Commission held in the office of the Governor on Tuesday, October 9, 1917, the Commission ordered the following minute:

MINUTE OF THE COMMISSION, OCTOBER 9, 1917

As an expression of the loss which the State of Maryland has suffered in the death of Professor Wm. Bullock Clark, and as a tribute to the efficient and whole-hearted service which Dr. Clark has rendered to the state in many lines of activity, the Commissioners of the Maryland Geological and Economic Survey order that the following summary be inscribed in the permanent records of the Commission.

WM. BULLOCK CLARK, PH. D., LL. D.,

STATE GEOLOGIST OF MARYLAND, 1896-1917

Wm. Bullock Clark became a resident of Maryland upon his appointment as an instructor at the Johns Hopkins University in the fall of 1887, and began at once an investigation of the geology and other physical features of Maryland, which continued uninterruptedly until his death and resulted in a great expansion of our knowledge of the state and a marked increase in the annual production of its mineral products.

For three years, from 1887 to 1890, Dr. Clark at his own expense or under the auspices of the Johns Hopkins University, explored and studied the sedimentary deposits of Southern Maryland. Two early evidences of his aptitude for directing organized scientific investigations for the advantage of the state were the direction of a successful expedition comprising 25 members, representing the U. S. Geological Survey, the Maryland Agricultural College, and the Johns Hopkins University, for a study of the physical features of Southern Maryland and the development of a plan of co-operation between the Johns Hopkins University, Maryland Agricultural College, and the U. S. Weather Bureau for a study of the climatic conditions of the state. Reports giving the results of these studies were published at the time, arousing considerable interest, which resulted the following year in the establishment by the general assembly of the Maryland State Weather Service. Dr. Clark was commissioned the Director and held this office until his death. For 25 years he gave his services in this office and was directly instrumental in bringing together the information now incorporated in numerous volumes published by the state.

About this time the Commissioners for the World's Fair in Chicago desired a book which would properly set forth the natural resources of the state and intrusted its preparation to members of the Johns Hopkins University under the editorial direction of Professors Williams and Clark. In this work was brought together the first comprehensive modern statement regarding the geology and mineral resources of the state. With the appearance and distribution of the report came a growing interest in the development of the state's mineral resources until, in the administration of Governor Lowndes, leaders of both political parties united in establishing the present Maryland Geological Survey. Very fittingly the members of this original Commission at their first meeting elected Professor Clark, the most eminent geologist in the state, as Superintendent and State Geologist.

The choice of Professor Clark as State Geologist was especially fortunate for the state since he combined in an unusual degree thorough training, broad outlook, power of organization, leadership, and a genuine joy in contact with all sorts of people, which qualities united to form a wise and efficient officer of the state.

These qualities were shown (1) in "the plan of operation" which he first proposed and which has needed no essential modification during the progress of the work;

(2) in early emphasis on the preparation of county maps which have increased in popularity year by year;

(3) in recognition of opportunities for unusual studies shown in the making of a magnetic survey before others availed themselves of the aid then obtainable;

(4) in his ability to interest the leaders of the federal scientific bureaus and the leading transportation, mining, and mercantile agencies in co-operative efforts which accrued to the benefit of the state;

(5) in his early recognition of the needs and desires of the people as shown in his arousement of the state on the question of improved highways before "Good Roads" became a popular or political slogan; and finally, in his unusual ability to draw out the respect and loyalty of all sorts and conditions of men without reward, or even a complete understanding of the good works which he proposed.

During Dr. Clark's administration of the Survey it has issued over 30 volumes of reports describing the building-stones, clays, coals, limestones, and other mineral deposits and geological formations of the state; in co-operation with the federal bureaus it has prepared and published

57 county maps, including topographic, geological, agricultural soils, and forestry maps; it has examined and reported upon the highway conditions of the state, determined the best materials available, established standards, and devised plans by which it constructed in whole or in part 196 miles of improved highways, and laid the foundations for the efficient work of the present State Roads Commission. It has also given technical advice freely to counties and municipalities regarding their improvements, and to countless citizens concerning the value of mineral deposits; and installed attractive and instructive displays of the state's resources at Buffalo, Charleston, St. Louis, and other smaller exhibitions, which have been honored by the award of three Grand Prizes, 19 Gold Medals, 31 Silver Medals, 12 Bronze Medals, and numerous Honorable Mentions.

From the reports on forests, in its County Reports, has developed the present State Board of Forestry, of which the State Geologist is a member and its Executive Officer.

The work of Professor Clark and the Maryland Geological Survey in behalf of improved highways was recognized in the organization of the State Roads Commission by his appointment as one of the Roads Commissioners, in which position he served the state from 1908 to 1914.

In 1900, Dr. Clark was called upon to represent the state as Commissioner in the resurvey of the Maryland-Pennsylvania boundary, commonly known as the Mason and Dixon Line, and somewhat later as an adviser at the Conference on Conservation held at the White House in 1908.

His activity in other lines for improvement of conditions in the state is attested by his work as an officer in the Henry Watson Children's Aid Society, the Maryland Children's Aid Society, the Maryland Association for the Prevention of Tuberculosis, the Alliance of Charitable Agencies, the Conservation Commission, the Emergency Committee for the Rehabilitation of the Burnt District of Baltimore, the committee to devise a sewerage system for Baltimore, and many other organizations.

In all these numerous and diversified efforts for betterment of the state of his adoption Professor Clark has shown untiring energy, unselfish zeal and devotion, which the Commission, on behalf of the state, gratefully acknowledges.

E. B. M.

PART I

THE GEOGRAPHY OF MARYLAND

BY

WM. BULLOCK CLARK

THE GEOGRAPHY OF MARYLAND

BY

WM. BULLOCK CLARK

INTRODUCTION

LOCATION.—The State of Maryland, lying midway between the North and the South, and stretching from the Atlantic Ocean to the crest of the Alleghanies, with the great estuary of Chesapeake Bay and its tributaries extending far into the land in all directions, possesses many natural advantages in its location. There is probably no state of equal size in the Union that has such a variety in its agricultural and mineral resources and in its sea and bay products, while its generally salubrious climate renders every section healthful as a place of residence. From its eastern to its western borders may be found a succession of districts suitable from their surroundings for the most diverse employments.

The State of Maryland is the most northern of the Southern States, and is situated between the parallels 37° 53′ and 39° 44′ north latitude and the meridians 75° 4′ and 79° 30′ west longitude.

BOUNDARIES.—The boundaries of Maryland are based upon both arbitrary locations and geographic features. Different interpretations of the descriptions of the limits of the early grants, such as "the land hitherto unsettled," and "the first fountain of the Potomac," led to prolonged disputes, some of which have only been settled in recent years. The northern, as well as parts of the eastern, southern, and western boundaries are conventional lines of which the best known is the "Mason and Dixon Line."

The *eastern* and *northern* boundaries of Maryland consist of the Atlantic Ocean and a line separating the former possessions of the Penns,

NOTE.—Compiled largely from published data brought together by the author and his associates for the Maryland Geological Survey.

now the states of Pennsylvania and Delaware, from those of the Lords Baltimore. From the original settlements of the country these lines were in dispute. The original grants to Lord Baltimore in 1632, which included the country to 40° north latitude, embraced territory (now part of Pennsylvania) which was subsequently granted in 1680 to William Penn and a smaller area (now Delaware) settled by the Swedes and Dutch, and later granted to the Duke of York and by him trans-

FIG. 1.—VIEW OF THE STATE HOUSE AT ANNAPOLIS.

ferred to Penn in 1682. By a decision of the English courts in 1760 interpreting an earlier agreement greatly to the disadvantage of Lord Baltimore, the boundary line was to run due west from "Cape Henlopen" (Fenwicks Island, 15 miles south of the point now known as Cape Henlopen) to a point midway between the Chesapeake and the Atlantic. From this "middle point" the line was to run northerly, tangent to a circle of 12 miles radius whose center was at Newcastle, Delaware. From the "tangent point," where the tangent line touched the circle, the boundary was to follow the circle to a point due north of the tangent point. From this point the line was to run due north to the northeast corner, which was to be on the parallel of latitude, 15 miles south of the southernmost part of Philadelphia, as it was at the time of the legal decision in 1760. From this northeast corner the boundary was to extend due west to the western limits.

FIG. 2.—VIEW OF CITY HALL, BALTIMORE.

Attempts had been made by local surveyors to run the lines during the decade preceding the assignment of the work in 1763 to Charles Mason and Jeremiah Dixon, noted English astronomers and mathematicians, but the difficulties of running such peculiar lines through unbroken forests had been too great for the colonial surveyors with their crude instruments. When Messrs. Mason and Dixon arrived in Philadelphia, in 1763, they found that the local surveyors had already determined the "middle point" and the "tangent point," and had run a provisional line as far as the northeast corner. From the time of their arrival in November, 1763, until December, 1767, Mason and Dixon were engaged in redetermining the earlier work and in running and marking the northern boundary which they continued to Dunkard's Creek, some miles beyond the limits of Maryland, where they were stopped by the Indians. Along the greater portion of the lines surveyed by them, each mile was marked by a stone monument (mounds of stone surrounding wooden posts were used west of Sideling Hill) which had on four out of five mile-stones the letter "P" engraved on the northern side, and the letter "M" on the southern side; while at each fifth mile was a stone of the same size, known as a "crown-stone," with the coat-of-arms of the Penns cut on the northern face and with that of Lord Baltimore on the southern. These stones came from the quarries on the Isle of Portland in England. Some of the original monuments remained in good condition, but many had become dilapidated or had been removed in the more than 100 years since the earlier survey, when the legislatures of Maryland and Pennsylvania made provision in 1900 for the relocating and remarking of the line, and this work was completed in 1904. This line, known as the Mason and Dixon Line, became famous in the great controversy preceding the Civil War, as the boundary between the free and slave-holding states, and has been regarded as the division line between the North and the South.

The *southern* boundary, likewise in dispute since Colonial days, was permanently settled in 1874, as far as the Maryland-Virginia portion was concerned, by a board of commissioners appointed by the states of Maryland and Virginia. According to this agreement the boundary follows the low-water line on the right bank of the Potomac River to Smith's Point at its mouth, thence northeasterly across Chesapeake Bay to the southern end of Smith's Island, and thence to the middle of Tangier Sound. Here the boundary runs south 10° 30′ west, until it intersects a straight line connecting Smith's Point and Watkins Point, and thence eastward through the center of Pocomoke Sound and Pocomoke River until it rcaehes the westward prolongation of the old Scarborough and Calvert line survcyed in 1668, which it follows to the Atlantic Ocean.

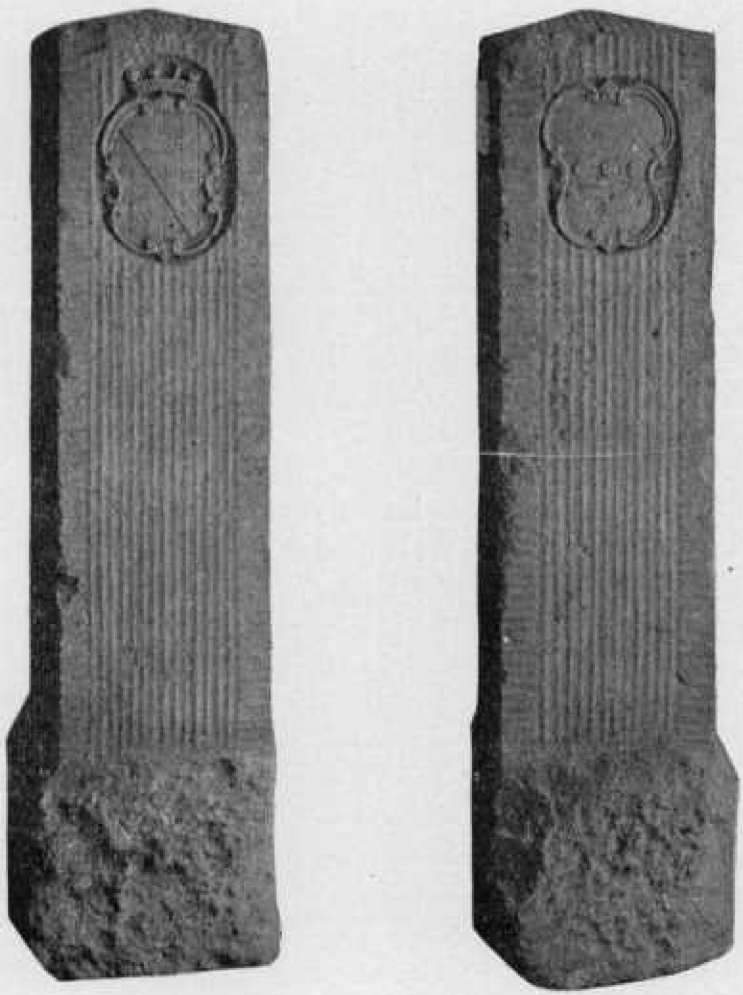

FIG. 3.—VIEW OF MASON AND DIXON LINE MONUMENT STONES.

There is still some eontroversy as to the exaet location of some of the boundary marks, espeeially in Pocomoke Sound, where the oyster interests of Maryland and Virginia conflict. The Maryland-West Virginia portion of the boundary also follows the right bank of the Potomac River and its north branch.

The *western* boundary of the state, according to the original charter, was to run due north from the "first fountain" of the Potomac River. The North Branch was early regarded as the main stream, but later surveys have shown the South Branch to be longer than the North Branch. The "Fairfax Stone," planted on October 17, 1746, and supposed to have been placed at the westernmost source of the North Branch, has been shown in later years to be on a tributary of that stream, the real source being about one mile farther west, which was marked by the State of Maryland in 1897 with a monument known as the "Potomac Stone." A very crooked line was run by Deakins in 1787 from the Fairfax Stone to the northern boundary line. Subsequently in 1859 a straight line was run by Lieutenant Michler, of the the U. S. Army, from the same point. In 1897 the State of Maryland ran a straight line from the Potomac Stone. The questions at issue were decided on May 27, 1912, by the Supreme Court of the United States in favor of the Deakins line of 1787, which thus becomes the legal western boundary of the state, separating it from West Virginia.

SIZE.—The extreme width of the state from east to west is 240 miles, and the extreme length from north to south 125 miles, the latter, however, narrowing toward the west where it becomes scarcely more than 1½ miles at Hancock. Beyond this point it again broadens, although narrowing again at Cumberland to 5 miles. The total area within the limits of the state is estimated at 12,327 square miles, of which 9941 square miles are land. The remaining 2386 square miles are water, distributed as follows: Chesapeake Bay proper, 1203; estuaries of the Bay, 1023; Chincoteague Bay, 93.

Maryland ranks forty-first among the states in area. It is about one-fourth the size of Pennsylvania, which borders it upon the north; one-half the size of West Virginia, its western neighbor; somewhat less than one-third the size of Virginia, which lies to the south; and about six times the size of Delaware, its neighbor on the east. It is only about one-twentieth as large as Texas, the largest state of the Union.

POSITION.—A comparison of the position of Baltimore, the largest city of the state, with some of the more prominent cities of this country and of the world, shows that several are very nearly on the same latitude, the following being within 1 degree or less: Columbus, Cincinnati, Indianapolis, Springfield, St. Louis, Topeka, Denver, San Francisco, Lisbon, Palermo, Athens, Peking, Constantinople, and Tokyo. In longitude it

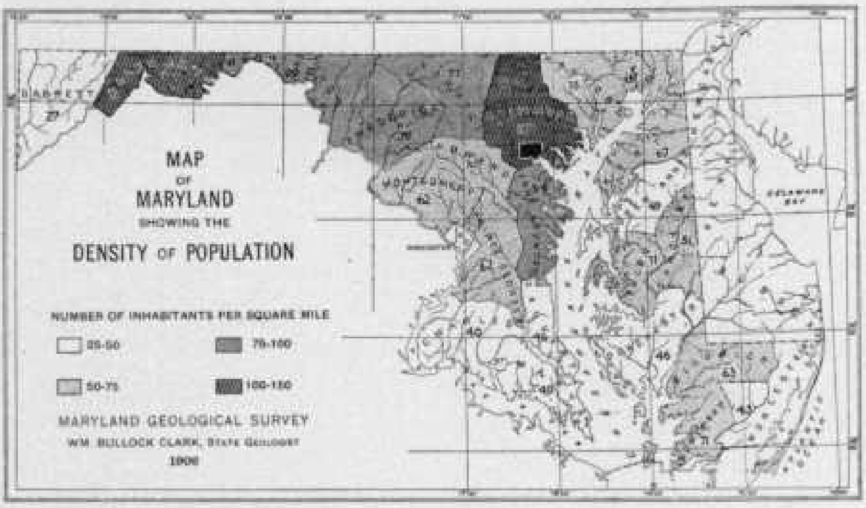

FIG. 4.—MAP SHOWING DENSITY OF POPULATION.

differs but a few degrees from Ottawa, Canada, on the north and Santiago de Cuba, the Isthmus of Panama, Quito, and Lima on the south.

POPULATION.—Maryland has a population of 1,295,346, according to the census of 1910, which gives it the rank of twenty-seventh among the states. Of this population 1,062,639 are whites and 232,250 are colored. The average colored population for the state is 17.9 per cent. In 12 of the counties it is in excess of 25 per cent, the maximum being reached in Charles County which has 52.3 per cent.

Native whites of native parentage comprise 59.2 per cent of the entire population; native whites of foreign or mixed parentage 14.8 per cent;

and foreign-born whites 8 per cent of the total population. The foreign-born white population came chiefly from Germany, Russia, and Ireland. The number of males 21 years of age and over are 367,908, of which 82.5 per cent are white and 17.4 per cent colored. Males of military age, 18 to 44, number 272,373. The number of persons above 10 years of age who are unable to read and write is 73,397, or 7.2 per cent of the population above this age, of which 23.4 per cent are among the colored and 11.9 per cent among foreign-born whites, and 2.6 per cent among native whites.

The total number of dwellings in Maryland is 253,805, with a total number of families of 274,824. The average number of persons per dwelling is 5.1, and the average persons per family 4.7.

TOTAL POPULATION OF THE STATE AT VARIOUS PERIODS

Census year	Population	Increase over preceding census		Per cent of increase for the U. S.
		Number	Per cent	
1634	200	......	....	....
1660	12,000	......	....	....
1671	20,000	......	....	....
1701	25,000	......	....	....
1715	30,000	......	....	....
1748	130,000	......	....	....
1756	154,188	......	....	....
1760	166,523	......	....	....
1770	199,827	......	....	....
1775	225,000	......	....	....
1782	254,050	......	....	....
1790	319,728	......	....	....
1800	341,548	21,820	6.8	35.1
1810	380,546	38,998	11.4	36.4
1820	407,350	26,804	7.0	33.1
1830	447,040	39,690	9.7	33.5
1840	470,019	22,979	5.1	32.7
1850	583,034	113,015	24.0	35.9
1860	687,049	104,015	17.8	35.6
1870	780,894	93,845	13.7	22.6
1880	934,943	154,049	19.7	30.1
1890	1,042,390	107,447	11.5	25.5
1900	1,888,044	145,654	14.0	20.7
1910	1,295,346	107,302	9.0	21.0

Counties.—Maryland is divided into 23 counties and Baltimore City, of which Garrett, Allegany, Washington and the western part of Frederick comprise the mountainous region known as Western Maryland; the eastern part of Frederick, Carroll, Montgomery, Howard, Baltimore, Harford and the northern part of Cecil the Piedmont area, which is also referred to under the name of Northern-Central Maryland; Anne Arundel, Prince George's, Calvert, Charles, and St. Mary's, commonly called Southern Maryland; and the southern part of Cecil, Kent, Queen Anne's, Talbot, Caroline, Dorchester, Wicomico, Somerset, and Worcester, known as Eastern Maryland. Of these 23 counties all but seven lie upon navigable waters.

There seems to have been no consistent method adopted in erecting the several counties of the state. Some, like St. Mary's and Kent, grew with the development of the province and were subsequently bounded by the erection of new counties; others, like Charles and Dorchester, were erected by the ruling of Lord Baltimore. Cecil County was erected by proclamation of the Governor; while Washington, Montgomery, Howard and Wicomico were established in constitutional conventions. The great majority of counties were, however, erected by Acts of Assembly. The records now extant do not show the original extent or the exact date of erection of several of the counties, but it is of interest to note that 18 out of the 23 counties were established before the close of the Revolutionary War, and 11 of these before 1700. Baltimore City, since 1851, has not been in any county, but unlike any other American city, except Greater New York, is a distinct division of the state.

The counties of Maryland, unlike those of many other states, are the ultimate units of territory and not the combination of townships. This fact, together with the paucity of large towns and the agricultural character of the communities, have made the counties as such of unusual importance in all political and social relations. Election districts are established in all the counties.

COUNTIES ARRANGED IN THE ORDER OF THE DATE OF THEIR ERECTION

Counties	Origin of name	Date of formation
St. Mary's	In honor of the Virgin Mary, the landing having been made on the Feast of the Annunciation	1637
Kent	After the English county	1642
Anne Arundel	After Lady Anne Arundel, wife of Cecil, second Lord Baltimore	1650
Calvert	After the family name of the Proprietary	1650
Charles	After Charles, Lord Baltimore	1658
Baltimore	From the Proprietary's Irish Barony (Celtic bilte mor; *i. e.*, the large town)	1659
Talbot	After Grace Talbot, daughter of George, first Lord Baltimore	1662
Somerset	After Mary Somerset, sister of Lord Baltimore	1666
Dorchester	After Earl Dorset, a family friend of the Calverts	1668
Cecil	After the Christian name of the second Lord Baltimore	1674
Prince George's	After Prince George of Denmark	1695
Queen Anne's	After Queen Anne of England	1706
Worcester	After the Earl of Worcester	1742
Frederick	After Frederick, heir apparent	1748
Caroline	After Lady Calvert, sister of the last Lord Baltimore	1773
Harford	After Sir Henry Harford, last Proprietary	1773
Washington	After General Washington	1776
Montgomery	After General Montgomery	1776
Allegany	After Oolikhanna; *i. e.*, beautiful stream	1789
Carroll	After Charles Carroll of Carrollton	1836
Howard	After John Eager Howard, the elder	1851
Wicomico	After the river of that name, from wicko, house, and mekee, building; *i. e.*, referring to an Indian town on the banks	1867
Garrett	After John W. Garrett	1872

HISTORY.—Chesapeake Bay was probably known to some extent to the Spaniards by the early part of the Sixteenth Century, long before the English attempted to establish themselves in any part of the American continent. The first account of the physical characteristics of the Maryland area was given, however, by Captain John Smith, of the Virginia colony, who, in an open boat with a few companions, began an exploration of the upper portions of Chesapeake Bay and its numerous tributaries

FIG. 5.—VIEW OF WYE HOUSE, A COLONIAL MANSION IN TALBOT COUNTY.

FIG. 6.—VIEW OF HOMEWOOD, BUILT BY CHARLES CARROLL OF CARROLLTON IN 1804. ON GROUNDS OF THE JOHNS HOPKINS UNIVERSITY.

in the year 1608. During the two trips which he made in the summer of that year, the shores of the Bay were surveyed as far as the Susquehanna River, the harbor of Baltimore was entered, and the Potomac River was ascended as far as the falls above Georgetown. The map which Captain Smith prepared as a result of his trips shows with remarkable correctness the outlines of the regions which he visited.

The charter of Maryland was granted by Charles I to George Calvert, first Lord Baltimore, but as he had died before the patent passed the Great Seal, as the result of delays caused by the objections of the Virginia Company, it was issued to his son Cecilius Calvert, second Lord Baltimore, on June 20, 1632.

The name of Maryland was given to the colony in honor of Queen Henrietta Maria, the wife of Charles I. Under the terms of the charter the territory to the north of Virginia to 40° north latitude was included in the grant to Lord Baltimore, who was made the owner of the land, Maryland thus becoming the first proprietary colony. Many liberties were allowed, including freedom from taxation, by the King, and practically royal power was conferred on the Proprietor.

The first permanent settlement was made on March 27, 1634, at St. Mary's by a party under the leadership of Leonard Calvert, brother of Lord Baltimore, who arrived with his associates on the *Ark and Dove.* They maintained from the start friendly relations with the Indians but found in William Claiborne, who had established a trading post on Kent Island on the Chesapeake in 1631 and who had opposed the granting of the Maryland charter, a bitter enemy who defied the authority of the Proprietary by force of arms. Although this settlement was brought under subjection, Claiborne continued an enemy of the colony and later fomented trouble again, even depriving the Governor of his office for a time.

One of the chief objects of Calvert in establishing the colony was to provide an asylum for persecuted Catholics, although he was equally desirous of having Protestant colonists. From the first, religious toleration was the recognized custom of the colony, and was definitely established by the Colonial Assembly in 1649 by the passage of the famous

"Act of Toleration," which granted religious liberty to all sects of trinitarian Christians.

Lord Baltimore reserved to himself the right to initiate legislation until 1638, when this was conceded to the people, the Proprietary still holding the veto power. About 1650 a company of Puritans from Virginia sought refuge in Maryland and made a settlement on the present site of Annapolis, then called Providence, and were permitted, in order to conciliate them, to be organized as Anne Arundel County. The success of the Puritans in England under Cromwell accentuated the conflict between the Proprietary and the Puritan party in Maryland, which became so serious that a Parliamentary commission in 1654 permanently deposed the officers of the former and appointed a Puritan Council, thus depriving the Lord Proprietary of his government. In 1658 the power of the Proprietary was again restored, to be soon disturbed, however, by the attempt of the Proprietary Governor to establish a commonwealth. With the coming of the English Restoration in 1660 order was finally established.

Again in 1688, because of the delay of Lord Baltimore's deputies in proclaiming the sovereignty of William and Mary, owing to the death of a messenger sent to the colony, a company of Protestants under the leadership of John Goode seized St. Mary's and assumed control of the government, and in 1692 Maryland was proclaimed a royal colony. Lord Baltimore was deprived of his political power and privileges, although his property rights were not affected. In 1694 the capital was moved from St. Mary's City to Annapolis. Maryland remained as a royal colony until the death of the third Lord Baltimore in 1715 when the fourth Lord Baltimore, who was a Protestant, was recognized as Proprietor. From this date the Proprietary continued until after the death of the sixth and last Lord Baltimore in 1771, when the opening of the Revolution, a few years later, put an end to it, Sir Henry Harford being Proprietor during this short interval.

Maryland's part in the French and Indian War was not conspicuous, but Braddock and Washington fitted out their expedition against Fort Duquesne (Pittsburgh) at Frederick. Fort Frederick, situated 40 miles farther west, was built in 1756, and both at this period and later served to protect the colony from the west.

The burning of the *Peggy Stewart* with a cargo of tea in the harbor of Annapolis on October 19, 1775, has ever since been celebrated by Marylanders as Peggy Stewart Day. No military operations took place in Maryland during the Revolutionary War, although the "Maryland Line"

FIG. 7.—VIEW OF THE HISTORIC WYE OAK, WYE MILLS, TALBOT COUNTY.

fought with valor in many engagements, especially those of Long Island, Camden, Cowpens, Guilford, and Eutaw Springs. In the first of these battles the Maryland troops covered the retreat of General Washington's army, and a monument to their valor has been erected in Prospect Park, Brooklyn, on which is inscribed, "In honor of Maryland's four hundred who on this Battlefield, August 27, 1776, saved the American Army." In 1776 General Washington was invested by the Continental Congress, then in session in Baltimore, with dictatorial powers as Commander-in-Chief of the Continental Army. On December 22, 1783, Washington resigned his commission as commander-in-chief of the army in the Senate chamber at Annapolis, where the Continental Congress was then in session. Maryland ratified the Constitution of the United States on April 28, 1788, being the last of the 13 colonies to come into the Union. She had refused to accept the articles of confederation until those colonies which had claims to western lands had surrendered them to the

FIG. 8.—FORT FREDERICK, WASHINGTON COUNTY, BUILT IN 1756. WHERE WASHINGTON FITTED OUT HIS EXPEDITION AGAINST FORT DUQUESNE IN THE FRENCH AND INDIAN WAR.

general government. In 1790 Maryland ceded to the federal government 60 square miles of territory for the National Capital, which became the District of Columbia in which Washington is situated. Fort McHenry, the construction of which had been started by patriotic citizens for the defence of Baltimore, was already partly completed in 1794 when it passed to the federal government. It was finally completed in 1805.

During the War of 1812 several Maryland towns were pillaged by the British, but Baltimore was saved from plunder by the repulse of the enemy at North Point and Fort McHenry. It was during the bombardment of the latter place that Francis Scott Key, who was held aboard a British vessel in the harbor of Baltimore, wrote "The Star-Spangled Banner."

Maryland was a slave-holding state at the outbreak of the Civil War, and sentiment was divided between the North and the South, but the decisive measures adopted by the national government made it impossible for the state to secede. Three of the battles of the Civil War were fought on Maryland soil, South Mountain (September 14, 1862), Sharpsburg, or Antietam (September 16-17, 1862), and Monocacy (July 9, 1864). There were also small conflicts at many points, especially along the Potomac.

In the history of the state are many incidents which have since become of national or international importance. The first wheat was shipped to Europe from Baltimore in 1771; the first regular steam packet that crossed the Atlantic direct from the United States sailed from Baltimore in May, 1838; the Morse telegraph line transmitted its first message ("What hath God wrought?") from Baltimore to Washington, April 9, 1844; while in the same city was manufactured the first armor plate for the Monitor in 1862. Baltimore was the first city in America to have a water company (1792), street gaslights (1816), a railroad (1828), an iron building (1851), an electric street railroad (1885), an electric locomotive (1895). The city contains the first official state monument to George Washington (1815), the oldest American lodge of the Independent Order of Odd Fellows (1819), and the oldest College of Dental Surgery (1839).

The earliest settlers in Maryland were Englishmen, whose descendants are now scattered all over the state, and comprise the leading element in the population. Many of the early settlers in the country adjacent to Pennsylvania were of German extraction, and their descendants are to-day numerous and influential. Next in importance are the negroes, who comprise nearly one-fifth of the population and who are relatively more prominent in Charles, Calvert, and St. Mary's counties, where they compose about one-half of the population, and least important in the western counties along the Mason and Dixon Line, where there is only one negro, on the average, to 14 whites. In Baltimore, Cecil, and Harford counties, the negroes comprise one-sixth of the population, while in the counties of the eastern and western shores, not previously enumerated, they form about two-fifths of the entire population. During the last 25 years there has been a great increase in the Polish, Hungarian, and Bohemian inhabitants, who have settled chiefly in Baltimore City.

Maryland has always been a religious center. As early as 1631 services were regularly conducted on Kent Island by an ordained minister of the Church of England. The first Presbyterian church in America was established at Snow Hill about 1700, and in 1766 Robert Strawbridge established the first Methodist congregation in America in Carroll, then Frederick, County. Many of the most prominent of the early settlers were Roman Catholics, and the See of Baltimore has held the first position in America since the decree of 1858. There are 59 denominations or sects represented in Maryland, and although many of them are scattered throughout the state they show local variations in strength, which are often closely related to the history, beliefs, and nationalities of the early settlers.

STATE GOVERNMENT.—The present government of the State of Maryland is based on a constitution formulated and ratified in 1867. Earlier constitutions were adopted in 1776, 1851, 1864, and the constitution of 1776 was very much changed in 1837. According to the present constitution the state is divided into 23 counties and Baltimore City, which in turn are subdivided into districts for school and election purposes. There are no units such as townships, but the local affairs of the cities, towns, and villages are carried on by officers in accordance with charters and special acts.

Among the state officials are the Governor, elected for four years, and the Secretary of State, who is appointed by the Governor. The Senate and House of Delegates, which together form the General Assembly or Legislature, consist of 27 Senators, elected for four years, one from each of the 23 counties and the four districts of Baltimore City, and 101 Delegates, elected for two years. Each of the legislative districts of Baltimore is entitled to six Delegates, the number allowed the largest county. The Assembly meets every other year on the first Wednesday in January, and may remain in session only 90 days. At the call of the Governor a special session may be held, which is limited by law to 30 days.

The judicial powers of the state are vested in a Court of Appeals composed of eight judges; a Circuit Court with eight chief judges (one for each judicial district), seven of whom are judges of the Court of Appeals,[1] the chief judge of Baltimore City not being a member of that court, and 22 associate judges, eight of the latter with the chief judge above-mentioned constituting the Supreme Bench of Baltimore City, the other judicial districts having two associate judges each; and an Orphans' Court with 72 judges. The Appeal and Circuit Court judges are elected for 15 years, the judges of the Orphans' Court for four, the registrars of wills for six, and the sheriffs for two. The Attorney-General of the state and the State's Attorneys are elected for four years. Justices of the peace, constables, coroners, and notaries are appointed by the Governor.

Among other prominent state officials are the Comptroller, who is the financier for the state, and who is elected by the people for two years; and the Treasurer, who is the banker and who is elected by the General Assembly for a two-year term.

The more important state organizations are the Board of Public Works, consisting of the Governor, Comptroller, and Treasurer; Maryland National Guard, State Conservation Commission, Land Office, State Board of Agriculture, State Geological Survey, State Roads Commission, State Board of Forestry, Bureau of Industrial Statistics, Immigration Bureau, Board of Education, Board of Health, Board of State Aid to Charities, Penal Commission, and State Lunacy Commission.

EDUCATION.—The educational history of the state dates back to 1696, when Governor Francis Nicholson established the first public school at Annapolis, now St. John's College. The state schools were brought under the general supervision of the State Board of Education in 1864, and are now supported by state and local taxation. A State Superintendent of Schools was provided for by the General Assembly of 1900. The number of public schools in Maryland in 1914 was 2485, of which 1935 were for the whites (Baltimore 95), and 550 for the colored (Baltimore 16). The number of public school teachers was 5996, of which 5056 were white (Baltimore 1589), and 940 colored (Baltimore 268). The number of public school pupils was 245,258, of which 200,783 were whites (Baltimore

[1] The eighth judge from Baltimore City does not serve in the Circuit Court.

76,539), and 44,475 colored (Baltimore 12,088). The total value of public school property in 1915 was $11,110,587 (Baltimore $6,065,717), and the amount expended for public school purposes for the year ending July 31, 1915, was $5,904,859.81 (Baltimore $2,585,312.95). The state school system also includes normal schools for teachers, schools for the deaf and dumb, and for the blind.

Baltimore is the educational center of the state. In this city are located the Johns Hopkins University (established in 1876, Medical School in 1892, Engineering Department, 1912); Maryland University (Medical College, 1807, Law School 1869, Dental School 1882, School of Pharmacy 1904, St. John's College added 1907); Goucher College (1888); Loyola College (Roman Catholic 1852); the Peabody Institute (1866); the Maryland Institute (1826); and several other institutions.

Within the limits of the state are also the State College of Agriculture at College Park (1859); St. John's College at Annapolis (1789); Washington College at Chestertown (1782); Mt. St. Mary's College at Emmitsburg (Roman Catholic, 1808); Western Maryland College at Westminster (Methodist Protestant, 1867); Rock Hill College near Ellicott City (1857); and many smaller institutions.

CHARITIES AND CORRECTIONS.—Maryland has several hundred charitable institutions which care for the poor and unfortunate of the state. Many of these are nonsectarian, but the great majority are supported by the various religious organizations. There has been established recently an Alliance of Charitable and Social Agencies of Baltimore that embraces the leading general organizations of this character, including the Federated Charities, Henry Watson Children's Aid Society, Babies' Milk Fund Association, Friendly Inn Association, Prisoner's Aid Society, Instructive Visiting Nurse Association, Maryland Association for the Prevention and Relief of Tuberculosis, Social Service Corporation, Mothers' Relief Society, Travellers' Aid Society, Mental Hygiene Society, and the Maryland Children's Aid Society.

There are several large hospitals in Baltimore, including the Johns Hopkins Hospital, the Maryland University Hospital, Mercy Hospital, Maryland General Hospital, etc., while there are local hospitals at Cumberland, Hagerstown, Cambridge, Easton, and other towns. There are also several hospitals for the insane maintained both by the state and by privately endowed boards, among the more important being the State Hospital at Springfield, maintained under state auspices, and the Sheppard and Enoch Pratt Hospital, maintained by private endowment. There is also an asylum and training school for the feeble-minded at Owings Mills and a State Sanitarium at Sabillasville.

The state has various correctional institutions, including the State Penitentiary at Baltimore and the House of Correction at Jessups. There are also reform schools for the incorrigible youth of the state.

HIGHWAYS, CANALS, AND RAILROADS.—During the early years of the province transportation was entirely by water, and compensation for boat hire instead of mileage was allowed to the members of the Assembly from Kent and Anne Arundel counties. At first the construction and repair of roads was a matter of private concern, and over a quarter of a century elapsed between the settlement at St. Mary's and the passage of the first road law of the colony in 1666, under which overseers were appointed by the county courts. Even at this time the "highwaies" were little more than trails through the forests and transportation by wagons was as yet unknown. A great advance upon the earlier methods was made by the establishment in 1695 of a regular post route, largely by land, from the Potomac River to Philadelphia via Annapolis and the Eastern Shore. Further road legislation was enacted in 1696 and in 1704, under the latter act provision being made for public roads 20 feet in width. This act remained the law of the province for 50 years, and it was during this period that the so-called "notch roads" were built. One of these, the Three-Notch road of Southern Maryland, shows even to-day the notches cut in the oaks along its route. During this period also were built many of the so-called "rolling roads" for the rolling of tobacco in hogsheads to tide. The name still persists in the Rolling Road of Baltimore County. In 1765 a stage line was established between Baltimore and Philadelphia, and soon thereafter ferries and stage lines extended southward into

FIG. 9.—ENTRANCE TO THE CHESAPEAKE AND DELAWARE CANAL AT CHESAPEAKE CITY, CECIL COUNTY.

FIG. 10.—TOLL HOUSE ON NATIONAL ROAD, BUILT AFTER THE STATE TOOK CONTROL OF THE ROAD IN 1834.

Virginia. With the western movement during the eighteenth century the construction of roads to the west began. Among these were the "Monocacy Road" and "Braddock's Road," the latter being the first road built across the mountains. The construction of "turnpikes" in Maryland by incorporated companies, which furnished the first improved roads in the state, dates from the passage of an Act of Assembly of 1804-5, under which the Frederick, Reisterstown, York and Falls Turnpike companies were soon incorporated. A few years later the Cumberland road was constructed to connect at Cumberland with the National Road built at the expense of the federal government from Cumberland to the west, and thrown open to the

FIG. 11.—A MODERN HIGHWAY NEAR PRINCESS ANNE, SOMERSET COUNTY.

public in 1818. From that time until the coming of the railroad in 1852 the "National Road" was "the one great highway over which passed the bulk of trade and travel and the mails between the East and West."

Maryland has constructed during the past decade one of the finest systems of improved highways to be found anywhere in the country. This work began with the passage in 1898 of a State Highway Law providing for a Highway Division in connection with the Maryland Geological Survey, under which the foundation for the later work was laid. In 1904 a State Aid Highway Act appropriating $200,000 annually to be met by an equal amount from the counties was passed; and in 1906 an act appropriating money for the construction of the Baltimore-Washington Boulevard was also enacted, the administration of both of these acts being also placed under the Maryland Geological Survey. In 1908 a State Road Commission was established for the construction of a main-artery system entirely at state expense, and $5,000,000 were appropriated for the work. In 1910 all of the highway work was placed under the State Roads Commission. Nearly 1500 miles of modern highways, out of a total state mileage of 14,483 miles, have been constructed up to the present, at a cost of about $15,000,000 under these several acts. This modern system of highways radiates from Baltimore to all portions of the state and connects all of the leading centers of population.

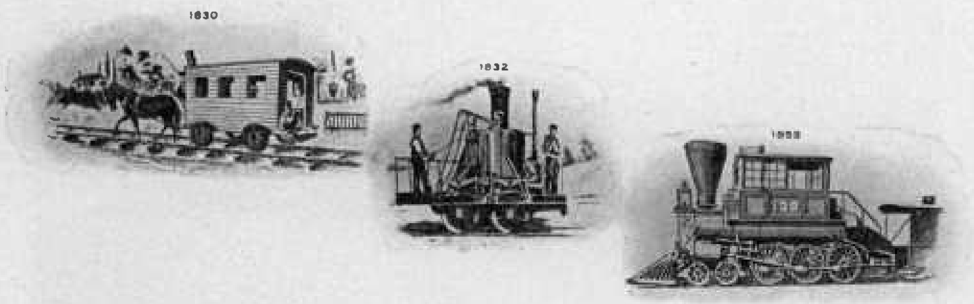

FIG. 12.—THE BALTIMORE AND OHIO RAILROAD IN 1830, 1832, AND 1858.

Many canal projects were proposed during the latter part of the eighteenth and early part of the nineteenth centuries, and several canals were built of which only two are to-day in operation—the Chesapeake and Delaware Canal connecting the Chesapeake and Delaware bays, started in 1824 and completed in 1829, which is 13½ miles long; and the Chesapeake and Ohio Canal, begun in 1828 and completed as far as Cumberland, its present terminus, a distance of 186 miles, in 1850, some years after the Baltimore and Ohio Railroad had reached the same point.

Railroad enterprises in Maryland began with the incorporation of the Baltimore and Ohio Railroad Company in 1827. Actual building was started by this company in 1828 and by 1830 15 miles had been constructed. During the next two decades railroad building proceeded with greater rapidity, and by 1850 there were 259 miles of railroads within the state. In 1909 this had been increased to 1394.19 miles. Beside the Baltimore and Ohio Railroad the other important lines are the various railroads under the control or management of the Pennsylvania system, the Western Maryland, the Maryland and Pennsylvania, and the Norfolk and Western railroads, and the two interurban electric railways—the Washington, Baltimore and Annapolis, and the Baltimore and Annapolis Short Line.

FOREIGN COMMERCE.—The foreign commerce of Maryland is confined to the port of Baltimore. The number of foreign vessels entered in the year 1910 was 865, and in the year 1914 was 1037. The total value of the

FIG. 13.—A MODERN ALL-STEEL COAL TRAIN ON THE BALTIMORE AND OHIO RAILROAD.

imports in the former year was $32,377,480, and in the latter $29,555,672. The number of foreign vessels cleared in the year 1910 was 878, and in the year 1914 was 1034. The total value of the exports in the former year was $74,067,406, and in the latter $106,822,295. The most important imports in the order of their value are pig iron, cork manufactures, iron ore, nitrate of soda, bananas, muriate of potash, toys and dolls, manganese ore, fertilizers, and burlaps. The most important exports are grain, copper, tobacco, cotton, flour, iron and steel manufactures, coal, agricultural implements, lards, meats, etc., lumber and lumber manufactures.

REVENUE, DEBTS, AND TAXATION.—The total assessed value of state property for state levy in 1915 was $1,274,824,811, of which $947,648.60

is subject to the full state tax of .32½ cents on the $100, the balance including securities and savings deposits being subject to lower fixed rates. The amount raised in this manner is used to meet the public school tax, the maintenance of roads tax, and interest on the various loans. The other expenses of the state are met from licenses, fees, etc.

The total funded debt of the state on September 30, 1915, was $22,685,880. As an offset to this the state held stocks, bonds, and cash to the credit of the sinking funds of a value of $6,210,589, leaving a net debt of $16,595,291. Among the assets of the state is a perpetual annuity of the Northern Central Railroad Company of $90,000, which has a value of $2,000,000 and upwards which would still further reduce the net debt.

The disbursements of the state for the year ending September 30, 1915, amounted to $11,263,751.09, and there was on that date in the treasury after deducting the amounts due to sinking funds $846,900.96. The state, however, owed to "dedicated funds" $1,018,769.11, and to unpaid balances of appropriations $1,274,687.70, leaving a total deficiency on that date of $1,446,555.81.

There is nothing in the constitution of the state limiting the power of the General Assembly to authorize bond issues either by the state or by its municipalities, except that "the credit of the state shall not in any manner be given, or loaned to, or in aid of, any individual, association or corporation, nor shall the General Assembly have the power in any mode to involve the state in the construction of works of internal improvement, nor in granting any aid thereto, which shall involve the faith or credit of the state."

An Act of Assembly in 1914 exempts from taxation for 1914 and thereafter all bonds or other obligations hereafter to be issued by the state or any county, city or municipal corporation, or other political subdivision, and all such securities heretofore issued by any county or municipal corporation which have been sold under terms rendering such county, city or municipal corporation liable for the state tax thereon.

The total assessed value of Baltimore City property for city levy in 1915 was $818,102,213. The full city tax rate was $1.92 per $100, the suburban rate $1.28, the rural rate $0.65, the securities rate $0.30, and the savings bank rate 0.18\frac{3}{4}$. The total appropriations for the year were $23,791,502.64. The total funded debt issued to January 1, 1915, amounted to $87,467,679.50.

GEOLOGY

The State of Maryland is so situated as to display, in spite of its comparatively small size, a remarkable sequence of geological formations. The most ancient rocks which made up the earth's crust as well as those still in the process of deposition are here found, while between these wide limits there is hardly an important geological epoch which is not represented. It is doubtful whether any other state in the Union contains as full a history of the earth's past.

All of the oldest rocks which are to-day entirely without, or with only slight traces of former life, are referred to the first great division of geological history called *Archean Time.* These oldest rocks are largely crystalline in character, so that there can be but little chance of encountering organic forms, even had they once existed in the strata. Even the least altered deposits, although they have afforded a few scattered remains of archaic forms at certain points, contain nothing more than the merest traces of the organisms of this early time.

When, however, life does once appear in all its variety, it is well-nigh the same in all the older rocks. In the most widely separated localities the same types recur in rocks of the same age, and this furnishes us with the key to the succession of deposits. From the time when the oldest fossil-bearing stratum was deposited until now, the story of life-progress and development is told by the rocks with sufficient clearness to be unmistakable. Local differences of conditions have probably always prevailed, as they do now, but the same types of organisms have always lived at the same time over the entire globe, so their remains serve as sufficient criteria for the correlation of the strata which contain them. The sequence of life-forms once made out gives us, for the whole earth, the means for fixing the order of deposits even when this is most profoundly disarranged by foldings of the strata into mountains, or by other earth movements.

Geologists distinguish three principal divisions in the history of life as read in the record of the rocks. During the earliest of these great time-divisions, archaic forms of life flourished—uncouth fishes, crustaceans, mollusks, and tree-ferns—most of them very unlike those now extant. On this account this is known as the period of most ancient life, or *Paleozoic Time.* To this succeeded a long lapse of ages when enormous reptiles predominated, associated with other types more like those that now inhabit the globe. To this is given the name of middle life, or *Mesozoic Time.* Finally living things began to assume the form and appearance with which we are familiar, so that this last grand time-division, which includes the present, is designated as the period of recent life, or *Cenozoic Time.*

Each of these three grand divisions of geologic time is in its turn separated into shorter subdivisions called *Periods,* characterized by their own peculiar types of life; and the several periods themselves are divided into *Epochs,* which vary more or less in character according to the region where they are developed. For this reason the chronological and stratigraphical divisions require an independent nomenclature, although this duality of geological classification can in most instances be readily adjusted to the contingencies of each district. The stratigraphical divisions are usually designated by local terms, and are known as *Formations.*

In Maryland there are representatives not merely of the great time-divisions, but of each subordinate period, as well as of many of the epochs. This may be best appreciated by referring to the accompanying table of geological formations.

TABLE OF MARYLAND GEOLOGICAL FORMATIONS

SEDIMENTARY ROCKS

AGE	FORMATION	
Cenozoic.		
Quaternary.		
Recent.		
Pleistocene	Talbot	= Columbia Group.
	Wicomico	
	Sunderland	

AGE	FORMATION	
Tertiary.		
Pliocene (?)	Brandywine.	
Miocene	St. Mary's	= Chesapeake Group.
	Choptank	
	Calvert	
Eocene	Nanjemoy	= Pamunkey Group.
	Aquia	
Mesozoic.		
Cretaceous.		
Upper Cretaceous	Rancocas.	
	Monmouth.	
	Matawan.	
	Magothy.	
	Raritan.	
Lower Cretaceous	Patapsco	= Potomac Group.
	Arundel	
	Patuxent	
Triassic	Newark.	
Paleozoic.		
Permian	Dunkard	= Coal Measures.
Carboniferous.		
Pennsylvanian	Monongahela	
	Conemaugh	
	Allegheny	
	Pottsville	
Mississippian	Mauch Chunk.	
	Greenbrier.	
	Pocono.	
Devonian.		
Upper Devonian	Catskill.	
	Jennings.	
	Chemung.	
	Portage.	
	Genesee.	
Middle Devonian	Romney.	
	Hamilton.	
	Marcellus.	
Lower Devonian	Oriskany.	
	Helderberg.	
	Becraft.	
	New Scotland.	
	Coeymans.	
Silurian	Tonoloway.	
	Wills Creek.	
	McKenzie.	
	Clinton.	
	Tuscarora.	

AGE	FORMATION	
Ordovician	Juniata	= Peach Bottom slate. Cardiff quartzite. Octoraro phyllites and schist.
	Martinsburg	
	Chambersburg	
	Stones River	
	Beekmantown	
Cambrian	Conococheague	= Cockeysville marble. Setters quartzite and mica schist. Susquehanna mica schist.
	Elbrook	
	Waynesboro	
	Tomstown	
	Antietam	
	Harpers	
	Weverton	
	Loudon	
Archean.		
Algonkian	Baltimore gneiss (in part).	

IGNEOUS ROCKS

AGE	FORMATION
Mesozoic.	
Triassic	Diabase.
Paleozoic-Archean	Pegmatite.
	Peridotite, pyroxenite and serpentine.
	Basic volcanics-Meta-andesite, meta-basalt.
	Acid volcanics-Meta-rhyolite.
	Granites and monzonites.
	Gabbro, norite, meta-gabbro.
	Baltimore gneiss (in part).

The separateness of the formations is less pronounced in the two divisions of the Coastal Plain, although the northeast-southwest trend of the nearly horizontal beds produces a predominance of the later Cenozoic formations on the Eastern Shore and of the Mesozoic and early Cenozoic deposits on the Western Shore.

In the Piedmont Plateau the twofold character of the province is more marked geologically. On the eastern side of Parrs Ridge the ancient sediments are highly metamorphosed by a development of new textures and minerals due to the recrystallization of the material under great pressure. This division is also marked by the presence of large masses of granular igneous rock which consolidated at great depths beneath the surface of the earth. One the western side of the median ridge the sediments are less metamorphosed and less thoroughly recrystallized, although their original textures have been more or less obliterated. There is also marked lack of deep-seated igneous rocks which are here represented by smaller masses of surface volcanics, both acid and basic, which have been less thoroughly recrystallized than their analogues in the eastern district. Along the western border of this western district, between the Monocacy and the mountains, the early Paleozoics have only slightly changed, the blue limestones of the Frederick Valley resembling the contemporaneous limestones of the Hagerstown Valley farther west. Immediately east of the mountains the earlier rocks are covered with the slightly inclined unmetamorphosed red and gray sandstones and conglomerates of Mesozoic age and intruded by the diabase dikes of the same period.

The threefold division of the Appalachian Region corresponds approximately to the threefold division in the sequence of the Paleozoic strata. The Blue Ridge and Great Valley are made up largely of Cambrian and Ordovician beds, in places so developed or eroded as to expose the associated igneous rocks; the Appalachian Mountains proper are made up of sharply folded Silurian and Devonian strata, each easily recognized by the characteristic life-forms; while the Alleghany Plateau is mainly composed of more gently folded later Devonian and Carboniferous deposits, carrying the valuable coal seams of the Cumberland basin.

Such, in brief, is the distribution of the geological formations in Maryland and their connection with easily recognized types of surface configuration occurring within the state. The sequence is of remarkable completeness and of great interest on account of the many types of topography and soils which the various formations produce.

PHYSIOGRAPHY

The State of Maryland forms a portion of the Atlantic slope which stretches from the crest of the Alleghanies to the sea, and is divided into three more or less sharply defined regions known as the Coastal Plain, the Piedmont Plateau, and the Appalachian Region. These three districts follow the Atlantic border of the United States in three belts of varying width from New England southward to the Gulf of Mexico. Maryland is, therefore, closely related in its physiographic features to the states which lie to the north and south of it, while its central location on the Atlantic border renders the Maryland section perhaps the most characteristic in this broad tract. In crossing the three districts from the ocean border the country rises at first gradually and then more rapidly until it culminates in the highlands of the western portion of the state.

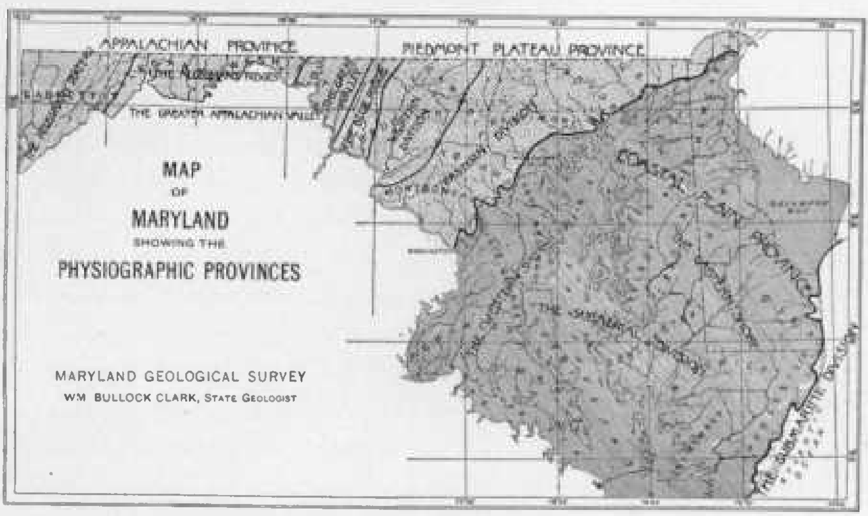

FIG. 14.—MAP SHOWING THE PHYSIOGRAPHIC PROVINCES.

The physical features of a country to no inconsiderable degree determine the pursuits of its inhabitants, and these indirectly affect their social, political, and financial welfare. The residents of mountainous districts have their peculiar occupations, while those of the lowlands find their employment in other ways. In regions bordering the sea or inland bodies of water, still other means of livelihood are sought by the people. The character of the soil and its adaptability to particular crops become also important factors, while the underlying rocks, not only by their influence upon the conditions of life already described, but also by their inherent wealth in mineral resources, still further influence the well-being of the community. It becomes necessary, therefore, to know something of the physical features of a country, or a state, if one would understand its past history or indicate the lines of its future prosperity.

COASTAL PLAIN

The Coastal Plain is the name applied to the low and partially submerged surface of varying width extending from Cape Cod southward through Florida and confined between the Piedmont Plateau on the west and the margin of the continental shelf on the east. The line of demarkation between the Coastal Plain and the Piedmont Plateau is sinuous and ill-defined, for the one passes over into the other oftentimes with insensible topographic gradations, although the origin of the two districts is quite different. A convenient, although somewhat arbitrary, boundary between the two regions is furnished in Maryland by the Baltimore and Ohio Railroad in its extension to Washington. The eastern limit of the Coastal Plain is at the edge of the continental shelf. In the vicinity of Maryland this is located about 100 miles offshore at a depth of 100 fathoms beneath the surface of the Atlantic Ocean. It is in reality the submerged border of the North American continent which extends seaward with a gently sloping surface to the 100-fathom line. At this point there is a rapid descent to a depth of 3000 fathoms where the continental rise gives place to the oceanic abyss.

THE DIVISIONS OF THE COASTAL PLAIN

The Coastal Plain, therefore, falls naturally into two divisions, a submerged or *submarine division* and an emerged or *subaerial division.* The seashore is the boundary line which separates them. This line of demarkation, although apparently fixed, is in reality very changeable, for during the geologic ages which are past it has migrated back and forth across the Coastal Plain, at one time occupying a position well over on the Piedmont Plateau, and at another far out to sea. At the present time there is reason to believe that the sea is encroaching on the land by the slow subsidence of the latter, but a few generations of men is too short a period in which to measure this change.

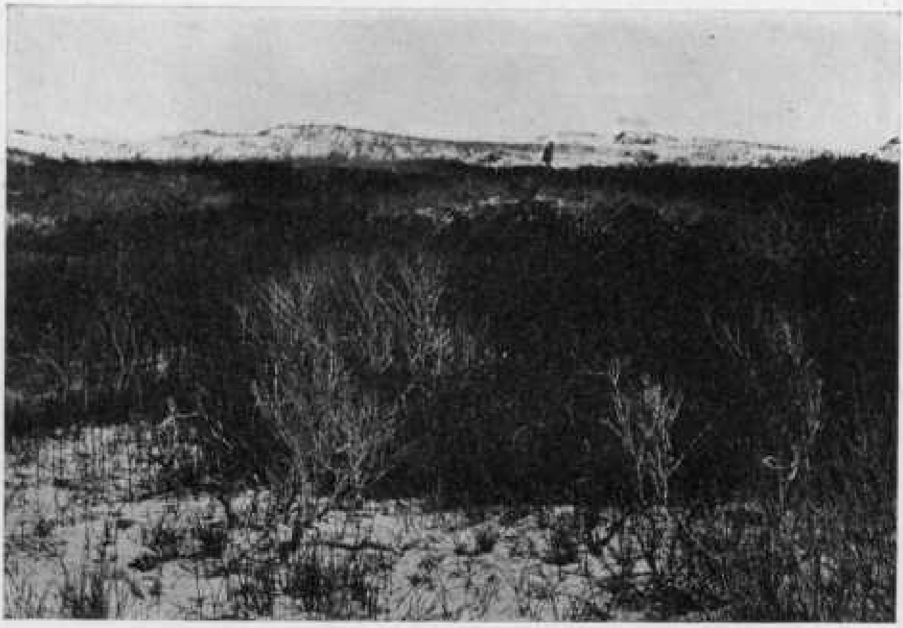

FIG. 15.—SAND DUNES NEAR OCEAN CITY, WORCESTER COUNTY.

FIG. 16.—VIEW OF A SAND SPIT, MOUTH OF FAIRLEE CREEK, KENT COUNTY.

The subaerial division is itself separable in Maryland into the Eastern Shore and the Western Shore. These terms, although first introduced to designate the land masses on either side of Chesapeake Bay, are in reality expressive of a fundamental contrast in the topography of the Coastal Plain. This difference gives rise to an Eastern Shore and a Western Shore type of topography. Chesapeake Bay and Elk River separate the

FIG. 17.—VIEW SHOWING THE NEARLY-HORIZONTAL MIOCENE FORMATIONS OF THE CALVERT CLIFFS, CALVERT COUNTY.

two. But fragments of the Eastern Shore type are found along the margin of the Western Shore at intervals as far south as Herring Bay, and again from Point Lookout northwestward along the margin of the Potomac River. On the other hand an outlier of the Western Shore type of topography is found at Grays Hill in Cecil County at the northern margin of the Eastern Shore. The Eastern Shore type of topography consists of flat, low, and almost featureless plains, while the Western Shore is a rolling upland, attaining four times the elevation of the former and resembling the topography of the Piedmont Plateau much more than that of the typical Eastern Shore. It will be seen later that these two topographic types, which at once strike the eye of the physiographer as being distinctive features, are in reality not as simple as they first appear, but are built up of a complex system of terraces dissected by drainage lines.

The Coastal Plain of Maryland, with which most of the State of Delaware is naturally included, is separated from that of New Jersey by the Delaware River and Delaware Bay and from that of Virginia by the Potomac River; but these drainageways afford no barriers to the Coastal Plain topography, for the same types with their systems of terraces exist as well in New Jersey and Virginia as in Maryland.

The Chesapeake Bay, which runs the length of the Coastal Plain, drains both shores. From the Western Shore it receives a number of large tributaries among which may be mentioned the Northeast, Susquehanna, Bush, Gunpowder, Patapsco, Magothy, Severn, South, Patuxent, and Potomac rivers. On the Eastern Shore its principal tributaries consist of Bohemia Creek, Sassafras, Chester, Choptank, Nanticoke, Wicomico, and Pocomoke rivers. These streams, which are in the process of developing a dendritic type of drainage, have cut far deeper channels on the Western than on the Eastern Shore. If attention is now turned to the character of the shore line, it will be seen that along Chesapeake Bay it is extremely broken and sinuous. A straight shore line is the exception, and in only one place, from Herring Bay southward to Drum Point, does it become a prominent feature. These two classes of shore correspond to two types of coast. Where the shore is sinuous and broken, it is found that the coast is low or marshy, but where the shore line is straight, as from Herring Bay southward to Drum Point, the coast is high and rugged, as in the famous Calvert Cliffs which rise to a height of 100 feet or more above the Bay. The shore of the Atlantic Ocean is composed of a long line of barrier beaches which have been thrown up by the waves and enclose behind them lagoons flushed by streams which drain the seaward slope of the Eastern Shore. Of these Chincoteague Bay is the most important.

The Coastal Plain contains five broad terraces designated from the oldest to the youngest by the names of Brandywine, Sunderland, Wicomico, Talbot, and Recent, after the geological formations of the same name. The first four and part of the fifth fall within the subaerial division, and

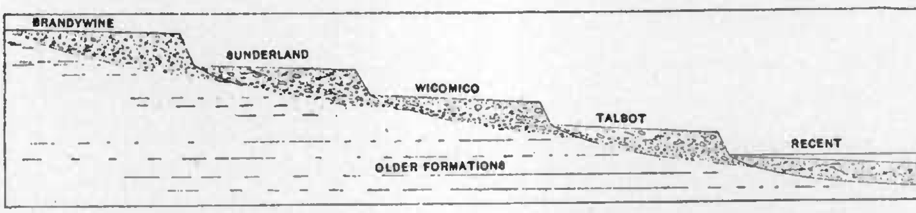

FIG. 18.—DIAGRAM SHOWING RELATIVE POSITION OF COASTAL PLAIN TERRACES.

the last one principally within the submarine division of the Coastal Plain. All five of the subaerial terraces are found on the Western Shore, while only three of them occur on the Eastern Shore. These terraces wrap about each other in concentric arrangement and are developed one above the other in order of their age, the oldest standing topographically the highest.

Stream Valleys.

Four generations of stream valleys can be discerned in the Coastal Plain of Maryland. Three of these no longer contain the streams which cut them. They have been referred to in the discussion as re-entrants penetrating the various terraces. The first is found developed

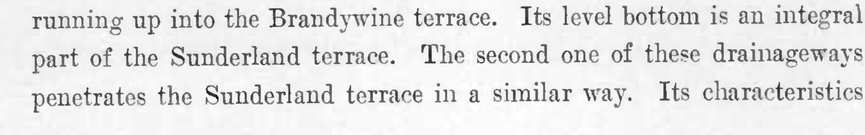

FIG. 19.—GEOLOGICAL SECTION PORT DEPOSIT TO SASSAFRAS RIVER.

as a flat-bottomed drainageway of greater or less width and extent, running up into the Brandywine terrace. Its level bottom is an integral part of the Sunderland terrace. The second one of these drainageways penetrates the Sunderland terrace in a similar way. Its characteristics are analogous to those entering the Brandywine terrace and its flat bottom forms an integral part of the Wicomico terrace. The third of these drainageways cuts a re-entrant within the body of the Wicomico terrace and its level floor forms an integral part of the Talbot terrace. The fourth and last of these drainageways is now in the process of formation. It is the system of valleys which are being cut by the Recent streams. Toward their headwaters these valleys are narrow and V-shaped, and if traced to their sources are often found to start from intermittent springs surrounded by a steep-walled amphitheater from 5 to 10 feet in height. Toward their lower courses these valleys are broad and flat and are frequently filled with fresh or brackish-water marshes. In the upper portions of their courses the valleys are being eroded. In the lower portions they are being filled. A glance at the map will serve to confirm the opinion which has been held for a long time, namely, that the rivers of the Coastal Plain of Maryland have been drowned along their lower courses, or, in other words, have been transformed into estuaries by the subsidence of the region. The filling of these valleys has taken place toward the heads of these estuaries. The headwaters of these Recent valleys are being extended inland toward the divides with greater or less rapidity.

Many of the tributary streams occupy the re-entrant valleys described above. The more energetic have succeeded in carrying out all of the ancient floors which formerly covered these valleys and formed a portion of the various terraces. Others have left mere remnants of these valley accumulations along the margins, while the less active streams have left the re-entrant valleys practically unmodified. In Southern Maryland the streams which drain into Chesapeake Bay from the eastern slope of Calvert County, as well as those which drain into the Patuxent River from St. Mary's and Prince George's counties, have shorter courses than those which drain into the Patuxent from Calvert County or into the Potomac from Prince George's, Charles, and St. Mary's counties. A similar contrast is obvious between the streams which enter the Atlantic Ocean from the Eastern Shore and those which enter Chesapeake Bay from the same region.

The cause of this shortening of streams on the northeast side of these divides is probably due not only to a tilting toward the southeast but also in a great measure, particularly along the Bay shore, to rapid wave erosion. The streams draining the eastern slope of Calvert County and the northeastern slope of St. Mary's and Prince George's counties were at one time longer, but the recession of the shore line has shortened their courses by the cutting away of their lower valleys. This is very clearly shown along the Calvert Cliffs where the waves have advanced so rapidly on the land that the former heads of stream valleys are now left as unoccupied depressions along the upper edge of the cliffs, while other streams cascade from the top of the precipice to the shore beneath, and still others more active have been able to sink their valleys to the water's edge by a very sharp descent. Other investigations have suggested that earth rotation may have had some influence in bringing the streams mentioned above into their present position, and although the streams are short, it is possible that they have been somewhat affected by this influence.

ECONOMIC PHYSIOGRAPHY OF THE COASTAL PLAIN

SOILS.—The various geological stages through which the Coastal Plain has passed have had considerable influence upon the soils, and through them upon the crops of the province. The early strata, those of Cretaceous and Eocene age, which are best developed in parallel belts along the northwestern boundary of the Coastal Plain, are sandy loams which yield good returns of fruit and garden truck. In this belt the very prosperous peach—and other fruit—farms have been located, and large quantities of fine peaches are still shipped from the northern counties of the Eastern Shore. The same belt extends northeastward into Delaware and New Jersey, where similar crops are raised. These strata carry with them a natural storehouse of valuable fertilizer in the form of greensand or glauconitic shell marl. In the early days of Eastern Shore farming this marl was much used as a fertilizer, particularly in Cecil, Kent, and Queen Anne's counties.

In the central and southern counties the clayey loams which come from the Miocene or Chesapeake deposits afford extensive areas of good wheat, grass, and tobacco lands, which formerly were of great importance to the

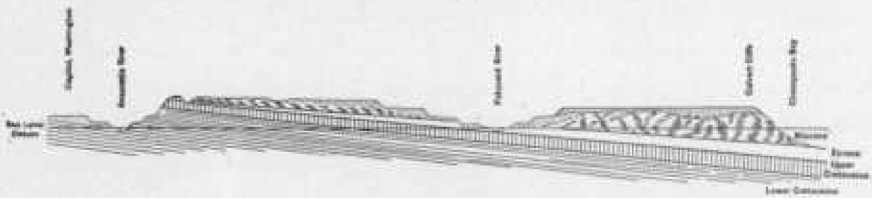

FIG. 20.—GEOLOGICAL SECTION WASHINGTON TO CALVERT CLIFFS.

state. Since the rapid development of the wheat fields of the West, however, the yield of these lands has become comparatively insignificant, so that at present the farmers are not able to make wheat crops pay even by the aid of expensive fertilizers. Among the best-paying crops of the Coastal Plain are the products of the lighter sandy loams of the Pliocene and Pleistocene deposits. These soils cover the whole Eastern Shore south of the Choptank and are also of importance on the more dissected Western Slope. Large and early crops of berries and melons are annually shipped from the cultivated areas of these soils, and the canning of tomatoes, corn, and other products constitutes one of the important industries of the province.

WATERWAYS.—The post-Brandywine and the post-Pleistocene submergences of the Coastal Plain have been of immense benefit to the inhabitants of Maryland. As a result of the drowning of the Chesapeake

FIG. 21.—GEOLOGICAL SECTION CAMBRIDGE TO ATLANTIC OCEAN.

River, ocean-going vessels are admitted as far inland as Georgetown, D. C., Baltimore, Havre de Grace, and Chesapeake City. Valuable harbors also are provided, so that much commerce has been attracted to Maryland shores. Besides interstate and international trade which is thus favored by the configuration of Chesapeake Bay with its deep exit to the high seas, trade within the state is greatly benefited by these waterways. That geologically recent submergence, whereby the river valleys carved in post-Pleistocene times were drowned for more than half their length, gave to the inhabitants of the Coastal Plain the most favorable facilities for easy and cheap transportation of their crops. The estuaries then formed are the entrances to tidal streams that penetrate into the very heart of the rich lands. They are generally of sufficient depth to admit the light-draught steamers plying on the waters of Chesapeake Bay, and the numerous wharves which are encountered on ascending any one of the navigable creeks testify to the readiness with which the people have availed themselves of their natural opportunities. In the proper seasons these wharves may be seen piled high with the crates of fruit and other products which are being sent to Baltimore for distribution among the neighboring states.

Besides thus affording easy paths of intercourse with other important sections of the state, the estuaries yield peculiar and characteristic products of their own. The same streams which, during the summer, are the arteries and highways of a commerce based on the products of the soil, become in winter the fields of one of Maryland's greatest industries—the oyster fisheries. Great quantities of these oysters are annually sent to Baltimore, and their gathering has given rise to a race of hardy fishermen and expert sailors only excelled by the cod fishers who sail every year to the Great Banks of Newfoundland. The oyster-canning industry, whereby the interior of the continent is supplied with canned oysters, has also arisen as an indirect result of the post-Pleistocene submergence. The diamond-back terrapin, the duck and other wild fowl of the littoral marshes also deserve a place among the list of resources which the geographic history of the province has bestowed upon this state.

RAILROADS.—While the many waterways which intersect the Coastal Plain have given boat traffic the best start among transportation facilities, railroads have been built to a number of points, thus connecting them more directly with the vigor and energy of the great commercial centers of

Baltimore, Philadelphia, and New York. Generally the railroad, seeking as it does that course which requires the least modifications from the natural topography in order to make an easy grade, has to pursue a more or less tortuous route. On the Eastern Shore the low and almost insignificant character of the divides and the shallow stream valleys permit the roads to run in the very direct routes from one objective point to the next. A glance at the map of the state shows these routes and the indifference which they display towards the divides. It is also noteworthy that, although touching at several water-side towns, the railroads are confined on the whole to those wider portions of the small peninsulas where the hauling distance to the boat lines becomes something of a factor in the cost of transportation. By reaching these remoter points they are thus able to maintain a foothold in spite of the lower rates offered by the boat lines. On the peninsula of Southern Maryland the few railroads are compelled to hold pretty closely to the divides, as a short distance on either side the country becomes so cut up that it would be wholly impracticable to build a line.

EFFECT OF TOPOGRAPHY UPON THE INHABITANTS.—When the early settlers came to Maryland they found the tracts of the Coastal Plain occupied by peaceful tribes of Indians who lived by fishing in the deeply-indented rivers and hunting through the pine and hardwood forests which covered the interstream areas. The settlers themselves took to farming, encouraged by the rich soils, and also obtained plenty of fresh fish and oysters from the neighboring waters. Soon large and prosperous plantations grew up, which afforded by their products good incomes to their owners. The earlier inhabitants were thus mainly agriculturists. As the value of the oyster beds increased, and the demands for the oyster grew, the race of oystermen sprang up. These men naturally settled along the shores near their work. At present the two classes, which originally must have been somewhat mixed, can be clearly distinguished, the regular farmer keeping to the higher interfluviatile areas, while along the shores and in the vicinity of the large towns are the houses of the oystermen. On the Western Shore the dissection of the interior lands near the Bay has handicapped the farmer very decidedly, while the deep rivers and estuaries give good opportunity for the fishermen to ply their trade.

Thus the geological and physical features of the Coastal Plain, which are the direct results of its geological history, are seen to have almost wholly determined the pursuits and the habits of its settlers and inhabitants.

THE PIEDMONT PLATEAU

The Piedmont Plateau, which is the name applied to the hill country that borders the Coastal Plain on the west and extends thence to the foot of the Appalachian Mountains, is a low plateau of complex origin whose rolling surface is traversed by highlands and cut by valleys that

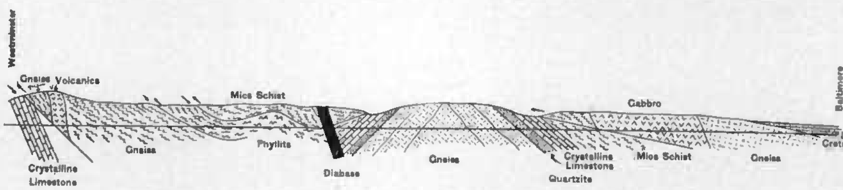

FIG. 22.—GEOLOGICAL SECTION WESTMINSTER TO BALTIMORE.

at times trench the uplands as deep gorges. From the fact that the physiographic features of the Appalachian Region which lies to the westward are contemporaneous in origin with those of the Piedmont Plateau, it is reasonable to suppose that no sharp line can be drawn between the two districts. The boundary can in fact with almost equal propriety be placed at the foot of North Mountain as at the foot of the Catoctin Mountain, although, all things considered, it has seemed best in Maryland to divide the two regions at the point where the first pronounced mountain range is reached.

To the northward the Catoctin and Blue Ridge highlands with their South Mountain extension in southern Pennsylvania gradually decline to the level of the lower plateau, and the surface of the Piedmont hill country with higher lands of inconspicuous elevation extends to the foot of the Alleghany ranges. To the southward, on the other hand, the Great Valley is less pronounced and the highlands of the Blue Ridge become a conspicuous part of the great Appalachian Region. In the south also the name Piedmont has become so widely intrenched in usage for the district lying to the eastward of the Blue Ridge mountains that it has seemed best to follow the same usage in Maryland.

THE DIVISIONS OF THE PIEDMONT PLATEAU

The Piedmont Plateau is divided into two regions called, respectively, the eastern division and the western division, which are separated by Parrs Ridge that gradually rises to an elevation of several hundred feet above the general surface of the Piedmont Plateau. This highland has an average elevation of 800 to 900 feet, rising to the northward in Carroll County and in the nearby regions of Pennsylvania to 1100 feet, but gradually declining southward across Howard and Montgomery counties

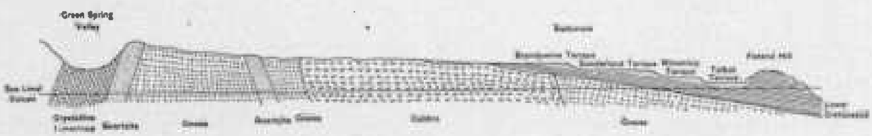

FIG. 23.—GEOLOGICAL SECTION GREEN SPRING VALLEY TO FEDERAL HILL.

until it reaches the lowland elevations of the Piedmont Plateau toward the Potomac Valley.

Parrs Ridge forms the divide between the streams flowing directly into the Chesapeake Bay and those flowing into the Potomac River. Among the more important streams entering the Chesapeake from the eastern division of the Piedmont are the Susquehanna, Bush, Gunpowder, Patapsco, and Patuxent rivers. The western division is largely drained by the Monocacy River and its tributaries into the Potomac River.

THE PIEDMONT PENEPLAINS

The Piedmont Plateau is made up of remnants of old plains cut out of the high plateau that formerly stretched across the district from the Appalachian Region and passed beneath tide just beyond the edge of the Coastal Plain, where it now forms the floor on which the Coastal Plain sediments rest. The eastern division is much less deeply eroded than the western, with the result that more frequently remnants of the oldest plains are found in the former than in the latter district. On the other hand, the later plains, but poorly developed along the eastern margin of the Piedmont, become gradually more pronounced westward, the youngest plains being well defined in the drainage basins of the Monocacy and along the Potomac. These old plains, now represented only by remnants of their earlier surfaces, are technically known as peneplains by physiographers. A *peneplain* is the name given to an area that has been reduced by erosion to approximately a level surface but little above the sea level of the period of its formation, but which may still have unreduced knobs or *monadnocks* in the interstream areas. Even where these monadnocks have largely wasted away the valley surfaces would naturally be somewhat lower than the divides and would rise slowly to the sides of the valleys as well as from the lower courses of all the streams to their heads. It is important to keep these facts in mind when endeavoring to reconstruct the ancient peneplain surface from the remnants of the old plains that are still left in the Piedmont district. It so happens that after the formation of the oldest peneplain now represented, later erosion has only resulted in the partial development of new plains, highlands, sometimes of wide extent, still remaining as monadnocks in the interstream areas.

The several plains recognized in the Piedmont district are known as the Schooley, the Weverton, the Harrisburg, and the Somerville peneplains, all of which, like the district to which they belong, have been traced far beyond the confines of the state.

STREAM VALLEYS

The present streams are now found in valleys of variable depth that trench the peneplain surfaces. In the eastern division of the Piedmont, where the Harrisburg and Somerville plains are at best but poorly developed, the streams appear for the most part as trenches in the Weverton plain. In the western division, on the other hand, they are found trenching the later peneplains and in the lower Monocacy and Potomac valleys the relations of the streams to the Somerville peneplain are clearly defined.

FIG. 24.—VIEW OF THE GORGE OF THE SUSQUEHANNA RIVER BETWEEN HARFORD AND CECIL COUNTIES.

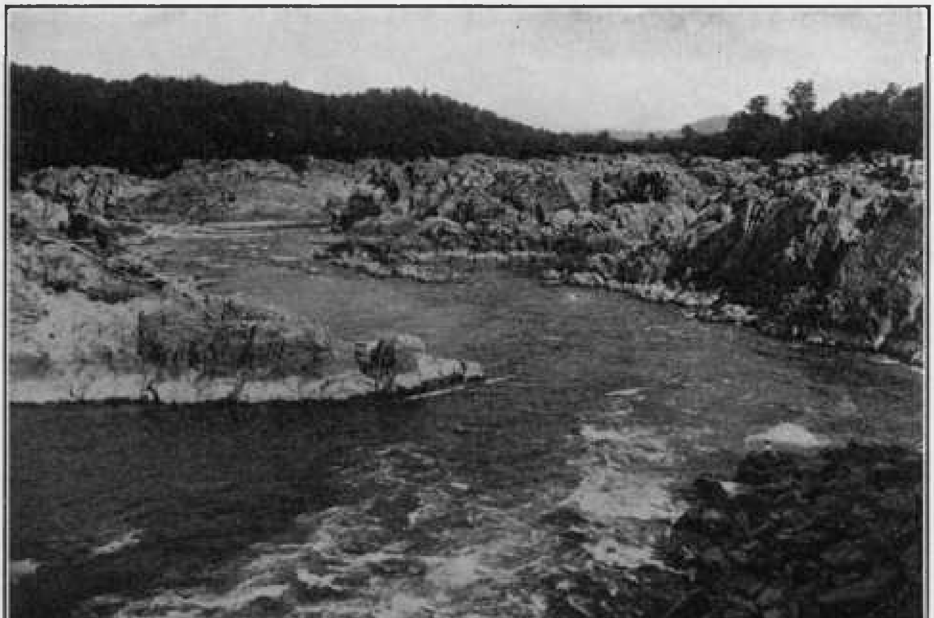

FIG. 25.—THE GREAT FALLS OF THE POTOMAC.

Some of these streams are more or less adjusted to the underlying rocks, as in the case of Jones Falls to the north of Baltimore; but a large portion of them are discordant, that is, seemingly unaffected by the rocks over which they flow. In the eastern division of the Piedmont the streams flow down the eastern slope of Parrs Ridge in approximately parallel courses to Chesapeake Bay, and in many instances the streams cut across the rocks with little regard to their physical characters. In the case of the Monocacy and its tributaries, we find that there has been little adjustment of the channels, the streams taking their courses across limestones, phyllites, and shales indifferently.

In general, both the main streams and their tributaries show drainage patterns similar to those of the Coastal Plain, and it is not impossible that the stream courses may have been in many instances superimposed on the rocks at no distant time in the past through a mantle of Coastal Plain sediments. Remnants of such a cover have been found far removed from the main body of the Coastal Plain, even as far westward as the Great Valley.

ECONOMIC PHYSIOGRAPHY OF THE PIEDMONT PLATEAU

The physiography of the Piedmont Plateau has materially influenced the settlement and occupation of those who chose this region for their homes.

SOILS.—The early settlers, having to raise all their food, naturally sought out the best locations for their broad farms and beautiful estates. On their arrival they found two general classes of farm lands.

The first class embraced the somewhat rolling but extensive tracts of the interstream upland areas. The soils were found to be good producers of corn, wheat, and grass, and the surface not so rough as to make its cultivation forbiddingly difficult. The long, continuous tracts of these interstream areas also made travelling easy, as long as one stayed on the upland, while the stream valleys were shut in and narrow. For these reasons, probably, the various stately manor lands were laid out where the upland expanses were greatest; and the mansions, surrounded by fine groves and broad fields, were located on the most promising of the small plateaus. In the earlier days the crops from these broad, upland farms were among the richest in the state and rivalled those of the Eastern Shore.

The second class of farm lands comprised the alluvial loams and sandy flood-plains along the streams. These lands are generally restricted in area, since the valley bottoms are usually narrow and limited in extent. Where streams have opened out lowlands on the marble and limestone areas, rich lands of considerable extent offer most favorable farm sites. The lands along the streams have the advantage of running water and good springs from the hill sides. They are not as well drained, however, as are the lands of the upland, and they are subjected to damaging floods. Comparatively few settlers chose the valley lands at first.

A marked exception to the above rule is found in the Monocacy Valley, where the farm lands are all located on the several benches and terraces leading down to the river or on the bottom-lands belonging to it. So little of the old upland is left that the conditions of occupation are quite different from those farther east.

STREAMS.—While the farming class were searching for good soils and favorable homestead sites, the manufacturers and millwrights were seeking favorable locations for mills, dams, and flumes. The streams of the Piedmont Plateau yielded a great abundance of waterpower, and soon mills dotted the valleys. Each section early came to be supplied with its grist mill, and in due time cotton mills were also built. These industries in time became of great importance. The flour mills are now generally abandoned, however, only a few of the most favorably situated ones having been able to maintain themselves against western competition. The cotton mills have held out much better, because it has not been until recent years that southern cotton has been spun and woven at home.

The waterpower which the Piedmont streams furnish is not the only wealth which they bring to the state. The land movements during late geological time have caused the streams to trench their courses considerably, and in so doing have rendered accessible the building stones which were previously hidden beneath the surface. The granites now extensively quarried at Port Deposit would not be so easily obtained and shipped had not the Susquehanna River cut its deep gorge. The locations of the serpentine quarries of Harford County are determined to a greater or lesser extent by the streams which intersect the rock. A formerly important soapstone quarry on Winter Run in the southeast corner of Carroll County was made possible only through the fact that the stream had there cut a deep gorge in a long band of steatitic serpentine. Along the Patapsco and Jones Falls many quarries of granite and gneiss have been located because the stream gorges offered favorable openings or transportation facilities.

It is interesting, by way of contrast, to compare the different conditions under which the Cardiff-Delta slates are quarried. As no stream cuts across Slate Ridge in the vicinity of those two settlements, the quarries have been located along the summit and are worked entirely from above. This is the most difficult way to attack the slates, and as there is no natural drainage for the quarries the water, which is constantly accumulating in the pits, gradually increases the cost of working.

LINES OF COMMUNICATION.—The valleys and ridges of the Piedmont Plateau furnish excellent examples of the way in which topographic features influence commerce and human activities.

One of the first acts of the early settlers of the Piedmont region was to lay out highways. These early roads were not always located advantageously with reference to the topography, but both the divides and the valleys were extensively employed. When the better turnpikes came to be built, however, they were almost without exception built along the divides. The reason for this was that fills and bridges were thereby avoided, and better drained roadbeds, not subject to floods, were obtained. Radiating in all directions from Baltimore, these old turnpikes may be followed into almost every corner of the state, and their location on the more elevated ridges enables the traveller to obtain beautiful views of the richly wooded, rolling uplands and tree-filled valleys.

The canals were built to overcome the obstructions to navigation which the "fall line" rapids occasioned, even in the larger streams, such as the Susquehanna and the Potomac.

One of the early canals was the Susquehanna Canal, built along the east shore of the Susquehanna River in order to transport merchandise from the limits of navigation at Port Deposit northward along that stream to the Pennsylvania line. This canal has now wholly fallen into disuse.

Another early and successful canal was constructed around the Great Falls by the Potomac Company. To obtain the necessary water and the most favorable grades this channel, now part of the Chesapeake and Ohio Canal, was laid out along the north bank of the Potomac, taking advantage of the natural trenches cut by that river. This canal was long the cheapest and best means of transportation between the coal and wheat lands of Allegany County and tidewater.

Since the era of railway construction began, every advantage has been taken of the topographic features of the country. The Baltimore and Ohio Railroad crossing the Piedmont Plateau from tidewater found an easy exit from the depression about Baltimore and a gentle, though crooked, grade to the crest of the divide by following up the South Branch of the Patapsco River to Mount Airy, and then along the Monocacy drainage to Point of Rocks.

The Western Maryland Railroad, striking north and then westward, could not utilize the lower course of the North Branch of the Patapsco on account of its narrow valley and very crooked channel. By following the broad, well-graded valley of Gwynns Falls as far as Emory Grove, however, an easy descent was found into the more favorable upper course of the North Branch of the Patapsco and thence an easy grade led to the sag in the divide at Westminster. A branch of the Western Maryland road running north from Emory Grove follows the Gunpowder-Monocacy divide as far as Manchester.

The Northern Central Railway enters the state from the north by following down the main branch of the Big Gunpowder, and does not leave this stream until at Ashland the broad marble lowlands about

Cockeysville open out and offer an easy crossing to the valley and gorge of Jones Falls, which it follows down to Baltimore from Lake Roland.

A striking example is afforded by the Maryland and Pennsylvania Railroad, which takes advantage of the gorge of Deer Creek to penetrate Rocky Ridge. Were it not for the aid thus rendered by the creek the engineers of the road would have been obliged to tunnel through the obstruction or else have gone a number of miles out of a direct course. Deer Creek would not have been located across the quartzite and so could not have cut the gorge had it not accidentally taken this position while flowing on the Coastal Plain covering, from which it was doubtless superimposed upon the quartzite. Besides the railway a county road also utilizes this gap and there are reasons to suppose that before the advent of the white man the Indians also used it as a thoroughfare.

In conclusion, it appears that the topography has very materially controlled the settlement and economic development of the Piedmont Plateau by determining the location of the farms, the mills, and the railroads.

THE APPALACHIAN REGION

The Appalachian Region borders the Piedmont Plateau upon the west and extends to the western limits of the state. It consists of a series of parallel mountain ranges with deep valleys which are cut nearly at right angles throughout much of the distance by the Potomac River. Many of the ranges exceed 2000 feet in elevation, while some reach 3000 and more in the western portion of the district. The streams have been to a large extent adjusted to the rocks over which they flow, although this is less evident in cases of the master stream, the Potomac River, than of the tributaries.

THE DIVISIONS OF THE APPALACHIAN REGION

The Appalachian Region is divided into three districts, known as the Blue Ridge district, the Greater Appalachian Valley, composed of the Great Valley and the Alleghany Ridges, and the Alleghany Plateau. Each district presents certain marked physiographic characteristics that separate it from the adjacent areas on the east and west.

The Blue Ridge district consists of the Catoctin and Blue Ridge mountains uniting to form the greater highland of South Mountain in the southern part of Pennsylvania. Beginning with an elevation of 2000 feet at the Maryland line, this highland gradually declines southward to the Potomac River where it has an elevation of less than 1500 feet at Maryland Heights overlooking the Potomac Valley. The eastern border of this district is formed by the Catoctin Mountain, which extends as an almost unbroken highland from the Pennsylvania line to the Potomac River at Point of Rocks. Succeeding the Catoctin upon the west is the Middletown Valley, which drains southward into the Potomac River through the Catoctin Creek. Along the western side of this district is the Blue Ridge Mountain proper. It extends as a sharply defined range

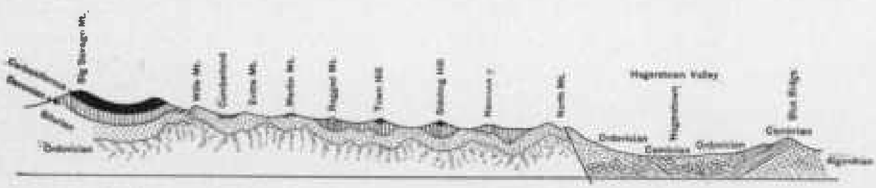

FIG. 26.—GEOLOGICAL SECTION BIG SAVAGE MOUNTAIN TO THE BLUE RIDGE.

from the South Mountain of Pennsylvania to the Potomac River, which it reaches at Weverton. Its crests form the boundary line between Frederick and Washington counties. The Blue Ridge in Virginia is not the direct continuation of the mountains so named in Maryland, but of a smaller range, the Elk Ridge, which adjoins the Blue Ridge on the west and reaches the Potomac River at Maryland Heights opposite Harpers Ferry.

The Greater Appalachian Valley embraces all of the country lying between the Blue Ridge on the east and Dans Mountain or Alleghany Front on the west. It admits of a twofold division into the Great Valley on the east and the zone of Alleghany ridges on the west. The Great Valley, known as the Hagerstown Valley in Maryland, the Cumberland Valley in Pennsylvania, and the Shenandoah Valley in Virginia, is a broad lowland, the floor of which averages from 500 to 600 feet in elevation, gradually increasing in height from the Potomac Valley toward the

Pennsylvania line. It extends from the Blue Ridge on the east to North Mountain on the west. It is drained by the Antietam River on the eastern side and the Conococheague River on the western side, both of these streams having their sources in Pennsylvania and flowing southward to the Potomac River. The Alleghany ridges which extend from North Mountain to the Alleghany Front consist of a series of parallel ridges of

FIG. 27.—VIEW OF THE VALLEY OF MONROE RUN ERODED IN THE SCHOOLEY PENEPLAIN OF THE ALLEGHANY PLATEAU.

varying elevations that extend from north to south across the state. Among the more important are North Mountain, Tonoloway Ridge, Sideling Hill, Town Hill, Green Mountain, Warrior Mountain, Collier Mountain, Martin Mountain, Nicholas Mountain, Shriver Ridge, and Wills Mountain. Between them are valleys that are drained mainly to the southward into the Potomac River. They vary in character, some being narrow and deeply trenched, while in others broad, level-topped areas appear, the origin of which will be shortly discussed.

The Alleghany Plateau forms the western part of the Appalachian Region and extends from the Alleghany Front to the western limits of the state. This highland, like the districts which lie to the eastward, is continued far beyond the confines of the state. To the southward it can

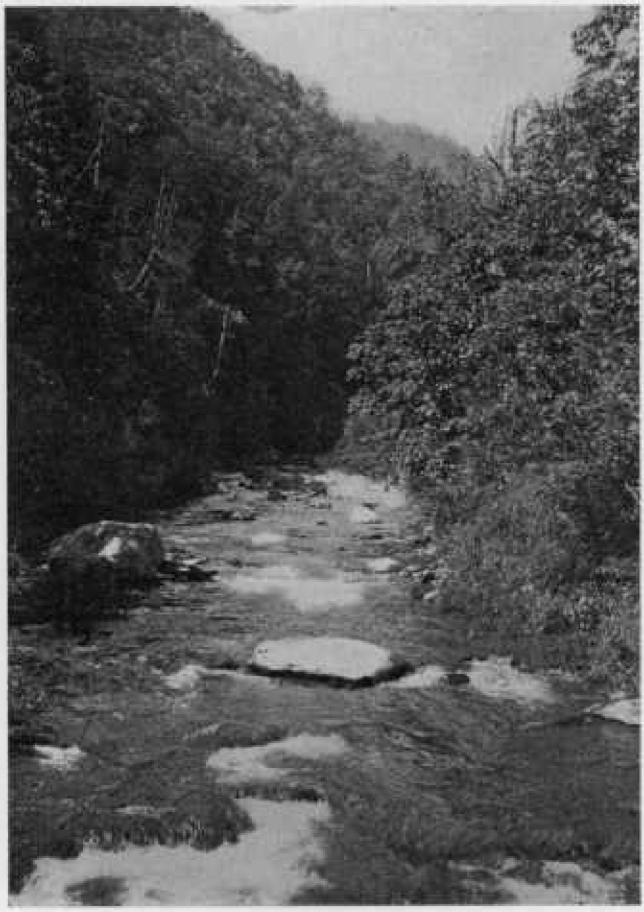

FIG. 28.—CRABTREE CREEK.

be traced through Virginia, Kentucky, and Tennessee to northern Alabama, where it is known under the name of the Cumberland Plateau. In Maryland this district consists of a broad highland across which ranges of mountains extend from northeast to southwest, reaching elevations of

3000 feet and more at several points in Big Savage, Great Backbone, and Negro mountains. The leading ranges of the district are Dans Mountain, Big Savage Mountain, Great Backbone Mountain, Negro Mountain, Winding Ridge, and Laurel Hill. The streams flow in part to the southward or eastward, as the case may be, into the Potomac River, and in part to the northward through the Youghiogheny Valley into the Monongahela River whence the waters reach the sea through the Ohio and the Mississippi. The latter district comprises much the larger part of Garrett County.

THE APPALACHIAN PENEPLAINS

The Appalachian Region, like the Piedmont Plateau, is composed of remnants of old plains which have been cut out from the high plateau, now represented by the level-topped crests of the highest ranges. The several peneplains succeed each other at different elevations, being represented by the low crests or broad, level-topped valleys that are here and there preserved in the highland region.

The peneplains found represented in the Appalachian Region are the continuations westward of the Piedmont peneplains and like them have here and there above the ancient surfaces unreduced knobs or monadnocks in what were probably interstream areas. As in the Piedmont district, the peneplain surfaces rise gradually up the old streams and toward the valley sides.

The Appalachian physiographic history is complicated by the fact that the drainage of the area has evidently changed during the period of peneplain development, the Potomac drainage having gradually encroached upon that of the Youghiogheny to the westward. It is probable, therefore, that the peneplains to the west of the Alleghany Front, as well, perhaps, as those a short distance to the east of the same, cannot be readily correlated with those farther eastward. On account of the higher gradient of the Potomac and its head-water tributaries, compared with the Youghiogheny and the drainage basin of which it is a part, an encroachment of the former would, in accordance with known physiographic laws, naturally result. In this way certain physiographic incongruities and even biological peculiarities in the distribution of the faunas of the present day may be explained.

The peneplains recognized in the Appalachian district are known as the Schooley, Weverton, Harrisburg, and Somerville plains, all of which are found in the Piedmont district to the east.

STREAM VALLEYS

The present valleys have trenched the peneplain surfaces to greater or less depth. Along the Potomac the trenching was mainly post-Somerville,

FIG. 29.—VIEW OF SWALLOW FALLS, YOUGHIOGHENY VALLEY, GARRETT COUNTY.

but up the tributaries, where the Somerville peneplain gradually disappears, the trenching was in part produced at the time of the formation of the Somerville peneplain itself and in some instances represents an even longer period of cutting.

The streams are to a considerable extent adjusted to the present structure, producing what has been described as a trellis or grape-vine system. At times wind-gaps are found cutting the crests of the mountains and representing the location of the streams across the hard rocks before they had been tapped by the tributary of some larger stream flowing along the softer beds, generally in a direction at right angles to the original system.

FIG. 30.—VIEW SHOWING FOLDED SILURIAN ROCKS OF THE APPALACHIAN REGION, WASHINGTON COUNTY.

At the point where the streams cross the hard sandstone ridges deep gorges result, but in the softer beds the channels are frequently wider, with low banks on either side.

ECONOMIC PHYSIOGRAPHY OF THE APPALACHIAN REGION

LINES OF COMMUNICATION.—The obstacles offered by the successive parallel ridges of the Appalachian province delayed the westward movement of the population in colonial days and restricted the east and west lines of travel to the valleys of the Potomac, the Susquehanna, and the James. The earliest inhabitants found these natural highways already selected as the lines of communication between the distant parts of the great Indian Confederacy, and accepted the experience of the aborigines by building their roads along the same lines.

As the population of the western portions of the state increased, the demand for more perfect highways became urgent, so that before the end of the eighteenth century several well-defined lines of travel had been established between the tidewater regions along the Atlantic and the Ohio drainage. The Cumberland road extended from Washington to Cumberland via Hagerstown and Hancock, and thus followed the line of easiest travel along the valley and across the divides at their lowest points. Beyond Cumberland the road was extended across Big Savage Mountain and the Alleghany Plateau, keeping on the divide between the Potomac and Youghiogheny until it entered the valley of the latter, which it followed to the Monongahela, and thence down stream to Pittsburgh.

Later promoters of the Chesapeake and Ohio Canal gained the right of way up the Potomac Valley which is followed to Cumberland. The course of the Potomac at Harpers Ferry and Point of Rocks offered the easiest means of communication across the Blue Ridge district, and when once occupied the Chesapeake and Ohio Canal effectually stopped the westward progress of the Baltimore and Ohio Railroad along the same route until a compromise was effected in 1832. West of Cumberland the railroads crossing the state follow the valleys of the rivers, utilizing the courses of the Potomac River, Wills Creek, Georges Creek, Jennings Run, the Savage River, and the Youghiogheny River.

NATURAL RESOURCES.—The resources of the Appalachians are varied and valuable. The early settlers found the mountains clothed with dense forests of pine and hardwood, but they lacked the means for transporting the lumber to a ready market. Even now, with a canal and several railroads, the cost of hauling from the forest to the point of shipment is so great as seriously to reduce the profits of the lumbering trade.

The many varieties of soil in the Appalachians are closely related to the geological formations, and their distribution is clearly influenced by the geological structure. Since most of the higher hills and sharp ridges are due to the presence of heavy beds of siliceous sandstone, the soils of the upper slopes are generally sandy and poor. Beneath these strata come beds of shales which are sometimes calcareous, so that the lower slopes, hills, and subsequent valleys contain soils which, while somewhat stony, give fair yields in wheat, corn, etc.

The Great Valley, with its rich limestone soil and easy means of access from the north and south, forms a broad band of the most fertile lands in the state. If it had not been for the re-elevation of the Shenandoah plain this district would be most favorable to farming. As it is, the rolling surface and steep valley slopes are somewhat difficult to till. The land is so rich, however, that the whole stretch of the valley is or might be under cultivation.

The chief sources of mineral wealth in the province are the deposits of coal, iron, and cement rock. The coal beds are the remnants of larger areas preserved by their depression below the limits of erosion during the formation of the Schooley peneplain. They have proved of inestimable value to the people of the state. The Clinton iron ores were formerly very valuable, but in the present state of the iron market they are of relatively little importance. The cement rock is obtained from the Cambro-Ordovician and Silurian limestones and is the basis of a growing industry. The exposures are favorably situated along the lines of travel, so that the mills have every advantage for the shipment of their product.

INHABITANTS.—The physiography, industries, and resources of the Appalachian province have strongly influenced the character and occupation of the inhabitants, who may be grouped into several well-marked classes. In the higher, more rugged and less populated portions of the area are the mountaineers, who gain their livelihood by lumbering and desultory farming. Gathered about the rich deposits of coal, iron ore, and cement are miners, who are occupied almost exclusively in the extraction of wealth from the underlying rocks. They present a class of marked characteristics in education, training, religion, and nationality. The valleys between the mountains, especially the Great Valley, and the larger, more level areas of the glades, furnish incentive and opportunity for farming communities, which are reasonably well recompensed for their efforts in the tilling of the soil. In the cities and large towns are concentrated those who serve as distributing agents for the products of the land and the necessities of the inhabitants.

THE CLIMATE

The climate of Maryland is as varied as its surface configuration, and is to a considerable extent dependent upon the latter. These climatic

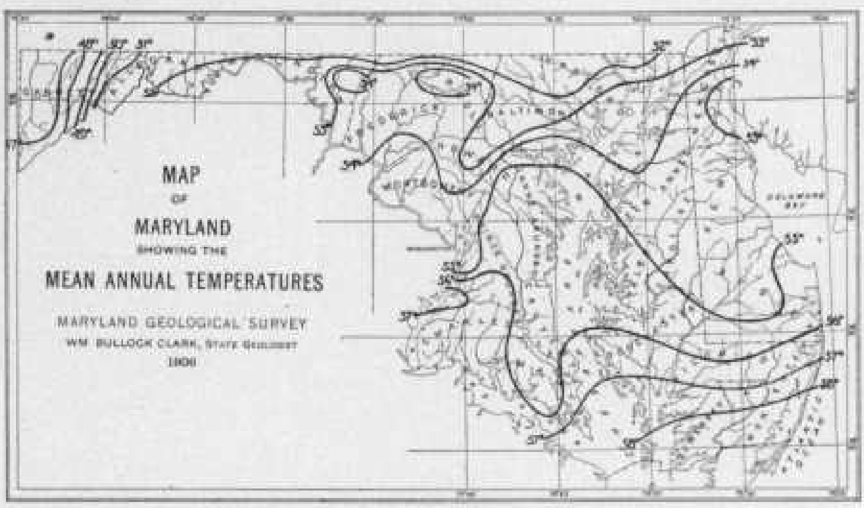

FIG. 31.—MAP SHOWING MEAN ANNUAL TEMPERATURES.

differences are also due to the nearness of the Atlantic Ocean and Chesapeake Bay. The climate of most of the state has the healthfulness common to the eastern part of the United States, and in character is midway between that of Maine and that of Florida. In the eastern and southern parts of the state the winters are mild and the summers hot, while in the western and more elevated portions the winters are quite cold and the summers delightfully cool. The so-called "climatic changes" depend upon differences in temperature, precipitation, winds, humidity, and barometric pressure.

The average temperature for the year varies materially in the several sections of the state, the temperature of the northern and western divisions, which ranges from an average of 27° in winter to 70° in summer, is several degrees lower than that of the southern and eastern divisions, where the temperature for the winter is on the average about 40° and for summer 77°. In general, the average temperature of

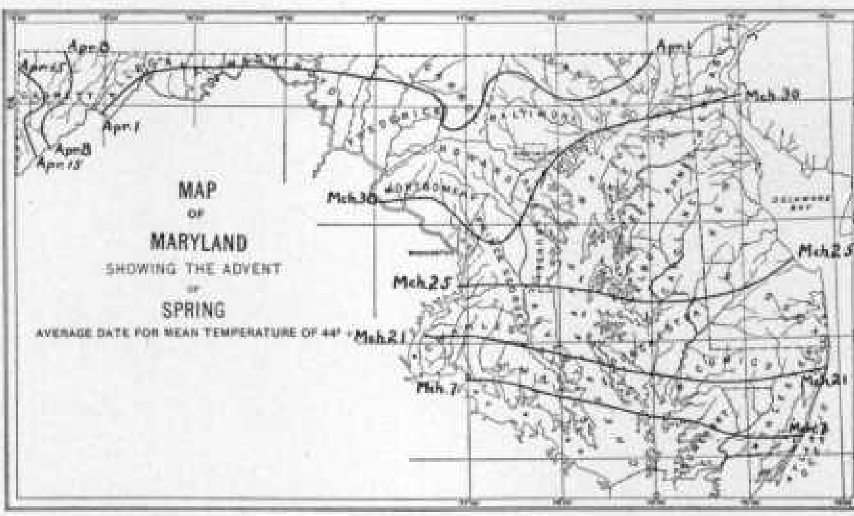

FIG. 32.—MAP SHOWING ADVENT OF SPRING.

Southern Maryland is 2° higher than that of Baltimore, while the temperature of the country to the north and west of the city decreases as the elevation of the land becomes greater. In the western part of the state the valleys are slightly warmer than the mountains, but are more liable to early frosts.

The precipitation of moisture in Maryland occurs in the form of rain, snow, and hail, usually the first, especially in the southern and eastern parts of the state. There are no distinctly wet and dry seasons, as in tropical countries, but careful observations show that there is more rain in the spring and late summer than in the autumn and winter. There are also special areas where there is considerable rainfall, and others in which the precipitation is slight. The records show that the areas of greatest rainfall are in southwestern Garrett County, on the eastern slope of the Catoctin Mountain in the Frederick Valley, and along the shores of Chesapeake Bay south of Annapolis and near Cambridge; while the areas of least precipitation are between Denton and Westminster and in the mountainous counties. The annual precipitation in the state varies, according to localities, from 25 to 55 inches.

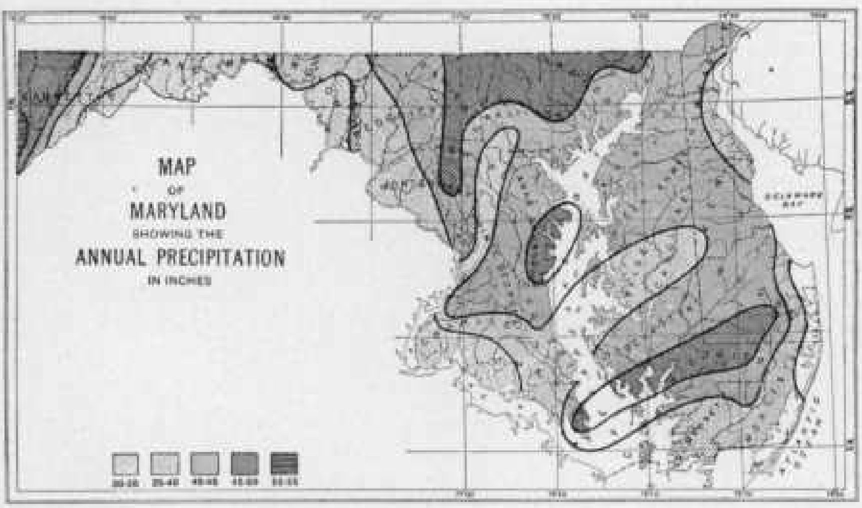

FIG. 33.—MAP SHOWING RAINFALL.

The winds in Maryland are prevailingly from the west, but during the summer they usually come from the south, and in the winter from the northwest and west, especially in the eastern and central portions of the state. In the mountainous regions of Western Maryland the winds are more commonly from the northwest and west throughout the year.

THE FLORA AND FAUNA

The native plants of Maryland are not unlike those of Virginia and Pennsylvania, and the range within the state is wider than that between adjacent areas in neighboring states. The most prominent trees are oak, hickory, pine, poplar, maple, locust, chestnut, cypress, red cedar, beech, and wild cherry. Among the wild fruit trees are the persimmon, the service berry, and Chickasaw plum. The various sorts of grapevine, the Virginia creeper, greenbrier, and morning glory are common climbers in the state, while the wild strawberry, blackberry, raspberry, blueberry, huckleberry, dewberry, and cranberry, all very abundant, represent the native small fruits. Besides these larger or fruit-bearing plants, there are countless others which carpet the ground in rapid succession from early spring until late autumn.

The animal life in Maryland is abundant, but does not show a great variety of the larger forms. Deer, black bears, and wildcats are sometimes taken in the wilder portions of the state. Usually, however, the mammals are represented only by such animals as ground-hogs, rabbits, skunks, weasels, minks, otters, opossums, and squirrels. Snakes are abundant, but most of the species are harmless. The copperhead and the rattlesnake are the most common venomous snakes, the former being the more vicious and dangerous.

The waters of Chesapeake Bay abound in shad, herring, menhaden, mackerel, crabs, terrapin, and oysters. Among the ducks which frequent Chesapeake Bay are the canvas-backs, red-heads, bald-pates, mallards, black-heads, and teal; while the land birds include the reed-bird, partridge, ruffed grouse (or "pheasant"), woodcock, snipe, plover, and Carolina rail. The "ducking shores" are visited by many hunters during the shooting season.

NATURAL RESOURCES

The leading natural resources of Maryland may be grouped under four heads: First, the mineral resources, including coal, building-stone, clay, etc.; second, the agricultural soils, embracing the many types of soil adapted to a great variety of crops; third, the forests with their lumber and other manufactured products; and fourth, the water products, taken from the sea, bays, and rivers of the state and affording a basis for the fishing and oyster industries. To these should also be added the water-power resources, which, although important, are less fully developed at the present time.

Mineral Resources

The mineral resources of Maryland are of much value and have yielded a great variety of products, some of which afford the basis for important commercial enterprise. The old crystalline rocks, confined for the most part to the Piedmont region between the Monocacy and the Chesapeake, have afforded the most varied mineral products. Here occur the most important building stones; the slates of Delta and Ijamsville; the granite of Port Deposit, Woodstock, Ellicott City, and Guilford; the gneiss of Baltimore; the marble of Cockeysville and Texas; the crystalline limestone of Westminster; the sandstone of Deer Creek; and the serpentine of Broad Creek and Bare Hills. In these oldest rocks occur also the ores of gold, copper, chrome, lead, and zinc. Iron ore is also found here, while all the flint, feldspar, kaolin, and mica in the state must be sought for in these rocks. These older rocks also appear in the Blue Ridge district bordering the Middletown Valley and have yielded traces of copper, antimony, and iron.

The rocks of later age, forming what geologists call the Paleozoic system, make up the western portion of the state. They furnish much sandstone and limestone suitable for building purposes, the latter also being burned extensively for agricultural purposes. There are also important deposits of cement rock that have afforded the basis for an extensive industry. At the top of the Paleozoic system of rock formations are situated the coal beds of the famous Cumberland-Georges Creek coal basin, including the wonderful "Big Vein" that is universally thought to furnish the highest quality of steam and smithing coal. These same rocks also contain important deposits of fireclay and iron ore, the former affording the basis for a very important firebrick industry.

The post-Paleozoic formations of the state, although not as rich in mineral products, are not devoid of deposits of economic value. The interesting variegated limestone breccia, known as Potomac marble, and the brown sandstone of Frederick and Montgomery counties belong to the oldest of these post-Paleozoic strata. The series of still unconsolidated beds, representing much of the remainder of post-Paleozoic time and

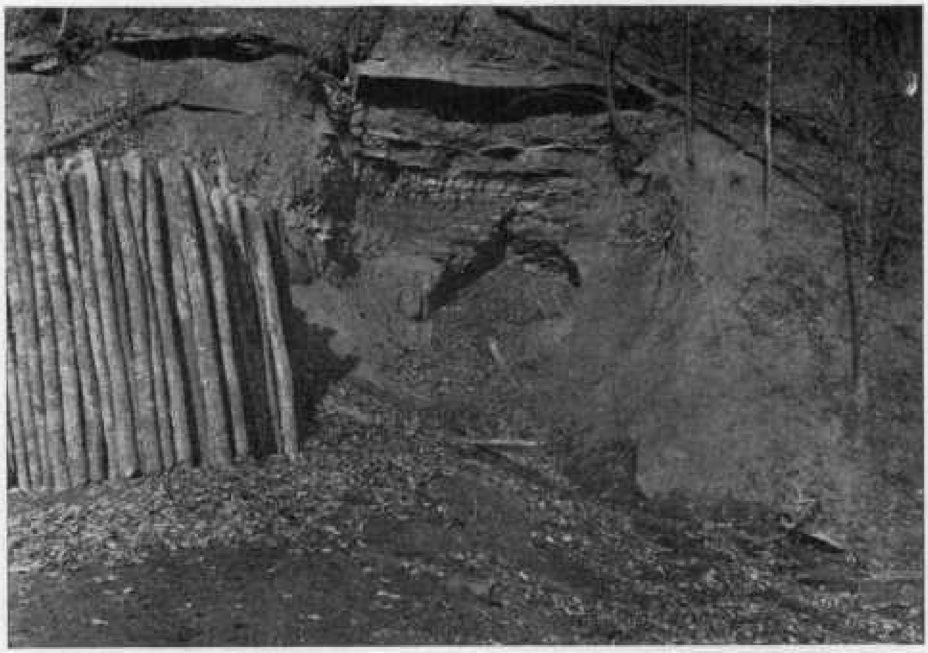

FIG. 34.—BEGINNING OF A MINE AT AN OUTCROP OF THE BIG VEIN NEAR LONACONING, ALLEGANY COUNTY.

FIG. 35.—MAIN ENTRANCE TO BLUEBAUGH MINE, NEAR BARRELVILLE, ALLEGANY COUNTY.

comprising all of Eastern and Southern Maryland, and known as the Coastal Plain, furnishes the chief supply of brick, potter's and tile clay; of sand, marl, and diatomaceous earth (silica); and much of the iron ore. The clay industry, particularly, is one of the most important in the state. The total value of the mineral products in 1916 was $14,737,773+.

Coals.—The coal deposits of Maryland are confined to western Allegany and Garrett counties, and are a part of the great Appalachian coal field which extends from Pennsylvania southward into West Virginia. The Maryland coal is mainly semi-bituminous or steam coal, and in the Georges Creek basin, near Cumberland, contains the famous "Big Vein," or fourteen-foot bed, that for steam-producing and smithing purposes has no superior and few equals in any portion of the world. Both above and below the Big Vein are a number of smaller workable seams that contain coal of fine quality, which is already securing an extensive market. The Maryland coal was discovered in the eighteenth century and has been continuously worked since 1836, when the first company was organized. The aggregate output of Maryland steam and smithing coal at the present day amounts to several million tons annually.

The Maryland Big Vein coal occurs in the upper coal measures, while the most important of the small veins are in the lower coal measures. The latter have received less consideration in the past on account of the reputation of the Big Vein, but are destined to play a very important part in future coal development in Western Maryland.

The Maryland coal is high in fixed carbon, and, especially in the case of the Big Vein, low in sulphur and ash, thus possessing in highest measure those qualities which gave to coal its steam-producing power.

Clays.—The clays of Maryland are widely extended, occurring in a great number of the geological formations. They are most extensively developed through a belt running from northeast to southwest along the western margin of the Coastal Plain, and including both the Baltimore and Washington regions. Other important clays are found in the central and western sections of the state, and even the southern and eastern counties are not without this material in large quantities. The Maryland clays are suitable for all grades of buildingbrick, tile, terracotta, firebrick, and some grades of pottery. Brickmaking began in Maryland in colonial days and has since been one of the most important industries in the state—the great brick works of Baltimore being among the largest of their kind. The manufacture of firebrick has been one of the most characteristic industries of Maryland for 50 years, and the brick made from the Carboniferous clays of Allegany and Garrett counties are regarded as the best in the country.

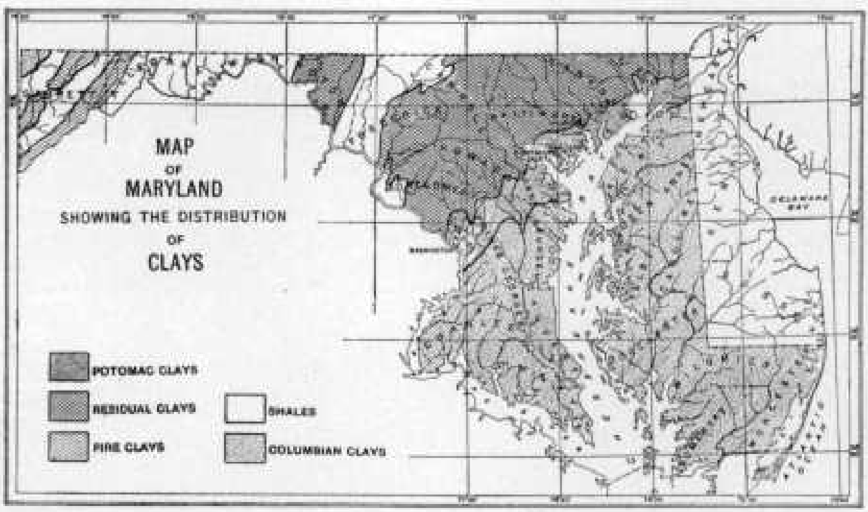

FIG. 36.—MAP SHOWING DISTRIBUTION OF THE CLAYS.

PORCELAIN MATERIALS.—The State of Maryland is well provided with porcelain materials, including flint, feldspar, and kaolin. The flint is widely distributed throughout the eastern portion of the Piedmont Plateau, and is especially abundant in Cecil, Harford, Baltimore, Carroll, and Montgomery counties. It occurs as vein fillings in the form of pure granulated or vitreous quartz. In Harford County, where the veins are most abundant, the quartz has been quarried in large amounts. It is crushed and then shipped in sacks to the potters.

Kaolin is produced mainly in Cecil County, which is part of the most important kaolin region in the United States, other deposits being found in the adjoining portions of Delaware and Pennsylvania. The kaolin has been worked extensively at several points, notably at Northeast, Cecil County, where large shipments of this material have been made annually. Considerable flint is extracted in the washing of the kaolin.

FIG. 37.—BEAVER DAM MARBLE QUARRY, COCKEYSVILLE, BALTIMORE COUNTY.

SANDS.—Sand deposits of economic value have been exploited both in the western and southern sections of the state, and the sandy sediment from the bed of the Potomac River and from other streams has also been dredged in large amounts. The Paleozoic formations of Western Maryland contain at two horizons important glass-sand deposits that have been mined extensively in nearby regions. The most extensively developed sand deposits in the state, however, are found in Anne Arundel County, where large excavations have been made in the Cretaceous deposits near the head of the Severn River, and a good grade of glass sand obtained. The location of these sand deposits at tide renders it possible to ship the materials cheaply by water, and it is probable that they will be much more fully utilized in the future than they have been in the past.

Molding sand, suitable for brass castings, is found in the vicinity of Catonsville, Baltimore County, and this deposit is worked to some

FIG. 38.—GRANITE QUARRY AT PORT DEPOSIT.

extent at the present time. A sand is secured from the south shore of the Patapsco River below Baltimore for pig-iron casting.

Many sands are used for building purposes, the Cretaceous sands of Anne Arundel and Baltimore counties finding large employment in this way. Some of the residual sands of the Piedmont Plateau region are similarly used, especially that derived from the quartzschist.

MARLS.—The Tertiary formations of Eastern and Southern Maryland contain important marl deposits that have never been developed except for local uses. Their agricultural importance has not been generally recognized, although they have been worked to some extent since the early decades of the century. The older Tertiary marls are glauconitic, and are not unlike the famous greensand marls of New Jersey, which have been so largely and successfully employed there as a natural fertilizer. Greensand marl contains a small percentage of phosphoric acid, some potash, and a greater or less amount of carbonate of lime. When spread upon the surface of the land the effect is slow, but is often more lasting than the commercial fertilizers. The younger Tertiary marls are mainly shell deposits, and are commonly known under the name of shellmarls. They frequently contain a large percentage of lime, and thus afford a valuable addition to certain soils.

DIATOMACEOUS EARTH.—Diatomaceous earth, known to the trade as silica or tripoli, has been produced in larger quantities in Maryland than anywhere else in the United States. It is confined to the middle Tertiary and consists of deposits of almost pure silica 30 to 40 feet in thickness. It is chiefly found in Calvert and Charles counties, where it has been more or less extensively worked at the mouth of Lyon's Creek on the Patuxent, and at Pope's Creek on the Potomac River. This remarkable deposit is composed of the microscopic shells of diatoms, and has found various uses in the trades.

IRON ORES.—The iron ore industry in Maryland was developed early in colonial days, and continued until a recent period to be one of the most important factors in the prosperity of the state. Numerous references to the iron ores and their manufacture into iron occur in the records of colonial times. The Principio Company, one of the largest of early commercial enterprises, controlled many furnaces and forges in Maryland and in Virginia, and both during the Revolutionary War and the War of 1812 furnished guns and projectiles to the army. These furnaces, as well as those in the western counties of the state, have long since been abandoned, with the exception of the Catoctin furnace in Frederick County, which has been in quite recent times in active operation. The only ores now being produced in Maryland to any extent are the carbonate ores derived from the clays along the western margin of the Coastal Plain, chiefly in Anne Arundel and Prince George's counties, and the brown hematite ores of Frederick and Carroll counties. It is interesting to note that this carbonate ore was probably the first iron ore worked in Maryland, and is, even to-day, highly prized for its tensile strength.

MINERAL PAINTS.—Mineral paint has been produced at several points in Maryland. Large quantities were obtained in former years from the brown iron ore deposits of Frederick County. Ochre mines have also been operated in Carroll and Howard counties. The deposits of chief importance at the present time, however, are found associated with the clays in Anne Arundel and Prince George's counties. In the latter locality the material is a fine and highly ferruginous clay that can be easily worked, and large quantities have been mined annually. It occurs in many grades and colors.

BUILDING AND DECORATIVE STONES.—The building and decorative stones of Maryland are widely distributed throughout the western and central portions of the state, and consist of many different varieties which, from their diversity in color, hardness and structural peculiarities, are well adapted for nearly all architectural and decorative purposes. Among the most important may be mentioned granite, gneiss, marble, limestone, slate, sandstone, and serpentine. Among the localities in Maryland where *granite* has been most extensively worked are Port Deposit, in Cecil County; Woodstock, in Baltimore County; and Ellicott City and Guilford, in Howard County. Other areas in Cecil, Howard, and Montgomery counties contain some good stone, but it is quarried only for local use. At the localities first mentioned, the granite is extensively quarried at the present time, and has afforded material for the construction of some of the most important buildings in the country, including the Capitol and Congressional Library in Washington, Fortress Monroe, Forts Carroll and McHenry, the U. S. Naval Academy, and other public and private buildings, as well as bridges in Baltimore, Washington, and Philadelphia. The excellent quality of the stone renders it available in many cases as a decorative stone, and monumental work has already been undertaken.

The more solid varieties of the *gneiss* occurring in and near the city of Baltimore are extensively quarried for use as foundation stone. This rock is of a gray color, and occurs in parallel layers of light and dark stone, which at times are more or less sharply contrasted. Buildings constructed of gneiss, of which there are many in Baltimore, are agreeable in appearance. Among the more important structures built of this stone may be mentioned the Goucher College buildings in Baltimore.

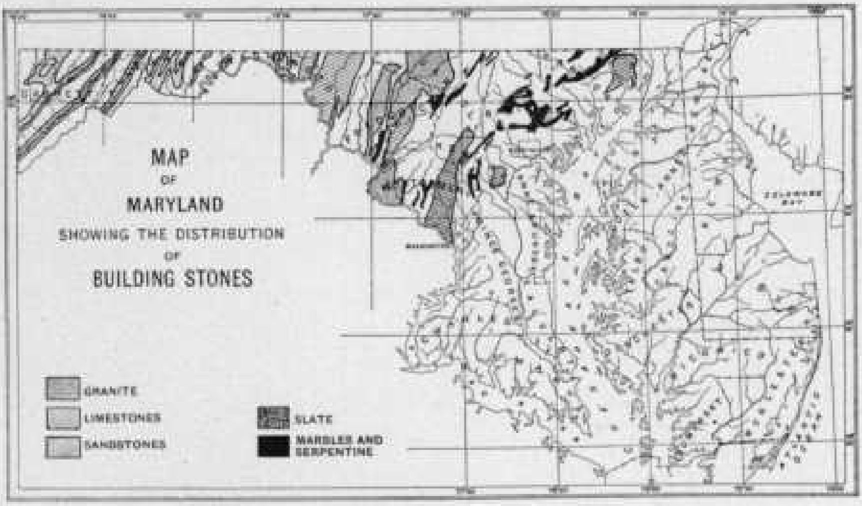

Fig. 39.—Map showing distribution of building stones.

The *marble* of Maryland is mainly confined to the eastern division of the Piedmont Plateau. The white varieties occur for the most part in Baltimore County, and the highly variegated marbles in Carroll and Frederick counties. The white marbles of Baltimore County are found in a series of narrow belts a few miles to the north of Baltimore City. The most important of the areas is that which extends northward from Lake Roland to Cockeysville, and which is traversed by the Northern Central Railway. The marble has been extensively quarried both at Cockeysville and Texas, the well-known Beaver Dam marble quarries of the former locality having been in successful operation for more than 75 years. The rock is a fine saccharoidal dolomite of great compactness and durability. Monoliths of large size can be obtained at the quarries. Many important structures in Baltimore, Washington, and Philadelphia have been made of this marble. Stone for the construction of the Washington Monument in Baltimore was taken from this locality as early as 1814.

The fine-grained, compact and variegated marbles, or crystalline limestones, of the western portion of the Piedmont Plateau in Carroll and Frederick counties compare favorably in their quality, texture, and beautiful veining with the well-known marbles from Vermont and Tennessee, and are deserving of much more attention than they have heretofore received. In the Wakefield Valley, west of Westminster, a beautifully mottled red and white marble occurs; others of black and white, gray and white, and blue and white veining occur near New Windsor and Union Bridge, and still others of a variegated yellow, with lighter veinings, have been derived from the same area. This marble, on account of the limited extent of the deposits, has not been regarded as of much economic importance, but the stone, when secured, is well adapted for purposes of interior decoration.

Another stone which may be classed with the decorative marbles is the "Potomac Marble," or "Calico Rock," of southern Frederick County. It has been used as a decorative stone in the old Hall of Representatives at Washington, where it forms a series of beautiful columns. It occurs, well exposed, at Washington Junction, Frederick County, and extends northward along the base of the Catoctin Mountain. The limestone fragments of which the rock is composed are imbedded in a red, ferruginous cement, and the stone, when polished, presents a very beautiful appearance.

The blue *limestones* of the Appalachian district have been used to some extent for building purposes, more especially in Hagerstown, where several structures have been made of this material. The blue limestone changes its color rapidly on weathering with a rather pleasing effect. A very compact, even-grained and pure cream-white stone occurs at one or two points in the Hagerstown Valley, but has not been exploited to any great extent as yet. The limestones are extensively used for foundation and other purposes.

The *slate* of northern Harford County is a part of the Peach Bottom slate belt that extends northward into Pennsylvania and southwestward into Baltimore and Carroll counties. The best slate in this belt is found not far from the Pennsylvania line in Harford County, the shipments, however, being largely made from Delta, Pennsylvania, and on this account the slate is often credited to Pennsylvania. The Peach Bottom slate has always enjoyed a very high reputation, and is second to none in its durable qualities. It has been worked since Revolutionary time.

The *sandstones* of different color which have been found at many localities in central and western Maryland are, many of them, well suited to furnish valuable building-stone, but only one or two localities have been commercially developed to any extent, although the stone is used locally at many points. The red sandstone of Triassic age in Frederick and Montgomery counties has long possessed a reputation in the building-stone trade. The most extensive quarries are situated on the Potomac River, near the mouth of Seneca Creek. The Seneca sandstone has been quarried in a more or less systematic way since 1774, and has always been highly regarded for its strength and durability and its deep red color. It has been used in the construction of many important buildings, including the Smithsonian Institution in Washington. The white Cambrian sandstone of the Catoctin and Blue Ridge mountains has been extensively utilized locally, and at times has found somewhat wider employment, especially by the railroad companies. In Allegany and Garrett counties the Silurian, Devonian, and Carboniferous sandstones have been quarried at several points, particularly in the vicinity of Cumberland, where two of these sandstone beds have furnished materials for steps, curbs, and architectural trimmings.

One of the most interesting and beautiful decorative stones in Maryland is the *serpentine,* which has been worked more or less extensively in Harford, Baltimore, and Cecil counties. The rock is very hard, and possesses a rich, emerald-green color, clouded with darker streaks of included magnetite. Maryland serpentine has been used for interior decoration in several large buildings in New York, Philadelphia, Baltimore, and Washington, and has great possibilities as a decorative stone.

A number of the other Maryland stones have been used for building and decorative purposes. Among these may be mentioned the black *gabbro,* locally known as "Niggerhead Rock," which occurs widely throughout the eastern portion of the Piedmont Plateau. It is very hard and tough, and cannot be economically quarried and dressed, and on that account has not found very wide use. The various other stones employed for building purposes can be regarded as having little more than local value.

LIME AND CEMENT PRODUCTS.—The limestone and marble deposits of Maryland have been extensively burned for building and agricultural uses. There are many kilns used for supplying lime for local purposes scattered throughout the district in which the calcareous rocks appear.

The limestone and marble are also used as a flux for blast furnaces, the main supply being derived from the coarse-grained marble of Baltimore County, and the limestones of Washington County.

Hydraulic cement has been extensively manufactured from the magnesian limestone of western Washington and Allegany counties at Hancock, Cumberland, and Pinto, where extensive plants were long in operation. More recently the manufacture of Portland cement has been successfully undertaken and extensive plants have been established at Union Bridge, Carroll County, and Security, Washington County, more than a million barrels of cement now being produced annually. Much hydrated lime is also manufactured which is used both for agricultural and building purposes.

GOLD DEPOSITS.—The crystalline rocks of the Piedmont Plateau have been found to carry gold in Maryland, Virginia, North Carolina, and Georgia. The gold occurs in quartz veins, which occupy the old lines of fracture in the rocks. Gold was first discovered in Maryland in 1849 in Montgomery County. The first mine was opened in 1867, and some wonderfully rich specimens have been obtained, although the gold is so unevenly distributed that it has never been worked with profit. Gold has been reported from other portions of the state, but these so-called finds are, when thoroughly sifted, found to be either entirely without foundation or the amount of gold so slight as to have no commercial value. The Montgomery County mines in 1890 produced between $15,000 and $20,000 worth of gold, but within the last few years the mines have been practically abandoned. A few hundred dollars worth of gold only is obtained annually.

ROAD MATERIALS.—Maryland is well provided with road-building materials of good quality. The trap rocks, which have shown themselves as the result of careful tests to be best adapted for this purpose, occur well scattered throughout the seven central counties of the state, and advantageously located for land and water transportation. The western counties, although without the trap rocks, are all provided with limestone, as well as siliceous deposits of value. Most of the counties of Southern Maryland, and the northern counties of the Eastern Shore, have iron-bearing gravels that can be employed with advantage for road-building purposes. The central and southern Eastern Shore counties have, in the absence of proper rock, a large supply of oyster shells, so that no section of the state is without road-building materials of some kind.

MINERAL WATERS.—The mineral waters of Maryland have attracted considerable attention, and several kinds are on the market at the present time. A few are represented as having medicinal properties, but the majority are sold principally as table waters, mostly in the City of Baltimore. Nearly all of the well-known waters come from the crystalline rocks of the Piedmont Plateau, a few only being reported from the Appalachian region and the Coastal Plain. Summer resorts have sprung up, as in the case of Chattolanee and Buena Vista, about the more important of these springs.

MISCELLANEOUS PRODUCTS.—There are several other mineral substances in Maryland, which are either not being worked at all or only to a very limited extent at the present time, that have had a very interesting history. Among them may be mentioned copper, chrome, and soapstone.

Copper was worked in Maryland at a very early period in colonial times, and until the discovery of the great copper fields of the Lake Superior region was an important mineral product of the state. The abandoned mines in Baltimore, Carroll, and Frederick counties to-day indicate the importance of the industry at this earlier period. Maryland copper was used to cover the dome of the Capitol at Washington.

Chrome ore was discovered in 1827 in the serpentine of the Bare Hills in Baltimore County, and subsequently other deposits were found in Harford and Cecil counties. For many years Maryland supplied most of the chrome ore of the world, but the discovery in 1848 of the great deposits of chromite in Asia Minor caused the practical abandonment of the chrome mines of Maryland, although Baltimore is still one of the most important centers for the manufacture of chromium salts.

Soapstone has been worked to some extent in Carroll, Harford, and Montgomery counties, the most important occurrences being in Carroll County, where there is a small production of this material at the present time.

Among other mineral substances known to occur in Maryland, although not commercially profitable at the present time, may be mentioned lead, zinc, manganese, antimony, molybdenum, graphite, mica, and asbestos.

Agricultural Soils and Crops

Maryland, with its great variety of soil and climatic conditions, offers exceptional advantages to the agriculturist. Within the borders of the state are lands admirably adapted to general farming, while the fine market and transportation facilities offer every inducement to those who wish to enter the field of specialized farming. Generally it is customary, in speaking of the different portions of the state, to refer to the Eastern Shore, Southern Maryland, Northern-Central Maryland, and Western Maryland. Each of these subdivisions is a distinct agricultural region and possesses certain peculiarities of soils, surface features, and climatic conditions, as well as different market and transportation facilities. The total value of Maryland agricultural products in 1909 was $43,920,149, while the live stock products brought the total to about $60,000,000.

The EASTERN SHORE includes the counties that lie on the eastern side of Chesapeake Bay. The extremes of climate are tempered by proximity to the ocean and Bay, and the lands have proved their special adaptability to early fruits and vegetables, in addition to the staple crops of wheat, corn, oats, and hay.

In the northern part of the Eastern Shore are fine wheat and corn lands. the wheat lands being rich loams which overlie clay loam subsoils. They

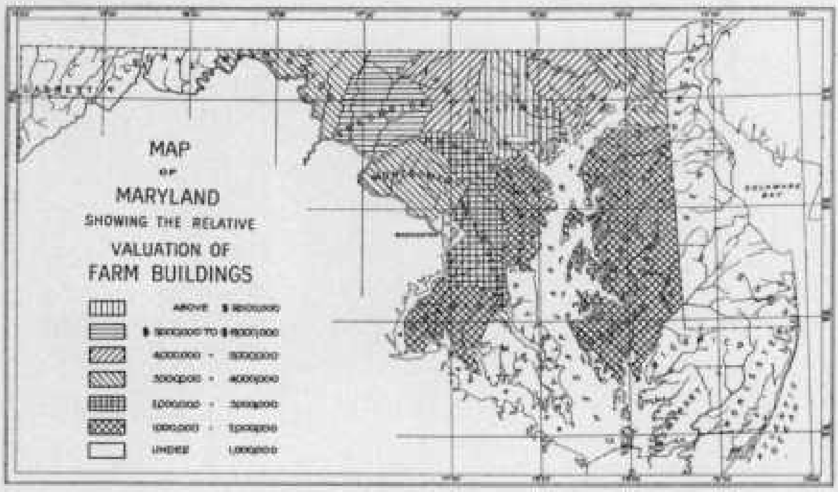

FIG. 40.—MAP SHOWING THE VALUATIONS OF FARM BUILDINGS.

are easy to cultivate, and can be made exceedingly productive. Soils of this character occupy large tracts of level upland in southern Cecil, Kent, Queen Anne's, and Talbot counties. These soils are of a rather yellowish red color, but there are other wheat lands with soils of a different character. In the lower counties, especially in portions of Dorchester, Caroline, Wicomico, and Worcester, are large areas of stiff clayey soil. Frequently these clays need underdrainage to make them produce well, as the subsoil is close and retentive.

There are also large areas of rich, sandy loams that are suited to growing vegetables and all kinds of small fruits, and consequently in many sections the canning industry has been enormously developed. The excellent transportation facilities allow perishable fruit to be shipped to all of the larger northern cities where it finds a ready sale. In some sections farming in recent years has undergone a complete revolution, the old staple crops have been given up and the more lucrative truck and fruit crops introduced. The peach crop from the Eastern Shore is very large in good seasons. The industry is rapidly spreading into the lower counties. Pears have recently proved a great success in Kent County.

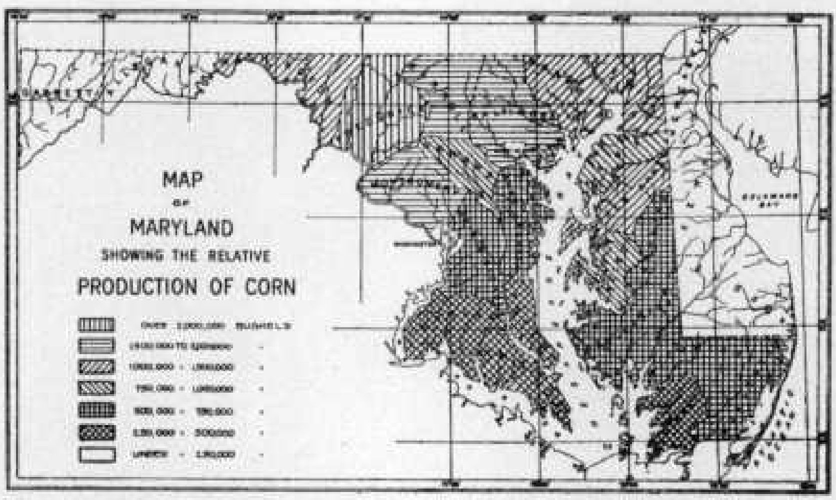

FIG. 41.—MAP SHOWING THE RELATIVE ANNUAL PRODUCTION OF CORN.

In connection with the soils of the Eastern Shore, some mention must be made of the large areas of tidal marsh lands. Thousands of acres of fertile land could be reclaimed at comparatively little expense, but as yet little or no attempt has been made in this direction. Lands that have been reclaimed are exceedingly fertile and will produce for an almost indefinite period.

SOUTHERN MARYLAND includes the lower counties of the state that lie on the western side of Chesapeake Bay. This land in general is higher and more broken than on the Eastern Shore.

The soils of Southern Maryland range in texture from gravelly loams to light clays. Generally speaking, they consist of loams and sands which are admirably adapted to growing all kinds of fruit and vegetables. The wheat lands are the heaviest types of soil found in Southern Maryland. They occur on the rolling uplands to a considerable extent, and as wide terraces along the Potomac and Patuxent rivers. These soils are heavy loams and clay loams, generally of a yellowish color. Some of these soils are still in excellent condition in spite of having been cultivated for

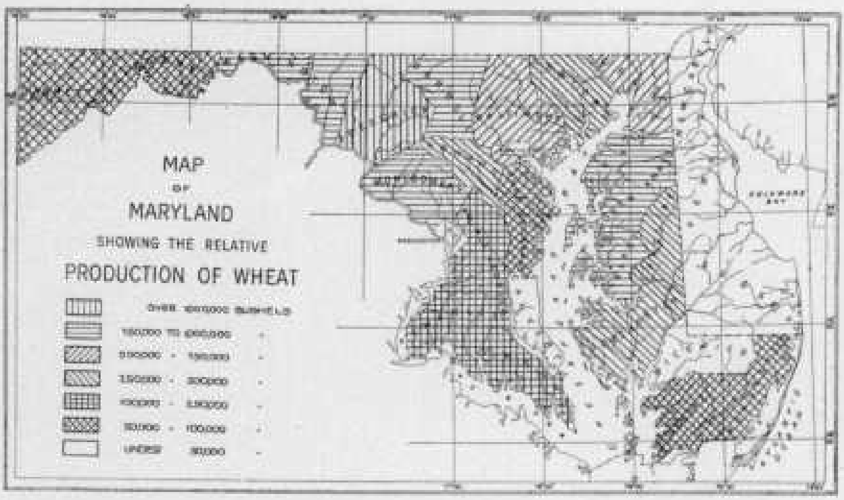

FIG. 42.—MAP SHOWING THE RELATIVE ANNUAL PRODUCTION OF WHEAT.

upwards of 200 years. On the uplands tobacco is grown as well as wheat. Wheat is grown on nearly all classes of soil in this portion of the state, but with very poor results on the lighter sandy loams. Lighter loams are found in some portions of the uplands and are better adapted to raising tobacco. The yield is less per acre but the quality is good. Maryland tobacco is exported chiefly to Holland, France, and Germany. It is a light, mild smoking tobacco, and formerly brought a much better price than at present. Competition with new tobacco-producing states and changing market demands have lowered the price and have correspondingly decreased the profits. The tobacco lands have been allowed to run down, and those farmers who have turned their attention to other crops are gratified with the results obtained. The sandy loams cover large areas of Southern Maryland. There are loose sandy soils which are too light in texture for producing wheat or grass, but since the extensive truck industry has been developed the lands that are near markets have greatly advanced in value. The sandy river necks south of Baltimore are famous truck-growing areas and produce enormous quantities of melons, peas, beans, strawberries, and small fruits. Shipments are made principally by boat when the distance is too far for hauling by wagon. There is also a very large peach industry in this section of the state.

While certain portions of Southern Maryland have made great advancement along the lines of successful agriculture, there are still large areas of productive soil that are lying idle or growing up in pine forests. Lack of transportation facilities has had much to do with bringing about these conditions in certain sections, and the sparsely settled condition of some of the counties has also prevented the development which the fertile nature of the soils would seem to warrant. By introducing crops adapted to the character of the soil, and with adequate transportation facilities, this region should be made even more productive than it was formerly.

NORTHERN-CENTRAL MARYLAND.—The agricultural soils of this section of Maryland are mainly residual, that is, they are the products of the slow decomposition of the underlying rocks. They are, with few exceptions, strong and fertile. They can be made very productive and are generally in a high state of cultivation. The soils may be discussed under the following classes: The limestone-valley lands, the red lands, the gray lands, the phyllite soils, and the barren lands of the serpentine areas.

The limestone-valley lands are perhaps the strongest soils found in the region. They are identical in many respects with the soils of the Hagerstown Valley. These soils are heavy red and yellow loams and clays. The largest valleys of these rich soils are found in Frederick, Baltimore, Carroll, and Howard counties. These soils by careful cultivation annually yield fine crops of grass, wheat, corn, and other cereals. Many

FIG. 43.—KENT COUNTY FARM LANDS OF THE TALBOT TERRACE PLAIN.

FIG. 44.—HARVESTING WHEAT IN KENT COUNTY.

FIG. 45.—FARMING LANDS NEAR LEONARDTOWN, ST. MARY'S COUNTY.

FIG. 46.—TOBACCO FIELD IN CHARLES COUNTY.

of these valleys have long been noted for their prosperous, well-managed farms. On account of their heavy, clayey nature they are famous grass lands, and large numbers of cattle are fattened in these valleys. The proximity to Baltimore and the excellent transportation facilities have also greatly stimulated the dairy interests.

The red lands may be divided into two subclasses. First may be described the red lands of Carroll and Frederick counties, which consist of red loams and clay loams. These soils occupy areas near the fertile

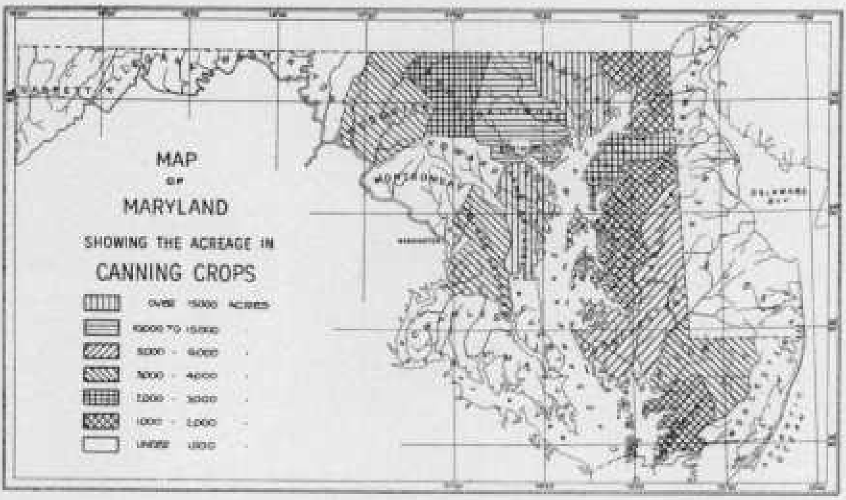

FIG. 47.—MAP SHOWING THE ACREAGE IN CANNING CROPS.

Monocacy limestone valley, and the difference between the soils of the two regions can be easily compared. In good seasons the red lands are almost as productive as the fertile limestone soils, but during years when the conditions for growth are unfavorable the yields are not so high as from the heavy, clayey soils of the limestone valleys. However, the red lands rank as good, strong soils, and generally produce excellent crops of grass, wheat, corn, oats, and potatoes, the principal crops grown in this section of the state.

The second class of red-land soils occupies areas in Cecil, Harford, and Baltimore counties. The soils are heavy red loams, grading into stiff clay loams of a reddish or yellowish color. These are likewise strong clay soils, naturally productive and capable of standing considerable hard usage. They produce good yields of the staple crops, such as wheat, grass, and corn. In addition they produce large yields of tomatoes and corn for canning purposes. The canning of corn, tomatoes, and other vegetables has been extensively carried on in Harford and Cecil counties for many years, and is one of the leading industries of these counties. The dairy interests are considerable on these strong soils, which produce excellent crops of hay and afford fine pasturage.

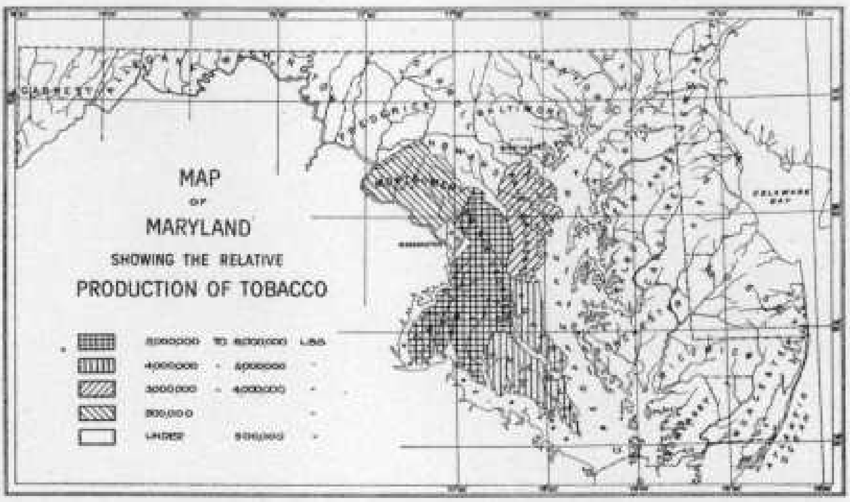

FIG. 48.—MAP SHOWING THE RELATIVE ANNUAL PRODUCTION OF TOBACCO.

The gray lands and the corn and wheat lands, derived from deposits of phyllite, are so nearly alike in many respects that they may be discussed together. These soils occupy large areas in Frederick, Carroll, Montgomery, Howard, Baltimore, Harford, and Cecil counties. The surface of the country away from the larger streams is gently rolling, but becomes hilly and broken along the principal streams. The surface drainage is good in the entire region. The soils are grayish-yellow loams which grade into yellowish clay loams. They are naturally productive, but on account of their rather light texture they must be farmed carefully or they become exhausted. They are excellent corn and wheat soils and are classed as good general farming lands. In Cecil and Harford counties they produce fine crops of late tomatoes for canning purposes. In Montgomery County they were formerly used to a considerable extent for growing tobacco. They are good grazing lands, and near Washington and Baltimore the dairy business is extensively carried on. In the neighborhood of these cities market gardening is also an important industry. The lighter loams, especially, yield fine crops of all kinds of vegetables, and the nearness to market allows the farmer to haul his produce directly to the consumer. Transportation facilities are also good.

WESTERN MARYLAND is divided into three well-marked districts from an agricultural point of view.

The eastern district includes the broad Hagerstown Valley and the Middletown and other smaller valleys, together with the mountain slopes adjoining. The Hagerstown Valley has a width of about 20 miles and contains a large number of excellent farms. The soils are red or yellow clay loams or clays derived from the weathering of the thick beds of limestone that occur there. These soils, by careful cultivation, produce large crops of wheat, corn, and grass. Thirty-five bushels of wheat per acre is not an uncommon yield, and from 50 to 100 bushels of corn can be raised. The railroad facilities are good in the valley, and Hagerstown, a prosperous manufacturing city, is situated in the center of the region. In addition to the large production of wheat and corn many cattle are annually fattened here.

Along the eastern margin of this valley is the center of the famous mountain peach industry. So excellent are the shipping facilities that peaches picked in the late afternoon are on sale in the New York market the next morning.

The smaller valleys, of which the Middletown Valley is the most important, contain good soils, mostly heavy loams and clays well adapted to raising corn, wheat, and grass, which are the principal crops grown.

The central district is rough and mountainous, and the greater portion is thickly wooded and not well adapted to farming purposes. The soils of the mountain ridges are thin and stony and difficult to cultivate. There are, however, some valleys in this region that possess limestone soils that are fertile and can be made quite productive. The largest of these valleys

FIG. 49.—TYPE OF BARN IN CARROLL COUNTY.

FIG. 50.—CATTLE RAISING AND DAIRYING IN CARROLL COUNTY.

lies 12 miles east of Cumberland, and the strong clay soils produce good crops of wheat and timothy hay. Other valleys of this region possess shale soils which can be made productive, and there are also large areas of hill pasture land which contain shale soils. Along the Potomac River and some of the larger creeks, especially near Cumberland, there are large tracts of alluvial bottomlands which annually make good yields of the staple crops. Fruit growing has lately been introduced in the hilly region east of Cumberland, and there are already many large and profitable peach orchards. Oats, buckwheat, wheat, rye, and potatoes are the main crops grown in this part of the state.

The western district comprises the Alleghany Plateau. The soils may be classed as the red sandstone and shale soils, the yellow sandstone soils, the

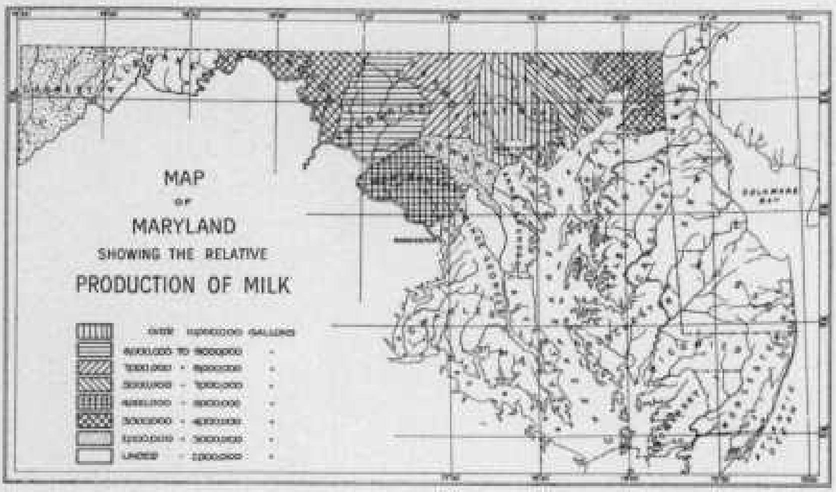

FIG. 51.—MAP SHOWING THE RELATIVE ANNUAL PRODUCTION OF MILK.

rough, stony soils of the mountain ridges and the "glades" or mountain swamp lands.

The red standstone soils occupy large areas in the central portion of Garrett County, and the yield of crops produced on these soils compares favorably with the best class of soils found in the entire state. The soil is a heavy red loam that grades into red clay loams. These soils occupy rolling valley lands and produce good crops of wheat, corn, oats, and buckwheat. The Cove country, as it is called in northwest Garrett County, has long been noted as a fine farming section, and there are still large areas of these fine soils which can be made fully as productive and prosperous as the section just mentioned.

The yellow sandstone soils comprise the greater portion of Garrett County and the Georges Creek Valley in Allegany County, and may be classed as heavy sandy loams. They produce good yields of buckwheat, wheat, oats, hay, and corn. In the native forest the sugar maple abounds, and a large income is derived from the sale of maple sugar each spring. These lands are also good pasture lands in addition to being well adapted to apple orchards.

The stony mountain soils include the shallow soils found along the crests and sides of the principal mountain ridges of this region. The soils

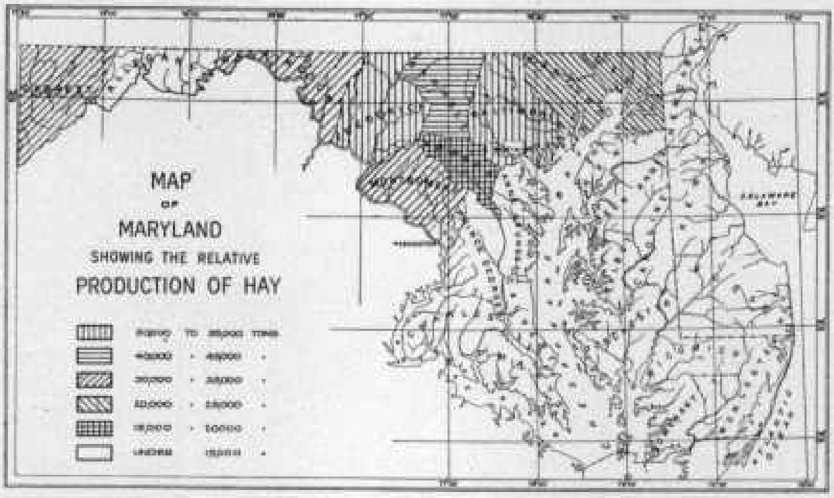

FIG. 52.—MAP SHOWING THE RELATIVE ANNUAL PRODUCTION OF HAY.

are thin, difficult to till, and not adapted to general farming purposes. They are extensively cleared, and are covered in many places with valuable tracts of merchantable timber, especially chestnut.

The "glades" are large swampy tracts of land which occur principally in the central portion of the county. Formerly the glades were famous cattle pastures during the dry seasons, but now large tracts of glade lands have been thoroughly drained and the soils, rich in decayed organic matter, produce good crops of oats, timothy, and even corn and wheat.

In conclusion it may be said that Maryland has a great variety of soils which are adapted to almost any crops that will grow in this section of

FIG. 53.—FARMING AND ORCHARD LAND, ALLEGANY COUNTY.

FIG. 54.—SUGAR-MAPLE GROVE NEAR BITTINGER, GARRETT COUNTY.

the United States. The greater portion of the arable land of the state is under cultivation and farmed at a fair profit, but there are extensive areas, especially in western and southern Maryland, where there is room for great agricultural development.

Forests

The forests of Maryland constitute a resource whose value is very great even to-day, when many years of cutting and often improvident use have

FIG. 55.—SAPLINGS OF LOBLOLLY PINE, ST. MARY'S COUNTY.

together reduced both area and quality of the original stand. Their value not only may be estimated as a commercial asset, but in other less apparent ways in which the forest plays a most important part. The uses of water power are multiplying with the development and increase of great manufacturing industries, and with this there is manifest a resultant demand for power which is both constant and cheap; good agriculture is admittedly a prime necessity for real prosperity in any country, state, or district, and as a cover of forest is a necessity for the power from streams so is a reasonable percentage of wooded land much to be desired where agriculture is to be permanently successful.

FIG. 56.—HEMLOCK FOREST, SIDELING CREEK, WASHINGTON COUNTY.

Maryland has at present 35 per cent of its land area in forest growth, with a stand of timber estimated at 3,829,776,000 board feet and possessing a value of $17,142,112. Once this percentage must have been

95 or even more. Of this timber stand 2,500,747,000 feet are hardwood and 1,328,029 feet are pine.

During the year 1914 the total value of the timber cut in Maryland amounted to $6,494;191, the cost of production being much the largest part.

WATER PRODUCTS

Chesapeake Bay and its tributaries, occupying less than one-quarter of the entire area of Maryland, supply to the people each year products of great value. Throughout the country this magnificent body of water is renowned for its oysters, crabs, terrapin, and shad, yet few even among the inhabitants along its shores realize the great wealth contained in its waters. The average value of the annual output is about $5,000,000.

THE OYSTER INDUSTRY.—The brackish and salt waters of Chesapeake Bay have long been known as the favorite home of the oyster. At the present time the "natural bars" occupy large areas on either side of the main channel of the Bay and about the mouths of the numerous rivers. The total area of natural oyster bars exclusive of the Potomac River is 215,968 acres, while the area of barren bottoms suitable for oyster culture in the same area is 100,800 acres. The most important oyster bottoms are along the shores of Dorchester, Somerset, Talbot, Queen Anne's, Kent, Anne Arundel, Calvert, and St. Mary's counties. If, however, the advantages afforded by the Bay were utilized by a proper system of oyster cultivation there is scarcely a foot of the bottom of the 2000 square miles covered by its shallow waters where oysters could not be reared, and it may be safely asserted that the annual product might reach the colossal amount of 100,000,000 bushels a year. The output of to-day, though insignificant when compared with what it might be, reaches 6,000,000 to 8,000,000 bushels a year, with a value of $3,000,000 to $4,000,000. In 1884, the banner year of Maryland oyster production, the yield was 15,000,000 bushels. The oysters obtained, besides supplying the local demands, support the imporant packing and canning trade of Baltimore, Crisfield, St. Michaels, Oxford, Cambridge, and Annapolis, whose products reach almost every inland town in the country. On the ocean front in the bays bordering Worcester County the oyster industry is rapidly developing.

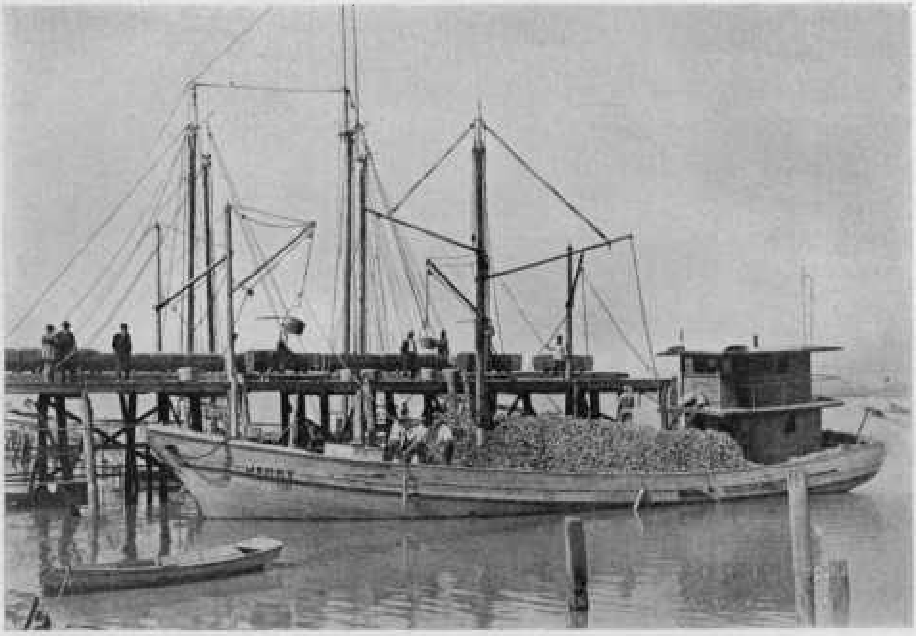

FIG. 57.—A BOAT-LOAD OF OYSTERS, SOMERSET COUNTY.

FIG. 58.—A FISH HATCHERY.

THE SHAD INDUSTRY.—The Fish Commission empty into Chesapeake Bay and its tributaries each year many million young fish to support the shad fisheries of the state, which depend upon the return of the adult shad in the spring of the year. The principal shad region of the Bay shore lies north of Swan Point, between it and the lower stretches of the Susquehanna. The principal landing points for the Bay shore fisheries are Havre de Grace, Northeast, Charlestown, Betterton, and Rock Hall. Large numbers are also caught in the Potomac River, the Pocomoke and

FIG. 59.—AN OYSTER AND CRAB-PACKING PLANT.

Tangier sounds, and in the Choptank, Chester, and Patuxent rivers. The season begins about the first of April and extends to the last of May or the first of June. The largest catches are usually in April. The annual value of the catch is about $250,000.

THE MENHADEN INDUSTRY.—This fish is by far the most abundant fish along the Atlantic coast of the United States and in many ways one of the most important, but since it is not usually regarded as edible it is little known outside of the fishery and fertilizing industries. The menhaden is a small fish seldom weighing a pound and close related to the herring and the shad. It usually makes its appearance in Chesapeake

Bay early in the spring and rapidly becomes more and more abundant, crowding into the sounds and inlets until the water is fairly alive with

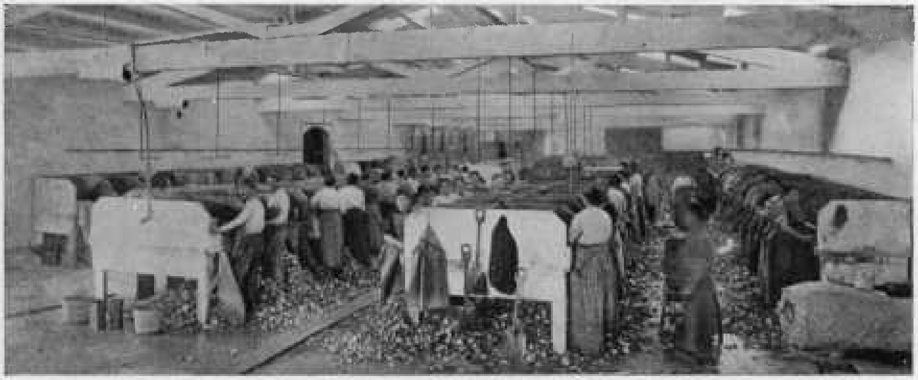

FIG. 60.—SHUCKING OYSTERS.

FIG. 61.—ICING OYSTERS.

them. They remain as long as the weather is warm, but as the winter approaches they pass out into the ocean, so that few are found in Chesapeake Bay after November. They are of great commercial importance from the fact that a valuable oil can be extracted from their bodies by pressure, while the solid residue is an important constituent of manufactured fertilizers. Small catches of the menhaden are made at various points along the shores of Chesapeake Bay, especially in the southern part, but the main industry is at present limited to the Potomac River, which yields more of these small fish than any other river along the eastern Atlantic coast. The total value of the catch in Maryland does not exceed $50,000 annually.

MISCELLANEOUS FISH.—Many other varieties of edible fish are secured from Chesapeake Bay. They reach the markets of the larger cities and towns of the region and some are shipped to distant points. The most highly prized edible fish is the Bay or Spanish Mackerel, which has its chief feeding ground in Chesapeake Bay. Among other important fish are Blue Fish, Trout, White Perch, Yellow Perch, Rock, Herring, Flounders, Sturgeon, Pike, and Pickerel. The total annual catch has a value of about $500,000.

THE CRAB INDUSTRY.—During the season, from April to October, the shallower waters of the shores and estuaries of Chesapeake Bay, as well as the waters on the ocean side, contain an indescribable number of crabs. This abundance causes a fierce competition for food so that the crabs are always hungry and ready to seize any sort of animal bait. The number of hard-shell crabs captured in a day is astonishing, a single fisherman sometimes catching 2000 between sunrise and ten in the morning. At the principal crab-canning centers of Oxford, Cambridge, and Crisfield a large part of the catch is picked and canned, yielding great quantities of crab meat annually. The crabs, during the few hours when their shells are soft, take no food and hide themselves in the sand or grass, so that soft-shell crabs are much less abundant and bring a higher price than the hard-shell. Moreover, when the crab is soft it is very delicate and easily killed, and is thus transported alive with difficulty. The irregularities in the daily catch which might arise under these adverse circumstances are avoided by the use of "shedding pens," which hold the "shedders" until they are soft. The total annual value of the crabs caught in Maryland is in excess of $300,000.

TERRAPIN.—The oyster and the crab suggest the terrapin as a third characteristic product of the shores of the Chesapeake. This expensive little tortoise ranges from New England to Texas, but is most abundant in the marshy lands from the Chesapeake southward. The terrapin is most easily caught in the summer when the demand is slight, so that the catch is "farmed" in pens and fed with crabs and fish until the winter, when as a delicacy the terrapin may bring as much as $75 per dozen.

CLAMS.—During the season, from May until September, the estuaries and bays of Somerset County afford clams in great abundance, especially from Tangier and Pocomoke sounds.

MANUFACTURES

The manufactures of the state, according to the census of 1910, amounted to $315,669,000, making Maryland the fifteenth state in the Union in the value of her manufactured products. The state has gradually lost its relative position, being seventh among the states in 1849, but has greatly increased its per capita production during that period. It was $57 in 1849 and $244 in 1909. Its proportion of the total value of manufactures of the country declined from 3.2 per cent in 1849 to 1.5 per cent in 1909.

CLOTHING.—The most important manufactured product is clothing, especially men's clothing, in which Maryland ranks fourth among the states. The greater part of this manufacture is carried on in Baltimore City.

COPPER, TIN, AND SHEET IRON PRODUCTION.—The second most important group of manufactured products is enumerated under this head, with an increase of 82.5 per cent in five years, due largely to the increased production of stamped and enameled ware.

CANNING AND PRESERVING.—Maryland has always been one of the chief centers for the canning and preserving industry, fruits, vegetables, fish, and oysters being the chief products. Many large establishments are found in Baltimore, while others are scattered throughout the central and eastern portions of the state near the source of supply.

SLAUGHTERING AND MEAT PACKING.—There has been a constant increase in the production of the slaughtering and meat-packing establishments of Maryland, until to-day it is one of the most important industries of the state.

LUMBER AND TIMBER PRODUCTS.—There are more establishments engaged in this industry than any other in the state, the produce consisting of lumber, shingles, cooperage materials, doors, sash, blinds, interior finish, and packing boxes. Many of these industries are in the counties near the source of timber supply, while others, especially those engaged in the manufacture of finished products, are located in Baltimore.

FIG. 62.—THE INTERIOR OF A BALTIMORE POTTERY.

FOUNDRY AND MACHINE-SHOP PRODUCTS.—Maryland produces a great diversity of foundry and machine-shop products for some of which it has a wide reputation. Most of these establishments are located in Baltimore.

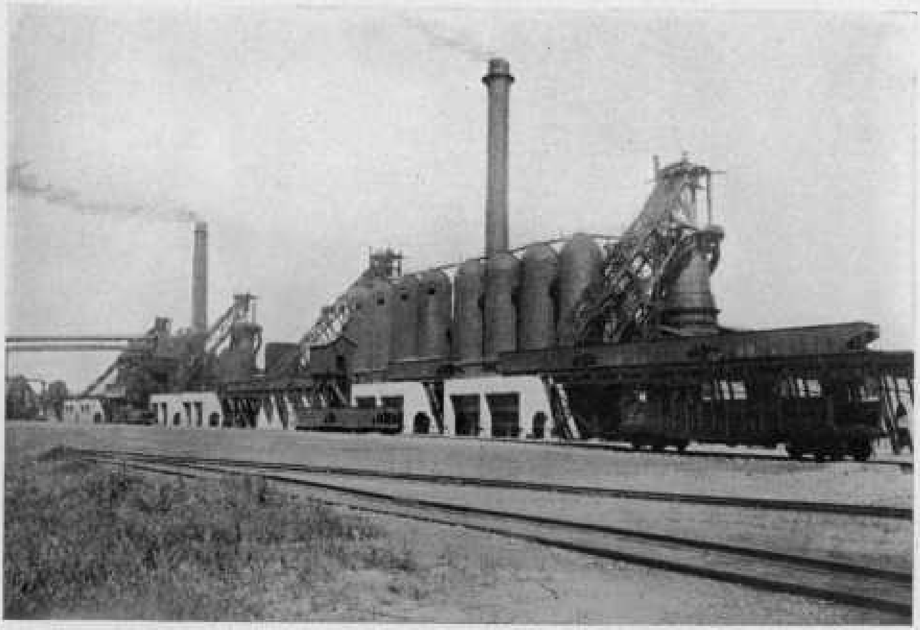

FIG. 63.—A BLAST FURNACE OF THE BETHLEHEM STEEL COMPANY, SPARROWS POINT.

FIG. 64.—ORE DOCKS AT SPARROWS POINT.

TOBACCO MANUFACTURE.—The City of Baltimore has always been an important center for tobacco manufacture, including chewing and smoking tobacco and snuff, as well as cigars and cigarettes.

FERTILIZERS.—The manufacture of fertilizers has been one of the characteristic industries of Maryland, the inception of the industry dating from about 1832, when the demand arose for a fertilizer in connection with tobacco culture. In 1879 Maryland was the leading state in the Union in

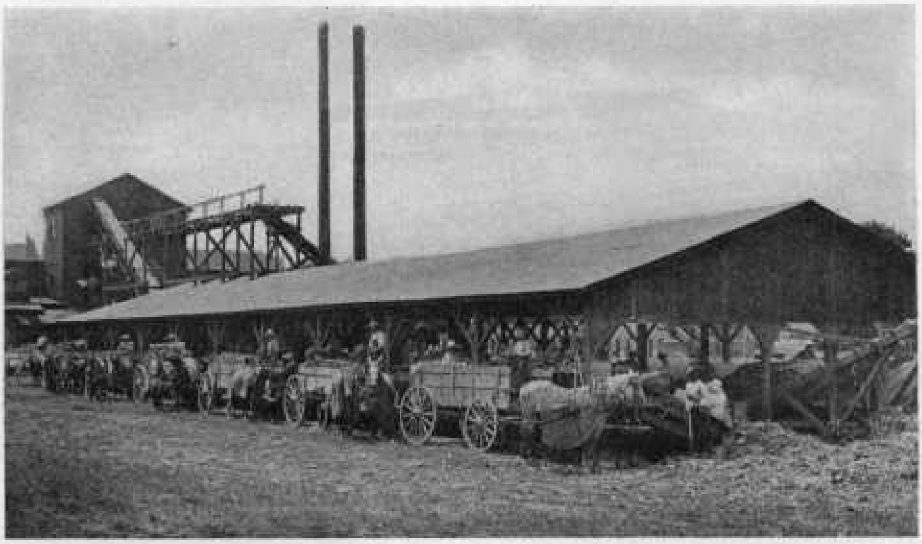

FIG. 65.—DELIVERING SWEET CORN AT CANNERY, EASTON, TALBOT COUNTY.

the manufacture of commercial fertilizers and it to-day ranks second in that respect. Most of the establishments are located in Baltimore or its vicinity, although there are several in other portions of the state.

IRON AND STEEL.—The manufacture of iron and steel, especially steel rails and plates for vessels, has increased greatly in importance in the last two decades, the chief industry being the Maryland branch of the Bethlehem Steel Company at Sparrows Point on the Patapsco River below Baltimore.

CITIES AND TOWNS

The State of Maryland has only four cities of more than 10,000 inhabitants, Baltimore with a population of 558,485 being the only great city. There are only 13 cities and towns which exceed 3000 in population, which shows that the occupation of the people of the counties is chiefly confined to agriculture, although the fishing and oyster industries of the Chesapeake Bay region and the mining and quarrying operations of the western and central counties likewise support a large scattered population. These

FIG. 66.—VIEW OF BALTIMORE HARBOR AND SKY-LINE.

towns and cities with a population of more than 3000, according to the U. S. Census of 1910, are the following:

BALTIMORE, with a population of 558,485, is the most important city of the state. It is situated at the head of navigation, on the Patapsco River, about 13 miles from Chesapeake Bay and 170 miles from the Atlantic Ocean at Cape Henry. Baltimore offers many advantages as a commercial center in its natural location, in its peculiar economic conditions, and in the liberal policy of its municipal administration. Its geographic situation is most advantageous for land and water transportation, direct lines of communication by rail connecting it with the great agricultural and mining regions of the south and west, while numerous

FIG. 67.—THE LOWER HARBOR FROM HISTORIC FORT McHENRY.

FIG. 68.—LIGHT STREET WHARVES AT THE HEAD OF BALTIMORE'S HARBOR.

lines of steamboats have developed a most important coastwise and foreign trade.

Baltimore, named after the then Proprietor of Maryland, Lord Baltimore, was laid out in 1729 on a tract of 60 acres, which cost only $600. Its rapid growth in population and commercial importance has been due to the many favorable conditions before cited. The principal industries are ready-made clothing, oystercanning and fruitpacking, shirts and overalls, fertilizers, straw goods, cotton duck, iron and copper, tobacco, drugs and medicines, clay products, shipbuilding, marble and stone work, lumber, and furniture making.

FIG. 69.—VIEW OF CUMBERLAND AND THE "NARROWS" OF WILLS MOUNTAIN.

Baltimore is renowned for its beautiful parks, places and public buildings, and on account of the many monuments in its public squares has been termed "The Monumental City." Druid Hill Park and Mount Vernon Place are famed for their beauty. Washington Monument, in the center of the latter, was the first of the public monuments to be erected to the Father of his Country. Baltimore is also the seat of the famous Johns Hopkins University and many other similar educational institutions.

CUMBERLAND, named after old Fort Cumberland of colonial days, is the second city in importance, with a population of 21,839. It is situated in Allegany County, on the upper waters of the Potomac River and on the direct line of communication with the west. The situation of this city is exceptionally favorable for manufacturing purposes on account of its location in the midst of rich resources in steam coals and lumber. It has many important industrial establishments. In the immediate neighborhood are materials suitable for the manufacture of glass, hydraulic cement, and high-grade building and firebricks. Next to Baltimore it is the most important railroad center in the state, being reached by the Baltimore and Ohio, Pennsylvania, and Western Maryland railroads.

HAGERSTOWN, named for Jonathan Hager, its founder, is the third city in size, with a population of 16,507. It is located in the center of the fertile Cumberland Valley and is one of the most enterprising towns of the state. It is the distributing point for a rich farming country and is also a prominent industrial center. The most noted of its manufactures are bicycles, silk, knit goods, shirts, brick, furniture, and carriage stock. Several railroads center at Hagerstown so that excellent transportation facilities are provided.

FREDERICK, named for the last Proprietor, Frederick, sixth Lord Baltimore, is the fourth city in size, with a population of 10,411. It is, like Hagerstown, the center of an important agricultural region and likewise has numerous industries, among them tanneries, foundries, sash factories, brick works, and knitting mills.

ANNAPOLIS, the capital of the state since 1694, when it was changed from St. Mary's City, is the fifth city in size, with a population of 8609. It is the oldest city in the state and was settled in 1649 under the name of Providence, afterward changed to Anne Arundeltown. In 1708 it received its name of Annapolis under a charter granted by the English queen. It is the seat of the United States Naval Academy, established in 1845, and of St. John's College, which was chartered in 1789. The State House is one of the most interesting buildings of the colonial period. Many private houses of the same period are still standing and are among the most beautiful structures of their kind in existence. The Continental Congress held its sessions here for a period and in the old Senate Chamber

FIG. 70.—VIEW OF ANNAPOLIS SHOWING THE NAVAL ACADEMY.

FIG. 71.—VIEW OF FROSTBURG.

of the State House Washington resigned, on December 22, 1783, his commission as Commander-in-Chief of the Continental Army. The chief industry is oyster-packing. The city is provided with excellent rail and steamboat communication.

SALISBURY, with a population of 6690, is the largest town on the Eastern Shore. It is an important business center and contains a variety of industries, the most important interests centering in lumbering.

CAMBRIDGE, with a population of 6407, is in the midst of a fertile farming country on the Eastern Shore and is an important shipping point for vegetables and fruits. It has a fine harbor and its shipping facilities, both by land and water, are excellent. The chief industries are oysterpacking and canning.

FROSTBURG, with a population of 6280, is situated in western Allegany County at an elevation of 2000 feet above tide. It is in the center of the coalmining district of the Georges Creek Valley and its interests largely center in that industrty.

HAVRE DE GRACE, with a population of 4212, is beautifully located at the mouth of the Susquehanna River. It is an important manufacturing and fishing center, its chief industries being canneries, flour and lumber mills, sash factories, and textile works.

BRUNSWICK, located on the Potomac River in Frederick County, with a population of 3721, is an important and rapidly growing railroad town containing large freight yards and repair shops of the Baltimore and Ohio Railroad. There are also several manufacturing establishments.

CRISFIELD, situated on the eastern shore of Chesapeake Bay near the Virginia line, with a population of 3468, is reached both by boat and rail. It is an important oyster and crab center, extensive shipments of both fresh and canned products being made from this point to all parts of the country.

WESTMINSTER, with a population of 3295, is an important distributing center for a rich farming district. The chief industries are flour mills and factories, the latter chiefly engaged in the manufacture of carriages and cigars. Western Maryland College, under the control of the Methodist Protestant Church, is situated here.

EASTON, with a population of 3083, is situated on the Choptank River, and has both water and rail communications. The town is the trading center for the surrounding grain and fruit country, its chief industries being mills, canning establishments, furniture, and shirt factories.

SUGGESTIONS FOR PHYSIOGRAPHIC AND GEOLOGIC EXCURSIONS

The great variety exhibited by the State of Maryland in its physiography and geology, and in the products of its mines and quarries, farms, and manufacturing plants renders it possible to see easily from each of the leading centers many of the interesting features of the state. A few suggestions for physiographic and geologic excursions are given in the following paragraphs.

BALTIMORE AND VICINITY

The City of Baltimore is so situated as to display in its eastern and southern sections and the areas adjacent thereto many of the characteristic features of the Coastal Plain, while in the northern and western parts of the city and in the surrounding country the characteristics of the Piedmont Plateau are shown. In the lower portions of the city, from Baltimore Street southward to Long Bridge, the city is built on the Talbot terrace (latest Pleistocene), the gravels and loams of this terrace overlying the clays of the Potomac group (Lower Cretaceous), while on Charles Street from Lexington Street north and throughout a wide area in the center of the city the Wicomico terrace (middle Pleistocene), much cut by streams which often reach the underlying Potomac clays and sands, forms the surface. Farther north and west at the level of Eutaw Place and portions of Druid Hill Park the Sunderland terrace (early Pleistocene), much dissected, caps the summits. On the highest levels around the northern and western sections of the city, the highlands contain remnants of the Brandywine (Pliocene) terrace, the underlying crystalline rocks, however, often appearing at the surface. The underlying Potomac clays and the ancient rocks of gneiss or gabbro outcrop at the higher levels, along the slopes of the hills and in the stream valleys (gneiss at Jones Falls; gabbro at Gwynns Falls above Calverton). In the upland areas the rocks are often disintegrated to considerable depths, producing a cover of residual materials. Many interesting minerals may be found in the quarries opened along the stream channels or in railroad cuts, among the more common being quartz, feldspar, pyroxene, hornblende, etc.

If wider areas are visited fine exposures of Potomac clays may be found on the southern shore of the Patapsco River (Hawkins Point), while at White Rocks and Rocky Creek nearby are younger Cretaceous sandstones of the Raritan formation. To the north of the city in many of the valleys crystalline limestone or marble may be seen (Texas, Limekiln Valley, and Green Spring Valley), the limestone forming the valley floors while harder quartzite or mica schist form the surrounding hills. The green serpentine, an ancient eruptive rock now much altered, of the Bare Hills region, is a special geologic feature of much interest. The streams about Baltimore have had a varied history and may be separated into two types, those flowing with rapid currents over a floor of crystalline rock, and the more sluggish, often tidal, streams whose beds are in the Cretaceous or later deposits. The line separating the two, which crosses the state from northeast to southwest, is known as the "fall line" (well shown at Relay, and Raspeburg) and represents the point where the streams flowing with rapid currents over the crystalline rocks reach the unconsolidated sediments of the Coastal Plain. The tidal streams represent part of the submergence which formed Chesapeake Bay and its many estuaries, and which has made possible the unparalleled water transportation of the state.

CENTRAL MARYLAND

This district corresponds in a general way with the Piedmont Plateau and affords a great variety of crystalline rocks, for the most part highly altered from their original constitution with the obliteration of many of their former characteristic structures, and with new ones developed which are characteristic of rocks of this type over a wide area of the Piedmont belt in adjoining states. Into these ancient metamorphosed crystallines have been injected molten rocks which to-day appear as pegmatite and diabase dikes. The texture of the rocks, as a result of recrystallization under great pressure, presents a characteristic foliation often much contorted. This may be widely seen in the more schistose rocks. Even the eruptives have frequently developed a similar schistosity. The rocks have been extensively folded and faulted, great overthrusts occurring which have greatly complicated the structure of the district. The higher upland surface of the Piedmont represents the old Schooley peneplain, while at lower levels have been developed the Weverton and Harrisburg peneplains, the last forming the floor of the Frederick Valley and some of the smaller streams which trench the Piedmont area.

TOWSON is situated for the most part on the crystalline Baltimore gneiss, the higher portions of the town reaching the ridge of Setter's quartzite, while to the north of this in the various valleys stretching to the north, west, and east may be found the so-called Cockeysville marble which has been so extensively worked for economic purposes. Towson lies on the surface of the ancient Schooley peneplain, this upland being more or less dissected by the streams which have cut their way through the overlying rock.

BELAIR is located on the broad upland plain of the Piedmont, known as Schooley peneplain, a large area of gabbro forming the underlying rock to the north and west, while the gneiss is the basal rock to the east. Some miles to the northward the Maryland and Pennsylvania Railroad runs through a small gorge capped by quartzite (Rocks of Deer Creek), while near the state line at Cardiff is the famous Peach Bottom slate district (Slate Ridge).

WESTMINSTER is near the center of the Piedmont area, and is situated on the broad plateau known as the Weverton peneplain, which in this district has not been deeply trenched by the stream channels. The most common rock of the region is the phyllite, intercalated with which are numerous lenses of crystalline limestone and basic volcanics, especially along the line of the railroad to the west of the city (Union Bridge). At several points in the center of the county are dikes of diabase rock.

ELLICOTT CITY nestles in the gorge of the Patapsco River in the midst of an area of gabbro cut at many points by dikes and larger bodies of granite, while farther west are numerous pegmatite dikes which have been the source of commercial feldspar.

ROCKVILLE is located in the schist district of the dissected central Piedmont. To the south is an area of basic volcanics, to the east are granites and diorites, and to the west dikes of serpentine and disbase. About Seneca and farther west is a large district composed of Newark breccia, sandstones, and shales (Triassic).

WESTERN MARYLAND

This region has been hitherto described under the name of the Appalachian Region and presents a great diversity in its physiography and geology. The rocks have been deformed into a series of folds, much faulted to the east, but generally becoming flatter to the west. The crests of the mountain tops represent the ancient Schooley peneplain, while the lower ridges and valleys successively represent the Weverton and Harrisburg peneplains, while along the Potomac and its larger estuaries terraces of later date may be observed. The rocks comprise the various Paleozoic formations from the Cambrian to the Permian, with here and there ancient igneous rocks, while along the eastern margin of the district are to be found the Triassic sandstones and shales. The Potomac has cut its way downward from the ancient peneplain over which it flowed across the numerous sandstone ridges of the district, while its tributary streams have for the most part made their channels in the softer rock.

HAGERSTOWN is situated on the broad valley floor of the Harrisburg peneplain, the underlying rocks being limestone of late Cambrian and early Ordovician age. A few miles to the west of the city extending from Williamsport to the northern border of the state is a low ridge of late Ordovician shale (Martinsburg). Along the mountain sides the Weverton peneplain is indistinctly shown, but in the level-topped crests of South (quartzite) and North (sandstone) mountains are remnants of the old Schooley peneplain. Fossil remains of the early Paleozoic formations showing the marine character of most of these formations may be collected at times in the quarries and railroad cuts.

Cumberland is located in the Potomac Valley and its tributary Braddock Run and is largely underlain by Silurian (Clinton) shale, often rich in fossils, showing the marine origin of the deposits. Cumberland is bounded on the west by Wills Mountain (Juniata and Tuscarora sandstones), which in its level-topped crest line shows with exceptional clearness the ancient level of the Schooley peneplain that once extended over the entire region before the valleys were cut in the softer beds. To the west as well as to the east of Wills Mountain, which represents the axis of a great fold, come in succession the various Silurian, Devonian, and Carboniferous formations. On the western limb of this fold in beds of Silurian age occurs the Devils Backbone. These various formations are often rich either in marine fossils or terrestrial plant remains, and Cumberland has long been classic ground for the geologist. The deep valley gradually cut by Braddock Run through the Wills Mountain anticline is of unusual geologic interest, while the numerous terraces in and adjacent to the city are among the best in the valley of the Potomac.

Oakland is located in the valley of the Youghiogheny River, the waters of which reach the Ohio River. It is situated on the Devonian shales (Jennings), which stretch as a broad belt from northeast to southwest across the county. East and west of Oakland the sandstone ridges constitute remnants of the ancient Schooley peneplain which in Garrett County must have stood at quite 3500 feet in elevation. Both in the Potomac basin to the southeast and the Oakland basin to the west, the Carboniferous deposits afford many localities from which both animal and plant remains may be secured. Oakland itself stands near the center of a great fold which is more flattened here than in the more eastern parts of the Appalachian district.

Southern Maryland

This area is embraced within the limits of the Coastal Plain and is composed of various geological formations from the Lower Cretaceous to the Pleistocene. The deposits are made up chiefly of gravels, sands, clays, and marls, which are in the main unconsolidated and dip at a very low angle to the southeast. The district has been subjected to a series of elevations and depressions since late Tertiary time, with the result that a complicated series of terraces has been developed along the margin of the Coastal Plain and in its various river channels. These later Tertiary and Pleistocene terraces succeed one another from above downward, the sea at the present day being engaged in the formation of the last of the series beneath the shallow marginal waters. The streams are largely tidal, the channels being submerged at the time the waters of the Atlantic filled the basin of the Chesapeake during the last great depression of the late Pleistocene epoch.

ANNAPOLIS is located on the Talbot terrace (late Pleistocene), the escarpment of the Wicomico terrace (middle Pleistocene) being found near the western margin of the city. On the Severn River nearby the Eocene strata occur beneath the Talbot, containing at many points characteristic marine fossils (mollusks, sharks' teeth, etc.), while farther up the stream occur beds of Upper Cretaceous age, also fossiliferous, dipping beneath the Eocene. The uppermost of these (Monmouth and Matawan) contain marine fossils, while the subjacent formations (above Round Bay), consisting of white sands and clays (Magothy and Raritan), contain at times terrestrial plant remains. To the south of Annapolis about South and West rivers occur the Miocene formations overlying the Eocene, the diatomaceous deposits of the latter being especially well represented around Herring Bay.

UPPER MARLBORO is situated on a tributary of the Patuxent River on the dissected upland surface of the Coastal Plain, the Eocene formations extensively outcropping in the surrounding region. Numerous marine fossils of Eocene age have been found in the greensand beds. In the valleys of Western Branch and the nearby Patuxent, the Talbot terrace is in places well developed, while at higher points remnants of both the Wicomico and Sunderland terrace are also found. Some miles to the south of Upper Marlboro the Brandywine terrace is typically developed, the broad plain in this region being the most extensive on the western side of the Chesapeake.

LA PLATA is situated near the southern end of the Brandywine terrace, although the plain is here much dissected, the lower terraces occurring not far away in the various stream channels. The underlying deposits are of Eocene age, generally greensand marls, frequently rich in fossil remains.

PRINCE FREDERICK is situated on the Sunderland terrace, which forms the crest of the highland between Chesapeake Bay and Patuxent River. To the east and west of the town the stream channels cut through to the underlying Miocene deposits which in Calvert County have furnished a great wealth of fossil remains, all of the Miocene formations being here well developed. The Wicomico and Talbot terraces appear one below the other at various points along the margin of the Chesapeake and Patuxent.

LEONARDTOWN is likewise situated on the Sunderland terrace with successively lower terraces appearing both along the Potomac and Patuxent river fronts and frequently extending up the tributary channels. Beneath these terraces, over a large part of St. Mary's County, are found the several Miocene formations, rich in marine fossils, and extensive collections both from this and adjacent counties now enrich the museums both of this and foreign countries.

NORTHERN EASTERN SHORE

The northern Eastern Shore is chiefly confined to the Coastal Plain. the deposits in general being similar to those found in Southern Maryland. They consist of representatives of the various formations from the Lower Cretaceous to the Pleistocene. The several terraces described for Southern Maryland are here developed, although the Brandywine and Sunderland terraces are much less extensively represented in this area. On the other hand, the Wicomico and Talbot terraces are much more largely developed and present broad terraced plains that are highly characteristic of the northern district, the escarpment separating the Talbot from the Wicomico terrace being one of the most distinctive physiographic features in the region. Tidal rivers extend far into the region, even the upper courses of the streams being for the most part sluggish because of the relatively slight elevation of the land.

ELKTON is situated at the head of Elk River on the Talbot terrace, which is underlain at this point by Potomac clays (Lower Cretaceous). Surrounding the town on the north, east, and west are the higher and older terrace formations (Wicomico and Sunderland). Farther to the northward is an extensive area of granite-gneiss overlain along the eastern margin by Cretaceous sediments. The very characteristic hypersthene gabbro outcrops at Grays Hill and along the valley of Big Elk Creek. Farther to the north and west in Cecil County occur serpentine and other eruptive rocks, while to the south along Elk Neck and in southern Cecil County may be found an extensive series of Upper Cretaceous and Tertiary formations, many of them rich in marine organic remains.

CHESTERTOWN is located on the Talbot terrace in the valley of Chester River, although the escarpment of the Wicomico terrace is found on the northern margin of the town. This older terrace covers an extensive area in central and eastern Kent County. Eocene deposits, either unaltered greensands or oxidized reddish sands, are found beneath the terrace cover.

CENTERVILLE likewise lies near the margin between the Talbot and Wicomico terraces, the latter covering an extensive area to the south and east of the town. Beneath these surface formations both at Centerville and throughout most of Queen Anne's County occur Miocene formations, which at a few points have furnished marine organic remains.

EASTON is likewise situated near the margin between the lower Talbot terrace and the next higher Wicomico terrace, the latter covering an extensive area in central and northern Talbot County. Beneath these formations the Miocene marine beds are found, as is the case farther north.

DENTON is situated in the valley of the Choptank River along the basin of which the Talbot terrace extends from Chesapeake Bay as far as Greenville. To the east and south of Denton the higher Wicomico terrace spreads out as a broad plain throughout the central, southern, and eastern portions of the county. Beneath this surface formation Miocene strata are found with their marine fossils.

SOUTHERN EASTERN SHORE

This division of the state is wholly within the area of the Coastal Plain and presents many features in common with the southern part of the district just described. It is very low, rising only at a few points to 80 feet in height above tide, this elevation being reached in the remnants of the Wicomico terrace, which extends southward only at a few points into the southern Eastern Shore. Most of the district is covered by the Talbot terrace, which around its landward margin does not exceed 40 feet in elevation, although a large part of the area in the southern counties is below 25 feet in elevation above tide. The underlying formation of Miocene age only outcrops at a few points in the northern part of the district, although deep-well borings have penetrated these and still older formations. Marsh lands cover extensive areas in Dorchester, Wicomico, and Somerset counties, while the Atlantic border of Worcester County has a splendidly developed ocean sand bar nearly inclosing a large area of brackish water known as Chincoteague Bay.

CAMBRIDGE is located on the Talbot terrace, which spreads as a level-topped plain of many hundred square miles in area in all directions, reaching far into the confines of adjacent counties. The Wicomico terrace appears some miles to the eastward at East Newmarket, but covers only a small area in eastern Dorchester County. Underlying the deposits of these terraces are the later formations of the Miocene, which outcrop at a few points near Cambridge and farther up the Choptank River where characteristic marine fossils have been found.

SALISBURY is situated on the Wicomico River on the Talbot terrace, although the Wicomico terrace appears not far to the north and east, but from its seaward slope it is much lower here than in the counties farther northward and the escarpment separating the two terraces is less sharply defined. No deposits of older date are found along the stream channels, although well borings have penetrated the underlying Miocene formations.

PRINCESS ANNE is located on the Talbot terrace but a few feet above tide level, the terrace here being broad and level and reaching well to the northern limits of the county, where at one point in the northeastern corner the Wicomico terrace projects itself for a short distance beyond the boundary. No underlying deposits are found along the stream channels, although they have been penetrated in well borings, especially at Crisfield, where a well boring over 1000 feet in depth has not only penetrated the Miocene deposits but also the Eocene and Cretaceous as well, although it has not touched bed rock.

SNOW HILL is likewise found on the Talbot terrace very near tide level, the terrace plain here likewise stretching in all directions for many miles. The Wicomico terrace is only found in a few detached areas near the north and northwest borders of the county. The Talbot terrace contains along its seaward margin various later deposits of wind-blown sand that at times reach the proportions of important dunes, while the bars and spits along the coast possess much of recent geologic interest. No underlying deposits are found, although deep-well borings in adjacent areas show that these formations exist at depths beneath the surface cover of terrace formations.

TABLE I.—GOVERNORS OF MARYLAND

BARONS OF BALTIMORE AND LORDS PROPRIETARY OF MARYLAND

GEORGE CALVERT, FIRST LORD BALTIMORE

LORDS PROPRIETARY

Cecil Calvert, Second Lord Baltimore	1632-1675
Charles Calvert, Third Lord Baltimore	1675-1715
Benedict Leonard Calvert, Fourth Lord Baltimore	1715
Charles Calvert, Fifth Lord Baltimore	1715-1751
Frederick Calvert, Sixth Lord Baltimore	1751-1771
Sir Henry Harford	1771-1776

PROVINCIAL GOVERNORS

Leonard Calvert	1633-1645
Richard Ingle (usurper)	1645
Edward Hill (chosen by the council)	1646
Leonard Calvert	1646-1647
Thomas Greene	1647-1649
William Stone	1649-1652
Richard Bennett, Edmund Curtis, William Claiborne (Commissioners of Parliament)	1652

William Stone 1652-1654
William Fuller and others (appointed by Commissioners of Parliament) 1654-1658
Josias Fendall 1658-1660
Philip Calvert 1660-1661
Charles Calvert 1661-1675
Charles Calvert, third Lord Baltimore..1675-1676
Cecilius Calvert (titular) and Jesse Wharton (real)................1676
Thomas Notley 1676-1679
Charles Calvert, third Lord Baltimore..1679-1684
Benedict Leonard Calvert (titular) and council (real)..............1684-1688
William Joseph (president of the council)........................1688-1689
Protestant Association under John Goode.........................1689-1692

ROYAL GOVERNORS

Sir Lionel Copley..1692-1693
Sir Edmond Andros..1693-1694
Francis Nicholson 1694-1699
Nathaniel Blackistone 1699-1702
Thomas Tench (president of the council)........................1702-1704
John Seymour 1704-1709
Edward Lloyd (president of the council)........................1709-1714
John Hart 1714-1715

PROPRIETARY GOVERNORS

John Hart 1715-1720
Charles Calvert 1720-1727
Benedict Leonard Calvert..1727-1731
Samuel Ogle 1731-1732
Charles Calvert, fifth Lord Baltimore..1732-1733
Samuel Ogle 1733-1742
Thomas Bladen 1742-1747
Samuel Ogle 1747-1752
Benjamin Tasker (president of the council)......................1752-1763
Horatio Sharpe 1753-1769
Robert Eden 1769-1774

REVOLUTIONARY GOVERNORS

Robert Eden (nominal) and Convention and Council of Safety (real).1774-1776

STATE GOVERNORS

Thomas Johnson 1777-1779
Thomas Sim Lee..1779-1782
William Paca 1782-1785
William Smallwood 1785-1788
John Eager Howard..1788-1791
George Plater (died in office)..1791-1792
James Brice (acting)..1792

Thomas Sim Lee	1792-1794
John H. Stone	1794-1797
John Henry, Democratic Republican	1797-1798
Benjamin Ogle, Federalist	1798-1801
John Francis Mercer, Democratic Republican	1801-1803
Robert Bowie, Democratic Republican	1803-1806
Robert Wright, Democratic Republican (resigned May 6, 1808)	1806-1808
James Butcher (acting)	1808-1809
Edward Lloyd, Whig	1809-1811
Robert Bowie, Democratic Republican	1811-1812
Levin Winder, Federalist	1812-1815
Charles Ridgely, Federalist	1815-1818
Charles Goldsborough, Federalist	1818-1819
Samuel Sprigg, Democratic Republican	1819-1822
Samuel Stevens, Jr., Democratic Republican	1822-1825
Joseph Kent, Democratic Republican	1825-1828
Daniel Martin, Anti-Jackson	1828-1829
Thomas King Carroll, Jackson Democrat	1829-1830
Daniel Martin, Anti-Jackson	1830-1831
George Howard (acting), Whig	1831-1832
George Howard, Whig	1832-1833
James Thomas, Whig	1833-1835
Thomas W. Veazey, Whig	1835-1838
William Grason, Democrat	1838-1841
Francis Thomas, Democrat	1841-1844
Thomas G. Pratt, Whig	1844-1847
Philip Francis Thomas, Democrat	1847-1850
Enoch Louis Lowe, Democrat	1850-1853
Thomas Watkins Ligon, Democrat	1853-1857
Thomas Holliday Hicks, American or Know-Nothing	1857-1861
Augustus W. Bradford, Unionist	1861-1865
Thomas Swann, Unionist	1865-1868
Oden Bowie, Democrat	1868-1872
William Pinkney Whyte, Democrat (resigned in 1874 to become, March 4, 1875, U. S. Senator from Maryland)	1872-1874
James Black Groome, Democrat	1874-1876
John Lee Carroll, Democrat	1876-1880
William T. Hamilton, Democrat	1880-1884
Robert M. McLane, Democrat	1884-1885
Henry Lloyd, Democrat	1885-1888
Elihu E. Jackson, Democrat	1888-1892
Frank Brown, Democrat	1892-1896
Lloyd Lowndes, Republican	1896-1900
John Walter Smith, Democrat	1900-1904
Edwin Warfield, Democrat	1904-1908
Austin L. Crothers, Democrat	1908-1912
Phillips Lee Goldsborough, Republican	1912-1916
Emerson C. Harrington, Democrat	1916-

TABLE II.—THE POPULATION AND AREA OF THE STATE BY COUNTIES

Counties	Date of erection	1910	Area in square miles	County towns
Allegany	1789	62,411	440.5	Cumberland.
Anne Arundel	1650	39,553	430.4	Annapolis.
Baltimore	1659	122,349	646.8	Towson.
Baltimore City	1729 1851	558,485	30.0	....
Calvert	1654	10,325	216.8	Prince Frederick.
Caroline	1726	19,216	317.4	Denton.
Carroll	1838	33,934	445.3	Westminster.
Cecil	1674	23,759	374.6	Elkton.
Charles	1660	16,386	462.0	La Plata.
Dorchester	1666	28,669	573.2	Cambridge.
Frederick	1748	52,673	660.0	Frederick.
Garrett	1872	20,105	681.0	Oakland.
Harford	1773	27,965	439.8	Belair.
Howard	1850	16,106	249.1	Ellicott City.
Kent	1637	16,957	281.0	Chestertown.
Montgomery	1776	32,089	517.6	Rockville.
Prince George's	1695	36,147	479.6	Upper Marlboro.
Queen Anne's	1706	16,839	363.4	Centerville.
St. Mary's	1637	17,030	369.1	Leonardtown.
Somerset	1668	26,455	328.6	Princess Anne.
Talbot	1661	19,620	267.1	Easton.
Washington	1776	49,617	457.3	Hagerstown.
Wicomico	1867	26,815	368.9	Salisbury.
Worcester	1742	21,841	491.5	Snow Hill.

TABLE III.—POPULATION OF PRINCIPAL CITIES AND TOWNS OF MARYLAND—CENSUS 1910

Annapolis	8,609	Havre de Grace	4,212
Baltimore	558,485	Hyattsville	1,917
Belair	1,005	Laurel	2,415
Berlin	1,317	Lonaconing	1,553
Brunswick	3,721	Midland	1,173
Cambridge	6,407	Mount Rainier	1,242
Centerville	1,437	Oakland	1,366
Chesapeake City	1,016	Oxford	1,191
Chestertown	2,735	Pocomoke City	2,369
Crisfield	3,468	Port Deposit	1,394
Cumberland	21,839	Princess Anne	1,006
Denton	1,481	Rockville	1,181
Easton	3,083	St. Michaels	1,517
Elkton	2,487	Salisbury	6,690
Ellicott City	1,151	Snow Hill	1,844
Emmitsburg	1,054	Takoma Park	1,242
Federalsburg	1,050	Westernport	2,702
Frederick	10,411	Westminster	3,295
Frostburg	6,028	Williamsport	1,571
Hagerstown	16,507		

TABLE IV.—LEGAL HOLIDAYS IN MARYLAND

1. New Year's Day, January 1.
2. Washington's Birthday, February 22.
3. Decoration Day, May 30.
4. Independence Day, July 4.
5. Defenders' Day, September 12.
6. Columbus Day, October 12.
7. Christmas Day, December 25.
8. Good Friday.
9. General Election Day.
10. Congressional Election Day.
11. All special days that may be appointed or recommended by the Governor of this State or the President of the United States as the days of thanksgiving, fasting and prayer or other religious observance, or for the general cessation of business.
12. Sundays.

Saturday afternoon is a holiday in Annapolis, Baltimore city and county, in the counties of Harford, Montgomery and Cecil, and in the towns of Ellicott City and Westminster.

Labor Day (the first Monday in September) is a Federal holiday by Act of Congress and is generally proclaimed by the Governor a legal holiday in Maryland.

Arbor Day is designated by the Governor as a day for tree planting.

Repudiation Day, November 23, is a legal half holiday in Frederick County.

Whenever the first of January, the twenty-second of February, the fourth of July, or twenty-fifth of December shall occur on Sunday, the Monday next following shall be a public holiday, provided that in such case all bills of exchange, bank checks, drafts and promissory notes which would otherwise be presentable shall be deemed to be presentable for acceptance or for payment on the Saturday next preceding such holiday.

TABLE V.—MINERAL PRODUCTS IN MARYLAND, 1916

Coal and Coke		$8,334,632
Clay Products:		
Brick and Tile, including Sand-Lime Brick	$1,548,295	
Pottery	277,575	
Clay mined	82,667	
		1,908,537
Stone Products:		
Granite and Trap	$633,218	
Sandstone	6,003	
Marble	59,506	
Limestone	223,182	
Slate	71,737	
		993,636
Lime and Cement		2,332,846
Sand and Gravel		900,061
Mineral Waters		99,020
Feldspar		83,951
Quartz		18,284
Iron Ore and Mineral Paint		32,540
Talc, Soapstone, Infusorial Earth		3,000
		$13,469,702

TABLE VI.—MARYLAND FARM STATISTICS—U. S. CENSUS 1910

Population of state	1,295,346
Rural population	637,154
Approximate land area of the state, acres	6,362,240
Land in farms, acres	5,057,140
Improved land in farms, acres	3,354,767
Number of all farms	48,923
Average acres per farm	301.4
Value of farm property	$286,167,028
Average value of all property per farm	$5,849
Average value of land per acre	$32.32

TABLE VII.—VALUE OF MARYLAND CROPS—U. S. CENSUS 1910

FARM CROPS

Corn	$11,015,298
Wheat	9,876,480
Hay and forage	6,011,749
Vegetables other than potatoes	5,729,400
Forest production of farms	2,349,045
Potatoes and sweet potatoes and yams	2,266,705
Fruits and nuts	1,577,987
Tobacco	1,457,112
Small fruits	1,227,548
Flowers, plants and nursery products	1,053,901
Oats	584,395
Rye	252,691
Buckwheat	99,216
Barley	79,231
All other grains and seeds	97,523
All other products	241,877
Total	$43,920,149

TABLE VIII.—VALUE OF MARYLAND LIVE STOCK PRODUCTS
U. S. CENSUS 1910

Domestic animals sold and slaughtered	$8,496,767
Milk, cream and butter fat sold and butter and cheese made	5,480,900
Eggs, partly estimated	3,235,759
Poultry raised, partly estimated	3,011,382
Wool, partly estimated	199,909
Honey	38,164
Wax	1,080

TABLE IX.—LUMBER AND TIMBER CUT BY COUNTIES FOR THE YEAR 1914

ACCORDING TO THE STATE BOARD OF FORESTRY

County	Mills	Cut—Cubic feet	Value
Allegany	45	3,016,400	$433,284
Anne Arundel	22	1,099,610	130,099
Baltimore	30	2,119,584	308,186
Calvert	20	1,448,475	202,597
Caroline	61	1,654,340	220,054
Carroll	25	991,960	118,850
Cecil	24	716,780	96,893
Charles	30	5,838,080	485,426
Dorchester	37	2,231,160	352,405
Frederick	51	809,965	179,004
Garrett	62	7,750,245	1,379,937
Harford	27	774,555	118,342
Howard	12	599,455	64,696
Kent	10	382,870	53,047
Montgomery	28	1,215,545	175,422
Prince George's	32	1,388,000	161,939
Queen Anne's	26	690,205	80,963
St. Mary's	33	1,226,755	157,002
Somerset	46	2,742,423	363,174
Talbot	38	1,274,994	135,012
Washington	26	1,460,950	189,350
Wicomico	64	3,949,470	592,318
Worcester	51	3,525,700	496,191
The state	800	46,907,521	$6,494,191

TABLE X.—MARYLAND MANUFACTURES FOR THE YEAR 1910

ACCORDING TO U. S. CENSUS

Product.	No. of establishments.	Capital invested.	No. of persons in industry.	Salaries and wages paid.	Cost of materials.	Value of product.
Clothing, men's, including shirts	359	$19,578,000	21,946	$9,364,000	$20,966,000	$36,921,000
Copper, tin and sheet iron products	81	24,719,000	5,980	2,893,000	10,808,000	16,909,000
Canning and preserving	468	8,377,000	9,755	2,277,000	10,009,000	13,709,000
Slaughtering and meat packing	54	3,808,000	1,324	869,000	11,503,000	13,683,000
Lumbering and timber products	561	9,182,000	8,165	2,874,000	6,507,000	12,134,000
Foundry and machine shop products	157	10,324,000	5,520	3,469,000	5,056,000	11,078,000
Tobacco manufacture	263	6,644,000	4,098	1,604,000	5,666,000	10,559,000
Fertilizers	41	9,098,000	1,750	1,035,000	6,063,000	9,673,000
Flour-mill and grist-mill products	295	3,729,000	935	320,000	8,003,000	9,268,000
Cars and general shop construction and repairs by steam railroads	21	4,264,000	5,926	3,818,000	5,193,000	9,059,000
Printing and publisbing	371	6,675,000	4,942	3,229,000	2,404,000	8,360,000
Bread and otber bakery products	516	3,214,000	2,820	1,095,000	4,363,000	6,868,000
Liquors, malt	20	8,834,000	1,095	1,080,000	1,569,000	5,690,000
Patent medicines and compounds and druggists' preparations	83	4,114,000	1,846	1,178,000	2,167,000	5,548,000
Cotton goods, including cotton smallwares	16	9,024,000	4,077	1,291,000	4,012,000	5,522,000
Liquors, distilled	25	4,863,000	387	357,000	1,149,000	5,362,000
Confectionery	54	2,753,000	1,888	748,000	3,162,000	5,082,000
Paper and wood pulp	13	8,399,000	1,349	779,000	3,278,000	4,894,000
Clothing, women's	72	1,694,000	3,030	1,159,000	2,285,000	4,351,000
Ship building, including boat building	46	4,413,000	1,968	2,258,000	1,849,000	3,535,000
Furniture and refrigerators	48	2,507,000	2,133	1,034,000	1,601,000	3,350,000
Hats, straw	7	2,607,000	1,808	984,000	1,783,000	3,347,000
Gas, illuminating and heating	18	26,954,000	817	487,000	629,000	3,223,000
Leather, tanned, curried, and finished	13	2,208,000	523	291,000	2,114,000	2,661,000
Marble and stone work	89	2,164,000	1,658	991,000	957,000	2,427,000
Umbrellas and canes	9	827,000	640	312,000	1,076,000	1,650,000
Musical instruments, pianos and organs and materials	7	2,301,000	833	526,000	566,000	1,466,000
Boots and shoes, including cut stock and findings	14	678,000	670	303,000	912,000	1,431,000
Carriages, wagons, and materials	126	1,192,000	960	417,000	541,000	1,330,000
Belting and hose, woven and rubber	4	826,000	315	136,000	995,000	1,318,000
Chemicals	3	1,676,000	316	195,000	684,000	1,313,000
Hosiery and knit goods	11	930,000	1,062	263,000	697,000	1,172,000
Leather goods	43	682,000	439	105,000	607,000	1,043,000
Glass	7	887,000	1,105	569,000	237,000	1,038,000
Ice, manufactured	42	2,552,000	466	313,000	300,000	1,022,000
Paint and varnisb	12	503,000	100	00,000	700,000	1,001,000
Brick and tile	40	5,117,000	1,331	540,000	249,000	971,000
Boxes, fancy and paper	17	733,000	770	244,000	395,000	853,000
Baking powders and yeast	7	251,000	201	90,000	489,000	840,000
Pottery, terra cotta, and fire clay products	16	973,000	799	387,000	206,000	757,000
Brass and bronze products	17	346,000	267	159,000	432,000	748,000
Mattresses and spring beds	19	373,000	252	115,000	469,000	729,000
Stoves and furnaces, including gas and oil stoves	8	754,000	471	289,000	205,000	676,000
Butter, cheese and condensed milk	44	257,000	137	49,000	524,000	654,000
Cooperage and wooden goods not elsewhere specified	40	428,000	384	155,000	358,000	617,000
Silk and silk goods, including throwsters.	4	488,000	681	192,000	237,000	512,000
Baskets, and rattan and willow ware	25	317,000	586	339,000	227,000	471,000
Lime	43	833,000	473	148,000	132,000	420,000
Millinery and lace goods	14	213,000	300	100,000	172,000	389,000
Silverware and plated ware.	10	322,000	215	136,000	115,000	355,000
Jewelry	15	202,000	121	66,000	132,000	257,000
Hats and caps, other than felt, straw and wool	17	69,000	155	70,000	90,000	208,000
Boxes, cigar	9	117,000	183	56,000	110,000	194,000
All other industries	523	30,234,000	15,427	8,282,000	62,155,000	78,121,000
State	4,837	$251,227,000	125,489	$59,053,000	$199,049,000	$315,669,000

TABLE XI.—ALTITUDES IN MARYLAND

ELEVATIONS OF POINTS IN MARYLAND, GROUPED BY COUNTIES

ALLEGANY COUNTY

Localities	Elevation in feet
Cumberland	626
Dan's Rock	2882
Frostburg	1929
Mt. Savage	1198
Westernport	1000
Piney Grove	937
Flintstone	828
Oldtown	564

ANNE ARUNDEL COUNTY

Annapolis	40
Marriott Hill	240
Davidsonville	185
Owensville	182
Odenton	160
Jewell	160
Friendship	150
Glenburnie	56

BALTIMORE CITY

City Hall	25
High Service Reservoir	350
Druid Hill Park (Mansion House)	320
J. H. U. (Carroll Mansion)	245
Mt. Royal Reservoir	155
Hotel Altamont (street)	270
Patterson Park Observatory	125
Johns Hopkins Hospital	105
Washington Monument (base)	100
Carroll Park (Mansion House)	95
Fort McHenry	30

BALTIMORE COUNTY

Localities	Elevation in feet
Towson (Courthouse)	465
Reisterstown	735
St. Thomas' Church	650
Pikesville	516
Catonsville	500
Chattolanee	410
Long Green	300
Fork	420
Parkton	420
Cockeysville	279
Lake Roland	360
Loch Raven	180
Relay Viaduct	71
Bradshaw	40
North Point	10

CALVERT COUNTY

Prince Frederick	150
Mt. Harmony	150
Port Republic	160
Bowens	160
Parran	136
Chesapeake Beach	15
Lower Marlboro	20

CAROLINE COUNTY

Denton	40
Marydel	64
Federalsburg	10
Greensboro	40

CARROLL COUNTY

Springfield Hospital	560
Westminster	774
Manchester	980
Hampstead	913
Bachmans Mills	631
Sykesville	383
Finksburg	565
Taneytown	493
Parr's Ridge near Manchester	1100

CECIL COUNTY

Elkton	29
Rock Spring	510
Woodlawn	465
Calvert	441
Rising Sun	387
Gray's Hill	268
Cecilton	85
Port Deposit	16
Chesapeake City	17

CHARLES COUNTY

Localities	Elevation in feet
La Plata	190
Hughesville	193
Patuxent	184
Chapel Point	160
Indian Head	40
Port Tobacco	25
Popes Creek	8

DORCHESTER COUNTY

Cambridge	20
Vienna	12
Church Creek	5
Drawbridge	3
Hurlock	50
Golden Hill	2
East Newmarket	43

FREDERICK COUNTY

Frederick	296
Sugar Loaf Mountain	1281
Thurmont	519
Monocacy Bridge	198
Point of Rocks	230

GARRETT COUNTY

Oakland	2461
Backbone Mountain (highest point in Maryland)	3340
Table Rock	3100
Altamont	2632
Accident	2395
Deer Park	2447
Mountain Lake Park	2405
Grantsville	2351
Friendsville	1501
Bloomington	1037

HARFORD COUNTY

Belair	396
Madonna	748
Darlington	324
Aberdeen	79
Perryman	50
Havre de Grace	35

HOWARD COUNTY

Localities	Elevation in feet
Ellicott City (Courthouse)	233
Clarksville	484
West Friendship	476
Marriottsville	295
Woodstock	276
Savage	200
Poplar Springs	729

KENT COUNTY

Chestertown	22
Blacks	70
Stillpond	78
Massey	64
Sassafras	34
Millington	27
Edesville	24
Georgetown	50

MONTGOMERY COUNTY

Rockville	450
Clarksburg	700
Gaithersburg	512
Dickerson	363
Cabin John Bridge	120

PRINCE GEORGE'S COUNTY

Upper Marlboro	39
Brandywine	233
Accokeek	210
Aquasco	158
Laurel	154
Bowie	149
Fort Washington	100
Beltsville	110
Hyattsville	46
Queen Anne	30

QUEEN ANNE'S COUNTY

Centerville	59
Sudlersville	67
Church Hill	35
Queen Anne	30
Kent Island Landing	5
Crumpton	22
Queenstown	10

SOMERSET COUNTY

Localities	Elevation in feet
Princess Anne	18
Eden	20
Wellington	27
Costen	21
Peninsula Junction	42
Kingston	8

ST. MARY'S COUNTY

Localities	Elevation in feet
Leonardtown	100
Newmarket	172
Mechanicsville	165
Jarboesville	110
Park Hall	100
Morganza	71
Ridge	42
Valley Lee	50
Chaptico	20

TALBOT COUNTY

Localities	Elevation in feet
Easton	30
Wye Mills	22
Trappe	55
Oxford	11
St. Michaels	8

WICOMICO COUNTY

Localities	Elevation in feet
Salisbury	23
Parsonsburg	80
Pittsville	55
Delmar	57
Whitehaven	5
Mardela Springs	27
Sharptown	10
Quantico	20
Allen	10

WASHINGTON COUNTY

Localities	Elevation in feet
Hagerstown	552
Quirauk Mountain	2145
High Rock	1822
Blue Ridge Summit	1407
Blue Mountain House	1280
Fort Frederick	465
Hancock	448
Sharpsburg	425
Maryland Heights	1468
Sideling Hill	1635

WORCESTER COUNTY

Localities	Elevation in feet
Snow Hill	21
Longridge	51
Berlin	45
Stockton	33
Girdletree	34
Whiteberg	30
Bishopville	23
Greenbackville	10
Pocomoke	8

PART II

THE SURFACE AND UNDERGROUND WATER RESOURCES OF MARYLAND, INCLUDING DELAWARE AND THE DISTRICT OF COLUMBIA

BY

WM. BULLOCK CLARK, EDWARD B. MATHEWS
AND EDWARD W. BERRY

PREPARED IN CO-OPERATION WITH THE U. S. GEOLOGICAL SURVEY

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BY

WM. BULLOCK CLARK, EDWARD B. MATHEWS, AND EDWARD W. BERRY

PHYSIOGRAPHY

The State of Maryland forms a portion of the Atlantic slope which stretches from the crest of the Alleghanies to the sea, and is divided into three more or less sharply defined regions known as the Coastal Plain, the Piedmont Plateau, and the Appalachian Region. These three districts follow the Atlantic border of the United States in three belts of varying width from New England southward to the Gulf of Mexico. Maryland is, therefore, closely related in its physiographic features to the states which lie to the north and south of it, while its central location on the Atlantic border renders the Maryland section perhaps the most characteristic in this broad tract. In crossing the three districts from the ocean border, the country rises at first gradually and then more rapidly until it culminates in the highlands of the western portion of the state.

The physical features of a country to no inconsiderable degree determine the pursuits of its inhabitants, and these indirectly affect their social, political, and financial welfare. The residents of mountainous districts have their peculiar occupations, while those of the lowlands find their employment in other ways. In regions bordering the sea or inland bodies of water still other means of livelihood are sought by the people. The character of the soil and its adaptability to particular crops also become important factors, while the underlying rocks, not only by their influence upon the conditions of life already described, but also by their inherent wealth in mineral resources, still further influence the well-being of the community. It becomes necessary, therefore, to know something of the physical features of a country, or a state, if one would understand its past history or indicate the lines of its future prosperity.

THE COASTAL PLAIN

The Coastal Plain is the name applied to the low and partially submerged surface of varying width extending from Cape Cod southward through Florida, bounded by the Piedmont Plateau on the west and the margin of the continental shelf on the east. The line of demarkation between the Coastal Plain and the Piedmont Plateau is sinuous and ill-defined, the one passing over into the other oftentimes with insensible topographic gradations, although the origin of the two districts is quite different. A convenient, although somewhat arbitrary, boundary between the two regions is furnished in Maryland and Delaware by the Baltimore and Ohio Railroad in its extension to Washington. The eastern limit of the Coastal Plain is at the edge of the continental shelf. In the vicinity of Maryland this is located about 100 miles off shore at a depth of 100 fathoms beneath the surface of the Atlantic Ocean. It is in reality the submerged border of the North American continent, which extends seaward with a gently-sloping surface to the 100-fathom line. At this point there is a rapid descent to a depth of 3000 fathoms where the continental rise gives place to the oceanic abyss.

THE DIVISIONS OF THE COASTAL PLAIN

The Coastal Plain, therefore, falls naturally into two divisions, a submerged or *submarine division* and an emerged or *subaerial division.* The seashore is the boundary line which separates them. This line of demarkation, although apparently fixed, is in reality very changeable, for during the geologic ages which are past it has migrated back and forth across the Coastal Plain, at one time occupying a position well over on the Piedmont Plateau, and at another far out to sea. At the present time there is reason to believe that the sea is encroaching on the land by the slow subsidence of the latter, but a few generations of men is too short a period in which to measure this change.

The subaerial division is itself separable in Maryland into the Eastern Shore and the Western Shore. These terms, although first introduced to designate the land masses on either side of Chesapeake Bay, are in reality expressive of a fundamental contrast in the topography of the Coastal Plain. This difference gives rise to an Eastern Shore and a Western

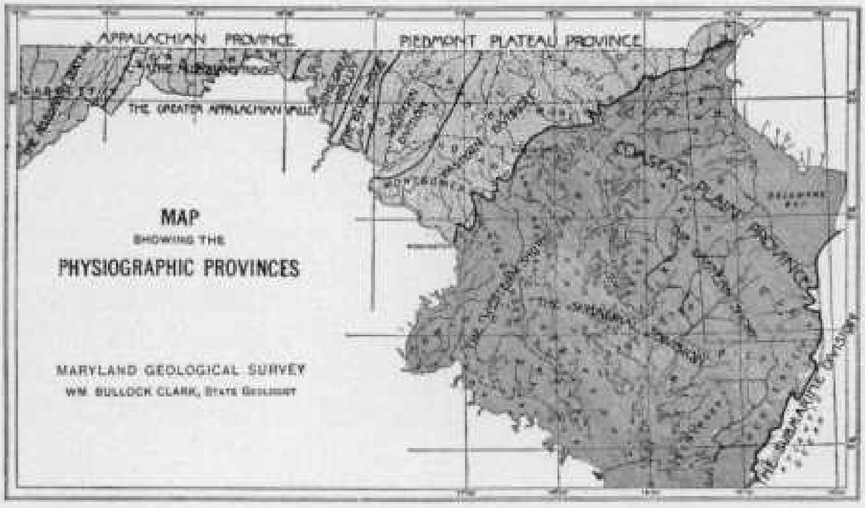

FIG. 72.—MAP SHOWING THE PHYSIOGRAPHIC PROVINCES.

Shore type of topography. Chesapeake Bay and Elk River separate the two. But fragments of the Eastern Shore type are found along the margin of the Western Shore at intervals as far south as Herring Bay, and again from Point Lookout northwestward along the margin of the Potomac River. On the other hand, an outlier of the Western Shore type of topography is found at Grays Hill in Cecil County at the northern margin of the Eastern Shore. The Eastern Shore type of topography consists of low, flat, and almost featureless plains, while the Western Shore is a rolling upland, attaining four times the elevation of the former and resembling the topography of the Piedmont Plateau much more than that of the typical Eastern Shore. It will be seen later that these two topographic types, which at once strike the eye of the physiographer as being distinctive features, are in reality not as simple as they first appear, but are built up of a complex system of terraces dissected by drainage lines.

The Coastal Plain of Maryland, with which most of the State of Delaware is naturally included, is separated from that of New Jersey by the Delaware River and Delaware Bay, and from that of Virginia by the Potomac River, but these drainageways afford no barriers to the Coastal Plain topography, for the same types with their systems of terraces exist in New Jersey and Virginia as in Maryland.

Chesapeake Bay, which runs the length of the Coastal Plain, drains both shores. From the Western Shore it receives a number of large tributaries, among which may be mentioned the Northeast, Susquehanna, Bush, Gunpowder, Patapsco, Magothy, Severn, South, Patuxent, and Potomac rivers. On the Eastern Shore its principal tributaries consist of Bohemia Creek, Sassafras, Chester, Choptank, Nanticoke, Wicomico, and Pocomoke rivers. These streams, which are in the process of developing a dendritic type of drainage, have cut far deeper channels on the Western than on the Eastern Shore. If attention is now turned to the character of the shore line, it will be seen that along Chesapeake Bay it is extremely broken and sinuous. A straight shore line is the exception, and only in one place, from Herring Bay southward to Drum Point, does it become a prominent feature. These two classes of shore correspond to two types of coast. Where the shore is sinuous and broken it is found that the coast is low or marshy, but where the shore line is straight, as from Herring Bay southward to Drum Point, the coast is high and rugged, as in the famous Calvert Cliffs which rise to a height of 100 feet or more above the Bay. The shore of the Atlantic Ocean is composed of a long line of barrier beaches which have been thrown up by the waves and enclose behind them lagoons flushed by streams which drain the seaward slope of the Eastern Shore. Of these, Chincoteague Bay is the most important.

The Coastal Plain contains five broad terraces designated from the oldest and highest to the youngest and lowest by the names of Brandywine, Sunderland, Wicomico, Talbot, and Recent, after the geological formations of the same name. The first four and part of the fifth fall within the subaerial division, and the last one principally within the submarine division of the Coastal Plain. All five of the subaerial terraces are found on the Western Shore, while only three of them occur on the Eastern Shore. These terraces wrap about each other in concentric

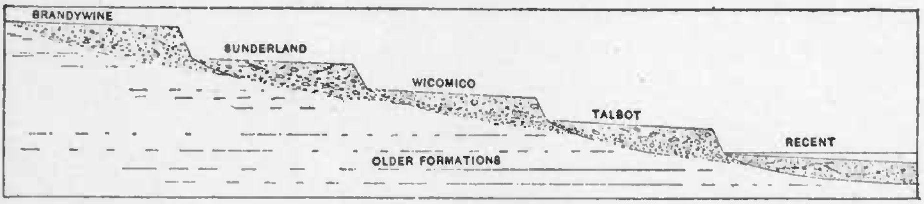

FIG. 73.—DIAGRAM SHOWING RELATIVE POSITION OF COASTAL PLAIN TERRACES.

arrangement and are developed one above the other in order of their age, the oldest standing topographically the highest.

THE STREAM VALLEYS

Within the Coastal Plain of Maryland there are discernible four generations of stream valleys. Three of these no longer contain the streams which cut them. They have been referred to in the discussion as re-entrants penetrating the various terraces. The first is found developed as a flat-topped drainageway of greater or less width and extent, running up into the Brandywine terrace. Its level bottom is an integral part of the Sunderland terrace. The second one of these drainageways penetrates the Sunderland terrace in a similar way. Its characteristics are analogous to those entering the Brandywine terrace and its flat bottom forms an integral part of the Wicomico terrace. The third of these drainageways cuts a re-entrant within the body of the Wicomico terrace and its level floor forms an integral part of the Talbot terrace. The fourth and last of these drainageways is now in the process of formation. It is the system of valleys which are being cut by the Recent streams. Toward their headwaters these valleys are narrow and V-shaped, and if traced to their sources, are often found to start from intermittent springs surrounded by a steep-walled amphitheater from 5 to 10 feet in height. Toward their lower courses these valleys are broad and flat and are frequently filled with fresh or brackish-water marshes. In the upper portions of their courses the valleys are being eroded. In the lower portions they are being filled. A glance at a map will serve to confirm the opinion which has been held for a long time, namely, that the rivers of the Coastal Plain of Maryland have been drowned along their lower courses, or, in other words, have been transformed into estuaries by the subsidence of the region. The filling of these valleys has taken place toward the heads of these estuaries. The headwaters of these Recent valleys are being extended inland toward the divides with greater or less rapidity.

Many of the tributary streams occupy the re-entrant valleys described above. The more energetic have succeeded in carrying out all of the ancient floors which formerly covered these valleys and formed a portion of the various terraces. Others have left more remnants of these valley accumulations along the margins, while the less active streams have left the re-entrant valleys practically unmodified. In Southern Maryland the streams which drain into Chesapeake Bay from the eastern slope of Calvert County, as well as those which drain into the Patuxent River from St. Mary's and Prince George's counties, have shorter courses than those which drain into the Patuxent from Calvert County or into the Potomac from Prince George's, Charles, and St. Mary's counties. A similar contrast is obvious between the streams which enter the Atlantic Ocean from the Eastern Shore and those which enter Chesapeake Bay from the same region.

The cause of this shortening of streams on the northeast side of these divides is probably due not only to a tilting toward the southeast, but also in a great measure, particularly along the Bay shore, to rapid wave erosion. The streams draining the eastern slope of Calvert County and the northeastern slope of St. Mary's and Prince George's counties were at one time longer, but the recession of the shore line has shortened their courses by the cutting away of their lower valleys. This is very clearly shown along the Calvert Cliffs where the waves have advanced so rapidly on the land that the former heads of stream valleys are now left as unoccupied depressions along the upper edge of the cliffs, while other streams cascade from the top of the precipice to the shore beneath, and still others more active have been able to sink their valleys to the water's edge by a very sharp descent.

THE PIEDMONT PLATEAU

The Piedmont Plateau, which is the name applied to the hill country that borders the Coastal Plain on the west and extends thence to the foot of the Appalachian Mountains, is a low plateau of complex origin whose rolling surface is traversed by highlands and cut by valleys that at times trench the uplands as deep gorges. From the fact that the physiographic features of the Appalachian Region which lies to the westward are contemporaneous in origin with those of the Piedmont Plateau, it is reasonable to suppose that no sharp line can be drawn between the two districts. The boundary can in fact with almost equal propriety be placed at the foot of North Mountain as at the foot of the Catoctin Mountain, although, all things considered, it has seemed best in Maryland to divide the two regions at the point where the first pronounced mountain range is reached.

To the northward the Catoctin and Blue Ridge highlands, with their South Mountain extension in southern Pennslyvania, gradually decline to the level of the lower plateau, and the surface of the Piedmont hill country with higher lands of inconspicuous elevation extends to the foot of the Alleghany ranges. To the southward, on the other hand, the Great Valley is less pronounced, and the highlands of the Blue Ridge become a conspicuous part of the great Appalachian Region. In the south also the name Piedmont has become so widely intrenched in usage for the district lying to the eastward of the Blue Ridge mountains that it has seemed best to follow the same usage in Maryland.

THE DIVISIONS OF THE PIEDMONT PLATEAU

The Piedmont Plateau is divided into two regions called, respectively, the Eastern Division and the Western Division, which are separated by Parrs Ridge which gradually rises to an elevation of several hundred feet above the general surface of the Piedmont Plateau. This highland has an average elevation of 800 to 900 feet, rising to the northward in Carroll

County and in the nearby regions of Pennsylvania to 1100 feet, but gradually declining southward across Howard and Montgomery counties until it reaches the lowland elevations of the Piedmont Plateau toward the Potomac Valley.

Parrs Ridge forms the divide between the streams flowing directly into Chesapeake Bay and those flowing into the Potomac River. Among the more important streams entering the Chesapeake from the eastern division of the Piedmont are the Susquehanna, Bush, Gunpowder, Patapsco, and Patuxent rivers. The western division is largely drained by the Monocacy River and its tributaries, into the Potomac River.

THE PIEDMONT PENEPLAINS

The Piedmont Plateau is made up of remnants of old plains cut out of the high plateau that formerly stretched across the district from the Appalachian Region and passed beneath tide just beyond the edge of the Coastal Plain, where it now forms the floor on which the Coastal Plain sediments rest. The eastern division is much less deeply eroded than the western, with the result that more frequently remnants of the oldest plains are found in the former than in the latter district. On the other hand, the later plains, but poorly developed along the eastern margin of the Piedmont, become gradually more pronounced westward, the youngest plains being well defined in the drainage basins of the Monocacy and along the Potomac. These old plains, now represented only by remnants of their earlier surfaces, are technically known as peneplains by physiographers. A *peneplain* is the name given to an area that has been reduced by erosion to approximately a level surface but little above the sea level of the period of its formation, but which may still have unreduced knobs or *monadnocks* in the interstream areas. Even where these monadnocks have largely wasted away, the valley surfaces would naturally be somewhat lower than the divides and would rise slowly to the sides of the valleys as well as from the lower courses of all the streams to their heads. It is important to keep these facts in mind when endeavoring to reconstruct the ancient peneplain surfaces from the remnants of the old plains that are still left in the Piedmont district. It so happens that after the formation of the oldest peneplain now represented, later erosion has only resulted in the partial development of new plains, highlands, sometimes of wide extent, still remaining as monadnocks in the interstream areas.

The several plains recognized in the Piedmont district are known as the Schooley, the Weverton, the Harrisburg, and the Somerville peneplains, all of which, like the district in which they are developed, have been traced far beyond the confines of the state.

THE STREAM VALLEYS

The present streams are now found in valleys of variable depth that trench the peneplain surfaces. In the eastern division of the Piedmont, where the Harrisburg and Somerville plains are at best but poorly developed, the streams appear for the most part as trenches in the Weverton plain. In the western division, on the other hand, they are found trenching the later peneplains, and in the lower Monocacy and Potomac valleys the relations of the streams to the Somerville peneplain are clearly defined.

Some of these streams are more or less adjusted to the underlying rocks, as in the case of Jones Falls to the north of Baltimore; but a large portion of them are discordant, that is, seemingly unaffected by the rocks over which they flow. In the eastern division of the Piedmont the streams flow down the eastern slope of Parrs Ridge in approximately parallel courses to Chesapeake Bay, and in many instances the streams cut across the rocks with little regard to their physical characters. In the case of the Monocacy and its tributaries we find that there has been little adjustment of the channels, the streams taking their courses across limestones, phyllites, and shales indifferently.

In general, both the main streams and their tributaries show drainage patterns similar to those of the Coastal Plain, and it is not impossible that the stream courses may have been in many instances superimposed on the rocks at no distant time in the past through a mantle of Coastal Plain sediments. Remnants of such a cover have been found far removed from the main body of the Coastal Plain, even as far westward as the Great Valley.

THE APPALACHIAN REGION

The Appalachian Region borders the Piedmont Plateau upon the west and extends to the western limits of the state. It consists of a series of parallel mountain ranges with deep valleys which are cut nearly at right angles by the Potomac River. Many of the ranges exceed 2000 feet in elevation, while some reach 3000 and more in the western portion of the district. The streams have been to a large extent adjusted to the rocks over which they flow, although this is less evident in the case of the master stream, the Potomac River, than of the tributaries.

THE DIVISIONS OF THE APPALACHIAN REGION

The Appalachian Region is divided into three districts, known as the Blue Ridge district, the Greater Appalachian Valley, composed of the Great Valley and the Alleghany Ridges, and the Alleghany Plateau. Each district presents certain marked physiographic characteristics that separate it from the adjacent areas on the east and the west.

The Blue Ridge district consists of the Catoctin and Blue Ridge mountains uniting to form the greater highland of South Mountain in the southern part of Pennsylvania. Beginning with an elevation of 2000 feet at the Maryland line this highland gradually declines southward to the Potomac River, where it has an elevation of less than 1500 feet at Maryland Heights overlooking the Potomac Valley. The eastern border of this district is formed by the Catoctin Mountain, which extends as an almost unbroken highland from the Pennsylvania line to the Potomac River at Point of Rocks. Succeeding the Catoctin upon the west is the Middletown Valley, which drains southward into the Potomac River through the Catoctin Creek. Along the western side of this district is the Blue Ridge Mountain proper. It extends as a sharply defined range from the South Mountain of Pennsylvania to the Potomac River which it reaches at Weverton. Its crests form the boundary line between Frederick and Washington counties. The Blue Ridge in Virginia is not the direct continuation of the mountain so named in Maryland but of a smaller range, the Elk Ridge, which adjoins the Blue Ridge on the west and reaches the Potomac River at Maryland Heights opposite Harpers Ferry.

The greater Appalachian Valley embraces all of the country lying between the Blue Ridge on the east and Dans Mountain, or the Alleghany Front, on the west. It admits of a twofold division into the Great Valley and the Alleghany Ridges. The Great Valley, known as the Hagerstown Valley in Maryland, the Cumberland Valley in Pennsylvania, and the Shenandoah Valley in the Virginias, is a broad lowland, the floor of which averages from 500 to 600 feet in elevation, gradually increasing in height from the Potomac Valley toward the Pennsylvania line. It extends from the Blue Ridge on the east to North Mountain on the west. It is drained by the Antietam River on the eastern side and the Conococheague River on the western side, both of these streams having their sources in Pennsylvania and flowing southward to the Potomac River. The Alleghany Ridges, which extend from North Mountain to the Alleghany Front, consist of a series of parallel ridges of varying elevations that extend from north to south across the state. Among the more important are North Mountain, Tonoloway Ridge, Sideling Hill, Town Hill, Green Mountain, Warrior Mountain, Collier Mountain, Martin Mountain, Nicholas Mountain, Shriver Ridge, and Wills Mountain. Between them are valleys that are drained mainly to the southward into the Potomac River. They vary in character, some being narrow and deeply trenched, while in others broad, level-topped areas appear, the origin of which will be shortly discussed.

The Alleghany Plateau forms the western part of the Appalachian Region and extends from the Alleghany Front to the western limits of the state. This highland, like the districts which lie to the eastward, is continued far beyond the confines of the state. To the southward it can be traced through Virginia, Kentucky, and Tennessee to northern Alabama, where it is known under the name of the Cumberland Plateau. In Maryland this district consists of a broad highland across which ranges of mountains extend from northeast to southwest, reaching elevations of 3000 feet and more at several points in Big Savage, Great Backbone, and Negro mountains. The leading ranges of the district are Dans Mountain, Big Savage Mountain, Great Backbone Mountain, Negro Mountain, Winding Ridge, and Laurel Hill. The streams flow in part to the southward or eastward, as the case may be, into the Potomac River, and in part to the northward through the Youghiogheny Valley into the Monongahela River, whence the waters reach the sea through the Ohio and Mississippi. The latter district comprises much the larger part of Garrett County.

THE APPALACHIAN PENEPLAINS

The Appalachian Region, like the Piedmont Plateau, is composed of remnants of old plains which have been cut out from the high plateau, now represented by the level-topped crests of the highest ranges. The several peneplains succeed each other at different elevations, being represented by the low crests or broad, level-topped valleys that are here and there preserved in the highland region.

The peneplains found represented in the Appalachian Region are the continuations westward of the Piedmont peneplains and, like them, have here and there above the ancient surfaces unreduced knobs or monadnocks in what were probably interstream areas. As in the Piedmont district, the peneplain surfaces rise gradually up the old streams and toward the valley sides.

The Appalachian physiographic history is complicated by the fact that the drainage of the area has evidently changed during the period of peneplain development, the Potomac drainage having gradually encroached upon that of the Youghiogheny to the westward. It is probable, therefore, that the peneplains to the west of the Alleghany Front, as well as those a short distance to the east, cannot be readily correlated with those further eastward. On account of the higher gradient of the Potomac and its headwater tributaries compared with the Youghiogheny and the drainage basin of which it is a part, an encroachment of the former would, in accordance with known physiographic laws, naturally result. In this way certain physiographic incongruities and even biological peculiarities in the distribution of the faunas of the present day may be explained.

The peneplains recognized in the Appalachian district are known as the Schooley, Weverton, Harrisburg, and Somerville plains, all of which are found in the Piedmont district to the east.

THE STREAM VALLEYS

The present valleys have trenched the peneplain surface to greater or less depth. Along the Potomac the trenching was mainly post-Somerville, but up the tributaries, where the Somerville peneplain gradually disappears, the trenching was in part produced at the time of the formation of the Somerville peneplain itself, and in some instances represents an even longer period of cutting.

The streams are to a considerable extent adjusted to the present structure, producing what has been described as a trellis or grape-vine system. At times wind-gaps are found cutting the crests of the mountains and representing the location of the streams across the hard rocks before they had been tapped by the tributary of some larger stream flowing along the softer beds, generally in a direction at right angles to the original system.

At the point where the streams cross the hard sandstone ridges deep gorges result, but in the softer beds the channels are frequently wider, with low banks on either side.

GEOLOGY

The geology like the physiography of this region shows an intimate relationship to the adjacent areas to the north and south, so that its complete interpretation can be gained only by taking into consideration the great eastern border region of which it is not only geologically but geographically a part.

As has already been pointed out, this territory falls naturally into three sharply contrasted provinces: an eastern coastal plain bordering the Atlantic Ocean and surrounding Chesapeake Bay; a central plateau; and a western region of mountains. These three main physiographic divisions were found capable of further differentiation into seven topographic belts, and these seven subordinate regions are each composed of a distinct series of geological formations.

The separateness of the formations is less pronounced in the two divisions of the Coastal Plain, although the northeast-southwest trend of the nearly horizontal beds produces a predominance of the later Cenozoic formations on the Eastern Shore and of the Mesozoic and early Cenozoic deposits on the Western Shore.

In the Piedmont Plateau the twofold character of the province is more marked geologically. On the eastern side of Parrs Ridge the ancient sediments are highly metamorphosed by a development of new textures and minerals due to the recrystallization of the material under great pressure. This division is also marked by the presence of large masses of granular igneous rock which consolidated at great depths beneath the surface of the earth. On the western side of the median ridge the sediments are less metamorphosed and less thoroughly recrystallized, although their original textures have been more or less obliterated. There is also marked lack of deep-seated igneous rocks which are here represented by smaller masses of surface volcanics, both acid and basic, which have been less thoroughly recrystallized than their analogues in the eastern district. Along the western border of this western district, between the Monocacy and the mountains, the early Paleozoics have only slightly changed, the blue limestones of the Frederick Valley resembling the contemporaneous limestones of the Hagerstown Valley farther west. Immediately east of the mountains the earlier rocks are covered with the slightly inclined unmetamorphosed red and gray sandstones and conglomerates of Triassic age and intruded by the diabase dikes of the same period.

The threefold division of the Appalachian Region corresponds approximately to the threefold division in the sequence of the Paleozoic strata. The Blue Ridge and Great Valley are made up largely of Cambrian and Ordovician beds, in places so developed or eroded as to expose the associated igneous rocks; the Appalachian Mountains proper are made up of folded Silurian and Devonian strata, each easily recognized by the characteristic life-forms; while the Alleghany Pleateau is mainly composed of more gently folded later Devonian and Carboniferous deposits, the latter carrying the valuable coal seams of the Cumberland basin.

THE PIEDMONT PLATEAU

A clear understanding of the various formations found within the limits of the Maryland portion of the Piedmont Plateau can only be gained through a consideration of the conditions present throughout the great Piedmont area of eastern North America, extending from Alabama northward as far as New York. Throughout this region are exposed numerous highly crystalline gneisses and schists associated with crystalline limestone, quartzites, and igneous rocks here and there covered by Triassic shales and sandstones.

RELATIONS OF THE EASTERN AND WESTERN DISTRICTS

The division of the Piedmont Plateau into an eastern district composed of much metamorphosed, highly crystalline rocks, and a western district characterized by less metamorphosed, so-called "semi-crystalline," rocks has long been recognized.

The rocks of the Piedmont of this area as a whole may be divided into several groups, the highly crystalline metamorphic sedimentaries of the eastern district, with their associated igneous rocks, their less altered equivalents of Cambro-Ordovician age in the western district, with their associated volcanic rocks, and the much younger sedimentary and igneous rocks of the Mesozoic. The various rocks which are most prominently developed will be more fully discussed in succeeding pages.

THE EASTERN DISTRICT

The rocks of the eastern district of the Piedmont show a clearly established sequence which may also be recognized, in part at least, at many points in the less well-known western district.

FORMATIONS OF THE EASTERN PIEDMONT PLATEAU

Paleozoic.	SEDIMENTARY ROCKS
Ordovician (?)	Peachbottom slate.
	Cardiff quartzite.
	Wissahickon phyllites and schists.
Cambro-Ordovician (?)	Cockeysville marble.
Cambrian (?)	Setters quartzite and mica schist.
Archean.	
Archean or Algonkian (?)	Baltimore gneiss (in part).
	IGNEOUS ROCKS
Mesozoic.	
Triassic	Diabase.
Paleozoic-Archean	Acid volcanics (meta-rhyolite).
	Pegmatite.
	Peridotite, pyroxenite, and serpentine.
	Granites.
	Gabbro, norite, and meta-gabbro.
	Baltimore gneiss (in part).

Highly Metamorphosed Sedimentary Rocks

The rocks lying east of Parrs Ridge and forming the eastern district of the Piedmont, with the exception of a few dikes of Mesozoic diabase, consist of metamorphosed sediments, and a diversified complex of intruded igneous rocks which have themselves been more or less metamorphosed from their original massive condition to schistose or laminated rocks. Each of the metamorphosed formations, beginning with the oldest, will be discussed in turn and then the various igneous rocks which represent one or more periods of igneous activity of a common parent magma.

THE BALTIMORE GNEISS.—The oldest formation in this area is the Baltimore gneiss, which occurs in several well-defined areas between the Susquehanna and Potomac rivers. The easternmost of these Baltimore gneiss occurrences is within the area of Cecil County, east of the Susquehanna River, and extends from this point southwestward, widening to an area of five miles or more in breadth where it is overlain by Coastal Plain deposits in Harford County. This formation is limited on either side by igneous rocks.

The second area of Baltimore gneiss is found in an anticlinal dome, 15 miles long and 5 miles broad, lying on either side of the Northern Central Railroad 10 miles south of the Mason and Dixon Line and 20 miles north of Baltimore. Three smaller areas occur in the vicinity of Baltimore. Two of them are portions of anticlinal domes which are either completely enclosed by overlying sediments or cut off by faults and igneous rocks, while the third, underlying the northwestern part of Baltimore City, is entirely surrounded by gabbro and other igneous masses and is overlain in great measure by the Coastal Plain deposits.

The rocks in each of these areas consist of highly crystalline gneisses composed of quartz, feldspar, and mica, with accessory minerals, which are so distributed as to produce well-marked, gray banded-gneisses, the individual bands of which vary from a fraction of an inch to several feet, the average thickness, however, being quite slight. Some of these bands are highly quartzose, resembling a micaceous quartzite; others are rich in biotite or hornblende, producing dark schists, which in a hand specimen are indistinguishable from metamorphosed igneous masses.

Sometimes separated by an appreciable unconformity and at other times separated by no apparent line, the Baltimore gneiss, unless bounded by igneous rocks or faults, is overlain by the next succeeding formation.

THE SETTERS QUARTZITE.—The Setters quartzite occurs usually as a narrow rim on the flanks of the areas of Baltimore gneiss, but is not continuous or always present.

The quartzite is a fine-grained, somewhat saccharoidal, thin-bedded rock of white or cream color in its typical development along Setters Ridge. At this point the beds are usually separated by thin films of muscovite or sericite in small sparkling flakes. On the surface between the individual beds are black tourmalines, which have been more or less disturbed, as is shown by the stretching which they have undergone. Locally, the rock may become very vitreous and massive. At other times it becomes more argillaceous, with a development of garnets, staurolite, and other accessory minerals.

THE COCKEYSVILLE MARBLE.—The maximum development of the Cockeysville marble is found in the synclinorium lying between the anticlines of Baltimore gneiss and quartzite about 10 miles north of Baltimore City, and on the flanks of the anticlinal dome northeast of Reisterstown. It is here found underlying the Wissahickon mica-schist, and overlying the quartzite, the various formations recurring at the surface through numerous foldings, the contact between the marble and the adjacent formations lying very close to the present surface of the country. Southwest from these larger areas of Cockeysville marble the formation may be traced with little or no interruption in well-defined valleys to the vicinity of Clarksville, in Howard County.

The marble occurring in these areas is in the majority of instances rich in magnesium and should be called a dolomite.

THE WISSAHICKON PHYLLITES AND SCHISTS.—The position which this formation holds in the stratigraphic sequence of rocks appears very clear in the district under discussion, where in each instance it is apparently younger than the marble and consequently younger than both the Setters quartzite and the Baltimore gneiss.

The more crystalline garnet-mica gneisses and schists of the Wissahickon lie east of the broad phyllite, or less crystalline phase, which extends southwestward from the Susquehanna River to southeastern Carroll Country.

North of the phyllite occurs a corresponding mass of the more crystalline Wissahickon schist. When, however, this is compared with the rocks of the southern limb of the synclinorium, it is found that these rocks average slightly less crystalline and less metamorphosed than the corresponding rocks on the south. There is also a corresponding lack of deep-seated igneous rocks. That they represent the same horizon seems to be well established by the areal distribution of the various masses, although it has been found impossible to carry the mapping of individual beds more than a few miles along the strike, and hence it has seemed inadvisable to attempt detailed representation on the maps. The Wissahickon schists on the west side of the syncline of phyllites passes southwesterly across the state, narrowing considerably in the southern portion of Carroll County and widening somewhat in passing southward to the Potomac River.

The areal distribution of the Wissahickon suggests an increased crystallinity eastward and decreasing crystallinity westward. To the eastward are the deeper igneous rocks in large masses, on the west smaller areas of surface volcanics.

The band of *phyllite,* sericitic, and chloritic schists forming a synclinal trough extending from the Susquehanna southward, enters the state from York County, Pennsylvania, continues as a belt, varying from 5 miles in breadth at the Susquehanna to about a mile at Whitehall, on the Northern Central Railroad, whence it gradually widens southward to an average breadth of 3 miles in the southern part of Carroll County. The areal distribution indicates a synclinal trough of considerable extent and well-defined character, which is warped at its center, and plunging northeastward and southwestward and reaching its maximum depth in the vicinity of Delta, Pennsylvania, where the Cardiff quartzite-conglomerate and Peachbottom slates are found folded within it.

The rocks constituting the phyllite portion of the Wissahickon formation are essentially sericitic, chloritic, and occasionally talcose schists, which clearly show their sedimentary origin, and have been less metamorphosed than the Wissahickon schists already described. They may be regarded as an infolded, considerably younger series, or they may represent a less metamorphosed upper portion of the Wissahickon formation. It seems probable that there is truth in both views, and during recent years the impression has developed that in Maryland they represent the upper portion of the Wissahickon formation, which has been less metamorphosed, but that they are not separated by any great interval from the more crystalline Wissahickon schists which border them on either side, and from which they cannot be separated by any sharp line.

THE CARDIFF QUARTZITE.—The Cardiff quartzite and quartzose conglomerate occur as a small and rather insignificant formation in the northeastern part of Harford County. They form a narrow band apparently resting on the phyllite and underlying the Peachbottom slate, wrapping around the latter and extending beyond its southwestern limits to the valley of Broad Creek. It is this formation which yields numerous boulders along the base of Slate Ridge. It is seldom well exposed and is of limited extent.

THE PEACHBOTTOM SLATE.—The Peachbottom slates extend as a narrow strip within the limits of the Cardiff quartzite and pass beyond it across the Susquehanna River into Lancaster County, Pennsylvania. This formation is composed entirely of characteristic blue-black slates, similar to the material put on the market, and the homogeneity of the formation is now so complete that it is impossible to perceive within it any succession of sedimentary beds.

Igneous Rocks

The metamorphosed sedimentary rocks already described constitute only part of the area of the eastern district of the Maryland Piedmont. Into them have been intruded vast masses of molten material which have consolidated for the most part into two main types, gabbro and granite, with smaller masses of peridotite, pyroxenite, and their alteration product serpentine, allied to the gabbros, and other smaller masses of pegmatite and meta-rhyolite allied to the granite.

The geological period in which these masses were intruded is still somewhat uncertain, depending upon the final determination of the age of the Wissahickon formation, but the manner in which they were formed is rather satisfactorily established.

THE GABBRO, NORITE, AND META-GABBRO.—The oldest, as well as the most extensive, of these igneous rocks which intruded the Baltimore gneiss and other existing rocks is the gabbro. There are three main areas of these rocks—the Stony Forest area of Harford and Cecil counties; the great belt or sheet which extends from the north of Conowingo, on the Susquehanna River, in a south-southwest direction to Baltimore City; and the irregular intrusive area which is mainly developed to the west of Baltimore and extends thence as far south as Laurel.

THE GRANITES.—The second in extent and the first in commercial importance among the igneous rocks of the eastern Piedmont are the granites. They are found in richest development about Port Deposit and Frenchtown on the Susquehanna River; at Woodstock and Ellicott City on the Patapsco River; at Guilford on one of the branches of the Patuxent River; near Washington on the Potomac; and in the great lenticular area extending northward from the latter point to Sykesville on the main line of the Baltimore and Ohio Railroad. In these areas are active quarries furnishing high-class building stone. Besides these major masses are smaller ones, as at Cockeysville and Franklinville, which have not been developed commercially.

THE PERIDOTITE, PYROXENITE, AND SERPENTINE.—The third type of eruptive rocks which penetrated the gneiss complex is younger than the preceding, but genetically allied to the gabbro. These two types are connected by many intermediate varieties; and these more basic rocks, which break through the gabbros as well as through the gneiss, may be regarded as having resulted from the gabbro magma which had become relatively poor in alumina, or in alumina and silica. The absence of alumina would prevent the formation of feldspar, and hence in the first case crystallization produced an aggregate of pyroxene called *pyroxenite;*

while in the second case an aggregate of olivine and pyroxene with more or less magnetite was the result. This type is called *peridotite*.

The two non-feldspathic types of eruptive rocks, pyroxenite and peridotite, are peculiarly subject to alteration. The pyroxene, when it occurs alone, tends to pass into secondary hornblende, and this in turn gives rise to talc. This is the origin of some of the extensive beds of steatite in eastern Maryland and Virginia. The talc is always mixed with more or less pale fibrous hornblende (tremolite) and chlorite. When, as in the peridotite, olivene accompanies the pyroxene, especially if it is bronzite, the rock tends to form serpentine instead of talc.

Both types of non-feldspathic eruptives are very intimately associated. They usually do not cover large areas, but occur in small lenticular patches. Varieties intermediate between the two extremes are common, so that the two alteration products, steatite and serpentine, are even more intimately mingled than the rocks themselves. These ultra-basic rocks are most abundantly developed in the serpentine area of Harford County which extends southwesterly across a corner of Cecil County from the "State line" serpentine area of Lancaster County to the vicinity of Jarrettsville. Other areas of considerable extent occur northwest of Baltimore, as at Bare Hills and Soldiers Delight, and in Montgomery County in the vicinity of Gaithersburg.

The Pegmatite.—The pegmatites, which are coarse-grained aggregates of quartz, feldspar, and occasional accessory rarer minerals, probably represent the last products of the consolidation of the magmatic reservoir from which all the igneous rocks of this region were originally derived. They are the richest in silica, alumina, and the alkalies, poorest in iron and magnesium, and coarsest in grain. These features suggest that they were formed when the residual magma, still highly heated, was scarcely more than an aqueous solution of the constituents which these rocks contain. They fill the cracks due to the contraction of the cooling rocks or orogenic movements, and are found most abundantly along the borders of the other igneous masses. This is especially true for the edges of the serpentine and gabbro masses and on the borders of the granitic areas. They occur irregularly through the rocks and their presence is usually indicated by an abundance of boulders or white chalk-like streaks in the roadside cuttings. They are abundantly developed in the valley of the Patapsco in Baltimore, Howard, and Carroll counties and along the Susquehanna in the vicinity of Castleton and Conowingo, where they are of sufficient size and purity to become of some commercial importance as the source of feldspar and "flint" used in pottery works.

THE ACID VOLCANICS (META-RHYOLITE).—Along the lower Susquehanna gorge in the vicinity of Frenchtown and Havre de Grace are a few dark colored rocks of greenish hue due to their contained epidote. These "greenstones" occur in small dikes cutting the adjoining rocks and may be traced away from the river on either side but especially to the eastward in Cecil County. They are of little areal importance but are of considerable interest since they represent almost the only evidence of former volcanic activity in the eastern district of Maryland.

THE MESOZOIC DIABASE intrudes all of the older crystalline rocks in a series of dikes that may be traced with occasional interruptions across the entire eastern district of the Piedmont. The rock is a typical Mesozoic diabase presenting no unusual features. It is seldom well-exposed, the courses of the dikes being marked by deep red soil and dark red or brown rounded boulders of "trap."

THE WESTERN DISTRICT

The rocks of the western district, while much less thoroughly known than are those of the eastern district, show among themselves a sequence which is strikingly in harmony with that discovered in the eastern district. On the eastern side of the western district the rocks are scarcely distinguishable from those of the eastern district, but in the western part of the district the rocks are much less metamorphosed. There the limestones of the Frederick Valley and the underlying quartzite of the mountains are indistinguishable from the corresponding rocks on the western side of the Blue Ridge. Moreover, the limestones are fossiliferous and show clearly that their age is the same as that of the limestones of the Shenandoah Valley. The rocks of the eastern side of the district are progressively more metamorphosed eastward and are practically devoid of fossils. The natural interpretation is that these rocks are younger than the limestones of the Frederick Valley, since the latter are dipping to the eastward beneath the mass of micaceous argyllites and sandstones. The frequent appearance of limestone valleys indicates that the structure is not simple and the finding of volcanic rocks similar to those of the Blue Ridge requires that judgment regarding the actual age of these eastern rocks be held in abeyance until the area has been mapped in detail.

At the present time it is possible to recognize the following types of rocks:

FORMATIONS OF THE WESTERN PIEDMONT PLATEAU

SEDIMENTARY ROCKS

	Western Side	Eastern Side
Mesozoic.		
Triassic	Newark Formation.	
Paleozoic.		
Cambro-Ordovician	Shenandoah Limestone.	Schists and Argyllites.
		Marbles and Limestones.
Cambrian	Weverton Sandstone.	Quartzites and Schists.

IGNEOUS ROCKS

	Western Side	Eastern Side
Mesozoic.		
Triassic	Diabase.	Diabase.
Archean	Basic volcanics. Acid volcanics.	Basic and Acid volcanics.

Sedimentary Rocks

THE QUARTZITES AND SCHISTS.—Areas of quartzite, chiefly in ridges more or less timbered, have been occasionally found in the preliminary study of the western district of the Piedmont. They appear to be similar lithologically to the Weverton sandstones of the mountains on the west. The stratigraphic position of these siliceous rocks with relation to the marbles and limestones has not been established. At times they appear to be above the latter and at other times below them.

THE MARBLES.—The highly calcareous rocks here referred to embrace those lying east of the Frederick Valley. They are more crystalline than are those of the latter locality and are, so far as is known, devoid of fossils. Whether or not they are local areas of more highly metamorphosed limestones of Shenandoah age has not been definitely settled, but this conclusion appears to be the one naturally suggested by the areal distribution of the marble exposures.

These marbles, which are frequently beautifully colored, occur in long narrow valleys, especially in the region of the Western Maryland Railroad. Exposures are few, owing to their relative weakness, and most of the areas underlain by these rocks are excellent farming lands.

THE SCHISTS AND ARGYLLITES.—Clearly overlying the marbles and separated from them by unconformities are certain schists and argyllites, part of the mass formerly called phyllites.

THE WEVERTON SANDSTONE.—Isolated areas of quartzitic sandstone similar to the sandstone of the mountains are developed along the eastern side of the Monocacy Valley in Frederick County. The most extensive deposit of this formation occurs in Sugar Loaf Mountain, near the boundary of Montgomery County. Here the sandstone is very homogeneous, fine grained, and compact, and very light in color.

THE SHENANDOAH LIMESTONE.—Along the extreme western border of the plateau country in the Frederick Valley is an extensive development of Shenandoah limestone similar to the more extensive development of this formation in the Hagerstown Valley.

THE NEWARK FORMATION.—The rocks of Triassic age are mainly confined to the western margin of the Piedmont Plateau and are represented by both sedimentary and eruptive materials. The deposits of the Newark formation unconformably overlie the limestone and phyllite which have been above described and cover a considerable area. Beginning as a belt some 10 miles in width in northern Carroll and Frederick counties, the formation gradually narrows toward the south, until in the region of Frederick its full width does not exceed 1 mile, while at one point directly to the west of Frederick the continuity of the beds is completely broken. Farther southward in western Montgomery County the belt of Newark deposits again broadens to a width of several miles.

The rocks of this formation consist largely of red and gray sandstones and conglomerates of both siliceous and calcareous varieties.

Igneous Rocks

THE BASIC VOLCANICS in the Piedmont and in the mountains seem to be remarkably alike. They are essentially bluish-green with white masses of epidote and quartz which on exposure become dull gray or yellow. The honeycombed or amygdaloidal character of many of the masses increases the individuality of these rocks which usually form rough surfaced ledges or areas thickly strewn with characteristic boulders. The original character of these basic volcanics was that of a diabase or andesite, but the subsequent metamorphism which they have suffered has often rendered them schistose and obscured their original appearance.

THE ACID VOLCANICS.—When only slightly metamorphosed, as in certain localities in the Blue Ridge, the acid volcanics are close-grained, dark bluish-gray or purplish rocks, frequently speckled with small feldspar phenocrysts. In the Piedmont occurrences, however, these highly siliceous volcanics have usually been modified by pressure until, in extreme instances, they are fissile slates. In the quarry, they may appear solid and massive and flecked with feldspars, but even here the schistosity is generally evident.

These same rocks occupy considerable areas in the mountains, but here their higher altitude and inaccessibility render them less important. The unconformity between these phyllitic meta-rhyolites and the overlying rocks is seen by the frequent absence of one or more of the younger formations.

THE DIABASE.—The sandstones and shales of the Newark formation, as well as the rocks of earlier age, are found penetrated by dikes of the igneous rock diabase. These dikes extend across the area, for the most part, in a north-south direction, and throughout central Frederick and Carroll counties, where the covering of sandstones and shales has been removed, are found penetrating the limestones and phyllites. The diabase decomposes with considerable rapidity, although the surface is generally covered with large boulders of undecayed material which show characteristic weathering.

THE APPALACHIAN REGION

The geology of the Appalachian Region, as in the case of the Piedmont Plateau, cannot be fully comprehended without taking into consideration the great belt of which it forms a part. The beds of sediments which form the limestones, sandstones, and shales of the Appalachian mountains were deposited in a wide, long trough, which once extended from north to south throughout the region now occupied by the mountains. This trough was undergoing gradual depression through most of Paleozoic time, until many thousands of feet of conformable beds had accumulated in it, mainly as the debris of a continental mass lying to the east.

This vast accumulation, at the close of Paleozoic time, was so compressed as to be forced up into a series of great folds. The present Appalachians are merely the remains of these ancient folds worn down by natural processes through many successive periods. It is by no means certain that the mountain crests ever stood higher than at present, for from the moment the land rose above the sea the forces of denudation became active, and with varying intensity have continued to the present day. The great folds have been from time to time planed down, to be again sculptured as the result of elevatory movements. The compressive force which raised these mountains probably acted from the east toward the west, since the most intense disturbance is always observable in the eastern portion of the range and dies away gradually into the central plains. A secondary result attributed to this action from the east, is that all the folds are tipped toward the west and all the great faults show a thrust in the same direction. In consequence of this the older sediments are toward the east and the younger toward the west, although the more or less abrupt folds into which they were thrown, when raised into a mountain chain, have since been cut off by erosion in such a manner as to show a repeated succession of strata and at the same time to present in portions of the eastern border area rocks of still earlier age.

The section made by Maryland across the Appalachian system between the Frederick Valley and the western line of Garrett County presents an almost complete series of these various formations. As has been already pointed out, the mountain system of Maryland is divisible into three distinct physiographic and geologic districts, but as the features of each division appear to some extent repeated in that which is adjacent to it, it seems more desirable to treat the geology of the Appalachian Region as a unit, and describe under each formation its distribution, character, and structure. Reference to the map will show the relations which these formations bear to the several geographic divisions.

The following divisions are recognized in the rocks of the Appalachian Region:

FORMATIONS OF THE APPALACHIAN REGION

Sedimentary Rocks

Paleozoic.		
Permian (?)	Dunkard	= Coal Measures.
Carboniferous.		
Pennsylvanian	Monongahela	
	Conemaugh	
	Allegheny	
	Pottsville	
Mississippian	Mauch Chunk.	
	Greenbrier.	
	Pocono.	
Devonian.		
Upper Devonian	Hampshire.	
	Jennings.	
	Chemung.	
	Portage.	
	Genesee.	
Middle Devonian	Romney.	
	Hamilton.	
	Marcellus.	
Lower Devonian	Oriskany.	
	Helderberg.	
	Becraft.	
	New Scotland.	
	Coeymans.	
Silurian	Tonoloway.	
	Wills Creek.	
	McKenzie.	
	Clinton.	
	Tuscarora.	
Ordovician	Juniata.	
	Martinsburg.	
	Chambersburg.	
	Stones River.	
	Beekmantown.	

Cambrian	Conococheague.
	Elbrook.
	Waynesboro.
	Tomstown.
	Antietam.
	Harpers.
	Weverton.
	Loudon.

IGNEOUS ROCKS

Paleozoic-Archean	Granites.
	Basic volcanics.
	Acid volcanics.

SEDIMENTARY ROCKS

THE CAMBRIAN PERIOD

The rocks of the Cambrian are confined to the eastern division of the Appalachian Region, previously described as comprising the Blue Ridge and Great Valley, and cover considerable areas in Frederick and Washington counties. They consist of sedimentary materials that have been much metamorphosed since they were deposited, and also subjected to marked structural disturbances, rendering their relations difficult of interpretation.

Lower Cambrian Sandstones and Shales

THE LOUDON FORMATION.—The Loudon formation, so called from its typical development in Loudon County, Virginia, is represented in Maryland in long, narrow belts of rock accompanying the mountain ridges, and found in the Catoctin Mountain, the Blue Ridge, and the Elk Ridge. The deposits consist largely of a fine, dark slate with limestones, shales, sandstones, and conglomerates. The coarser and thicker deposits are found in narrow synclines upon the surface of the pre-Cambrian rocks; the thinner and finer beds are in the synclines which are overlain by the Weverton sandstone. The limestones occur in the form of lenses in the slate and are best developed along the eastern side of the district just to the west of the Catoctin Mountain, where they are generally highly metamorphosed. Beds of sandstone occur in the Loudon formation, although more prominently developed to the south of the Potomac River. The thickness of the formation is very variable, ranging from a few to over 500 feet.

The formation as a whole has been much metamorphosed, alteration being most apparent in the argillaceous beds, which have been changed into slates and schists, all traces of the original bedding being frequently lost. The slate readily decomposes, forming low ground, but the more siliceous rocks commonly occur as small hills or ridges.

The Weverton Formation.—The Weverton formation, so called from its occurrence near Weverton, at the point where the Blue Ridge reaches the Potomac River, consists of massive beds of fine, pure sandstone, quartzite, and conglomerates. They are usually white, the coarser beds somewhat gray. In the Blue Ridge the sandstones are streaked with black and bluish bands. The deposits are mainly composed of quartz grains, which are well worn and washed quite clean of fine argillaceous materials. They at times show cross-bedding, which indicates that the formation was largely laid down in shallow water. The thickness of the formation is about 200 feet.

The Weverton sandstone has been subjected to but little metamorphism, as the quartz particles which comprise the deposits do not afford materials which admit of much alteration. Slight schistosity is evident in the southern part of the Cactoctin Mountain. The sandstone decays slowly and generally forms projecting ledges on the surface of the country.

The Harpers Formation.—The Harpers formation, so called from its typical occurrence at Harper's Ferry, is composed largely of sandy shales with a few sandstone layers imbedded in its upper portion. The shales are of a dull bluish-gray color when fresh, and weather to a light greenish-gray. Argillaceous materials predominate, with frequent small grains of quartz and feldspar, while other materials derived from the pre-Cambrian volcanics appear sparingly. The thickness of the Harpers formation is difficult to determine, owing to the absence of any complete section of it. Its outcrops are everywhere included between faults which have cut off intermediate thicknesses. It has been estimated, as the result of a number of measurements, to have a probable thickness of 2700 feet.

The shales have been subjected everywhere to considerable alteration, the feldspathic materials being partially recrystallized into quartz and mica, with the development of schistosity. The metamorphism is much more pronounced along the eastern border, in the Catoctin area, where the change has proceeded so far as to produce a mica-schist in which small quartz lenses are developed between the layers. Decomposition has affected the shale to considerable depths, the argillaceous materials furnishing a sufficient amount of clay to produce a soil of some value, but on steep slopes it is easily washed.

THE ANTIETAM FORMATION.—The Antietam formation receives its name from Antietam Creek, along the tributaries of which the deposits of this formation are most typically developed. The rock is a sandstone which grades below by gradual transitions into the Harpers shale. The sandstone is composed of small grains of white quartzite well worn and sorted, and it contains a small percentage of carbonate of lime. Its color is almost invariably of a dull brown. The formation has a thickness of about 500 feet.

The Antietam sandstone shows little alteration in its typical area, but east of Catoctin Mountain there are some very siliceous schists that may possibly represent it. The more calcareous varieties weather readily, but numerous blocks of the sandstone generally strew the surface.

Middle and Upper Cambrian Limestones

The Shenandoah Limestone (Lower Part)

The Shenandoah limestone, so called from the fact that it forms the floor of the Shenandoah Valley, a part of the Great Valley above described, is composed of a great series of blue and gray limestones and dolomites in which locally slates and sandy shales are present. In certain places in eastern Washington County beds of pure fine-grained white marble are also found. The thickness of the entire Shenadoah limestone is estimated to reach approximately 10,000 feet. The upper 4000 feet of this formation is of Ordovician age as shown by fossils, while the lower 6000 feet is referred to the Cambrian. Recent investigations in Maryland have shown that the limestone comprises seven distinct stratigraphic units, so that the term Shenandoah limestone will in the future be retained only as a group name. The following divisions have been referred to Cambrian time:

THE TOMSTOWN LIMESTONE.—Drab to white magnesian limestone with thick beds of pink and pearl-colored marble. Thickness of this division, 1000 feet. Occupies valley at foot of Blue Ridge. Lower Cambrian.

THE WAYNESBORO SHALE AND SANDSTONE.—Purple to gray shale and flaggy sandstones. Middle Cambrian fossils. 1000 feet thick. Forms narrow elongate hills in area of Tomstown limestone.

THE ELBROOK LIMESTONE.—Massive bluish-gray magnesian limestone in the middle with gray shaly limestone and shale above and below. Occupies an area less than a mile wide, running northeast to southwest along a line about 5 miles east of Hagerstown. 3000 feet thick. Middle Cambrian.

THE CONOCOCHEAGUE LIMESTONE.—2000 feet thick. Thin-bedded blue limestone banded with siliceous laminæ that weathers out into slaty or shaly fragments. Edgewise conglomerate abundant in certain layers, especially at the base. Scoriaceous chert, sandy oölites, and *Cryptozoon proliferum* characteristic of the basal beds. Occupies a band several miles wide along northeast-southwest line, several miles east of Hagerstown and a smaller area in the valley east of North Mountain.

The limestone deposits have been but little altered, but the shaly beds have been generally more metamorphosed with the production of mica, which causes a more or less clearly defined schistosity. The decay of the limestone through solution has left an insoluble residuum of red clay, through which protrude at times beds of harder materials. The more rapid solution of the Shenandoah limestone than the rocks of the other formations has produced the broad fertile Hagerstown Valley. Similar deposits also underlie much of the Frederick Valley as well.

THE ORDOVICIAN PERIOD

The rocks of the Ordovician period occur in both the Frederick Valley and the Great Valley in association with the Shenandoah limestone (lower part) just described. They consist of sedimentary materials that have been on the whole much folded and at places are faulted. This period comprises two divisions known respectively as the Shenandoah limestone (upper part) and the Martinsburg shale.

Lower and Middle Ordovician Limestones

The Shenandoah Limestone (Upper Part)

The Shenandoah limestone, which has already been described in the previous paragraphs as in part of Ordovician age, contains a fauna of fossil brachiopods, gastropods, corals, and crinoids in its upper members. The line of separation between the Cambrian and Ordovician portions of this limestone can always be definitely determined by the siliceous limestone member (Stonehenge) at the base of the Beekmantown, which forms a characteristic hilly topography.

THE BEEKMANTOWN LIMESTONE.—Drab magnesian and siliceous limestones containing Beekmantown fossils. Entire division 2300 feet thick. Occupies large areas east and west of the shale belt.

THE STONES RIVER LIMESTONE.—Homogeneous, dove-colored, pure limestone, somewhat fossiliferous, 1000 feet thick. Occurs in narrow bands east and west of the great shale belt which occupies the middle portion of the Great Valley.

THE CHAMBERSBURG LIMESTONE.—Crystalline, fossiliferous, thin-bedded limestone, mainly of Black River age, 300 feet thick.

Upper Ordovician Shales and Sandstones

THE MARTINSBURG FORMATION (Utica-Eden), so called from its typical development in the vicinity of Martinsburg, West Virginia, occurs in several areas along the western border of the Hagerstown Valley and in the region immediately adjacent to it upon the west. This formation consists of sandstone at the top and of black and gray calcareous and argillaceous shales at the base, which are fine-grained and show but slight variations within the limits of the State of Maryland. The shales bear from 5 to 20 per cent of carbonate of lime. The deposits were formed in shallow seas which contained graptolites, corals, brachiopods, and trilobites which have left some fossil remains. The fauna comprises that of the Utica and Eden shales of New York and the Ohio Valley. The thickness of the formation is about 2000 feet. At the top of the Martinsburg and below the Juniata are several hundred feet of sandstones and sandy shales containing fossils of the Maysville formation of the Ohio Valley.

There has been but slight alteration in the shale, which is usually not sufficient to obscure the bedding which, however, was never sharply marked. The rocks of this formation have suffered considerable decay as the result of the solution of the carbonate of lime contained in them.

The Juniata Formation (red Medina), so called from its typical occurrence upon the Juniata River in Pennsylvania, is limited to the western portion of the central division of the Appalachian Region, in western Allegany County. It is best developed in "The Narrows" of Wills Mountain to the northwest of Cumberland. The formation consists of alternating shales and sandstones of a deep red color. No fossils have been observed in it in Maryland. The formation has a thickness in Wills Mountain of over 600 feet.

THE SILURIAN PERIOD

The rocks of the Silurian period occur to the west of the deposits of Ordovician age just described, entering into the formation of the Appalachian Mountains in association with strata of Devonian age. They have been less metamorphosed and less faulted than the strata of the older formations. Five divisions have been recognized in the sequence of Silurian deposits, known respectively as the Juniata, Tuscarora, Clinton, Niagara, and Cayuga formations.

The Tuscarora Formation, so called from its development in Tuscarora Mountain in Pennsylvania, is found at widely separated points in the Appalachian district. Upon the east it enters into the formation of North Mountain, the most eastern ridge of the central Appalachians, and upon the west forms Wills Mountain just to the west of Cumberland, and also occurs at several points in the intervening country. The rock is chiefly sandstone, which is hard and massive, generally white or gray in color, and consists for the most part of coarse quartz grains. The deposits of the Tuscarora formation have been subjected to little alteration and the hard sandstone stands out as ridges upon the surface.

THE CLINTON FORMATION is named from its exposure at Clinton, New York. It is confined to the central Appalachian Region in Maryland, occurring in three, narrow, isolated belts west of Hancock, Washington County, and in three V-shaped areas in Allegany County about the Wills Mountain, Evitts Mountain, and Tussey's Mountain anticlines. It is composed of shales of a grayish-olive to reddish color interbedded with thin sandstones, which give place to thin-bedded limestones near the top of the formation. Two beds of iron ore (hematite) of a deep red color are contained in it, one 6 inches to 30 feet thick occurring near its base, and another about 1 foot thick near its summit. The latter usually overlies a heavy quartzitic sandstone. The original character of these two bands of iron ore was probably that of a highly ferruginous fossiliferous limestone from which the calcium carbonate has been removed by solution. The shale between the iron-ore beds usually suffers much erosion, producing characteristic valleys.

THE MCKENZIE FORMATION consists of interbedded shale and limestone which weathers to a fertile soil. The formation occupies valleys which lie between the hard sandstone of the Wills Creek formation and the top of the Clinton. It receives its name from McKenzie Station on the Baltimore and Ohio Railroad southwest of Cumberland. It is 250 to 275 feet thick.

THE WILLS CREEK FORMATION consists of calcareous shales and argillaceous limestone in addition to which it contains several beds of sandstone. Some of the limestone contains clay in such proportion as to yield a natural cement rock of which four beds are found in Allegany County. The lower part of the formation consists of red sandstone and shale known as the Bloomsburg sandstone which contrasts sharply with the overlying gray rocks. The Bloomsburg sandstone forms a prominent ridge where it outcrops upon the surface. The overlying strata weather to a fertile soil. This formation receives its name from Wills Creek in Cumberland. It is 450 to 500 feet thick.

THE TONOLOWAY FORMATION consists of interbedded limestone and calcareous shale. The limestone is characteristically thin-bedded and weathers to small, hard pieces upon the surface of the ground. The strata give rise to a characteristic reddish soil. This formation receives its name from Tonoloway Ridge in Washington County. It is 600 feet thick.

THE DEVONIAN PERIOD

The deposits of Devonian age enter, together with the Silurian rocks, into the formation of the central division of the Appalachian Region, and together with the Carboniferous deposits, into the formation of the Alleghany Plateau. They consist of sedimentary materials that have been but little altered since they were deposited, although in places subjected to considerable structural disturbances. Three divisions are recognized in the strata of Devonian age known respectively as the Lower Devonian, Middle Devonian, and Upper Devonian.

The deposits of Lower Devonian age comprise two divisions known respectively as the Helderberg formation and the Oriskany formation.

THE HELDERBERG FORMATION is named from its exposure in the Helderberg Mountains, New York. It occurs in the central Appalachian Region, being exposed west of North Mountain and west of Hancock in Washington County, and upon the Wills Mountain, Evitts Mountain, and Tussey's Mountain anticlines in Allegany County, in association with the formation last described. It consists of limestones usually purer and more massive than those of the Upper Silurian formation, together with some shales. It comprises three divisions in Maryland, known respectively as the Coeymans, New Scotland, and Becraft members of the Helderberg formation. Of these members, the last is restricted to the region about Cherry Run, West Virginia.

THE ORISKANY FORMATION is named from its exposure at Oriskany Falls, New York. It is confined to the central division of the Appalachian Region in western Washington and Allegany counties. The deposits of the Oriskany formation are typically rather coarse-grained, somewhat friable sandstones, white or yellow in color. At times the materials become very coarse-grained, resulting in a clearly defined conglomerate, while at other times, especially in the western portion of the area, the materials are fine-grained, with here and there interstratified layers of coarser materials. These deposits afford excellent glass sand.

One division is recognized in the Middle Devonian deposits, known as the Romney formation.

THE ROMNEY FORMATION, so called from its exposure at Romney, West Virginia, is confined to the central division of the Appalachian Region, and occupies very much the same areas as those given above for the Oriskany sandstone. It comprises two divisions known respectively as the Marcellus and Hamilton members of the Romney formation.

The Marcellus member, so called from its typical exposure at Marcellus, New York, consists of thin, fissile, black shales, which weather into thin, flat, black plates. Several thin bands of limestone frequently occur some distance above its base. It contains numerous fossils characteristic of the Marcellus formation of New York. Its thickness is about one-third that of the entire Romney formation.

The Hamilton member, so called from its typical exposure at Hamilton, New York, consists of black shales containing, usually, two heavy beds of sandstone, one of which is near the middle and the other near the top of this division. The upper part of the shales weather into yellow to brown, hackly fragments which are highly characteristic of the Hamilton. The lower part weathers into thin, dark plates, often closely resembling those of the Marcellus shales. Eastward near Elbow Ridge a conglomerate develops in this member, while west of Wills Mountain the entire Romney formation thins, the sandstones becoming greatly reduced in volume.

Fossils abound in this division, especially in its upper half, including many species characteristic of the Hamilton of New York. Its thickness is about two-thirds that of the entire Romney formation.

The strata of Upper Devonian age contain two divisions termed, respectively, the Jennings and the Hampshire formations.

THE JENNINGS FORMATION, so called from its development at Jennings Gap, Virginia, is found both throughout the central and western divisions of the Appalachian Region. Within the Appalachian Mountains proper it is frequently repeated throughout western Washington and Allegany counties and occurs as the oldest formation represented in the Allegany Plateau of Garrett County. It underlies the well-known "glades." It comprises three divisions known respectively as the Genesee, Portage, and Chemung members of the Jennings formation.

The Genesee member consists of a deep-black, fissile shale weathering into flat, black plates, and often exhibits pronounced jointing.

The Portage member consists of olive-green to gray shales, alternating with thin, fine-grained micaceous sandstones. The shales weather into thin, flat plates which contrast with the hackly fragments of the Romney shales below, while it is also more resistant to weathering.

The Chemung member consists of olive-green to brownish-red shales and sandstones. A conglomerate occurs near its base in Washington County, while a second conglomerate is found 500 to 600 feet below its summit in numerous localities, forming well-marked ridges.

THE HAMPSHIRE FORMATION (Catskill in part).—The Hampshire formation, so called from Hampshire County, West Virginia, occurs both in the central and in the western portion of the Appalachian Region. It is best developed in the western portion of Allegany and Garrett counties. The deposits of the Hampshire formation consist principally of thin-bedded sandstones, separated by fine-grained shales, although at times the sandstones become thick-bedded, and may merge gradually into the shales. Shales predominate in the upper portion.

THE CARBONIFEROUS PERIOD

The rocks of the Carboniferous period are confined to the western division of the Appalachian Region, where they largely constitute the Alleghany Plateau, and are found in western Allegany and Garrett counties. Two divisions are recognized, known respectively as the Mississippian and the Pennsylvanian.

The Mississippian

Three divisions are represented in the deposits of Mississippian age, known as the Pocono, Greenbrier, and Mauch Chunk formations.

THE POCONO FORMATION.—The Pocono formation, so called from Pocono, Pennsylvania, is the basal member of the Carboniferous and directly overlies the Hampshire formation above described. It occurs in a series of narrow belts which extend from northeast to southwest through western Allegany and Garrett counties. The Pocono formation consists mainly of hard, thin-bedded, flaggy sandstone, which is seldom coarse-grained, although in a few instances slightly conglomeritic. Thin layers of black shale and coaly streaks, in which plant remains are sometimes preserved, occur in some localities, although not a conspicuous feature of the formation.

THE GREENBRIER FORMATION.—The Greenbrier formation, so called from Greenbrier County, West Virginia, occurs in very much the same areas in western Allegany and Garrett counties. The deposits consist mainly of limestone strata in which are interbedded shales and some sandstones. The limestones are more sandy toward the base.

THE MAUCH CHUNK FORMATION (Canaan).—The Mauch Chunk formation, so called from Mauch Chunk, Pennsylvania, flanks the ridges of western Allegany and Garrett counties and grades gradually downward into the Greenbrier deposits. The strata consist chiefly of red shales, interstratified with flaggy, red-brown, fine-grained sandstones. The sandstone is at times micaceous. Thin beds of dark carbonaceous shales occur at times near the top of the formation.

The Pennsylvanian

Four divisions are recognized in the strata of Pennsylvanian age known as the Pottsville, Allegheny, Conemaugh, and Monongahela formations.

THE POTTSVILLE FORMATION, so called from Pottsville, Pennsylvania, is the lowest division of the Coal Measures and forms the mountain ridges which border the coal basins. The Pottsville formation consists of beds of sandstone and conglomerate interstratified with sandy shales in which thin beds of coal are locally developed. The sandstones and conglomerates are mainly composed of fine quartz grains and pebbles which are commonly cemented by means of siliceous materials. These coarse deposits are also frequently cross-bedded and are very irregular both in their extent and sequence.

The Allegheny Formation is named from its typical exposure upon the Allegheny River, Pennsylvania. It occupies the basal portion of the basins within the synclines which are outlined by the Pottsville conglomerate in western Allegeny and Garrett counties. It consists of a series of sandstones, shales, limestones, and coal seams.

The Conemaugh Formation is approximately the same as the division formerly known as the Lower Barren Coal Measures. It receives its name from its exposure along the Conemaugh River in western Pennsylvania. It overlies the Allegheny formation, with which it is associated at the localities cited in the discussion of that formation. It consists of a series of sandstones, shales, conglomerates, limestones, and coal seams.

The Monongahela Formation (Elkgarden) is approximately the same as the division formerly called the Upper Productive Coal Measures. It is named from its typical exposure along the Monongahela River in Pennsylvania. In Maryland this formation is restricted to the Georges Creek-Potomac basin. It consists of a series of shales, sandstones, limestones, and coal seams.

THE PERMIAN PERIOD

The rocks which are referred to the Permian are confined to the central portion of Georges Creek Valley in western Allegany County, where they rest with apparent conformity upon the Carboniferous deposits below. The single formation recognized in these rocks is denominated the Dunkard formation.

The Dunkard Formation is approximately the same as the division formerly known as the Upper Barren Coal Measures. It is named from its exposure on Dunkard Creek, Pennsylvania. Its strata apparently conformably overlie the Monogahela formation of Carboniferous age. It occurs in patches along the center of the Georges Creek Valley where erosion has left fragments capping the top of the higher lands. It consists of limestones, sandstones, shales, and coal seams.

IGNEOUS ROCKS

The igneous rocks of the Appalachian district are limited to the eastern division of the Blue Ridge and Catoctin mountains. No rocks of igneous origin have been found in the part of Maryland lying west of the Hagerstown Valley. The igneous rocks of the Blue Ridge-Catoctin area are similar to those already described and are classified under the heads of Acid volcanics, Basic volcanics, and Granites.

The Acid Volcanics

The acid volcanics of the Appalachian district of Maryland occupy an irregular area north and northeast of Myersville near the head of the Middletown Valley between the Blue Ridge and Catoctin mountains. They form the higher slopes of the headwaters of Catoctin Creek and extend well up to the state line. They are closely related to similar masses in Pennsylvania and Virginia and are represented in several smaller outlying masses, some of which have already been described.

The Basic Volcanics

The basic volcanics of the Maryland Appalachian district are more wide-spread than the acid volcanics, occupying between two and three times as much surface as the latter. Like them they are also represented in masses of similar rock to the north and south of Maryland, and in detached bodies to the east of Catoctin Mountain, as already described. They were formed by intrusions of basic material both before and after the formation of the acid volcanics. The products of these intrusions, which were originally quite similar, have been changed by the varying conditions to which they have been subjected since they were first formed. The present rocks have been classed as "Andesite" and "Catoctin schists." The andesite is found in adjacent areas in Virginia but has not been recognized in Maryland where the sole representative of the basic volcanics is the Catoctin schist. This schist forms practically all of the region between the eastern flanks of the Blue Ridge and the western flanks of Catoctin Mountain, except the central area occupied by acid volcanics and the southwestern part of the Middletown Valley along the Potomac, where the volcanic rocks seem almost crowded out by the numerous intrusions of granite.

The Granites

Intimately intermingled with and cutting the acid and basic volcanics already described are intricately anastamosing bodies of granite which occur in long, narrow belts varying in breadth from 1 yard to 6 miles, with an average width of perhaps 100 yards. By far the greatest development is in the valley lands north of the Potomac River in the Middletown Valley.

THE COASTAL PLAIN

The area of low land and shallow sea floor which borders the Piedmont Plateau on the east and passes with constantly decreasing elevation eastward to the margin of the continental shelf has been described under the name of the Coastal Plain. It is made up of geological formations of late Mesozoic and Cenozoic age. These later formations stand in marked contrast to the older strata to the westward in that they have been but slightly changed since they were deposited. Laid down one above another upon the eastern flank of the Piedmont Plateau when the sea occupied the present area of the Coastal Plain, these later beds form a series of thin sheets that are inclined at low angles seaward so that successively later formations are encountered in passing from the inland border of the region toward the coast. Oscillation of the sea floor with some variation both in the angle and direction of tilting took place, however, during the period of Coastal Plain deposition. As a result the stratigraphic relations of the formations, which have generally been held to be of the simplest character, possess in reality much complexity along their western margins, and it is not uncommon to find that intermediate members of the series are lacking, as a result of transgression, so that the discrimination of the different horizons, in the absence of fossils, often requires the utmost care.

The Coastal Plain sediments were laid down after a long break in time following the deposition of the red sandstones and shales (Newark formation) of Triassic age, which overlie the crystalline rocks of the western division of the Piedmont Plateau, and complete the sequence of geological formations found represented in Maryland and Delaware. From the time deposition opened in the coastal region, during early Cretaceous time, to the present, constant sedimentation has apparently been going on, notwithstanding the fact that frequent unconformity appears along the landward margins of the different formations.

The formations comprise the following:

FORMATIONS OF THE COASTAL PLAIN

Cenozoic.			
Quaternary.			
Recent.			
Pleistocene	Talbot		
	Wicomico	= Columbia Group.	
	Sunderland		
Tertiary.			
Pliocene (?)	Brandywine.		
	Cohansey or Yorktown.		
Miocene	St. Mary's		
	Choptank	= Chesapeake Group.	
	Calvert		
Eocene	Nanjemoy	= Pamunkey Group.	
	Aquia		
Mesozoic.			
Cretaceous.			
Upper Cretaceous	Rancocas.		
	Monmouth.		
	Matawan.		
	Magothy.		
	Raritan.		
Lower Cretaceous	Patapsco		
	Arundel	= Potomac Group.	
	Patuxent		

THE CRETACEOUS PERIOD

The Potomac Group (Lower Cretaceous)

The formations here described include what was long known as the Potomac formation, so called from the Potomac River, in the drainage basin of which the deposits of this age are well shown, but which is now recognized as representing several quite distinct stratigraphic units. These formations have only been found in their full development in the middle Atlantic coastal area, while the lower formation extends southward to the Alabama area, and the upper formations extend both to the northward and southward. The Potomac was deposited largely, if not entirely, under continental conditions.

The Potomac group is divided into the Patuxent, Arundel, and Patapsco formations of Lower Cretaceous age.

THE PATUXENT FORMATION.—The Patuxent formation, so called from its typical development in the upper valleys of the Little and Big Patuxent rivers, is the basal formation of the Coastal Plain series, and is found lying directly upon the crystalline rocks of the Piedmont Plateau. It appears near the landward margin of the Coastal Plain and has been traced as a narrow and broken belt from Cecil County across Harford, Baltimore, Anne Arundel, and Prince George's counties to the border of the District of Columbia.

The deposits consist mainly of sand, sometimes quite pure and gritty, but generally containing a large amount of kaolinized feldspar, producing a clearly defined arkose. Clay lumps are at times scattered in considerable numbers through the arenaceous beds. Frequently the sands pass over gradually into sandy clays, and these in turn into argillaceous materials, which are commonly of light color, but often become highly colored and are locally not unlike the variegated clays of the Patapsco formation. The more arenaceous deposits are cross-bedded, and the whole formation gives evidence of shallow-water origin. The dip of the beds is about 40 feet in the mile to the southeast. The Patuxent formation is estimated to attain a thickness of about 350 feet, but it may be considerably thicker at some points.

THE ARUNDEL FORMATION.—The Arundel formation, so called from Anne Arundel County, where the strata are well developed, consists of a series of large and small lenses of iron ore-bearing clays which occupy ancient depressions in the surface of the Patuxent formation and are unconformable to that formation. These lenses have been traced all the way from Harford County to the border of the District of Columbia. The clays are highly carbonaceous, lignitized trunks of trees being often encountered in an upright position with their larger roots still intact. Scattered through the tough dark clays are vast quantities of nodules of iron carbonate, at times reaching many tons in weight, and known to the miners under the name of "white ore." In the upper portion of the formation the carbonate ores have changed to hydrous oxides of iron, which the miners recognize under the name of "brown ore." The largest lenses have been found to reach a thickness of nearly 125 feet.

THE PATAPSCO FORMATION.—The Patapsco formation, so called from its typical occurrence in the valley of the Patapsco River, forms the uppermost division of the Potomac group. It extends entirely across the state from the Delaware border to the Potomac River, and throughout this distance is one of the most important members of the Cretaceous series. Beyond Maryland it extends southward to central Virginia.

The deposits of this division consist chiefly of highly colored and variegated clays which grade over into lighter colored sandy clays, while sandy bands of coarser materials are at times interstratified. The sands frequently contain much decomposed feldspar and rounded lumps of clay also occur. The sands are often cross-bedded, and all the deposits give evidence of shallow-water origin. The formation is estimated to reach a thickness of 200 feet. The deposits rest unconformably upon the Arundel below and dip from 35 to 40 feet in the mile to the southeast.

The Upper Cretaceous

The formations referred to the Upper Cretaceous overlie the Lower Cretaceous deposits unconformably. The lowest formation is of estuarine origin in Maryland, while the highest formations are distinctly marine. They apparently represent the Cenomanian and Senonian with possibly the lower portions of the Danian of Europe.

THE RARITAN FORMATION.—The Raritan formation, so called from its typical development in the valley of the Raritan River in New Jersey, extends across that state into Delaware and Maryland. It is found in

Cecil and Kent counties and extends thence southwestward along the eastern border of Harford and Baltimore counties into Anne Arundel County, where it broadens out and occupies a considerable extent of country along the Severn River. Beyond the Patuxent Valley the area of outcrop narrows, as the result of the transgression of the overlying Upper Cretaceous strata.

The deposits of the Raritan formation consist chiefly of thick-bedded and light-colored sands, which at times become gravels. Frequently in the lower portion of the formation the sands grade over into the clays, which are generally light in color and highly siliceous, although they are sometimes deeply colored. The thickness of the Raritan formation reaches about 200 feet. The deposits overlie unconformably the Patapsco sediments below and dip about 35 feet in the mile to the southeast.

THE MAGOTHY FORMATION.—The Magothy formation, so called from the Magothy River in Anne Arundel County, overlies the deposits of the Raritan unconformably. It extends as a narrow belt from New Jersey southward along the eastern margin of the earlier formations. The Magothy formation crosses Delaware, Cecil, and Kent counties on the Eastern Shore and Anne Arundel and Prince George's counties on the Western Shore.

The materials consist of sands and clays which change rapidly both horizontally and vertically. The sands are commonly of light color, although lenses with bands of darker sands occur. The clays often appear finely laminated with sand layers between and are occasionally nearly black in color, due to the presence of vegetable matter. The thickness of the Magothy formation in Maryland is very variable, ranging from 90 feet down to 20 feet or less. Its average thickness is probably about 50 feet. The formation has a dip of 30 to 35 feet in the mile to the southeast.

THE MATAWAN FORMATION.—The Matawan formation receives its name from Matawan Creek, New Jersey, in the vicinity of which it is extensively developed. It lies along the eastern margin of the Magothy formation upon which it rests unconformably. The Matawan formation forms a narrow belt which crosses Delaware, southern Cecil, and northern Kent counties, and then reappears upon the Western Shore in Charles and eastern Anne Arundel counties and thence continues southwestward with constantly narrowing confines across Prince George's County.

The deposits of the Matawan formation consist mainly of dark-colored micaceous sandy clays which at times are somewhat more sandy in the upper portions and more argillaceous in the lower portions, although in general the formation is very homogeneous throughout, from Kent County southward. The formation has an average thickness of about 50 feet on the Eastern Shore, but gradually thins southward until it is not over 10 feet in thickness in Prince George's County. The deposits have a dip of from 20 to 30 feet in the mile to the southeast.

THE MONMOUTH FORMATION.—The Monmouth formation, so called from its typical development in Monmouth County, New Jersey, overlies the Matawan formation conformably and extends from New Jersey southward across Delaware into Maryland, but is very much less extensively developed in the State of Maryland than to the northward, although some of its chief characteristics still prevail. The Monmouth formation lies to the east of the Matawan deposits already described and forms a narrow belt crossing Delaware, Cecil, Kent, Anne Arundel, and Prince George's counties.

THE RANCOCAS FORMATION.—The Rancocas formation, so called from its typical occurrence in the valley of Rancocas Creek in southern New Jersey, where it conformably overlies the Monmouth formation, is well developed throughout that state and in Delaware, but due to the transgression of the basal Eocene deposits is probably lacking in Maryland.

In Delaware the Rancocas formation consists of greensand marls which are frequently highly calcareous. The deposits are in general quite arenaceous and on the whole less glauconitic than the Sewell marls in New Jersey, to which horizon they evidently belong. The formation has a thickness of about 20 feet in central Delaware, but gradually thins out toward the Maryland line where the Eocene deposits have transgressed the Rancocas and directly overlie the Monmouth formation.

THE TERTIARY PERIOD

The Tertiary deposits form part of a complex series of formations that extend from New Jersey southward to the Gulf. At no point in the middle Atlantic region is the series more complete or better exposed than in the Chesapeake Bay district and the bluffs along the Maryland and Virginia streams have been classic ground for the study of American Tertiary strata. These Tertiary beds unconformably overlie the Cretaceous deposits which they gradually transgress landward. The Tertiary of Maryland and Delaware is chiefly represented by the Eocene and Miocene, although deposits of presumably Pliocene age also occur.

The Eocene

The deposits of Eocene age lie above and to the east of those previously described. They strike across the area from northeast to southwest and can be traced southward into the State of Virginia. In the Potomac Valley they dip about 12½ feet in the mile to the southeast.

The Pamunkey Group

The Pamunkey group, so called from the Pamunkey River in Virginia, has an extensive development both in Maryland and Virginia. The surface of the Pamunkey group is largely covered by deposits of later date. Numerous outcrops occur along the streams, particularly in the valley of the Potomac River, the interstream portions of the country being generally covered by later deposits. The Pamunkey group has been divided into the Aquia and Nanjemoy formations.

THE AQUIA FORMATION.—The Aquia formation, so called from Aquia Creek, Virginia, is found unconformably overlying the Cretaceous deposits from Delaware southwestward and southward as far as southern Virginia. From Cecil County it crosses Kent and the northern portion of Queen Anne's County on the Eastern Shore, and thence extends across Anne Arundel, Prince George's, and Charles counties on the Western Shore, being particularly well exposed in the valley of the Potomac.

The deposits which consist chiefly of greensands and greensand marls, at times highly calcareous and less frequently argillaceous, have a thickness of about 100 feet at the point where the beds disappear below tide.

THE NANJEMOY FORMATION.—The Nanjemoy formation, so called from Nanjemoy Creek, Charles County, is found conformably overlying the Aquia formation. So far as known it is confined to the Western Shore, outcropping at various points across southern Anne Arundel, northern Calvert, southern Prince George's, and central Charles counties. The most extensive sections of the Nanjemoy formation in Maryland are in the vicinity of Upper Marlboro, along the Patuxent River, and along the Potomac River in southern Charles County from Popes Creek northward. The best part of this section is opposite Charles County along the Virginia bank of the Potomac to the east of Potomac Creek.

The deposits consist of greensands, often highly argillaceous and less frequently calcareous than the lower beds, and with here and there layers containing abundant crystals and crystallized masses of gypsum. The thickness of the deposits is about 125 feet where best exposed, although the beds thicken to some extent eastward.

The Miocene

The Miocene deposits form part of a broad belt of middle Tertiary formations. The strata attain considerable thickness and constitute the most important element in the Coastal Plain series with the possible exception of the Cretaceous formations. The deposits are mainly if not wholly marine and fossils are numerous at most horizons. They constitute a single group known as the Chesapeake group.

The Chesapeake Group

The Chesapeake group, so called from the characteristic development of the deposits in the Chesapeake Bay region, occupies a wide area of distribution throughout the eastern and southern counties of Delaware and Maryland. It overlies the Eocene formations unconformably and in places along the western margin transgresses them to the Cretaceous deposits below. The surface of the Chesapeake group is for the most part covered by the deposits of later date. Fine outcrops, however, occur along the larger stream channels and in the bluffs bordering Chesapeake Bay and its estuaries. The Chesapeake group has been divided into the Calvert, Choptank, and St. Mary's formations.

The Calvert Formation.—The Calvert formation is named from Calvert County, where in the Calvert Cliffs the best sections of Miocene deposits on the Atlantic border are found.

The beds, which consist largely of sands, clays, marls, and diatomaceous earth, have a total thickness of about 200 feet, although it becomes less than this westward, while at the same time it thickens along the dip to the eastward. The dip is about 11 feet in the mile.

The Choptank Formation.—The Choptank formation receives its name from the Choptank River on the northern bank of which the deposits of this age are well exposed. Like the preceding formation, the deposits are deeply buried and few exposures are observable on the Eastern Shore. The Choptank formation overlies the Calvert formation unconformably.

The deposits consist of sands, clays, and marls, with here and there indurated ledges.

The St. Mary's Formation.—The St. Mary's formation is named from St. Mary's County where the formation is well developed. On the Eastern Shore it is buried beneath a mantle of later deposits. While it evidently occurs in southern Delaware and in Caroline, Talbot, Wicomico, and Dorchester counties, Maryland, no outcrops are known. On the Western Shore it has been found only in Calvert and St. Mary's counties. The deposits consist of clay, sand, and sandy-clay, the latter typically greenish-blue in color and bearing large quantities of fossils. Locally the beds have been indurated, and at times clusters of radiating gypsum crystals are found. The formation has a thickness of 150 feet, although it thins down to the northwestward and thickens seaward below tide, as shown by well borings. Its average dip is 10 feet to the mile.

The Pliocene (?)

In southern Delaware and throughout Worcester County, Maryland, the uppermost recognized formation of the Miocene, the St. Mary's formation, is overlain by several hundred feet of a predominantly sandy formation, but containing some gravels and clay lenses. This is probably the Cohansey formation, named from the surface outcrops in Cumberland County, New Jersey, although it may represent the Yorktown formation of the Virginia region. It is rather generally met with in wells in Sussex County, Delaware, and Worcester County, Maryland, and is a frequently utilized source of artesian supply in this region. It is of late Miocene or Pliocene age.

The only formation which has been referred to this period within the State of Maryland is the Brandywine. Its age has been long in doubt, and there are not yet sufficient data to refer it definitely to any period. All that can be said is that it is younger than the Miocene which it covers and older than the oldest Pleistocene beds found in the same vicinity.

THE BRANDYWINE FORMATION is confined to the eastern margin of the Piedmont Plateau and the western border of the Coastal Plain. Throughout this area it is believed to have once extended as a continuous mantle westward over a considerable surface of the Piedmont Plateau and eastward over the Coastal Plain. At the present time it has suffered so much from erosion that in Maryland it has been reduced to a mere fragment of its former extent. The largest area is located on the Coastal Plain southeast of Washington, where it forms the divide between the Patuxent and Potomac rivers as far south as Charlotte Hall. This area has been much dissected by stream erosion, and around its borders there are many outliers which were separated from the larger mass by the removal of the material which once connected them. Along the eastern slope of the Piedmont Plateau there is a long line of outliers which rest either on beds of Potomac or directly on the crystalline rocks of the Piedmont. The most important of these are located in the western part of the District of Columbia, near Burtonville, at Catonsville, near Loch Raven, near Stockton, and on the Piedmont area of Cecil County near Woodlawn.

The materials composing the Brandywine formation consist of clay, loam, sand, and gravel which are often highly ferruginous, the iron being present in the deposits as a cement binding the loose materials together in ledges of local development.

The Brandywine formation is chiefly developed as a terrace lying irregularly and unconformably on whatever older formation chances to be beneath it. These range from pre-Cambrian and Paleozoic (the metamorphic rocks of the Piedmont Plateau) up into the later beds of the Miocene series. Although the oldest of surficial deposits, the Brandywine formation lies topographically highest and at the center of a concentric border of younger terrace formations which wrap about it. It has a thickness on the average of less than 50 feet, although at some points a thickness considerably greater has been observed.

THE QUATERNARY PERIOD

The Quaternary deposits of Maryland and adjacent states form an extensive veneer throughout all but the highest portions of the Coastal Plain, frequently burying from view the deposits of earlier age in the interstream areas. The Quaternary is represented by both the Pleistocene and the Recent.

The Pleistocene

Superficially overlying most of the older formations throughout the greater part of the Coastal Plain and extending in places on to the Piedmont Plateau are beds of Pleistocene age which, with marked variations in thickness, composition and structure, extend from the glacial deposits of northern New Jersey through the south Atlantic and Gulf states to the Mexican border. The Pleistocene deposits belong to a single division known as the Columbia group.

The Columbia Group

The Columbian group, so called from the characteristic development of the deposits in the District of Columbia, is widely extended as surficial deposits throughout the eastern and southern counties of Maryland, over most of Delaware, as well as along the main stream channels that extend into the region of the Piedmont Plateau. These deposits form a series of terraces that wrap about the Brandywine and the higher portions of the older formations and thence extend as fluviatile deposits up the stream courses. The Columbia group has been divided into the Sunderland, Wicomico, and Talbot formations.

THE SUNDERLAND FORMATION.—The Sunderland formation, so called from Sunderland in Calvert County, was formerly developed as a nearly continuous deposit of the Coastal Plain region below the Brandywine highlands, but erosion has now removed it over wide areas. Like the former it finds its greatest development in Southern Maryland, where it forms the divide of Calvert County and of Charles and St. Mary's counties west and south of the Brandywine area. Numerous outliers occur to the westward. A few of them are found within the body of the Coastal Plain region, while many others occur either on the Piedmont Plateau or on the margin between it and the Coastal Plain.

The materials which compose the Sunderland formation consist of clay, loam, sand, gravel, peat, and ice-borne blocks. These as a rule do not occur in well-defined beds, but grade into each other both vertically and horizontally. The coarser materials, with the exception of the ice-borne boulders, are usually found with a cross-bedded structure, while the clays and finer materials are either developed in lenses or are scattered throughout the formation and may occur in the gravel beneath or in the loam above. There is distinguishable throughout the formation a tendency for the coarser materials to occupy the lower portion and the finer the upper portion of the formation, but the transition from one to the other is not marked by an abrupt change and coarser materials are frequently found above in the loam and finer materials below in the gravel. As a whole, the material is coarser in the Potomac and Susquehanna basins than elsewhere.

The sources from which the Sunderland sea derived the materials for its deposits were principally confined to the Coastal Plain, although the rivers also brought in contributions from the Piedmont Plateau and the mountains of western Maryland. The thickness of the Sunderland formation is very variable. The average thickness probably does not exceed 25 feet, although at some points it reaches a thickness of from 60 to 80 feet. A few plant fossils have been recognized in the clay beds, but the fossiliferous localities in the Sunderland formation are much fewer than in the later deposits of Pleistocene age.

THE WICOMICO FORMATION.—The Wicomico formation, so named for the Wicomico River in Southern Maryland, has been developed as a broad terrace below and fringing the Sunderland, at times completely filling and largely obliterating the bottoms of the ancient stream valleys that trenched the Sunderland surface. It has at the present time a much larger areal development than the Sunderland and has been much less dissected by erosion than the latter, with the result that the terraced surface has been far better preserved. Its largest development is on the Eastern Shore, where it forms the watershed throughout the center of the region, extending as far southward as Worcester County.

The materials which constitute the Wicomico formation are similar to those found in the Sunderland and in fact many of them have been derived from that formation. They consist of clay, loam, sand, gravel, peat, and ice-borne boulders. The distribution of these materials is similar to that described in the Sunderland in that they grade one into the other both vertically and horizontally, but with the preponderance of the coarser materials at the base of the formation, while the finer deposits are largely developed toward the top.

THE TALBOT FORMATION.—The Talbot formation, the name for which is suggested by Talbot County where the formation is widely developed, occupies the area between the margin of the older surficial deposits and the seashore. It wraps about the Wicomico and other terrace deposits as a border and extends up re-entrant valleys as a veneer. Erosion has attacked this terrace to such a slight extent that it may be considered as continuous, although here and there small areas have been separated from the otherwise unbroken surface. Like the Wicomico formation it finds its greatest development on the Eastern Shore and particularly in the southern portions of that area where it forms broad flats which decline lower and lower until they pass into marshes and blend imperceptibly with the beach. On the Western Shore it also has an extensive development, particularly toward the head of the Bay.

The materials which compose the Talbot formation consist of clays, loam, sands, gravel, peat, and ice-borne boulders.

The Recent

The Recent deposits embrace chiefly those being laid down to-day over the submarine portion of the Coastal Plain and along the various estuaries and streams. To these must also be added such terrestrial deposits as talus, wind-blown sand, and humus. In short, all deposits which are being formed under water or on the land by natural agencies belong to this division of geological time.

The Recent terrace now under construction along the present ocean shore-line and in the bays and estuaries is the most significant of these deposits and is the last of the series of terrace formations which began with the Brandywine, the remnants of which to-day occupy the highest levels of the Coastal Plain and which has been followed in turn by the Sunderland, Wicomico, and Talbot.

Beaches, bars, spits, and other formations are built up on this terrace belt and are constantly changing their form and position with the variations in currents and winds. Along the streams flood plains are formed that in the varying heights of the water suffer changes more or less marked. On the land the higher slopes are often covered with debris produced by the action of frost and the heavy downpours of rain which form at times accumulations of large proportions known as talus and alluvial fans. An illustration of the former is seen in the Devil's Race-course on the western slope of the Blue Ridge, the heavy blocks in this instance being separated by the action of frost and subsequently precipitated down the steep mountain side.

A deposit of almost universal distribution in this climate is the humus or vegetable mold which being mixed with the loosened surface of the underlying rocks forms our agricultural soils. The intimate relationship therefore of the soils and underlying geological formations is evident.

The deposit of wind-blown sands more or less important everywhere, as may be readily demonstrated at every period of high winds, is especially marked along the sea-coast in Worcester County where sand dunes of considerable dimensions have been formed. Other accumlulations in water and on land are going on about us all the time and with those already described represent the formations of Recent time.

PRECIPITATION

Source and Amount

The normal precipitation in this region, whether falling as rain, hail, sleet, or snow, ranges from 30 to 55 inches. This is greatest in the extreme western part of Maryland on the Alleghany Plateau, where the conditions favor both frequency and intensity of rainfall and snowfall. Throughout the Great Valley, that is, in eastern Allegany and Washington counties, the annual precipitation decreases rapidly; a second area of diminished precipitation is found over upper St. Mary's and the southern part of Charles County; and a third occurs over a narrow portion of the Eastern Shore bordering on the Atlantic, in Maryland and southern Delaware. In these three areas the normal annual precipitation is from 31 to 35 inches.

East of the Blue Ridge the annual precipitation increases, and throughout the Piedmont Plateau area it amounts to from 40 to 45 inches, being in general near the lower figure west of Parrs Ridge and near the higher figure east of Parrs Ridge.

A narrow area over which the normal annual fall is less than 40 inches lies just west of the Atlantic coast area already mentioned as one of the dry divisions, and a second limited area of this kind is found to embrace southwestern Kent County in Delaware and portions of Caroline, Talbot, Prince George's, Howard, and Baltimore counties in Maryland. With these exceptions, and that already noticed in portions of Charles and northern St. Mary's counties, Maryland, the normal annual precipitation for the Coastal Plain is from 42 to 48 inches. The bands of greatest precipitation in this latter area include southern Anne Arundel County, and from southern St. Mary's County northeastward over portions of Dorchester and Wicomico counties and southern Delaware.

The normal annual precipitation is divided throughout the seasons as follows: Spring and summer will have 11.5 to 12 inches, and fall and winter 9.5 to 10 inches.

Snowfall never fails completely even in the warmest winters, although it may be reduced to insignificant proportions except in the mountains.

DISPOSITION

Of the precipitation which falls as rain each year, a considerable portion immediately flows away in the surface streams and ultimately reaches the sea. The percentage of the rainfall which sinks into the ground to return to the surface to form springs after a longer or shorter journey, or which

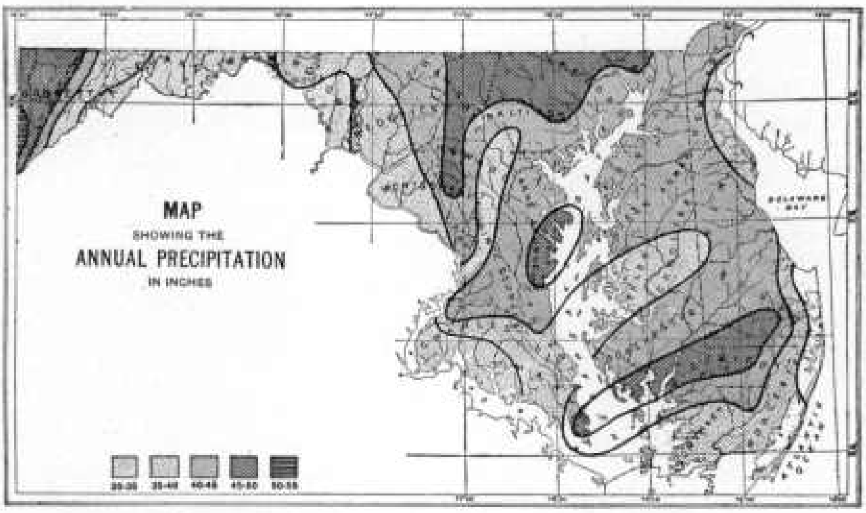

FIG. 74.—MAP SHOWING THE ANNUAL PRECIPITATION.

is added to the underground water supply depends on several factors: (1) The character of the rains, whether slow and steady or torrential; (2) on the nature of the country, whether mountainous or flat or of intermediate type; (3) the character of the vegetation, whether thick and facilitating storage, or whether thin and thus with little influence in preventing rapid runoff; (4) on the character of the soil, whether porous and absorbent or heavy and close-grained, as rock or clays, and consequently more or less impervious; (5) and on the previous state of saturation of the underlying beds.

The amount of precipitation which falls in other forms than rain may act in a similar way in areas like Southern Maryland or the lower Eastern

Shore where snow seldom accumulates for long periods during the winter, while in the colder and particularly the mountainous regions snow may accumulate until the spring thaws, at which time it is subject to the influences just enumerated for normal rainfall.

The amount of precipitation that is lost by evaporation or that takes a part in chemical reactions in the ground is relatively negligible, and the amount that is extracted by the vital activity of the vegetation, while larger, is still a relatively small percentage.

SURFACE WATERS

The surface waters of a region may be grouped under the headings of streams, lakes, ponds, and swamps. Since lakes and ponds are prac-

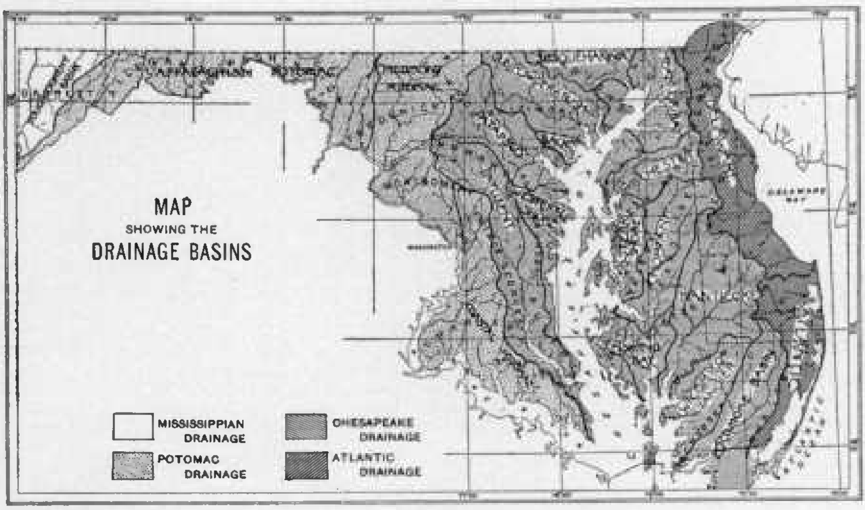

FIG. 75.—MAP SHOWING THE DRAINAGE BASINS.

tically absent throughout Maryland and Delaware, and since swamps are not sources of potable waters and are valuable hydrographically only as they act as storage reservoirs and thus prevent rapid and destructive runoff, the only surface waters to be considered in the present report are those of streams.

The greater part of the Maryland-Delaware region lies in the Atlantic drainage, but a small area in the western part of Maryland is drained by the Youghiogheny River, whose waters ultimately find their way into the Gulf of Mexico by way of the Ohio River. The most important drainage areas are as follows: (1) The Youghiogheny River drainage, which includes the greater part of Garrett County; (2) the Potomac River drainage, which includes Allegany, Washington, and Frederick counties, and portions of Garrett, Carroll, Montgomery, Prince George's, Charles, and St. Mary's counties; (3) the western Chesapeake Bay drainage, which includes Harford, Baltimore, Anne Arundel, Calvert, and Howard counties, and portions of Cecil, Carroll, Montgomery, Prince George's, Charles, and St. Mary's counties; (4) eastern Chesapeake Bay drainage, which includes Kent, Queen Anne's, Talbot, Caroline, Dorchester, Wicomico, and Somerset counties, and portions of Cecil and Worcester counties in Maryland and the western parts of Newcastle, Kent, and Sussex counties in Delaware; (5) the direct Atlantic Ocean drainage, which includes a small area in Worcester County, Maryland, and the eastern part of Sussex County in Delaware, in which the streams flow directly into the Atlantic Ocean or its tributaries; (6) the Delaware River drainage, which in this area includes the restricted basins of numerous small creeks in Newcastle and Kent counties, Delaware, which are shown on the accompanying map as a part of the Atlantic drainage area.

Most of the streams belong to one of two types, although there are some streams which exhibit the characteristics of both types in different portions of their courses. One type is found west of a northeast-southwest line, known as the "fall line," extending across the state through Wilmington, Elkton, Baltimore, and Washington. Here the streams have fairly steep gradients and flow over rocky beds. Their courses lie through a rolling country in which hard rocks prevail. Rapids and gorges are of frequent occurrence, and there are many opportunities for water-power development. Some of these have been utilized, but there are still many available power sites that are capable of yielding a large amount of horsepower.

East of the "fall line" the streams and the topography and geology have a different character. Here the country is less rolling and the surface formations are unconsolidated sands and clays. The streams flow sluggishly in winding courses and in the lower counties open out and become estuaries. Here also the streams are navigable in their lower courses, but owing to the slight velocity they split up rapidly in places, and on many streams the head of navigation is several miles farther down stream than it was a half century ago. As a result of the general flatness of the country there are no water-power sites in this section. In this area also a smaller proportion of the rainfall finds it way into the streams, as the loose, porous soil, most of which is cultivated, absorbs the water very quickly.

As there are no natural lakes of importance in the state there is no regularity in the stream flow, such as would exist if there were storage reservoirs on the headwaters of the streams. The flow of the streams varies according to the rainfall. Hence in cleared areas that are highly cultivated the rainwater runs off quickly and the streams rise rapidly at times of large precipitation. In wooded areas the water is held back and reaches the streams more gradually.

SURFACE WATERS OF THE COASTAL PLAIN

The surface waters of the coastal district are relatively unimportant as sources of potable water supply when compared with the underground waters. At no points are they employed to any extent for either public or private uses. This is due not so much to the generally small size of the streams above the head of tide as to their unpotable quality. Not only are they quickly rendered roily by the rush of the fine materials found along their banks, but their sluggish currents render the waters unwholesome in other respects. Furthermore, vegetation is widely found in the waters, rendering them disagreeable for domestic purposes, and few are not contaminated by sewage.

The streams of northern Newcastle and Cecil counties, and those of western Anne Arundel and Prince George's counties, especially when their sources are in the highlands of the Piedmont Plateau, are better adapted for potable uses than those elsewhere in the area. Some of the streams reaching the margin of the coastal district in Baltimore and Harford counties may be similarly employed. Even these streams, however, are inferior to those found in the higher areas of the state. Practically all of the streams therefore of Eastern and Southern Maryland may be classed as undesirable for potable uses.

SURFACE WATERS OF CENTRAL MARYLAND

Streams of Central Maryland are much more important as sources of potable water supply than those of the Coastal Plain, and are extensively used for municipal and corporate purposes, at the same time spring waters are also widely employed for private uses. Except where man has been responsible for their contamination, these waters are almost universally of good quality and adapted to potable uses. Great care has to be exercised in using surface waters anywhere to see that sanitary regulations are enforced, since a contaminated supply of this character may and frequently has spread disease over wide areas.

The Potomac, Susquehanna, Jones Falls, and Gunpowder rivers, and Brandywine Creek, as well as one or two other streams have been used as sources of public water supply in this district, and although they have not been as fully protected from contamination in all instances as is wise, the supplies on the whole are excellent, especially when scientifically filtered. Baltimore, Washington, Wilmington, and Havre de Grace use the surface waters of the larger streams mentioned, while Hagerstown, Frederick, and Perryville derive their supplies from small streams and springs.

The region under discussion has many unused supplies which, with proper safeguards against contamination and filtration, might be rendered available, among the larger streams being the Patapsco, Patuxent, Monocacy, Antietam, and Conococheague rivers.

SURFACE WATERS OF WESTERN MARYLAND

The surface waters of Western Maryland are the chief sources of potable water supply for that area. The streams flowing in narrow valleys can be readily empounded, and as they flow for the most part in regions of few inhabitants can be readily protected from contamination. The numerous springs occurring on the lower slopes and in the valleys are fed from the higher ridges and are admirable sources of local water supply. Cumberland, the largest city in this district, obtains its water supply from Evitts Creek. The North Branch of the Potomac above Westernport, the Youghiogheny, Tonoloway, and Sideling creeks afford fine supplies of unutilized potable waters.

UNDERGROUND WATERS

Under the head of underground waters are included supplies obtained from springs, from the old-fashioned, relatively shallow, dug wells, and from the generally deeper drilled wells that utilize artesian waters.

MOVEMENT OF UNDERGROUND WATERS

The underground waters rarely move in definite channels of appreciable size in any way resembling surface streams, and this occurs only in regions where thick limestone beds contain caverns. Such cavern streams of any size are practically unknown in this area, and for the world at large they may be said to constitute an extremely small proportion of the world's water supply.

Supplies which form the source from which practically all wells draw their water are to be regarded as coming from more or less saturated parts of porous beds, such as sand and sandstones, or beds with minute systems of joints, such as those common in crystalline rocks. In all such situations the underground water whether influenced by gravity or capillarity moves in the minute interstices of the rock or sand bed, and this movement may best be conceived as a slow seeping in which the rate of movement is a few feet per day, rather than a few miles as in surface streams.

WATER TABLE

The effect of the constant percolation of water into the ground is to saturate certain layers, and this saturated zone, or frequently its upper surface, is known as the water table. The position of the water table depends on the topography, the varying porosity of different rocks, and the amount of rainfall. Where precipitation is heavy the water table is near the surface, except on very steep slopes, while in arid regions or during dry seasons it retires to greater or less depths. The relation of the water table to the topography is shown in the accompanying diagram (Fig. 76).

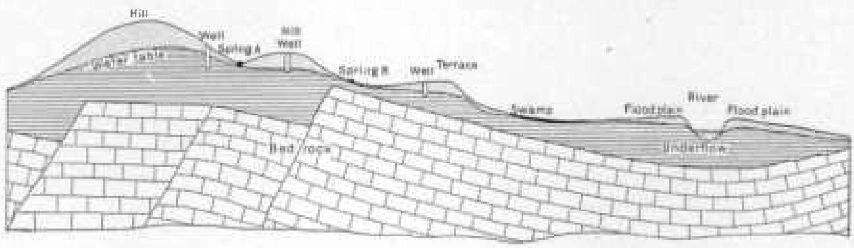

FIG. 76.—DIAGRAMMATIC SECTION SHOWING THE RELATION OF WATER TABLE TO SURFACE IRREGULARITIES.

VARIATIONS OF PRESSURE OR HEAD

Water pressures or head are very unequal even in the same bed or zone of saturation. They also vary greatly in different beds in the same region. Pressures depend upon a number of variable factors. These include: (1) The position of the water table, which varies with the factors already enumerated under that head; (2) the character of the water-containing beds, whether coarse- or fine-grained, and hence offering less or more resistance to the underground movement of the water; (3) changes in the adjacent beds as regards their coarseness of grain, and the effects of faults, joints, or other natural breaks. In artesian wells a fourth and most

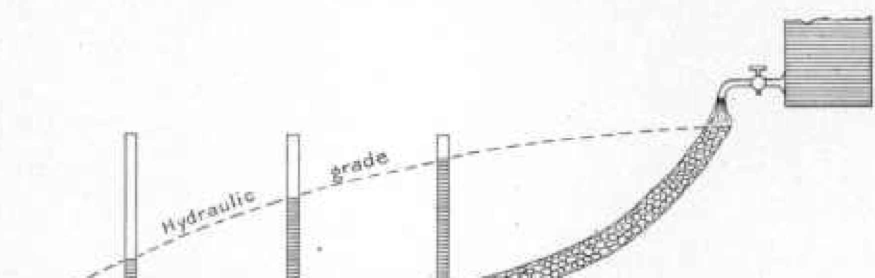

FIG. 77.—DIAGRAM SHOWING THE LOSS IN HEAD BY FRICTION AND LEAKAGE.

important factor is the character and elevation of the source of the underground water for the particular bed penetrated. The principles governing the loss of head, or what is known as the hydraulic grade, are illustrated in the accompanying diagram (Fig. 77).

Causes Producing Artesian Wells

The term artesian well has been employed in different senses in the past, and frequently in Maryland the term is used for only those wells which overflow at the surface. This is an incorrect conception. In this report, as well as in the publications of the U. S. Geological Survey, by an artesian well is meant any well which conforms to the hydrostatic principle by means of which confined underground waters tend to rise because of the pressure of the water column due to the ascending of the water-containing beds to higher elevations. The presence or absence of a flow is dependent entirely on whether this pressure is sufficient to lift the water above the surface of the ground or not. It is customary in works on hydrology to compute these heads with reference to a general datum plane, usually that of mean sea level, but in the present report the more readily understandable datum is the surface, consequently throughout the

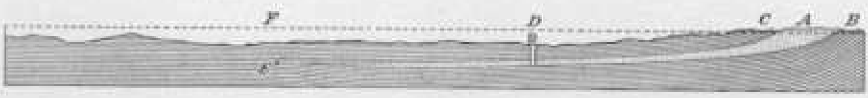

Fig. 78.—Diagram illustrating artesian conditions in the coastal plain.

text heads are given as + or − with respect to the surface of the country where wells are located, although in the maps the contours are drawn with respect to depths below tide.

Artesian wells are possible where a porous stratum capable of saturation reaches the surface in a region where the rainfall is sufficient. This stratum should be confined between two impervious layers. The ideal conditions for obtaining an artesian well are indicated in the accompanying diagram (Fig. 78), which is practically an ideal vertical section from northwest to southeast across the Coastal Plain region of Maryland. The actual conditions are much more variable and complex.

Referring to the first diagram, there is a porous sand or sandstone with clay or shale both above and below it. Rain falling on the surface-marked catchment area sinks into the sand and gradually moves down the slope toward the southeast. If the position of a drilled well is enough lower than the catchment area so that the mouth of the well is below the hydraulic grade, determined by height and friction in the bed and well as illustrated in Figure 78, there results a flowing well, the water rising to the hydraulic grade which is the "head" or static head of the well.

A variation of these conditions is furnished where the strata are gently folded, as in the western counties of Maryland, and the water-bearing bed rises in two directions as shown in Figure 79. In such situations there are two catchment areas and the underground waters are moving in two directions toward the intermediate valley.

Water-bearing or other geological beds are rarely continuous for scores of miles beneath the ground without some changes in thickness or character of materials, so that instead of the ideal conditions illustrated in the diagram the conditions approximate these ideal conditions either more or less closely. It may happen that the sand bed, like those of the Lower Cretaceous or of the Calvert formation, may not vary through very wide

FIG. 79.—DIAGRAM ILLUSTRATING ARTESIAN CONDITIONS IN WESTERN MARYLAND.

limits, but the confining beds may vary, resulting in water-bearing sands now confined by clay lenses at one level and elsewhere at another level. In this case the head may be much greater beneath such a clay lens than it is where the clay cover is absent or of small extent.

SPRINGS

The mode of occurrence of springs is regulated by the geological structure, and hence there is a great variety in the conditions which produce them, depending on the relations of permeable and impermeable strata. Shallow springs in general are formed where the land surface is depressed in valleys, or on hill slopes so that it penetrates the water table. A normal hillside spring is formed where readily permeable beds rest on less permeable strata, as shown in Figure 80.

Variations from this normal type are dependent on the inclination of the strata, the flatness or irregularity in the surface of the underlying impervious bed, and whether the water-bearing layer is covered by an impervious stratum. Other springs may be due to fairly defined channels in the surficial rocks and may be regular or intermittent in character, dependent on the geological structure. Shallow springs usually reflect the

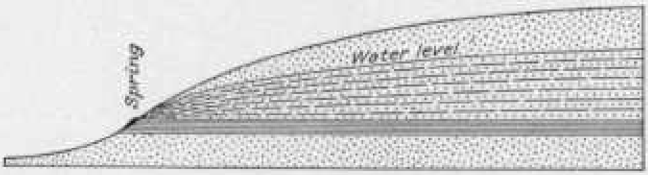

FIG. 80.—DIAGRAM SHOWING AN ORDINARY HILLSIDE SPRING.

seasonal variation in the rainfall. On the other hand, springs that owe their existence to a saturated bed confined between impervious beds may be of large volume and regular flow and may often have a considerable hydrostatic head, particularly in mountainous regions.

Other springs are illustrative of ordinary artesian well conditions where the water-bearing bed under a considerable head is cut by a fault, as shown diagrammatically in Figure 81, and illustrates deep-seated springs, like those at Clear Spring or Big Spring in Washington County. The same results are accomplished in regions where the strata are folded and water in a confined, saturated bed, circulating at great depth under pressure,

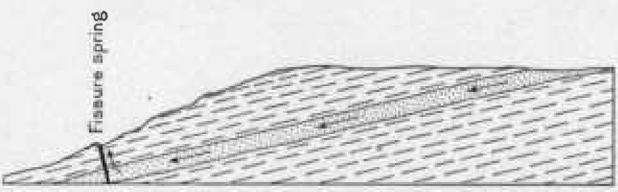

FIG. 81.—DIAGRAM SHOWING A DEEP-SEATED SPRING.

forces its way to the surface at the point of contact between the saturated bed and the overlying or underlying impervious beds. Springs of this sort are not uncommon along the Alleghany ridges in Washington County. The historic Berkeley Springs, near the Maryland border in West Virginia, is the best known instance of this last type of spring.

Springs from sands, sandstones, clays, shales, or slates are seldom polluted. Usually such pollution is likely to occur where houses, barns, or vaults are located on higher ground near the spring and especially where towns are so located. Springs in limestones or springs due to faults or joints in crystalline rocks are easily contaminated from considerable distances by direct underground channels.

Springs where utilized should be protected from stock, from surface drainage, from wind-blown refuse, and from subsurface drainage. The diagram (Fig. 82) illustrating the location of dug wells also shows the manner in which subsurface drainage down a slope can pollute a spring.

When springs which have been guarded against surface wash become muddy after rains it is safe to assume that surface impurities are readily accessible and the use of such springs should be avoided.

SHALLOW DUG WELLS

Throughout a large portion of Maryland and Delaware the old-fashioned dug wells, because of the ease with which they can be constructed, are still the main sources of domestic supplies. Farms, which are all more or less remote from towns or other areas of congested population would seem to be almost ideally situated for obtaining wholesome water from such sources. This is not the case, however, since polluted water is exceedingly common in such wells and typhoid is usually more prevalent in country districts than in cities. While shallow dug wells are easily rendered insanitary, the rather general failure to protect such water supplies is usually due to the lack of knowledge of the manner in which waters circulate through the ground and the ways in which they can become polluted. If care is taken in the location of wells so that they are not too near vaults or farm yards, nor down the slope from such sources of pollution, they can be used with safety in the great majority of cases. Figure 82 illustrates for a hypothetical situation the right and wrong location for wells and is readily understood without special comment.

The easiest and cheapest method of obtaining limited supplies of water in sections where the water table is near the surface is by driving a pipe into the ground. Such wells, however, easily become clogged with sediment, nor is their storage capacity as great as in the ordinary type of dug well. The seasonal fluctuations of level of the ground water is liable to cause them to fail in dry seasons unless they are deep enough to be below

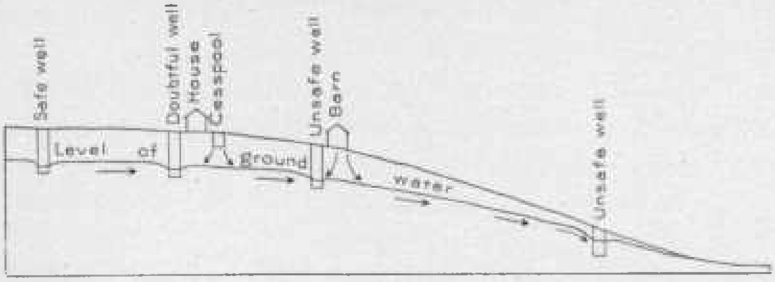

FIG. 82.—DIAGRAM SHOWING RIGHT AND WRONG LOCATIONS FOR WELLS.

the water level during drouth conditions, as is shown graphically in Figure 83.

In regions where the subsoil is underlain by clay, dug wells should be as wide and deep as possible to insure ample storage, since while clay usually contains water the pore spaces are so fine that there is little movement of the water, and clays are for most practical purposes considered non-permeable. The ideal condition is approached where the subsoil is underlain by clay and the clay is in turn underlain by sand, as shown in Figure 84. If care is taken to prevent pollution from entering the well at its mouth, the water remains free from contamination.

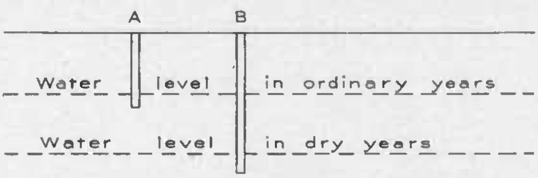

FIG. 83.—DIAGRAM SHOWING RELATIONS BETWEEN DEPTH AND AN UNFAILING SUPPLY OF WATER.

Even where wells are not dug through a capping of clay, if the well is deep enough in sands or sandstones it is liable to be wholesome because the water in passing through such materials is subject to a natural filtration which partially or wholly removes pollution.

Dug wells in regions of limestone, such as the Frederick and Hagerstown valleys, are more readily contaminated than wells in other types of rocks, because of the frequent formation of underground channels in limestone and the absence of natural filtration, such as was described in the preceding paragraph.

There is no infallible chemical test for detecting pollution in small amounts. A chemist thoroughly familiar with the normal character of the local water may be able to recognize such pollution, but waters contain so many harmless substances dissolved from the rocks or soil through which the water has passed that chemical analyses are often inconclusive.

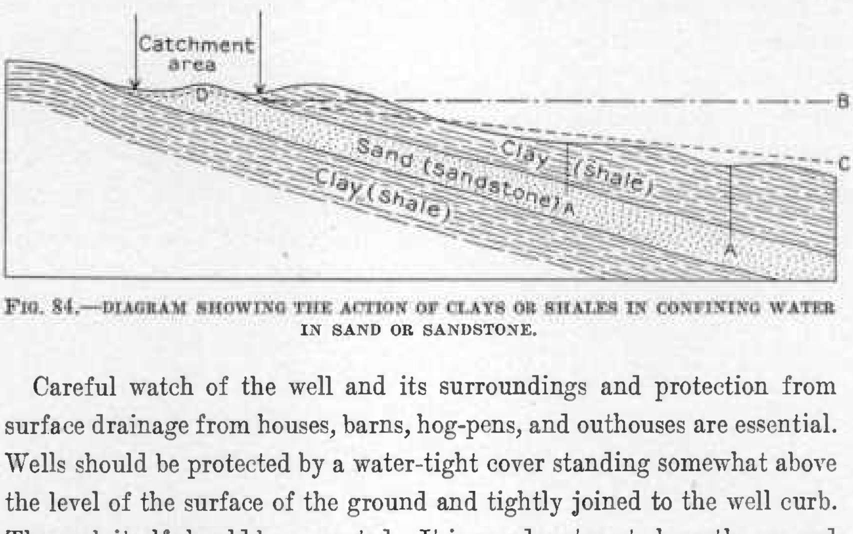

FIG. 84.—DIAGRAM SHOWING THE ACTION OF CLAYS OR SHALES IN CONFINING WATER IN SAND OR SANDSTONE.

Careful watch of the well and its surroundings and protection from surface drainage from houses, barns, hog-pens, and outhouses are essential. Wells should be protected by a water-tight cover standing somewhat above the level of the surface of the ground and tightly joined to the well curb. The curb itself should be cemented. It is an advantage to have the ground slope away from the well mouth on all sides.

THE UNDERGROUND WATERS OF THE COASTAL PLAIN

The underground waters of the coastal district are the chief source of supply within this area. They are obtainable from a number of water-bearing strata found within the series of geological formations that compose the district. These several water-bearing horizons, like the formations of which they are a part, dip east-southeast toward the coastal border at angles varying from 10 feet to the mile for the younger Miocene formations to 40 to 50 feet to the mile for the older Lower Cretaceous formations. Since these water-bearing strata persist over wide areas their regularly increasing depth eastward beneath the surface may be computed with considerable accuracy. The most important water-bearing horizons in the coastal district occur (1) in the basement beds underlying the Coastal Plain deposits, (2) the Patuxent and Patapsco formations of the Lower Cretaceous, (3) the Raritan, Magothy, and Monmouth formations of the Upper Cretaceous, (4) the Aquia and Nanjemoy formations of the Eocene, (5) the Calvert, Choptank, and St. Mary's formations of the Miocene, and (6) the several surficial formations of the Pleistocene, the latter furnishing only shallow wells because of the slight thickness of the deposits. The depths at which the great majority of good potable supplies have been secured from the underlying formations vary from 50 to 500 feet. A number of wells at much greater depth occur, but the time and expense involved in sinking such wells have limited their drilling chiefly to corporations and municipalities. Most of the waters are derived from pumping wells, but where the outcropping edges of the water-bearing layers are at higher levels, flowing wells may be obtained at lower levels along the dip of the beds.

WATER FROM THE BASEMENT ROCKS

Water may be secured from the basement rocks underlying the Coastal Plain deposits in a belt not exceeding 5 miles in width along the inner margin of the coastal area. Such supplies are potable when they occur under an adequate cover of 50 feet or more of Coastal Plain deposits, or when the source of the water is well within the basement rocks so as to be protected from surface contamination.

Depth.—Generally from 75 to 300 feet.

Static Head.—50 to 100 feet below the surface; non-flowing; generally pumped by air compression.

Quantity.—Small to large. Moderate supplies have been obtained at many points, especially in the vicinity of Baltimore. A well at the corner of Howard and Pratt streets, Baltimore, at a depth of 90 feet furnishes 4 gallons per minute, and another at Mt. Winans at a depth of 90 feet affords a yield of 35 gallons per minute, while a third at the corner of Pleasant and North streets, Baltimore, at a depth of 240 feet yields 40 gallons per minute. Larger quantities of water have been obtained at various depths, a well at Havre de Grace, Harford County, at a depth of 200 feet yielding 100 gallons per minute, and another at Evergreen Lawn, Harford Road, a few miles to the northeast of Baltimore, at a depth of 650 feet furnishes 100 gallons per minute.

Quality.—Mostly good, although at times high in iron.

WATER FROM THE LOWER CRETACEOUS DEPOSITS

Water is obtainable at two well-marked horizons in the Lower Cretaceous deposits; one in the Patuxent formation, where it is found at two levels, and the other in the Patapsco formation.

PATUXENT FORMATION.—The two principal sources of water found in the Patuxent are, one near the contact with the basement rocks and the other about 350 feet higher in the upper beds of the formation. To the east of Washington the difference in water levels is somewhat more than 350 feet, while at Baltimore the interval has been reduced gradually northward to about 300 feet. Because of the rather rapid slope of the basement beds, water within 500 feet of the surface is generally limited to a belt 4 or 5 miles in width.

Depth.—Generally from 100 to 500 feet.

Static Head.—From 100 feet below to 10 feet above the surface; mostly non-flowing; none pumped by suction, some by force pumps.

Quantity.—Variable, often large (lower horizon). A well at Jessups, Anne Arundel County, 180 feet in depth, furnishes 20 gallons per minute; one at Hyattsville, Prince George's County, 285 feet, yields 30 gallons per minute, and several wells at the Naval Proving Grounds at Indian Head, Charles County, at 388 to 463 feet in depth yield from 60 to 80 gallons per minute. Among larger wells may be mentioned one drilled by Martin Wagner and Company, at Wagners Point near Curtis Bay, in Anne Arundel County, that at 373 feet yields 80 to 120 gallons per minute, and another at Brooklyn, Anne Arundel County, belonging to the Brooklyn and Curtis Bay Electric Light and Water Company, which

FIG. 85.—MAP SHOWING LOWER CRETACEOUS WATERS.

O-O—Line where base of Lower Cretaceous passes below tide level.
A-A—Line northwest of which Patuxent waters are found within 500 feet of tide level.
B-B—Line northwest of which the top of the Lower Cretaceous is within 500 feet of tide level and where Lower Cretaceous waters may be expected within this depth.

at a depth of 425 feet is reported to furnish 275 gallons per minute (upper horizon). The wells at this horizon furnish for the most part small yields, and as they are generally located on low ground have a natural flow. Numerous wells in Hyattsville, Prince George's County, and vicinity, at depths of 80 to 100 feet give flows of 6 to 10 gallons per minute. At Wagners Point on the south side of the Patapsco River in Anne Arundel County a well 170 feet deep furnishes 45 gallons per minute by pumping, and at Naval Academy Junction in Anne Arundel County a well 315 feet deep yields 20 gallons per minute.

Quality.—The wells from the Patuxent horizons are fairly good for potable uses, although containing a fairly large amount of mineral matter in solution. All of them, especially those from the lower horizon, are highly alkaline.

PATAPSCO FORMATION.—Important supplies of water are obtainable from the Patapsco formation in a belt about 20 miles wide. Many small wells have been secured along the western margin of the formation at depths between 50 and 100 feet, while larger wells occur at greater depths.

Depth.—From 100 to 600 feet.

Static Head.—From 75 feet below to 15 feet above the surface; mostly non-flowing; for the most part pumped by suction pumps.

Quantity.—Small wells with yields of 10 to 20 gallons per minute have been obtained at a depth of 55 to 85 feet at Hawkins Point on the south shore of the Patapsco River, Anne Arundel County; at Linthicum, Anne Arundel County, at a depth of 110 feet, and at Lincoln Park, Prince George's County, at a depth of 185 feet. A yield of 25 gallons per minute has been obtained at this horizon at Downs Station, Anne Arundel County, at a depth of 103 feet, and a yield of 40 gallons per minute at Naval Academy Junction, Anne Arundel County, at a depth of 170 feet. Larger supplies have been obtained on the Naval Academy grounds at Annapolis, where from a depth of 587 to 600 feet 275 gallons per minute have been pumped.

Quality.—Usually hard, with iron in variable quantities, but in general good for potable purposes.

WATER FROM THE UPPER CRETACEOUS DEPOSITS

Water may be secured at several horizons in the Upper Cretaceous deposits, although chiefly confined to the more sandy beds of the Raritan and Magothy formations.

RARITAN FORMATION.—Water is obtainable chiefly from the lower beds of this formation, although locally water has been found at higher horizons. It occurs in a belt 10 to 12 miles in width.

Depth.—Usually more than 100 feet.

Static Head.—Ranging from 75 feet below to several feet above the surface; many flowing wells on the Eastern Shore; pumping by suction pumps.

Quantity.—Large and small. Among small wells may be mentioned one at Millersville, Anne Arundel County, which is 130 feet in depth and yields 8 to 10 gallons per minute, and another at Odenton, Anne Arundel County, which is 56 feet deep and yields 6 gallons per minute. Of larger production from this formation are wells at Rock Hall, Kent County, 400 feet in depth, which flow 3 to 5 gallons per minute and by pumping yield 50 to 60 gallons per minute. At Chestertown the well supplying the municipality is 583 feet in depth and flowed when opened up 20 gallons per minute. A yield of 120 gallons per minute is now secured by force pump.

Quality.—Good, free from all mineral matter except iron.

MAGOTHY FORMATION.—This formation, because of its arenaceous character, is widely water-bearing and wells are obtainable in a belt 12 to 20 miles in width.

Depth.—Usually more than 100 feet.

Static Head.—From 50 feet below to 10 feet above the surface; many flowing wells on Eastern Shore; pumped chiefly by suction pumps.

Quantity.—Supplies of water have been secured from the Magothy formation as follows: At Chestertown, Kent County, from wells 160 feet deep 5 gallons per minute (pumped with an air compressor); at the Annapolis Water Works, Anne Arundel County, from four wells 135 to 160 feet deep about 10 gallons per minute; at Revell, Anne Arundel County,

FIG. 86.—MAP SHOWING UPPER CRETACEOUS WATERS.

O-O—Line where the base of the Upper Cretaceous passes below tide level.
A-A—Line northwest of which the lower (Raritan) Upper Cretaceous waters are found within 500 feet of tide level.
B-B—Line northwest of which the upper (Matawan, Monmouth) Upper Cretaceous waters are found within 500 feet of tide level.

from a well 150 feet deep 15 gallons per minute are pumped; on the Severn River a short distance above Annapolis at 135 feet several wells flow 20 or more gallons per minute; at Eastport, Anne Arundel County, a well 218 feet deep flows 30 gallons per minute; at Tilghman and Sherwood, Calvert County, several wells at a depth of about 420 feet flow 8 to 15 gallons per minute and would probably yield a larger amount if pumped; west of Cambridge, Dorchester County, wells of about 500 feet in depth flow 3 to 6 gallons per minute.

Quality.—Very good, some iron present, with high temporary hardness.

WATER FROM THE EOCENE DEPOSITS

Water is found at two horizons in the Eocene, one in the lower and the other in the upper portions of the deposits.

AQUIA FORMATION.—Abundant water near base and an important stream near top, the latter always heretofore known as Nanjemoy water. This name is continued for it throughout the present report in order to avoid confusion. It is discussed in the following paragraphs.

NANJEMOY FORMATION.—The water is rather widely scattered through this formation; the only definite zone determined being one called Nanjemoy, but really in the upper part of the Aquia formation.

Depth.—75 to 500 feet.

Static Head.—From 40 feet below to 5 feet above the surface; a few flowing wells; generally pumped by suction pumps.

Quantity.—Large and small. Many wells of small size are found, among them four wells at Millington, Kent County, 100 feet in depth which yield by pumping 10 gallons per minute; a well at Eastport, Anne Arundel County, 70 feet in depth which yields 8 gallons per minute, and others at Churchton, Deal, Shadyside, and Galesville, Anne Arundel County, which at depths of 90 to 130 feet flow 2 to 5 gallons per minute, which could probably be much increased by pumping; a well at Tompkinsville, Charles County, which at a depth of 265 feet flows 3 gallons per minute; and numerous wells near Madison and Woolford, Dorchester County,

FIG. 87.—MAP SHOWING EOCENE WATERS.

O-O—Line where the base of the Eocene passes below tide level.
A-A—Line northwest of which Eocene waters (Aquia and Nanjemoy) are found within 500 feet of tide level.

which at depths of 300 to 350 feet flow 1 to 2 gallons per minute and could undoubtedly yield 30 to 40 gallons per minute by pumping. Of wells of somewhat larger yields at the present time may be mentioned one at Oxford, Talbot County, 350 feet deep which yields by pumping 25 gallons per minute, another at Greensboro, Caroline County, 240 feet in depth which yields 30 to 35 gallons per minute; and one at Queen Anne, Queen Anne's County, of the same depth and about the same capacity. A number of wells of much larger yield have been drilled, among them one at Benedict, Charles County, 345 feet deep which flows 45 gallons per minute, and would show a very much larger capacity if pumped; a well at Denton, Caroline County, with a depth of 285 feet which yields by pumping 75 gallons per minute; and a well at the Eastern Shore State Hospital at Cambridge, Dorchester County, 390 feet deep from which 190 gallons per minute are pumped by means of an air compressor with two jets, the lower 175 feet below the surface.

Quality.—Good, although frequently hard; at times sandy.

WATER FROM THE LOWER MIOCENE DEPOSITS

Water is obtainable from the Lower Miocene deposits in a belt about 45 miles in width at depths less than 500 feet.

Calvert Formation.—The water horizon of the Calvert formation is located above the top of the basal diatomaceous earth member and extends from about 35 or 40 feet to 75 feet above the base of the formation.

Depth.—From 50 to 500 feet, the shallower wells near the outcrop yielding small quantities of water. The chief supplies are secured at about 300 feet in depth.

Static Head.—Generally from 30 feet below to 10 feet above the surface, an extreme head of 20 feet above sea level having been observed.

Quantity.—Large and small. Among small wells which derive their water from this horizon may be mentioned several at Chesapeake Beach, Calvert County, 125 feet in depth which flow 2 gallons per minute, and another at Oxford, Talbot County, 130 feet deep which yields 10 gallons per minute by pumping. Somewhat larger supplies have been secured at Solomons Island, Calvert County, where wells 265 feet in depth flow

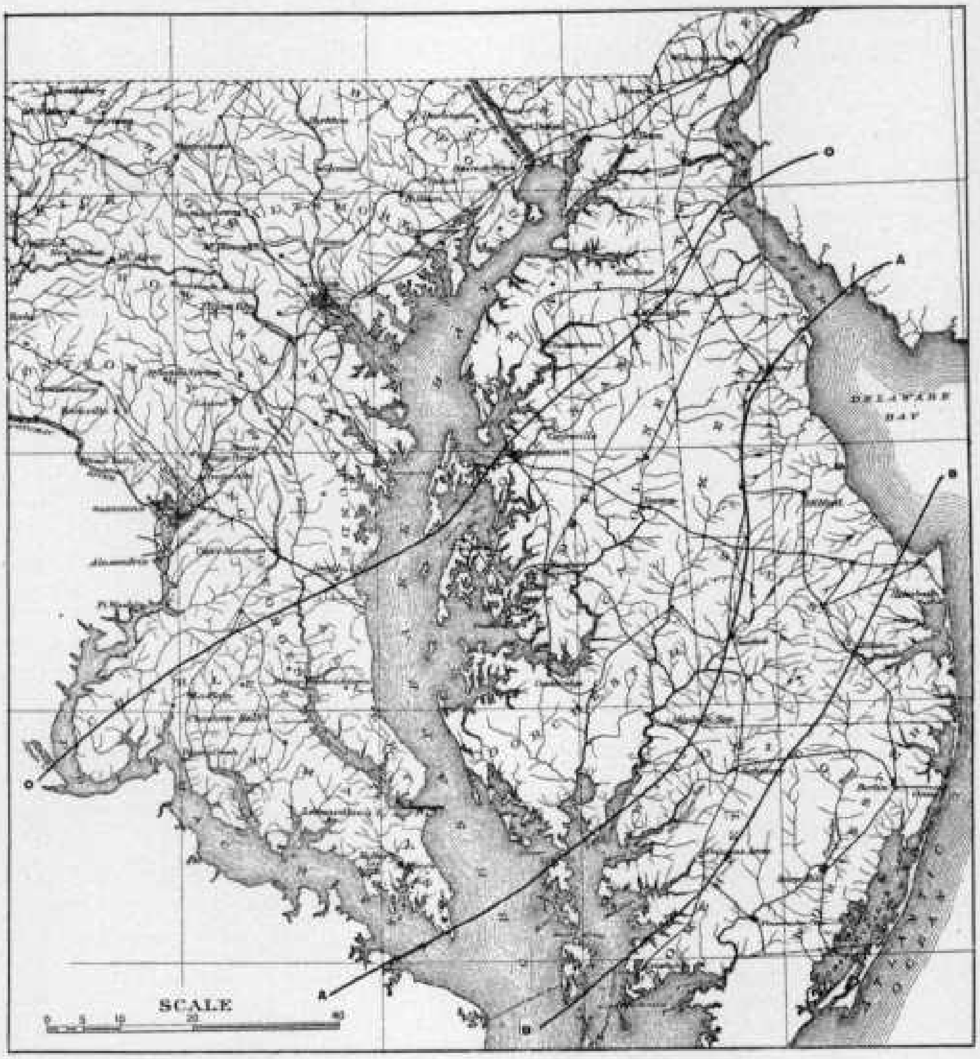

FIG. 88.—MAP SHOWING LOWER MIOCENE (CALVERT) WATERS.

O-O—Line where base of Miocene passes below tide level.
A-A—Line northwest of which lower Miocene waters are found within 500 feet of tide level.
B-B—Line northwest of which lower Miocene waters are found within 1000 feet of tide level.

3 gallons per minute; at Leonardtown, St. Mary's County, where wells 270 feet in depth flow 10 gallons per minute; at Easton, Talbot County, where wells 115 feet deep yield 30 gallons per minute by pumping; at Denton, Caroline County, where wells 180 feet deep flow 10 gallons per minute and supply 40 gallons per minute by pumping; and at Federalsburg, Caroline County, where wells 265 feet in depth flow 20 gallons per minute and furnish by pumping 40 gallons per minute.

Quality.—Uniformly good, slightly hard, at times containing in solution a greater or less amount of alkaline earths.

WATER FROM THE UPPER MIOCENE DEPOSITS

Water may be secured from Upper Miocene deposits at depths of less than 250 feet only in the extreme southeastern portion of the state on the Eastern Shore.

ST. MARY'S FORMATION.—The best known water-bearing horizon in the Upper Miocene is at the base of the St. Mary's formation, but water may come in part from the upper beds of the Choptank formation below. It occurs in a belt about 30 miles in width.

Thick and prevailingly sandy beds of late Tertiary age are found on top of the St. Mary's formation in southern Delaware and in Wicomico, Somerset, and Worcester counties, Maryland. These sands have already been referred to in the account of the geology as representing either the Cohansey formation of New Jersey or the Yorktown formation of Virginia. They are frequently but irregularly water-bearing, so that there is a wide belt of country on the Eastern Shore southeast of a sinuous line drawn from Dover, Delaware, to Cambridge, Maryland, where waters in the upper Miocene are likely to be encountered within 100 feet below tide as shown on the accompanying map (Fig. 89). These later horizons are, however, much less persistent than those of the older Coastal Plain formations, and in parts of the area mapped they appear to be entirely wanting.

Depth.—From 90 to 250 feet.

Static Head.—From several feet below to 10 feet above the surface; usually flowing; easily pumped by suction.

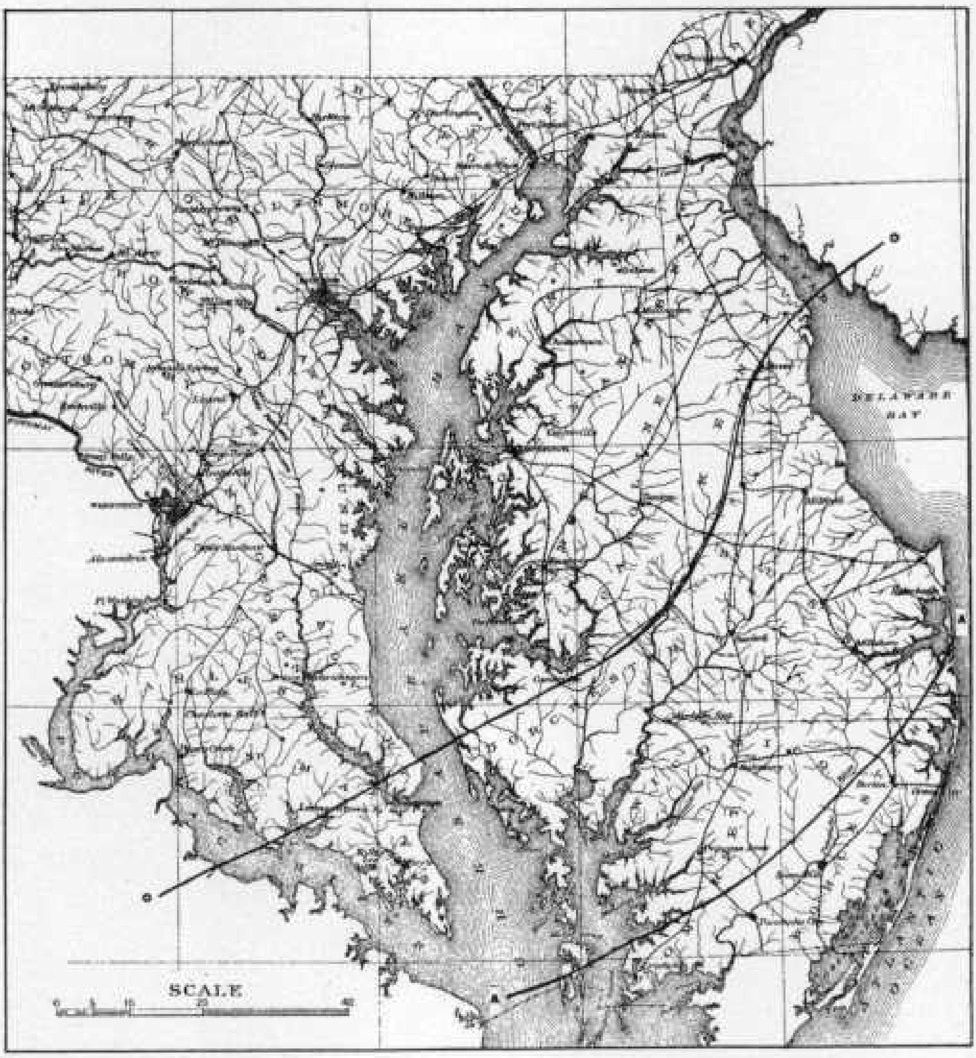

FIG. 89.—MAP SHOWING UPPER MIOCENE WATERS.

O-O—Line where the base of the upper Miocene passes below tide level.
A-A—Line northwest of which various small water horizons of the upper Miocene may be encountered within 100 feet below tide level.

Quantity.—Large and small. Among the wells which derive their supply from this horizon may be mentioned the following: Several wells at Whitehaven, Wicomico County, 95 feet deep, which flow 10 gallons per minute; wells at Salisbury, Wicomico County, 90 feet in depth, which yield 30 gallons per minute by pumping; wells at Crisfield, Somerset County, 225 feet deep, which supply 30 gallons per minute by pumping; and wells at Snow Hill, Worcester County, 267 feet deep, from which 70 gallons per minute are pumped. Other wells of larger capacity are those at Ocean City, Worcester County, 250 feet in depth, which flow 30 gallons per minute and yield 100 gallons per minute by pumping; at Pocomoke City, Worcester County, where a well 247 feet in depth flows 40 gallons per minute and yields 175 gallons per minute by pumping. This latter well struck higher water horizons in the St. Mary's formation, first at 120 feet, where 60 gallons per minute could be pumped, and another of salt water at 225 feet, which yielded 100 gallons per minute by pumping.

Quality.—Good, usually alkaline with varying amounts of iron.

WATER FROM THE PLEISTOCENE DEPOSITS

Water is obtainable rather generally throughout the Coastal Plain at the base of the blanket of Pleistocene formations. The supplies, however, are for the most part small, the more important being found at the base of the Wicomico and Talbot formations; the latter, the latest of the geological formations of the state, forms a low terrace adjoining the tide waters and is therefore frequently invaded for considerable distances by the salt and brackish waters. It is for this reason usually unpotable, or at least unpalatable, and is easily liable because of the poor surface drainage to become contaminated. The Wicomico formation which occurs at a somewhat higher level is not subject to the same deleterious effects as the Talbot formation, and the same is likewise true of the still higher terrace deposits of earlier Pleistocene age, but because of their limited area of extent they are of relatively small importance as water horizons. Their higher elevation likewise renders them less stable as receptacles for a permanent natural supply, and they will not be further considered in this discussion.

Depth.—From 8 feet in the wells of the Talbot formation to 45 feet in the deeper wells of the Wicomico formation.

Static Head.—Generally from 3 to 5 feet, closely dependent on the rainfall, the level of the water in the well being the same as the top of the ground water; never flowing; pumped by hand or suction pumps.

Quantity.—Small. The quantity of water derived from Pleistocene wells is always small, probably never more than a few gallons per minute. The supply of water in all wells is exhausted in less than an hour's steady pumping.

Quality.—Generally poor, usually high in iron, and salty near borders of salt or brackish water; very liable to surface contamination.

UNDERGROUND WATERS OF CENTRAL MARYLAND

The underground waters of Central Maryland are derived chiefly from shallow wells, except in proximity to the larger municipalities where wells of greater depth are not uncommon. This is especially true of the region about Baltimore.

The underground waters come from (a) shallow wells that do not reach below broken and oftentimes disintegrated materials of the upper portions of the underlying rocks, generally less than 60 feet in depth, and (b) from deeper well borings that cut the water fissures of the solid rock generally at depths of from 50 to 350 feet. The former are meteoric or rain waters that are easily subject to contamination, while the latter are deep-seated waters that through hydrostatic pressure have generally come from long distances and are rarely if ever contaminated. The quality of these waters is also dependent on the mineralogical composition of the rocks, of which four general types may be recognized: (1) Calcareous or calcareous-magnesian rocks, (2) siliceous rocks, (3) iron-magnesian rocks, and (4) aluminous rocks.

WATER FROM CALCAREOUS AND CALCAREOUS-MAGNESIAN ROCKS (LIMESTONES, MAGNESIAN-LIMESTONES, MARBLES, ETC.)

Water is widely found in the calcareous and calcareous-magnesian rocks of the central area. These rocks occur in more or less isolated patches in the eastern part of the district, but in the western part of the area are found as broad belts extending from north to south across the state.

Depth.—50 to 300 feet, although a few wells of greater depth have been sunk.

Static Head.—Generally from about 40 feet below to a few feet above the surface; with few exceptions are non-flowing; generally pumped.

Quantity.—Large to small. A few wells are found in the marble belts to the north and northwest of Baltimore in Baltimore County. At Lutherville a well 140 feet deep with a head near the surface yields 12½ gallons per minute by pumping; another well nearby, 125 feet in depth with a head 15 feet beneath the surface, yields 70 gallons per minute; a short distance farther north, at Timonium, a well 159 feet, which heads nears the surface, yields 30 gallons per minute. In the Green Spring Valley a well 113 feet in depth with a head 18 feet beneath the surface yields 56 gallons per minute.

At Clarksville, Howard County, to the southwest of Baltimore, a well 30 feet in depth with a head 26 feet beneath the surface yields 12 gallons per minute.

A number of wells are found in the isolated limestone areas of Carroll County, among them a well at Westminster 90 feet in depth with a head 14 feet beneath the surface which yields 50 gallons per minute; and another at the same place, 70 feet in depth with a head 27 feet beneath the surface, yields 35 gallons per minute; at Uniontown a well 25 feet in depth, which heads 10 feet beneath the surface, yields a small supply; at Union Bridge a number of wells in the limestone yield variable supplies, some very large, among them are three adjacent wells 50 feet in depth with a head 12 feet beneath the surface which yield 50 gallons per minute; another well 170 feet deep with a head of 13 feet yields 400 gallons per minute; another 214 feet deep with a head 12 feet beneath the surface yields 50 gallons per minute; another 246 feet in depth with a head 12 feet beneath the surface yields 50 gallons per minute, and still another 464 feet deep with a head 12 feet beneath the surface yields 300 gallons per minute.

A number of wells are found in the Frederick County limestone belt, among them several wells at Frederick. One 96 feet in depth with a head 20 feet beneath the surface yields 100 gallons per minute; another 123 feet deep with a head 70 feet beneath the surface which yields 60 gallons per minute; and still another 178 feet in depth with a head 100 feet beneath the surface which yields 10 gallons per minute. At Libertytown a well 75 feet in depth with a head 10 feet beneath the surface yields a large but undetermined supply; at Woodsboro a well 30 feet in depth with a head 20 feet below the surface also yields a large but undetermined supply; a well at Buckeystown 90 feet deep with a head 20 feet beneath the surface yields 5 gallons per minute.

Many excellent wells are found in the broad limestone belt of Washington County. Many such wells have been drilled at Hagerstown as follows: A well 90 feet in depth with a head 20 feet beneath the surface yields 265 gallons per minute; a well 102 feet in depth with a head 15 feet beneath the surface yields 53 gallons per minute; a well 120 feet deep with a head 12 feet beneath the surface yields 150 gallons per minute; a well 137 feet in depth with a head 20 feet beneath the surface yields 200 gallons per minute; a well 154 feet deep with a head 20 feet beneath the surface yields 150 gallons per minute; a well 193 feet deep with a head 20 feet beneath the surface yields 180 gallons per minute; a well 263 feet deep with a head 15 feet beneath the surface yields 116 gallons per minute; a well 275 feet in depth with a head 6 feet beneath the surface yields 200 gallons per minute; a well 325 feet in depth with a head 60 feet beneath the surface yields 56 gallons per minute. A well at Halfway, about 3 miles southeast of Hagerstown, 65 feet deep with a head 20 feet beneath the surface yields 3 gallons per minute; at Maugansville a well 60 feet in depth with a head 20 feet beneath the surface yields 3 gallons per minute; a well at Pinesburg driven through the argillaceous rock into the limestone with a head 15 feet beneath the surface yields 5 gallons per minute; a well at Downsville 65 feet in depth with a head 40 feet beneath the surface yields 4 gallons per minute.

Quality.—Water generally hard with a rather high percentage of mineral matter.

WATER FROM THE SILICEOUS ROCKS

(GRANITES, GNEISS, QUARTZITES, SANDSTONES, ETC.)

Water is found in large quantities in the siliceous rocks, especially in the more porous beds. Numerous wells are found in the gneiss and granite deposits near Baltimore, some reaching to considerable depths. Many small wells are likewise found in the extensive belt of Triassic sandstones of Frederick County.

Depth.—From 50 to 300 feet.

Static Head.—Generally from 50 feet to near the surface; non-flowing; always pumped.

Quantity.—At Port Deposit, Cecil County, a well 114 feet deep with a head 10 feet in depth yields 42 gallons per minute. At Havre de Grace, Harford County, a well 60 feet deep with a head 23 feet beneath the surface yields 60 gallons per minute; a well at Churchville 60 feet deep yields 20 gallons per minute.

At Overlea, Baltimore County, three wells 65 to 100 feet in depth yield together 45 gallons per minute. There are several wells on the south side of the Green Spring Valley in the quartzitic schist. One at Rogers 138 feet in depth with a head near the surface yields 60 gallons per minute; one at Garrison 178 feet in depth with a head 60 feet below the surface yields 30 gallons per minute; a well at Brightside 206 feet deep with a head 25 feet below the surface yields 33 gallons per minute; a well at Stephenson 42 feet in depth with a head 15 feet below the surface yields 36 gallons per minute; a well at Loch Raven 541 feet in depth with a head near the surface yields 150 to 200 gallons per minute; a well at Ruxton 152 feet in depth yields 43 gallons per minute; a well at Pikesville 240 feet in depth with a head 42 feet beneath the surface yields 15 gallons per minute; and another well nearly 500 feet in depth yields 50 gallons per minute; a well at Thistle Mills, opposite Ilchester, 151 feet in depth yields 17 gallons per minute.

A well 5 miles west of Ellicott City, Howard County, 280 feet deep with a head 15 feet below the surface yields 26 gallons per minute; a well at Woodstock 72 feet deep with a head 35 feet below the surface yields 20 gallons per minute; a well at Elioak 95 feet in depth with a head 42 feet beneath the surface yields 25 gallons per minute.

A well at Sykesville, Carroll County, 123 feet in depth with a head 20 feet beneath the surface yields 60 gallons per minute.

At Rockville, Montgomery County, two wells 225 feet in depth with a head 12 feet below the surface yield together 50 gallons per minute, and another well in the same locality 225 feet in depth with a head 12 feet beneath the surface yields 45 gallons per minute; a well at Cabin John Bridge 95 feet in depth with a head 30 feet beneath the surface yields 40 gallons per minute.

A well at Jefferson, Frederick County, 57 feet in depth with a head 45 feet beneath the surface yields 15 gallons per minute; a well at Brunswick 150 feet in depth with a head 20 feet beneath the surface yields 45 gallons per minute, and another well at the same place 315 feet in depth with a head 5 feet below the surface yields 100 gallons per minute; a well at Braddock Heights 200 feet deep with a head 15 feet beneath the surface yields 10 gallons per minute.

A well at McCoy's Ferry, Washington County, 70 feet deep with a head 60 feet beneath the surface yields 4½ gallons per minute.

Quality.—Generally excellent, with small amounts of mineral matter in solution.

WATER FROM IRON-MAGNESIAN ROCKS

(GABBRO, SERPENTINE, DIABASE, BASIC VOLCANICS, ETC.)

Numerous wells, for the most part of small capacity, are found in the iron-magnesian rocks. It is generally more difficult to secure adequate and potable supplies from these rocks than from the siliceous rocks previously described. Water fissures are apparently much less frequent, and many more unsuccessful attempts have been made to secure water from these rocks than from any of the others in the central part of the state.

Depth.—Generally from 50 to 250 feet.

Static Head.—From 50 feet beneath the surface to a few feet above the surface; never flowing; always pumped.

Quantity.—Large to small. At Rising Sun, Ceeil County, four wells 105 to 166 feet in depth with a head 6 feet beneath the surfaee yield 50 gallons per minute eaeh.

A number of wells occur in thc gabbro belt in Harford County. At Belair a well 100 feet in depth with a head 8 feet beneath the surface yields 75 gallons per minute; another at the same place 233 feet deep with a head 3 feet beneath the surfacc yields 60 gallons per minute; and still another 300 feet in depth with a head 8 feet beneath the surfaee yields 70 gallons per minute; at Darlington a well 105 feet in depth with a head 30 feet beneath the surface yields a small supply; at Fallston a well 100 feet in depth with a head near the surface yields 5 gallons per minute; and another at the same place 101 fect in depth with a hcad near the surface yields 23 gallons per minute.

Many wells have been drilled in the area of gabbro and associated rocks about Baltimore in Baltimore County, and a large number of failures have resulted. A considerable number of producing wells are found, however, although for the most part of small capacity. A well at Fort 160 feet in depth with a head near the surface yields 6 gallons per minute; at Necker a well 52 feet in depth with a head 46 feet beneath the surface yields 60 gallons per minute; at Cub Hill a well 393 feet in depth with a head 150 feet beneath the surface yields 35 gallons per minute; a well at Belgravia 107 feet in depth with a head 31 feet beneath the surfaee yields 15 gallons per minute, and anothcr at the same plaee 45 feet in depth with a head 38 feet beneath the surfaee yields ½ gallon per minute; a well at Arlington 96 feet in depth with a head 8 feet beneath the surfaee yields 25 gallons per minute; another well 125 feet in dcpth with a head 8 feet beneath the surface yields 40 gallons per minute; another well at the same plaee 141 feet in depth with a head 4 feet beneath the surfaee yields 100 gallons per minute; another well at the same place 167 feet in depth with a head 30 feet beneath the surfaee yields 60 gallons per minute; and still another at the same plaee 200 feet in depth with a head 30 feet beneath the surface yields 60 gallons per minute. A well at Fords Lane near Park Heights Avenue, 225 feet deep with a head near the surface, yields 26 gallons per minute; and another at Seven-Mile Lane at Park

Heights Avenue 50 feet in depth with a head 6 feet below the surface yields 12 gallons per minute; a well at Sudbrook Park 81 feet in depth with a head 25 feet beneath the surface yields 40 gallons per minute; at Woodlawn a well 108 feet in depth with a head 30 feet beneath the surface yields 50 to 60 gallons per minute; and another at the same place 137 feet in depth with a head 18 feet beneath the surface yields 9 gallons per minute; a well at Howard Park 180 feet deep with a head near the surface yields 35 gallons per minute; and another in the same locality 116 feet deep with a head near the surface yields 35 gallons per minute; at Gwynn Oak Park a well 161 feet deep with a head near the surface yields 20 gallons per minute; a well at Catonsville 103 feet in depth with a head 16 feet beneath the surface yields a large but undetermined supply.

A well at Potomac, Montgomery County, 82 feet in depth with a head 20 feet beneath the surface yields 10 gallons per minute; and another at the same place 40 feet in depth with a head 10 feet beneath the surface yields 3 gallons per minute; at Gaithersburg a well 70 feet in depth with a head 20 feet below the surface yields a large but undetermined supply; another well at the same place 80 feet in depth with a head 70 feet beneath the surface yields 20 gallons per minute.

At Mt. Pleasant, Frederick County, a well 115 feet in depth with a head 25 feet beneath the surface yields a large but undetermined supply; at Blue Ridge Summit, Pennsylvania, just north of the Maryland line, a well 312 feet in depth with a head 104 feet beneath the surface yields 40 gallons per minute; and another in the same vicinity 100 feet in depth with a head near the surface yields 50 gallons per minute.

Quality.—Generally good, some high in iron and other mineral matter.

WATER FROM THE ALUMINOUS ROCKS

(MICA-SCHIST, SLATE, SHALE, ETC.)

Water has been found in moderate amounts in the aluminous rocks The wells are for the most part shallow except in a few local areas.

Depth.—From 50 to 250 feet.

Static Head.—Generally from 50 feet below the surface to near the surface.

Quantity.—Large to small. A well at Forest Hill, Harford County, 72 feet in depth with a head near the surface yields 25 gallons per minute; a well at Street 107 feet in depth yields 20 gallons per minute.

A well at Reisterstown, Baltimore County, 190 feet in depth with a head near the surface yields 25 to 30 gallons per minute; at Glyndon a well 130 feet in depth with a head 20 feet beneath the surface yields 16 gallons per minute.

A well at Mt. Airy, Carroll County, less than 40 feet deep with a head 20 feet below the surface yields a large but undetermined supply; and a well in the same locality 117 feet in depth with a head 30 feet beneath the surface yields 80 gallons per minute; a well at Lineboro 41 feet in depth with a head 19 feet beneath the surface yields a small supply.

A well at Rockville, Montgomery County, 281 feet in depth with a head 30 feet beneath the surface yields 30 gallons per minute; and a well at Sandy Springs 94 feet in depth with a head 35 feet beneath the surface yields 15 gallons per minute; a well at Great Falls 80 feet in depth with a head 30 feet below the surface yields 20 gallons per minute; a well at Dickerson 72 feet in depth with a head 20 feet beneath the surface yields 4 gallons per minute.

A well at Kempton, Frederick County, 92 feet deep with a head 62 feet beneath the surface yields a large but undetermined supply.

A well at Williamsport 45 feet in depth with a head 20 feet beneath the surface yields 2 gallons per minute; another at the same place 97 feet in depth with a head 30 feet beneath the surface yields 5 gallons per minute; another well 210 feet deep with a head 100 feet beneath the surface yields 25 gallons per minute and still another at the same place 487 feet in depth with a head 30 feet beneath the surface yields 15 gallons per minute.

Quality.—Generally good, not as a rule high in mineral matter.

UNDERGROUND WATERS OF WESTERN MARYLAND

Nearly all of the underground waters of Western Maryland are obtained from shallow wells. A few wells of greater depth have been drilled but the many streams, springs, and shallow wells afford so much good water that even municipalities and corporate interests find it more economical to make use of these sources of water supply.

The underground waters, as in the central area, may be secured from shallow wells in the broken upper part of underlying rocks, such supplies often being found very near the surface. In a region of few habitations, and when care is taken as to the immediate sanitary conditions, such supplies may be safely employed. The deeper-seated waters may be found in the arenaceous (sandy) layers and supplies may be encountered in the lower portions of the folds, but generally the strata are so consolidated that the water is encountered in the larger fissures which afford channels for the circulating waters.

Two types of waters are found, those derived (1) from calcareous rocks and (2) from siliceous and siliceous-aluminous rocks.

WATER FROM CALCAREOUS ROCKS

Water may be secured in considerable quantities from the various calcareous formations of Western Maryland. These rocks are found in a succession of narrow belts extending from north to south across the area.

Depth.—50 to 300 feet.

Static Head.—Generally from less than 40 feet below to 5 feet above the surface, a few wells of much lower head; non-flowing, very few flowing; generally pumped.

Quantity.—Small to large. A well at Hancock, Washington County, 66 feet in depth with a head 36 feet below the surface yields 15 gallons per minute; another well at Round Top, Washington County, 278 feet in depth with a head 178 feet beneath the surface yields by pumping 50 to 70 gallons per minute.

A well at Flintstone, Allegany County, 31 feet in depth with a head 11 feet beneath the surface yields a few gallons per minute; a well at Cumberland, Allegany County, 56 feet in depth flows 1 gallon in 10 minutes with a head of 5 feet above the surface. Its yield could be materially increased by pumping. Another well at Cumberland 100 feet in depth yields by pumping 80 to 90 gallons per minute, the level of the water standing 25 feet beneath the surface; and a third well at Cumberland 84 feet in depth with a water level 6 to 8 feet beneath the surface yields 100 gallons per minute.

A well at Sang Run, Garrett County, 82 feet in depth with a water level 30 feet below the surface yields 5 to 10 gallons per minute.

Quality.—Water always hard, with a rather high percentage of mineral matter.

WATER FROM SILICEOUS AND ALUMINOUS ROCKS

Water may be generally secured from the siliceous and aluminous rocks of the western section of the state, and a number of such wells, for the most part of shallow depth, have been drilled. They are found rather widely distributed in the several non-calcareous formations which follow the same strike but occupy much broader belts in Western Maryland than do the calcareous rocks.

Depth.—Generally from 30 to 250 feet; a few deeper wells have been drilled.

Static Head.—Generally from about 50 feet below to a few feet above the surface, a few wells with much lower head; nearly all non-flowing; generally pumped.

Quantity.—Large to small. A well at Big Pool, Washington County, 30 feet in depth which heads 22 feet below the surface yields 2 gallons per minute; at Old Fort Frederick, Washington County, a well 50 feet in depth which heads at 45 feet beneath the surface yields 3 gallons per minute; a well at Indian Spring, Washington County, 40 feet deep with a head 20 feet beneath the surface yields 3 gallons per minute; a well at Hancock, Washington County, 440 feet deep with a head 90 feet beneath the surface yields 200 gallons per minute; another well at the same locality 127 feet in depth with a head of 47 feet beneath the surface yields 60 gallons per minute; still another at the same place 85 feet in depth with a head 41 feet beneath the surface yields 40 gallons per minute; and another 55 feet deep with a head only 3 feet beneath the surface yields 100 gallons per minute; a well at Millstone, Washington County, 112 feet deep with a head 80 feet beneath the surface yields 28 gallons per minute.

A well at Cumberland, Allegany County, 260 feet deep with a head 12 feet below the surface yields 300 gallons per minute; another well in the same area 225 feet in depth with a head of 16 feet beneath the surface yields 12 gallons per minute; another well 80 feet in depth with a head of 20 feet beneath the surface yields 15 gallons per minute; and still another well 40 feet in depth with a head of 20 feet beneath the surface yields a large but undetermined supply. A number of wells in the western part of Allegany County in the Georges Creek Valley and adjacent areas have been drilled which furnish a large supply. Among them may be mentioned a well 2 miles east of Frostburg 160 feet in depth with a head slightly above the surface which flows 8 gallons per minute; another well at Mount Savage 39 feet in depth with a head 33 feet beneath the surface yields 10 gallons per minute; another well at Mount Savage 105 feet in depth with a head 30 feet beneath the surface yields 75 gallons per minute; a well at Ellerslie 210 feet in depth with a head 40 feet below the surface yields a large but undetermined supply; a well at Charlestown 125 feet in depth with a head 70 feet below the surface yields 50 gallons per minute; another well at Barton 72 feet in depth with a head 28 feet beneath the surface yields a moderate supply; on the Maryland side of the Potomac River opposite Keyser, West Virginia, a well 60 feet deep with a head 40 feet beneath the surface yields a large but undetermined supply; a well at Westernport 165 feet deep with a head 10 feet beneath the surface yields 100 gallons per minute.

A well at Grantsville, Garrett County, with a depth of 30 feet and a head 9 feet below the surface yields 3 gallons per minute; a well at Accident, Garrett County, 88 feet in depth with a head 45 feet beneath the surface yields 1 gallon per minute. A well at Selbysport, Garrett county, 40 feet in depth with a head 30 feet beneath the surface yields an abundant but undetermined supply; a well at Oakland, Garrett County, 250 feet deep with a head 20 feet beneath the surface yields 35 gallons per minute; and another well at the same place 80 feet in depth with a head 3 feet beneath the surface yields 22 gallons per minute. At Crellin, Garrett County, a well 180 feet in depth with a head 20 feet beneath the surface yields 50 gallons per minute; a well at Deer Park, Garrett County, 90 feet in depth flows 1 gallon per minute; a well on the Maryland side opposite Bayard, West Virginia, 60 feet in depth with a head 25 feet in depth yields a small supply.

Quality.—Water generally good, especially from the siliceous rocks; often hard and frequently with some iron content; at times containing sulphur, especially when derived from the coal measures.

LOCAL DESCRIPTION OF WATER RESOURCES

COUNTIES OF THE EASTERN SHORE OF MARYLAND

Cecil County

Cecil, the northeastern county of Maryland, lies at the head of Chesapeake Bay, and its longest boundaries are those separating it from Lancaster and Chester counties, Pennsylvania, on the north and from Newcastle County, Delaware, on the east. The northern half of the county lies in the Piedmont Plateau and the southern half in the Coastal Plain—the line of division being approximately that of the Baltimore and Ohio Railroad. The two types of topography are less contrasted in this county than elsewhere in the state. While the Coastal Plain type of low, flat country is developed to the southeast of Elk River, northwest of this stream to the border of the Piedmont the country is a rolling upland. The Piedmont Plateau is here a gently rolling upland except where it is crossed by the more important drainage channels, such as Big Elk, Little Elk, Principio, Octoraro, and Conowingo creeks, and the Susquehanna River. Wherever these streams cross the county they have cut deep and narrow gorges which impart a ruggedness to the otherwise rolling topography.

TABLE OF ELEVATIONS

	Feet		Feet
Calvert	441	Fredericktown	20
Cayots	83	Harrisville	366
Charlestown	41	Iron Hill	125
Chesapeake City	17	Northeast	12
Childs	137	Perryville	27
Conowingo	77	Port Deposit	16
Earleville	85	Principio	302
Elk Neck	195	Richardsmere	93
Elkton	28	Rising Sun	387
Fair Hill	385	Singerly	165

GEOLOGY

The northern half of the county is formed by the very ancient crystalline rocks of igneous or metamorphic origin which are much folded and faulted. The areal distribution and petrographic features of these gneisses, granites, gabbros, pyroxenites, peridotites, serpentines, and the various dike rocks are fully described in the Geology of Cecil County published by the Survey. South of a line drawn from Iron Hill to Perryville the crystalline rocks of the Piedmont are concealed, except for a few scattered outliers, by the sands, clays, gravels, and loams of the Cretaceous, Tertiary, and Pleistocene formations. Exclusive of the surficial deposits of the Pleistocene terrace formations most of the Coastal Plain part of the county is covered by the sands, clays, and gravels of the Lower and Upper Cretaceous formations, the Eocene of the Tertiary being found in only the southeastern corner of the county.

SURFACE WATERS

Cecil is well supplied with surface streams, all of which, except the Susquehanna, are relatively short with a corresponding small discharge, and expand to form estuaries in their lower courses. The Susquehanna, flowing into Maryland from Pennsylvania and forming the boundary between Cecil and Harford counties for a distance of 25 miles, one of the largest rivers on the Atlantic slope of the United States, has only about 1 per cent or 255 square miles of its drainage area in Maryland. As it approaches the Maryland line it flows in a rocky gorge varying in width from a few hundred feet to 1 mile and consequently develops many rapids. From extensive records the mean discharge has been found to range from 30,000 to 50,000 second-feet. Extensive hydro-electric developments a short distance north of the Maryland line at McCalls Ferry furnish electric power much utilized in Baltimore. The largest of the local streams in Cecil County is Octoraro Creek, which rises in southeastern Pennsylvania and flows into the Susquehanna about 2 miles above Port Deposit. The average flow is rarely more than 500 cubic feet per second, except during the winter and spring, at which time the melting of snow and the spring rains cause rapid rising and about double the discharge.

The only municipality utilizing surface waters for a public supply is Elkton, which pumps water from Big Elk Creek to a reservoir with a capacity of 750,000 gallons. Unfortunately the drainage basins of all the streams are inhabited and hence the water cannot always be considered potable except where it is properly filtered.

UNDERGROUND WATERS

Artesian Waters

Very few deep wells have been drilled in Cecil County, and none of these have obtained water under sufficient pressure to rise to the surface.

At Elkton, Cecil County, two wells were drilled by the Southern Pulp Company. A large supply of water was encountered at about 100 feet, but it was so highly charged with sulphur that it was unfit for use. The well was continued to 490 feet without obtaining much more water and was finally abandoned. A second well was drilled 16 feet from the first, but was abandoned at 407 feet on account of loss of drilling tools in the bore. The water in the second well was the same as that in the first.

At Chesapeake City, a 116-foot well encountered an abundant supply. The water is reported to have been pure, but later to have become highly charged with iron. At first the supply was used for domestic purposes, but it was finally abandoned because of the iron in it.

Unsuccessful wells have been drilled at Cecilton, Charlestown, and on Elk Neck. At Cecilton the drill passed through 150 feet of clay without encountering water. If the drilling had been continued water would probably have been encountered in the upper part of the Raritan within less than 250 feet of the surface. At Charlestown drilling was carried to a depth of 130 feet, but the water encountered was too highly charged with iron to be used for ordinary purposes. On the upper part of Elk Neck a drilled well 364 feet deep was reported, but the amount of water encountered was said to be too small for use.

The town of Rising Sun is supplied by four 6-inch wells, ranging in depth from 105 to 166 feet, which yield by pumping about 200 gallons

No.	Location	Owner or tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Chesapeake City.	Wm. A. Queck .	15	112	6	....	....	Patapsco	—6	......	Very strong in iron	1890	....	Discontinued on account of increasing iron.
2	Elkton.........	Southern Pulp Co.	20	490	2½	....	100	Crystallines	....	Large	Unsatisfactory	1885	....	Never used.
3	Elkton.........	Southern Pulp Co.	20	407	..	....	....	Crystallines	....	......	Unsatisfactory	1885	....	Never used.
4	Elkton.........	Southern Pulp Co.	20	72	..	....	....	Crystallines	—24	......	....	....		
5	Iron Hill.......	P. B. & W. R. R.	125	95	6	....	....	Crystallines	—25	......	Soft	1909		
6	Northeast, 6½ mi. S.	Dr. H. Henry . .	15	100	6	100	100	Crystallines	—58	30	Good	1916		
7	Port Deposit, ¾ mi. SE.	E. W. Haviland.	15	104	6	12	104	Crystallines	—10	42	Soft	1913		
8	Rising Sun, ½ mi. E.	Rising Sun Water Works.	[illegible]	105 122 139 166	6	....	....	Crystallines	—6	50 each	Soft	1913	Norris and Scotten	Public supply, 4 wells in this group.

per minute. The water, which is soft, rises to within 6 feet of the surface and is distributed from a standpipe, the daily consumption being about 25,000 gallons.

Non-Artesian Waters

SPRINGS.—Springs are numerous, especially throughout the Piedmont portion of the county and along the inner margin of the Coastal Plain portion. In general, the springs from the older formations have a larger and more constant flow than those from the younger. There is also a difference in the amount of inorganic matter present, the water from the deep-seated springs being more highly mineralized than that from the shallower sources. Spring water is utilized for domestic and farm purposes, and as it is usually soft it is generally regarded as satisfactory. In many localities springs are extensively used, the town of Perryville obtaining its entire public supply from this source.

SHALLOW WELLS.—For a long time the greater part of the population of Cecil County relied upon springs and shallow dug wells for their water supplies, but with the installation of municipal water systems, the wells and springs of the larger towns gradually fell into disuse and were abandoned. Throughout the farming districts and in the small towns the conditions remain the same as they were more than a generation ago, the majority of the inhabitants still depending upon springs and dug wells.

The depths of the dug wells vary greatly, ranging from less than 10 to nearly 90 feet. On the Talbot formation wells are seldom more than 25 or 30 feet deep, and many of them are not over 10 or 15 feet. In these wells the water level is near the surface, though locally it may fluctuate with the amount of rainfall. On the Wicomico formation the wells are apt to be deeper than on the Talbot, though in some places where the surface of the Wicomico has not been deeply eroded shallow wells obtain a plentiful supply of water. The depths of wells on the Wicomico formation range from less than 10 to more than 80 feet, but most of the wells are between 20 and 40 feet. The water level in these wells varies and in many places the wells even when deep contain only a few feet of water. Some wells fail entirely in dry weather, but fortunately this condition is rare.

The quality of the water from shallow wells is generally reported to be excellent, though in some places shallow wells near buildings may become polluted by the entrance of contaminated surface water or by percolation downward through the sands surrounding the wells. In most places wells may be sunk beneath clay beds and the surface water can be excluded by the use of water-tight casings fitting closely in the well. The amount of inorganic matter present in the supplies from shallow wells is so small that the water is usually soft or only slightly hard. But few wells report iron in the water, and then the amount is so slight that it seldom interferes with the usefulness of the supply.

KENT COUNTY

The surface of Kent County is essentially a plain. The broad divide between Sassafras River on the north and Chester River on the south is a terrace plain ranging in elevation from about 45 to 80 feet. The southwestern portion of the county is a similar terrace plain ranging from sea level to about 35 feet in elevation. The stream valleys are broad and shallow and the only sharp declivities are found along the scarp separating the lower from the upper plain or where the streams have cut into the upland as at Betterton, along Stillpond Neck, and at Worton Point.

TABLE OF ELEVATIONS

	Feet		Feet
Betterton	45	Massey	64
Butlertown	45	Melitota	49
Chestertown	22	Millington	27
Crosby	15	Morgnec	45
Galena	70	Rockhall	15
Georgetown	15	Stillpond	78
Goltz	70	Smithville	82
Kennedyville	50	Tolchester	20
Locust Grove	77	Worton	65

GEOLOGY

The surface of the county is made up almost entirely of the loams and sands of the two terrace formations previously mentioned. About two-thirds of the county is formed by the higher terrace or Wicomico formation and about one-third by the lower terrace or Talbot formation. It is only along the scarp separating these two terraces and in the stream valleys that limited exposure of the older geological formations are seen. Immediately beneath the surficial terrace deposits in the southeastern part of the county are found a few feet of the Calvert, the oldest formation of the Miocene. Beneath the Calvert and underlying that part of the county southeast of a line drawn from Georgetown southwest to Rockhall is about 35 feet of the glauconitic sand of the Aquia formation of the Eocene. Northwest of this line the surficial deposits are underlain in descending order by the glauconite, clays, and sands of the Monmouth, Matawan, Magothy, and Raritan formations of Upper Cretaceous age. Beneath the Upper Cretaceous and underlying the whole county at great depths, but nowhere exposed at the surface, are the formations of the Lower Cretaceous, and at still greater depths and forming the rock floor are the crystalline rocks which reach the surface across the Bay in Harford County.

SURFACE WATERS

The two large streams, Sassafras River and Chester River, which form respectively the northern and southern boundaries of the county, are tidal estuaries and their waters are consequently brackish and more or less charged with organic matter and are therefore unsuited as sources of potable water. The small streams are all short and expand almost immediately into estuaries or marshes. The amount of flow is limited, the water is charged with organic matter, and practically all receive more or less drainage from inhabited areas and are therefore extremely liable to pollution. None are, nor should be, utilized as sources of domestic or municipal supplies.

UNDERGROUND WATERS

Artesian Waters

The absence of large centers of population or industrial enterprises requiring large quantities of water has limited the number of drilled wells in Kent County, since shallow dug, or driven wells furnish ample supplies for domestic or farm purposes. At Chestertown two of the wells at the ice plant, between 160 and 170 feet deep, are thought to draw water from a bed in the Monmouth. The water only rises to within 30 feet of the surface but the supply is large. A well about 1½ miles southwest of Morgnec is 224 feet deep and is drawing from the Matawan. The water is soft and rises to within 10 feet of the surface.

Two wells at Rockhall found water at about 345 feet that is thought to come from the Magothy, being correlated with the lower Magothy level in the Chestertown well. These wells have a fair flow, the exact amount unknown, but the water is so highly charged with iron that it is not palatable.

At the Chestertown Water Works two attempts have been made to secure water from deep wells, but although water was found in both wells the results were not satisfactory and so the wells were abandoned. The log of the second and deeper well is given below.

DEEP WELL OF CHESTERTOWN WATER WORKS

(Put down winter of 1908-1909. J. H. K. Shannahan Company, Contractors.)

	Feet
Pleistocene.	
Soft yellow clay	0–6
Soft yellow marl containing shells	6–60
Eocene.	
Aquia formation.	
Soft gray marl containing shells	60–113
Soft black marl, hard boulders	113–129
Upper Cretaceous.	
Monmouth formation.	
Hard and soft marl alternating from green to black	129–150
Hard dark brown sand	150–200
Matawan formation.	
Gray and black sand, water bearing, pumped 15 gallons	200–230
Gray clay and sand	230–251
Soft gray sand rock	251–257
Hard black sandy clay	257–268
Magothy formation.	
Soft black loamy micaceous clay	268–332
Soft coarse white sand, water bearing, tested about 20 gallons per minute	332–335
Soft lead-colored clay	335–340
Soft coarse white sand, water bearing, no test	340–344

	Feet
Raritan formation.	
Soft clay alternating red and white	344–355
Soft sandy clay alternating red and white	355–390
Reddish sands, grains loose and free, water bearing	390–395
Soft sandy red clay	395–421
Hard red clay	421–480
Soft rock (sandstone ?)	480–480½
Sand, traces of water	480½–481½
Soft gray clay	481½–492
Very hard rock	492–492½
Tough sticky gray clay	492½–540
Hard gray sandy clay	540–550
Free white sand, water bearing, tested 80 gallons per minute	550–581
Lower Cretaceous.	
Patapsco formation.	
Soft gray sandy clay	581–625
Very hard red and white sandy clay	625–632
Hard boulder	632–632½
Tough light pink clay	632½–648
Tough red clay	648–700
Gray sandy clay, alternated hard and soft	700–706
Coarse white sand, trace of water	706–713
Tough purple clay	713–750
Tough red clay	750–955
Patuxent formation.	
Soft purple clay containing hard boulders	955–981
Very hard purple clay	981–1002
Coarse reddish sand, quite free. Flows 14 gallons per minute at + 2 feet	1002–1004
Soft gray clay	1004–1023
Red clay, somewhat hard	1023–1050
Soft gray clay	1050–1056
Very hard gray clay	1056–1060
Soft red clay	1060–1100
Soft gray sandy clay containing boulders	1100–1108
Soft gray sandy clay	1108–1110
Large boulders	1110
Soft gray sandy clay	1110–1135
Coarse sand, water bearing. Flows 50 gallons per minute. Very salty	1135

The first well stopped at 583 feet near the base of the Raritan, where a supply was encountered which overflowed 20 gallons per minute. The second well passed through to the Patuxent sands at a depth of 1135 feet and encountered a flow of about 50 gallons per minute with a head 2 feet above the surface, but this water was too salty to use. The abandonment of these two wells, or more strictly the shallower, since the water in the deeper well was unfit for use, demonstrates the need of a change in well-drilling methods. By the system in use in the Coastal Plain of Maryland the driller merely washes out a hole in the ground, hammering down cast-iron pipe until he strikes a stratum which yields a flow or a good head of water. The small water zones that may be penetrated escape his notice, and since he knows no way to add them to the large flow which he hopes to strike he seldom keeps accurate records of the beds passed through or the water they contain.

Referring to the section of the Chestertown well, it will be seen that there was a water level in the Eocene (the one from which the shallowest ice-plant well at that place draws), one in the Monmouth (the level which supplies the two other wells at the ice-plant), a lower horizon in the Matawan, two in the Magothy, and three in the Raritan. But the finished well drew only from the last and yielded an insufficient supply.

The idea of drawing from several levels at once has perhaps occurred rather vaguely to those who have had to suffer most from this method of drilling, but the only apparent way to do this is by leaving the portions of the well opposite the water-bearing strata uncased. This is impossible because of the objectionable sand and silt that would be pulled up by the pumps, although in some deep wells in more consolidated material it is possible to leave the well uncased after the loose, near-surface materials have been passed.

The drillers in California were confronted with the same problems, sharpened considerably, in that the strata were looser, filled with larger boulders, and were much thicker. Then, too, since the wells were sunk with the view of obtaining water for irrigation an enormous supply was demanded. These impelling reasons led to the development of a special type of well construction known as the "stovepipe" well, which is discussed by C. S. Slichter.[1] Short lengths of large casing are forced down by hydraulic jacks, accurate records of water zones are kept, and after a

[1] U. S. Geol. Survey, Water Supply Paper No. 110, pp. 32-36, 1905.

sufficient number are penetrated to yield the desired supply the casings are slit or perforated at the desired levels by appropriate tools of which a considerable variety are in use in the West. To give an idea of the amount of water yielded by wells of this construction several yields of California wells are noted. From wells averaging 250 feet in depth 300,000 to 2,000,000 gallons a day have been pumped, while several deeper wells in southern California 500 to 700 feet deep flow 3,000,000 gallons daily. It may not be possible to duplicate these yields in the East, but some such method would unquestionably have saved the Chestertown well and would greatly increase flows in other wells in the Coastal Plain at present dependent upon one water bed.

The adoption of this method would necessitate a few radical changes in rigging. The hydraulic jacks might not be absolutely necessary, but the advantages of their use are so numerous that their inclusion in the rig would greatly increase its efficiency. Perhaps the greatest difficulty, however, aside from that of overcoming prejudice and custom, would be that of securing the proper casing in the East, although the sections are very simply constructed and could easily be copied.

Summarizing the artesian prospects in Kent County, it may be said that in the western part of the county the results of deep drilling have not been entirely satisfactory. In the vicinity of Millington fair supplies of hard water can be obtained at less than 125 feet, but the head is too low to give flows. However, the water rises to within less than 10 feet of the surface and can be easily pumped. Toward the shore of Chesapeake Bay it may be necessary to drill from 250 to 400 feet. Flows have been obtained on low ground near the Bay. Other artesian wells could doubtless be obtained by drilling to the same water horizons. The depth required can be estimated by adding 20 to 30 feet for each mile toward the southeast from known wells, or subtracting a like amount for each mile toward the northwest. The head is only a few feet above sea level, and flowing wells cannot be obtained except on the lower portion of the Talbot plain. On the higher ground the water should rise near enough to the surface to be pumped.

With a few exceptions the artesian wells of Kent County have obtained satisfactory water, but at Rockhall a 400-foot well encountered water high in iron, and at Chestertown the deep well procured salt water. These facts suggest that deep drilling may prove unprofitable, although elsewhere throughout the Coastal Plain of Maryland the Lower Cretaceous water horizons have yielded large supplies and usually of good quality.

Non-Artesian Waters

SPRINGS.—Aside from small springs at various points and liable to more or less seasonable fluctuations there is one of good size along the Sassafras River at Betterton. This spring, known as the Idlewhile, has attracted considerable attention and is extensively advertised by the owner of the Idlewhile Hotel. The spring has a flow of about 25 gallons per minute and is reported to have had a constant volume during the last 40 years. It emerges in a small depression near the shore and the water probably comes from a sand bed in the Magothy formation. The construction of a wall about the spring and of a small house over it excludes dirt and surface water.

SHALLOW WELLS.—The majority of the inhabitants of Kent County utilize shallow wells for their water supply since water is usually obtainable in sufficient quantities for domestic or farm use at inconsiderable depths, is generally of good quality, and because of the equably distributed rainfall is dependable at all seasons of the year.

In the lower areas along the Bay and up the Chester River, as at Melitota, Tolchester, Sandy Bottom, Crosby, Edesville, Rockhall, and as far up the river as Millington, variable but usually sufficient amounts of water are found in the Talbot formation at depths ranging from 8 to 25 feet. Naturally these wells exhibit a variety of conditions reflecting their local environment, since the shallow water table is the direct result of downward seepage from the rainwater falling on the surface of the ground. In some places the water is pure and wholesome and free from organic or mineral matter. Elsewhere the water may be so high in iron or organic matter as to be unfit for use. The Talbot water is thus a very accessible supply and usually ample and of good quality, but very susceptible to local surface conditions and also liable to marked fluctuations during especially wet or dry seasons.

The broad level surface of the Wicomico terrace which forms the central and eastern part of the county, like the Talbot, comprises a thin mantle of sand and loam which like the Talbot stores the water which falls as rain on its surface. The water table is generally somewhat lower than on the Talbot terrace and the wells must be sunk somewhat deeper, striking their first water zone at the base of the Wicomico formation at depths varying with the surface topography and ranging from but 12 feet at Worton to the more common depth around 30 feet.

The Wicomico water, like the Talbot, is accessible and usually ample and of fair quality, although frequently hard. The older geological formations, already mentioned in the introductory paragraph on the geology of the county, lie so near the surface that they are readily tapped by comparatively shallow wells. In the northern part of the county along Sassafras River and in the northwestern part along the Bay the wells penetrate the Upper Cretaceous formations. At Betterton, where the wells vary in depth from 40 to 80 feet, an ample supply of good water is obtained from the Magothy formation. A well at Coleman, 70 feet deep, draws from this same horizon.

In the region underlain by the Aquia formation of the Eocene, it is only necessary to go to shallow depths to obtain Eocene water. At Galena three wells at different elevations strike Aquia water at from 40 to 60 feet. At Kennedyville, Morgnec, and Sandy Bottom this same water horizon is found at from 50 to 65 feet. At Chestertown the public supply wells penetrate this zone at from 58 to 70 feet, while at Millington, where the surficial formations are thick and are underlain by the Calvert it was necessary to go down 100 feet to strike the Aquia water zone. All the Eocene wells have a noticeable head, the Kennedyville well rising to within 4 feet of the surface. This Eocene water seems to be consistently hard but not otherwise objectionable. There should be no difficulty in finding this water in the southern part of the county and it should be especially

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled
1	Chestertown	Chestertown Water Co.	15	583	8	583	583	Raritan	....	+2	20	100	......	....
2	Chestertown	Chestertown Water Co.	15	1135	8	1135	1135	Patuxent	Cased off	+2	50	....	Salt	....
3	Chestertown	R. G. Nicholson	35	100	3	100	100	Aquia	Cased off	−30	..	....	Hard	....
4	Chestertown	R. G. Nicholson	35	160	6	160	160	Monmouth	Cased off	−30	..	....	Hard	....
5	Chestertown	R. G. Nicholson	35	170	6	170	170	Monmouth	Cased off	−30	..	....	Hard	....
6-19	Chestertown (14 wells)	Chestertown Water Co.	15	58-70	Five 3 Nine 2½	58-70	58-70	Aquia	....	....	..	....	Hard	....
20	Chestertown, 3 mi. NE	H. Klinefelter	75	224	4½	......	223	Magothy	....	−40	..	....	Soft	1901
21	Galena	Catholic Church	65	61	3′ 8″	Bricked	61	Aquia	....	−58	..	....	Hard	1860
		Davis Bros.	..	60	1½	60	60	Aquia	....	−40	..	160	Hard	1916
22	Kennedyville	Penn. R. R.	..	65	6	65	65	Aquia	....	−15	..	11½	Soft	1880
23-25	Massey (3 wells)	Penn. R. R.	64	48-55	2	48-55	48-55	Calvert	....	−10	..	85	Soft	1909
26	Millington	J. P. Ahern	20	102	4	52	......	Aquia	....	−4	..	..	Hard	1907
27	Millington	Central Hotel	27	105	3	30	......	Aquia	....	−4	..	....	Hard	1907
28	Millington	J. E. Higgman	21	102	4	......	......	Aquia	....	−4	..	....	Hard	1907*
29	Millington	W. H. Soper	10	99	4	......	......	Aquia	....	....	..	....	Hard	1907
30	Morgnec, 1½ mi. SW	....	45	224	4½	223	......	Matawan	....	−40	..	....	Soft	....
31	Rockhall, ½ mi. SE	Rockhall Canning Co.	3	300	2	300	300	Magothy	....	+10	2	....	Hard	....
32	Rockhall, ½ mi. SE	Rockhall Canning Co.	3	345	2	......	345	Magothy	..?......	+10	6	....	Hard	....
33	Rockhall, 1½ mi. S	G. E. Leary & Son	3	400	?	400	400	Magothy	....	+8	5	....	Hard	....
34	Rockhall, 1½ mi. S	G. E. Leary & Son	3	400	1½	350	400	Magothy	....	+4	5	....	Hard	....
35	Stillpond, 7 mi. S	Mrs. Janver	78	256	4	180	250	Magothy	....	−65	..	10	Hard	1904
36	Tolchester	Tolchester Beach Co.	30	60	1½	60	60	Matawan?	....	....	..	....	Hard	....

*Tapped 4 feet above creek, at which point it flows slightly.

valuable since it is not deeply buried and because it will be more dependable and not so easily depleted a supply as the surface waters of the Pleistocene, and by proper locating the water should be brought within easy pumping distance of the surface.

The public supply wells at Chestertown and one of the wells at the ice plant, 99 feet deep, probably all draw from the Eocene, although at different levels.

As previously mentioned, the southeastern part of Kent County is underlain by the Calvert formation of the Miocene which in Southern Maryland and on the lower Eastern Shore is a most important artesian horizon. It is unimportant in Kent County but is sometimes utilized by shallow wells in this part of the county.

QUEEN ANNE'S COUNTY

Queen Anne's County, lying betwen the low divide of the Delaware-Maryland peninsula and Chesapeake Bay, is a region of low relief. Its surface, which is essentially an unbroken, undulating plain, rises from tide level to an average height of about 70 feet for all except the extreme western part of the county. Locally the surface may rise to between 80 and 90 feet. The stream valleys are broad and shallow and rapidly widen into estuaries.

TABLE OF ELEVATIONS

	Feet		Feet
Ashland	71	Pondtown	64
Barclay	70	Price	65
Carmichael	62	Queen Anne	30
Catlin	50	Queenstown	10
Centerville	25	Roe	72
Chester	10	Ruthsburg	68
Church Hill	30	Starr	77
Crumpton	22	Stevensville	10
Ingleside	62	Sudlersville	70
Love Point	12	Tilghman	78
Mattapex	12	Winchester	15
Normans	10		

GEOLOGY

Except for a broad terrace along the Chester River and in the stream valleys, the surface of the whole county east and northeast of Queenstown is formed by the sands and loams of the Wicomico formation, and the flat upper surface of this formation has been called the Wicomico plain or terrace. Bordering the stream channels and forming the surface of the western end of the county are the similar sands and loams of the Talbot formation, constituting a similar plain lying at a lower level and separated from the higher Wicomico plain by a well-defined scarp of about 10 feet in height. Both of these are of late Pleistocene age and have suffered little erosion so that their essentially level surfaces of deposition are still preserved. Immediately beneath these surficial deposits and underlying the whole county, except the northern extremity of Kent Island, are the sands, clays, and marls of the Calvert formation, the oldest Miocene deposits found in Maryland. These are only exposed at the surface in limited areas in the stream valleys, but lie at shallow depths and afford important supplies of water. Beneath the Calvert but nowhere exposed at the surface, except at a few points along the Chester River in the northern part of the county, is the Aquia formation of the Eocene, comprising in this region about 30 feet of glauconitic sands. Lying still deeper and nowhere reaching the surface within the limits of the county are the successively older formations of the Upper and Lower Cretaceous whose essentially sandy constitution make them important sources of deep-seated artesian waters.

SURFACE WATERS

The only large stream is the Chester River which forms the northwestern boundary of the county. Its water is brackish and receives the drainage of inhabited areas and is therefore not potable. The smaller streams are either tidal estuaries, such as Corsica River and Wye River, or are contaminated by drainage and contain but small amounts of water, which is not utilizable.

UNDERGROUND WATERS

Artesian Waters

Artesian waters are more widely utilized in Queen Anne's than in Kent County, largely because the former is more thickly settled and the shallow wells are consequently more exposed to contamination. Artesian wells have thus far been almost uniformly successful in procuring good water at no great depths, since the Calvert and Aquia, as well as the Upper Cretaceous formations, are water bearing. It should be possible to obtain a fair supply at depths of less than 250 feet throughout a large part of the county, and reference to the accompanying list will show many successful wells that are less than 150 feet deep. Deeper wells have been sunk at Centerville and Love Point where large amounts of water were required, but it is not clear that a shallower supply might not have been obtained at the Centerville well from the same horizon that furnishes water for the railroad wells.

The head of the water is not great enough to give flows at more than a few feet above sea level, and hence flowing wells can only be obtained on the lower portion of the Talbot formation. The water should everywhere rise near enough to the surface to be pumped, and on the Talbot and lower portions of the Wicomico formations suction pumps may be used, though on higher ground deep-well pumps might be necessary. In attempting to obtain water the driller may depend upon the nearest deep wells as a guide, provided allowance be made for the fact that the depth to the water horizons increases toward the southeast at a rate of between 20 and 35 feet per mile.

At Crumpton a well 55 feet deep taps a zone of water in the Calvert formation and flows about 5 gallons per minute. At Queenstown the ice company's wells find a flow of about 6 gallons a minute at 75 feet, also from the Calvert formation, and the wells at the railroad station 90 to 100 feet deep tap the same water zone, but here the water rises to only within 6 to 15 feet of the surface. At the southernmost point in the county, Queen Anne, and at Hillsboro in Caroline County, the Calvert formation shows the first evidences of the numerous water zones so conspicuous a slight distance farther to the southeast. At Queen Anne four wells, one at 80 feet, two at 125 feet, and one at 157 feet, are down into the Calvert. All of these wells flow and all yield hard water. About 3 miles northwest of Queen Anne, a well situated at an altitude of 60 feet went down 100 feet to probably the 80-foot bed at Queen Anne. The water in this well does not come to the surface and has to be pumped. The Eocene water seems to be confined to one bed and underlies the county at depths of from about 100 feet near Millington to 240 feet at Queen Anne. This horizon contains water that is everywhere hard, a condition noted in Kent County. It has been tapped by wells near Catlin, at Church Hill, Winchester, between Chester and Dominion, Stevensville, Love Point, and at Queen Anne. The well near Catlin passed this horizon at 100 to 132 feet (see log). At Church Hill the water is reported from a black ooze at 140 feet. At Winchester hard muddy water was found at 200 feet, near Chester it was reached at 160 feet. The Stevensville well struck the same bed at 130 feet and a well at Love Point reached this horizon at 100 feet. At Queen Anne a well 240 feet deep is thought to find water in the Eocene, the doubtful feature being the reported softness of the water, this being the only instance in the county of soft Eocene water. The Eocene water while not the best in the county is apparently the most constant both in distribution and quality.

Slightly below the Eocene water a bed has been found in the Monmouth of the Upper Cretaceous which supplies the wells at Catlin 223 feet deep, at Stevensville 203 feet deep, and near Chester 227 feet deep. This horizon has been passed in the deeper wells at Churchville and Love Point, but has not been explored to the southeastward. The well at Stevensville is reported to contain sulphurous water, although this does not seem probable. The well near Chester has been abandoned because the water was hard and muddy. A log of the Catlin well is given below. It shows a thickness of almost 150 feet of black and green sand, a condition typical of the basal Eocene and unweathered Monmouth.

It is thought that the sandstone at 52 to 70 feet is at the base of the Calvert formation, and it is worthy of note that this horizon which is elsewhere a good source of supply does not appear to contain much water at this locality.

WELL AT CATLIN

	Feet
Red yellow clay with gravel	0–15
Yellow sand and gravel, surface water	15–22
Soft blue clay	22–52
Gray sand	52–70
Red and yellow sand, iron ore, water	70–100
Black sand, water bearing	100–132
Hard sandstone	132–133
Black sand	133–135
Black and gray sand, ferruginous water	135–145
Light green clay	145–160
Black sand	160–174
Dark green sandstone	174–205
Green sand	205–216
Hard sandstone	216–217
Black sand, water bearing	217–223½

At Centerville deep wells have been successful. The well at the ice factory found water at 343 feet, probably in the Matawan formation, with a head sufficient to bring it within 2 feet of the surface. The log of this well is not detailed enough to warrant its publication, the only significant feature being the bed at 119 to 185 feet of the omnipresent Eocene "black sand." A deeper well was drilled at the Centerville Water Works and the following log was secured by the Survey:

WELL OF CENTERVILLE WATER WORKS

	Feet
Made ground	0–8
Marsh mud	8–25
Green clay	26–106
Gunpowder stuff "shells"	106–170
Olive yellow coarse sand, green sand and white quartz grains	170–230
Greensand, only a few quartz grains	230–240
Olive-colored sand like 170 to 230 feet	140–280
Olive-colored sand, darker than above	180–356
Gray sand	356–360
Olive sand with cementatious concretions of lime	360–365
Shell layer	365–370
Mixture of greensand and yellow quartz sand, varying in color, shells. Water at 428 feet	370–430
Reddish mixture of green and yellow quartz	430–460
Dark olive-colored mixture of clay, green sand and olive-colored quartz sand	460–480

An important feature of this log is the presence of a water bed at the base of the Magothy 428 feet deep. This horizon was also passed in the 400-foot well at Love Point, a log of which is given below.

WELL AT LOVE POINT

	Feet
Light red clay	0–10
Sandy clay, yellow-red	10–22
Sand, gravel and iron ore (sand from red to black)	22–100
Arenaceous clay (gunpowder)	100–200
Arenaceous clay (gunpowder), water pumped 10 gallons	200–206
Arenaceous clay (gunpowder), but darker and finer than above	206–284
Dark micaceous clay	284–360
Coarse white water-bearing sand, small amount of iron	350–360
Fine reddish sand, water bearing, volume pumped 40 gallons 15 feet from top of well and 11 feet above tide; water ferruginous	360–382

The agreement between the Love Point well and the deep well at Chestertown is much closer than that of the Centerville well with either of the other two. The Love Point well is just about along the strike with Chestertown, and the similarity of lithology and the correspondence in depth to the water beds is quite marked. At Chestertown the base of the Magothy was marked by coarse white water-bearing sand at 340 feet. In the Love Point section, given above, the same "coarse white water-bearing sand" is found at 350 feet. In the Chestertown well a bed of reddish sand at 390 feet furnished water, and in the Love Point well the "fine reddish sand" at 382 feet pumps 40 gallons a minute.

The deep well at Centerville passed the Magothy water but did not report the water in the "reddish sand." The horizon at the bottom of the Centerville well is the same as that found at Chestertown at a depth of 550 to 581 feet.

Non-Artesian Waters

SPRINGS.—Small springs are not uncommon throughout the county in situations where the stream valleys intercept water levels. The supplies of water furnished are small and apt to fluctuate with the seasons. All are of local origin and are of negligible importance as sources of either public or private supplies.

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Catlin	Mrs. H. H. Klinefelter	70	232½	4½	217	220-230	Monmouth	..	—33	..	20	......	....		
2	Centerville	Municipality	20	665	10	200	428	Raritan	665	—3	..	300	Hard	1901	....	Public supply.
3	Centerville	Price Bros.	20	333	4	180	330	Matawan	..	—4	..	60	Hard	1905	G. A. McDaniel....	Ice factory.
4,5	Centerville (2 wells)	P. B. & W. R. R.	20	225	1½	125	220	Aquia	..	—15	..	60	Soft	1887	....	Abandoned in 1902.
6	Chester, 2¼ mi. SE	G. R. McCready	10	227	1½	160	......	Monmouth	..	—2	..	......	Hard	1899	....	Muddy.
7	Chester, 2¼ mi. SE	G. R. McCready	10	160	4	160	......	Aquia	..	—2	..	......	Hard	1908		
8	Church Hill	Town pump	45	24	8	..	......	Wicomico	..	....	..	Good	Soft	....		
9	Church Hill	Levi Pippin	45	18	3	..	......	Wicomico	..	....	..	Good	Soft	....		
10	Love Point	Md. & Va. R. R.	12	400	6	..	......	Raritan	..	....	..	Good	Hard	1907		
11	Love Point	Md. & Va. R. R.	12	100	6	50	20-100	Aquia	..	....	..	Insufficient	Hard	1906		
12	Queen Anne	Stewart Jarrell	10	80	2	80	80	Calvert	..	+8	..	......	Hard	1900	....	Not used.
13	Queen Anne	Stewart Jarrell	10	157	4	157	157	Calvert	..	+10	12	......	Hard	1905	....	Canning factory.
14	Queen Anne	Stewart Jarrell	10	135	4	125	125	Calvert	..	+6	6	......	Hard	1904		
15	Queen Anne	P. B. & W. R. R.	15	240	1½	140	240	Upper Cretaceous	..	—18	..	30	Soft	1902		
16	Queen Anne, 3 mi. NW	Hugh Brown	60	100	4	100	100	Calvert	..	..	..	Good	......	1904		
17	Queenstown	H. Y. Roberts	10	40	1½	40	36-40	Wicomico	..	—15	..	Large	Hard	1909		
18	Queenstown	E. W. Fried	10	90	3	40	90	Calvert	40	—6	..	......	Soft	1906		
19	Queenstown	Md. & Va. R. R.	10	90	3	80	80-90	Calvert	..	—3	..	100	Soft	1905	G. A. McDaniel.	
20	Queenstown	Md. & Va. R. R.	5	100	6	100	100	Calvert	..	—40	..	200	Iron	1906		
21	Queenstown	H. G. Perry	10	42	1½	42	38-40	Wicomico	..	—20	..	Large	Hard	1909		
22	Queenstown	Queenstown Ice Co.	10	139	6	30	75	Calvert	..	+4	30	......	Soft, Iron	1911	....	No water below 75 feet.
23	Queenstown	Elec. Light & Power Co.	10	70	1½	70	70	Calvert	..	+2	6	......	Soft	1914		
24	Stevensville	J. R. Benton	12	203	4	173	200	Monmouth	..	—5	..	Large	Sulphur	1908		
25	Stevensville	M. E. Church	8	130	1½	130	130	Aquia	..	....	..	......	Hard	1900	....	Sandy, not used.
26	Winchester	T. J. Melvin	12	200	1½	130	......	Aquia	..	....	..	......	Hard	....	....	Muddy, not used.
27	Wye Island	J. S. Sewell	10	78	2	..	14	Talbot	..	....	..	......	......	1907		

SHALLOW WELLS.—In this as in the other Eastern Shore counties bordering on the Bay the inhabitants of the low lands of the Talbot terrace obtain abundant supplies of water in the sands of the Talbot formation at depths of from 10 to 15 feet, or sometimes at slightly greater depths. This water has the usual advantages and disadvantages of surficial waters, the ease of reaching the water table being offset by the danger of contamination and the uncertainty of the supply during periods of dry weather. Since the major portion of the county is covered by the deposits of the Wicomico formation domestic supplies can be obtained from these at depths of from 15 to 45 feet. Sudlersville and Church Hill, both at an elevation of about 65 feet, furnish the records for the deepest Wicomico wells, although they are probably duplicated at a good many other places. At Ingleside, Barclay, Tilghman, etc., the Wicomico supply runs at the more common depth of 18 to 30 feet. The Wicomico water is consistently good, in the absence of direct pollution, and is a very valuable source of potable water.

CAROLINE COUNTY

Caroline County lies almost entirely on the broad central divide of the Eastern Shore which is formed by the sandy loam of the Wicomico formation. This is known topographically as the Wicomico terrace or plain. This plain has been moderately dissected by streams, although over extensive areas it is still an almost level country lying from 40 to 60 feet above sea level. Three wide tongues of lower-lying plain penetrate the county from the south along the valley of the Choptank River, Tuckahoe, and Marshyhope creeks. This plain, which is known as the Talbot plain, is less dissected than the higher Wicomico plain and ranges in elevation from sea level to about 30 feet. Federalsburg is situated on this plain and Denton is situated at the junction of the Wicomico and Talbot plains on the steep slope that usually separates these two levels.

TABLE OF ELEVATIONS

	Feet		Feet
Bethlehem	47	Henderson	58
Burrsville	58	Hillsboro	47
Choptank	5	Hobbs	55
Concord	55	Marydel	62
Denton	40	Newton	40
Federalsburg	29	Ridgely	67
Goldsboro	64	Smithville	36
Greensboro	39	Williston	24

GEOLOGY

The surface of the county is made up almost entirely of the loams, sands, gravels, and marsh lands of the Talbot and Wicomico formations previously mentioned. There are a few limited exposures of the older Miocene along Tuckahoe Creek and on the upper Choptank River. The Choptank formation of the Miocene underlies the southern part of the county at no great depth, but is unimportant as a water-bearing horizon within the limits of this county. Beneath the Choptank is found the Calvert formation of the Miocene, a thick series of sands and clays underlying the whole county and an important source of artesian water. Still deeper the successively older formations of the Eocene and Cretaceous are encountered. These are prevailingly sands and clays, generally carrying an abundance of water but lying at great depths. Since the Calvert horizon is so much more easily reached and usually furnishes an abundance of satisfactory water it is seldom necessary to drill to greater depths, although there are several wells at Denton that draw their water from the Eocene which approach to within 200 to 300 feet of the surface in the northern part of the county. One well at Hillsboro reaches the Upper Cretaceous at 440 feet.

SURFACE WATERS

The surface waters of Caroline County are not important sources of supply because the large streams are all tidal and either salt or brackish, and the small streams contain very little water in dry weather. The streams all receive drainage from inhabited areas and are of doubtful sanitary character. These conditions have prevented the use of surface water and there is no prospect of its future development.

UNDERGROUND WATERS

Artesian Waters

The Choptank formation outcrops in limited areas in the southern part of the county, but of the wells whose records are available none is thought to encounter water in this formation. The amount of water contained is probably rather small and then, too, the horizon occupies an unfavorable position, since it is slightly too deep for shallow wells and too shallow for deep wells. The head on the Choptank water would not be very great.

The Calvert formation is the main water-container of this county and through its thickness of over 200 feet of clays and sands there are many streams of water, some of which seem to owe their pressure to the local character of the bed or to the transition from a sand bed just before it graded into a clay, which would obviously get a much greater flow than if the sand were continuous. The Calvert formation is made up of clays and sands, and the notable impossibility of correlation of some of the water horizons with other wells close at hand is quite probably due to this gradation of materials. The wells at Ridgely 80 to 85 feet deep encounter a soft water that rises to within 6 feet of the surface. At Greensboro and Hillsboro, both along the strike with Ridgely, the wells are deeper. At Hillsboro recorded wells are 102, 145, and 165 feet deep, all drawing from Calvert horizons, the 141- and 165-foot wells probably drawing from the same stratum. These wells have a small flow of soft water. At Greensboro two wells 180 feet deep contain water reported hard and containing sulphur. The water in these wells has only head enough to bring it to the surface, while another well 160 feet deep containing similar water flows 80 gallons a minute. In these Greensboro wells the water comes from 120 feet. At Federalsburg, wells find water in the Calvert at depths of 230 to 285 feet with a head sufficient to give flows of 10 to 35 gallons a minute. The water in the shallowest well of this series is hard and contains iron, but the others report soft water. Records of four wells show flows obtained at the various depths: 150 feet, 3 gallons; 248 feet, 35 gallons; 255 feet, 20 gallons; 285 feet, 15 gallons. The 248-foot well shows water at 90 and 150 feet; the 255-foot well shows water at 180 and 210 feet; and the 285-foot well shows water at 160 feet.

A generalized section of one of the city supply wells, 248 feet deep, is given below:

WELL AT FEDERALSBURG

	Feet
Sand and gravel	0–10
Marsh mud, bad odor	10–20
Blue sandy clay	20–28
Fine sand and gravel	28–36
Very fine bluish sandy clay	36–70
Shell rock with iron ore alternating with fine blue sandy clay	70–248
Shell rock bands varied in thickness from 1 to 14 feet.	

Other wells at Federalsburg varying in depth from 133 to 185 feet find flows in higher beds of the Calvert. The Federalsburg wells with their various depths are a striking demonstration of the richness of the Calvert formation in water beds.

The Eocene water is reported from only two localities in Caroline County, but it probably underlies the whole county at depths of from 200 to 500 feet. The wells at Greensboro and Denton strike the characteristic hard water at depths of 240 to 285 feet. These wells have a small flow dependent on the elevation of the mouth of the well. The first city well at Denton was a non-flowing well, the second one was drilled down near the river and it flows. The wells at West Denton, 350 and 400 feet deep, indicate a second Eocene level. The shallower well flows 120 gallons a minute, while in the second one the water stands within 20 feet of the surface. These two wells and the city wells at Denton noted above show the control of elevation upon the head of water in a well and they clearly demonstrate the basic falseness of a classification which makes flowage the criterion of an "artesian" well.

A well at Hillsboro 440 feet deep has a —22 head of good water. At 300 feet the well passed through "gunpowder material" (Eocene) and is probably drawing from a bed in the uppermost Matawan. This is the only well in the county that gets so low in the column.

Caroline County has a large supply of artesian water in the Calvert and Eocene beds, and by locating on low land the wells should be made to flow. However, the water should everywhere rise within easy pumping distance.

Non-Artesian Waters

SPRINGS.—The flat nature of the country has not been favorable for the formation of springs and they are practically absent throughout the county, making it necessary for the inhabitants to rely upon wells for domestic and farm purposes.

SHALLOW WELLS.—The shallow wells of Caroline County draw their supply from the surface waters of the Pleistocene sands and gravels, and since the Talbot is only represented in a few areas along the larger streams

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Bethlehem, 3 mi. N.	J. Berger............	5	100	4	60	100	Calvert	80	+8	20	....	Soft	1909	....	Three wells, supplying duck farm.
2	Choptank	W. J. Wright.........	5	150	2	80	150	Calvert	....	+1½	5	....	Soft	1904	....	Three wells, supplying boilers and canning factory.
3	Denton	Municipality	40	285	8,6	270	270	Aquia	200	−11	..	75+	Hard	1905	....	Public supply.
4	Denton	Municipality	40	270	6,4½	270	270	Aquia	....	+3	12	....	Hard	....	....	Public supply, two wells.
5	Denton	Green & Merrick......	25	280	4	60	280	Aquia	....	....	..	....	Soft	1914	....	Ice plant.
6	Denton	G. S. Raleigh & Son..	40	400	4	40	....	Aquia	....	−70	..	60+	Hard	1908	....	Also use 15 driven wells, 35-40 feet deep. Cannery.
7	Denton, W.........	G. S. Redden..........	10	350	6	180	350	Aqnia	180	+10	120	....	Soft	1907	....	Softened by Calvert water at 180 feet.
8	Denton, W.........	Whitby & Son.........	10	180	3	60	180	Calvert	....	+14	10	40	Soft	1908		
9	Federalsburg	Municipality	10	180	2	60	150	Calvert	....	+2	3	....	Soft	1903	....	Public supply.
10	Federalsburg	Municipality	10	248	2	40	248	Calvert	90	+8	35	....	Soft	1904	....	Public supply.
11	Federalsburg	Municipality	10	265	2	265	265	Calvert	....	+5	15	....	Soft	1913	....	Public supply.
12	Federalsburg	Ora Patton.............	10	285	2	145	285	Calvert	160	+3	15	....	Soft	1908		
13	Federalsburg	W. H. Davis...........	10	248	2	40	248	Calvert	90	+8	35	....	Soft	1904		
14	Federalsburg	H. B. Messenger.......	10	255	3	155	250	Calvert	180,210	+6	20	75	Soft	1903		
15	Greensboro	F. P. Roe & Bros......	15	290	6	210	290	Calvert	160	+2	10	....	Soft	1905		
16	Greensboro	Riverside Hotel........	10	160	6,4½	35	120	Calvert	....	+12	80	....	Hard	1902	Shanahan..	Public supply.
17	Greensboro	F. P. Roe & Bros......	20	150	6	30	120	Calvert	....	Surface	..	Ample	Hard	1903	....	Canning.
18	Greensboro	F. P. Roe & Bros......	20	150	6	30	120	Calvert	....	Surface	..	Ample	Hard	1904	....	Canning.
19	Greensboro	F. P. Roe & Bros......	20	240	6,4	240	240	Aquia	....	Surface	..	Ample	Hard	1907	....	Canning.
20	Greensboro	J. M. Swing & Bro....	20	285	4½	285	285	Aquia	....	+5	10	....	Hard	....	McDaniel..	Canning.
21	Hillsboro	....	30	440	6	440	440	Matawan	....	−22	..	....	Hard	....		
22	Hillsboro	Smart & Jorel..........	55	102	..	....	....	Calvert	....	+2	5	....	Hard	....	Pentz.	
23	Hillsboro	....	40	145	..	..	....	Calvert	....	+4	5	....	Hard	....		
24	Hillsboro	....	20	165	..	....	....	Calvert	....	+3	8	....	Hard	....		
25	Ridgely	John Scully............	55	86	1½	86	86	Calvert	....	−6	..	Ample	Soft	1905		
26	Ridgely	A. W. Thompson.......	55	84	4	84	84	Calvert	....	−8	..	Ample	Soft	1913	Pentz......	Ice plant.
27	Ridgely	Municipality	55	65 - 80	2	65-80	65-80	Calvert	....	−7½	..	Ample	Soft	1903	....	Several wells. Public supply.

most of the water comes from the base of the Wicomico. The Wicomico has a much larger surface exposure and hence contains more water. The common depth for shallow wells is from 15 to 30 feet and usually the water is of good quality, but local pollution by inhabitants or by drainage from some of the numerous swamps may render the water unfit for use or impart a disagreeable marshy taste or odor. At Federalsburg and at several other points the shallow water contains iron which is in the form of a colloidal hydrate, especially noticeable if a vessel of water is left standing for some time.

The shallow wells commonly supply enough water for household or farm uses and occasionally two or three such wells will furnish enough water for a canning factory. At Preston the usual depth for wells is 45 feet, the water being reported from a coarse yellow sand. This is the maximum depth for Pleistocene water in this county. The most widespread type is the dug well, so common during the early history of the region, but in many localities this type is being replaced by wells constructed by driving a pipe of small diameter into the ground. In some places the driven wells draw from the same water horizons as the shallow wells, but locally they reach deeper water-bearing beds. The driven well is generally superior to the dug well because the casing is better adapted for excluding impure surface waters.

TALBOT COUNTY

Talbot, lying between Queen Anne's on the north, Caroline on the east and south, and Chesapeake Bay on the west, is centrally located on the Eastern Shore. It is a region of low relief, no part rising above 65 feet above sea level. The streams are tidal estuaries and the surface is but little dissected by erosion and is consequently a gently undulating, broad, flat, fertile plain.

GEOLOGY

The surface of the county consists almost entirely of the two latest Pleistocene terrace plains, the Wicomico occupying the eastern half of the county and lying at an altitude of from 40 to 60 feet. This is separated from the lower-lying Talbot plain, which occupies the western half of the county, by an escarpment or steep slope extending in a north and south direction from Wye Mills to near Chancellor Point on the Choptank River.

Beneath these surficial formations of loam, sand, and gravel are the Choptank and Calvert formations of the Miocene. These outcrop in limited areas in the stream valleys and comprise clays, sands, and marls. These are in turn underlain by the Eocene which is an important water horizon but does not reach the surface on the Eastern Shore south of Kent County. The Eocene is in turn underlain by the deeply buried formations of the Cretaceous.

TABLE OF ELEVATIONS

	Feet		Feet
Barber	47	Oxford	5
Bellevue	5	Queen Anne	30
Bloomfield	10	Royal Oak	6
Bruceville	35	Skipton	61
Claiborne	5	St. Michaels	8
Copperville	10	Stumptown	50
Cordova	45	Tilghman	4
Easton	30	Trappe	55
Hambleton	52	Tunis Mills	10
Kirkham	14	Windy Hill	15
Longwood	51	Wittman	12
Manadier	57	Wye Mills	22

SURFACE WATERS

The surface streams of Talbot County are not important sources of supply because the large streams are all tidal and either salt or brackish, and the small streams contain very little water in dry weather. The streams all receive drainage from inhabited areas and are of doubtful sanitary character. The conditions enumerated have prevented the use of surface water and there is no prospect of its future development.

UNDERGROUND WATERS

Artesian Waters

Attempts to procure artesian water in Talbot County have been uniformly successful, but flowing wells have been obtained only where the surface is less than 20 feet above sea level. The deepest artesian well in the eounty is the 1015-foot well at the Easton Water Works, and the shallowest is a 29-foot well at Copperville. This well is diseussed by Miller,[1] who believes that "although the well was not driven below the Pleistoeene deposits the water probably eomes from a greater depth and finds its way to the base of the pipe through some deep-seated fissure in the Calvert strata." The flow of the well is very small and the water is highly eharged with iron, a feature not usual with the Calvert waters, but whieh has probably been aequired in this ease through the passage of the water through the Pleistoeene gravels.

The Mioeene deposits are represented in this eounty by the Choptank formation whieh outerops in some of the stream beds in the southern part of the eounty, and by the Calvert formation whieh is seen at the surfaee at a few plaees in the northern part along Wye River and its tributaries. The Choptank formation is not important as a water-bearing horizon, but the Calvert water has long been known and utilized. This water is soft and very good. An analysis of the water from the 135-foot wells at Easton is given on a subsequent page. The Calvert water levels are ineapable of as elose eorrelation as in the neighboring eounties due to the horizontal gradation of the materials. The Calvert wells vary in depth from 166 to 195 feet. A well at Cordova, about 40 feet above sea level, is 116 feet deep with the water within 8 feet of the surfaee. At Easton the Calvert long supplied the eity with its water, the water bed being reaehed at 104 to 135 feet. These wells all flowed originally, but when the deep well was sunk the water in the shallower wells fell to −10 feet and would furnish no water while the 10-ineh well was being pumped.

Two wells at Grubin Neek, 160 and 186 feet deep, draw from the Calvert horizon but do not flow, and at Windy Hill a well 180 feet deep has a small flow of water from the same stratum.

Two horizons have been reeognized in the Eoeene, one at the base of the Aquia and one at or below the base of the Nanjemoy. The basal Aquia water is in use at only three loealities, while the Nanjemoy wells are more seattered.

[1] Miller, B. L. Geologic Atlas of the U. S., U. S. Geol. Survey, Choptank Folio No. 182, 1912, p. 8.

AQUIA.—The well at "The Anchorage," 265 feet deep, which has a small flow of hard water, and two other wells on Miles River Neck, 255 and 272 feet deep, which yield hard water but do not flow, are the shallowest wells in the county that draw from the Aquia water. At Oxford the basal Eocene water is 350 feet deep, hard, with no flows, and at Barkers Landing on the Choptank River the water is at a depth of 370 feet, is hard and rises to within 8 feet of the surface.

NANJEMOY.—The 195-foot well on Long Point reported by Darton (Bull. U. S. Geol. Survey No. 138, p. 133) and assigned by him to the Calvert level is probably Nanjemoy. More information concerning this well than that given by Darton could not be obtained.

About 2 miles directly south of the Long Point well a boring at Royal Oak 224 feet deep found water which was in a dark sand underneath a sand rock. The water is hard and slightly turbid, both qualities which are fairly constant in the Eocene water.

About 3 miles west of Easton a well was drilled on Dr. Nickerson's property to a depth of 297 feet in which the water in use was encountered in a bed of sand and gravel that was 48 feet thick, according to the following log supplied by the driller:

	Feet
Recent.	
Soft brown clay	0–6
Soft green sand	6–117
Miocene.	
Soft green sand, shells	117–160
Eocene.	
Soft blue clay	160–235
Soft blue sand	235–249
Nanjemoy.	
Hard rock	249–249½
Aquia.	
Green sand and gravel. Water	249½–297

There are two wells at Trappe, 375 and 400 feet deep, and another one about 1 mile west, 311 feet deep, reaching hard water that stands at −14, −46, and −15 feet respectively. By the character of the water and the low head it would seem to be from the Eocene beds, but the shoal depths at which the water is reached operates somewhat against such a conclusion. It may be suggested here that the upper member of the Eocene is at this point making its first appearance on the Eastern Shore, nowhere cropping at the surface. This suggestion finds support in a slight thickness of clay and sand shown in the log of the Easton well, which has been referred to the Nanjemoy. It does not seem likely that the Calvert has as great a thickness as is demanded by the reference of these wells of that horizon. In the Choptank folio (*loc. cit.*) Miller gives contours for the Eocene water level and states that the main stream is probably at the base of the Nanjemoy formation. This does not seem to be the position occupied by the main stream in this county since the main stream is thought to be that which supplies St. Michaels at 260 feet, Miles River Neck at 255 to 270 feet, and Oxford at 380 feet, with a distant well at Barkers Landing 370 feet deep. The wells at Royal Oak 224 feet, west of Easton 249 feet deep, and near Trappe 311, 375, and 400 feet (the latter two are at an elevation of 50 to 65 feet, the 311-foot well at 20 feet, and all the others at less than 10 feet) are thought to be at the base of the Nanjemoy. This is the level which becomes important across the river in Dorchester County and is about 75 feet above the lower water level of the Eocene. These are exactly the same relations as were observed in Caroline County, where at Denton the first Eocene stream is encountered at 270 feet and the second at 350 feet below sea level.

The wells drawing from Upper Cretaceous streams fall into two classes: First, the numerous wells on Tilghman Island near Sherwood and near McDaniel around 340 to 400 feet in depth; second, the wells at Claiborne and Tunis, 440 and 486 feet deep respectively, and also the 1015-foot well at the Easton Water Works.

The wells of the first group draw from one of the best streams in the Upper Cretaceous, barring the Magothy, and the horizon is thought to be the upper part of the Matawan. A log of a well on Tilghman Island, 380 feet deep, is given below.[1]

[1] Fuller, M. L., and Sanford, Samuel. Record of Deep-Well Drilling for 1905, U. S. Geol. Survey, Bull. No. 298, pp. 233, 234.

WELL AT TILGHMAN

	Feet
Columbia.	
Hard buff clay	0–12
Soft micaceous gray sand with a little glauconite	12–18
Soft dark brownish-gray micaceous sand	18–40
Calvert.	
Gray sand containing shell fragments	40–50
Hard gray sandy micaceous clay	50–130
Eocene.	
Soft rock (glauconite with a little sand and gravel). A little water	130–155
Monmouth.	
Hard black earth (dark clay with much glauconite, a little sand, some bits of shells)	155–340
Hard dark sand (glauconite with coarse sand and bits of shells), some water	340–360
Matawan.	
Hard dark sand (less glauconite and more grains of brownish quartz than preceding, some bits of shells), plenty of water	360–380

In the original grouping of the materials the Monmouth was omitted, but in view of the fact that the Monmouth at its outcrops is known to be distinctly marine in origin its absence here would be hard to explain. The above log contains several points of interest. The hard sandy clay at 130 feet is the same as the "sand rock" encountered on Long Point at 195 feet, while the water at 155 feet is probably the same as that found at the "Anchorage" at 265 feet. The main water level, besides supplying the wells at Sherwood, of depths around 365 feet, and those near McDaniels, 340 to 380 feet, is found also in the well at Tunis Mills, 437 feet deep, where the water was originally so alkaline that it foamed in the boilers. Another well drawing from the same level is located about 1½ miles west, and the following materials were penetrated in the course of drilling:

	Feet
Soft yellow clay	0–15
Soft blue clay	15–65
Sand rock, blue	65–86
Soft blue clay	86–179
Hard blue rock	179–181
Soft green sand	181–190
Soft blue clay	190–250
Soft sandy black clay	250–298
Gravel	298–$301\frac{7}{12}$
Soft sandy black clay	$301\frac{7}{12}$–425
Hard blue clay ?	425–559
Green sand and gravel	559–590

These wells all flow, although the amount is not very large, the maximum reported being 20 gallons per minute. At Easton this horizon was encountered at 570 to 600 feet, and at Oxford two wells 540 feet deep have flows of 25 gallons per minute from the same stream.

The well at Claiborne 444 feet deep was referred by Darton[1] in 1896 to the Magothy, and Miller in the recent Choptank folio (1912, Bull. U. S. Geol. Survey No. 182, p. 8) reassigns it to the Magothy along with the 540-foot well at Oxford. The Claiborne well and the 486-foot well at Tunis are here thought to be possibly Magothy, but the Oxford wells are quite certainly no lower than the upper Matawan. To correlate the Oxford wells with that at Claiborne would require that the dip be less than 10 feet in the mile, which is not at all in accordance with observation at the outcrops nor with the experience in wells. The well at Tunis is about 1½ miles down the dip from the Claiborne well and the difference in depth after correction for elevation is 40 feet. This would give a dip of about 25 feet in the mile, which is exactly the average dip of the beds at their outcrop.

The Easton well, the log of which is appended, was sunk with the object of augmenting the supply drawn from the shallow wells in the Calvert.

WELL OF THE EASTON WATER WORKS

	Feet
Made ground	0–5
Marl with whole shells	5–35
Light green clay	35–50
Dark brown clay	50–80
Dark green clay	80–99
Sand rock	99–100
Green sandy clay	100–104
Light gray sand, water bearing, containing shark teeth, shells, large pieces of bone. Pumps 120 gallons per minute and heads up to —10 feet[2]	104–135

[1] Darton, N. H. Bull. U. S. Geol. Survey No. 138, 1896, p. 133.

[2] During about 1885 when the Water Works were installed, six 4-inch wells were put down to this same stratum, all of which flowed at that time. When the 10-inch well was sunk it was found that the water only rose to within 10 feet of the ground, and that the smaller wells would furnish no water when the large one was being pumped.

	Feet
Soft light-green sandy clay	135–170
Soft sandstone	170–171
Soft green sandy clay	171–190
Sandstone	190–190½
Soft green clay, black specks	190½–270
Hard blue clay	270–271
Light coarse sand	271–280
Soft rock or hard blue clay	280–282½
Clean light-green clay	282½–299
Boulder	299–300½
Black sand or marl	300½–306
Hard crust	306–307
Black sandy clay or marl, no shells	307–390
Black sandy clay or marl	390–570
Sand and gravel, yellow white and black, water bearing. Pumps 20 gallons per minute and heads up to —6 feet	570–600
Fine black sand with boulders	600–651
White sandy clay with boulders	651–681⅚
White clay	681⅚–688 5/12
Soft sandstone	688 5/12–689
White sandy clay, hard streaks and gravel (?)	689–727⅔
Soft sandstone	727⅔–728⅙
White clay	728⅙–729½
Soft sandstone	729½–730 5/12
Soft green and brown clay with black sand	730 5/12–802
Yellow clayey sand, similar to that at 570–600 feet	802–835
White clay or marl, with hard and soft streaks, containing shells and sand	835–870
Sandy clay, gray when dry	870–888
Soft black sandy clay	888–960
Soft rock	960–960½
Black sandy clay	960½–966
Soft rock	966–967
Black sandy clay	967–995
White sand, water bearing, well flows	995–1015

The well passed through the Calvert water horizon, the upper Matawan level at 570 to 600 feet, and is drawing from the main stream of the Magothy. It should be stated here that when Darton and Miller spoke of the Potomac waters they included the Raritan which they probably thought was the horizon of this well, and it has only been recently that the Raritan has been assigned to its proper place at the base of the Upper

Cretaceous. With this in mind, Miller's refercnce of the Easton well to the Potomac group is not so much at variance with the present assignment.

In the above log the 80-foot thickness of "green clay, black specks" may bc too thick to be referrcd to the Nanjemoy, but the lithology is very strikingly like the clays of the Nanjemoy. There is possibly a division in this bed that was not noticed by the driller, which may also be true of the 180 feet of black sandy clay or marl at 390 to 570 feet, since some slight thickness of Monmouth probably occurs. The bed of "yellow clayey sand" at 802 to 835 feet may be the level that supplies the wells at Claiborne and Tunis Mills. The water from the white sand is plcntiful and strongly alkaline. It is satisfactory for use when mixed with that from the shallow wells, but has not been tried alone.

This Magothy stream is the largest one that has been encountcred in the county thus far. The Patuxent water level is probably more than 1000 feet below the Magothy and should yield large flows of water which, however, would probably be highly mineralized. The Magothy beds dip about 30 fect in the mile to the southeast, so that, with the Easton well for a guide, other localities can judge its depth. After the Magothy, the next horizon in importance is the one in the upper Matawan, that which is shown in the Easton well at 570 to 600 feet, and on Tilghmans Island at a little less than 400 feet. This bed dips to the southeast at about 25 feet to the mile, so that with the Tunis Mills, Oxford, and Easton wells for guides, it too may be easily located. After these two come the Eocene and Calvert horizons which have so far never failed to yield water, although the quantity and quality have not always becn satisfactory.

Non-Artesian Waters

SPRINGS.—Springs are practically absent in the low-lying country throughout the central and southern Eastern Shore, and there are no true springs in Talbot County other than local seepages and these should not be used for domestic purposes since they are uncertain in amount of water furnished and especially liable to contamination.

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Claiborne	B. C. & A. R. R.	5	444	....	444	444	Magothy	....	10	....	Large	Hard	1896		Scales boilers.
2	Claiborne		5	100	1½	100	100	Calvert	....	6	....	....	Soft	....		
3	Copperville		10	29	2	29	29	Calvert	....	+2	6	....	Soft, some iron	....		Water probably percolates upward from Calvert.
4	Copperville	Dennis & Carroll	10	300	2	200	300	Upper Cretaceous	....	+2	Small	40	Soft	1907		Used for boilers and general purposes.
5	Cordova	Saulsburg Bros.	40	116	4	100	100-116	Calvert	....	−8	....	....	Soft	1908		Used for boilers and canning.
6	Cordova	Saulsburg Bros.	40	116	6	100	100-116	Calvert	....	+1½	....	....	Soft	1901		Used for boilers and canning.
7	Cordova	Talbot Packing & Preserving Co.	40	116	6	100	100-116	Calvert	....	−1½	....	Good	Soft	....		
8	Cordova	Talbot Packing & Preserving Co.	40	80	6	....	....	Calvert	....	−8	....	....	Hard	....		Used for boilers and canning.
9	Easton	Easton Water Co.	20	366	4	366	366	Calvert	....	+10	....	....	......	1886		City supply.
10	Easton	Easton Water Co.	20	1015	10	1015	1015	Magothy	100	Surface	....	....	Alkaline	1901		City supply.
11	Easton	Easton Water Co.	20	135	....	135	100-135	Calvert	....	−10	....	....	Soft	....		City supply.
12	Easton, 1½ mi. W.	Edw. B. Hardcastle	8	590	....	....	590	Matawan	....	....	....	30	......	1911	Shannahan.	
13	Easton, 3 mi. W.	Dr. Nickerson	12	297	5½	249	249-297	Nanjemoy	....	−6	....	....	......	1912		
14	Easton (Bakers Landing).		15	370	3	370	370	Aquia	....	−8	....	....	Hard	....		
15	Cruhin Neck		12	186	1½	180	180-186	Calvert	....	....	....	....	Hard	....		
16	Cruhin Neck		12	200	4	160	160-200	Calvert	....	....	....	....	Hard	....		
17	Howells Point	Mrs. Thos. Martin	12	200	4	118	160	Calvert	....	−3	....	Small	Hard	....		
18	Howells Point	J. O. Dickinson	12	180	1½	180	180	Calvert	....	....	....	Small	Hard	1886		
19	McDaniels	Warner & Monroe	14	340	1½	314	300	Matawan	120-150	+5	15	....	Hard	....		
20	McDaniels, 1 mi. NW.	Mr. Pearson	5	380	8	260	350-380	Matawan	....	+5	....	30-60	......	....		
21	Miles River Neck (Long Point).		5	195	3	....	195	Nanjemoy	....	Surface	....	....	......	....		
22	Miles River Neck	Zenos Burns	10	125	3&2	125	125	Calvert	....	Near surface	....	....	Hard	....		
23	Miles River Neck	Mr. Bailey	10	255	3&2	255	255	Aquia	....	Near surface	....	....	Hard	....		
24	Miles River Neck (Anchorage).		15	265	3	....	265	Aquia	....	Surface	....	....	Hard	....		
25	Miles River Neck	Mr. Shipley	10	272	3&2	272	272	Aquia	....	Near surface	....	....	Hard	....		
26	Oxford	Municipality	5	360	4½	145	350	Aquia	....	−9	....	....	......	....		Public supply.
27	Oxford	American Ice Co.	5	540	6,2½	540	540	Matawan	....	+5	15	80	Hard	1908		Scales boilers.
28	Oxford	American Ice Co.	5	535	6	528	530	Matawan	....	+3	30	60	Hard	1908		Scales boilers.
29	Oxford	American Ice Co.	5	125	3	125	125	Calvert	....	−4	....	12	Hard	1909		
30	Oxford	Wm. M. Bergman	5	351	3	300	300	Aquia	150	−8	....	....	Hard	1909		
31	Oxford	Capt. John Bridges	5	125	3	125	125	Calvert	....	−10	....	....	Hard	....		
32	Oxford	Wm. B. Newman	5	350	4	....	350	Aquia	....	−8	....	....	Hard	1909		
33	Oxford	School	5	350	4	....	350	Aquia	....	−8	....	....	Hard	....		
34	Oxford	J. Valient	5	350	4	....	350	Aquia	....	−8	....	10	Hard	1905		
35	Royal Oak	H. E. Hughes	10	224	4½	184	....	Nanjemoy	....	−6	....	....	Hard	1914		
36	St. Michaels	Municipality	8	200	6	....	....	....	....	....	....	....	......	....		Recently became muddy.
37	St. Michaels, 3 mi. NW.	C. C. Kimball	..	360	4	....	....	....	....	−12	....	....	......	....		
38	St. Michaels, 3 mi. NW.	C. C. Kimball	..	260	2	....	....	....	....	−12	....	....	......	....		
39	Trappe	D. C. Kirby	50	375	4	375	....	Nanjemoy	....	−14	....	25	Hard	1909		
40	Trappe	D. C. Kirby	55	400	6,3	250	....	Nanjemoy	....	−46(?)	....	35	Hard	1916		
41	Trappe, 1 mi. W.	E. A. Powell	20	311	4	80	250	Nanjemoy	....	−15	....	....	Hard	1908		
42	Windy Hill	Windy Hill Packing Co.	6	180	4	40	160	Calvert	....	+4	....	....	Hard	1908		
43	Tunis Mills	Tunis Lumber Co.	10	437	3	....	....	....	....	+1	10	....	Soft	1889		

Shallow Wells.—In Talbot County the shallow wells drawing, as they do, from the thin cover of Pleistocene sands, have the usual range in depth of from 8 to 20 feet, and the most common depths are about 10 to 15 feet. Locally driven wells have been sunk to depths of 40 and 45 feet, as at Skipton, but such wells are comparatively rare, and the majority of the inhabitants of the counties, except in the larger towns, use water from wells less than 20 feet deep. These shallow wells encounter water in beds of sand and gravel belonging to the Talbot and Wicomico formations. This shallow water is quite commonly marshy, coming probably from beds containing a large amount of vegetable matter, and in a few places the water tastes strongly of iron due to the amount of that mineral contained in the pebbles or nodules of the Pleistocene.

In a few places near the shore the water contains considerable salt, enough to render it brackish. This is most noticeable on some of the low islands, but it has also been reported on the mainland near tide water.

Dorchester County

Dorchester County is situated in the southern part of the Eastern Shore, and is almost surrounded by the waters of the Choptank River on the north, Chesapeake Bay on the west, and the Nanticoke River on the south and east. Most of the county is low and flat and imperfectly drained, and hence it includes a greater area of swamp and marsh land than any other county in Maryland. This is especially true of the southwestern portion. In the northeastern part of the county the divide between the Choptank and Nanticoke rivers, as far south as the vicinity of Linkwood and Reids Grove, is a nearly flat plain above 30 feet in elevation and gradually rising toward the northeast, until in the extreme northern part of the county it reaches elevations of 50 feet. In the remainder of the county lying southwest of this area and in the major stream valleys within this area the land is less than 30 feet above tide, and extensive areas are almost at tide level and form undrained marsh lands of great extent.

TABLE OF ELEVATIONS

	Feet		Feet
Airey	16	Milton	5
Brookview	24	Reids Grove	25
Bucktown	4	Rhodesdale	40
Cambridge	20	Salem	19
Church Creek	5	Secretary	22
Cornersville	2	Smithville	6
Crapo	2	Taylor Island	3
Eldorado	13	Thomas	2
Ennalls	36	Thompson	16
Hudson	4	Vienna	12
Hurlock	45	Williamsburg	40
Lakesville	4	Wingate	3
Linkwood	21	Woolford	5
Lloyds	2	Wrights	3
Madison	3		

GEOLOGY

Although Dorchester County is underlain by the successively older Miocene, Eocene, and Cretaceous formations, the amount of erosion is so slight that the streams have not cut through the surficial mantle of loams and sands of the Wicomico and Talbot formations. As mentioned in the preceding section, the northeastern part of the county consists largely of the Wicomico plain and the balance and major portion of the county is made up of the lower-lying Talbot plain.

SURFACE WATERS

The surface streams are for the most part tidal and unsuitable for use. The smaller streams carry no large amounts of water, fluctuate from season to season, are apt to contain a great deal of vegetable matter in suspension, and since all receive the drainage from inhabited areas they are liable to pollution and are unsuitable as sources of domestic or municipal supplies.

UNDERGROUND WATERS

Artesian Waters

There are four horizons in Dorchester County that are furnishing water for artesian wells, one in the lower Calvert, one at the base of the Choptank, one in the Nanjemoy level, and a level which seems to be the upper

Matawan, corresponding to that found in Talbot County at Easton and Oxford at 570 and 540 feet. This Matawan level along with the Nanjemoy supplies by far the greater number of the wells in this county.

CHOPTANK WATER.—This horizon is a purely local supply and furnishes the water for the artesian wells at three neighboring towns, Eldorado, Brookview, and Vienna. These wells have a similar depth and all have a slight flow of soft water. Logs of two wells were secured, one at Eldorado and one at Vienna.

WELL AT ELDORADO

	Feet
"Fullers earth"	50–100
Shells	100–125
Sand	125–150
Pink clay and "fullers earth"	150–180
Sand, water	180–185
Rock	185–190
Gray sand and water	190–200

WELL AT VIENNA

	Feet
"Fullers earth"	60–90
Shells	90–120
Sand	120–150
Soft, gritty rock	150–180
Sand, little water	180–200
Rock	200–210
Sand and water	210–225

These logs are not detailed enough to allow any fine differentiation. The materials are all Miocene, and probably the complete section includes parts of two of the Miocene formations, the St. Mary's and the Choptank. The Eldorado well flows 8 gallons a minute at an altitude of 13 feet above sea level. The Vienna well flows 4 gallons a minute at very nearly the same altitude as the Eldorado well.

This horizon is a good source of water, but it is very doubtful whether it has a wide extent. It is more likely a water-containing sand lens of restricted distribution.

BASAL CALVERT WATER.—The wells drawing their water from the lower portion of the Calvert are in the eastern part of the county and, strangely enough, the records of deep wells in the northwestern part make no mention of any water at the depth where the Calvert might be expected. Wells have been sunk to near the base of the Calvert formation (as in other parts of the Coastal Plain the basal Calvert is usually encountered within 50 fect above the base of the formation) at East Newmarket where the town-supply well is 290 feet deep, at Hurlock 228, and at two localities near Secretary 250 and 280 feet deep. The well at Hurlock struck two streams of water, the upper one, which is cased off, at 192 feet and the lower, the one in use, at 250 feet. A log of this well is given below:

WELL AT HURLOCK

	Feet
Sand and gravel	0–88
White clay	88–134
Blue marl	134–154
Sandy gray clay	154–184
Hard shells	184–189
Soft shell rock	189–192
Sand and shell with water	192–207
Blue clay	207–222
Hard clay	222–223
Soft clay	223–239
Hard shell rock	239–240
Softer shell rock	240–241
Hard shell rock	241–246
Soft shell rock	246–250
Free sand	250–262

Of these wells only one, the 250-foot well northeast of Secretary on the Choptank, flows, and this well flows 3 or 4 gallons a minute 8 feet above sea level. The other three wells have good heads, about 15 feet above sea level, but since the surface at all three localities is beyond the limit of flow they must be pumped.

The distribution of the Calvert water might at first glance seem to be very fortuitous and the failure to find this stream in the western part of the county might be ascribed to faulty methods of drilling or to other human errors if it were not for the consistent agreement of numerous drillers, all of them pastmasters of their trade. However, from the records of several wells in the northwestern part of the county and from the evidence afforded by a well sample from near Gum Swamp, it seems possible that the Calvert water is absent because of subsurface irregularities. This will be discussed more fully further on.

NANJEMOY WATER.—This water bed, which supplies several localities in Talbot County, assumes great importance in the northwestern part of Dorchester and supplies the large amounts of artesian water used at Cambridge and the immediate vicinity. The wells in this neighborhood are drilled to a depth of 320 to 390 feet, the variation being due to differences in elevation and position along the dip. The public supply of Cambridge comes from six wells about 375 feet deep which yield an alkaline, soft water. The following analysis is of the water as furnished to the residents of Cambridge:

	Parts per Million
Turbidity	10.0
Alkalinity	36.2 N/50
Hardness	39.3
Total dissolved solids	509

	Parts per Million
SiO_2	26.9
Fe	0.02
Al	0.13
Ca	8.4
Mg	4.6
Na	154.8
K	——
CO_3	24.3
HCO_3	392.8
SO_4	9.0
Cl	8.0
NO_3	0.0

There are several other wells at Cambridge that have very nearly the same depth and which yield the same alkaline water. The well at the Eastern Shore State Hospital, about 1½ miles east of Cambridge, is 390 feet deep and belongs to this group.

The amount of water yielded by the individual wells has shown progressive decrease since the horizon was first tapped in this vicinity in 1888. The first wells sunk had good flows, but since the addition of so many wells in later years the flows have ceased and the water now stands a few feet below sea level. Not only has the head diminished, but in the canning season when the wells at the canning factories are pumped hard and also the city consumption is greater, the level of the water in the hospital well is appreciably lowered.

The cessation of flows has been relatively sudden, but now that the operation of natural laws has prohibited the waste of the stored water and all the users must pump their wells the total exhaustion of the Nanjemoy stream is an event not likely to take place in the near future.

The following log is an incomplete section of the well at the Hern Canning Company, and is too vague to allow separation of the different beds.

WELL AT CAMBRIDGE

	Feet
Gray clay with shells	25–223
Shell rock	223–224
———	224–265
Gray coarse sand, water	265–312
Green clay	312–355
Hard rock	355–358
Fine green sand	358–368
Rock	368

Besides being used at Cambridge, the Nanjemoy horizon has been tapped at Church Creek in wells 350 and 360 feet deep, at Woolford and 1 mile west of Woolford in wells 340 and 365 feet in depth respectively. At Madison numerous deep wells have been drilled, the majority of them with the Nanjemoy, which lies at a depth of 300 feet, as their objective; but several wells have been drilled on down into the Upper Cretaceous. These deeper wells have all reported the Nanjemoy water at 300 to 320 feet. A log of a 320-foot well at Madison is given below:

WELL AT MADISON

	Feet
Sand	0–20
Sandy clay, soft stone streak	20–80
Sandy clay, hard stone streak	80–90
Clay	110–300
Sand, water	300–320

The base of the Calvert cannot be identified in this log.

At Taylor Island the Nanjemoy water was cased off at 340 feet in a 500-foot well. At Cornersville the Nanjemoy was passed at 280 feet, and at Hudson this same stream was noted at 270 feet. The water from this horizon is usually reported "soft," which probably means that it is somewhat alkaline. The head on this stream has decreased so that even in the low lands of northwestern Dorchester County it is seldom possible to get flows any more, but the water will rise to about 3 or 4 feet above sea level.

MATAWAN WATER.—There are numerous wells on the flat series of necks in the extreme northwestern part of the county that have tapped a good stream of soft water at depths around 500 feet. These wells, which are all situated in a circumscribed area, show surprising similarity in depth, in the character of the water, and in the static head of the water. Wells tapping this stream are those at Taylors Island 500 to 515 feet deep, which have a flow of 6 gallons a minute 5 feet above sea level; at Madison, where the wells are 500 to 510 feet deep and have a very slight flow, about 1 gallon a minute at an altitude of 3 feet; at Wrights and Hudson in wells 480 feet deep where the water is not under pressure enough to cause flows at a 3-foot altitude; at Cornersville, 460 feet, no flow at an altitude of 3 feet; and at Thomas where the well is 485 feet deep and the water level several feet below the surface. Unfortunately good logs of these wells are not available, although an incomplete log of a well on Taylor Island has been secured.

WELL ON TAYLOR ISLAND

	Feet
Yellow clay	0–8
White sand	8–30
Boulders and gravel	30–40
Blue clay	40–130
Dark bluish sands containing pebbles	130–180
Blue clay	180–188
Blue rock	188–188⅓
Blue clay, occasional lamina of black sand	188⅓–250
Hard rock with quartz pebbles	250–251
Blue clay, alternating with black sand	251–300
Thin layer of shells, blue sand and clay	300–495
1 inch of hard rock	350
Black sand, water	495

This well, put down in 1905 for Dr. Shriver, was sunk to a depth of 501 feet and originally flowed 12 gallons a minute at an altitude of about 3 feet, but the yield has steadily decreased until at present the flow is less than 6 gallons.

Another well drawing from this Upper Cretaceous horizon is located 7 miles southwest of Cambridge and was drilled in 1902 for Mr. Wm. Radcliff. The following section of this well is very interesting when compared with the other Upper Cretaceous wells in the vicinity and with the deep well at Easton.

WELL 7 MILES SOUTHWEST OF CAMBRIDGE

	Feet
Marl	0–34
Green clay	34–104
Blue sandstone	104–106
Blue and green clay marl with shells	106–193
Sandstone crust	193–194
Green clay	194–300
Fine gray sand carrying some water	300–310
Green clay with black specks in it	310–574
Brown sand and gravel, water bearing	574–600

Records show that the water level found at Cambridge at around 300-350 feet disappears to the west, and a stream from brown sand is the important level in western Dorchester County. This has also been encountered in Talbot County in the deep well at Easton and at Oxford. Samples from a well on Mr. Gibbs' place, Gum Swamp, Dorchester County, contains *Ostrea tecticosta,* a typical Monmouth fossil, from 388 feet. From all other indications the base of the Calvert should be about 300-350 feet below tide at this point, so this is an interesting situation.

Non-Artesian Waters

SPRINGS.—There are no large springs in Dorchester County. Small springs are not rare where the surface of the country is irregular enough to permit the outcrop of seeping water, as in the northeastern part of the county. Springs are less common than in more elevated and dissected portions of the state and those in Dorchester are all small and are rarely utilized.

Shallow Wells.—The shallow wells of Dorchester County vary in depth from 8 to 50 feet, reaching their maximum in the eastern and higher part of the county where the Wicomico is thickest. The dug and driven wells in the low swamp lands and islands of the Chesapeake are seldom more than 14 feet deep and usually the water is very poor. Typical wells and depths are those at Hudson, 9 to 14 feet; Hills Point, Taylor Island, and Madison, 8 to 12 feet; and Lloyds, Cornersville, and James, 8 and 9 feet deep. The water frequently contains iron, although this mineral is very sporadic in its occurrence, but it is very readily noticed since it occurs in the form of an insoluble hydrate which will stain a cloth or will be deposited on the side of vessels. The organic matter frequently noticed in these wells is most likely derived from the swamp vegetation and thick muck of the lowlands, since the subsoil is very rich in decayed vegetation to a depth of 8 or 10 feet.

These shallow wells have a very intimate connection with the rainfall, a heavy rain greatly increasing the supply and also bringing in large amounts of suspended soil, so that the water after a rain is quite muddy. The water level fluctuates with the seasonal rainfall and in some few cases falls below the well in extreme droughts. Prolonged heavy rains produce an immediate change, appreciably increasing the amount of water.

In the eastern portion of the county where the wells are deeper, commonly 20 to 30 feet, the water is purer and less likely to fail in dry spells. Most of these wells, like the shallower ones westward, draw from the Pleistocene deposits, but the materials are here coarser and allow more circulation so that organic impurities are more easily expelled. The depth to the base of the Pleistocene deposits cannot be accurately determined, but it is thought that the wells that, in the eastern part of the county, have been driven 50 to 60 feet below the surface, indicate the base of the Pleistocene sands.

The wells at Hurlock which supply the water for town use are shallow wells 50 to 55 feet deep. These wells along with one at Ralph 40 feet deep, one at Reids Grove 40 feet, and some of the wells at Eldorado 35 to 40 feet in depth are probably down to the base of the Pleistocene.

The wells which are drawing from the sands and gravels at the base of the Wicomico are usually somewhat shallower, typical wells being those at Ellwood 20 to 30 feet, Eldorado about 20 feet, Hurlock 15 to 25 feet, East Newmarket 15 to 30 feet, Williamsburg 30 feet, and Galestown 25 feet deep. The water is generally of good quality, carries varying amounts of iron and is more dependable than the shallower wells to the westward. That this water, however, is not very far removed from that in the Talbot is shown by the fact that one well, at the canning house in East Newmarket, went dry after several years, and at several other points the water level is noticeably depressed during dry weather.

The water in the shallow wells of the higher eastern part of the county is much more palatable than that from the low swamp lands along the Bay. Iron is sometimes present in objectionable quantities, but the excessive amounts of organic matter and salt which characterize the western wells are seldom noticed here, the salt never.

The taste of vegetable matter that has been reported from several localities, notably at Secretary, is due either to insecure casings, permitting seepage into the wells, or to contamination less direct, from dwellings, barns, or outhouses.

An example of the possibilities of properly constructed shallow wells is furnished by those which supply the town of Hurlock. This system, privately owned, consists of a battery of 13 driven wells, 1½ and 1¼ inches in diameter, which supply to the town an average of 12,000 gallons a day, which is probably very close to the maximum yield of this system. This supply has lasted a good many years and has given good service for shallow wells, but it is doubtful whether a growing town like Hurlock will be able to depend upon this source much longer both because of the limited amount of water available and the danger of pollution in a thick settlement.

Shallow wells, then, may be expected to furnish fair amounts of good water in the higher parts of the county, but to the westward and along the Nanticoke River the water will probably be salt, muddy, and generally objectionable.

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Black Creek	H. L. Phillips	..	377	1¼	70	....	....	+	3	6	Soft	1900	Bradshaw.	
2	Brookview	Z. H. Brinsfield	24	210	2	100	210	Choptank	+4	Large	....	Hard	1904	....	Canning factory.
3	Cambridge	Dorchester Water Co.	6	375	8	....	....	Nanjemoy	....	....	....	......	....	....	Two wells, municipal supply.
4	Cambridge	Dorchester Water Co.	6	375	10	....	....	Nanjemoy	....	....	....	......	....	....	Three wells, municipal supply.
5	Cambridge	Dorchester Water Co.	6	375	12	....	....	Nanjemoy	....	....	....	......	....	....	One well, municipal supply.
6	Cambridge	Cambridge Gas Co.	6	364	4,2	....	....	Nanjemoy	....	....	100	Hard	1888		
7	Cambridge	L. K. Warren	25	405	4½,3	350	405	Nanjemoy	−22	....	100	Soft	1909	....	Flow ceased after nearby wells were pumped.
8	Cambridge	Wallace Canning Co.	5	360	4	....	....	Nanjemoy	−	....	....	Soft	....		
9	Cambridge	....	..	368	8	....	....	Nanjemoy	+4	....	300	Hard	1893		
10	Cambridge	Cambridge Mfg. Co.	6	300	2	150	....	Nanjemoy	+5	....	75	Hard	....	....	Originally flowing. Supply decreasing.
11	Cambridge	Cambridge Ice Co.	..	375	6	375	375	Nanjemoy	−20	....	....	Soft	....	Shannahan.	
12	Cambridge, 1½ mi. E.	State Hospital	..	390	8	....	....	Nanjemoy	−15	....	190	Soft	1914		
13	Cambridge, 1½ mi. E.	Philips Packing Co.	25	375	6	....	....	Nanjemoy	−14	....	Ample	......	1903		
14	Cambridge, 2 mi. W.	Mrs. W. M. Dicks	10	360	6	335	335-360	Nanjemoy	+3	6-20	60	Soft	1904		
15	Cambridge, 6½ mi. NW.	James Palmer	2	590	4½	300	590	Nanjemoy	+12	12	....	Soft	1902	J. B. Richardson.	
16	Church Creek	M. E. Church	..	360	1½	360	360	Nanjemoy	−3	....	....	Soft	1916		
17	Church Creek, ¼ mi. SE.	Mrs. J. M. Willis	5	395	1½	360	395	Nanjemoy	+1	2	....	Soft	1903		
18	Cornersville, 1 mi. SE.	Arthur Travis	2	545	1½	250	328	Matawan	....	....	....	Soft	1909		
19	East Newmarket	Municipality	..	290	6	....	200	Choptank	+2	8	....	Soft	1905	....	Public supply.
20	Eldorado	Z. M. Birnsfield	13	202	2	180	....	Calvert	....	....	....	Soft	....		
21	Hudson, ¾ mi. E.	H. Speddon	14	503	1½	320	485-503	Matawan	+1½	1½	....	Soft	1905		
22	Hurlock	W. C. Bradley	45	45-55	1¼,1½	....	18-20	Wicomico	−1½	....	....	Soft	1907	....	Thirteen wells, public supply.
23	Hurlock, 5 mi. SW.	T. A. Colbourne	8	250	3	72	....	Calvert	+	....	....	Soft	....	J. B. Harrison.	
24	Lloyds, ½ mi. N.	Frank Thompson	2	460	2	60	460	....	Surface	....	....	Soft	....	....	Public supply.
25	Madison	Municipality	3	575	1½	300	515	Matawan	+1	Slight	....	Soft	....		
26	Madison, ¾ mi. SW.	E. Branock	3	500	1½	....	500	Matawan	+1½	1½	....	Soft	....		
27	Madison	Harrington Bros.	3	300	1½	....	300	Nanjemoy	−4	....	....	Soft	....		
28	Madison	Harrington Bros.	3	510	1½	....	510	Matawan	+2	2	....	Soft	....	....	Two wells.
29	Madison	Dr. B. Smith	3	500	1½	....	500	Matawan	+½	Slight	....	Soft	....		
30	Madison, ¾ mi. NE.	L. Travers	3	375	1½	....	375	Matawan	+6	Slight	....	Hard	1907		
31	Madison, ¼ mi. SE.	H. P. Tull	3	510	1½	....	510	Matawan	+2	3	....	Soft	....	....	Stopped flowing in 1909.
32	Robbins	Wm. H. Robbins	..	777	3½,1½	580	....	Matawan	+12	....	....	......	1913	A. G. Robbins.	
33	Secretary, ½ mi. SW.	Wm. B. Hurst	22	300	4	75	280	Calvert	−8	....	....	Hard	1904		
34	Taylors Island	B. E. Harrington	4	515	1½	180	575	Matawan	+3	3	....	Soft	1901		
35	Taylors Island	B. E. Harrington	4	500	2,1½	500	500	Matawan	+	6	....	Soft	1910	....	Two wells, canning.
36	Taylors Island	O. A. Keene	4	492	1½	180	492	Matawan	+3	4½	....	Soft	1908		
37	Taylors Island	Dr. J. K. Shriver	4	501	1½	188	501	Matawan	+8	2½	....	Soft	1905		
38	Thomas	W. F. Linn	2	505	1½	320	485-505	Matawan	....	....	....	......	1909		
39	Thomas	Noah Webster	2	40	3½	35	35-40	Talbot	−18	....	20	......	1908	....	Boilers and canning.
40	Thomas	Noah Webster	2	124	2½	93	94-124	Choptank	−18	....	....	......	1907	....	Boilers and canning.
41	Thomas	Noah Webster	2	424	1½	387	387	Matawan	−18	....	2	......	1908	....	Boilera and canning.
42	Vienna	Dr. E. P. Gullett	12	88	1¼	88	88	Choptank	−3	....	....	Hard	1897		
43	Vienna	John Webb	12	235	2	200	230	Choptank	+2	6	....	Soft	1904		
44	Vienna	Arnickby	12	208	1½	208	208	Choptank	+	3	....	Soft	1916		
45	Woolford	W. H. Wild	5	340	1½	....	340	Nanjemoy	+6	Slight	....	Soft	1899	Wheatley.	
46	Woolford, 2 mi. W.	W. J. Youngman	3	365	1½	....	365	....	+	½	....	Soft	1894		
47	Wrighta, ½ mi. W.	J. D. Thomas	3	500	½	334	480	Matawan	−1½	....	....	Soft	1909		
48	Wrights, ¼ mi. S.	T. J. Wheatley	3	503	1½	483-503	483-503	....	+1	½	....	Soft	1897		

WICOMICO COUNTY

Wicomico County, lying between Dorchester County, Maryland, and Sussex County, Delaware, on the north and Somerset and Worcester counties, Maryland, on the south, is a region of low relief. Its surface is essentially a plain but little dissected by streams and with broad, flat stream valleys. The streams are slow and considerable areas are covered with swamps. In the western part of the county there are extensive salt marshes along the Nanticoke and Wicomico rivers. The elevations range from only a few feet above sea level in the western part of the county to a maximum of 84 feet in the vicinity of Parsonsburg in the eastern central part of the county.

TABLE OF ELEVATIONS

	Feet		Feet
Allen	11	Nanticoke	30
Bivalve	15	Parsonsburg	80
California	20	Pittsville	55
Camden	25	Powellville	32
Canton	20	Quantico	20
Delmar	50	Royal Oak	11
Frankford	30	Salisbury	15
Fruitland	42	Sharptown	15
Hebron	40	Tyaskin	23
Jersey	10	Walston	52
Jesterville	5	Wetipquin	14
Mardela Springs	30	Whitehaven	5
Minksville	45	Willards	39

GEOLOGY

The geology of Wicomico County is monotonously simple, since at no point has an outcrop of any materials older than the Pleistocene been observed. The Pleistocene, however, is well developed and covers the entire county with a mantle of sands and sandy loams. Gravels are not so extensively developed as in the counties farther northward. The oldest terrace in the county is the Wicomico (named from its development on the Wicomico River in Charles and St. Mary's counties). It is delimited below by an escarpment at an elevation of 40 feet. Lying at a lower level than the Wicomico is the Talbot terrace which extends from the 40-foot contour line down to sea level and is broken at several levels, notably at 30 feet, by minor intra-formational scarps.

The Pleistocene deposits are underlain by the Miocene deposits, a deep well at Parsonsburg showing that the several Miocene formations extend to a depth of about 1100 feet.

SURFACE WATERS

The only large streams in the county are the Nanticoke, which forms its northwestern boundary and expands in its lower course into a broad tidal estuary; the Wicomico, which rises within the county and is navigable for steamboats as far as Salisbury in the central part of the county; and the Pocomoke, which rises in Delaware and forms the eastern boundary separating Wicomico from Worcester County. There are many creeks, such as Barren, Rewastico, and Quantico, which flow into the Nanticoke; Rockawalking, Beaverdam, Tonytank, and Passerdyke, which flow into the Wicomico; and Nassawongo, which eventually reaches the Pocomoke; but none of these are of any size or commercial importance.

The Nanticoke and Wicomico rivers are tidal and the water is consequently salt or brackish. The smaller streams are sometimes dammed for grist mills, but the waters receiving the surface drainage of inhabited areas is unsanitary and should not be used for domestic purposes.

UNDERGROUND WATERS

Artesian Waters

Under this heading will be included all of the wells in Wicomico County, since even wells in the Talbot terrace are known to flow, and many wells on the Wicomico plain have large heads, frequently sufficient to cause overflows. Several wells have been sunk beyond the lowest Pleistocene horizon but none of these wells, among which the deepest was one 402 feet at Delmar, has been able to secure good water.

The Pleistocene waters come from several different levels, but there is little variation in quality although the amount of water in the deeper wells is usually greater and more dependable.

TALBOT FORMATION.—At Clara some wells 15 feet deep were unsatisfactory because of the large amount of salt in the water. This condition may be encountered on the lower end of the peninsula between the Wicomico and Nanticoke rivers, so that it will not be prudent to use this shallowest level. At Tyaskin and Bivalve, however, the wells 10 to 15 feet deep are reported satisfactory. At Quantico the usual depth for wells is 10 to 25 feet where a suitable supply is found, and at Sharptown the Talbot wells are from 25 to 35 fect deep, the depth below tide being about 20 feet. Some of the wells at Sharptown rise to within 15 feet of the surface. The other wells from the Talbot have varying heads, all very small and some of them hardly noticeable. The quality of this water is very good so long as pollution from buildings is avoided. Iron is present only in small quantities, and with the exception of the tip of the peninsula salt will probably not be met with.

WICOMICO FORMATION.—The main water levels in the Wicomico are relatively constant, and have yielded many good flows. Typical wells are at Rockawalking, 50 feet deep with a head of 3 to 5 feet below the surface; near Melson, 60 feet deep with a head of 12 feet below the surface; at Pittsville, where wells range in depth from 15 to 60 fect, but here the water is scarce; at Willards, where the depth is 50 to 60 feet; and at Sharptown, 50 to 70 feet deep, where the head varies from below tide several feet to 8 feet above. At this last locality there is a flowing well down within 10 feet of the bank of the Nanticoke and only 4 feet above mean tide. The flow of this well, called a "spring" by the residents, is perhaps 4 gallons per minute of water containing both iron and sulphur. At Hebron the wells are 40 to 45 feet in depth, do not flow, but have a head 20 feet below the surface; at Delmar this upper level of the Wicomico is struck at 40 to 65 feet, and although the head raises the water to within 5 feet of the surface the taste is so objectionable that usually the wells are sunk deeper. At Salisbury this level is found from 45 to 65 feet, but since there are many wells drawing from the bed none of them flow.

The quality of the water, while not unsanitary or unpotable, is frequently unpalatable because of the occurrence of iron. This mineral is very widespread and very abundant at this horizon and is frequently accompanied by marsh gas and at Sharptown by sulphur. In some wells the amount of iron is so great that it will, on oxidation, clog up the pipes. A maxim among the well drillers in this region is, "The deeper you go, the more iron you get." This is true as between the first or Talbot level and this upper Wicomico horizon, which among the Pleistocene waters has the maximum content of iron, but the next horizon which lies at a rather uniform depth over the whole county does not show the increase in iron content that the driller's aphorism would imply.

The water at the base of the Wicomico terrace is the most widely used in Wicomico County. The wells to this horizon supply the most water in the county and the best. The depth, which varies somewhat, 80 to 100 to 120 feet, gives nearly the maximum thickness for the Pleistocene deposits in Maryland, although they are a few feet thicker along the Atlantic coast in Worcester County. In Darton's report these wells were classed as "high in Cheasapeake," but the uniformity of depth over the entire county and apparent absence of dip requires that they be referred to the Pleistocene.

The water from the base of the Pleistocene is used from wells at Whitehaven, 70 to 100 feet deep which flow several gallons a minute at an elevation of 5 feet above tide; at Mardela Springs, wells 70 to 97 feet have a head 20 feet above sea level at an elevation of 27 feet above tide; and at Delmar, where the depth ranges from 80 to 120 feet and the head is sufficient to raise the water to within 8 feet of the surface. At Salisbury there are many wells that originally flowed, some of them 25 gallons or more a minute, but there have been so many wells sunk to this horizon that the consumption has overreached the supply. The following analysis of the Salisbury Public Supply water shows a hard water which will probably incrust boilers:

	Parts per Million
Turbidity	0.0
Alkalinity	1.2 N/50
Hardness	47.1
Susp. matter	0.0
Total dissolved solids	184

	Parts per Million
SiO_2	21.1
Fe	.2
Al	.3
Ca	11.6
Mg	4.4
Na	23.7
K	—
CO_3	0.0
HCO_3	14.6
SO_4	5.0
Cl	34.2
NO_3	40.1

Several wells have been drilled at various localities in an attempt to find a larger and better supply, but the results have not been satisfactory. A well at Salisbury was reported to be 147 feet deep but the length of the casing is not accurately known and so it does not seem probable that this well, which originally flowed but is not used now, drew its water from any other than the Pleistocene horizon.

A well was drilled at Salisbury in 1893 to a depth of 424 feet and the following log was furnished by the contractor:

WELL AT SALISBURY

	Feet
Pleistocene.	
Surface sand	0–6
Dark clay	6–25
White sand	25–35
Fine sand	35–43
Coarse sand, pebbles, water	43–65
Iron crusts	65–67
White clay	67–68
Iron-colored sand, water	68–93
Clayey sand with lignite	93–102
Fine green sand, water	102–116
Miocene.	
Blue sticky clay, mixed with sand	116–135
Fine gray sand, coarser below	135–185
Coarse gravel and fine sand, water	185–257
Clay and fine sand, shells	257–263
Blue clay, shell bed at 274 feet	263–350
Gravel and sand	350
Clay mixed with fine blue sand	350–355
Blue marl, cobblestone at 376 feet	355–376
Marl, grading into gritty sand, small mollusks	376–388
Gray sand	388–424

The log shows three water beds in the Pleistocene, the lowermost of which lies on the top of a clay bed and is the horizon which furnishes by far the greater part of the water used in Salisbury. This well used the water from the bed at 257 feet for a while, but its use was later abandoned and now the basal Pleistocene horizon furnishes the water for the ice factory.

A well at Delmar was drilled to 402 feet and the hole was reported dry from 80 feet to the bottom. The section follows:

WELL AT DELMAR

	Feet
Fine sand	40
Sand, water at 80 feet	48–130
White sand and soft sand (rock ?)	130–157
Black sandy clay	157–168
Sand gravels and pebbles, sand at top and bottom reddish	168–207
Light-colored sand, bluish, very hard	207–220
Fine sand	220–264
Light gray clay, fine white shells at 300 to 304 feet	264–306
Hard sand	306–341
Marl or clay with fine shells	341–374
Sand	374–386
Clay	386–402

The fact that this well was dry after the Pleistocene water was passed emphasizes the restricted development of the shallower Miocene water beds, since at Salisbury, only 6 miles distant, a water horizon was encountered at 257 feet, and a well at Parsonsburg, the discussion of which follows, reports three water horizons between the base of the Pleistocene and 240 feet.

The Parsonsburg well is a prospect for oil and gas, owned and promoted by the St. Martin's Oil and Gas Company. At present the total depth is 1186 feet. Through the courtesy of the driller, Mr. R. J. Christie, the Survey has received samples of the drillings as the boring progressed, and the following log is compiled from these samples:

WELL AT PARSONSBURG

	Feet
Gray fine argillaceous sand, a few flakes of mica	315
Tough gray clay, shell fragments	360–365
Blue-gray clay, *Turritella plebeia, T. variabilis* var. *cumberlandiana, Alectrion peralta*	365–380
Tough clay, light in color, fine textured	380–390
Purplish and greenish-blue clay, *Turritella plebeia, T. variabilis*, and var. *cumberlandiana*	390
Gray sand with a weak clay binder	450–455
Same as above, *Balanus concavus, Pecten* probably *madisonius, Scutella aberti*	455–475
Small rounded quartz sands, black grains. Responds to phosphate test. *Nonionina scapha*	475
Fine quartz sand like above, no black mineral; coherent pieces of sandstone, *Balanus concavus. Pecten* sp.	480
Fine quartz sand same as above, carries a few grains of black mineral as in 475–480. Shell fragments	510–550
Fine quartz sand, good clay binder, making a gray mixture. Irregular echinoid spines, very small, very abundant	550–560
Fine quartz sand in a diatomaceous earth binder, very light gray	560–565
Gray argillaceous sand, fragments of *Pecten*	600–610
Pecten bed, fragments of *Pecten* in fine gray sand	610–618
Light gray fine sandy clay	618–670
Light gray clay	670–675
Light gray clay, somewhat more earthy	700
Sand, large and small grains in gray clay binder	750
Clear quartz sand, very light gray	755
Coarser quartz sand, gray	760
Impure gray diatomaceous earth	800
Sandstone, gray	824–832
Gray clay, finely arenaceous	840
Fine gray quartz sand, shell fragments. Large piece of calcite. *Cristellaria cultrata*	960
Fine gray sand like preceding, shell fragments larger and more numerous	982–995
Sand, iron-stained, contains pyrrhotite and shell fragments, *Nodosaria consobrina* var. *emaciata*	995–1002
Fine gray sand, foraminifera abundant, composed almost entirely of *Sagrina* sp. Cushman (typically Miocene)	1002–1007
Gray diatomaceous earth	1007–1090
Fine quartz sand, green with fine black specks	1090–1095
Fine gray sand	1095–1100
Soft drab earth	1100–1107
Very fine gray sand	1111–1130

Of the fossils identified from this well none, except *Cristellaria cultrata* which occurs at various localities from the Liassic to the Recent, *Nodosaria consobrina* var. *emaciata* which ranges from the Cretaceous to the Recent, and *Balanus concavus* which is abundant throughout the Neogene of the world, have ever been reported from other than Miocene strata.

Turritella plebeia is of no value in separating the Miocene into its several formations; this is true also of *T. variabilis* var. *cumberlandiana.* The typical form, however, of *Turritella variabilis* is restricted to the St. Mary's formation and this fossil together with *Alectrion peralta,* also characteristic of and restricted to the St. Mary's, occur in the first 390 feet of the Parsonsburg well, and this depth is thought to mark the St. Mary's formation. *Balanus concavus,* as stated above, ranges through the entire Neogene and is found in all three formations of the Miocene in Maryland. *Pecten ? madisonius* is represented by a fragment which cannot be identified with assurance; moreover, the species is not characteristic of any one horizon. *Scutella aberti* occurs only in the Choptank, and *Nonionina scapha* has been identified both from the Calvert and Choptank. The lower limit of the Choptank cannot be drawn on the evidence of organic remains, but in this section it is placed at 618 feet where it is marked by the thick bed of *Pectens* in a sand matrix.

The base of the Calvert is even more difficult to differentiate, although it seems probable that the well has not yet passed through the entire thickness of Miocene strata. *Cristellaria cultrata,* which occurs at 960 feet, has been reported from the Crisfield well at a depth 776 feet. Not much reliance can be placed in this form since it occurs also in the Cretaceous of New Jersey. Fortunately more abundant and more typical foraminifera were obtained from a bed deeper in the well. The sample of gray sand occurring from 1002 to 1007 feet is crowded with tests of a genus concerning which Dr. Joseph A. Cushman makes the following statement: "The genus *Sagrina* which is by far the most common in both the samples is a comparatively late genus, and at the time of the Challenger Expedition was the only known fossil in the Pliocene and Miocene. However, it does occur in the Oligocene but, so far as I am aware, it is not at all characteristic of the Eocene. That alone would point toward Miocene." In the Maryland Geological Survey reports on the Tertiary deposits, R. M. Bagg described one species of this genus, *S. spinosa,* from the Miocene but the genus was not found in the Eocene. Dr. Cushman further says: "So on the whole I should say Miocene. The general character of the other genera and species also seems to suggest Miocene. I have run over a number of Eocene lots from the southern Coastal Plain and without exception the assemblage is very different." He cautions, however, that "this should not be considered final."

The thick bed of impure diatomaceous earth which underlies the bed carrying *Sagrina* may mark the base of the Miocene, but the materials beneath are not essentially distinct from Miocene strata in character, so that deeper drilling and the study of more samples will be necessary before this line can be drawn.

Mr. Christie has sent a memorandum of the water beds which he has encountered, and of nine horizons only the shallowest and the deepest are reported by him to be good. The appended table gives the depths to the various water levels and notes on the character of the water.

	Feet	
First water sand, white sand	35–40	water free from iron and has been used in boiler for more than nine months. Does not scale.
Second water sand	60–90	brackish, bad odor.
Third water sand	140–150	small amount.
Fourth water sand	170–180	small amount.
Fifth water sand	230–240	bad odor.
Sixth water sand	280–510	bad odor, brackish.
Seventh water sand	560–565	brackish.
Eighth water sand	755–760	highly mineralized.
Ninth water sand	940–945	"a little sweet, as if it has some sugar in it."

The last two beds underlie all of Wicomico County at depths of from 700 to 1300 feet, but the ease with which large amounts of water can be obtained at very shallow depths will prevent this horizon from being widely utilized, and besides the degree of mineralization may render it useless for some purposes. Unfortunately the casing was sunk beyond this bed before a sample could be gotten for analysis, but the water came from the same bed as does that in the Isle of Wight well, and an analysis of this latter water may be found on a subsequent page.

Non-Artesian Waters

SPRINGS.—There are no large springs in Wicomico County, but small springs yielding a few gallons of water per minute are not uncommon, particularly at the base of the usually steep slope separating the higher or Wicomico terrace from the lower or Talbot terrace. At Mardela Springs in the northern part of the county a chalybeate spring has long had a local reputation for its medicinal water. The water issues from the base of the Wicomico formation and is heavily charged with iron. The yield is relatively small, nevertheless the Mardela Spring Water Company sold 50,000 gallons for medicinal purposes and utilized 100,000 gallons in the manufacture of soft drinks during 1916.

SHALLOW WELLS.—The shallow wells in Wicomico range in depth from a few feet to about 50 feet. Where they are deeper they are usually drilled instead of dug. Much of the eastern half of the county is covered by the sands and loams of the Wicomico formation. These are usually water bearing toward the base of this formation and hence water is struck from within a few feet to 30 feet of the surface, according to the height of the present surface. Similarly in the somewhat lower western part of the county wells dug in the Talbot formation usually strike water within 25 to 30 feet of the surface. These wells usually supply sufficient water for household or farm use, although locally the supply may be deficient or the quality poor and there is always danger of contamination from the seepage of outhouses, stables, etc., where care is not exercised in their location.

OIL AND GAS PROSPECTS IN WICOMICO COUNTY

In the last 20 years or so a belief has arisen among some of the residents of Wicomico County that large pools of oil or gas, or both, underlie their county and would be reached and opened up by drilling. This belief is founded chiefly on the experience with shallow wells. "Surface indications," which have been invoked to prove the presence of oil and gas, are decidedly inconclusive evidence and would, if relied upon, lead to some very expensive and probably disappointing ventures.

The oil and gas agitation centers around Parsonsburg and Pittsville. Twenty-five years or more ago, the date is not definitely known, a well was sunk by Mr. White about 3 miles north of Parsonsburg to a depth of between 30 and 40 feet. At the time of sinking no notice was paid to the slight gurgling which was heard in the well, but about five years later when Mr. J. W. Wimbrow put down a 36-foot well at his place in Parsonsburg and struck a relatively large volume of gas, Mr. White remembered the gurgling he had heard in his well earlier. Mr. T. W. Parsons then recollected that he had heard the same gurgling when he first sunk a well at his mill about 1 mile south of Parsonsburg. These are the first records of gas in Wicomico County.

Mr. Wimbrow's well was the first well from which the gas was used. When the well reached a depth of 36 feet there was a strong rush of gas which, when lighted, flamed to a height of 12 feet. The gas from this well was piped into the house and used for two years when the flow ceased.

Since then numerous wells in this neighborhood have encountered gas which, in some wells, was under pressure enough to force out a jet that could be ignited, but in most cases the pressure was only enough to indicate the presence of the gas by the gurgling sound or the infrequent bubbles that arose to the surface. A significant feature in the Parsonsburg region is that when Mr. Wimbrow's well was sunk 25 years ago no water was found below the surface water at 12 feet. Water accompanied the gas in all of the wells sunk. The supply of water from the gas sand at 35 feet is such that Mr. R. J. Christie, who is drilling a well at Parsonsburg for the St. Martin's Oil and Gas Co., says that he uses it in his boilers with no trouble and "counts it a satisfactory water for all purposes." The gas pressure in all wells that could be observed is very low, and the flow discontinuous so that the gas, when ignited, would burn for a few minutes with a colorless flame and then die out.

An analysis of this gas has been made by the Bureau of Mines and is given here:

O_2	.19
N_2	77.96
CO	1.99
CH_4	19.86

Heating value at 0° C. and 76 cm. of mercury (atmospheric pressure), 211 B. t. u. Specific gravity (air, 1), .9.

The constituent that burns is the CH_4, or "marsh gas," which can be noticed around thick marshes or along shores near recently buried vegetable or animal matter. The large amount of nitrogen present clearly shows the organic origin of the gas. Oxygen and carbon dioxide are not usual components of pure natural gas, but are present here, probably, through contamination with air. The preponderance of nitrogen and the fact that the only hydrocarbon present is methane, a gas commonly arising from decaying vegetation, suggests that this gas comes from a buried swamp, local in distribution, since it has not been found outside of the region within a radius of 5 miles of Parsonsburg.

A comparison of this gas with the natural gas that comes from the Appalachian field and supplies Pittsburgh shows that the Parsonsburg gas is very poor in heat units, possessing a heat value at 0° C. and 76 cm. of mercury of only 211 B. t. u. as opposed to 1180 B. t. u. for Pittsburgh natural gas at the same conditions of temperature and pressure. The Pittsburgh gas contains in addition to 83 per cent of methane (the hydrocarbon of natural gas possessing the least heat value) 16 per cent of ethane, the next higher hydrocarbon in the heat value scale. It can be seen from these figures that good natural gas contains at least 99 per cent of hydrocarbons (the extra 1 per cent of Pittsburgh gas is nitrogen), while the gas from Wicomico County contains less than 20 per cent, and only the number of the series possessing the least heat value.

A feature which does not seem to have impressed promoters of the Wicomico County project is that the gas so far encountered was restricted to shallow depths, and that at no lower point down to the present bottom of the well, has there been more favorable indication of

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Delmar	J. W. Feeny	50	95	1¼	95	95	Basal Pleist.	....	....	....	....	Soft	....		
2	Delmar	Waller	55	64	1¼	64	64	Wicomico	....	—6	....	....	Soft	1885		
3	Hebron	J. O. Wilson	40	45	1¼	40	40-45	Wicomico	....	....	....	....	Soft	1908		
4	Mardela Springs	M. E. Parsons	27	70	1¼	70	70	Wicomico	....	—6	....	....	Hard, Iron	1909		
5	Mardela Springs	Mrs. L. Lloyd	27	70	1¼	70	70	Wicomico	....	—8	....	....	Hard, Iron	1909		
6	Mardela Springs	Nelson & Co.	27	60	1¼	60	60	Wicomico	....	—6	....	Large	Hard, Iron	1909		
7	Mardela Springs	Langedale & Co.	27	97	1¼	97	97	Basal Pleist.	....	—5	....	Large	Hard, Iron	1908		
8	Parsonsburg	J. W. Wimbrow	80	36	1½	36	....	....	....	....	....	....	....	1890	....	No water, some gas.
9	Parsonsburg	J. W. Wimbrow	80	195	1½	195	195	St. Mary's	....	—36	....	....	....	....	....	Water did not rise near enough to surface to use suction pump.
10	Parsonsburg	St. Martins Oil & Gas Co.	80	1130	..	1130	940-945	Calvert	230, 480. 550, 755.	....	....	....	Highly min. Alkaline	1917	R. J. Christie.	Prospect for oil and gas.
11	Salisbury, 1 mi. S.	Rector	25	79	1½	79	79	Wicomico	....	+12	16	....	Hard, Iron	1907		
12	Salisbury	Frank Todd	25	147	1½	(?)	(?)	Basal Pleist.	....	....	....	....	....	....	....	Flowed for a short time after well was finished.
13	Salisbury	Municipality	10	70	1½	72	72	Wicomico	....	+10	Large	....	Hard	1900	....	Not used.
14	Salisbury	Salisbury Ice Co.	15	50	2	50	50	Wicomico	....	Few	....	Large	Hard	1906	....	Ten wells of this depth.
15	Salisbury	B. C. & A. R. R.	20	70-75	1¼	70-75	70-75	Wicomico	....	....	....	100	Hard	1895	....	Four wells in this group.
16	Salisbury	T. H. Mitchell & Co.	20	112	1¼		112	Basal Pleist.	....	+4	6	....	Hard, Iron	1894		
17	Salisbury	Salisbury Water Co.	10	50-80	6	50-80	50-80	Wicomico	....	....	....	250 (Total)	Hard	1908	....	Public supply, ten wells.
18	Salisbury	Salisbury Water Co.	10	266	6	100	70	Wicomico	....	+4	5	....	Iron	1895	....	Not used.
19	Salisbury, 3 mi. W.	L. W. Gunby	15	70	1½	70	70	Wicomico	....	+1	4	....	Hard, Iron	1903		
20	Salisbury, 3 mi. W.	Harvey Ellszey	15	118	1½	118	118	Basal Pleist.	....	+7	12	....	Sulphur, Iron	1905	....	Water has a marshy odor.
21	Salisbury, 3 mi. W.	Glen Purdue	15	118	1½	118	118	Basal Pleist.	....	+8	14	....	Hard, Iron	1907		
22	Salisbury, 3 mi. W.	Cement Factory	15	112	1½	112	112	Basal Pleist.	....	+5	....	....	Hard, Iron	1906	....	Used for mixing cement.
23	Sharptown	N. W. Owens	15	68	1¼	68	68	Wicomico	....	—20	....	....	Soft	1909		
24	Sharptown	Mrs. Jas. Twilley Est.	10	56	1¼	56	56	Wicomico	....	....	....	....	Hard, Iron	1889		
25	Sharptown	Mrs. Jas. Twilley Est.	5	49	1¼	49	49	Wicomico	....	+4	5	....	Hard, Iron	1900		
26	Whitehaven, ½ mi. N.	Capt. Wm. Dolby	3	71	1¼	71	71	Wicomico	....	+5	10	....	Hard, Iron	1890	....	Used in canning factory.
27	Whitehaven, ½ mi. N.	R. W. Staton	3	84	1¼	84	84	Wicomico	....	+5	5	....	Hard, Iron	....		
28	Whitehaven, ½ mi. N.	R. W. Staton	3	90	1¼	90	90	Basal Pleist.	....	+5	4	....	Hard, Iron	....		
29	Whitehaven	W. K. Leatherbury	3	95	1¼	95	95	Basal Pleist.	....	+5	4	....	Hard, Iron	1907	....	Used in canning factory.
30	Whitehaven	W. K. Leatherbury	3	91	1¼	91	91	Basal Pleist.	....	+5	2	....	Hard, Iron	1907		
31	Whitehaven	Geo. H. Lorimer	3	74	1½	74	74	Wicomico	....	+2	3	....	Hard, Iron	1903	....	Corrosive water.
32	Whitehaven	S. W. Dolby	3	90	1½	90	90	Basal Pleist.	....	+2	4	....	Hard, Iron	1892	....	Corrosive water.
33	Whitehaven	Chas. Shields	3	68	1½	68	68	Wicomico	....	+3	6	....	Hard, Iron	1906	....	Corrosive water.
34	Whitehaven, 2 mi. N.	Oscar Robertson	5	102	1½	102	102	Basal Pleist.	....	Level	....	....	Hard, Iron	1908	....	Corrosive water.
35	Whitehaven, 2 mi. N.	Oscsr Robertson	3	75	1½	75	75	Wicomico	....	+1	2	....	Hard, Iron	1900	....	Corrosive water.

petroleum or gas. The low pressure, quick exhaustion, and restricted distribution indicate a pool of marsh gas and not a deep-seated, large pool of gas or oil.

Some wells in this area show a scum and this fact has been used as an argument in favor of the presence of a pool of oil or natural gas. One sample examined qualitatively by the U. S. Bureau of Mines was found to consist chiefly of organic matter, another was examined by the U. S. Geological Survey and described as consisting of iron oxide. The character of the scums are probably variable. Films of iron oxide are very commonly mistaken for indications of oil, and films of organic matter are frequently found unconnected with oil pools.

WORCESTER COUNTY

Worcester, the most southeasterly county of Maryland, extends along the ocean front from Sussex County, Delaware, to Accomac County, Virginia. The surface of the country is flat and most of it lies within 40 feet of sea level. Swamps are present along the principal streams and the border facing the Atlantic comprises sandy barrier islands behind which are broad, shallow inlets bordered by marshes. Small areas surrounding Berlin and near St. Martin, as well as a larger area extending for about 4 miles west of Bishop, and considerable areas comprising most of Colbourne's Election District (No. 6) and the northern half of Atkinson's Election District (No. 7), range in elevation from 40 to 50 feet.

TABLE OF ELEVATIONS

	Feet		Feet
Berlin	45	Pocomoke City	8
Bishop	41	Saint Martin	37
Bishopville	23	Snow Hill	21
Boxiron	16	Stockton	33
Germantown	29	Taylorville	10
Ironshire	37	Unionville	10
Klej Grange	29	Welbourne	15
Millville	37	Whaleysville	32
Ocean City	5		

GEOLOGY

Almost the entire surface of the county consists of the loams and sands of the Talbot formation, the youngest of the Pleistocene formations, or of more recent alluvial and wind-blown sediments. The higher areas mentioned consist of the similar materials of the Wicomico formation, also of Pleistocene age and slightly older than the Talbot formation. Lying beneath these thin Pleistocene materials and underlying the whole county is a thick series of predominantly sandy beds which are tentatively referred to the Cohansey formation, and beneath this are the similar materials of the St. Mary's formation. At still greater depths are the other Tertiary and Cretaceous formations, but none of these are exposed within the limits of the county.

SURFACE WATERS

Aside from the Pocomoke River, which crosses the western half of the county and elsewhere forms its western boundary, the surface streams are few in number and small in size. Pocomoke River is sluggish, full of suspended vegetable and mineral matter and partially tidal, and furnishes neither water power nor potable waters. Most of the smaller streams of the country which flow directly into the inlets bordering the Atlantic are tidal estuaries and likewise unsuitable for domestic use.

UNDERGROUND WATERS

Artesian Waters

Experience has demonstrated the possibility of obtaining abundant artesian supplies in Worcester County. The important deep wells are located at Isle of Wight, Ocean City, Pocomoke City, and Snow Hill. It is not always possible to determine the exact horizon supplying the artesian water, since the county is underlain by a great thickness of Tertiary sands. However, at Ocean City there is no doubt that the flow encountered in the city wells and the well of the Atlantic Hotel Company is from the horizon in the upper part of the Cohansey formation. These wells all draw from the same water-bearing bed and have heads sufficient to raise the water to 6 feet above sea level. The well of the Atlantic Hotel Company is situated 50 yards northwest of the city wells and its flow is diminished when the city wells are being pumped. The water from this horizon is strongly charged with iron and contains other inorganic matter in solution, but it is used by many of the inhabitants of the city and gives satisfaction. The mode of occurrence of this water insures its freedom from injurious organic impurities, any such impurities entering at the outcrop of the water-bearing beds near the Maryland-Delaware line would be eliminated before the water reached the wells at Ocean City, and impure surface waters at Ocean City are effectually excluded by the clays and marls which overlie the water-bearing bed.

It is probable that the water horizon encountered at Ocean City underlies nearly, if not quite, all of the eastern portion of the county. The depth to this water-bearing bed diminishes toward the north and west and increases toward the south and east of a line drawn about southwest from Ocean City. However, flows should not be expected except where the surface is low, for, as previously stated, the head of the water at Ocean City is only about 6 feet above sea level. Unfortunately it is not known whether good water was encountered above the 250-foot horizon at Ocean City, though probably such was the case, and for this reason it might be possible to obtain good supplies from shallower wells. At Pocomoke City several deep wells have been drilled and fortunately a good record was kept of the material penetrated to a depth of nearly 500 feet. This record, together with the water horizons encountered, has been published by the New Jersey Geological Survey[1] and the following logs have been adapted from these records:

WELLS AT POCOMOKE CITY

I

	Feet
Sand and loam	0–12
Coarse yellow gravel, large as shellbarks, with plenty of water (surface water)	12–15
Fine blue clay	15–43
Clay with shells	43–53
Clay with great numbers of shells	53–68
Fine gravel and sand, not much water	68–94
Gravel and clay	94–95
Fine quicksand	95–105
Abundance of water at 97 feet.	

[1] Woolman, Lewis. Artesian Wells, Ann. Rept. of the State Geologist, New Jersey, 1899, pp. 116, 117.

II

	Feet
Made ground	0–15
Yellow and brown mixed clay	15–30
Dark clay	30–75
Gray sand with good water, flowed 3 gallons a minute	75–85
Green clay	85–120
Coarse sand with water, which overflowed; pumped 60 gallons a minute. Water was very hard	120–123
Dark green clay	123–186
Gravel and sea shells	186–189
Sand rock	189–195
Light colored coarse sand; when dry nearly white; contains water which flowed 45 gallons a minute and from which there was pumped 150 gallons a minute (salty)	195–225
Dark green clay with some sea shells	225–245
Very hard fine-grained sandstone rock	245–247
Sand like that at 200 feet, only this had sea shells in it; also contained water of quality same as at 200 feet. Flowed 45 gallons and pumped about 175 gallons a minute	247–290
Light gray clay, like putty	290–470
Hard and soft marl beds	470–485
Coarse sand with water, flowed 50 gallons and pumped 100 gallons a minute. Strong with "sulphur"	485–496

The water obtained at 485 and 496 feet was quite highly mineralized, though it was possible to use it in connection with the next higher horizon. Subsequently, wells were drilled to a depth of 580 feet, where they encountered brackish water which was unfit for use. The variation in the character of water from the different horizons in these wells at Pocomoke City shows clearly the increasing mineralization which sometimes accompanies increasing depth.

Within the last few years another well has been drilled at Pocomoke City to a depth of 1400 feet where a flow of alkaline water was encountered coming apparently from the Aquia Eocene. This well belongs to the city and is used at times when the quantity of water obtained from the shallower wells, previously described, is not sufficient. The water from the deep well is so alkaline that it is commonly described as "soft," and it removes from boilers the scale that is formed when water is used from the shallower wells. It is doubtful if water from such a great depth would be satisfactory for continued use.

The Isle of Wight Oil Company put down a well in 1914 on the Isle of Wight to a depth of 1706 feet. Although drilled in the hope of striking oil no oil was encountered. Several water horizons were passed through and cased off, but at 1700 feet so extensive a flow of water was encountered that it was determined to give up the hope of striking oil in this well and utilize the water. The well started at a diameter of 16 inches which was gradually reduced to 4 inches. No strainer was used. The water headed above the surface and flowed 250 gallons per minute. The water has a temperature of 68° F. and shows the following anaylsis in parts per million:

NH_4Cl	11.07	$MgSO_4$	222.46
NaCl	4124.18	$NaHCO_3$	146.32
KCl	112.32	$Ca(HCO_3)_2$	339.33
SiCl	trace	Ferrous bicarbonate	1.23
Sodium metaborates	59.85	Alumina	0.43
$CaSO_4$	41.0	Silica	67.60

This water is bottled and sold as mineral water. The high content of chlorides and sulphates and the excess of magnesium over calcium indicates that this water is probably what is known as a fossil water, that is, it has been retained in the beds since they were deposited as sediments in the lower Miocene sea. There has been no noticeable change in the flow since the well came in. The water apparently comes from the base of the Miocene (Calvert formation), although this region was so far south of the shore of the Miocene land that this correlation is uncertain. The mineral character of the water is quite different from the normal type of Calvert waters found farther northwest and nearer to the surface and to the catchment area for these waters.

Non-Artesian Waters

SPRINGS.—Springs are scarce and unimportant throughout Worcester County. The few that occur are seepages along the scarp of the Wicomico formation in the areas already mentioned where the Wicomico is present.

SHALLOW WELLS.—The principal source of water is the shallow wells, and though locally deep wells have been sunk and are being used with satisfactory results, most of the shallow wells draw their water from the porous sands of the Talbot formation. A supply large enough for a single household or for a farm can usually be obtained by digging a well less than 20 feet deep, and in many places near the coast ample quantities of water are obtained at less than 10 feet. The most common type is the dug well such as formerly supplied nearly all the inhabitants. However, in recent years wells have been constructed by driving pipes of small diameter into the ground until they encounter porous beds containing water. This form of well is a great improvement on the old-fashioned dug well. It is free from dirt and dust and the casing fits tightly, thus excluding surface drainage. Some of the driven wells are located upon the Wicomico formation and are somewhat deeper than the average wells of the Talbot formation. This is the condition at Berlin where driven wells have a general average of over 40 to 130 feet in depth. Other areas of Wicomico occur in the northern and northwestern parts of the county. In addition to these deeper wells of the Wicomico formation there are a few wells in the Talbot that are from 30 to slightly more than 100 feet deep, and several wells at Ocean City are more than 30 feet, while a few exceed 100 feet. It is not definitely known whether these deeper wells penetrate the base of older formations, for the Pleistocene may attain a thickness of more than 100 feet in this portion of the state. The quantity of water supplied by the shallow wells is ample for all domestic uses, and the largest manufacturing plants of these counties can readily be supplied by a few wells. The amount of water varies with the season, the level rising in rainy seasons and sinking during droughts, so that in some places the wells are entirely dry during seasons of deficient rainfall. Near the shore the water table sometimes rises so high that it is possible to dip water from the well, and again in the same well the level may be several feet below the surface. In various parts of the county, especially near the coast, there is a large percentage of organic matter in the Pleistocene deposits, which upon decomposition gives rise to hydrogen sulphide gas, causing a disagreeable odor, and if present in large quantities is objectionable. This organic matter is usually confined to one or more definite layers which represent

No.	Location	Owner or tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Berlin	Municipality	35	100	8	100	100	Cohansey	....	−10	....	Ample	Hard	1909	....	Two wells, public supply.
2	Berlin	Municipality	35	100	4½	100	100	Cohansey	....	....	....	Ample	Hard	....	....	Two wells, public supply.
3	Berlin	Thos. Franklin	45	185	1¼	185	185	Cohansey	....	—	....	Small	Hard	1900		
4	Berlin	J. H. Massey	35	80	1¼	80	80	Pleistocene	....	−14	....	Ample	Soft	....		
5	Berlin	Umphreys & Adkins	40	68	1¼	68	68	Pleistocene	....	−16	....	Ample	Hard	1907		
6	Berlin	G. R. Ayers	45	60	1¼	60	60	Pleistocene	....	—	....	Ample	Hard	....		
7	Berlin	J. O. Hoskins	35	90	2	90	90	Pleistocene	....	—	....	....	Soft	1898		
8	Berlin	C. L. Jones	35	60	1¼	60	60	Pleistocene	....	−4	....	....	Soft	....	Massey.	
9	Berlin, ½ mi. W.	Harrison & Sons	40	45	1¼	40	40-45	Pleistocene	....	−16	....	Ample	Hard	1890	....	Nurseries.
10	Berlin, ½ mi. W.	Harrison & Sons	40	70	2	70	70	Pleistocene	....	−16	....	Ample	Hard	1897	....	Nurseries.
11	Berlin, 2½ mi. N.	Chas. Matthews	35	48	1¼	48	48	Pleistocene	....	−14	....	Small	Hard	1909		
12	Berlin	Mrs. Henry Bell	35	50	1¼	50	50	Pleistocene	....	−14	....	Small	Hard	1909		
13	Isle of Wight	Isle of Wight Oil Co.	5	1706	16½	1700	1700	Calvert	Cased off	+	250	....	Mineral	1914	....	Three wells, public supply.
14	Ocean City	Municipality	5	256	6	256	256	Cohansey	....	+4	40	100	Hard	1907	....	Flow affected by city wells 50 yards away.
15	Ocean City	Atlantic Hotel Co.	5	256	6	256	256	Cohansey	....	+4	Large	....	Hard	1894		
16	Ocean City	Plimhimmon Hotel	5	107	1½	107	107	Cohansey	....	−2	....	Small	Hard	1892	....	Several other wells of this depth and character.
17	Ocean City	R. J. Dennis	5	74	1¼	74	74	Pleistocene	....	−2	....	Small	Hard	1890	....	Public supply consists of 7 wells, records of others except those given not available.
18	Pocomoke City	Municipality	8	1420	6	....	....	Aquia	....	....	....	Large	Soft	1907	....	Not potable, reserved for fire use.
19	Pocomoke City	Municipality	8	130	6	....	....	Cohansey	....	+16	....	Large	......	1907	Shannahan.	Public supply.
20	Pocomoke City	Municipality	8	580	6	....	....	St. Mary's	....	....	....	....	Brackish	....	....	Two wells.
21	Pocomoke City	Municipality	10	137	4½	137	137	Cohansey	....	+4	....	115	......	1911	....	Public supply.
22	Pocomoke City	Elect. & Ice Mfg. Co.	10	....	3,4	....	....	....	....	+	....	120	......	1910		
23	Snow Hill	Municipality	10	340	8	....	....	Cohansey	....	+8	70	....	......	1897	....	Whip factory.
24	Snow Hill	Municipality	10	267	6	....	....	Cohansey	....	+8	70	....	Soft	1897		
25	Snow Hill	A. D. Irvine	12	70	2	70	70	Cohansey	....	−8	....	Ample	Soft	....		
26	Snow Hill	Snow Hill Butter-dish & Basket Co.	10	70	1½	70	70	Cohansey	....	−20	....	60	Soft	1909		
27	Taylorsville	George Minor	10	80	1¼	80	80	Pleistocene	....	+1½	Small	....	Hard	1905		
28	Taylorsville	Charles Clark	10	50	1½	50	50	Pleistocene	....	+1½	Small		Hard	1905		

old marsh beds buried beneath subsequent deposits, and it is generally possible to obtain good water either above or below the organic materials. The amount of inorganic matter in wells is seldom large enough to interfere with the uses of the water, though the presence of iron at some localities renders it unfit for washing. When boiled the iron is changed to an insoluble compound which stains cloth. In a few places there is more or less saline matter in the Pleistocene deposits and this results in salt water. The sanitary character of the shallow well water is often doubtful, especially where wells are located near dwellings, and the danger is increased if the supply is taken from sands that are not overlain by dense clay or marl.

SOMERSET COUNTY

Somerset together with Worcester comprises the extreme southern part of the Eastern Shore district of Maryland. Most of the surface of the county is flat and lies within 40 feet of tide, only a small area in the extreme northeastern part of the county rising a few feet above tide level. The streams are sluggish and pass into tidal estuaries without well-marked valleys or interstream divides.

TABLE OF ELEVATIONS

	Feet		Feet
Bedsworth	4	Manokin	9
Bethel	2	Marion	7
Birdtown	3	Mt. Vernon	6
Chance	2	Oriole	2
Costen	21	Peninsula Junction	14
Cottage Grove	18	Princess Anne	18
Crisfield	5	Rehoboth	10
Dames Quarter	2	St. Stephen	3
Deal Island	2	Tulls Corner	6
Dublin	18	Upper Fairmount	8
Eden	30	Ward	6
Fairmount	5	Wellington	27
Freetown	5	Wenona	3
Habnab	10	West	39
Hopewell	6	Westover	14
Landonville	4	Widgeon	17

GEOLOGY

The surface of the county consists almost entirely of the loams and sands of the Talbot formation, the youngest of the Pleistocene marine terraces. In the extreme northeastern part of the county in the East Princess Anne Election District (No. 15) a small area extending from east of Eden southward to west consists of the similar materials of the Wicomico formation, the next oldest formation of the Pleistocene and lying about 10 feet above the Talbot.

Beneath these thin and essentially surficial formations the whole county is underlain by a great thickness of sands, clays, and marls of the Miocene formations, none of which reach the surface in this region. Beneath these and at great depths are the successively older formations of the Coastal Plain belonging to the Eocene and Cretaceous, but these are so deeply buried that any consideration of them as sources of underground water may be omitted.

SURFACE WATERS

The streams of the county are all tidal estuaries and the small creeks which flow into them. Their valleys are shallow and poorly defined and often swampy and their lower courses expand into flat, salt marshes. They are not capable of utilization as sources of potable waters nor do they furnish any water power.

UNDERGROUND WATERS

Artesian Waters

The demand for artesian waters has been slight, consequently but few wells have been drilled and these principally at Crisfield and Princess Anne. The municipality has put down four deep wells at Crisfield, and there are three other wells at this place over 1000 feet deep—two belonging to the Crisfield Ice Manufacturing Company and the third to S. E. P. Dennis & Son. These are regarded at the present time as obtaining their water from the basal Miocene (Calvert formation), but it is possible that the water-bearing beds are in the Eocene or at the top of the Upper Cretaceous, as earlier students concluded. A log of one of the deep wells at Crisfield was compiled by Darton,[1] and the following record is adapted from his description:

WELL AT CRISFIELD

	Feet
Sand and loam, gravel at base	0–13
Buff and gray sandy clays, shell fragments	13–100
Dark gray sandy clays, few pebbles, shell fragments	100–110
Gray clay	110–120
Gray clay, many shells	120–130
Clay, light greenish gray	130–135
Clay, shells and siliceous concretions	135–140
Sand, very fine, greenish gray, glauconitic	140–147
Tough clay, light greenish gray	147–150
Sandy clay, greenish gray	150–160
Clay, lead gray	160–170
Glauconitic sands, loose, greenish, shell fragments	170–177
Glauconitic sands, loose, greenish, Perna fragments	177–185
Glauconitic sands, moderately coarse, shells	185–190
Shells in sand	190–230
Sand, dark greenish gray, shell fragments	230–235
Argillaceous sand, gray	235–240
Clay, greenish gray, with siliceous concretions and lignite fragments	240–268
Siliceous concretions	268–270
Clay, dark gray	270–280
Clay, tough, greenish gray, shells	280–285
Clay, light, greenish, with siliceous concretions	285–290
Clay, dark olive, lignite, ferruginous crusts, shell fragments	290–310
Clay, light greenish	310–340
Sand, with shell fragments	340–345
Argillaceous sand, light green, with fragments of *Pecten madisonius*	350–360
Fine sand, greenish gray fragments, *Pecten jeffersonius*	370
Clay, greenish gray, sandy below	380–385
Sand, light greenish gray, moderately fine	390–420
Clay, light greenish gray	420–430
Clay, very sandy, light greenish gray	430–460
Sand, very fine, dark greenish gray, micaceous	460–465
Sandy clay, dark greenish gray	466–467
Clay, dark greenish gray, shell fragments	469
Clay, sandy, dark greenish gray, lighter below	473–480
Clay, bright greenish gray	485

[1] Darton, N. H. Artesian Well Prospects in the Atlantic Coastal Plain, U. S. Geol. Survey, Bull. No. 138, pp. 129-131.

	Feet
Sand, fine, greenish gray	490
Clay, light greenish	495–510
Clay, very light greenish tint, very diatomaceous	535
Clay, dark gray	545
Clay, greenish gray, diatomaceous	555
Sand, argillaceous, shell fragments, *Turritella plebeia*	565
Sandy clay, greenish gray	575
Clay, bright gray	585–595
Clay, light gray, diatomaceous, *Anomia*	600–605
Sand, fine, greenish gray, shell fragments, glauconite	610
Sand, fine, greenish gray	620
Clay, sandy, shell fragments	630
Clay, light gray, diatomaceous	640–650
Clay, bright gray, diatomaceous	660
Clay, very sandy, dark greenish gray	670
Clay, light greenish gray, diatomaceous	675–690
Clay, gray, sandy	700–
Clay, light gray, diatomaceous	710
Sand, fine greenish gray, large glauconite grains	720
Clay, dark buff, diatomaceous	740
Clay, light gray, diatomaceous	750
Clay, darker gray, diatomaceous	760
———	770
Rock with large grains of glauconite	771–775
Argillaceous sand, dark olive green, large proportion of glauconite; coarse at 820 feet, finer at 800 feet, quartz pebbles and oyster shell fragments at 810 feet	780–850
Clay, very light greenish gray, shells (Sp.) at 932 feet	855–950
Clay, slightly micaceous	955
Clay, more sandy, more micaceous	960
Clay, bright gray, sandy, micaceous, with plant fragments of *Severn* aspect	961–963
Sand, fine gray, some mica	965
Clay, black, with pyrite fragments	970
Clay, very compact, light gray	971–972
Sand, fine, micaceous, coarser below, lignite at 990 feet	974–1005
Clay, bright gray, tough	1005–1015
Sand, fine gray	1015–1025
Sand, moderately fine, gray, micaceous	1025
Clay, bluish gray, with reddish streaks	1033–1040
Sand, moderately coarse, gray, some serica, water	1042–1052
Clay and sand, gray sandy, reddish streaks	1052–1064
Clay, light gray, very compact (hardest to present depth)	1064

The following log of the deepest municipal well was compiled from a series of samples furnished by the driller:

	Feet
Mottled red and gray clay	1000–1069
Light-gray sand	1075–1100
Lignite with pyrite and some lignitic gray sand	1100–1107
Mottled red and gray clay	1122–1140
Light-yellow micaceous sand	1140–1158
Mottled red and gray clay	1158–1242
Light-gray micaceous sand	1242–1262

Experience at Crisfield indicates that there is an abundance of water available for deep wells, but that the quality is poor. In attempting to procure large yields from the city wells at Crisfield considerable difficulty was experienced on account of fine sands collecting in the wells. An air-lift was installed in the well 1100 feet deep, and the suction was sufficient to bring the fine sand merely to the surface. Owing to the inferior quality and the difficulty encountered when attempting to pump the deep wells, it is believed that several shallow wells would be preferable to the deep ones.

The wells at Princess Anne all obtain their water from the base of the Talbot formation or the top of the Cohansey, and this is also true of the Deal Island and Marion wells.

One or more of the three water horizons noted at 71 to 85, 120 to 123, and 195 to 225 feet at Pocomoke City in Worcester County could probably be encountered in the southern part of the county, but, with the possible exception of the flowing wells at Rehoboth, wells have not been sunk to any of them. Toward the south the depths to these horizons increase and northward they diminish, the rate of change amounting to only a few feet per mile. The head is only sufficient to give flows on low ground, but water from these horizons could be easily pumped on the surface of the Talbot formation.

Deeper water horizons were penetrated at Pocomoke City and Crisfield, and while they indicate a general extension of deep-seated waters beneath the county, the character of the supplies has thus far been found to be poor.

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Crisfield	Municipality	5	1100±	8	....	....	Calvert	+8	15	....	Hard	1906	....	Three wells became clogged with sand through using air-lift pump.
2	Crisfield	Municipality	5	225	6	....	....	Cohansey	+	....	30	Hard	1897	....	Public supply.
3	Crisfield	Municipslity	5	1028	6	....	....	Calvert	+	....	....	......	....	....	Public supply.
4	Crisfield	Crisfield Ice Mfg. Co...	3	1060	8	....	....	Calvert	+12	130	....	Soft	1892	....	Unfit for domestic use.
5	Crisfield	Crisfield Ice Mfg. Co...	3	1018	8	....	....	Calvert	+12	....	30	Soft	....		
6	Crisfield	S. E. P. Dennis & Son..	3	1038	8	....	....	Calvert	+19	22	....	Soft	1895		
7	Crisfield	E. M. Collins..........	5	57	2	57	57	Talbot	−2	....	....	Hard	1909		
8	Crisfield	Joseph Payette........	5	47	2	47	47	Talbot	−2	....	....	Hard	1890	....	Not used.
9	Crisfield	Long Colburn & Co....	0	147	2	147	147	Cohansey	−2	....	Ample	Hard	1902	....	Varies with rainfall.
10	Crisfield	Davis	..	150	2	150	150	Cohansey	−2	....	Small	Hard	1908	....	Not used.
11	Deal Island....	Ice Company..........	..	99	6	94	....	Talbot	−4	....	50	......	1915	E. D. Miller.	
12	Marion	W. R. Wittington.....	..	28	½	....	....	Talbot	−	....	60	......	1916	....	Three wells. Ice plant.
13	Princess Anne..	Municipality	15	37	2	37	37	Talbot	−11	....	....	Soft	1906	....	Public supply.
14	Princess Anne..	Municipality	15	70	6	60	60-70	Talbot	−	....	....	Soft	1897	....	Two wells. Public supply. The three pump 70 gallons per minute.
15	Princess Anne..	Municipality	15	50	2	50	50	Talbot	−4	....	Large	Soft	1905	....	Eight wells.
16	Princess Anne..	J. D. Colburn..........	15	96	1¼	96	96	Talbot	−10	....	Ample	Hard	1907		
17	Princess Anne 5 mi. N.	Edgar Jones..........	4	80	½	80	80	Talbot	+1½	....	....	Soft	1903		

Non-Artesian Waters

SPRINGS.—Springs are practically absent throughout the county because of the flat character of the surface, and what few do occur are merely seepages and not true springs, and are therefore of slight importance.

SHALLOW WELLS.—The principal source of domestic supplies is obtained from shallow wells, either the old-fashioned dug well or the well obtained by driving an iron pipe into the ground. A supply sufficiently large for household uses can usually be obtained in either of these ways within 10 to 30 feet of the surface, but care is necessary to guard such wells from pollution.

One of the most unsatisfactory places for shallow wells is near the shore of Chesapeake Bay at Crisfield. Some of these wells at this locality are brackish and others are so highly charged with iron that the water is unfit for use. For this reason Crisfield has a great many cisterns where rain-water is caught and stored for domestic use. Some of the low areas along the shore and on the islands in Chesapeake Bay present the same difficulties that are encountered at Crisfield, but fortunately there are comparatively few persons residing in such places.

THE BALTIMORE DISTRICT

Because of the extensive suburban and industrial development in the vicinity of Baltimore, the region adjacent to the city, and more especially that region to the southeast comprising Back River Neck, Patapsco River Neck in Baltimore County, and the country along the south bank of the Patapsco River in Anne Arundel County, is considered in connection with the city.

TOPOGRAPHY

The Baltimore region, comprising the area shown on the accompanying map, embraces two types of topography. The "fall line," or line of contact between the crystalline rocks of the Piedmont district and the unconsolidated sediments of the Coastal Plain district, is a sinuous boundary crossing the northwestern part of the region.

The Piedmont district, which comprises the northwestern part of the city and the adjacent suburban region, has a rolling, picturesque topography of considerable relief and reaches elevations of 400 feet. The stream valleys are narrow and deep and often gorge-like, as in the case of Jones Falls and Gwynns Falls.

The Coastal Plain district, which includes the central and southeastern portions of the city and adjacent parts of Baltimore and Anne Arundel counties, ranges in elevation from about 200 feet near the "fall line" to sea level. The region adjacent to the "fall line," which includes the older formations of the Coastal Plain, because of its age and greater elevation, is much dissected and has a rolling topography. Farther to the southeast, particularly on the various river necks, the surface is essentially flat and the streams are converted into broad tidal estuaries.

GEOLOGY

The rocks of the Piedmont portion are highly crystalline and have been faulted and intensely folded. They consist principally of Baltimore gneiss and gabbro. The Coastal Plain formations include those of the Lower and Upper Cretaceous, and the terrace formations of Pleistocene age. These latter from the oldest and highest to the youngest and lowest are the Brandywine, Sunderland, Wicomico, and Talbot.

The Cretaceous formations consist of sands and clays and underlie most of the Baltimore region, affording important water-bearing zones as they dip to the southeast. The Pleistocene deposits comprise gravels, sands, and loams present as remnants on the uplands and as thin surficial sheets on the lowlands.

SURFACE WATERS

The principal streams are the broad estuaries of Middle, Back, and Patapsco rivers and their branches, which lie almost wholly in the Coastal Plain and are unsuitable as sources of potable water. Stemmers Run, Herring Run, Jones Falls and Gwynns Falls, which rise in the Piedmont district and empty into Middle, Back and Patapsco rivers, respectively, are rapidly flowing, fluctuating streams, which in former times were more or less utilized but have gradually, with the growth of population, had their lower courses polluted by sewage. They are, therefore, no longer available for potable supplies within this district, although the upper courses of Herring Run and Patapsco River are both utilized by water companies supplying some of the suburban towns. These streams also develop some water power in their Piedmont portions, which have been more or less utilized for milling and manufacturing purposes.

UNDERGROUND WATERS

Artesian Waters

The artesian waters of the Baltimore district are considered under two heads, one treating of the artesian waters of the Coastal Plain area and the other the artesian waters of the Piedmont area. The former is the more important of the two, since it is so intimately connected with the great industrial development in the Coastal Plain area south and southeast of the city.

The Coastal Plain Area

This region includes the southern and eastern parts of Baltimore City and the country adjacent to Patapsco River to Bay Shore and Bodkin Point. A large number of successful wells have been drilled though but few of them flow. The flowing wells have only been obtained on low ground, but the principles governing the occurrence of the water are the same for both the flowing and the non-flowing wells, and hence they are all classed as artesian. From the present industrial development in this section there is reason to believe that a large number of new wells will be drilled in the future.

The most important water horizons occur in the Patuxent formation, which consists of beds of sand, gravel, and clay resting on the sloping surface of the crystalline rocks of the Piedmont region which extends beneath the Coastal Plain. In Canton and vicinity the wells show the presence of at least three, and possibly four, water-bearing horizons. The lower of these horizons is a bed of gravel lying on the floor of the crystalline rocks. This bed, which will be indicated as Patuxent horizon No. 1, furnishes a very large amount of water and supplies a large number of wells in South Baltimore, Canton, Highlandtown, and the region to the southeast.

Patuxent horizon No. 2 lies about 35 or 40 feet above No. 1 and is also a very large producer of good water in numerous wells in this district. Another horizon, No. 3, lying about 30 feet above No. 2, yields a little

FIG. 90.—MAP OF THE BALTIMORE DISTRICT. CONTOURS AT 100-FOOT INTERVALS SHOW THE APPROXIMATE SURFACE OF THE UNDERLYING CRYSTALLINE ROCKS FROM WHERE THEY PASS BELOW TIDE (0) DOWN TO 700 FEET.

water, but its maximum capacity is not known because it has not been extensively exploited. There appears to be a still higher horizon, No. 4, but it only shows in a few places. These horizons were recognized and discussed by Darton [1] in an earlier report on this region, but since Darton's bulletin was published the lower or No. 1 horizon has been more extensively developed in the vicinity of Canton and Highlandtown, and is now regarded as of equal importance to the No. 2 horizon.

The wells in the Canton and Highlandtown districts are situated mostly along Clinton Street on the water front and along the line of the Philadelphia, Baltimore & Washington Railroad from the grain elevators north to Fayette Street. The wells drawing from horizon No. 1 are as follows: Those located at the fertilizer works at the foot of Clinton Street, Sandford & Brooks, near the water front and south of Clinton Street; Davison Chemical Company, Eighth Street and Third Avenue; the Baltimore Copper Smelting & Rolling Company, Fourth Avenue and Fifth Street; Canton Iron & Steel Company, Fourth Avenue and Second Street; one well at No. 1 elevator, Northern Central Railroad, on Clinton Street; one well at the Standard Oil Company's Refinery, Toome and Seventh Streets; the breweries in Highlandtown; the Crown Cork & Seal Company, Eastern Avenue and Twelfth Street; the Continental Can Company, Fayette and Fourteenth Streets, and two wells belonging to the Highlandtown Ice Company, Canton Avenue and First Street.

The No. 2 horizon, like the No. 1 horizon, supplies a large number of wells. The following wells appear to draw water from this horizon: The Lazaretto lighthouse; several wells at the No. 1 elevator, Northern Central Railroad; most of the wells at the Standard Oil Company's Refinery on Toome Street; wells at two slaughter houses near Eastern Avenue; the well at the Northern Central Railroad powerhouse; the Stewart Distillery, Fifth and Bank Streets; two wells belonging to the Maryland Pure Rye Distillery; and the well at the Williams Veneer Company, Baltimore and Eighth Streets.

The No. 3 horizon lying approximately 100 feet above the crystalline rocks supplies several wells. The wells belonging to T. J. Kurdle, butcher, located at Fifth and Eastern Avenue, and the Steiner Mantle Company, Eighth and Fairmont Avenue, obtain water from this horizon. One of

[1] Darton, N. H. U. S. Geological Survey, Bull. No. 138, pp. 142-148.

the wells at the Maryland Pure Rye Distillery appears to draw from the No. 3 horizon, which has also been reported in the wells at the Standard Oil Company's Refinery. It is quite possible that other wells obtain water from this horizon, as it has been reported from widely separated places.

There is a possible fourth, or No. 4 horizon, as indicated by the 66-foot well at the old plant of the Gas Company, Fait Avenue and Chesapeake Street. This horizon may be used by other wells in Canton and Highlandtown, but there is no authentic report of such use.

At one or two breweries attempts have been made to procure water from the crystalline rocks. The National Brewery, O'Donnell and Third Streets, reports rock at about 230 feet and one well with 100 gallons per minute from a depth of 330 feet, and another well with 90 gallons at 430 feet. The Monumental Brewing Company, Lombard and Seventh Streets, reports rock at 250 feet and 150 gallons of water in the rock at 480 feet. The Wienke Airy Distilling Company, Eastern Avenue and Seventeenth Street, reports rock at about 220 feet and 40 gallons per minute in the rock at 420 feet.

The wells between Canton and the basin are mostly situated along the river front on Boston Street. While most of them obtain water from the No. 2 horizon of the Canton and Highlandtown region, there are several that are supplied by the No. 1 horizon. At the J. S. Young Company, 2731 Boston Street, there is one well 147 feet deep yielding 60 gallons per minute. This well probably obtains its water from No. 2 horizon. At this locality a well which was drilled to a depth of 1000 feet encountered crystalline rock at about 190 feet. About 55 gallons per minute was secured in this well, and while the exact depth to the supply is not known, the driller reports traces of water at 400 feet, and a large quantity at 640 to 660 feet. According to the statement of the superintendent of the plant the water was unfit for use because it was muddy. The well was cased to the crystalline rock but was later drawn back 40 feet and thus increased the supply to about 100 gallons per minute. This well doubtless obtains water from both the No. 1 and No. 2 horizons. Another well at this locality yields 40 gallons from a depth of 96 feet; probably from the No. 3 horizon.

The well at the Canton Box Company, 2515 Boston Street, obtained slightly salty water at a depth of 96 to 100 feet, probably from the No. 2 horizon. This well was drilled over 20 years ago and possibly the salt water enters from the harbor through a corroded casing. The 176-foot well of H. J. McGrath, Atlantic Wharf, and the wells at the foot of Wolfe Street belonging to the American Ice Company, appear to draw from the No. 1 horizon. The Ice Company wells tap the No. 2 horizon and possibly the No. 3 horizon.

The No. 3 horizon supplies the 106-foot well at Louis Grebb's, 2357 Boston Street; the 98-foot well of Miller Bros. & Company, 901-913 S. Wolfe Street; the 94-foot well of the Booth Packing Company, Wolfe and Lancaster Streets; and the 90-foot well of J. Langrell, 2115 Aliceanna Street. For various reasons many of the wells in this region have been abandoned. In some places the wells have become clogged, while in other places the ground is so saturated with acids that the pipes are corroded and the water contaminated.

On the water front between Wolfe Street and the head of the basin there is a small number of wells and many of the older wells of this locality have been abandoned. All of those belonging to the city were closed by the Health Department, and others were abandoned on account of changes in the burned district. At the plant of Louis Eckels Ice Manufacturing Company, Gough Street near Broadway, three wells were reported as having depths of 125, 135, and 165 feet respectively. They obtained water from a horizon which has been correlated with the No. 1 horizon of the Canton district, and the crystalline rock was encountered at about 95 feet. The yield, in the order mentioned, is 32, 20, and 45 gallons per minute. There are several wells situated on Central Avenue which probably draw from the No. 3 horizon.[1]

The wells at the plant of Louis Elmer & Sons, Central Avenue and Bank Street, obtain water from the same horizon at depths of 60 to 70 feet. They only yield 15 to 20 gallons each. At the Bennett Potteries there is one well 50 feet deep which furnishes a large supply of water from a horizon that has not been definitely correlated with those at Canton.

[1] Darton, N. H. U. S. Geological Survey, Bull. No. 138, p. 144.

At the plant of the Cooperative Ice Company, S. Frederick Street near Baltimore Street, a 125-foot well did not obtain water, though it passed through the No. 1 horizon and entered the crystalline rock at 60 feet. The Hammond Ice Company drilled about 30 wells to a depth of 100 feet at the foot of Block Street. Water was encountered in all of these wells and some of it contained sulphur. This horizon has been correlated with the No. 2 horizon at Canton.[1] The ice factory was never completed and hence these wells were never used. Sharp & Dohme, Pratt and Howard Streets, have four wells, 77, 85, 90, and 94 feet deep, respectively. Rock is reported at 77, 85, and 88 feet. The 90-foot well has a yield of 4 gallons of water, but the depth to the water horizon is not known. The 94-foot well obtained 20 gallons of water from a bed of clean, yellow sand at a depth of 62 feet. This sand extends down to the crystalline rocks and the water is from horizon No. 1.

At the plant of the Baltimore Refrigerating & Heating Company, 426 S. Eutaw Street, 20 wells were drilled to a depth of 100 feet. Crystalline rock was encountered at 70 feet and the water occurs in a bed of gravel at 45 to 55 feet deep. The aggregate yield of the 20 wells is 60 gallons per minute and the same amount can be obtained by pumping 10 of them. Another well at this place was drilled to a depth of 304 feet. Solid rock was encountered at 70 feet and 45 gallons of water per minute was obtained at 304 feet, but the yield subsequently diminished to 25 gallons. The cause for this reduction could not be ascertained.

The Knickerbocker Ice Company, York and William Streets, reports eight wells which were originally 150 feet deep. These wells filled up to a depth of 90 feet with sand. An aggregate yield of 250 gallons per minute was obtained from the eight wells and all appear to be supplied by the No. 1 horizon. The water has a brackish taste and contains considerable iron.

The American Ice Company, Hughes and Henry Streets, have eight wells ranging in depth from 110 to 136 feet. The water occurs in the No. 2 horizon, which is here a coarse, yellow sand. The aggregate yield of the eight wells is 615 gallons per minute.

[1] *Op. cit.*, p. 144.

Wm. Numsen & Sons, Jackson Street and Fifth Lane, have reported one well which obtained 26 gallons per minute from a bed of sand at 100 feet. The supply is somewhat hard and contains some sulphur. A 65-foot well at this locality yields about the same amount of water as the deeper one.

There are several wells located close to the water front between Fort McHenry and the intersection of Jackson Street and Fifth Lane. They range in depth from 109 to 138 feet and obtain water from the No. 1 and No. 2 horizons. The well at Platt & Company's, Clement and Boyle Streets, obtained 30 to 40 gallons per minute in a bed of white sand and gravel representing the No. 2 horizon. Torsch & Company's well, Lawrence and Clement Streets, obtained 50 gallons per minute at 138 feet in a fine gravel with a pinkish cast, which is probably the No. 1 horizon. At the Piedmont & Mt. Airy Guano Company's plant, foot of Woodall Street, there is a well 109 feet deep. Water occurs in the No. 2 horizon which, at this locality, is a bed of coarse gravel overlain by a white, sandy clay. The well had a large yield but it was abandoned because the water formed a hard glass-like scale in the boilers.

G. Ober & Sons Company, foot of Hull Street, near the ferry landings, has had several wells drilled. One well which was sunk in 1891 has a yield of about 20 gallons per minute from the No. 2 horizon at a depth of 90 feet. In 1897 a second well was sunk to a depth of 110 feet and gave about 30 gallons per minute. The present well, 130 feet deep, was drilled in 1901 and has a yield of 30 gallons per minute, probably from horizon No. 1. At 125 feet a water horizon was encountered that supplied water having a brilliant red color. The ground at this place is thoroughly saturated with sulphuric acid which rapidly destroys the casings and renders the water unfit for use within less than six years from the time the wells are drilled.

Louis Ehrman, 1032-34 Haubert Street, has a well 128 feet deep which yields about 40 or 45 gallons of water per minute. This water occurs in a fine white sand belonging to the No. 1 horizon. At the Baltimore Dry Dock Co., close to Fort McHenry, there is a well 118 feet deep which has a fair yield of soft water.

The water horizons in the wells enumerated below have not been correlated with the horizons at other localities. At the Baltimore Distillery, Russell and Carey Streets, 500 gallons per minute are obtained from eight wells 38 to 40 feet deep, The water-bearing bed is a gravel. The water contains a very high percentage of iron and is probably contaminated by impure surface water. The Hilgartner Marble Company, Sharp and Ostend Streets, had five wells, 44 to 115 feet deep, which furnished a large amount of water. For some unknown reason the supply failed in less than a year after the wells were drilled. The water was not satisfactory because it contained a very high percentage of iron and stained the marble. Strong iron water occurs in a 33-foot well at the packing house of Wm. Grecht Company, foot of Sharp Street. Salty water was encountered at White & Middleton's, Charles and Winder Streets. This well reaches crystalline rock at 200 (?) feet. The well at the Thompson Chemical Company, Winder and Leadenhall Streets, obtains 85 gallons of water from a bed of yellow sand and gravel at 104 feet.

Salty water was obtained at a depth of 190 feet near the electric plant of the Consolidated Gas & Electric Company, formerly the Maryland Telephone Company, at Gold and Winder Streets. The National Enameling & Stamping Company, Light and Wells Streets, have one well 162 feet deep, which yields 90 gallons of excellent water per minute.

In the Westport region the crystalline rock is near the surface, though in the southeastern part of the district there is a thin veneer of the Patuxent formation and horizon No. 1 is present. The Maryland Glass Corporation procured a small quantity of water in crystalline rock at 238 to 267 feet, and the Western Maryland Railroad obtained a little poor water at 60 feet. The Carr-Lowry Glass Company have one well 205 feet deep. Crystalline rock was encountered at about 80 or 90 feet and the water was probably obtained from horizon No. 1. No water was found in the rock. The supply previously mentioned contained a white sediment. This company sunk two or three other wells to the crystalline rock without obtaining water. They also have two or three old wells of unknown depth that have been abandoned because of the small quantity of water.

In the region between Canton and Sparrows Point there are numerous successful wells, and while most of them are located at the plant of the Maryland Steel Company, there are several at other places. These will be described in order, beginning at Canton and proceeding toward Sparrows Point.

In a well 296 feet deep at the No. 3 elevator of the Northern Central Railroad three water-bearing beds were encountered, the first at 185 feet, the second at 220 feet, and the third at 296 feet. The horizons should probably be correlated with Nos. 1, 2, and 3 of the Canton district. The elevator well yields 104 gallons per minute, but it is not known whether it draws from all of the water horizons or from only the lower one.

The wells at the distilleries located at the head of Colgate Creek probably draw from the Nos. 2 and 3 horizons. At St. Helena there is one well which yields 75 gallons per minute from a depth of 75 feet, possibly from the No. 4 horizon.

At Sollers Station, near Bear Creek, two wells were drilled for the United Electric Railways' powerhouse. A section of one of these wells shows water at 19 to 21 feet, 149 to 159 feet, and 284 to 287 feet. The water encountered in this well at 19 to 21 feet is probably surface water. The other well secured 110 gallons at 200 to 226 feet. It is quite possible that these supplies come from Nos. 2, 3, and 4 horizons.

The 160-foot well of the Aluminum Ore Company at Turners Station probably taps the No. 4 horizon. The two wells of the Bartlett Hayward Co. at Turners Station clearly show the southeastward continuation of the deep channel underlying the Coastal Plain and conspicuously shown by the well records in Highlandtown. These wells each yield 200 gallons of good water for steaming purposes, the water heading within 15 to 20 feet of the surface.

Considerable success has been met with in the wells belonging to the Bethlehem Steel Company located at Sparrows Point. A large number of wells have been drilled ranging in depth from 112½ to 611 feet. There seem to be four general horizons here similar to those in the region to the northwest. Each of these horizons furnishes good supplies, the largest yields usually coming from the deepest wells. One well 509 feet deep yields 364 gallons per minute, while another well 301 feet 7 inches deep yields 328 gallons per minute.

At Fort Howard there is one well 314 feet deep which yields 110 gallons per minute, probably from the horizon just above the lower one at Sparrows Point. The 743-foot well at Bay Shore Park flows 50 gallons per minute at 3 feet above the ground. A section of this well does not show any water horizons except that which occurs at 721 to 743 feet. It probably coincides with the lower horizon at Sparrows Point. The water is somewhat hard and contains some iron. The depth of the No. 1 horizon at this locality is about 150 feet lower than it should be if the slope of the underlying crystalline rocks maintained the uniformity indicated elsewhere in the Coastal Plain. Presumably there is a valley-like depression in these rocks underneath Bay Shore extending northwest along the north shore of Patapsco Neck, as is indicated by the well records at Sparrows Point, Highlandtown and Turners Station. Approximate depths can be calculated from the contours of the map shown in Figure 90 on page 339. At Rosedale, about 4 miles east of the city limits on the Philadelphia Road, several wells have been drilled ranging in depth from 75 to 150 feet. There is a bed of red clay varying from 35 to 100 feet in thickness overlying the water-bearing sand. These wells are all close together and they have an average yield of about 10 gallons per minute each. At Rossville, about 3 miles northeast of Rosedale on the Philadelphia Road, a well was drilled 229½ feet and secured a large supply of water in rock; the water is hard and contains iron.

At Middle River, on the Philadelphia, Baltimore & Washington Railroad, an attempt was made to obtain a flowing well. Water was found at 20, 70, and 123 feet, but it was so turbid that the well was abandoned.

The well drilled on the property of George R. Willis near Bengies yields 40 gallons per minute from a light yellow sand with a small quantity of gravel, probably the No. 2 horizon, at a depth of 180 feet.

At Prospect Park on Eastern Avenue near Back River 25 to 30 gallons per minute were secured at a depth of 136 feet, and at the disposal plant of the Baltimore City Sewerage Commission, located on Back River near Eastern Avenue, 10 to 15 gallons per minute were secured at 156 feet in a fine yellow sand. Probably the No. 3 horizon is the source of supply in both of these wells.

The large number of successful wells in the vicinity of Brooklyn, Seawall, Curtis Bay, and Hawkins Point indicate a wide and general extension of the Patuxent water under the Curtis Bay-Patapsco Peninsula. At Brooklyn several wells have been sunk to a depth of 55 to 85 feet, dependent upon the surface elevation, which yield a fair supply of water carrying a small amount of iron. At East Brooklyn and Seawall several successful wells have been sunk. The wells at the plant of the Martin Wagner Company show water at the following depths: 95 to 105; 230 to 240; 310 to 375. These wells probably tap horizons Nos. 2, 3, and 4. The section of another well at this locality shows these three horizons at about the same depth. At the pumping station of the Brooklyn & Curtis Bay Light & Water Company, opposite the South Baltimore car shops, there have been a number of wells drilled to depths ranging from 109 to 575 feet. The deeper wells at this locality encounter rock at about 375 feet. Water-bearing strata occur at 70 to 90, 100 to 120, 180, 200, 215, 235, 300, 337½ feet. The Curtis Bay Chemical Company have 10 wells from 200 to 275 feet deep which average 77 gallons each, the water being eminently satisfactory for boiler use and manufacturing purposes. The Standard Guano Company have three 200-foot wells which overflow at the surface and yield about 15 gallons each. The Republic Distilling Company have 19 wells, four 100, three 125, and twelve 300 feet deep. The deeper wells apparently tap the Patuxent water bed No. 3, so conspicuous along the north shore of the Patapsco, and yield satisfactory boiler and distilling water which heads about 30 feet below the surface and each pumps about 300 gallons per minute. The 125-foot wells head within 17 feet of the surface and pump 250 gallons per minute. The 100-foot wells head about 30 feet below the surface and pump 125 gallons per minute. These evidently tap the No. 4 or a still higher Patuxent water bed. Evidently large quantities of soft water can be obtained in this district within 300 feet of the surface. At Flood's Park, Curtis Bay, a large supply of good water was obtained at about 65 feet, which is probably from the No. 4 horizon. At the U. S. Revenue Cutter Service Station, Arundel Cove, water was obtained at about 216 feet, probably in the No. 3 horizon. Two wells have been drilled at the Quarantine Station to depths of 136 and 150 feet respectively. The first well obtained 40 gallons per minute at about 132 feet. The water horizon in the second well is at the bottom. This water has been condemned by the Health Department of Baltimore. The well was drilled to rock which was encountered at 420 feet, but no water was obtained below 150 feet. Horizons Nos. 1, 2, and 3 are absent here, but it is quite probable that these wells tap the No. 4 horizon.

At Hawkins Point there are three wells, two located at the works of the Davison Chemical Company and the third at Fort Armistead. The wells at the chemical works are 148 and 160 feet deep, yielding 40 and 60 gallons per minute, respectively, and are from the No. 4 horizon. At the fort there is a well which is 570 feet deep and yields 50 gallons per minute. It is quite possible that this water occurs in the crystalline rock though the character of the horizon could not be ascertained.

In the region along the Baltimore & Annapolis Short Line, from Patapsco River to Glenburnie, there are a few wells which are fairly successful. A well near Pumphreys Station, reported to be 125 feet deep, furnishes a large supply of good water which may possibly come from the No. 4 horizon. At Linthicum Heights a well 80 to 90 feet deep yields a fairly good supply of somewhat hard water. At Glenburnie two wells are reported, one 52 feet deep, and the other 65. Both yield a large supply of water.

The accompanying map of the Baltimore district shows the areas belonging to the Piedmont Plateau and to the Coastal Plain. The "fall line" is approximately indicated by the line marked o, which marks the position where the crystalline rocks of the Piedmont pass below tide level. The surface of these rocks beneath the Coastal Plain is shown by contours drawn at 100-foot intervals. These are only approximate since a large percentage of the wells, particularly those some distance southeast of the "fall line," do not reach the underlying crystalline rocks, and the available data are insufficient. In general, this level is one of the most valuable water horizons not only in this district but throughout the state. The surface of these underlying rocks does not slope uniformly, however. For example, there is a well-marked valley beneath the Coastal Plain sediments extending southward through Highlandtown and southeastward to Sparrows Point, and a less well-marked valley is indicated from the vicinity of Calverton southeastward to Locust Point. These inequalities may diminish or totally interfere with the yield from the horizon known as Patuxent horizon No. 1, where this horizon happens to be on a ridge of the underlying rocks.

With these contours as a datum plane the water prospects at any locality can readily be determined for any of the Patuxent horizons by adding the elevation at the surface and subtracting the distances at which these horizons lie above the crystalline floor.

The Piedmont Plateau Area

This area, as shown on the accompanying map, includes the northern and western portions of the city and adjacent suburbs, or what might be called the northeastern, northwestern, and southwestern sections of the city and the contiguous territory in Baltimore County which is so intimately a part of the city. Some of the wells which have been drilled in the Coastal Plain region into the underlying Piedmont rocks have already been mentioned. It may be said of the general artesian prospects of such wells that previous experience is an unreliable indication of what may be expected. Some of these wells have furnished satisfactory amounts of water of good quality and others have not. In general, it may be said that even if they reach water the head is apt to be low.

The information available for wells in the Piedmont area is brought together in the accompanying tables. The amount of this information is not large and the usual uncertainty regarding artesian prospects in crystalline rocks is strikingly illustrated. These rocks are intensely folded and abound in small joint and fault planes so that definite water beds are absent, the main water content circulating through these minute cavities which may be at one level in one well and at a very different level in a nearby well. The head is also liable to vary through wide limits, and for the same reasons in adjacent wells.

Inasmuch as demands for domestic supplies are amply cared for by the municipal supply, and it is only large industrial concerns that need to supplement the public supply, and as these are located for the most part in the Coastal Plain portion of the Baltimore district, the uncertain character of the Piedmont artesian resources is not as serious as would otherwise be the case. Wells put down in the suburban district north and west of the city have already been enumerated in the discussion of the water resources of Baltimore County and need not be repeated in the present connection. A number of wells have been drilled in the northeastern section of the city. The greater part of this exploitation has been by the breweries in that section. Wiessner's Brewery, Gay and Lanvale Streets, has three deep wells, one of which is reported to have been drilled to a depth of 3000 feet without securing any large amount of water. A 600-foot well at this place struck a water zone at a depth of 300 feet which is reported as pumping 200 gallons per minute. Wells at the Bauernschmidt Brewery, Gay and Federal Streets, 315 and 400 feet deep, each yielded between 25 and 30 gallons per minute, but apparently caused a diminution in the yield of the Wiessner wells.

A well at Brehm's Brewery, on Brehm's Lane east of Belair Road, was sunk to a depth of 1500 feet without encountering a satisfactory supply, although about 13 gallons per minute were struck between 700 and 800 feet. A well of the Standard Brewing Company, Gay Street and Lafayette Avenue, 286 feet deep, furnishes 15 gallons per minute of ferruginous water. At the Von der Horst Brewing Company's plant, corner of Gay

Street and North Avenue, a 300-foot well is reported as yielding 120 gallons per minute.

Several private wells in the vicinity of Gay Street and North Avenue yield small amounts of water, and it would appear that the chances of obtaining small supplies at depths around 300 feet are fairly good in this immediate vicinity. The Evergreen Lawn Improvement Association on Hamilton Avenue near Harford Road have three 6-inch wells. One 240 feet deep struck 36 gallons per minute at 80 feet and probably tapped a nearby vertical fault plane containing water. Another well was sunk to a depth of 475 feet without encountering any water, and a third 654 feet deep yielded over 100 gallons per minute. The number of wells in the northwestern section of the city is small and the prospects are similarly uncertain.

The Roland Park Company have put down a number of wells and obtained large amounts of water from depths between 148 and 227 feet. One well at Mount Washington was entirely dry and the other wells in the vicinity are all shallow and probably obtain small amounts of water from the loose materials above the crystalline rocks. The West Arlington Improvement Association have two 197-foot wells in which the water rises to within 30 feet of the surface and the yield is reported as large.

Successful wells have been drilled at Melvale and along Park Heights Avenue, but no definite water horizon can be predicted. The Garrett well on Charles Street near Merrymans Lane yields 70 gallons per minute from a depth of 342 feet, the water heading 50 feet below the surface. A 190-foot well at Electric Park furnishes 75 gallons per minute, and two wells at Denmore Park 106 and 140 feet deep yield 50 and 20 gallons respectively.

But few wells have been drilled in the western section of the city and the results are very irregular. The abbatoir well at Calverton furnishes 60 gallons per minute from an unknown depth. The American Ice Company have several wells; one at Schroeder and Baltimore Streets was sunk to a depth of 1017 feet. It furnishes 20 gallons per minute. This company has two other wells at Franklin and Pulaski Streets which are

200 and 242 feet deep. At 200 feet water was struck which headed 15 feet below the surface. The yield was 40 gallons per minute from one well and 60 gallons from the other. The Baltimore Refrigerating & Heating Company at 426 S. Eutaw Street have a 304-foot well which produced 25 gallons per minute, but the water is so bad that the well is not used.

There are a considerable number of wells at Claremont. All of these yield greater or less amounts of water. The water from the 48-foot well at the Claremont Abbatoir was unsanitary and is not used. An 82½-foot well at this plant yields 70 gallons per minute. The Davison Chemical Company have two wells at Claremont 101½ and 139½ feet deep. They are reported as each furnishing 75 gallons per minute.

The Greenwald Packing Company have two wells at Claremont each 196 feet deep. One is reported to yield 130 gallons per minute and the other 12 gallons. The Globe Brewing Company at Hanover and Conway Streets have a 197-foot well which yields 10 gallons per minute, and the Hannis Distilling Company, Ostend and Warner Streets, have an 800-foot well that yields 20 gallons per minute from a depth of 200 feet. Wells on the Frederick Road near Mt. Olivet Cemetery and at Mount Winans report small yields from between 238 and 360 feet. At Levy's Hat Factory, Pratt and Lombard Streets, a 525-foot well furnishes 130 gallons per minute, the water heading 37 feet below the surface.

It would appear that the chances of striking water within 300 feet of the surface in the western section of the city are good, but that the amount is an entirely uncertain quantity.

Non-Artesian Waters

SPRINGS.—There are numerous springs in Baltimore and vicinity, the majority of which are located near the "fall line" in the Coastal Plain section and throughout the deeply dissected Piedmont section. Many of these within the city limits were formerly used, but all except one, or possibly two, have long been abandoned on account of the danger of contamination. A large spring situated about the center of the block bounded by St. Paul, Monument, Calvert, and Center Streets is being used by the Monticello Pure Rye Distillery, located on Calvert near Center Street. This spring is near the foot of the Wicomico terrace which runs approximately north and south along Charles Street from Fayette to Chase Streets. At this locality clear and cold water bubbles up from a coarse yellow sand at an estimated rate of 200 gallons per minute. This flow is reported to vary somewhat, but the supply is always large. The water flows by gravity to storage tanks and then through the condensers of the distillery and an ice cream factory. There was formerly another large spring located at the base of this hill about four blocks farther south, reported to be a very much larger spring, but the point of emergence is now covered.

In the Piedmont area around Baltimore there are many springs, both large and small, some of which, like the Chattolanee Spring in the Green Spring Valley, have long been celebrated.

These spring waters are utilized in the manufacture of soft drinks and in supplying table water. Upwards of a million gallons of table water are sold annually in Baltimore and vicinity. The principal concerns engaged in this business are the Chattolanee Spring Water Company, Powhatan Spring Water Company, Rognel Heights Water Company, Royal Spring Water Company, Caton Spring Water Company, and Brooklandwood Farms and Spring Company.

The Chattolanee and Brooklandwood springs are situated in the Green Spring Valley north of the city. The Royal Springs are at Ruxton Heights. Caton, Powhatan and Rock Crystal springs are west of the city at Catonsville, Woodlawn, and Rognel Heights respectively.

Analyses of these various spring waters are given elsewhere in this report.

SHALLOW WELLS.—Shallow wells have entirely gone out of use within the city as it is impossible to obtain an uncontaminated supply from such sources. Some shallow wells are still being used in the suburban district, but they are dangerous and it is only a question of time when their use will cease altogether. It is therefore unessential to discuss shallow wells for the Baltimore district.

TABLE OF WELLS IN NORTHWEST BALTIMORE

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Date drilled	Driller
1	3503 N. Charles St.	L. T. Appold	240	125	6	125	Crystallines	....	—21	......	9		
2	Charles & 40th Sts.	N. Bartlett	220	300	6	....	Crystallines	....	—28	......	....	1895	O'Donovan.
3	Denmore Park	Hotel Denmore	420	106'10"	..	95	Crystallines	2 gals. at 35	—20	......	50	1911	Hodhall.
4	Denmore Park	Hotel Denmore	420	140	..	....	Crystallines	....	....	......	20	....	
5	Electric Park	Electric Park Amusement Co.	420	190	6	190	Crystallines	....	—30	......	75	1898	O'Donovan.
6	Charles St. near Merriman Lane	W. T. H. Garrett	368	342	6	342	Crystallines	....	—50	......	70	1896	O'Donovan.
7	Charles St.	....	....	197	..	197	Crystallines	....	....	......	35	1895	O'Donovan.
8	Bellona Ave. near Charles St.	C. S. Golding	....	100' 10"	6	100' 10"	Crystallines	....	....	......	12	....	Downin.
9	Charles St. Road	John Mathews	....	205	6	205	Crystallines	....	—60	......	....	1896	O'Donovan.
10	Park Ave. & Saratoga St.	St. Alphonsus Church	40	42	5	42	Crystallines	....	....	......	55	1900	C. Miller.*
11	Charles St. near Madison St.	Stafford Hotel	100	315	8	90	Crystallines	....	....	......	15	1905	Rust.
12	Park Heights Ave.	Numsen	400	82½	6	82½	Crystallines	....	....	......	15-18	....	Downin.
13	Melvale	E. A. Jackson	....	150	6	150	Crystallines	....	—40	......	15	1896	O'Donovan.
14	Melvale	C. O. Lee	....	103	6	103	Crystallines	....	—40	......	10	....	O'Donovan.
15	Roland Park	Roland Park Elec. & Water Co.	220	180	6	175-180	Crystallines	....	....	......	100+	....	Downin.
16	Roland Park	Roland Park Elec. & Water Co.	220	497' 6"	6	227	Crystallines	....	....	......	18	1906	Downin.
17	Roland Park	Roland Park Elec. & Water Co.	220	148	6	148	Crystallines	....	—12	......	70	....	Downin.
18	Roland Park	Car Barn, United R. R.	220	386	6	386	Crystallines	....	....	5	....	....	
19	West Arlington	West Arlington Imp. Co.	460	197	..	197	Crystallines	....	—30	......	Strong	1893	
20	West Arlington	West Arlington Imp. Co.	460	197	..	197	Crystallines	....	—30	......	Many	1893	O'Donovan.†
21	Mt. Washington	Otto Mattfeldt	260	158½	6	158½	Crystallines	....	....	No water	....	....	O'Donovan.†
22	Mt. Washington	Dixon	260	56	6	56	Crystallines	30 & 40 cased off	—6	......	20	1908	C. E. Downin.
23	Lake Ave. near Charles St.	Michael Jenkins	400	300	8	300	Crystallines	....	—15	......	7	....	C. E. Downin.

* Not in use. † Could not verify in 1910.

TABLE OF WELLS IN SOUTHWEST BALTIMORE

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Schroeder & Baltimore Sts.	American Ice Co.	75	1017	6	....	....	....	....	....	20	....	....	Downin.	
2	Franklin & Pulaski Sts.	American Ice Co.	160	242	6	....	200	Crystallines	....	−14	60	....	1911	J. S. Downin.	
3	Franklin & Pulaski Sts.	American Ice Co.	160	200	6	....	200	Crystallines	10 gals. at 33 ft.+	−15	40	....	1911	J. S. Downin.	
4	Pratt & Eutaw Sts.	Armour & Co.	40	178	6	....	178	Crystallines	....	....	40-50	....	....	Downin.	
5	Pratt St. & Frederick Ave.	Baltimore Brewing Co.	100	312	....	....	....	....	....	....	18	....	....	Downin	Plant closed down.
6	Russell & Carey Sts.	Baltimore Distilling Co., 4 wells.	10	40	2½	....	37-40	Pleistocene	....	....	250 in all	Poor	1904	Baltimore Artesian Well Co.	Four wells.
7	426 S. Eutaw St.	Baltimore Refrigerating & Heating Co.	30	100	8	....	45-57	Crystallines	....	30-35	60 in all	Bad	....	Downin	Twenty wells, not used.
8	426 S. Eutaw St.	Baltimore Refrigerating & Heating Co.	30	304	8	....	304	Crystallines	....	−30	25	Bad	....	Miller	Not used.
9	Claremont	Claremont Abattoir	90	82½	6	....	82½	Crystallines	....	....	70	....	1903	Downin.	
10	Claremont	Claremont Abattoir	90	48	6	....	48	Pleistocene	....	....	12	Bad	1903	Downin	Abandoned.
11	Claremont	Davison Chemical Co.	90	139½	6	....	139½	Crystallines	....	....	75	....	1903	Downin.	
12	Claremont	Davison Chemical Co.	90	101½	6	....	101½	Crystallines	....	....	75	....	1903	Downin.	
13	Claremont	Greenwald Packing Co.	80	196	6	....	180-196	Crystallines	....	....	130	....	....	Downin.	
14	Claremont	Greenwald Packing Co.	80	196	6	....	180-196	Crystallines	....	....	12	....	....	Downin.	
15	Hanover & Conway Sts.	Globe Brewing Co.	20	197	6	....	197	Crystallines	....	....	10	....	....		
16	Ostend & Warner Sts.	Hannis Distilling Co.	10	800	....	....	200	....	....	....	20	....	....		
17	Ostend & Warner Sts.	Hannis Distilling Co.	10	42	12	....	....	Pleistocene	−6	....	70	....	....		
18	Ostend & Warner Sts.	Hannis Distilling Co.	10	42	12	....	....	....	−6	....	70	....	....		
19	Sharp & Ostend Sts.	Hilgartner & Sons.	10	44	4	....	....	....	....	....	Many	Very bad	....	....	Abandoned.
20	Pratt & Lombard Sts.	Levy's Hat Factory	40	525	8 to 6	....	....	Crystallines	−37	....	130	....	1911	F. P. Rust	Driller claims well will yield 200 gallons per minute.
21	Frederick Rd. near Mt. Olivet Cemetery.	Mr. Lober	120	360	....	....	360	Crystallines	....	....	15	....	....	Downin.	
22	Hollins St. & Calverton Rd.	Lipps Soap Factory	80	200	....	....	200	Crystallines	−65	....	35	....	....		
23	Mt. Winans	Md. Glass Corporation	20	267	6	....	238-267	Crystallines	....	....	Small	....	....	Downin.	
24	Edmondson Ave. nr Cathedral Cemetery	Montgomery property	200	98½	6	....	98½	Crystallines	....	....	3	....	....	Downin.	
25	Pratt & Howard Sts.	Sharp & Dohme	30	90	6	....	90	Crystallines	....	....	4	....	....	Downin.	
26	Pratt & Howard Sts.	Sharp & Dohme	30	94	6	....	62	Crystallines	....	....	20	....	....		
27	Ridgely St. nr. B. & O. R. R.	Spring Garden Brewing Co.	20	500	....	....	....	Crystallines	....	....	Dry	....	....		
28	Calverton	Sheep Butchers' Abattoir	80	....	....	....	....	Crystallines	....	....	66	....	....	....	Place closed.
29	Winder & Leadenhall Sts.	Thompson Chemical Co.	10	104	6	104	104	Crystallines	....	−30	85	Soft	1894		
30	Westport	Western Md. R. R.	10	60	....	....	....	Crystallines	....	....	Small	Very bad	....		
31	Frederick Road	Wilkins Hair Factory	60	200	6	....	200	Crystallines	....	....	35-40	....	1909	Downin.	
32	Frederick Road	Wilkins Hair Factory	60	206	6	....	206	Crystallines	....	....	4	....	1909	Downin.	
33	Frederick Road	Wilkins Hair Factory	60	225	6	....	225	Crystallines	....	....	35-40	....	1909	Downin.	
34	1220 Frederick Road	Chas. Wiskow	200	254	6	....	90 & 200	Crystallines	....	−12	20	....	1911	Hoshall.	
35	1220 Frederick Road	Chas. Wiskow	200	109	6	....	30 & 80-109	Crystallines	....	−7	22½	....	1911	Hoshall.	

TABLE OF WELLS IN NORTHEAST BALTIMORE

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Depth to principal supply	Geologic horizon	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Gay & Federal Sts	Bauernschmidt Brewing Co	100	400	..	....	Crystallines	....	25	....	....		
2	Gay & Federal Sts	Bauernschmidt Brewing Co	100	315	..	....	Crystallines	....	31	....	....		
3	Oliver & Dallas Sts	Mr. Branzinger	80	321	4½	—29	Crystallines	—29	40	....	1899	C. Miller.	
4	Brehm's Lane near Belair Road	Brehm's Brewery	140	1500	8	700-800	Crystallines	....	13	....	....	Harper	Another well here, 1300 feet deep, is dry.
5	Duncan & McElderry Sts	Mr. Herring	90	62	6	....	Crystallines	....	No water	....	....	C. Miller.	
6	Washington & McElderry Sts	Mr. Novak	80	84	5	....	Crystallines	—80	......	Muddy	....	Thomas.	
7	Gay & Lafayette Ave	Standard Brewing Co	120	286	6	....	Crystallines	....	15	Iron			
8	Gay & North Ave	Von der Horst Brewing Co	120	300	10	....	Crystallines	....	120	....	....		
9	Harford Road near Weber's Park	E. E. Weaver	200	203	6	203	Crystallines	....	2	....	1907	Goshall.	
10	Harford Road near Weber's Park	H. A. Weaver	200	112	6	112	Crystallines	....	1	....	1907	Hoshall.	
11	Gay & Lanvale Sts	Wiessner's Brewery	140	1500	8	....	Crystallines	....	10±	....	1907	Harper.	
12	Gay & Lanvale Sts	Wiessner's Brewery	140	3000	8	....	Crystallines	....	15±	....	1907	Harper.	
13	Gay & Lanvale Sts	Wiessner's Brewery	140	600	..	300	Crystallines	....	200	....	....		
14	Franklin Ave. near Belair Road	C. A. Morningstar	220	159	6	145	Crystallines	....	1	....	1911	Hoshall.	
15	York Road, Govans *	Mr. McCabe	....	300	..	....	Crystallines	—30	......	....	....	C. E. O'Donovan.	
16	Gittings & Bellona Ave	Estate of Henry Schwartz	....	200	6	....	Crystallines	—29	40+	....	1897	Wm. Beck.	
17	Hamilton Ave. near Harford Road.	Evergreen Lawn Imp. Assoc	150	654	6	...	Crystallines	35 gals. at 510	100+	....	....	Harper	This well was reported a year later as having a yield of 250 to 300 gallons per minute.
18	Hamilton Ave. near Harford Road.	Evergreen Lawn Imp. Assoc	180	475	6	....	Crystallines	....	Dry	....	1906	Harper.	
19	Hamilton Ave. near Harford Road.	Evergreen Lawn Imp. Assoc	180	240	6	80	Crystallines	....	36	....	1906	Harper.	
20	Lauraville	Mr. Harper	300	132	3	....	Crystallines	....	No water	....	1904	Balto. Artsn. Well Co.	
21	Lauraville	August Breidenstine	250	38	3	35-38	Crystallines	....	10	Excellent	1904	Balto. Artsn. Well Co.	
22	Lauraville	R. B. Mason	....	....	..	100-108	Crystallines	—50	20	Excellent	1895	Balto. Artsn. Well Co.	

* Darton, N. H. U. S. Geol. Survey, Bull. No. 138, 1895. Could not verify in 1910.

TABLE OF WELLS IN SOUTHEAST BALTIMORE

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Aliceanna & W. Falls Ave.	City. Public well	10	112	3	....	70	Pleistocene	....	....	Poor	....	....	Condemned by City Health Department and abandoned.
2	....	Balto. Dry Dock Co.	5	167	6	....	....	Patuxent	....	100	......	....		
3	Foot of Warren St.*	Beacham Bros.	10	58	1½	....	....	Pleistocene	—18	Fair	......	....		
4	Foot of E. Winder St.*	Chesapeake Glass Co.	20	54	1½	....	....	Pleistocene	....	150	Bad	....		
5	Foot of E. Winder St.*	Chesapeake Glass Co.	20	68	1½	....	....	Pleistocene	....	175	Bad	....		
6	Foot of E. Winder St.*	Chesapeake Glass Co.	20	127	2	....	....	Patapsco	....	100	Good	....		
7	Foot of E. Winder St.*	Chesapeake Glass Co.	20	117	2	....	....	Patapsco	....	100	Good	....		
8	Foot of E. Winder St.*	Chesapeake Glass Co.	20	122	2	....	....	Patapsco	....	100	Good	....		
9	York St.*	Marble Works	10	60	2½	....	....	Pleistocene	....	Small	Brackish	....		
10	York St.*	Marble Works	10	200	6	....	....	Crystallines	....	Small	Brackish	....		
11	Covington & Donaldson Sts.*	Horner & Co.	10	....	....	....	....	....	—10	250	......	....		
12	Light St. Bridge.*	....	5	....	....	....	....	....	+	Large	Iron	....		
13	Ferry Landing.*	....	10	....	....	....	....	....	....	Large	Good	....		
14	Block & Albemarle Sts.*	Maltby Estate	10	900	....	....	....	Crystallines	....	Good	......	....		
15	Pratt & Light Sts.*	Maltby House	10	100	12-10	....	....	Patapsco	....	40	......	....		
16	Foot of Chester St.*	Sugar Refinery	5	112	....	....	....	Patapsco	....	Large	......	....		
17	Near Ft. McHenry	Warren Mfg. Co.	5	148	4	....	....	Patuxent	....	50	......	....		
18	Eastern Ave & Chester St.	Sheppard & Co.	30	80	12	....	....	Pleistocene	—20½	500	......	....	....	The yield of this well and the head of the water decreased very considerably in 1910.
19	Lawrence & Clement Sts.	Torsch Packing Co.	5	138	6	138	138	Patuxent	—14	50	......	1895	Wm. Rust & Co.	
20	Foot of Streeper St.	Fait & Slagel Co.	5	98	9	....	....	Patuxent	....	20	......	....		
21	Foot of Streeper St.	Fait & Slagel Co.	5	112	10	....	....	Patuxent	....	Many	......	....		
22	Foot of Kenwood Ave.*	Tunis Lumber Co.	5	148	1½	....	148	Patuxent	....	Many	......	....		
23	Boston & Luzerne Sts.*	G. G. Tyler	5	225	4	....	....	Patuxent	—6	Many	......	....		
24	Boston & Luzerne Sts.	G. G. Tyler	5	120	6	....	....	Patuxent	....	40	......	....		
25	Boston & Concord Sts.*	Wagner & Co.	..	100	6	....	....	Patuxent	—7	50	......	....		
26	Boston & Concord Sts.*	Wagner & Co.	..	100	1½	....	....	Patuxent	—7	30	......	....		
27	Charles & Winder Sts.	White & Middleton Gas Engine Co.	30	200+	6	....	....	Patuxent	—6 to —8	Fair	Salty, not used	1905	Clark Hoshall.	
28	Foot of Woodall St.	Wm. E. Woodall & Co.	5	115	8	115	115	Patuxent	—6	16	......	1879	Miller.	
29	Wolfe & Thames Sts.*	Winebrenner Bros.	5	127	4	....	85	Patuxent	—1	50	......	....		
30	2512 Boston St.	Canton Box Co.	5	96-100	8	....	96-100	Patuxent	—20	Good	Slightly salty	1884		
31	2731 Boston St.	The J. S. Young Co.	5	147	6	140	147	Patuxent	—18	60	......	1900	Miller.	
32	2731 Boston St.	The J. S. Young Co.	5	1000	....	....	190?	Crystallines	—30	100	......	1907	Thos. B. Harper.	
33	Hughes & Henry Sts.	Amer. Ice Co. 8 wells	5	110-136	6	110-136	110-136	Patuxent	—5	615 in all	......	1899	....	There are 8 wells in this group all connected.
34	Wolfe & Fell Sts.	Amer. Ice Co. 12 wells	5	145-165	6,8	145-165	145-165	Patuxent	—20	Large	......	....	....	These 12 wells are all connected and there is no way to determine yield.

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TABLE OF WELLS IN SOUTHEAST BALTIMORE.—Continued

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
35	Wolfe & Fell Sts.*	American Ice Co.	5	157	....	....	155-157	Patuxent	—15	300	......	....	....	These two wells were reported by Darton, but could not be verified. Rock was struck at 137 feet in both wells.
36	Wolfe & Fell Sts.*	American Ice Co.	5	317	....	....	....	Patuxent	....	....	......	....	....	
37	Central Ave. & Gough St.	Bartholomay Brew. Co.	15	320	8	....	....	Patuxent	....	No water	......	....		
38	Central Ave. & Fleet St.	Edwin Bennett Pottery Co.	10	50	8	50	50	Pleistocene	—27	Large	Good	...	....	Reported by Darton, could not verify.
39	Eastern Ave. & Bethel St.*	Bohemian Church	15	22	5	....	45-50	Pleistocene	....	Many	......	1898		
40	Wolfe & Lancaster Sts.	Booth Packing Co.	5	96	10½	....	....	Pleistocene	—18	1	......	....	C. Miller.	
41	Thames & Wolfe Sts.	John Boyle Co.	5	142	3	....	....	Patuxent	—4	200	......	1884		
42	Lakewd Ave. & Boston St.*	Chipman & Son	5	123	6	....	70-75	Patuxent	—6	150	Strong iron	1905	....	Reported by Darton in 1895. In 1910 well was said to yield 1000 gallons per minute.
43	McComas near water front.	Consol. Gas & Elec. Co.	20	150	4	148	....	Patuxent	....	Many	......	....	Baltimore Artesian Well Co.	Not used on account of iron in water.
44	Fait Ave. & Kenwood Ave.	Consol. Gas & Elec. Co.	40	66	6	40	30	Pleistocene	....	30	Salty, not used	1907		
45	Frederick nr. Baltimore St.	Co-operative Ice Co.	10	125	8	....	40-66	Crystallines	—17	65	......	1894	Downin	Four other wells at this place gave out about the time this well was drilled and were abandoned.
46	Hillen & Front Sts.	Darby Candy Co.	15	300±	8	....	....	Crystallines	....	No water	......	1907	Thos. B. Harper.	
47	Wolfe & Lancaster Sts.*	Davison & Co.	5	....	8	....	....	....	....	Plenty	......	....	....	Water is unfit for use.
48	President & Fleet Sts.*	Duker & Co.	10	90	....	....	....	Pleistocene	—3	Many	......	....		
49	Gough St. near Broadway.	Lewis Eckles & Sons Ice Mfg. Co.	20	135	4½	135	135	Patuxent	—35	20	......	1905	Sam. Downin.	
50	Gough St. near Broadway.	Lewis Eckles Ice Mfg. Co.	20	165	6	130	130	Patuxent	—35	45	......	1906	Sam. Downin	Four-foot strainer at 90 feet.
51	Gough St. near Broadway.	Lewis Eckles Ice Mfg. Co.	20	125	8	....	125	Patuxent	—35	35	......	1909	Sam. Downin	Ten-foot strainer at 90 feet.
52	1032-34 Haubert St.	Lewis Ehrman	20	128	8	128	128	Patuxent	—18	45	......	....		
53	President & Styles Sts.	Lewis Elmer & Sons 3 wells.	10	35±	....	....	....	Pleistocene	....	5-6 each	......	....	....	Three wells in this group.
54	Central Ave. & Bank St.	Lewis Elmer & Sons 5 wells.	10	55	....	....	....	Pleistocene	....	No water	......	....	....	Five wells in this group.
55	Central Ave. & Bank St.	Lewis Elmer & Sons	10	60	4½	....	30-60	Pleistocene	....	Large	......	....	....	This well choked up after 9 months and could not be reclaimed.
56	Central Ave. & Bank St.	Lewis Elmer & Sons 3 wells.	10	72	6	....	60-70	Pleistocene	—15	15-20 each	......	1909	D. Miller	Three wells in this group.
57	Central Ave. & Bank St.	Lewis Elmer & Sons 3 wells.	10	72	4½	...	60-70	Pleistocene	—15	15-20 each	......	1909	D. Miller	Three wells in this group.

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TABLE OF WELLS IN SOUTHEAST BALTIMORE.—CONTINUED

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
58	Calvert & Baltimore Sts...	Emerson Hotel.........	15	90	10	....	55	Crystallines	—35	40	......	1911	Thos. B. Harper.	
59	Ft. McHenry *...........	....	20	145	....	....	....	Patuxent	....	....	......	....		
60	Boston & Hudson Sts.......	Farren & Co...........	5	116	....	....	....	Patuxent	—23	40	......	....		
61	Charles & Barre Sts.*.......	Gail & Ax............	20	380	6	....	....	Crystallines	....	No water	......	....	Redpath & Potter.	
62	Calvert near Center.......	Gardiner Dairy Co......	20	000	....	....	....	Crystallines	Small	....	......	....	C. E. O'Donovan...	This well was reported in 1910 as being 200-300 feet deep by engineer in charge.
63	2301 Boston St............	Gibbs Preserving Co....	5	100	8	....	....	Patuxent	—10	100	......	....		
64	2357 Boston St............	Louis Grebb...........	5	106	4½	....	106	Patuxent	—16	40-50	......	....		
65	Foot of Block St...........	Hammond Ice Co......	5	100	6	....	....	Pleistocene	....	....	......	....	....	These wells are not in use. Plant closed permanently.
66	Caroline & Fleet Sts.......	Heise & Bruns.........	10	70	10	....	....	Pleistocene	—1	....	......	....	....	Well abandoned on account of large amount of iron in water.
67	Federal Hill *.............	Jones Paper Mill......	20	402	....	....	150	Crystallines	—75	75	......	....		
68	8th St. bet. Gough & Pratt.	Kimball & Tyler.......	60	183	6	....	140-183	Patuxent	....	35-40	......	....		
69	Pleasant & Guilford Ave...	Kingan Provision Co...	25	240	4	240	240	Crystallines	—12	40	......	1897	Downin.	
70	York & Williams Sts.......	Knickerbocker Ice Co..	10	150	6	....	150 ?	Patuxent	—20	250 in all	Brackish, much iron	1901	Downin	Originally these wells were 150 feet deep. Most of them have filled in to about 90 feet.
71	2115 Aliceanna St..........	J. Langrell & Bro.....	5	90	8	90	90	Pleistocene	....	100±	Soft	1901	Shannahan.	
72	Block & Caroline Sts......	Lauer & Suter.........	10	99	3	....	45-48	Pleistocene	—8	100	Very poor	1904	Baltimore Artesian Well Co.	
73	Foot of Lakewood Ave....	H. J. McGrath.........	5	176	2½	176	176	Patuxent	....	30	Hard	1889		
74	Foot of Lakewood Ave....	H. J. McGrath *.......	5	114	2	....	....	Patuxent	....	20	......	....		
75	901-913 Wolfe St..........	Miller Bros. & Co......	10	98	6	98	98	Pleistocene	—25	35	Hard	1905	Miller.	
76	Foot of Montgomery St....	Moore & Brady.........	5	135	8	....	53	Patuxent	—10	Many	......	....		
77	Light & Wells St...........	National Enamelling & Stamping Co.	35	167	6	167	167	Patuxent	—40	75	Soft	....	Downin	In 1910 this well was claimed to have a yield of 90 gallons.
78	Boston & Luzerne Sts......	Norton Tin Co. 4 wells.	5	50-60	12	....	50-60	Pleistocene	....	35-60 each	......	....	....	Four wells in this group. Ruined by acid overflowing tanks and saturating ground around the wells.
79	Boston & Luzerne Sts......	Norton Tin Co........	5	120	8	....	120	Patuxent	Many	....	......	....		
80	Jackson St. & 5th Lane....	Wm. Numsen & Sons Inc.	10	100	....	....	100	Patuxent	—10	60	......	....	....	This well was reported in 1910 as having run dry about 1903.
81	Jackson St. & 5th Lane....	Wm. Numsen & Sons Inc.	10	114	6	....	114	Patuxent	....	60	......	1903	Downin	Reported in 1910 as having a capacity of 26 gallons.
82	Foot of Hill St............	G. Ober & Sons Co....	5	130	4 & 2	130	130	Patuxent	—10 to —15	30	Good	1901		
83	Foot of Woodall St........	Piedmont & Mt. Airy Guano Co.	5	109	4	109	109	Patuxent	—13	Large	Soft	1905	Miller.	
84	Clement & Boyle Sts.......	Platt & Co............	5	110	6	100	100	Patuxent	—6	30-40	Hard, iron	1904	Downin	Reported by driller at time of drilling as being 119½ feet deep with a yield of 60 gallons.
85	Foot of West St...........	Balto. Dry Dock Co...	5	72	2½	....	72	Pleistocene	....	Many	......	....		
86	Adjoining Ft. McHenry....	Balto. Dry Dock Co...	5	118	6	118	118	Patuxent	—20	Large	......	1904		

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TABLE OF WELLS IN BALTIMORE COUNTY EAST AND SOUTHEAST OF BALTIMORE CITY

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Back River	Sewerage Disposal Plant, Baltimore City.	25-30	156	6	146	146-156	Patuxent	10, 18-20, 130	—15	15	......	1909	Chas. Hoshall.	
2	Prospect Park, Back River.	H. A. Brehm	40	138	4	135	136	Patuxent	....	—20	25-30	Soft	1907	Downin.	
3	Bay Shore Pk, pwr house.	United Railways	10	634	6	....	....	Patuxent	....	....	150	Hard	1907	Shannahan.	
4	Bay Shore Pk, pump house.	United Railways	10	743	8	....	721-743	Patuxent	....	+3	150	Hard	1907	Shannahan.	
5	Bay Shore Park	United Railways	6	402′6″	8	....	402′6″	Patuxent	....	....	100	Iron	1907	Shannahan.	
6	Bay Shore Park	United Railways	6	339′6″	8	....	339′6″	Patuxent	....	....	66	Iron	1905	Shannahan.	
	Canton														
7	2272 S. Clinton St	Amer. Agri. Chem. Co	5	230	8	230	230	Patuxent	....	—20 to —30	Large	......	1897	Rust Well Co.	
8	2272 S. Clinton St	Amer. Agri. Chem. Co	5	240	6	240	240	Patuxent	....	....	Good	......	1902	Rust.	
9	1st St. & 3d Ave		20	212	..	....	165	Patuxent	....	....	45	......	....		
10	Clinton & 3d Sts		20	87	4	....	87	Patuxent	....	—16	20	......	....		
11	Clinton & 3d Sts		20	90	4	....	90	Patuxent	....	—16	20	......	....		
12	Clinton & 3d Sts		20	160	..	....	....	Patuxent	....	....	Many	......	....		
13	1st St. & 3d Ave		..	50	..	....	....	Patuxent	....	....	10 each	......	....		Six wells.
14	1st St. & 3d Ave		2	114	8	....	....	Patuxent	....	....	75	......	....		
15	5th Ave.		..	223½	8	....	....	Patuxent	....	....	200	......	....		
16	4th Ave. & 5th St		15	225-240	8	225-240	225-240	Patuxent	....	—50	750 in all 4 wells	......	1903 1905	Shannahan	Four wells.
17	4th Ave. & 5th St		15	225	6	225	225	Patuxent	....	—50	45	......	1903	Shannahan.	
18	Clinton & 9th Sts.*	Baltimore Guano Co	10	125	12	....	....	Patuxent	....	....	Many	......	....		
19	Clinton & 9th Sts.*	Baltimore Guano Co	10	170	3	....	....	Patuxent	....	....	Many	......	....		
20	Clinton & 9th Sts.*	Baltimore Guano Co	10	220	3	....	....	Patuxent	....	....	Many	......	....		
21	Clinton & 9th Sts.*	Baltimore Guano Co	10	80	3	....	....	Patuxent	....	....	Many	......	....		
22	Foot of Clinton St	Baugh Chemical Co	10	245	8	....	233	Patuxent	150 cased off	—18	200	Good	1908	Shannahan.	
23	4th Ave. & 2d St	Canton Iron & Steel Co	15	215	8	215	215	Patuxent	....	—52	100	Good	1902		
24	4th Ave. & 2d St	Canton Iron & Steel Co	15	235	8	235	235	Patuxent	....	—42	100	Good	1905		
25	10th St. & 5th Ave.*	Canton Power House Co	20	198	8	....	....	Patuxent	....	....	100	......	....		
26	2d Ave. & 8th St.*	Davison Acid Works	20	196	4½	....	....	Patuxent	....	—26	40	......	....		
27	3d Ave. & 8th St	Davison Chemical Co	20	210	8	210	....	Patuxent	....	—40	50±	Good	1905	Shannahan.	
28	4th Ave. & 8th St.*	Electric Refining Co	15	129	10	....	....	Patuxent	....	....	120	......	....		Two wells.
29	4th Ave. & 8th St.*	Electric Refining Co., 2 wells.	15	50 100	3 6	....	....	Patuxent	....	....	160 in all	......	....		Plant abandoned in 1903.
30	4th Ave. & 8th St.*	Electric Refining Co	15	216	8	....	....	Patuxent	....	....	150	......	....		
31	O'Donnell & 3d Sts	G. B. S. Brewing Co	80	225-235	10	....	225-235	Patuxent	....	....	70 in all	......	....		Two wells.
32	Clinton & 5th Sts.*	Griffith & Boyd	5	90	12	....	....	Patuxent	....	....	Many	......	....		
33	Clinton & 5th Sts	Griffith & Boyd	5	190	10	....	....	Patuxent	....	....	Many	......	....		
34	O'Donnell & 3d Sts	Geo. Gunther, Jr., Brewing Co.	80	208	6	208	208	Patuxent	....	—56	120	......	....		Not in use.
35	O'Donnell & 3d Sts	Geo. Gunther, Jr., Brewing Co.	80	207?	6	....	....	Patuxent	....	....	50-60	......	....	Miller.	
36	Toone & 3d Sts	Geo. Gunther, Jr., Brewing Co.	40	197	8	197	197	Patuxent	60	—60	175	Hard	1899		
37	Clinton & 10th Sts.*	Lazaretto Fertilizer Co	5	220	..	....	....	Patuxent	....	—22	Many	......	....		
38	Lazaretto Light House	U. S. Government	5	165±	1¼	165±	165±	Patuxent	....	—18	5	Hard	1886	J. E. Robinson.	
39	Clinton & 11th Sts.*	Md. Fertilizer Co., 3 wells.	5	140	2½, 1¼	....	....	Patuxent	....	—8	15	......	....		Three wells.
40	O'Donnell & 11th Sts	Md. Pure Rye Distillery	40	121	8	121	121	Patuxent	....	—35	80	Soft	....		
41	O'Donnell & 11th Sts	Md. Pure Rye Distillery	40	157	6	157	157	Patuxent	....	—40	27	Soft	....		
42	O'Donnell & 11th Sts	Md. Pure Rye Distillery	40	172	8	172	172	Patuxent	....	—45	92	Soft	....		
43	O'Donnell & 11th Sts	Md. Pure Rye Distillery	40	187	8	187	187	Patuxent	....	—45	80	Soft	....		
44	O'Donnell St.*	Monumental Distilling Co., 2 wells.	..	170, 190	..	....	....	Patuxent	....	—12	Many	......	....		Two wells.
45	O'Donnell & 3d Sts	National Brewing Co	80	330	10	330	330	Patuxent	....	—75	100	......	1887		

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TABLE OF WELLS IN BALTIMORE COUNTY EAST AND SOUTHEAST OF BALTIMORE CITY.—CONTINUED

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
46	O'Donnell & 3d Sts.	National Brewing Co.	80	230	10	230	230	Patuxent	....	—75	65	......	1891		
47	O'Donnell & 3d Sts.	National Brewing Co.	80	430	8	230	430	Crystallines	....	—90	90	......	1892		
48	Clinton St. bet. 5th & 6th Sts.	Northern Central R. R.	5	183	16	183	183	Patuxent	....	....	....	......	1876	....	This well originally flowed at +2 feet and had a large yield. Head of water lower 30 feet and well was abandoned on this account.
49	Clinton & 6th Sts.	Northern Central R. R.	5	183	8	183	183	Patuxent	....	+2	Fair	Iron and magnesia	....		
50	10th St. & 5th Ave.	Northern Central R. R.	20	197	8	190-197	190	Patuxent	....	—50	125	Good	....		
51	Clinton & 6th Sts.	Northern Central R. R.	5	215	8	215	215	Patuxent	....	—20	130	Iron and magnesia, silica and salt	....	Downin.	
52	Foot of 13th St.*	Northern Central R. R.	5	165	16	....	....	Patuxent	....	....	150	......	....		
53	Clinton St. & 6th Ave.	Northern Central R. R.	5	170	4	....	....	Patuxent	....	....	70	......	....		
54	Bet. 1st & 2d Sts. & 11th & 12th Aves.	Sanford & Brooks	5	252	6	....	252	Patuxent	....	—12	300-350	Soft	1909	S. M. Dexter.	
55	1st Ave. & 8th St.	Standard Oil Company	35	130	20	....	....	Patuxent	....	—40	400	......	....		
56	2d Ave. & 2d St.	Standard Oil Company	20	195	12	....	....	Patuxent	....	—20	550	......	....		
57	2d Ave. & 2d St.	Standard Oil Company	20	184	13	....	....	Patuxent	....	....	200	Highly acid	....	....	This supply has decreased from 350 gallons.
58	7th St. bet. Toone St. & 1st Ave.	Standard Oil Company	40	184	10	....	170-180	Patuxent	141-147	....	175	......	1909	Shannahan.	
59	5th St. bet. Toone St. & 1st Ave.	Standard Oil Company	40	185	10	....	185	Patuxent	....	....	75	Somewhat acid	....		
60	8th St. & 1st Ave.	Standard Oil Company	40	190	8	....	190	Patuxent	....	....	25	......	....		
61	....	Standard Oil Company	40	200	8	....	175-180	Patuxent	147'6"-153'6"	....	200	Slightly acid	....		
62	5th St. & P. B. & W. R. R.	Standard Oil Company	40	200	6	....	180-190	Patuxent	150-160	....	Small	......	1907	Shannahan.	
63	5th St. & P. B. & W. R. R.	Standard Oil Company	40	200	6	....	....	Patuxent	....	....	....	......	....		
64	Toone & 7th Sts.	Standard Oil Company	40	213	10	....	213	Patuxent	....	....	100	Very acid	....	....	This well formerly gave a yield of 150 gallons.
65	Clinton & 11th Sts.*	Stickney Iron Co.	10	175	..	....	....	Patuxent	....	....	....	......	....		
66	1st St. & 9th Ave.	Susquehanna Fertilizer Co.	10	200	10	....	....	Patuxent	....	—3	....	......	....		
67	Fort Carroll	U. S. Government	5	168	6	....	200	Patuxent	120	—20	Many	......	....	....	Not in use.
68	Chesterwood Excursion Grounds.	Free Excursion Society	..	172	4½	....	150-168	Patuxent	....	....	....	......	....		
69	Colgates, 5 wells	Federal Distilling Co.	100	180-200	..	....	172	Patuxent	....	....	50	......	....	....	Five wells in this group.
70	Colgates, 3 wells	Federal Distilling Co.	100	184-190	..	....	....	Patuxent	....	—15 to —20	300	Very good	....	....	Three wells in this group.
71	Colgates, 5 wells	Ferndorf & Brown	100	110-135	6	....	184	Patuxent	....	—20	500	......	1906	Shannahan.	Five wells in this group.
72	Colgates, 2 wells	....	100	150	2	..	110-135	Patuxent	....	—8 to —11	250-300	......	1905	Shannahan.	
73	Colgates	N. C. R. R. No. 3 Elevator.	5	296	8	....	....	Patuxent	....	....	70	......	....		
74	Dundalk	McShanes Foundry	20	120-130	8	....	290	Patuxent	185-220	—19	104	......	1907	Shannahan	
	Highlandtown														
75	Fayette & 14th Sts.	Continental Can Co.	120	172	6	172	172	Patuxent	....	—40	50-60	Good	1907	Downin.	
76	Eastern Ave. & 12th St.	Crown Cork & Seal Co.	60-80	204	6	204	204	Patuxent	....	....	125	......	1908	Shannahan.	
77	Gough & 3d Sts.	Geo. W. Gengnagel	80	196'8"	4½	196'8"	196'8"	Patuxent	34 & 120	—88	Large	Good	....		
78	Canton Ave. & 1st St.	Highlandtown Ice Co.	80	257	6	257	257	Patuxent	....	....	40	Good	....		
79	Canton Ave. & 1st St.	Highlandtown Ice Co.	80	262	6	262	262	Patuxent	....	....	40	Good	1906	Downin.	
80	Eastern Ave. & 5th St.	Thos. J. Kurdle	70	110	4	110	110	Patuxent	....	—40	50±	Good	....		
81	Eastern Ave. & 3d St.	Thos. J. Kurdle	70	210	6	....	192	Patuxent	....	—60	Large	Good	1909	Newkirk.	
82	Lombard & 7th Sts.	Monumental Brewing Co.	60	480	10	308	480	Patuxent	....	—80	150	Good	1900	Rust Well Co.	
83	1st St. & 3d Ave.*	Orient Distilling Co.	20	210	..	....	....	Patuxent	....	....	65-80	......	....		
84	1st St. & 3d Ave.*	Orient Distilling Co.	20	185	..	....	....	Patuxent	....	....	65-80	......	....		
85	1st St. & 3d Ave.*	Orient Distilling Co.	20	125	..	....	....	Patuxent	....	....	....	Poor water	....		
86	Bank & 3d Sts.	Schluderberg Packing Co.	90	408	..	....	160	Patuxent	230	—98	150	......	....		
87	Bank & 3d Sts.	Schluderberg Packing Co.	90	290	6	....	290	Patuxent	....	....	75-80	......	....		
88	Fairmont Ave. & 8th St.	Steiner Mantel Co.	60	120	3	120	120	Patuxent	....	—3 in.	3	Soft	1906	Downin.	

* Darton, N. H. U. S. Geol. Survey, Bull. No. 138, 1895. Could not verify in 1910.

TABLE OF WELLS IN BALTIMORE COUNTY EAST AND SOUTHEAST OF BALTIMORE CITY.—CONTINUED.

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
89	Bank & 5th St.	Stewart Distilling Co.	75	197-202	4,6	197-202	197-202	Patuxent	30	−54	100 each	Good	....		
90	Eastern Ave. & 17th St.	Weinke-Airey Co.	100	420	6	220±	420	Patuxent	....	−200	40	......	....		
91	Baltimore & 8th Sts.	Williams Veneer Co.	60	188	4	186	186	Patuxent	....	−46	15	Soft	1904		
92	St. Helena	Chas. Lewis	20	75±	6	....	....	Patuxent	....	....	75	......	....		
93	Sollers	United Railways	10	226	8	....	200-226	Patuxent	....	....	110	Hard	1903	Rust Well Co.	
94	Sollers	United Railways	10	287	6	....	284-287	Patuxent	149-159	−16	50	Hard	1903	Shannahan.	
95	Sparrows Point	Bethlehem Steel Co. 13M	10	112½	4	106	....	Patuxent	....	−31½	23.40	......	....	Downin.	
96	Sparrows Point	Bethlehem Steel Co. 9M	10	120½	4	119	....	Patuxent	....	−40½	28.76	......	....		
97	Sparrows Point	Bethlehem Steel Co. 5M	10	122	4	119	....	Patuxent	....	−36	43.30	......	....		
98	Sparrows Point	Bethlehem Steel Co. 1M	10	122	4	117	....	Patuxent	....	−37	42.30	......	....		
99	Sparrows Point	Bethlehem Steel Co. 2M	10	122½	4	....	....	Patuxent	....	....	42.19	......	....		
100	Sparrows Point	Bethlehem Steel Co. 7M	10	123	4	119	....	Patuxent	....	−34	42.30	......	....		
101	Sparrows Point	Bethlehem Steel Co. 6M	10	123	4	119	....	Patuxent	....	−34	42.30	......	....		
102	Sparrows Point	Bethlehem Steel Co. 4M	10	124	4	122	....	Patuxent	....	−39½	57.52	......	....		
103	Sparrows Point	Bethlehem Steel Co. 16M	10	124	4	119	....	Patuxent	....	−33	42.30	......	....		
104	Sparrows Point	Bethlehem Steel Co. 14F	10	128	8	123½	....	Patuxent	....	−36	175	......	....		
105	Sparrows Point	Bethlehem Steel Co. 12F	10	128	6	100½	....	Patuxent	....	−31	102.4	......	....		
106	Sparrows Point	Bethlehem Steel Co. 17M	10	133	8	130′10″	....	Patuxent	....	−65′10½″	91.80	......	....		
107	Sparrows Point	Bethlehem Steel Co. 15M	10	176	6	161	....	Patuxent	....	−40½	198.62	......	....		
108	Sparrows Point	Bethlehem Steel Co. 14M	10	186	6	169	....	Patuxent	....	−45	198.62	......	....		
109	Sparrows Point	Bethlehem Steel Co. 13F	10	192	8	143′7″	....	Patuxent	....	−30	163.4	......	....		
110	Sparrows Point	Bethlehem Steel Co. 17F	10	194′4″	8	145′4″	....	Patuxent	....	−29	163.4	......	....		
111	Sparrows Point	Bethlehem Steel Co. 18M	10	194½	8	....	....	Patuxent	....	....	234	......	....		
112	Sparrows Point	Bethlehem Steel Co. 12M	10	195	6	170	....	Patuxent	....	−43	223.2	......	....		
113	Sparrows Point	Bethlehem Steel Co. 20M	10	206′10″	8	175	....	Patuxent	....	−48	261.2	......	....		
114	Sparrows Point	Bethlehem Steel Co. 16F	10	208	8	158′11″	....	Patuxent	....	−31	100	......	....		
115	Sparrows Point	Bethlehem Steel Co. 16F	10	208	8	167	....	Patuxent	....	−31	185-8	......	....		
116	Sparrows Point	Bethlehem Steel Co. 2C	10	213	8	179	....	Patuxent	....	−27	92	......	....		
117	Sparrows Point	Bethlehem Steel Co. 3C	10	221′8″	8	204	....	Patuxent	....	−20	185-8	......	....		
118	Sparrows Point	Bethlehem Steel Co. 3C	10	221′8″	8	....	....	Patuxent	....	−20	102	......	....		
119	Sparrows Point	Bethlehem Steel Co. 15F	10	270	8	163	....	Patuxent	....	−24	163.4	......	....		
120	Sparrows Point	Bethlehem Steel Co. 16W	10	276	8	160′8″	....	Patuxent	....	−24	186	......	....		
121	Sparrows Point	Bethlehem Steel Co. 19M	10	301′7″	8	180′8″	....	Patuxent	....	....	328	......	....		
122	Sparrows Point	Bethlehem Steel Co. 17W	10	303	8	167′5″	....	Patuxent	....	−24	163	......	....		
123	Sparrows Point	Bethlehem Steel Co. 4C	10	424½	8	....	....	Patuxent	....	−22	131	......	....		
124	Sparrows Point	Bethlehem Steel Co. 4C	10	424½	8	....	....	Patuxent	....	−22	121.5	......	....		
125	Sparrows Point	Bethlehem Steel Co. 1C	10	427′4″	8	241	....	Patuxent	....	−15	153	......	....		
126	Sparrows Point	Bethlehem Steel Co. 21M	10	495	8	230	....	Patuxent	....	−5	235.37	......	....		
127	Sparrows Point	Bethlehem Steel Co. 15F	10	509	10	177	....	Patuxent	....	−2	362.87	......	....		
	The following wells cannot be verified:														
128	Sparrows Point	Bethlehem Steel Co.	10	98	4	....	....	Patuxent	....	....	20	......	....	....	Darton's Bull. No. 90.
129	Sparrows Point	Bethlehem Steel Co.	10	125	4-6	....	....	Patuxent	....	....	100-200	......	....	....	40 wells. Darton's Bull. No. 90.
130	Sparrows Point	Bethlehem Steel Co.	10	194	..	....	175-194	Patuxent	....	....	200	......	....		
131	Sparrows Point	Bethlehem Steel Co.	10	210	4	....	....	Patuxent	117-140 185-204 285-298	....	100	......	....	....	Darton's Bull. No. 90.
132	Sparrows Point	Bethlehem Steel Co.	10	302	8	....	....	Patuxent	....	....	....	......	....		
133	Sparrows Point	Bethlehem Steel Co.	10	420	..	....	282-291 394-420	Patuxent	....	....	....	......	....		
134	Sparrows Point	Bethlehem Steel Co.	10	495	..	....	....	Patuxent	....	....	....	......	....	....	To granite rock. No water below 210 feet. Darton's Bull. No. 90.

SUPPLEMENTARY TABLE OF WELLS SOUTHEAST OF BALTIMORE

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth of supply	Geologic horizon	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
135	Curtis Bay	Curtis Bay Chemical Co...	10	200–275	6	200–275	200, 275	Patuxent	—50	77	Soft	1915	....	Satisfactory for boiler use and manufacturing purposes.
136	Curtis Bay	Curtis Bay Chemical Co...	10	200–275	6	200–275	200, 275	Patuxent	—50	77	Soft	1915	....	Satisfactory for boiler use and manufacturing purposes.
137	Curtis Bay	Curtis Bay Chemical Co...	10	200–275	6	200–275	200, 275	Patuxent	—50	77	Soft	1915	....	Satisfactory for boiler use and manufacturing purposes.
138	Curtis Bay	Curtis Bay Chemical Co...	10	200–275	6	200–275	200, 275	Patuxent	—50	77	Soft	1915	....	Satisfactory for boiler use and manufacturing purposes.
139	Curtis Bay	Curtis Bay Chemical Co...	10	200–275	6	200–275	200, 275	Patuxent	—50	77	Soft	1915	....	Satisfactory for boiler use and manufacturing purposes.
140	Curtis Bay	Curtis Bay Chemical Co...	20	200–275	6	200–275	200, 275	Patuxent	—50	77	Soft	1915	....	Satisfactory for boiler use and manufacturing purposes.
141	Curtis Bay	Curtis Bay Chemical Co...	20	200–275	6	200–275	200, 275	Patuxent	—50	77	Soft	1915	....	Satisfactory for boiler use and manufacturing purposes.
142	Curtis Bay	Curtis Bay Chemical Co...	20	200–275	6	200–275	200, 275	Patuxent	—50	77	Soft	1915	....	Satisfactory for boiler use and manufacturing purposes.
143	Curtis Bay	Curtis Bay Chemical Co...	20	200–275	6	200–275	200, 275	Patuxent	—50	77	Soft	1915	....	Satisfactory for boiler use and manufacturing purposes.
144	Curtis Bay	Curtis Bay Chemical Co...	20	200–275	6	200–275	200, 275	Patuxent	—50	77	Soft	1915	....	Satisfactory for boiler use and manufacturing purposes.
145	Curtis Bay	Standard Guana Co........	30	200	6	190	190–200	?	+2½	15	Soft	1915	....	Satisfactory for boiler use and manufacturing purposes.
146	Curtis Bay	Standard Guana Co........	30	200	6	190	190–200	?	+2½	15	Soft	1916	....	Satisfactory for boiler use and manufacturing purposes.
147	Curtis Bay	Standard Guana Co........	30	200	6	190	190–200	?	+2½	15	Soft	1916	....	Satisfactory for boiler use and manufacturing purposes.
148	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
149	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
150	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
151	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
152	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
153	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
154	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
155	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
156	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
157	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
158	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
159	Curtis Bay	Public Distilling Co.......	20	300	8	300	300	Patuxent	—30	300	Some iron	1917	Shanahan	Satisfactory for boilers and distilling.
160	Curtis Bay	Public Distilling Co.......	20	100	6	100	100	Patuxent	—30	125	Some iron	1916	Curtis Woodruff Co....	Satisfactory for boilers and distilling.
161	Curtis Bay	Public Distilling Co.......	20	100	6	100	100	Patuxent	—30	125	Some iron	1916	Curtis Woodruff Co....	Satisfactory for boilers and distilling.
162	Curtis Bay	Public Distilling Co.......	20	100	6	100	100	Patuxent	—30	125	Some iron	1916	Curtis Woodruff Co....	Satisfactory for boilers and distilling.
163	Curtis Bay	Public Distilling Co.......	20	100	6	100	100	Patuxent	—30	125	Some iron	1916	Curtis Woodruff Co....	Satisfactory for boilers and distilling.
164	Curtis Bay	Public Distilling Co.......	20	125	12	125	125	Patuxent	—17	250	Some iron	1915	....	Satisfactory for boilers and distilling.
165	Curtis Bay	Public Distilling Co.......	20	125	12	125	125	Patuxent	—17	250	Some iron	1915	....	Satisfactory for boilers and distilling.
166	Curtis Bay	Public Distilling Co.......	20	125	12	125	125	Patuxent	—17	250	Some iron	1915	....	Satisfactory for boilers and distilling.
167	East Brooklyn	U. S. Asphalt Co..........	10	300	4	150–200	300	Patuxent	—25	70	Soft	1915	....	Boiler use.
168	East Brooklyn	U. S. Asphalt Co..........	10	300	4	150–200	300	Patuxent	—25	70	Soft	1915	....	Boiler use.
169	East Brooklyn	U. S. Asphalt Co..........	10	300	4	150–200	300	Patuxent	—25	70	Soft	1917	....	Boiler use.
170	East Brooklyn	U. S. Asphalt Co..........	10	300	4	150–200	300	Patuxent	—25	70	Soft	1917	....	Boiler use.
171	Fairfield	Prudential Oil Corporation.	20	225	4	200	225	Patuxent	—30	80	Soft	1916	Pentz	Boiler use.
172	Fairfield	Prudential Oil Corporation.	20	225	4	200	225	Patuxent	—30	80	Soft	1916	Pentz	Boiler use.
173	Fairfield	Prudential Oil Corporation.	20	225	6	200	225	Patuxent	—30	80	Soft	1915	Pentz	Boiler use.
174	Fairfield	Prudential Oil Corporation.	20	225	6	200	225	Patuxent	—30	80	Soft	1915	Pentz	Boiler use.
175	Fairfield	Prudential Oil Corporation.	20	225	6	200	225	Patuxent	—30	80	Soft	1915	Pentz	Boiler use.
176	Fairfield	Prudential Oil Corporation.	20	225	6	200	225	Patuxent	—30	80	Soft	1917	Pentz	Boiler use.
177–187	Sparrows Point ...	Bethlehem Steel Co.......	10	270	8	270	270	Patuxent	—65	240	Soft	1917	Shanahan	Eleven wells. Boiler use.
188	Sparrows Point ...	Bethlehem Steel Co.......	10	611	8	611	611	Patuxent	—15	?	Soft	1917	Shanahan	Boiler use.
189	Sparrows Point ...	Bethlehem Steel Co.......	10	306	8	306	306	Patuxent	—60	200	Soft	1917	Shanahan	Boiler use.
190–192	Sparrows Point ...	Bethlehem Steel Co.......	10	500	8	500	500	Patuxent	—20	200	Soft	1917	Shanahan	Three wells. Boiler use.
193–196	Sparrows Point ...	Bethlehem Steel Co.......	10	225	8	225	225	Patuxent	—65	200	Soft	1915	Shanahan	Four wells. Boiler use.
197	Turners Station ...	Bartlett Hayward Co......	12	530–550	8	530–550	530–550	Patuxent	—15	200	Soft	1915	Shanahan	Boiler use.
198	Turners Station ...	Bartlett Hayward Co......	12	530–550	8	530–550	530–550	Patuxent	—20	200	Soft	1915	Shanahan	Boiler use.
199	Turners Station ...	Aluminum Ore Company...	12	160	8	160	160	Patuxent	?	100	Soft	....	Shanahan	Boiler use.

COUNTIES OF SOUTHERN MARYLAND

ANNE ARUNDEL COUNTY

Anne Arundel County lies wholly within the Coastal Plain province. The crystalline rocks which underlie the whole county and emerge beneath the sediments of the Coastal Plain to form the Piedmont Plateau country lying to the northwest, are exposed in the extreme western part of the county in the valley bottoms of the Big and Little Patuxent rivers.

The surface is rolling and much broken, particularly in the southern half of the county where the higher interstream divides are much dissected. Also along the boundary between Anne Arundel and Howard County some of the hills reach elevations of nearly 300 feet. The surficial deposits which constitute the plains of the Eastern Shore counties have been largely eroded in Anne Arundel County, where they are represented by remnants except the lowest or Talbot plain which is well developed on the necks of the northern part of the county. Broad tidal estuaries reach from the Patapsco and Chesapeake nearly half-way across the county.

TABLE OF ELEVATIONS

	Feet		Feet
Annapolis	20	Harmons Station	150
Bay Ridge	22	Jessup	200
Bridewell	200	Linthicum	175
Brooklyn	60	Millersville	120
Churchton	10	Naval Academy Junction	160
Deale	8	Odenton	180
Earleigh Heights	70	Patuxent	110
Eastport	15	Pumphreys	160
Galloway	8	Revell	115
Glenburnie	56	Shadyside	10

GEOLOGY

Nearly all the formations of the Coastal Plain are represented by outcrops in Anne Arundel County. They reach the surface in bands extending across the county from northeast to southwest and dip beneath the surface toward the southeast. The majority are unconsolidated sands and clays. The oldest of these, the Patuxent, Arundel, and Patapsco formations, form the surface in that part of the county lying northwest of a line drawn from Hawkins Point to Patuxent Station on the Philadelphia, Baltimore and Washington Railroad. The more porous beds of these formations become important water horizons throughout most of the area of the county. The several formations of the Upper Cretaceous, which are exposed immediately southeast of the belt where the Lower Cretaceous lies at the surface, are thinner than the latter and of variable but in general sandy composition. Water is found in all of them, but especially in the older or Raritan and Magothy formations. Both the Aquia and Nanjemoy formations of the Eocene are represented at the surface. The former occupies considerable areas southeast of a line drawn from Gibson Island to Priest Bridge on the Patuxent River, and is an important horizon for underground water in the southeastern part of the county. The overlying Nanjemoy formation is exposed in only a limited area in the southern part of the county and is unimportant in this region as a source of underground water, although it becomes an important water horizon farther south in Calvert County. It must be repeatedly emphasized that an important water zone in the upper part of the Aquia formation has long gone by the name of the Nanjemoy water horizon, and this somewhat confusing usage is continued in the present report rather than cause greater confusion by the changing of the name, since the reader is more interested in the actual water zones than in the terminology of the water beds.

The Calvert formation of the Miocene is widely distributed in the southeastern part of the county, but is an unimportant water zone in this region. It becomes of great importance in Southern Maryland and on the Eastern Shore south of Kent County.

The surficial terrace formations of Pliocene (?) and Pleistocene age are all represented in Anne Arundel County, but are much dissected by erosion and are unimportant except as sources of small springs and shallow dug wells. They usually carry water at their base which can be obtained at shallow depths, but is subject of fluctuations in amount and is readily contaminated by surface seepage, so that in a region as thickly settled as parts of Anne Arundel County these shallow waters can only be utilized with the greatest caution.

SURFACE WATERS

The principal streams of the county are tidal estuaries reaching back from the Patapsco River and the Bay. There is little swamp land, and these rivers are most important as sites for summer homes and avenues of communication between the truck farms of the county and the Baltimore market. As sources of water power or public or private supplies they are not utilizable since the larger estuaries are brackish and even the small streams have a low gradient, small supply, and are almost invariably subject to contamination. The Patuxent, which forms the southwestern boundary of the county, furnishes some water power at Laurel in the adjoining county of Prince George's, but it is of no importance as a source of water supply or power in this county since it is lined by swamps and full of organic matter. It only becomes navigable just before leaving the county.

UNDERGROUND WATERS

Artesian Waters

Because of the relief, and absence over wide areas of sands and gravels of Pleistocene age, the inhabitants of the greater portion of the county are forced to extend their wells down to some porous bed, usually the nearest to the surface at that point. Most of these shallow artesian wells draw a water that differs very slightly from the surface waters of the Pleistocene.

The Miocene deposits outcrop only in the southern portion of the county and do not, as far as available records show, yield any water. The base of the Calvert is exposed along the bay shore at the southern end of the county, preventing the storage of rainfall. Across the Calvert County line at Chesapeake Beach many wells have a flow of Calvert water from 85 feet.

Numerous wells in the lower part of the county draw water from beds of Eocene age, the majority of them tapping the horizon called Nanjemoy, which, as is explained earlier, is not stratigraphically Nanjemoy but Aquia. However, because of the presence of another, the basal Aquia water level, this upper horizon will continue to be called Nanjemoy in accordance with the water-supply literature which in the past has rather accurately drawn its depth but has misinterpreted its position in the column. Little[1] more closely approached the correlation here given when he states that "the water-bearing horizon seems to be about midway in the Aquia." Experience with the other counties puts it higher than this, about 75 to 90 feet above the base. This upper horizon is the level which furnishes the flowing wells in the low district east of Sudley, which range in depth from 90 to 160 feet. These wells flow a few gallons a minute at altitudes less than 12 feet above sea level. The water is hard and carries appreciably large amounts of iron.

An analysis of the water from a well at Galloway 72 feet deep, owned by William Smith, is given below:

	Parts per Million
Turbidity	0.0
Alkalinity	18.4 N/50
Hardness	255.6
Total dissolved solids	359.

	Parts per Million
SiO_2	39.4
Fe	0.3
Al	0.4
Ca	83.3
Mg	11.3
Na	9.5
K	——
CO_3	224.5
SO_4	45.4
Cl	31.9
NO_3	0.0

This horizon will not be of importance west of Sudley (where it might be expected about 100 feet below tide) since the head will be very low, although three wells at Tracy's Landing 135 and 140 feet deep have reached the Nanjemoy water, and with an elevation of 25 feet at the mouth of the well have small flows. There seems to be some slight variation in the depth to this water, due probably to the clays which may be locally developed. However, the deviation from normal is not very great.

Below the Nanjemoy level is the stream at the base of the Aquia which has been tapped by several wells in the county. One at Fairhaven 270 feet deep is thought to draw from this horizon, although definite information regarding the length of the casing could not be obtained. Several wells

[1] Little, H. P. Md. Geol. Survey, Report on Anne Arundel County, p. 132, 1917.

near Eastport, 60 to 73 gallons per day, have reached this horizon, but the water hardly rises to sea level besides being hard and carrying iron.

Of the Upper Cretaceous formation the Magothy and Raritan are the important water-bearing horizons, the Magothy being used mostly along the lower part of the Severn River. At Eastport the Magothy yields flows from 208 feet, and at Severnside and on the opposite side of the river near Luce Creek the Magothy stream was reached at 135 feet. The Annapolis Water Company has 10 wells down 129 to 160 feet to the Magothy level, but since the elevation at the mouth of the well is over 20 feet the water only comes to within 6 feet of the surface. A well at Revell, well mouth 114 feet high, is drawing Magothy water from 150 feet. The water was very marshy and carried very large amounts of iron in the form of the colloidal hydrate.

The Magothy water is frequently unsatisfactory as it carries both iron and sulphur, the amounts of which, however, are quite variable.

The Raritan water level has been very little used in the county except for shallow wells, such as those at Odenton at 56 and 65 feet, and at Millersville where the Raritan water is much used by the owners of driven wells 120 to 135 feet deep. The log of the well at the Naval Academy shows that the Raritan stream there lies at a depth of 306 feet, giving it an average dip of 30 feet to the mile southeast of Millersville. This horizon is probably the one that supplied the "sulphurous, irony water" reported by Darton[1] from Bay Ridge at a depth of 470 feet. This well has been abandoned.

The water at the base of the Lower Cretaceous deposits has been long known and utilized. This stream, called basal Potomac by Darton, yields a very large supply of good water, and is extensively used in the immediate neighborhoods of Baltimore and Washington. From the more complete records available since Darton's work, it is now possible to extend the correlation farther than Darton's material allowed.

Three water horizons are recognized, the basal Patuxent, the upper Patuxent, and the Patapsco, which latter, however, is more localized in its

[1] Darton, N. H. Bull. U. S. Geological Survey No. 138, p. 127, 1896.

extent than the other two. These horizons correspond in a general way to Darton's A, B, and C levels.

The Patapsco water supplies wells at Naval Academy Junction, 103 and 170 feet deep, which have heads that raise the water 60 feet above sea level, although the mouth of the well is 160 feet high.

At Patuxent Station the Patapsco stream was encountered at 108 and 118 feet with an equally large head. Again, west of Harmans at 86 feet and at Glenburnie 52 and 65 feet deep.

The wells at the United States Naval Academy, Annapolis, 587 and 600 feet deep, have encountered the same stream which supplies the shallower wells in the western part of the county. The following log of one of these wells is taken from Fuller and Sanford[1] after shifting the position of the base of the Raritan.

WELL AT U. S. NAVAL ACADEMY, ANNAPOLIS

	Feet
Recent.	
Made ground	0–20
Aquia.	
Coarse orange-colored sand with some clay and bits of shells	20–40
Coarse greenish to orange-colored sand with some clay	40–60
Monmouth and Matawan.	
Fine greenish sand and dark clay	60–140
Magothy.	
Very tough drab clay	140–180
Medium light-gray sand with streaks of light-colored clay, sand water bearing, flowing water	180–220
Raritan.	
Tough clay with fine white sand	220–250
Fine sand with flowing water	250–270
Coarse water-bearing sand; flowing water	270–306
Patapsco.	
Tough red clay	306–340
Pink and red clay with coarse sand	340–360
Coarse brownish sand, water bearing	360–400
Coarse light-buff sand, water bearing	400–415
Pink clay containing gravel	415–435
Crust of iron ore	435
Varicolored sand, water bearing	435–465

[1] Fuller, M. L., and Sanford, S. Deep Well Drilling, 1905. Bull. U. S. Geological Survey No. 298, p. 232.

	Feet
Crust of iron ore	465
Varicolored sand, water bearing	465-510
Crust of iron ore	510
Dark-blue clay	510-516
Very tough red or pink clay (crust of iron ore at 524 and 545 feet)	516-548
Yellow sand, lower portion coarse and water bearing	548-583
Pink clay	583-587
Coarse sand and gravel, pebbles ½ inch in diameter, large flow of water	587-601
Very hard rock	601

Casing used: 250 feet of 12-inch, 170 feet of 10-inch, 181 feet of 8-inch; length of strainer, 15 feet.

These wells flow 30 gallons a minute at 8 feet above tide. The water is hard and contains considerable iron, but in use this is removed by means of a filtration system. The log shows the Magothy water level which is used by other wells in the vicinity, the stream in the Raritan, and no less than six water horizons in the Patapsco. The water level at the top of the Patuxent has been encountered at Naval Academy Junction at a depth of 315 feet where the water rises to within 80 feet of the surface. At South Baltimore one of the wells put down by the Brooklyn & Curtis Bay Light & Water Company passed the water of the Upper Patuxent at 180 feet and reached the base at 350 feet. The same level was reached at Wagners Point at 170 feet, and near Fairfield at 155 feet.

The Upper Patuxent water is also used very extensively in Baltimore County on the Patapsco River Neck where it is found at depths around 150 and 160 feet.

The basal Patuxent water is very irregular in depth due to the inequalities of the crystalline floor. This water has been reached near Jessups at 180 feet and at Bridewell where the crystallines were encountered at 187 feet. The wells around South Baltimore find this lowest stream at depths which increase to the southeast at the rate of about 85 feet in the mile. A well at Fairfield reached the basal Patuxent at 350 feet, one at South Baltimore found water at the same depth, while another well at the same locality was drilled 440 feet and was dry at the bottom. No data were available concerning the Upper Patuxent stream in this well. A well at Wagners Point is 375 feet deep, and a well at the City Quarantine Station was drilled 420 feet to bed rock and found no water below 150 feet and the stream at that level was unfit for use. Another well about 1 mile farther down at Hawkins Point reached the basal Patuxent at 570 feet.

These wells show the irregularity of distribution of this water and for that reason the contours can be given only for the base of the Patuxent, and even there they may well be incorrect. The water is hard but otherwise it is usually unobjectionable, although the well at Quarantine yielded water that had to be condemned. The experience of wells into the crystallines has been uniformly discouraging. The well at Bridewell reached bed rock at 187 feet and continued on to 500 feet with no additional water. The wells around the northern extremity of the county, while they have not so far penetrated beyond the base of the Cretaceous, have shown that the crystallines cannot be expected to furnish much water.

Non-Artesian Waters

SPRINGS.—Springs are very abundant throughout much of Anne Arundel County. Many of the springs utilized as such are scarcely worthy of the term, however, consisting merely of seepages of water into holes dug through a thin covering of sand to a clay bottom. Yet such springs are frequently utilized in spite of the danger of surface contamination.

The two horizons at which springs are most often found in this county are at the contact of the Potomac and Pleistocene formations and just below the contact of the Matawan and Monmouth formations. The water of the former is usually cool, clear, and tasteless; that of the latter, though often containing iron, is seldom disagreeable in springs, though in deep wells it may be entirely useless. The springs from this latter horizon are extremely abundant, and in the area of the Matawan-Monmouth contact many of the inhabitants depend wholly upon them for their supply.

Springs are of course found at other horizons, especially intraformationally in the Potomac group, where there are rapid alternations of sands and clays, but the two most constant occurrences are those cited above.

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Head	Volume of flow	Yield by Pumping	Character of water	Date drilled	Driller	Remarks
1	Annapolis	Annapolis Water Co.	20	129	8,6	..	....	−6	....	....	Hard	1900	....	Two wells.
2	Annapolis	Annapolis Water Co.	20	160	..	..	....	−6	....	....	Hard	1900	....	Eigbt wells.
3	Annapolis	Naval Academy	10	abt. 600	8	600	600	+10	....	270	Hard	1902		
4	Annapolis	Naval Academy	10	587	8	587	587	+10	....	Large	......	1904		
5	Annapolis, 1¼ mi. NW	P. M. Wamble	20	330	6	..	....	....	....	....	......	....	....	No water.
5a	Annspolis, 1¼ mi. NW	P. M. Wamble	20	135	6	135	120-135	....	120	....	......	....		
6	Arundel-on-the-Bay	A. M. Bosley	17	76	1½	76	76	−13	....	1+	Hard	1909	Henry Atwell.	
7	Arundel-on-the-Bay	Town	0	180?	..	..	....	....	....	....	Salt	1909	Robert Leatherberry.	
8	Bay Ridge	E. E. Howell	22	85	1½	85	85	−8	....	....	Hard	1909	Henry Atwell.	
9	Bridewell	Md. House Correction	200?	500	6	180	180	−80	....	....	Hard	....	....	Rock encountered at 180 feet.
10	Brooklyn	Dr. Chas. H. Brooks	60	85	4	85	85	−20	....	8-9	Hard	1906	J. W. Craig.	
11	Brooklyn	Lewis Griennensen	40	55	4	..	55	−40	....	....	Hard	1902	J. W. Craig.	
12	Chalk Point	George W. Hyde	2	108	1½	60	100	+1	½	....	Hard	1909		
13	Chalk Point	Hyde & Wakeland	10	92	1½	60	90	−2	....	....	Hard	1909		
14	Cbalk Point	Tolchester Steamboat Co.	3	160	1½	..	....	+2	1	....	Hard	1899		
15	Churchton	F. Dawson	8	140	1½	56	130	+3″	1½	....	Hard	1906		
16	Churchton	A. E. Glover	8	120	1½	12	120	+3″	2	....	Hard	1906	....	Ceasea flowing in dry weather.
17	Cburchton, 1 mi. S.	Mrs. Emma Lane	8	120	1½	120	120	+2½	9	....	Hard	1895		
18	Churchton, ¼ mi. SE	John H. Rodgers	8	104	1½	104	104	+1½	1	....	Hard	1896		
19	Deale, 1 mi. N.	Wm. Collison	8	142	1½	132	182	....	1	....	Hard	1909		
20	Deale, 1 mi. N.	Wm. Collison	8	135	1½	20	130	....	1	....	Hard	1909		
21	Deale, near	Z. Deale	8	130	1½	..	130	+1	2+	....	Hard	1897	....	Flow decreased.
22	Deale, ½ mi. SW	Murray Leatherberry	8	125	2½	104	....	+10	....	....	Hard	....		
23	Downs Station, near	Egbert Kelly	..	103	4½	103	103	−40	...	25+	Hard	....		
24	Earleigh Heights	Geo. W. Hopf	70	40	4	40	40	−35	....	Large	......	1902	David Stone.	
25	East Brooklyn	The Ellis Company	10	325	6	325	325	−5	....	100	Hard	1908	N. H. Milligan.	
26	East Brooklyn, ⅓ mi. SE.	Martin Wagner Co.	10	100	6	100	100	−7	....	35+	......	1898	Steele.	
27	East Brooklyn, ⅓ mi. SE.	Martin Wagner Co.	10	200	8	200	200	−7	....	45	Hard	1901	Rust Well Co.	
28	East Brooklyn, ⅓ mi. SE.	Martin Wagner Co.	10	170	6	170	170	−7	....	45	Hard	1900	Shannahan.	
29	East Brooklyn, ⅓ mi. SE.	Martin Wagner Co.	10	373	8	373	373	−7	....	80-120	Hard	1898	Shannahan.	
30	Eastport, ½ mi. SE	Mr. Barnett	0	72	1½	72	72	−10	....	Ample	......	1908	Henry Atwell.	
31	Eastport	A. C. Braun	15	218	6	218	....	+6″	Large	....	Hard	1908		
32	Eastport, ½ mi. SE	P. Kelly	3	73	1½	73	73	−10	....	Ample	Hard	1908		
33	Eastport, ½ mi. SE	Wm. McNasby	..	60	1½	60	60	−9	....	Ample	Hard	1908		
34	Eastport	Fred C. Staley	15	208	6	..	....	+	50	....	......	....		
35	Eastport, ½ mi. SE	Rich. Stenchcomb	5	110	1½	110	110	−5	....	Ample	Hard	1908	....	At 60 feet reported head of water, 14 feet; at 110 feet reported head of water, 5 feet.
36	Fairfield	Rasin Monumental Co.	..	350	6	..	....	−8?	....	40	Hard	1901	Shannahan.	
37	Fairhaven	H. P. Owings	5	270	..	..	....	+Few	....	....	Hard	1907		
38	Galloways, ⅛ mi. SE	Wm. Smith	4	72	1½	..	70	+6″	½	....	Hard	1909		
39	Galloways, ⅛ mi. SE	Wm. Smith	5	120	1½	..	....	+2	....	....	......	1901		
40	Galloways	Tolchester Stesmboat Co.	0	85	2	..	....	+5	Few	....	Hard	1899		
41	Gailoways	M. M. Wayson	8	150	2	140	140	+8	Several	....	Hard	1899		
42	Gallowaya	S. R. White	2	98	2	98	98	+1	1	....	Hard	1901		
43	Galloways, ¼ mi. S.	Wm. Zang	5	93	1½	..	93	+2	1	....	Hard	1908		
44	Glenburnie	Curtis Creek Mining & Mfg. Co.	56	65	6	65	65	−28	....	....	Soft	1909	John W. Craig.	
45	Glenburnie	W. F. Kuethe	56	52	4	52	52	....	....	Large	Soft	1901	John W. Craig.	
46	Harmans Station	Rev. R. L. Jacobs	150	86	4	86	86	−60	....	18	Hard	....		
47	Hawkins Point	Davison Chemical Co.	20	160	10	160	160	−20	....	60	Very hard	1901	Sbannaban	Considerable decrease in quantity.
48	Hawkins Point	Davison Chemical Co.	20	148	10,6	148	148	−18	....	40	Very hard	1895	Shannahan.	
49	Hawkins Point	Fort Armistead	20	570	6	..	570	−34 to −38	....	50	Hard	1898		

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
50	Jessup	Clarence Coltman	200	180	6	180	180	−80	....	....	Hard	....		
51	Leitch	E. G. Crown	5	160	1½	12	160	+2	1½	....	Hard	1909		
52	Leitch	F. Leitch Estate	5	160	1½	..	160	+4	10	....	Hard	1899		
53	Linthicum	Linthicum Heights Co.	174	110	6	110	110	−50	....	12+	Hard	1909		
54	Millersville	Dr. H. B. Grant	120	130	4	130	130	−50	....	....	Hard	1903		
55	Millersville	Fletcher Joyce	120	130	6	130	130	−50	....	....	Hard	1896		
56	Millersville	Millersville Academy	120	130	6	130	130	−50	....	....	Hard	1901		
57	Naval Academy Junction	Geo. M. Murray Estate	160	305	6,4½	315	315	−80	....	....	Hard	1908		
58	Naval Academy Junction, ⅛ mi. E	Thos. Beasley	160	103	4	103	103	−40	....	....	Hard	1909		
59	Naval Academy Junction	W. B. & A. R. R.	160	170	6	170	....	....	....	....	Hard	1908		
60	Odenton	W. J. Jones	160	56	1½	56	56	−2	....	6	Soft	1908		
61	Odenton, 3 mi. S.	George Mankin	180	65	4	65	....	−40	....	Few	Hard	1892		
62	Patuxent	Anne Arundel Canning Co.	110	118	2½	118	118	−7	....	Many	Hard	1908		
63	Patuxent	Wm. Leubbers	..	108	4	108	108	−4½	....	25+	Hard	1908		
64	Portland	John Clokey	110	130	4	130	130	−40	....	....	Hard	1908		
65	Portland	Murray, Silver & Beasley	..	165	6	..	....	−20	....	....	Hard	1892		
66	Pumphreys	....	100	125	6	..	....	....	....	Large	Soft	....		
67	Quarantine Station	City of Baltimore	20	420	6,4	420	150	....	....	....	......	1902	Downin	Fluctuates with tide.
68	Quarantine Station	City of Baltimore	20	136	6	132	132+	−6±	....	40	......	1902	Downin.	
69	Revell	E. D. Preston	114	150	6	148	145	−90	....	15	Hard	1905	Downin.	
70	Round Bay	....	20	225±	6	..	....	....	Large	....	Hard	....		
71	Shadyside	James O. Atwell	10	108	1½	45	94	+Few	....	....	Hard	....		
72	Shadyside	George Greiner	10	90	1½	45	80	+Few	....	....	Hard	....		
73	Shadyside	Thomas Leck	10	90	1½	40	80	+Few	Few	....	Hard	....		
74	Shadyside	Thomas Leck	10	160	1½	45	150	+Few	Few	....	Hard	....		
75	Shadyside	Thomas Leck	10	118	1½	45	110	+Few	Few	....	Hard	....		
76	Shadyside	James O. Norvell	10	130	1½	40	122	+Few	Few	...	Hard	....		
77	Shadyside	Robt. F. Norvell	10	130	1½	40	120	+Few	Few	....	Hard			
78	Shadyside	W. Norvell	10	160	1½	102	120	+Few	Few	....	Hard	....		
79	Shadyside	O. Rogers	10	130	1½	40	....	+Few	Few	....	Hard	....		
80	Shadyside	W. Rogers	10	130	1½	40	....	+Few	Few	....	Hard	....		
81	South Baltimore	Brklyn & Curtis Bay Light & Water Co.	20	415	8	..	....	....	....	275	......	....		
82	South Baltimore	Brklyn & Curtis Bay Light & Water Co.	20	440	..	..	....	....	....	....	......	....	....	No water.
83	South Baltimore	Brklyn & Curtis Bay Light & Water Co.	20	416	8	..	337½	....	....	300+	......	1907	Harper	20 gallons between 215 and 235 feet, rock at 400 feet.
84	South Baltimore	Brklyn & Curtis Bay Light & Water Co.	20	575	8	..	300	....	....	100	......	1907	Harper	Not used on account of turbidity.
85	South Baltimore	Brklyn & Curtis Bay Light & Water Co.	20	130	8	..	100-120	....	....	200+	......	1907	Harper.	
86	South Baltimore	Brklyn & Curtis Bay Light & Water Co.	20	109	8	..	109	....	....	175	......	1907	Harper.	
87	South Baltimore, ½ mi. S.	John T. Flood	5	65	2	..	65	....	....	....	Hard	1888		
88	South Baltimore, 2 mi. S.	U. S. Revenue Cutter Serv.	20	216	6	125?	216	−10	....	20+	......	1901	Downin.	
89	Tracy's Landing	Thomas Leitch	25	140	1½	20	....	+2	Few	....	Hard	1899		
90	Tracy's Landing	Andrew Manifold	25	135	1½	..	....	+8	3	....	Hard	1909		
91	Tracy's Landing	James T. Tucker	25	135	1¼	..	65	+2	5	....	Hard	1908	Shannahan.	
92	Wagners Point	....	..	381	8	..	356-381	....	75	....	......	1910		

SHALLOW WELLS.—Shallow wells in Anne Arundel County include not only those wells drawing from Pleistocene deposits but also many wells which have penetrated some older formation close to or even forming the surface.

In the southern portion of the county where the surficial deposits cover the most of the region the wells range from 15 to 35 feet in depth, reaching a somewhat irony water at the base of the Pleistocene gravels. This water of course being strictly dependent upon the downward percolation of rainfall in the immediate vicinity may show some effects of dry spells, but extended droughts are very rare.

In the northern and western portion of the county the wells must be sunk somewhat deeper, and since most of these wells report appreciable heads they will be discussed along with the artesian wells. One well at Earleigh Heights 40 feet deep has a hard water from the Magothy which stands 5 feet in the well.

PRINCE GEORGE'S COUNTY

Prince George's County lies almost wholly within the Coastal Plain province, the underlying crystalline rocks, which represent the seaward extension of the Piedmont Plateau, rise from the mantle of Coastal Plain deposits in limited areas in the extreme northwestern part of the county near the Montgomery County and District of Columbia line.

The elevations range from the level of tide in the estuaries to over 400 feet near the northwestern boundary of the county southwest of Laurel. From the fall line, which is close to the line of the Baltimore and Ohio Railroad, the stream divides slope gently to the southeast at an average elevation of about 140 feet. This originally gently sloping country of unconsolidated sands and loams has been deeply dissected by the streams tributary to the Potomac and Patuxent rivers and is now much broken by a complex network of hills and valleys.

TABLE OF ELEVATIONS

	Feet		Feet
Accokeek	200	Laurel	160
Aquasco	158	Leeland	80
Berwyn	100	Muirkirk	150
Bladensburg	20	North Keys	164
Bowie	150	Nottingham	15
Brandywine	233	Piscataway	30
Brightseat	200	Riverdale	60
Cheltenham	237	Seat Pleasant	200
College Park	80	T B	225
Collington	140	Townshend	216
Fort Washington	120	Tuxedo	40
Hardesty	88	Upper Marlboro	40
Hyattsville	80	Westphalia	120

GEOLOGY

There are a few exposures of the crystalline rocks of the Piedmont in the deeper valleys along the northern border of the county. These are dipping steeply to the southeast, and throughout the balance of the county are deeply buried by the unconsolidated sediments of the Coastal Plain. The latter outcrop at the surface in bands crossing the county from northeast to southwest, each formation disappearing by passing under the next youngest one toward the southeast. The Lower Cretaceous gravels, sands, and clays constituting the Patuxent, Arundel, and Patapsco formations, outcrop in the northwestern portion of the county. The Upper Cretaceous, made up of sands, clays, greensands, and shell marls, and comprising the Raritan, Magothy, Matawan, and Monmouth formations, outcrops from the valley of the Patuxent River between Governor Bridge and Hicks Mill to the Potomac at Fort Washington. The Aquia and Nanjemoy formations of the Eocene comprise more or less glauconitic clays and shell marls and outcrop in a broad belt 10 miles or more in width extending from the mouth of the Magothy River to the Western Branch of the Patuxent River. The sands, clays, diatomaceous earth, and marls of the Calvert and Choptank formations of the Miocene occupy a wide area southeast of the Eocene. They are largely buried, however, by a thin layer of terrace deposits belonging to younger formations, and exposures are generally limited to stream valleys. The Pliocene (?) is represented by the gravels, loams, and sands of the Brandywine terrace which forms the surface cover over the stream divides, especially in the southern portion of the county. The three Pleistocene terraces, Sunderland, Wicomico, and Talbot, form mantles of loam, sand, and clay, becoming lower in elevation and less dissected by erosion as they become younger—the oldest and highest plain, known as the Sunderland, being much dissected and forming the surface of the secondary stream divides below the Brandywine surface. Its elevation ranges from 200 feet in the northern and central portions of the county to 180 feet in the southern portion. The next younger or Wicomico, which lies at elevations of from 90 to 100 feet, is found in all the stream valleys and is especially well developed in the Potomac Basin. The youngest or Talbot terrace forms a but slightly broken plain lying below 45 feet in elevation. It is found in all the stream valleys and is especially well developed in the valleys of the Anacostia and Patuxent rivers.

SURFACE WATERS

Situated between the Patuxent and Potomac, both tidal rivers, the county is drained by small tributaries of these two streams. With the exception of the power developed in the Patuxent at Laurel there is no water power of any considerable value in the county, although small powers on tributary streams are utilized at several localities for grist mills. With the exception of Takoma Park in the District of Columbia, which utilizes the waters of Sligo Creek for the municipal water supply, the surface waters are not used for domestic purposes nor is such use to be recommended in areas as thickly settled as Prince George's County.

UNDERGROUND WATERS

Artesian Waters

Artesian supplies have been obtained in Prince George's County only from strata of Cretaceous age, and all of the wells except those at one locality, Upper Marlboro, where the Magothy vein is in use, draw from beds of the Lower Cretaceous. Of the other water horizons, the Matawan-Monmouth, which in Calvert and St. Mary's counties assumes great importance, probably does not exist as a water-bearing bed, since these formations outcrop in continuous beds in only the lower part of Prince George's County and cannot be expected to furnish water except possibly at the southeastern tip around Trueman Point and Chalk Point. Here these lie at a depth of about 85 feet below sea level, and flows may be secured if the well mouth is located within 10 feet of tide. The Eocene horizons which also supply the water in some wells in the neighboring counties have not, so far as known, been tapped by any artesian well in Prince George's County, although they may be expected to yield flows in the valley of the Patuxent from depths ranging from about 100 feet below tide at Nottingham to around 130 feet below tide at Trueman Point. Like the Calvert the Eocene water will not flow at altitudes greater than 10 or possibly a maximum of 15 feet.

The sandy strata of the Magothy formation are water bearing over wide areas. In Prince George's County the Magothy supplies the water for the wells at Upper Marlboro and the vicinity, but although it extends under the southeastern portion of the county at depths ranging to 400 feet below tide, it has not been further exploited. At Upper Marlboro and Marlboro there are six wells with depths around 220 feet. These wells have a small flow at an altitude of about 30 feet. The following section taken from Darton[1] shows a greater thickness of Eocene than would be expected, but it is possible that the lower part of the "greensand" should be referred to the Monmouth.

WELL AT MARLBORO

	Feet
Eocene.	
Greensand marl, "Pamunkey" fossils	0–185
Hard rock strata	185–190
Magothy.	
Gray micaceous clay with "Severn" fossils	190–215
White water-bearing sand, lignite and silicified coarse sand	215–222

The water from the Magothy has been stated by the authors of the Patuxent folio,[2] and repeated by Miller,[3] to be characteristically irony or

[1] Darton, N. H. U. S. Geological Survey, Bull. 138, p. 134.
[2] U. S. Geological Survey, Patuxent folio, p. 12.
[3] Miller, B. L. Maryland Geological Survey, Prince George's County.

sulphurous, or both. By observation, however, these minerals are shown to be rather limited in distribution. An analysis of the water from the well at the Court House in Marlboro shows a hard water, but the amount of iron is very small and the only sulphur present is in the form of sulphates. The analysis follows:

	Parts per Million
Turbidity	0.0
Alkalinity	16.8 N/50
Hardness	177.6
Suspended matter	211

	Parts per Million
SiO_2	26.1
Fe	0.02
Al	0.8
Ca	61.1
Mg	6.0
Na	5.1
K	—
CO_3	—
HCO_3	205.0
SO_4	13.9
Cl	2.7
NO_3	0.0

A comparison of this analysis with that of the water from the Easton well, which is also down to the Magothy level, shows that there is only a slight increase in mineralization with depth, and in the Easton water, also, the quantities of iron and sulphur are small enough to be unnoticed. The Magothy water then, at least in Prince George's County, will be a palatable, unobjectionable drinking water, and when used in boilers the soft scale which it will deposit can readily be removed by boiler compounds. Another well in Marlboro 160 feet deep has struck water that is reported to come from a "hard rock" bed, probably the same as that at 185 to 190 feet in Darton's section. The water is soft and stands down in the pipe at a distance of 20 feet or more, although the level is very little higher than that of the other wells in the vicinity. The low head together with the fact that none of the other five or six wells which have been drilled in the neighborhood have reported any water bed higher than the Magothy makes it appear improbable that this well has struck any other definite horizon. More likely the water is an upward seepage from a lower level.

The rapidly intergrading clays and sands of the Lower Cretaceous formation form excellent traps for underground water, but because of this very rapidity of change in lithology these small horizons cannot be traced even short distances. Locally, however, they have been proven for large yields, the most important in this county being in the valley of the Eastern Branch, northeast of the District line.

Beside these restricted water veins there are in the Lower Cretaceous two other levels that have been explored in a belt along the northwestern and western edge of the county where the deposits do not lie too far below the surface. The deepest of these, the basal Patuxent, is tapped from Laurel southwest to the District of Columbia. The other level which is in the Patapsco formation supplies only four wells, three of which can be correlated with one another, while the fourth, at Fort Washington, is at the site of a deeper well which, because of its interesting revelations, makes inadvisable a close correlation of the 260-foot well with the other Patapsco wells of the county. Around Baltimore and south of Anne Arundel County the Patapsco yielded water in large quantities, and although this particular horizon has not been very extensively used in Prince George's County, the few wells that have been sunk to it have reported a plentiful supply of good water.

The water at the base of the Patuxent, or the water which flows along the crystallines, as it is sometimes denominated, has been reached only in wells northeast of the District line. A well west of the Baltimore and Ohio Railroad station at Hyattsville was drilled 206 feet and struck water in a coarse sand. A comparison of the log of this Hyattsville well with that of a well at the Maryland Agricultural College shows interesting parallels.

WELL AT HYATTSVILLE. MR. WM. M. LEWIN'S PROPERTY

	Feet
Sandy yellow clay	0–35
Yellow clay	35–60
Blue clay	60–168
Red clay	168–188
Blue clay with sand streaks containing water	188–200
Coarse sand containing a large supply of water	200–206

The water from this sand bed rose to within 15 feet of the surface.

WELL AT MARYLAND AGRICULTURAL COLLEGE

	Feet
Sandy yellow clay with some gravel	0–11
Dry yellow sand	11–18
Red clay	18–32
Blue clay	32–49
Red clay	49–120
Blue clay	120–126
Blue clay with streaks of sand bearing considerable water (quite irony)	126–145
Soft rock of soapstone nature	145–191
Quartz	191–193
Soft gneiss rock	193–209
Hard gneiss rock at which depth well was abandoned. No water found in the rock formations	209–284

The well mouth at the Agricultural College is 145 feet above sea level and is about 2 miles up the dip from the Hyattsville well, which is at an elevation of 30 feet above sea level. Since the Agricultural College well struck the blue clay with sand at 128 to 145 feet and the Hyattsville well struck the same bed at 188 to 300 feet, the corrections for elevation give a dip of just about 100 feet to the mile for the basal Cretaceous beds at this point. Other wells at Hyattsville, notably those that supply the town with water, have entered the basal Patuxent water at depths of near 250 feet. These wells have a slight flow, 4 to 6 gallons per minute, if the well top is within 30 feet of tide.

The municipal supply at Hyattsville is obtained from six wells located in the Anacostia Valley at approximately 20 feet above sea level. Four are 242 feet deep, two being 8 inches and two 2 inches in diameter, one is 218 feet deep and 6 inches in diameter, and one is 212 feet deep and 6 inches in diameter. The wells are about 50 feet apart, and in 1908 when first pumped they yielded 136 gallons per minute. Since that date the yield has decreased to 80 gallons per minute. Since the experience at Hyattsville illustrates conditions in the Lower Cretaceous all along the inner margin of the Coastal Plain from Wilmington to Washington it merits some discussion. While pumping tends to clog the strainers with sand which can be temporarily cleared by the various methods of back flushing, tests show that there is free connection and interference among the wells, heavy pumping of one lowering the capacity and head of the others. There are two ways to obviate this. Wells tapping the same water horizon should be at least 300 feet apart. They should be located in a direction at right angles to the flow of the underground water. Here and along the Coastal Plain border throughout Maryland the catchment area is only a few miles away and the water is flowing toward the southeast. Batteries of wells should therefore be in a northeast-southwest line.

The following section is of a well near Muirkirk. This section is unaccompanied by any data regarding diameter, owner, water, etc., but the depth to the basement rocks is definitely shown, as well as some of the weathered crystallines.

WELL AT MUIRKIRK

	Feet
Tough red clay	0–48
Fine white clay	48–118
Light pink pebble sand	118–123
Light yellow micaceous sand	123–138
Dark gray crystalline rock	138–153
Light pinkish-gray rock	153–162
Dark gray crystalline rock	162–186

In this well the Patuxent formation extends from near the surface to a depth of about 123 feet, and the basal bed consists of a pink pebbly sand 5 feet in thickness. Beneath this is a light-yellow micaceous sand which evidently represents a weathering product of the underlying crystalline rock.

A well at the Experiment Station of the U. S. Department of Agriculture, 1 mile east of Beltsville, struck water at a depth of 323 feet. The altitude of the well mouth is around 200 feet and the water is reported to stand 180 feet down in the pipe. This well yields a large quantity of good water, slightly alkaline, and the engineer states that he can pump the well 50 gallons a minute for 24 hours and not lower the water appreciably.

These wells which draw from the water vein at the base of the Patuxent add a little more evidence to that already collected at the outcrops regarding the dip of this old sea floor. The Maryland Agricultural College well compared with that at Hyattsville shows that at that point the crystallines dip at the rate of a little more than 100 feet to the mile. A little farther north the Muirkirk well definitely establishes the thickness of the Patuxent at that point, and this depth, when corrected and applied to the Experiment Station well, gives an inclination each mile of a little less than 100 feet.

Throughout the greater part of Prince George's County the Patuxent will be too far below the surface to be of use. A deep well prospecting for oil about 1 mile south of Meadows had not passed through the Patuxent at a depth of 1522 feet.

The following log was compiled by N. H. Darton from samples received by the U. S. Geological Survey. From the depth of this well it would seem that the steep declination of the crystalline floor does not diminish greatly in Prince George's County.

WELL 1 MILE SOUTH OF MEADOWS

	Feet
Yellowish gray clay and gravel	0–18
Dark-greenish micaceous clay, not limy	18–48
Fine to coarse grayish sand with yellow red and dark-greenish clay. Glauconite and shell fragments	48–108
Dark sandy micaceous clay, not limy	108–120
Medium to coarse sand with some dark clay, contains bits of shells and much glauconite	120–126
Fine textured light red clay with gray streaks, containing pebbles up to ½ inch in diameter	126–136
Medium fine dark-green clayey sand and limy clay, containing a glauconite, a greensand marl	136–148
Red pebbly clay and a medium to coarse greenish sand containing glauconite	148–159
Shell fragments, with a little coarse sand and glauconite	159–189
Rock and sand, no sample	189–192
Fine to medium greenish-gray limy sand, contains much glauconite and a few shell fragments	192–200
Soft rock, no sample	200–202
Medium to fine dark-green limy and clayey sand, much glauconite and a few shell fragments	202–220
Hard rock, no sample	220–223
Coarse gray and yellowish sand with a little pink and a little dark-greenish clay, some glauconite and shell fragments	223–263
Coarse grayish sand and fine gravel, with shell fragments and a little glauconite	263–350

	Feet
Red clay, not limy, with fine gravel and a little dark-gray clay	350–370
Medium to coarse grayish sand with a little yellow to red clay and a little glauconite	370–400
Yellowish gravel with a little dark limy glauconite sand, some bits of shells and reptilian teeth	400–413
Gumbo, no sample	413–433
Yellowish gravel and coarse sand, shell fragments, red and brown clayey nodules, bits of lignite, and a very few grains of glauconite	443–451
Gravel and coarse sand, red-brownish clay and bits of glauconitic marl	451–511
Light brownish-gray gritty clay with bits of lignite	511–523
Rock, no sample	523–525
Light grayish-brown gritty clay	525–595
Rock, no sample	595–598
Red white and gray clay	598–663
Rock, no sample	663–665
Red clay with fine gravel and lignite	665–795
Gravel and coarse grayish sand, a little red and dark clay and lignite	795–855
Brown buff red and white clay	855–895
Medium to coarse brownish-gray sand with a little red clay	895–980
Rock, no sample	980–982
Red and gray pebbly clay	982–1002
Gravel and coarse sand, with red brown and gray clay	1002–1037
Red and stiff gray to dark-gray clay with fine gravel	1037–1102
Gray to dark-gray gritty and stiff unctuous clay, also red clay	1102–1172
Red and stiff gray clay with fine gravel	1172–1190
Stiff unctuous gray and dark-gray clay, reddish and gray sandy clay	1190–1290
Stiff unctuous or sometimes gritty gray dark-gray red and brownish clay and fine gravel, called shale by driller	1290–1390
Fine brownish-gray and dark-gray sandstone, fine dark conglomerate, reddish sandy clay and lignite	1390–1396
Gray dark-gray and brown unctuous clay with coarse sand and gravel, called shale by driller	1396–1511

This well, along with several others in the Maryland Coastal Plain, was sunk with the object of reaching oil and gas, the promoters being encouraged by small "shows" of gas at shoal depths. The gases which are mistaken for natural gas are given off by decaying vegetation buried with the beds. This gas will naturally be encountered near the surface where lie the most recently deposited strata. The substance which forms an iridescent scum on the surface of standing water, as in swamps or on water from some wells and which has popularly been mistaken for petroleum, is bog iron ore in process of forming.

The Upper Patuxent water has been reached in a circumscribed area near the Anacostia River valley. This horizon is at the same level as the one that supplies large amounts of water in the vicinity of Baltimore, but no well has reported this horizon between Naval Academy Junction, Anne Arundel County, and Riverdale in Prince George's County. Locally, however, the Upper Patuxent water has been proven for large yields, and at Hyattsville, Riverdale, and Bladensburg, as well at at several points inside the District, many wells have been sunk to this vein and on low ground they will flow 5 or 6 gallons a minute.

At Bladensburg the depths range from 80 to 110 feet with varying flows, 1 to 6 gallons per minute, of an alkaline water which, although chalybeate, is only mildly so and does not have the objectionable taste of large quantities of iron. A little to the east, on the Anacostia River between Bladensburg and Benning, a well was drilled 160 feet to this horizon, and although the well mouth is 25 feet above the level of the Anacostia River the water rises to within 5 feet of the surface. The water from this well is also alkaline and contains small amounts of iron.

The Upper Patuxent water cannot safely be forecast for any other part of Prince George's County, but in the restricted area directly northeast of the District water will be obtained from this bed at depths of from 70 to 160 feet below sea level.

The Patapsco horizon, like the Upper Patuxent, occurs also to the north in Anne Arundel County, but the former apparently is a continuous water-bearing bed through into Prince George's County. A well near Collington at an elevation of 120 feet found this stream at a depth of 180 feet. The water is hard and contains some iron. Another well at Lincoln Park, elevation 200 feet, obtained water from the same level in a well 185 feet deep, and a well on the farm of William Holmead near Brightseat Postoffice was sunk 228 feet to the Patapsco vein. The elevation at this locality is 200 feet above sea level and the water rose to within 150 feet of the surface, which shows a good head for the supply. The log of the well is as follows:

WELL NEAR BRIGHTSEAT

	Feet
Sandy yellow clay	0–30
Black marl	30–85
Blue sand	85–93
Yellow sand with some water	93–150
Red clay	150–176
Blue clay	176–209
Red clay	209–222
Red clay with layers of sandstone, containing a fair supply of water	222–228

The other well in Prince George's County which is referred to the Patapsco supply is located at Fort Washington, where a well 260 feet deep was drilled and is pumped 60 to 80 gallons a minute. This well was begun in the Aquia formation and after a few feet passed into the Patapsco. It would not seem likely that the Patapsco should be 250 feet thick at this point so close to the outcrop and near where the surface crops of the Patapsco pinch out. It is possible, then, that this well, too, draws from the Upper Patuxent horizon. A second well was drilled at this same locality and was sunk 1000 feet without reaching the crystallines. The following is a partial log of this deep well.

WELL AT FORT WASHINGTON

	Feet
Blue clay	582 7/12–584 7/12
Soft gray sandstone	584 7/12–600 1/6
Yellow clay	600 1/6–623 1/6
Blue clay	623 1/6–627
Blue clay with sand	627–677 1/6
Yellow clay	677 1/6–718 1/6
Rock (boulder)	718 1/6–718 7/12
Yellow clay	718 7/12–720 7/12
Rock	720 7/12–726 7/12
Blue clay with sand	726 7/12–732 7/12
Fine white sand	732 7/12–737 7/12
Light-red clay with sand	737 7/12–765 7/12
Gravel, coarse	765 7/12–785 1/3
Slate formation	785 1/3–790 1/3
Sand with slight quantity of yellow clay	790 1/3–845 2/3
Yellow and blue clay	845 2/3–865 2/3
Yellow and blue clay with little quantity of sand	865 2/3–896 5/12
Yellow and blue clay	896 5/12–1000

This well shows an extraordinary thickness for Lower Cretaceous deposits at a point near where they have been thought to thin out. An obvious and probably the correct explanation is that this well is located along an old stream channel, that of the pre-Cretaceous Potomac. The Potomac above the fall line is an ancient stream, post-Triassic and pre-Cretaceous in its present form, but probably already defined, although poorly, during the Triassic elevation. Back in the Piedmont province the bed of the Potomac is 300 to 400 feet below the surface of the country 3 or 4 miles in from the banks and so, even though the valley of the ancient Potomac was not quite so deep as at present, a transgressing sea such as that which deposited the Patuxent sands would fill in this valley in an attempt to make a regular and even coast line.

Non-Artesian Waters

SPRINGS.—There are a large number of springs in Prince George's County, and while none of them is very large they will usually furnish enough water for a single household or farm. The springs are usually situated on the sides of the valleys or at the head of small depressions in some of the terraces which form the surface of the country. In general, they are but little used because they are not always convenient to houses. The flow seldom exceeds 4 or 5 gallons per minute, and many of the springs are scarcely more than mere seeps from the surface sands. There is a general fluctuation of volume due to variations in the amount of rainfall, and a few of the springs from surficial sources cease flowing during very dry weather. In contrast to this general rule, a few of them are not affected by changes in precipitation, but maintain their volume practically unchanged during both wet and dry seasons. The water in these springs may be from either Pleistocene or older sands. Springs from the Pleistocene sands are more numerous but their flow is usually affected by seasonal changes. The water from most of the springs is pure, being remarkably free from both organic and inorganic impurities, although locally where springs are supplied from the Pleistocene sands the water may become contaminated by organic matter from the surface, but fortunately this condition is uncommon.

More commonly the foreign matter is inorganic material dissolved from the substances contained in the water-bearing sands. One of the most common is iron obtained from nodules and boulders containing this element imbedded in the water-bearing sands. The other substances are those common to ordinary ground waters and their presence in some of the water makes it slightly hard. Water from some of the springs near Washington has an extensive sale, but this is chiefly as drinking water. At various times efforts have been made to develop mineral springs but they have not been very successful. Among the springs thus exploited was the Bladensburg Spa which furnishes a water high in iron.

The following analysis of the water from the Bladensburg spring is incomplete but will show the essential constituents:

	Parts per Million
Iron bicarbonate	1.44
Magnesium sulphate	1.92
Calcium sulphate	2.56
Sodium chloride	.49
Sodium bicarbonate	.02
Silica	.54
Nitrogen (as free ammonia)	.00
Nitrogen (as albuminoid ammonia)	.06
Nitrogen (as nitrites)	.06?
Nitrogen (as nitrates)	trace
Chlorine	3.00
Oxygen consumed	1.66
Gas, cubic inches per gallon	3.12

SHALLOW WELLS.—The shallow wells of Prince George's County are, naturally, the commonest, since there are few manufacturing plants or canneries, and of the communities requiring municipal supplies several are within reach of surface supplies that can be utilized. The varied surface geology of Prince George's County and the topographic dissection renders shallow wells a valuable source of water in small quantities.

The dug wells are frequently not over 10 or 15 feet deep and the general range of shallow wells seldom exceeds 20 to 40 feet. The shallowest wells are those located on low ground near the level of the large bodies of surface water. As one ascends to the uplands the wells usually become progressively deeper, though there are local exceptions to this general rule where water-bearing sands lie near the surface. This condition is most commonly found on the broad areas of nearly flat terraces, though it is sometimes found on the slopes. The deepest wells are located on high hills where permanent supplies can only be obtained by sinking the wells to sands or gravels overlain by heavy beds of clay and marl.

Many of the shallow wells obtain water from some of the formations of Pleistocene age that form the terraces. On the lower terraces the shallow wells usually obtain their supplies within the Talbot formation, but on the higher terraces the deeper wells often penetrate to the older geological formations, although the Brandywine, through its wide extent, will furnish water from its base.

The quantity of water in the shallow wells is seldom large, amounting in most wells to less than 10 feet and in many to only 3 or 4 feet. Some of the wells that obtain water from the surficial sands are affected by the amount of rainfall, and the quantity of water varies from several feet during rainy seasons to little or none during droughts. In the deeper wells there is less variation in quantity of water, the level remaining relatively constant despite the change in amount of rainfall. Even after making allowance for variations it is usually possible to obtain large enough supplies from shallow wells to meet all the demands of the rural population.

The quality of the water from shallow wells varies with the depth and location of the well, and there are local differences which appear to be independent of depth and location. The quantity of organic matter is controlled by local conditions. In some places the water-bearing beds contain decaying vegetation which gives the water a disagreeable odor and may also affect the taste. This condition is most common in the Talbot formation, but it has also been noted in some of the other horizons. Very shallow wells or those improperly cased may receive organic matter by the entrance of contaminated surface water, but fortunately this condition may be remedied by properly and tightly casing the well or by sinking the well to water-bearing sands or gravels covered by impervious clays or marls, and then inserting water-tight casings. The amount and

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Remarks
1	Bladensburg	Ed. Gasch	6	80	2	80	80	Patuxent	+8	4	..	Iron	....	
2	Bladensburg	J. N. Edlavitch	7	90	2	90	....	Patuxent	+8	....	..	Hard	1908	
3	Bladensburg	E. B. Garges	5	75	1½	70	70	Patuxent	+4	....	..	Hard	....	
4	Bladensburg	F. Gasch	5	85	1½	65	85	Patuxent	+4	8	..	Hard	1905	
5	Bladensburg	John Haynes	7	75	1½	72	72	Patuxent	+5	6	..	Hard	1908	
6	College Park	H. J. Patterson	80	30	4	....	30	Wicomico	7	....	8	Hard	....	
7	College Park	State Agricultural College	....	227	6	96	96	....	......	....	1½	Soft	....	Robt. Saunders.
8	Collington	Jas. Woodward	130	180	6	180	180	Raritan	−110	....	12	Hard	....	
9	Decatur Heights	D. H. Improvement Co.	....	280	6	180	....	....	......	....	..	......	....	Abandoned on account of sand.*
10	Experiment Station	U. S. Government	....	323	8,6	323	323	....	−200	....	50	Soft	....	
11	Ft. Washington, ½ mi. E.	U. S. Government	80	260	8,6	248	250	Raritan	−8	....	30-60	Soft	....	
12	Hyattsville	Hyattsville Ice Corp.	....	116	6	110	115	Patuxent	+	6	80	Hard	....	
13	Hyattsville	Hyattsville Ice Corp.	....	285	6	285	285	Patuxent	−2	....	..	Hard	....	
14	Hyattsville	J. A. Westlake	....	96	5	96	96	Patuxent	......	....	..	Soft	1887	
15	Hyattsville	Municipality	20	212-242	8,6	212-242	212-242	Patuxent	+	Slight	80	Hard	1908	6 wells. Yield has decreased from 136 gallons.
16	Laurel, 1½ mi. SE.	W. H. Kelly	....	70	4	65	70	Patuxent	......	....	Good	......	1904	
17	Lincoln Park	Lincoln Pk. Ld. & Imp. Co.	....	185	4½	185	185	Patapsco	−50	....	..	Hard	....	
18	Marlboro	Hemingway Canning Co.	30	200	1½	200	200	Magothy	......	....	..	Hard	1903	Abandoned.
19	Marlboro	Hemingway Canning Co.	30	200	1½	200	200	Magothy	......	....	..	Hard	1903	
20	Marlboro	H. W. Gore	40	228	1½	228	228	Magothy	+1	....	..	Hard	1903	
21	Marlboro	Municipality	40	220	1½	220	220	Magothy	+2	....	..	Hard	1903	
22	Marlboro	Municipality	40	222	....	214	214	Magothy	+3	10	..	Hard	1895	
23	Marlboro	John Traband	40	222	1½	216	220	Magothy	+10	Small	..	Hard	1904	
24	Marlboro	P. B. & W. R. R.	40	160	2½	144	160	Magothy	−20	....	37	Soft	1906	
25	Marlboro, 1½ mi. E.	R. S. Hill	140	270	4	270	270	Magothy	−150	....	6	Hard	....	
26	Tuxedo, 1 mi. W.	E. A. Moseley	25	160	1½	146	160	Patuxent	+20	Good	..	......	....	

*This well is not in use since there is too much sand in the water and it cannot be eliminated. Another well was cased 250 feet and when it was continued it caved in under the end of the pipe. The water now used comes from a dug well 56 feet deep which supplies about 400 gallons per hour. White sand supplies the dug-well water.

character of the inorganic matter in water from shallow wells is controlled by the nature of the soluble materials in the water-bearing beds and the opportunities for solution. The most common substances are those present in nearly all ground water, such as lime, magnesia, iron, etc. These substances make the water hard and the iron is especially annoying because it forms a red or yellow deposit when the water is exposed to the air or boiled. Iron is found in much of the shallow well water, especially since there are nodules or boulders of the ore abundantly scattered through the Pleistocene sands and gravels.

CHARLES COUNTY

Charles County lies wholly within the Coastal Plain of Southern Maryland. Much of the country lies at a considerable elevation above tide for a Southern Maryland county, and the surface, originally flat terrace plains, is now much dissected by the network of minor streams, only the flat-topped divides preserving the original level surface.

The major elevations of these divides gradually increase toward the north and northwest from 100 feet on Cobbs Neck in the southern part of the county to 180 to 220 feet near the Prince George's County boundary.

TABLE OF ELEVATIONS

	Feet		Feet
Bel Alton	170	Mt. Pisgah	159
Benedict	10	Nanjemoy	60
Bryantown	133	Newport	20
Clifton Beach	10	Pomonkey	166
Dentsville	160	Popes Creek	8
Hilltop	133	Port Tobacco	40
Hughesville	193	Shiloh	100
Indian Head	94	Tomkinsville	20
Ironsides	126	Waldorf	225
La Plata	190	Wayside	10
Marshall Hall	20	White Plains	194
McConchie	144		

GEOLOGY

The geological formations exposed in the county range in age from the Lower Cretaceous to the Pleistocene. The former are exposed in a narrow belt along the Potomac in the northwestern part of the county, extending from Marshall Hall to Stump Neck. The materials are sands and clays of limited outcrop. The Eocene greensands, sands, and clays are exposed along the Potomac from Mattawoman Creek southward and in most of the stream valleys throughout the county, giving rise to light yellow loams, excellent for truck and canning crops. These formations underlie all of the county to the southeast of the Cretaceous belt. The Calvert formation of the Miocene, which overlies the Eocene, forms a widespread mantle of sandy clays throughout the county except where it is hidden from view by the surficial terrace deposits of the Brandywine, Sunderland, Wicomico, and Talbot formations. The Brandywine forms the surface of the flat-topped divide forming the axis of the peninsula of Southern Maryland and extends southward into the northeastern part of the county from Prince George's County as far as La Plata and Hughesville. Its materials are sands and gravels, and these give rise to the poorest farming lands in the county. Bordering the Brandywine terrace at a lower level and separated from it by a more or less well-marked escarpment or steep slope are found the sandy loams of the Sunderland formation, which give rise to excellent tobacco and trucking soils. These form the surface over wide areas in the Cross Roads, Hilltop, La Plata, and Allens Fresh Election Districts. Lying at a still lower level and not especially well developed, except in the southern half of the Cross Roads Election District, are found the sands and gravelly loams of the Wicomico formation. The lowest-lying terrace of sand, clay, and gravel known as the Talbot formation forms a narrow border to the next highest or Wicomico terrace and is not extensively developed in Charles County except on Tayloe, Cedar Point, and Cobbs Neck.

SURFACE WATERS

More than half the county boundary is formed by the waters of the Potomac, from which the three large tidal estuaries of the Nanjemoy, Port Tobacco, and Wicomico, extend northward into the county. These are all tidal and therefore not potable. The smaller streams are numerous and generally distributed, but the flow is limited and all are liable to pollution. Since the industries of the region are practically restricted to agriculture and fishing, there is not likely to be any local congestion of population which will require the use of surface waters.

UNDERGROUND WATERS

Artesian Waters

With the exception of the wells at Indian Head and one at Allens Fresh, all of the artesian water in use in Charles County comes from beds of Eocene age. In this account of the artesian waters the shallow wells which draw from the Calvert or basal Chesapeake water level are disregarded since the head is very small and data regarding this class of wells are very meager.

The wells drawing from the Eocene water level form the majority of the deep wells in the county. The water seems to be confined to one level, probably at the base of the Aquia. The water is reported soft, a feature not common to the Aquia water on the Eastern Shore but perhaps due here to the nearness of outcrops. This horizon is tapped at Port Tobacco at 160 feet, at Nanjemoy at 175 feet, at Chapel Point at 236 feet, where the well does not flow due to the elevation; at Popes Creek at 202 feet, at Newport at 248 feet, at Wayside and Tompkinsville at 267 and 265 feet. These wells except the one at Chapel Point all flow and all of them yield a good water. This bed probably underlies all of the county southeast of a line drawn a few miles back of the northwestern shore along the Potomac, becoming increasingly important southeastward.

A well at Benedict is 346 feet deep and has a small flow of hard water. This well also draws from the Aquia; the slightly greater depth than would be expected is probably the result of a slight thickening of the deposits. A well near Allens Fresh is 412 feet deep and has a flow of about 13 gallons a minute of soft water. This well has encountered the stream in the Magothy which has been mapped by Darton, Shattuck, and Miller as the main stream of the Upper Cretaceous. This level was also tapped by the town well at La Plata, which was sunk to a depth of 560 feet with the mouth of the well at an elevation of 190 feet. The water in this well stood 125 feet below the surface, an impossible depth to work a suction pump, but not too deep for an air cylinder. The wells at the Naval Proving Ground, Indian Head, are drawing from a sand in the Patuxent formation. The log of the first of these wells, taken from Darton,[1] is given below.

[1] Darton, N. H. Artesian Well Prospects in Atlantic Coastal Plain, Bull. U. S. Geological Survey No. 138, 1896, pp. 134, 135.

WELL AT INDIAN HEAD

	Feet
Soil with light sand	0–15
Cobblestone and clay	15–18
Red clay and gravel	18–22
Sand and gravel	22–27
Red clay with water	27–34
Dark marl	34–42
Red clay and sand mixed	42–54
Hard tough sandy clay	54–72
Red tough clay	72–87
Hard sandy clay	87–95
Red hard clay	95–110
Rock	110–112
Hard sandy clay	112–122
Very dark sandy clay	122–125
Dark clay and sand	125–134
Mixed red sand and clay	134–142
Dark sandy clay	142–160
Blue hard sandy clay	160–170
Gray sand and clay	170–220
Dark-blue sand and sandy clay	220–230
Hard clay and sand	230–260
Very fine gray sandy clay, with little gravel	260–285
Light-gray sandy clay	285–302
Clay and sand	302–313
Gray sandy clay	313–328
Clay and sand	328–340
Clay and sand, with little dark-red gravel	340–346
Sand, mixed with red clay	346–353
Part red and part gray clay	353–358
Soft rock	358–360
Red clay	360–365
Hard red beds	365–368
Hard red beds with blue intercalations	368–376
Blue and red beds	376–387
Blue beds and sand	387–392
Clay mixed with sand	392–400
Sandy clay and rock	400–409
Gray rock	409–424
Mixed sand and sandy clay	424–435
?	435–442
Blue sandy clay and sand	442–445
Sandy clay and sand	445–456
Hard sand with gravel	456–463½

The major portion of this section is referred to the Patuxent (the Arundel is not recognized), while the beds from 42 to 112 feet are identified as Patapsco. Whether or not this well is drawing from the base of the Patuxent is not known for certain, but the mention of sand and gravel as the base of the section together with the great thickness forces the conclusion that this well has almost reached the crystalline floor. In the Patuxent folio[1] underground water contours are given that would place the basal Potomac waters much farther down in this well. If, however, consideration is given to the straightening of the strike to a more nearly north and south direction which is noticeable in the Potomac Valley and which is finally achieved in Virginia, the base of the Patuxent should be found at some such depth as that of the Indian Head well.

The first of the government wells at Indian Head, the one given above, was about 100 feet above tide and did not flow, but the later ones have been drilled nearer to water level and have achieved varying flows.

Charles County, then, is underlain by the Eocene horizon, by the Magothy and by the Patuxent waters. The Patuxent probably lies at a depth of from 1200 to 1400 feet along a line drawn through Waldorf and La Plata and will rise or sink at the rate of about 60 feet to the mile, according as distances are taken either to the northwestward or southeastward of this line.

The Eocene water will probably continue to be the objective of most of the future wells of this county and should be reached at moderate depths over its entire distribution, but will yield flows only on low land within 25 feet of tide level.

Non-Artesian Waters

SPRINGS.—In no part of the Coastal Plain are springs more numerous than in Calvert, Charles, and St. Mary's County, and Charles has probably more than either of the other two. Good springs are frequent, but only a few of them are utilized because it is usually more convenient to obtain water from wells located near the houses. The springs are fed mostly

[1] Geologic Atlas No. 182, U. S. Geological Survey, 1907.

by the water absorbed from rainfall by the surficial sands, through which it sinks until its downward movement is stopped by marls or clays. The point of emergence is on the slopes or in the ravines which are cut into the surface of the Pleistocene terraces. While most of the springs issue from sands of Pleistocene age not infrequently the Miocene sands near the surface are trenched by the streams and furnish good springs.

The volume of flow is seldom large, though most of the springs will supply a single household and many of them would furnish enough water for several families. Some of the weaker flows from the Pleistocene formations fail in extremely dry weather, but many of the stronger springs are not materially affected by drouths, the springs from the Miocene formations, for example, usually having a fairly constant flow. The spring water is usually free from organic and inorganic impurities. Locally where springs emerge from thin beds of Pleistocene sand they may receive some water containing organic matter of a more or less deleterious character, but most of the water from the Pleistocene formations and practically all of that from the Miocene formations is free from such contamination. The percentage of inorganic matter in solution in the spring water is commonly so low that the supplies are soft, but locally there is enough mineral matter in solution to make the water slightly hard. Some of the springs from the Pleistocene formations supply water containing iron, dissolved from deposits in the sands, but the quantity is seldom large enough to interfere with the use of the water.

SHALLOW WELLS.—Dug, driven, or even drilled shallow wells supply most of the water used for domestic purposes in Charles County. The amount of relief and the presence of sands of Pleistocene and Miocene age which form the surface of the county all contribute to the ease of reaching a fairly constant supply of good water. The wells vary in depth from 15 to 40 feet. Locally, wells are deeper, reaching a depth of 80 feet, as at Allens Fresh, although this well probably should be classed as artesian since the water is under a slight head. As a matter of fact, a good many of the wells on the uplands are down into the Miocene, but the dissection is so great as to prevent storage and so inhibits flows or even large heads.

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Remarks
1	Allens Fresh	J. A. Posey	15	412	2	412	412	Magothy	+5	13	....	Soft	1897	Boilers.
2	Bel Alton	P. R. Wills	160	33	4	....	33	Calvert	—25	..	....	Soft	1870	Hotel.
3	Benedict	Numsen & Davis	10	347	1¼	345	346	Aquia	+15	45	....	Hard	1908	Canning.
4	Indian Head	U. S. Government	100	463	6	....	....	Patuxent	—80	..	....	Soft	....	
5	Indian Head	U. S. Government	10	388	8	....	....	Patuxent	+3	20	104	Soft	....	
6	Indian Head	U. S. Government	15	409	8	....	....	Patuxent	+	..	100	Soft	1399	
7	Indian Head	U. S. Government	15	432	4	....	....	Patuxent	+	..	83	Soft	1898	
8	Nanjemoy	....	15	175	..	....	....	Aquia	+	1	....	Soft	....	
9	Newport	L. S. Herbert	20	234	1½	234	234	Aquia	+6	5	....	Soft	1898	
10	Newport	J. P. Tippett	35	248	1½	248	248	Aquia	+1½	3½	....	Soft	1906	
11	Newport	R. S. Tippett	20	235	1½	235	235	Aquia	+3	9	....	Soft	1903	
12	Popes Creek	Chas. Drinks	8	206	1¾	206	206	Aquia	+1	1	....	Soft	1905	
13	Port Tobacco	County	25	160	1¼	160	160	Aquia	—5	3	....	Hard	1899	
14	Tompkinsville	Wm. J. Frere	20	265	1½	265	265	Aquia	+3	1	....	Soft	...	
15	Wayside, 2 mi. W.	M. N. G. Hungerford	20	267	1½	267	267	Aquia	+1	¼	....	Soft	1896	Intermittent.

The quality of the water furnished by shallow wells is usually very good, but local conditions easily affect their purity. Bryantown, for instance, had an epidemic of typhoid fever several years ago because the town is situated on the side of a hill and downward drainage was constantly polluting the lower wells. The well on the top of the hill was the only one that failed to show the danger signal, *Bacillus coli.*

The need of locating wells so that they will be in no danger of sewage pollution is an elementary lesson in sanitation and has been iterated and reiterated in every publication concerned with public health. If the wells cannot be removed from danger of seepage drainage they should be sunk to below a continuous impervious bed, typified in this region by clay. Besides harmful organic matter the water sometimes contains less harmful but more disagreeable substances, usually in the form of decayed vegetable matter deposited with the sands. While this cannot be excluded from the water it is seldom harmful, and unless the water is rendered unpalatable its presence can usually be disregarded.

Inorganic matter is frequently present in the shallow water, the most noticeable element being iron, which is sometimes present in objectionable quantities, staining clothes and forming a scum on the surface of standing water. Iron is very irregularly distributed in the shallow wells, so irregularly that only a part of the wells in a given community may show its presence, although they all are of the same depth. The mineral is dissolved by the water in its passage from the sands and gravels of the Pleistocene which are frequently coated with iron and locally composed of iron crusts or nodules.

CALVERT COUNTY

Calvert County lies wholly within the Coastal Plain province. The relief is slight and the former level surface has been dissected by streams to form the present rolling upland made up of three terrace plains ranging from sea level, in the case of the lowest, to about 180 feet in the case of the highest, which forms the main divide of the county.

TABLE OF ELEVATIONS

	Feet		Feet
Adelina	130	Mt. Harmony	181
Bowen	160	Olivet	20
Broome Island	20	Parran	136
Chaney	150	Port Republic	160
Chesapeake Beach	5	Prince Frederick	150
Cox	140	St. Leonard	40
Dunkirk	110	Sheridan Point	30
Governor's Run	5	Solomons	1–12
Leitch's Wharf	15	Sunderland	166
Lower Marlboro	20	Wallville	120
Lyons Creek	60		

GEOLOGY

The oldest geological formation exposed in Calvert County is the Nanjemoy formation of the Eocene which outcrops in a limited area in the northwestern part of the county and comprises marls, sands, and greensands. Overlying the Nanjemoy are the three formations of the Miocene, the Calvert, Choptank, and St. Mary's, which consist of marls, clays, diatomaceous earth, and sands. These cross the county in belts from northeast to southwest and form the surface of most of the county except where they are hidden by the thin mantle of clay, sand, and gravel of the surficial terrace formations of Pleistocene age, the Sunderland, Wicomico, and Talbot.

SURFACE WATERS

Calvert County, except for its northern boundary, is entirely surrounded by the waters of Chesapeake Bay and the Patuxent River, which receive the entire drainage of the county. The divide lies to the east of the center of the county, hence the streams flowing into the Chesapeake are much shorter than those flowing into the Patuxent. Among the former the largest are Fishing and Parker creeks. The latter include Lyons, Hall, Cocktown, Hunting, Battle, Island, St. Leonard, Hellen, and Mill creeks. Nearly all of these have their lower valleys transformed into estuaries or marshes. In the absence of large towns the streams have never been utilized for water supply purposes nor are their waters potable because of the usually large amount of organic matter in suspension and the liability to contamination from the runoff of the adjoining cultivated lands. No measurements of stream flow have been made, and because of the gentle slopes the amount of water power developed is slight, although in some instances dams have been constructed and the power utilized by small manufacturing concerns. Ten horsepower is reported as utilized on a tributary of Hall Creek at Chaneyville, and 25 horsepower is utilized on St. Leonard Creek at St. Leonard.

UNDERGROUND WATERS

Artesian Waters

Artesian wells are rather numerous, especially around the southern end of the county. They are practically limited to the valleys since flows are unobtainable at higher levels than 20 feet and most of the wells are located much closer to tide than this. The whole county is underlain by artesian water of good quality, coming from four different levels. Water has been encountered in the lower beds of the Calvert, in the Nanjemoy, in the Aquia, and one well draws its supplies from the uppermost Matawan.

The Calvert water horizon supplies the greatest number of wells in the county and has been tapped by wells from Chesapeake Beach southward. The wells at Chesapeake Beach find the Calvert water at a depth of about 80 feet, but owing to inaccurate records the exact depth cannot be ascertained. The casings are short of the entire depth and so several streams may be in use. A log of one of the 85-foot wells follows:

WELL AT CHESAPEAKE BEACH

	Feet
Clay with little gravel	0–30
Blue clay with some shells	30–85
Coarse blue sand, water	85+

The well was in the Calvert all the way. Several of the wells at this locality that go down 180 to 200 feet have probably encountered a horizon in the Nanjemoy, but this is impossible of verification because the upper water is not cased off. A good many of the 80-foot wells flow, but there is a marked interference with the flows of neighboring wells when one of the series is pumped hard. The only remedy for this is to put spigots on the pipes and to turn off the flow when it is not in use. Spigots would be very helpful at other places in the Coastal Plain and at other places in Calvert County. At Broome Island two wells about 50 feet apart were sunk to the Calvert at a depth of 225 feet. The first well had a flow of about 3 gallons a minute, but when the second well was sunk the flow of the first well diminished to about a quart a minute and the second well now has all the flow. If these two wells were fitted with spigots they could both have the flow, besides saving the water that is now wasted. At Solomon's Island where the Calvert water is much used and where the wells all have a flow, the yield has decreased very much as additional wells have tapped the horizon. Here, too, the water is allowed to run to waste into the river when spigots would ensure every user a greater head and in addition would store up the unused water. The water zone at the base of the Calvert formation supplies the wells at Governor Run, 225 feet deep; at Broome Island, 225 to 230 feet deep; at Wallville, 252 feet deep; and the numerous wells at Solomon's Island and the adjacent mainland at depths of from 240 to 275 feet. The wells at Governor Run, Broome Island, and Wallville reach to the very base of the Calvert formation, while the wells at Solomon's penetrate to about 50 to 60 feet above the base, as estimated for that locality.

The Solomon's Island wells flow at levels a few feet above tide, but the flows are very small and are strongly affected by tides. The water is slightly warm, having a temperature of about 60° F., and a mineral analysis of the water from the well opposite Webster's store shows a slightly hard water with fair quantities of the alkaline earths.

	Parts per Million
Turbidity	0.0
Alkalinity	15.6 N/50
Hardness	89.7
Total dissolved solids	221

	Parts per Million
SiO_2	52.1
Fe	.01
Al	.6
Ca	18.4
Mg	10.5
Na	37.4
K	—
CO_3	22.8
HCO_3	143.9
SO_4	6.0
Cl	2.6
NO_3	1.3

There are two wells in the county that have tapped the water at the base of the Nanjemoy formation. A well at Sheridan Point, 300 feet deep at a 30-foot elevation, found good water that heads within 15 feet of the surface, and a flowing well at Solomons 480 feet deep yields the same "soft" water. Several wells at Chesapeake Beach report water from about 180 feet, but the records are very inaccurate and the length of the casings not definitely known, so that it cannot be definitely stated that the Nanjemoy is reached at Chesapeake Beach, although it seems very probable that such is the case, as this zone should be reached at a depth of about 175 feet. This level underlies the whole county, but owing to the greater accessibility of the Calvert water zone it is not extensively used.

WELL AT CHESAPEAKE BEACH

	Feet
Muck and sandy loam	1–17
Light-gray clay	17–60
Dark-gray sand	60–90
Flowing water, 3 gallons per minute	90–92
Dark-colored glauconitic sand	90–122
Light-gray clay	122–165
Dark glauconitic sand	165–180
Small flow of water at	165
Dark glauconitic sand	180–268
Light-gray micaceous clay	268–280
Reddish-gray clay	280–285
Reddish-gray sand	285–293
Water about 5 gallons per minute, rises 6 feet above surface or about 17 feet above mean tide	Lost
Dark-colored glauconitic sand with shell fragments	340–343
Flow of water, 10 gallons per minute.	

A well at Chesapeake Beach 295 feet deep, and one at Leitch's Wharf 370 feet deep are the only wells in Calvert County that draw from the Aquia water zone. The water from these wells is hard, with a larger amount of iron than is common in the water of the Calvert formation. These wells fall in line with that at Benedict, Charles County, and indirectly with the other wells in Charles County. There are several wells at Chesapeake Beach 380 feet deep that are thought to draw from the upper part of the Matawan formation, the level found in the Easton well at 570 feet and at Oxford at 540 feet. The wells at Chesapeake Beach being close to tide have a flow of about 10 gallons of hard water per minute. The log given above was prepared from samples saved by the driller.

This log shows the much-used water zone at the base of the Calvert, 90 feet deep at this locality, the water in the upper part of the Aquia formation, which is here called the Nanjemoy water, the water at the base of the Aquia formation, and that in the Matawan. The water from all of these zones headed above the surface and consequently flowed.

Calvert County is thus shown to be underlain by several water horizons of wide extent. The Aquia horizon, the deepest in the county save the relatively unimportant Matawan zone, underlies the whole county, reaching an approximate depth of 650 feet at the southern end. The Nanjemoy also underlies the whole county at depths of from about 180 feet along a line drawn from Deep Landing to Chesapeake Beach to 500 feet, or slightly more, at the southern end. The Calvert, which is the most important of the water zones in this county, cannot be expected far northwest of Chesapeake Beach, but to the southeastward it becomes increasingly important, reaching its greatest development in this county around the mouth of the Patuxent. New wells are constantly being drilled to this horizon and the head of the water is continually decreasing so that the warning already given cannot be too strongly emphasized, *flows should be turned off when not in use.*

Wells can be expected to yield good water at practically every point in the county, but flows can be looked for only when the mouth of the well is within 20 feet of tide level and the wells in the Calvert horizon will have to be within 10 feet of tide in order to flow.

Non-Artesian Waters

SPRINGS.—The rolling topography and almost flat geological formations favor the development of springs. The ground water sinking through the porous beds of the Pleistocene until it reaches the less porous

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Volume of flow	Character of water	Date drilled	Remarks
1	Broome Island	David Elliott	3	225	3" to 4' hal. 1½"	225	225	Calvert	..	+6	15 gal. hr.	Soft	1912	
2	Broome Island	Wilson Elliott	3	230	3" to 40' hal. 1¼"	230	230	Calvert	..	+7	1 gal. min.	Soft	1016	This well took all the flow from the preceding.
3-7	Chesapeake Beach	Chesap. Beach Hotel Co.	2	380	1½	380	380	Matawan	90	+6	55	Hard	1900-1909	
8	Chesapeake Beach, ¾ mi. NE.	George Hawkward	5	126	2½, 1¼	....	126	Calvert	..	+6	1½	Hard	1909	
9	Chesapeake Beach, ¾ mi. NE.	Dr. D. Binkert........	5	130	2	....	130	Calvert	..	+7	....	......	1909	
10	Chesapeake Beach, ¾ mi. NE.	Nellie L. Birtwell.....	5	200	1½	80	....	Nanjemoy	..	+6	....	Hard	1908	
11	Chesapeake Beach, 1½ mi. NW.	W. E. Pario...........	5	276	2	40	....	Aquia	..	+2	2½	Hard	1909	
12-16	Chesapeake Beach	N. Chesap. Beach Co.	5	125-164	1¾	125-160	....	Nanjemoy	..	+8 to −10	Small	Hard	1901-1905	
17	Chesapeake Beach	....	5	295	......	....	....	Aquia	..	+10	6	......	....	
18	Governor Run.................	Wm. Dorsey	4	225	2	125	....	Calvert	..	+12	4	Soft	1904	
19	Leitch's Wharf, 1 mi. N.......	Mrs. Caleb Boyd......	10	370	1½	370	....	Aquia	..	+14	8	Hard	....	Slightly brackish.
20	Sheridan's Point	....	30	300	......	....	....	Nanjemoy	..	+20	....	Soft	....	
21	Solomon's	W. H. Kopp...........	15	480	1½	360	....	Nanjemoy	..	+12	2	Soft	1910	Decreased from 5 gallons.
22	Solomon's	P. T. Vail.............	15	255	1½	217	....	Calvert	..	+10	....	Soft	1914	
23	Solomon's	W. H. Crockett.......	5	265	1½	265	265	Calvert	..	+8	1	Soft	1903	
24	Solomon's	W. H. Crockett.......	4	263	1½	263	263	Calvert	..	+7	1	Soft	1903	
25	Solomon's	Johnson & Co.........	2	250	1½	....	250	Calvert	..	+4	1	Soft	....	
26	Solomon's	W. E. Northam........	12	260	1½	260	260	Calvert	..	−10	....	Soft	1909	
27	Solomon's	Patuxent Fish Co.....	3	280	2	....	....	Calvert	..	+2	....	Soft	....	
28	Solomon's	J. Kelly	4	255	1½	220	220	Calvert	..	−6	....	Soft	1914	
29	Wallville, 1 mi. SW...........	I. C. Bowen...........	15	252	2	150	252	Calvert	..	+20	100+	Soft	1904	
30	Wallville, ¾ mi. SW..........	Benj. Parran	15	180	2	150	....	Calvert	..	+13	....	Soft	1004	

Miocene deposits flows along this contact until it is tapped by some valley slope. Because of the thinness of these Pleistocene deposits the springs are less numerous in Calvert than in the other counties of Southern Maryland and they frequently fail in dry seasons. The spring water is frequently charged with iron and because of the danger of contamination from surface drainage should not usually be depended upon for domestic use.

Shallow Wells.—The majority of the inhabitants, living as they do along the divides where run the roads, depend upon shallow wells for water. Most of the shallow wells draw from Pleistocene sands, which are relatively thin in this county so that the wells are correspondingly shallow. The range in depth of the Pleistocene wells is from about 15 to 45 feet. There are a good many wells in the county that are sunk to about 60 to 90 feet and find water in the upper beds of the Miocene formation which lies nearest to the surface at the particular locality. These wells are scattered over the whole county irrespective of any particular stratigraphic level and are usually very close to the catchment area of the sand and so have rather low heads, but the improved quality of the water and the greater reliability of supply are very great advantages over the shallower Pleistocene wells.

St. Mary's County

St. Mary's, the southernmost county in Maryland, occupies the peninsula between the Potomac and Patuxent rivers and Chesapeake Bay. Its surficial deposits erode easily and its former level surface has been much dissected, resulting in a rolling topography. Four levels or terrace surfaces are recognizable. The lowest, lying between tide and 45 feet elevation, is known as the Talbot terrace plain, and is an almost unbroken flat over much of its extent. The second, known as the Wicomico plain, is somewhat more dissected, its surface rising toward the divides and lying between 55 and 80 feet above tide. The third, known as the Sunderland, forms the main divide of the county. It is much more dissected than the other two and its rolling surface rises toward the northwest to a height of about 180 feet. A fourth and older terrace plain, still more dissected than the preceding, extends southeastward to the vicinity of Charlotte Hall and is known as the Brandywine plain.

TABLE OF ELEVATIONS

	Feet		Feet
Blakistone	10	Mechanicsville	165
Bushwood	5	Morganza	71
California	115	Newmarket	172
Charlotte Hall	167	Oakley	20
Clifton Mills	30	Palmer	5
Colton	5	Park Hall	100
Compton	9	Pearson	5
Cornfield Harbor	10	Piney Point	5
Chaptico	20	Ridge	42
Great Mills	20	River Springs	5
Hermanville	111	Scotland	10
Hollywood	130	St. George Island	5
Jarboesville	110	St. Inigoes	20
Laurel Grove	135	Trappe	86
Leonardtown	10	Valley Lee	40
Maddox	50		

GEOLOGY

The oldest deposits now exposed within St. Mary's County are three formations of the Chesapeake group of Miocene age. They are, from oldest to youngest, the Calvert, Choptank, and St. Mary's formations. These consist of sands, clays, and marls. Beneath the Miocene but nowhere exposed in the county is the Eocene. The Eocene and the Calvert formation of the Miocene underlie the whole county and are the source of abundant underground water. Overlying the Miocene are the sands, loams, clays, and gravels of the four surficial formations, the Brandywine, Sunderland, Wicomico, and Talbot, which lie at successively lower levels and form the terrace plains previously mentioned.

SURFACE WATERS

St. Mary's County is almost entirely surrounded by water, but in the absence of large towns or extensive industries requiring large amounts of water the streams are not utilized as sources of supply. Patuxent River forming the northeastern boundary, Potomac River forming the southern boundary, and Wicomico River forming part of the western boundary are all tidal and consequently are brackish. The most important streams entirely within the county are Chaptico Creek, McIntosh Run, St. Clement and St. Mary's rivers. In addition to these four small rivers, there are many smaller creeks along the coast, all of which have the same general characteristics. Their basins are small and flat with considerable length of tidal flow. No water power is now utilized in the county, although at one time a small power plant on St. Mary's River at Clements was used for milling. Chaptico Creek has a drainage area of 32 square miles. The effects of the tide are apparent to just above Chaptico. The discharge, measured in 1904, about ½ mile above Chaptico bridge was 12 second-feet.

St. Clement River has a drainage area of 23 square miles and is marshy toward its mouth. Its discharge is about 6.6 second-feet. McIntosh Run has a drainage area of 26 square miles and a discharge of 4.7 second-feet measured about 1 mile above Leonardtown. None of the streams of the county should be utilized for potable water since all are very liable to contamination and contain much vegetable matter in suspension.

UNDERGROUND WATERS

Artesian Waters

Many artesian wells have been drilled in recent years, particularly in the low-lying areas adjacent to the Patuxent and Potomac rivers. The water zones reached in these wells are of wide extent and their depths below the surface can be predicted with reasonable certainty for any locality in the county.

Two principal water horizons are known, one in the Calvert formation of the Miocene and the other and deeper one in the underlying Eocene.

Wells are down into the Calvert and the Nanjemoy, although the horizon called Nanjemoy is more probably the upper part of the Aquia, but in order to distinguish between the water at the base of the Aquia the upper level is called Nanjemoy. The Calvert is the main water horizon and has been encountered under good heads from Leonardtown southeastward. At Leonardtown the water in the Calvert formation has been found at 195 feet in a well, the samples of which were described by N. H. Darton as follows:

WELL AT LEONARDTOWN

	Feet
Light-gray sandy clay	20–165
Light-green sand with shell fragments	165–190
Dark-green micaceous sand with shell fragments	190–195

It has been impossible to identify this well with any of those reported from Leonardtown, so it is not known whether this is a partial record of one of the deeper wells recorded in the appended table. A record of a well drilled by Mr. L. Rude in 1909 and compiled by him is as follows:

WELL AT LEONARDTOWN

	Feet
Hard light clay	0–12
Hard blue clay	12–120
Soft dark clay	120–130
Soft light sand	130–170
Light sand rock (overflow of 1 gallon per minute)	170–185
Soft black earth	185–220
Soft black sand	220–228
10 gallons per minute.	

The wells at Leonardtown 260 feet deep do not have their casings extended all the way to the bottom, so that it is impossible to tell whether they are drawing from the basal bed of the Calvert as does the well at Wallville in Calvert County, but it seems likely that they do since they probably extend all the way through the 60 or 70 feet of water-bearing beds at the base of the formation.

The water in the beds at the base of the Calvert formation supplies the wells at Blakistone Island 156 feet deep, Leonardtown, Sotterly, along the beach near Millstone Landing and Pearson, Great Mills, Valley Lee, Piney Point, St. George's Island, the 277-foot well at Portobello, St. Inigoes, Drayden, and Cornfield Harbor. The Calvert water is first reached about 60 to 70 feet above the base of the formation, and in some wells enough water is found in the first bed while in others it is necessary to go slightly deeper. This condition is due to the fact that the materials in the lower part of the Calvert are rather variable and for this reason water may be forced down slightly by a change in lithology.

The Calvert water is reported to be soft and an analysis of water from Millstone made on the grains-per-gallon system is given by Shattuck and Miller[1] in the St. Mary's folio. This analysis is not very complete, but shows rather large amounts of calcium, magnesium, and sodium carbonates with the alumina and iron oxide combined as .0525 grain per gallon. The alumina probably comprises almost all of this amount, since iron is not present in large quantities in the Calvert water. The analysis is given below.

GRAINS PER U. S. GALLON (231 CU. IN.)

Silica	3.0967
Alumina and iron oxide	.0525
Calcium carbonate	3.1025
Magnesium carbonate	2.3152
Sodium carbonate	3.6507
Sodium chloride	.4899
Sodium sulphate	Trace

The Eocene water in this county comes from a level that at Chaptico and west of Maddox is about 90 feet above the water at the base of the Aquia. As shown by the sections given below, which have been taken from the drillers' records at these places, the water comes from a bed in the uppermost Aquia trapped under the lowermost bed of the Nanjemoy formation.

WELL AT MADDOX

	Feet
Fine dark-gray sand	1–8
Fine light-gray sand	8–12
Fine dark-gray sand	12–70
Glauconitic sand, containing shell fragments	70–120
Glauconitic sand	120–225
Brown clay, containing glauconitic sand	225–248

[1] Geologic Atlas, U. S. Geological Survey, St. Mary's folio No. 136, p. 7, 1906.

WELL AT CHAPTICO

	Feet
Light-yellow sand, containing small white quartz pebbles	1–20
Dark-gray sand with shell fragments	20–70
Gray sand with many shell fragments	70–80
Gray sand with a few shell fragments	80–120
Light-gray sand with many glauconitic grains	120–250
Dense yellow clay, glauconite grains probably from beds	250–270
Yellow sand with many glauconite grains	270–295

Stratigraphically this water is not Nanjemoy but comes from the upper part of the Aquia formation, but since in the literature the position has always been given as the base of the Nanjemoy and there is another water-bearing level in the Aquia formation, this water horizon may still be called Nanjemoy to avoid confusion.

Numerous wells in the northwestern part of the county at Oakley, Palmers, Portobello, Bushwood, Compton, and on Blakistone Island, besides those at Chaptico and Maddox, draw from this Nanjemoy water horizon. The water is reported to be soft, but unfortunately no analyses are available. The water is under a good head, rising 22 feet above tide at Chaptico. This is perhaps the limit of height to which this water will rise and it should not be expected to rise quite to this height. Fifteen feet is nearer the level to which this water will ordinarily rise above tide.

St. Mary's County is thus shown to possess two valuable water levels that can be rather definitely located and correlated, both levels supplying good water and both having good heads. The Survey does not possess much information regarding the depletion of the stored water, but at several places decreases have been noted. In the Eocene wells around Oakley, Palmers, Compton, and Blakistone Island there has been a steady although slight decrease in flow, and around Piney Point, St. George Island, and St. Inigoes the flow of Calvert water has also diminished, in fact the well at St. Inigoes Manor has entirely ceased to overflow. These instances merely make more evident the insistent need for some regulation of the use of underground waters. When one considers the slow rate at which the underground water moves, probably less than 2 feet an hour, and that one well flowing only 3 gallons a minute will exhaust over

4000 gallons in a day, it will at once be seen that unless measures are taken to check the present great and widespread waste of these waters the supply must soon show disturbing diminution and eventually actual exhaustion of many wells.

Non-Artesian Waters

The majority of the inhabitants of the county depend upon springs and shallow wells for water for domestic purposes.

Springs.—The nature of the topography of the region with many stream valleys cut almost to sea level combined with the gentle dip of the different beds of varying permeability afford excellent conditions for the development of springs. The ground water sinking through the porous Pleistocene deposits until the less porous beds of the Miocene are encountered, flows along the contact until it is tapped by some valley slope where it issues as a line of seepage or as a spring. A large percentage of the ground water is not checked at the contact of the Pleistocene and Miocene but passes downward through the sandy layers of the latter formation until its farther progress is checked by more argillaceous beds along which it flows until the layer outcrops at the surface. The more deep-seated springs of the latter sort which penetrate Miocene beds are apt to be purer than the shallow springs and furnish an unfailing supply of excellent water. In addition to the increased danger of contamination in the shallower springs, they are very apt to fail in dry weather.

Some of the springs are remarkable because of the large quantity of exceptionally pure water which issues from them, and also because of their continuous flow since the earliest settlement of the state with probably undiminished volume. The most famous one is Governor's Spring, a short distance east of St. Mary's City, which was the first permanent settlement in Maryland and for a long time its capital. Another spring, equally well known, is the excellent spring at Charlotte Hall which has long furnished the supply of water for the boy's school at that place.

Shallow Wells.—Shallow wells are the common source of water for the agricultural population, and these usually supply a good water in sufficient quantities for domestic use. Except on the top of narrow divides between deep valleys, the ground-water level lies near the surface

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Head	Volume of flow	Character of water	Date drilled	Driller	Remarks
1	Blackistone	W. W. Blackistone	8	278	1½	278	278		+2	½	Soft	1897	Johnson.	
2	Blackistone	W. W. Blackistone	8	280	1½	280	280	Nanjemoy	+2	2-3	Soft	1908	L. Rude.	
3	Blackistone	J. W. Renehan	8	156	1	156	156	Nanjemoy	+2	1	Soft	1903	Charles Files.	
4	Bushwood	....	12	287	2	287	287	Calvert	+2	..	......	....		
5	Chaptico	A. C. Welch	20	295	1½	295	295	Nanjemoy	+2	2	Soft	1905	L. Rude	There are 3 wells in this town similar in all respects to this well.
6	Compton, 1 mi. SE	Harrison Ewell	10	247′6″	2	247	247	Nanjemoy	+1½	3-4	Soft	1905	Rude & Clark	Tide affects this well.
7	Compton, 1 mi. N	J. R. Sypher	7	302	2	302	302	Calvert	+10	8	Soft	1909	R. B. Harrison.	
8	Compton, 1 mi. S	H. & G. Wehrheim	10	315	1½	315	315	Nanjemoy	+12	8	Soft	1907	L. Rude	Tide affects this well.
9	Cornfield Harbor	Jas. Hall	10	390	1½	....	....	Nanjemoy	+7	..	Soft	1885	S. J. Wailes.	
10	Cornfield Harbor	Jas. Hall	10	400	1½	....	....	Calvert	+7	..	Soft	1886	S. J. Wailes.	
11	Drayden	W. Ford & Co.	10	287	1¼	....	....	Calvert	+	8	Soft	1905		
12	Great Mills	Helen R. Cecil	20	270	2	60	....	Calvert	+13?	½	Soft	1899	Adams	Very high tides increase flow slightly.
13	Leonardtown	Xaverian Brothers	10	225	1	....	....	Calvert	+	1½	Soft	1914		
14	Leonardtown	E. B. Abell	10	287	2	....	....	Calvert	+	1	Soft	1894		
15	Leonardtown	Hotel St. Mary's	10	263	1½	....	....	Calvert	+14	10	Soft	1907	L. Rude.	
16	Leonardtown	Hotel St. Mary's	10	265	1½	....	....	Calvert	+14	10	Soft	1907	L. Rude.	
17	Leonardtown	J. F. Neal	10	220	2	....	177	Calvert	+2½	1	Soft	1894	L. Rude.	
18	Leonardtown, ¼ mi. E	....	10	228	1½	220	225	Calvert	+12	10	Soft	....		
19	Maddox, 2 mi. W	....	10	275	1½	248	270	Nanjemoy	+14	6	Soft	....		
20	Oakley	J. M. Dent	20	316	1½	40	315	Nanjemoy	+2	3	......	1889	Johnson.	
21	Palmer, 1 mi. N	W. E. Thompson	6	294	1¾	107	294	Nanjemoy	+6	8	Soft	....	Charles Files.	
22	Pearson (Millstone Ldg.)	J. H. Craddock	6	290	1½	200	290	Calvert	+6	4	Soft	1904	L. Rude.	
23	Pearson (Millstone Ldg.)	J. H. Craddock	4	290	2	290	290	Calvert	+6	4	Soft	1903	Milburn.	
24	Pearson, 1½ mi. W	Dr. A. L. Hodgson	6	257	2½	265	256	Calvert	+6	3	Soft	1904	Milburn.	
25	Pearson, 1 mi. E	Wm. Whiting	4	287? 350s	4	....	250	Calvert	+7	6	Soft	1902	Johnson	Tide affects flow slightly.
26	Piney Point	Piney Point Hotel	5	272	2	272	272	Calvert	+7	1	......	....	Johnson	Tide has a very marked affect on the flow of this well.
27	Piney Point, 1½ mi. NW	J. W. Waugh	5	245	1½	245	245	Calvert	+10	..	Soft	1891	L. Rude.	
28	Portobello	A. Hyatt	2	480	1½	470	475	Nanjemoy	+10	10	......	1909		
29	Portobello	A. Hyatt	2	270	1½	80	....	Calvert	+8	2	Soft	1904		
30	Portobello	A. Hyatt	2	277	1½	80	277	Calvert	+1½	2½	Soft	1904	Adams	Tide increases flow 100 per cent.
31	St. George Island	Adams Bros.	6	265	2	40	265?	Calvert	+7	2	Soft	1904	L. Rude	Tide affects this well.
32	St. George Island	Adams Bros.	5	272	1¾	60	272?	Calvert	+7	3	Soft	....	Johnson.	
33	St. George Island	Wm. Clark	4	287	1½	212	280	Calvert	+	2	Soft	1905		
34	St. George Island	Mr. R. E. Sears	5	280	1¼	....	....	Calvert	+7	1	Soft	1905	John A. Adams.	
35	St. Inigoes	St. Inigoes Manor	20	298	2	100	....	Calvert	+18	..	Soft	1889	Johnson.	
36	St. Inigoes	....	20	365	1½	....	....	Calvert	+	2	Soft	....		
37	St. Inigoes	....	20	300	1½	....	....	Calvert	+	2	Soft	....		
38	Valley Lee, 1½ mi. W	B. H. Duke	3	260	1	260	260	Calvert	+13	1	Soft	1903?	Rude & Clark.	
39	Valley Lee, 1½ mi. W	B. H. Duke	14	260	1½	260	260	Calvert	+16	3	Soft	1908?	Rude & Clark.	

and an abundance of water can be obtained from dug wells of shallow depth. On the narrow divides, however, the water table during dry seasons sinks almost to sea level and thus necessitates wells of considerable depth. On the other hand, on the broad, low-lying flats bordering the Potomac dug wells rarely need to be over 20 feet in depth and sometimes the water in them rises nearly to the surface. The water in these shallow wells is very apt to contain impurities, usually of organic origin, although iron salts are also liable to be present in greater or less amounts. Some of the wells on St. George Island are only 12 feet deep and the water in these is more or less brackish because of seepage from the river. The location of shallow wells in or near settlements should be given very careful consideration, since most of the villages are on hills and household drainage is especially liable to contaminate the wells.

COUNTIES OF CENTRAL MARYLAND

HARFORD COUNTY

Harford County lies to the west of the headwaters of Chesapeake Bay and extends to the Pennsylvania line. Over three-quarters of its area is in the Piedmont Plateau district and is a gently rolling upland, while the southeastern quarter is in the Coastal Plain district and is low and flat.

TABLE OF ELEVATIONS

	Feet		Feet
Aberdeen	79–89	Forest Hill	544
Abingdon	160	Havre de Grace	35
Belair	396	Magnolia	28
Cardiff	430	Norrisville	760
Churchville	406	Rocks	300
Cresswell	243	Sharon	375
Darlington	324	Upper Crossroads	584
Edgewood	29	Van Bibber	22
Fallston	442		

GEOLOGY

The Piedmont portion of the county is formed by the very ancient crystalline and sedimentary rocks of igneous and metamorphic origin which are much folded and faulted. These comprise quartzite, slates, granite, serpentine, gabbro, phyllites, and gneiss, and outcrop as shown on the geological map of the county published by the Maryland Geological Survey. A part of the area is described in the Tolchester folio of the U. S. Geological Survey and the whole district will be described in the county report of Harford County in the course of preparation by the Maryland Geological Survey.

The Coastal Plain portion which lies almost entirely to the southeast of the Baltimore and Ohio Railroad comprises sands and clays of Cretaceous age and surficial sands, gravels, and loams belonging to the Pleistocene terrace formations which are geologically very young.

SURFACE WATERS

There are no large streams in the county except the Susquehanna River, which forms its eastern boundary, and the Gunpowder which forms its western boundary. The latter is utilized for the Baltimore City supply and the former furnishes the public supply of Havre de Grace, and is an abundant source of water power which it not, however, utilized in the county. The surface streams within the county are all small except the Bush which is a tidal estuary. Because of their small size and liability to contamination the small streams are not usually fit for domestic use.

UNDERGROUND WATERS

Artesian Waters

There are relatively few deep wells in the county and the amount of information concerning them is so limited that it is difficult to formulate a satisfactory statement of the possibilities of future development. In the Coastal Plain portion of the county the Cretaceous sands usually contain an abundant supply of water at no great depths, but in the Piedmont portion, since the water is found in joints and fault plains and the rocks are much contorted, there is no definite clue to what the driller will strike. There are several wells at Aberdeen, one on the property of Charles C. Brown, 233 feet deep, in which the water rises to within 2 or 3 feet of the surface and pumps 60 gallons a minute of slightly hard water. The Belair Water & Light Company utilizes the Wallis Spring and has two driven wells 2½ miles northwest of the town. These are 6 inches in diameter and 300 and 333 feet deep respectively. The water is of good quality, heads 8 feet below the surface and pumps 70 gallons per minute. The town of Cardiff is partially supplied by 200- and 230-foot 6-inch wells located at Delta across the Pennsylvania line.

A number of wells have been put down at Havre de Grace. These range from 43 to 200 feet in depth. The shallower draw their supply from the upper surface of the underlying crystalline rocks and yield large quantities of soft water which is admirable for manufacturing purposes but liable to surface contamination and hence should be used with caution for domestic purposes. The deeper wells, 100 to 200 feet deep, also yield an abundance of water, 60 to 100 gallons per minute, heading about 20 feet below the surface. There are two successful wells at Sharon.

The following records of wells at Van Bibber well illustrate the variations in materials encountered in the Coastal Plain portion of the county:

ALTVATER AND SCHOENHALS WELL, 2 MILES WEST OF VAN BIBBER

	Feet
Gravel	0–2
Yellow clay	2–10
Red clay	10–95
Blue clay	95–125
Sand with a little water	125–126½

J. T. NORRIS' WELL, ¾ MILE NORTHEAST OF VAN BIBBER

	Feet
Surface soil	0–4
Yellow clay	4–60
Quicksand	60–70
Red clay	70–108
Cemented gravel	108–110
Fine sand	110–113
Sand and gravel, 50 gallons of water	113–116

Non-Artesian Waters

SPRINGS.—There are large numbers of small springs throughout the hilly portion of the county, utilized locally for domestic purposes. The town of Aberdeen with a daily consumption of 50,000 gallons is supplied by a spring from which the water is pumped into a standpipe giving a

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Depth to subordinate supply	Head	Yield by pumping	Character of water.	Date drilled	Driller	Remarks
1	Aberdeen	C. R. Courtney	65	6	50	60	....	....	4	Soft	....	Walter Crowl.	
2	Aberdeen	Krouse Bros. Ice Plant	123	6	65	120	23 & 30 cased	—23	15	Soft	....	Allison & Stearns.	
3	Aberdeen, 6 mi. SE.	James Breese	127	..	..	118-127	....	....	36	......	....	Shannahan.	
4	Belair	Chas. C. Brown	233	6	27	233	....	—2′4″	60	Slightly hard	....	Day.	
5	Belair	Jos. R. Coule Ice Plant	100	..	63	100	....	—8	75	Hard	....	Allison & Stearns	Public supply, 2 wells.
6	Belair, 2½ mi. NW.	Belair Light & Water Co.	300-333	6	..	300	....	—8	70	Soft	1915	Allison & Stearns.	
7	Churchville	Mr. Boot	63	6	53	60	Small at 53	....	20	Soft	....	Walter Crowl.	
8	Creswell	Miss Dallam	40	6	15	35	Small at 15	....	15	Soft	....	Walter Crowl.	
9	Creswell	Mrs. L. DeBaun	38	6	..	35	....	....	10	Soft	....	Walter Crowl.	
10	Darlington, ½ mi. SE.	Jonea	105	6	25	105	....	—30	....	Soft	....	Day.	
11	Edgewood, ¼ mi. N.	P. B. & W. R. R.	114	..	..	....	....	....	....	......	1891	....	Abandoned.
12	Fallston	Mrs. Wilson Moore	107	6	34	100	....	....	5	Soft	....	Walter Crowl.	
13	Fallston	Mr. Poblinn	101	6	34	101	....	....	23	Soft	....	Walter Crowl.	
14	Forest Hill	James Swan	71	6	51	71	....	....	1½	Soft	....	Walter Crowl.	
15	Forest Hill	Townes & Ward	72	6	..	72	....	....	25	......	....	Walter Crowl.	
16	Forest Hill	E. Tweber	116	6	56	116	....	....	30	......	....	Walter Crowl.	
17	Forest Hill	A. Wilson	116	6	56	116	....	....	22	......	....	Walter Crowl.	
18	Havre de Grace	Havre de Grace Elec. Co.	60	6	60	60	....	—23	60	Hard	....		
19	Havre de Grace	Havre de Grace Elec. Co.	43	6	..	43	....	—21	100	Soft	....		
20	Havre de Grace	Havre de Grace Real Estate & Power Co. Textile Mills	200	6	..	200	....	—22	Large	......	....		
21	Havre de Grace	Whitney's Ice Plant	100	6	..	....	....	....	100	......	1916	Scott & Norris.	
22	Havre de Grace	Whitney's Ice Plant	87	6	..	....	....	....	60	......	1916	Scott & Norris.	
23	Havre de Grace	Wm. G. Whitney	70	6	..	....	....	—45	....	......	....		
24	Rocks	Frank Bleary	80	6	80	80	....	....	....	......	....	Walter Crowl.	
25	Rocks	Henry Hoover	107	6	..	72	....	....	2	Soft	....	Walter Crowl.	
26	Sharon	Samuel Ady	116	..	50	116	....	....	6	Soft	....	Walter Crowl.	
27	Sharon	L. H. Williams	64	6	32	60	....	....	30	Soft	....	Walter Crowl.	
28	Street	J. M. Selbreth	107	6	45	107	....	....	20	......	....	Walter Crowl.	
29	Thomas Run	L. A. Williams	76	6	29	70	....	....	7	Soft	....	Walter Crowl.	
30	Van Bibber	Altvater & Schoenhals	116½	3	..	125-126½	....	—50	3	......	....	Baltimore Art. Well Co.	
31	Van Bibber	J. T. Norris	116	3	..	113-116	....	—57	50	Good	....	Baltimore Art. Water Co.	

pressure of 50 to 60 pounds. Belair obtains part of its supply from the Wallis Spring and springs form the principal source of supply at Magnolia. It is possible that some of the springs may have medicinal value, although the only mineral spring noted is a large sulphur spring at Abingdon.

SHALLOW WELLS.—Throughout the farming districts and in the small towns dug wells are relied upon for domestic purposes. These range in depth from 10 to 100 feet and can usually be depended upon to yield a moderate supply which is generally reported as of excellent quality. In the more thinly settled portions of the county, if care is taken in the location and pollution is prevented, such wells are eminently satisfactory.

BALTIMORE COUNTY

Baltimore County, centrally located and surrounding Baltimore City, is the most populous county in the state. It extends from tidewater on the Patapsco, Back, Middle, and Gunpowder rivers to the Mason and Dixon Line, which separates it from York County, Pennsylvania, on the north. The river necks of the southeastern border are low, flat farming lands of the Coastal Plain district which rise and become more broken toward the "fall line." The fall line separates the Coastal Plain from the Piedmont Plateau and is a transitional zone approximately marked by the line of the Baltimore and Ohio Railroad.

Northwest of this line and comprising most of the area of the county the country is a much broken upland with high ridges and narrow stream valleys which gradually rise from elevations of from 100 to 200 feet along the "fall line" to over 800 feet in the northern part of the county. The average elevation is well over 300 feet. Except for the limestone valleys, like the Green Spring, Worthington, and Dulaney valleys, the country is sharply broken and the stream valleys are narrow, particularly toward the north and west, often forming rocky gorges, like those of the Gunpowder, Jones Falls, Gwynns Falls, and Patapsco.

The southern and Coastal Plain portion of the county is low and flat, the topography of which is dominated by the surface mantle of sands, loams, and gravels of the Pleistocene terrace plains. The stream valleys are drowned and form broad tidal estuaries.

TABLE OF ELEVATIONS

	Feet
Arbutus	80
Arlington	440
Ashland	285
Bay View	72
Belgravia	180
Bengies	30
Bradshaw	40
Brighton	460
Brooklandville	284
Catonsville	500
Chase	20
Cockeysville	279
Colgate	30
Cowenton	?
Denmore Park	450
Dixon Hill	340
Dundalk	20
Eklo	790
Emory Grove	680
Euclid Heights	450
Gardenville	160
Glenarm	350
Glyndon	695
Govans	358
Grange	10
Granite	461
Greenwood	330
Gwynnbrook	540
Gwynn Oak Park	360
Halethorpe	69
Hamilton	336
Highlandtown	100
Hoffmanville	723
Howard Park	400
Howardsville	455
Kenwood Park	167
Kingsville	271
Lake Station	225
Landsdowne	71
Lauraville	220
Loch Raven	180
Loreley	75
Lutherville	326
Melvale	190
Middle River	30
Monkton	320
Mount Washington	198
Oella	154
Overlea	200
Owings Mills	496
Parkton	420
Perry Hall	256
Phoenix	240
Pikesville	576
Pimlico	450
Ralston	516
Randallstown	585
Raspeburg	167
Reisterstown	735
Relay	71
Rosedale	60
Ruxton	266
St. Denis	70
St. Helena	20
Sherwood	285
Sollers	5
Sparks Station	268
Sparrows Point	10
Stemmers Run	20
Stevenson	363
Sudbrook Park	490
Texas	327
Thistle	130
Timonium	392
Towson	465
Turner	15
Walters	25
West Arlington	440
Whitehall	348
Whitemarsh	20

GEOLOGY

The major portion of Baltimore County is underlain by the crystalline rocks of the Piedmont Plateau. These comprise ancient igneous rocks, such as granites, gneisses, and gabbros, and highly metamorphosed ancient sedimentary rocks, which have been altered to gneisses, quartzites, marbles, and phyllites. The Baltimore and Wissahickon gneisses cover the largest areas. These rocks have all been intensely folded in former geological times and much faulted and overthrust, so that their chronologic sequence is intricate and greatly obscured.

The Coastal Plain portion of the county is made up of the gravels, sands, and clays of the Lower Cretaceous lying on the depressed margin of the crystalline rocks and comprising in ascending order the Patuxent, Arundel, and Patapsco formations. Toward the extremity of the river necks but lying mostly below tide are found the sands and clays of the oldest Upper Cretaceous formation, the Raritan. Overlying these Cretaceous sediments and forming the surface over most of the Coastal Plain part of the county and extending into the Piedmont valleys as stream deposits are the loams, sands, and gravels laid down at four comparatively recent times when the land stood at lower levels. Each of these periods of depression, which are all Pleistocene in age, resulted in a smoothing of the surface and the deposition of a thin mantle of sediments as a marine terrace, which upon subsequent emergence became a terrace plain. These plains in order of their age are the Brandywine, Sunderland, Wicomico, and Talbot. The older and higher plains are naturally the most dissected by erosion, while the two youngest, the Wicomico and Talbot, particularly the latter, preserve almost intact their original flat surfaces.

SURFACE WATERS

The county is well supplied with streams. Those of the Coastal Plain portion, as previously mentioned, are tidal estuaries, with brackish water and with much mineral and vegetable matter in suspension, and are entirely unsuitable for domestic or municipal use. The streams of the Piedmont Plateau portion of the county are rapidly flowing, fluctuating streams which when not contaminated by man are available as sources of municipal water supply. All are a part of the Chesapcake Bay drainage system and reach the Bay through the estuaries of the Gunpowder, Middle, Back, and Patapsco rivers. The principal Piedmont streams are the Gunpowder and its branches, Stemmers Run, Herring Run, Jones Falls, Gwynns Falls, and Patapsco River. The upper courses of these streams are variously utilized, but the lower courses are all rather thickly settled and unsanitary. Baltimore City obtains its supply from the Gunpowder at Loch Raven, where an impounding reservoir with a capacity of 2,250,000,000 gallons has recently been constructed. The water is treated chemically and filtered and its use has resulted in a marked decrease in typhoid and similar diseases. The Baltimore County Water & Electric Company obtains its water from Herring Run for the supplies northeast of the city and from Patapsco River for the district north and west of Baltimore City.

The Piedmont streams develop considerable water power which is utilized locally for small milling operations.

UNDERGROUND WATERS

Artesian Waters

Since the largest percentage of the population is suburban to Baltimore City and is largely served by water companies, and since in the more rural districts springs and shallow dug wells are largely utilized, the exploitation of the underground resources is less than might be expected. This has been further influenced by the uncertainty attending the drilling of wells in the crystalline rocks which underlie so much of the county, as well as the great cost of such drilling as compared with operations in the unconsolidated sediments of the Coastal Plain.

In crystalline rocks the underground waters occur in joint and fault planes and minute cavities in the rocks, and since such rocks are intricately folded and faulted it is impossible to predict the prospects with any degree of accuracy. Occasionally a well will fail completely, as for example, a 265-foot well at Gwynnbrook which was entirely dry. A number of wells have been put down at Arlington to depths of from 100 to 200 feet and all reach water under a good head and pump from 20 to 100 gallons per minute of satisfactory water rather high in iron. A 125-foot well at Lutherville pumps 70 gallons per minute of hard water which heads 15 feet below the surface and is derived from the Cockeysville marble. Other and deeper wells at Lutherville yield much smaller quantities of water.

Numerous wells have been put down in the towns suburban to Baltimore, especially around Pikesville and Reisterstown. These are for the most part between 100 and 300 feet deep and all yield small amounts of siliceous water with a fair head. Some of the deeper wells in this district, as the 500-foot well at the Suburban Club, give greater yields up to 50 gallons per minute, while other deeper wells have small yields, like the 587-foot well at the Jewish Consumptive Hospital which yields but 17 gallons per minute. The Ruxton Water Company has two wells, 152 and 178 feet deep, which together pump 60 gallons per minute. The Suburban Water Company at Arlington have seven 8-inch wells ranging in depth from 70 to 175 feet and supply a daily consumption of about 300,000 gallons.

The Artesian Water Company at Howard Park have five 6-inch wells to depths of from 117 to 200 feet and supply a daily consumption of about 72,000 gallons. The Roland Park Water Company in addition to utilizing springs have twenty-five 6-inch wells from 95 to 500 feet deep and supply a daily consumption of about 250,000 gallons. Little can be said of the artesian prospects throughout the county, although small yields are usually obtained at moderate depths as is shown in the accompanying list of wells which brings together all the information obtainable at the present time.

In the Coastal Plain portion of the county, which is more fully discussed in connection with the Baltimore district, there are several artesian horizons which are available and are largely utilized from Highlandtown to Bay Shore in connection with the extensive industrial development along the north shore of the Patapsco. The most important of these lies at the contact between the sands and gravels of the Patuxent formation and the underlying crystalline rocks and dips rapidly toward the southeast. North of Highlandtown and at Lansdowne it is about 100 feet below tide. At Walters, Hudson Heights, Highlandtown, and Baltimore Highlands it is about 200 feet below tide. At Brooks Hill and Colgate it is 300 feet below tide. On lower Back River Neck and in the vicinity of Dundalk and Turners it is about 500 feet below tide, while at Sparrows Point it is about 600 feet down.

This horizon is the most important and almost invariably yields large amounts of water. It is overlain by two or three less important water horizons at distances of from 30 to 40 feet.

Non-Artesian Waters

SPRINGS.—Along the fall line and throughout the Piedmont portion of the county springs are very numerous, as might be expected, and some of these yield very large amounts of pure water, such as the celebrated Chattolanee Springs in the Green Spring Valley. Beside furnishing part of the supply of various suburban water companies over 1,000,000 gallons of spring water are sold each year for table water in Baltimore City, and large additional amounts go into the manufacture of soft drinks. Among the better known springs are the Chattolanee and Brooklandwood in the Green Spring Valley, the Royal Springs near Ruxton, the Caton Springs at Catonsville, the Powhatan Spring at Woodlawn, and the Rock Crystal Springs at Rognel Heights. Good springs are numerous at Bengies, Chase, and Westport, and throughout the central and northern parts of the county and are much utilized locally. In some localities springs are scarce, for example, in the region of Middle River there are only a few, and at Walters only one was noticed. These springs occur at the base of the hills or in small depressions in the surface of the terraces. Most of them have a good yield of clear, cold water, but the supplies are little used except in places where the springs are near dwellings. The amount of inorganic matter carried in solution is seldom large, though at Chase there is a noticeable quantity of iron, and there is also some sulphur.

SHALLOW WELLS.—Shallow dug wells are still largely utilized throughout the rural parts of the county. Their depths and the amount of water which they yield are variable. They generally reach the water table in the loose materials overlying the crystalline rocks. The depth of these wells varies considerably, the shallowest being only 14 or 15 feet and the deepest about 80 feet. The source of the water is usually a white sand or gravel, but locally, as at Chase, the water bed is reported to be a red, clayey sand. There are clay beds above the water horizons at Westport, Walters, and Bengies. These clay beds are important because they exclude impure surface waters, but locally their value is impaired by their lack of continuity.

The amount of water in the dug wells differs from place to place and in some localities it varies with the rainfall. The following list gives a good idea of the variation in depth.

	Feet
Westport	30–40
Walters	25–50
Middle River	14–30
Bengies	15–40
Chase	12–80

The quantity of water could not be determined at all these places. At Westport the wells contain 8 to 10 feet of water, at Middle River 3 to 6 feet, and at Bengies and Chase 3 to 4 feet. The quantity of water at most of these localities is not greatly affected by normal drouths, but during continued dry weather some of the wells may become dry.

The quality of water obtained from the dug wells is variable though in most places it is hard. Soft water is reported from some wells at Walters, and others near the Chesapeake and its estuaries yield brackish water. In general, the amount of mineral matter in solution is not great enough to be objectionable. At Bengies and Chase some wells supply water containing large quantities of iron, and at the latter place a few of them yield sulphur water. In general it may be said that the use of shallow wells becomes more dangerous each year as the country becomes more thickly settled. Unless the wells are situated so that they cannot be contaminated by surface drainage and the seepage of sewage their use should be discontinued.

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Arbutus	Indust. School for Boys	775	..	..	....	....	....	......	....	......	....	P. H. & J. Conlan.	
2	Arlington	Pimlico Race Track	200	..	..	....	....	—30	......	60	......	1895	C. E. O'Donovan	
3	Arlington	Martin & McAndrews	167	6	..	....	....	—30	......	60	......	1898	C. E. O'Donovan	
4	Arlington	Cons. Gas & Elec. Co.	96	6	..	....	....	—8	......	20-25	......	1911	Clark Hoshall	
5	Arlington	T. I. Zimmerman	125	6	..	125	....	—8	......	40	......	1911	Clark Hoshall	
6	Arlington	T. I. Zimmerman	141	6	..	141	....	—7	......	100	......	1911	Clark Hoshall	
7	Bay View Junction	P. B. & W. R. R.	82	8	82	82	....	—40 to —45	......	62	Hard	1892	....	There are two wells in this group.
8	Bay View Junction	P. B. & W. R. R.	36	..	..	....	....	....	......	....	......	....	....	These four wells are all connected with one pump and are not run separately.
9	Bay View Junction	P. B. & W. R. R.	40-46	..	..	....	....	....	......	....	......	....	....	
10	Belgravia	John Anderson	107	6	..	74	....	—31	......	15	......	1911	Clark Hoshall.	
11	Belgravia	Mr. Miller	45	6	..	45	....	—38	......	¼	......	....	Clark Hoshall.	
12	Brightside	D. M. J. Cromwell	206	6	..	206	....	—25	......	35	......	1899	C. E. O'Donovan.	
13	Brooklandville, Brown's Hill.	....	95	..	..	....	....	—4	......	7	......	1898	C. E. O'Donovan.	
14	Brooklandville, Brown's Hill.	....	400	..	..	....	....	....	......	....	......	....		
15	Catonsville	John Gibbs	103	..	..	102 & 103	....	—16	......	Large	Iron	1885	Downin.	
16	Catonsville	Spr. Grove Insane Asy.	....	..	..	....	....	....	......	150	......	....	....	There are three wells in this group, no definite information at hand.
17	Chattolanee	Mr. Thompson	317	6	..	317	....	—37	......	22	......	1899		
18	Chattolanee	H. I. Keyser	130	6	..	130	....	—6	......	14	......	1899	C. E. O'Donovan.	
19	Chattolanee	Mr. Cover	214	6	..	205 to 210	....	—79	......	14	......	1911	Clark Hoshall.	
20	Cowenton	John Hottyner	92	..	72	90	....	....	......	....	Soft	....	Walter Crowe.	
21	Cowenton	W. Smith	143	6	100±	140	....	....	......	1	Soft	....	Walter Crowe.	
22	Cub Hill, Harford Rd.	W. S. Farmer	395	6	..	395	....	—150	......	35	......	1897	C. E. O'Donovan.	
23	Eccleston	Jas. Piper	200	6	..	60,100,160	....	—27	......	9	......	1911	Clark Hoshall.	
24	Eccleston	John K. Shaw	187	6	..	187	....	....	......	15	......	....		
25	Eccleston	Redmond C. Stewart	114	6	..	112	....	—65	......	22	......	1911	Clark Hoshall.	
26	Forks	John Irwin	160	6	30	....	....	....	......	6	Soft	....	Walter Crowe.	
27	Ford's Lane near Park Heights Ave.	A. Mendall	224	6	..	225	....	....	......	26	......	....	Clark Hoshall.	
28	Garrison	W. S. Diffenderfer	359	..	..	359	....	—40	......	6	......	1898	O'Donovan.	
29	Garrison	Robt. Harrison	126	6	..	126	....	....	......	6	......	....	Clark Hoshall.	
30	Garrison	E. Waesche	43	6	..	43	....	—18	......	14	......	....		
31	Garrison	Jas. L. McLain	178	6	..	178	10 galls. at 42	—6	......	30	......	1911	Clark Hoshall.	
32	Glencoe	W. H. Graffin	150	6	..	150	....	....	......	12	......	1910	Clark Hoshall.	
33	Glyndon	W. G. Atkinson	215	4	..	60?	....	....	......	Good	......	1903	Crist & Son.	
34	Glyndon	Yates & Stocksdale	148	6	..	130	....	....	......	16	......	....		
35	Glyndon	Mrs. Melvin Bay	167	6	..	167	....	....	......	¼	......	1909	Clark Hoshall	Another well here 227 feet deep is dry.
36	Glyndon	S. Yeates	136	6	80	132	....	—20	......	16+	Slightly hard	1909		

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
37	Green Spring Valley...	Green Spring Valley Hunt Club.	113	6	..	113	....	—18	......	65	......	1896	E. O'Donovan.	
38	Reisterstown Road, Gwynnbrook.	L. W. Nordenburg.....	92	6	..	....	....	—32	......	4	......	1911	Clark Hoshall.	
39	Reisterstown Road, Gwynnbrook.	L. W. Nordenburg.....	265	6	..	....	....	....	No water	....	......	....		
40	Gwynn Oak Park......	United Railways.......	161'4"	6	..	....	....	....	......	20	......	....		
41	Howard Park..........	Howard Park Co.......	180	6	..	....	....	....	......	35	......	1910	Clark Hoshall.	
42	Howard Park..........	Howard Park Co.......	116	6	..	....	....	....	......	35	......	1910	Clark Hoshall.	
43	Ilchester	Thistle Mls., well No. 1	887	6	..	....	....	....	......	2½	......	....	Downin.	
44	Ilchester	Thistle Mls., well No. 2	151	6	..	....	....	....	......	17	......	....	Downin.	
45	Ilchester	Thistle Mls., well No. 3	73	6	..	....	....	....	Slight	2¼	......	....	Downin.	
46	Ilchester	Thistle Mls., well No. 4	33	6	..	....	....	....	......	7	......	....	Downin.	
47	Ilchester	Thistle Mls., well No. 5	24	6	..	....	....	....	Dry	0	......	....	Downin.	
48	Ilchester	Thistle Mls., well No. 6	43	6	..	....	....	....	......	9	......	....	Downin.	
49	Lake Station	Blake	40?	..	..	....	....	....	Dry	....	......	1897	C. E. O'Donovan.	
50	Loch Raven	Md. School for Boys...	541	6	..	....	....	....	......	150-200 est.	......	....	Clark Hoshall......	Slight flow occurs at 35 feet.
51	Lutherville	W. Gill Smith.........	250	6	50	....	....	—50	......	1½	......	1916	Clark Hoshall.	
52	Lutherville	Gustavus Ober	152	6	..	....	....	....	......	25	......	....	Downin.	
53	Lutherville	Gustavus Ober	140	6	..	....	....	....	......	12½	......	1910	Clark Hoshall.	
54	Lutherville	Gustavus Ober	220	6	..	....	....	....	......	....	......	....	Downin	Abandoned.
55	Lutherville	Edwin T. Hambleton..	125	6	..	....	....	—15	......	70	......	....	Downin.	
56	Maryland Line.........	Dr. Wilson	66	6	..	25	....	—20	......	....	Soft	1896		
57	Middle River..........	....	60	..	..	60	....	....	......	20	......	1896	O'Donovan	Could not be verified in 1910.
58	Middle River..........	....	209	..	..	....	....	....	No water	....	......	1896	O'Donovan.	
59	Necker P. O...........	Sebastian Miller.......	52	6	..	....	....	—46	......	60	......	1904	C. Miller.	
60	Overlea	Md. Sch. for the Blind.	560	10	..	65-100	....	....	......	....	......	1911	F. P. Rust.......	This group of three wells showed a yield of 45 gallons per minute in all tests made by Rust.
61	Overlea	Md. Sch. for the Blind.	442	6	..	....	....	—4	......	....	......	1910	Clark Hoshall....	
62	Overlea	Md. Sch. for the Blind.	67	6	..	....	....	—4	......	....	......	1910	Downin	
63	Owings Mills	Ward	117	6	..	....	....	—45	......	7	......	1911	Clark Hoshall.	
64	Owings Mills	Reuben Foster	700	..	..	....	Dry	....	......	....	......	....		
65	Owings Mills	Alfred Poor	206	6	..	....	....	—28	......	30	......	1899	C. E. O'Donovan.	
66	Park Heights Ave. & Seven-mile Lane.	Erdman & Fox.........	50	6	..	50	....	—6	......	12	......	1908	C. E. Downin.	
67	Perry Hall	Balto. Co. School Com.	107	6	51	....	....	....	......	14	Soft	....	Walter Crowe.	
68	Phoenix	Simon Kent	170	6	..	....	....	—33	......	10	......	1899	C. E. O'Donovan.	
69	Pikesville	John A. Barker........	86	6	..	....	....	—25	......	7	......	1911	Downin.	
70	Pikesville	Bell Telephone Co.....	241	6	..	....	....	—42	......	15	......	1911	Clark Hoshall	
71	Pikesville	Druid Ridge Cemetery.	80	..	..	....	....	....	......	5	......	1907	C. E. Downin......	This supply was reduced ½ by dynamiting.
72	Pikesville, Naylor Lane & Reist. Rd.	Mr. Foley	60	6	..	60	....	—23	......	10	......	1911	Clark Hoshall.	

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
73	Pikesville	Mr. Fosdick	76	6	..	76	48	—32	......	12	......	1911	Clark Hoshall.	
74	Pikesville	Chas. E. Grogan	81½	6	..	....	....	....	......	15	......	1911	Downin.	
75	Pikesville	James Graham	70	6	..	....	....	—7	......	14	......	....	Clark Hoshall.	
76	Pikesville	John McGuire	200	8,6	..	....	....	....	......	40	......	1911	Clark Hoshall.	
77	Pikesville	Suburban Club	500	..	..	....	....	....	......	50	......	1910	Clark Hoshall.	
78	Pikesville	Suburban Club	428	8	90	....	....	....	......	15-20	......	1898	C. E. O'Donovan.	
79	Pikesville	Mrs. Symes	117	6	..	....	20 gallons at 75-80 ft. Cased off.	....	......	1¼	......	....	C. E. Downin.	
80	Pikesville	Mr. Weinberg	120	6	..	....		—10	......	22	......	1908	Downin.	
81	Pikesville	Troop A, Md. Nat. Grd.	90	6	80	90	....	—14	......	36	Good	....	Downin.	
82	Pikesville	....	110	6	..	....	....	—15	......	30	......	....	Downin.	
83	Reisterstown	Hannah Moore Acad.	180	6	..	....	....	....	......	7	......	....		
84	Reisterstown	Hannah Moore Acad.	190	8	..	....	....	—40	......	25-30	......	1890		
85	Reisterstown	Hannah Moore Acad.	350	6	..	....	....	....	......	1¼	......	1911	Clark Hoshall	
86	Reisterstown	Jewish Consump. Hosp.	175	6	..	250	....	—30	......	6	......	1911	Clark Hoshall	This supply was reduced to 1 qt. by dynamiting.
87	Reisterstown	Jewish Consump. Hosp.	300	6	..	....	....	....	......	12	......	....	Clark Hoshall	
88	Reisterstown	Jewish Consump. Hosp.	587	6	..	....	....	....	......	17	......	....	Clark Hoshall	
89	Reisterstown, 1 mi. NE.	Mt. Pleasant Hospital.	600	..	..	587	5 to 6 at 100-110	....	......	20	Soft	1910	Clark Hoshall	
90	Reisterstown, 1 mi. NW.	Mt. Pleasant Hospital.	300	6	..	....	....	...	......	17	Soft	1910		
91	Rogers	Frank Zimmerman	250	6	..	....	....	....	......	2	......	1907		
92	Rogers	Mr. Richardson	138	6	..	80-1,250	....	....	......	00	......	1910	Hosball.	
93	Rogers	Wm. H. Whitridge	81	6	..	138	....	....	......	30	......	....	Downin.	
94	Rogers	Wm. H. Whitridge	103	6	..	81	....	—30	......	30	......	1911	Downin.	
95	Rossville	Connell's Brick Yard	85	6	..	103	....	—30	......	94	......	....	O'Donovan.	
96	Ruxton	Ruxton Water Co.	152	6	..	85	....	—17	......	42	......	1899	Clark Hoshall.	
97	Ruxton	Ruxton Water Co.	178	6	..	....	....	....	......	18	......	1910	Clark Hoshall.	
98	Sherwood	George Ewing	75	6	..	....	....	....	......	30	......	1910	Clark Hoshall.	
99	Sherwood	Dr. Stevenson	60	6	..	75	....	....	......	60	......	1910	Clark Hoshall.	
100	Sherwood	Geo. H. Blackistone	387	6	..	60	....	....	No water	....	......	1910	Clark Hoshall.	
101	Sparks Station	Chas. Price	120	6	..	....	....	....	......	20	......	1911	Clark Hoshall.	
102	Sparks Station	W. H. Price	110	6	..	....	....	....	......	10	......	1910	Clark Hoshall.	
103	Sudbrook Park	Sudbrook Park Co.	81'4"	6	..	....	....	....	......	40	......	1910	Webbert.	
104	Stevenson	Wm. Cockey	42	6	30	....	10-15 gals. at 50 ft.	—25	......	36	......	1911	Downin.	
105	Stevenson	Wm. B. Cockey	75	6	..	40	....	—15	......	30	......	....	Hoshall.	
106	Timonium	Mrs. Francis T. Homer.	159	6	..	75	....	....	......	30	......	1910	Downin.	
107	Upper Falls	Balto. Co. School Com.	81	6	56	75	....	....	......	8-9	......	....	Walter Crowe.	
108	Woodlawn	R. B. Tippert	138	6	..	....	....	—18	......	50-60	......	1910	Downin.	
109	Woodlawn	Thayer Stock Farm	108	6	..	....	....	—30	......	16?	......	1911	Clark Hoshall.	
110	Woodstock	Woodstock College	350	6	345	....	....	—1	......	....	......	....	Louis Schultz.	

Carroll County

Carroll County lies entirely in the Piedmont province. It is divided into two nearly equal parts by Parr's Ridge which runs in a northeast-southwest direction from Wentz to Mount Airy. This ridge, capped with igneous rocks known as phyllites, reaches an elevation of about 800 feet at the southern border of the county, rising to over 1000 feet at its northern boundary. This ridge forms the dividing line between the streams flowing directly into Chesapeake Bay and those tributary to the Potomac River. The eastern portion of the county is a much dissected rolling upland with narrow stream valleys, the hills ranging from 500 to 800 feet in height. West of Parr's Ridge the surface becomes gradually less in elevation to about 400 feet in the Monocacy Valley at the western border of the county.

TABLE OF ELEVATIONS

	Feet		Feet
Bachmans Mills	631	Mount Airy	810
Barrett	667	New Windsor	440
Eldersburg	642	Silver Run	707
Finksburg	565	Stumptown	520
Gamber	675	Sykesville	383
Gosnell	725	Taneytown	493
Hampstead	913	Taylorsville	820
Harney	500	Union Bridge	402
Keysville	486	Union Mills	600
Lineboro	693	Uniontown	630
Louisville	606	Westminster	774
Manchester	975	Winfield	788

GEOLOGY

Below the surface soil and mantle of weathered rock the county is, with the exception of the western portion to the north and west of Union Bridge, underlain by a complex of crumpled and faulted crystalline rocks of igneous and metamorphic origin. There is some granite around Sykesville and phyllites at Finksburg, but with this exception the eastern quarter of the county is underlain by Wissahickon gneiss, giving rise to loamy micaceous soils and hence good farming land. Aside from small patches of diabase, marble, and gneiss, the central portion of the county consists of a complex of acid and basic volcanic rocks, giving rise to heavy soils in the valleys and rocky, thin soils on the ridges, which are nevertheless good farming lands. Underlying the western third of the county are the red and gray sandstones and shales of the Newark formation—sedimentary deposits of Triassic age which furnish what are chiefly grass and wheat lands.

SURFACE WATERS

Carroll is well supplied with small streams furnishing very many small water powers for local milling operations. The larger streams include the Gunpowder which crosses the northeastern corner of the county, the Monocacy which forms the boundary of the county on the west, and the two branches of the Patapsco along the eastern and southern boundaries. Since the population is largely agricultural there has been no demand for the utilization of stream water with its risks of fluctuating supply and contamination. The municipalities have hitherto utilized the abundant springs or have driven wells for their supplies.

UNDERGROUND WATERS

Artesian Waters

Aside from the purposes of municipal supplies the need for artesian water has not been acutely felt throughout the county and while a considerable number of shallow wells have been drilled there are few deep wells in the county. The nature of the underlying rock throughout most of the county in which the water is confined to joint and fault planes renders it impossible to forecast artesian prospects with any degree of confidence, such as is possible outside the Piedmont belt where the various geological formations are in undisputed succession and contain many permeable beds at definite horizons. Since 1903 the Union Bridge Water Company has put down six wells. These are all 6 inches in diameter and range in depth from 50 to 464 feet. The water is probably obtained from the sandstone beds of the Newark formation of Triassic age and is slightly hard. The water in all the wells heads about 12 feet below the surface. The two 50-foot wells pump 50 gallons, as does another 246 feet deep. A

170-foot well, put down in 1913, pumps 400 gallons, and the deepest, a 464-foot well, pumps over 300 gallons.

The wells at Westminster are none of them over 100 feet deep. They strike from 25 to 60 gallons per minute under a good head at depths between 70 and 90 feet. There is apparently a dependable water horizon within 100 feet of the surface in this vicinity.

The State Hospital at Sykesville has three wells, one 140 feet and two 505 feet deep. All show good yields of soft water. The 140-foot well heads 22 feet below the surface and pumps 35 to 40 gallons. The 505-foot wells head 17 feet below the surface and each pumps from 50 to 60 gallons. The Warfield well at Sykesville yields 28 gallons per minute from a depth of 120 feet, but the water heads 45 feet below the surface.

There are a number of productive wells at Mount Airy. One at the Mount Airy canning factory furnishes 80 gallons per minute from between 90 and 97 feet. A 70-foot well at Ridgeville heads 12 feet below the surface and yields 83 gallons per minute of soft water.

The available data for the balance of the wells in the county are given in the accompanying table and do not require especial comment.

Non-Artesian Waters

SPRINGS.—Springs are abundant throughout the county, particularly along Parr's Ridge and the adjacent subordinate ridges near it. These are widely used for domestic and farm purposes and contribute to the public supply of the town of Westminster. New Windsor depends entirely on springs for its public supply, the consumption being 50,000 gallons daily.

SHALLOW WELLS.—Dug wells of shallow depths are utilized for domestic supplies throughout a large part of the county. The amount of water varies in character and quantity from locality to locality. It is apt to be hard and to show seasonal fluctuations in amount. In the centers of population shallow wells are particularly liable to surface contamination and should not be used. In the more thinly settled districts they should be safe if care is taken in their location with respect to sanitation and drainage of the immediate vicinity.

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Depth to subordinate supply	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Barrett, 1¼ mi. E.	John R. Bennett	65	6	40	65	......	—45	....	Soft	....	J. Lockard.	
2	Eldersburg	Dr. M. D. Norris	130	6	40	100	......	—55	Small	Hard	1911	Louis Schultz.	
3	Gosnell	Mrs. Ecker	70	6	9	70	......	—50	Cood	Soft	1911	Edmondson.	
4	Lineboro	L. W. Hiltrick	41	6	6	41	......	—19	....	Soft	1914	Edward Rohbach.	
5	Lineboro	W. H. Wirtz	24	6	24	24	......	—5	....	Soft	1916	Edward Mien.	
6	Louisville	Mr. Cosnell	70	6	0	40	......	—40	2	Soft	....	Edmondson.	
7	Manchester	G. W. Gregory	81	6	20	75	......	—41	....	Very hard	1905	S. T. Christ.	
8	Manchester	Gregory Ice Cream Co.	80	6	20	64	......	—3	....	Soft	1911	S. T. Christ.	
9	Morgan Run	Geo. P. Beasman	60	6	14	..	......	—44	8	Hard	1900	Lockard.	
10	Mt. Airy	Byron L. Dorsey	48	6	6	36-38	......	—34	6-8	Soft	1907	Owner.	
11	Mt. Airy	Byron L. Dorsey	94	6	10-15	60-74	......	—60	Strong	Soft	1893	Owner.	
12	Mt. Airy	C. E. Harris	65	6	9	50	Small at 35-40	—8 to —10	Large	Soft	1910	A. J. Cain.	
13	Mt. Airy	Mt. Airy Canning Factory	117	6	44	90-97	33	—30	80	Soft	1916	A. J. Cain.	
14	Mt. Airy	Mt. Airy Ice & Electric Co.	26	6	..	26	......	—6	17	....	1912		
15	Mt. Airy	Simpson's Hotel	40	6	6	30-40	......	—20	Strong	Very hard	1883	B. S. Dorsey.	
16	Mt. Airy	S. W. Stackhouse	173	6	6	70	Small at 120-130	—6	3 qts. per hour	Soft	1904	A. J. Cain.	
17	Mt. Airy	S. W. Stackhouse	306	6	8	260	......	—100	1	Soft	1913	A. J. Cain.	
18	Mt. Airy, 3 mi. N.	C. E. Brashear	82	....	8	..	......	—76	....	Hard	1885	A. J. Cain	This well is located on Parr's Ridge.
19	Ridgeville	Nelson Hotel	86	6	..	86	......	....	Fair	Hard, iron	....	A. J. Cain.	
20	Ridgeville	D. W. Dudderar	85	6	10-12	85	......	—28	10-15	Soft	....	A. J. Cain.	
21	Ridgeville	Jesse P. King	70	6	4	40-50	......	—12	83	Soft	1913	A. J. Cain.	
22	Silver Run	C. J. Kiok	312	6	20	40	......	—20	5	Soft	1914/15	Shoemaker, Allison & Elliott.	
23	Silver Run	A. W. Fener	88	8	30	30	......	—28	30-50	Soft	1915	O. T. Shoemaker.	
24	Sykesville	Springfield State Hospital	140	6	..	140	......	—22	35-40	Soft	1897	C. E. O'Donovan.	
25	Sykesville	Springfield State Hospital	505	6	50	505	......	—17	60	Soft	1911	Louis Schultz.	
26	Sykesville	Springfield State Hospital	505	6	50	505	......	—17	50	Soft	1911	Louis Schultz.	
27	Sykesville	W. H. D. Warfield	128	6	45	120	......	—45	28	Soft	....	Louis Schultz.	
28	Sykesville	Arthur M. Zile	128	8	10	85?	......	—15 to —120	60	Slightly hard	1912	Louis Schultz.	
29	Sykesville, 1 mi. S.	James P. Carter	55	6	30	55	......	—30	7	Soft	1916	James Edmondson.	
30	Taylorsville	George Magin	62	6	5	52	......	—35	14	Hard	1916	A. J. Cain.	
31	Taylorsville, ¼ mi. E.	Thomas G. Moore	42	6	10	26	......	—17	....	Soft	1914	Lockard.	
32	Union Bridge	Union Bridge Water Co.	50	6	22	50	......	—12	50	Slightly hard	1903/4	L. A. Downin	Two wells like this in all respects. Public supply.
33	Union Bridge	Union Bridge Water Co.	214	6	22	214	......	—12	50	Slightly hard	1903/4	L. A. Downin	Public supply.
34	Union Bridge	Union Bridge Water Co.	464	6	22	464	......	—12	300+	Slightly hard	1903/4	L. A. Downin	Public supply.
35	Union Bridge	Union Bridge Water Co.	246	6	22	246	......	—12	50	Slightly hard	1903/4	L. A. Downin	Public supply.
36	Union Bridge	Union Bridge Water Co.	170	8" to 50' 6" to 176'	170	170	......	—13	400	Hard	1913	O. T. Shoemaker	Public supply.
37	Union Mills	E. F. Groff	68	6	?	30	......	—30	....	Soft	....	DeGroff.	
38	Union Mills	E. F. Croff	82	6	20	35	......	—34	....	Soft	....	Shoemaker.	
39	Uniontown, 1¼ mi. N.	W. P. Engles	51	6	20	25	......	—10	....	Hard	....	Shoemaker.	
40	Westminster	H. E. Koontz	100	0	100?	70-80	......	—27	35	Slightly hard	....		
41	Westminster	Westminster Ice & Cold Storage Co.	90	6	90	90	......	—14	40-60	Very hard	1894	Lockard.	
42	Westminster	Westminster Metal & Fndy. Co.	90	....	65	90	......	—2	40	Hard	1912	Shoemaker.	
43	Westminster	B. F. Shriver & Co.	55	....	55?	40	......	—3	25-30	Soft	....	Lockard.	
44	Winfield	Ziles Creamery	66	....	66	66	......	—40	Cood	Soft	....	Edmondson.	
45	Winfield	Ray Yohn	103	....	10-15	60	......	—35	....	Soft	1914		
46	Winfield, 2 mi. S.	Ambrose Stracker	65	6	8	40	......	....	Fair	Hard	1914		

HOWARD COUNTY

Howard County, except for its eastern margin, lies wholly in the Piedmont Plateau district. The surface is a rolling upland ranging in elevation from about 200 feet along the eastern border of the county to over 800 feet in the western part. The country is much dissected by streams, but these usually flow in narrow valleys and the greater part of the county consists of gently rolling uplands, becoming somewhat more broken toward the west and forming rich farm lands.

TABLE OF ELEVATIONS

	Feet		Feet
Alberton	230	Harwood	102
Atholton	359	Highland	520
Carrs Mill	481	Ilchester	102
Clarksville	484	Jonestown	470
Columbia	402	Lisbon	592
Cooksville	581	Long Corner	825
Daisy	553	Marriottsville	295
Davis	261	Mayfield	559
Dayton	574	Mountview	646
Dorsey Run	239	Oakland Mills	425
Elioak	433	Orange Grove	98
Elkridge	69	Poplar Springs	729
Ellicott City	141	Roxbury Mills	386
Florence	628	Savage	200
Fulton	448	Scaggsville	438
Gary	560	Waterloo	232
Glenwood	540	West Friendship	476
Guilford	290	Woodstock	392
Hanover	91		

GEOLOGY

The Lower Cretaceous sands and clays of the inland border of the Coastal Plain cover disconnected areas in the eastern part of the county from Elkridge to Laurel. The balance of the county is underlain by crystalline rocks, largely granites and gneisses. These are much folded and faulted and are usually deeply weathered and covered with a heavy mantle of soil.

SURFACE WATERS

The surface streams are for the most part small and subject to great seasonal variation in the amounts of water they carry. All are liable to surface contamination and none is utilized as a source of supply. Some water powers are developed along Patapsco River which forms the north-eastern boundary of the county, and along the Patuxent which forms the southern boundary of the county. This is particularly true at Ellicott City on the former stream and at Laurel on the latter. Small water powers are also utilized for milling on various small creeks in the western part of the county.

UNDERGROUND WATERS

Artesian Waters

But few artesian wells have been drilled in Howard County since there are no large centers of population or industries requiring large amounts of water. The abundance of springs and the usual productiveness of shallow dug wells have obviated the necessity of seeking at greater depths water for domestic and farm purposes. All of the deep wells in this area derive their water from crystalline rocks. In such rocks the water occurs in fractures, joints, and faults. Since the rocks are much folded and these various water fissures enumerated do not occur in a uniform or continuous manner it is entirely impossible to forecast the artesian prospects in this area. There are no deep wells in the county, the deepest being the 306-foot well at Doughoregan Manor and the 265-foot wells of the Ellicott City Water Company. These all derive their water from the granite, have a head from within 5 to 15 feet of the surface and pump from 25 to 50 gallons per minute.

Non-Artesian Waters

SPRINGS.—Springs are generally distributed throughout the county and are frequently utilized locally. None of large size has been reported. The water usually carries varying amounts of mineral matter.

SHALLOW WELLS.—Dug wells are in general use for domestic purposes. These range in depth from a few feet to 70 or 80. Water can usually be obtained at the contact of the weathered surficial materials with the

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Depth to subordinate supply	Head	Yield by pumping	Character of water	Date drilled	Driller
1	Clarksville	J. N. Miller	484	80	6	40?	30	Gneiss	....	—25	Strong	Hard	1914	Edmondson.
2	Clarksville	Irwin Ridgeley	484	30	5	..	30	Gneiss	....	—26	12	Hard	1904	J. E. Robinson.
3	Clarksville	Bradley Zepp	484	32	5	..	32	Gneiss	....	—20	25	......	1898	J. E. Robinson.
4	Clarksville	E. W. Zepp	484	79	6	79	75	Gneiss	....	—23	Good	Soft	1914	Edmondson.
5	Cookville, ¼ mi. N.	Chas. Cawthorne	560	55	6	28	55	Granite	....	—41	10-12	Hard	1906	Louis Schultz.
6	Elioak, 1 mi. E.	J. D. Brown	400	65	6	50	55	Gneiss	25 & 40 cased off	—42	25	Soft	1914	Edmondson.
7	Ellicott City	Ellicott City Water Co.	400	85	6	..	63	Granite	....	....	20	......	1905	Downin.
8	Ell. City, 2½ mi. W.	Doughoregan Manor	375	306	6	60	280+	Granite	....	—10 to —15	26	Soft	1914	Schultz.
9	Ell. City, 2½ mi. W.	Ellicott City Water Co.	400	265	6	40	185	Granite	....	—5	35	Hard	1916	Louis Schultz.
10	Ell. City, ½ mi. W.	Ellicott City Water Co.	400	265	6	43	185	Granite	....	—8	50	Hard	1916	Louis Schultz.
11	Fulton	Phillip Smallwood	448	20	5	..	70	Gabbro	....	—60	7	......	....	J. E. Robinson.
12	Lisbon	H. W. Snyder	590	48	7	8	48	Gneiss	....	—22	....	......	1916	Cain.
13	Montview	Alfred Amoss	646	73	..	69	69	Gneiss	....	—5 to —6	....	Hard	....	
14	Scaggsville	Christopher Renn	438	60	5½	..	60	Gneiss	....	—55	....	......	1892	J. E. Robinson.
15	Woodstock	J. E. Seward	....	72	6	27	72	Gneiss	....	—35	20	Soft	1913	Edmondson.

underlying hard rock. Outside of the towns, if care is taken to locate wells so that they will not receive drainage from outhouses or barnyards, the water is potable. Shallow wells are always dangerous, however, in even small centers of population since it is practically impossible to prevent contamination.

MONTGOMERY COUNTY

The surface features of Montgomery County are similar in character to those of the adjoining county of Howard and the other Maryland counties along the eastern border of the Piedmont. The surface is a much dissected, rolling upland, ranging in elevation from between 200 and 300 feet along the eastern border to over 800 feet in the northern part of the county where Parr's Ridge enters the county from the northeast and gradually sinks to the general level of the western part of the county which is between 400 and 500 feet.

From Seneca to the bend of the Potomac at the mouth of the Monocacy the country is underlain by the sandstones of the Newark formation, and this area is both flatter and lower than elsewhere in the county and seldom reaches 400 feet.

TABLE OF ELEVATIONS

	Feet		Feet
Ashton	498	Glen Echo	120
Barnesville	540	Great Falls	140
Beallsville	515	Hyattstown	362
Boyds	424	Kensington	301
Brookville	475	Laytonsville	?
Burtonsville	480	Linden	320
Cabin John	150	Martinsburg	425
Chevy Chase	360	Olney	544
Clagettsville	660	Poolesville	475
Clarksburg	700	Potomac	364
Claysville	565	Redland	450
Colesville	430	Rockville	432
Damascus	846	Sandy Springs	490
Darnestown	436	Seneca	198
Dawsonville	305	Silver Spring	340
Dickerson	363	Spencerville	520
Forest Glen	308	Takoma	280
Gaithersburg	512	Washington Grove	530
Garrett Park	301	Woodfield	616
Germantown	449		

GEOLOGY

The unconsolidated sands and clays of the Lower Cretaceous cover disconnected areas along the eastern border of the county adjoining Prince George's County. The western part of the county from Seneca to the Frederick boundary on the Potomac is underlain by the red and gray sandstones and shales of the Newark formation of Triassic age. Elsewhere and including the major portion of the county the underlying rocks beneath the surface mantle of soil are granites, gneisses, serpentine, and basic and acid volcanic rocks of great age and highly crystalline. These are much crumpled, and while underground waters are plentifully stored in joints and fault planes, they occur in no regular or predictable position, and it is therefore impossible to predict the artesian prospects for areas of this kind.

SURFACE WATERS

The surface streams are small and subject to great seasonal variation. All are liable to surface contamination and should not be utilized for domestic or municipal supplies, except where they are subject to scientific filtration. The two larger streams are the Patuxent, which forms the Howard boundary, and the Potomac, which forms the southern boundary. The latter carries large amounts of water and develops extensive water power at Great Falls and elsewhere in the county. The former is utilized to some extent for water power and small developments are utilized for milling operations on various small streams throughout the county. The public supply of Washington is taken from the Potomac at Great Falls.

UNDERGROUND WATERS

Artesian Waters

There are no large centers of population or manufacturing enterprises requiring large amounts of water, so that throughout much of the county the inhabitants utilize springs and shallow dug wells for domestic purposes. The number of artesian wells that have been put down is small and none reach great depths. The yield and head vary through wide

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Depth to subordinate supply	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Ashton, ¼ mi. N.	M. J. Stabler	168	6	168	118	....	—24	6	Soft	....	Fisher.	
2	Barnesville	Adamstown Canning & Supply Co.	87	6	6	87	....	—25	100	Soft	1906		
3	Barnesville	F. P. Hays	225	6	0	225	....	—15	....	Soft	1910	W. T. Hilton & Sons.	
4	Bealsville	Howard Griffith	90	6	..	80	....	—45	15	Soft	1913	W. T. Hilton & Sons.	
5	Boyd	James Norris	42	6	0	38	....	—10	20	Soft	1916	W. T. Hilton & Sons.	
6	Boyd	Mrs. Cora Pollock	68	6	68	68	....	—12 to —14	3	Soft	1912	W. T. Hilton & Sons.	
7	Boyd	....	150	6	30	100-150	....	—30	2	Soft	1911	W. T. Hilton & Sons.	
8	Brookville	W. H. Nicholson	54	6	10	54?	....	—18	....	Soft	1908		
9	Burtonsville	Milton Phelps	68	5	..	....	....	....	Large	Iron	1892	Geo. Analt.	
10	Cabin John Bridge	Wm. H. Bobinger	100	6	6	60 & 95	....	—30	40	Soft	1912	Saunders.	
11	Clarksburg	W. W. Dronenburg	68	6	9	68	....	—25	Good	Soft	1901	Walker.	
12	Clarksburg	Levi Price	68	6	..	....	....	....	Good	Hard	....		
13	Claysville	O. H. Walker	40	6	..	....	....	....	Good	Soft	....	Walker.	
14	Colesville, 1½ mi. NE	Capt. Overton	100	..	60	....	....	....	25	....	....		
15	Damascus	Rufus Burdette	425	6	8	40?	....	....	Small	....	....	A. J. Cain.	
16	Damascus, 1¼ mi. W.	Roy Moxley	50	6	8	35-40	....	—25	3 to 4	Soft	....		
17	Darnestown	Mrs. Clara Bell	110	6	16	60	....	—58	2½	Hard	1916	W. T. Hilton & Sons.	
18	Darnestown, 1½ mi. SW	James H. Offet	81	6	54	81	....	—30	....	Soft	1908	Fisher.	
19	Darnestown *	Andrew Small Academy	180	6	..	60	....	—60, —70	....	Hard	1890		
20	Dawsonville	Milton G. Darby	70	6	7	70	....	—20	....	Hard	....	W. T. Hilton & Sons	
21	Dickerson	Howard Robertson	72	6	9	60	....	—.20	6	Hard	1912	Fisher.	
22	Forest Glen	National Park Seminary	287	6	47	145?	....	—10	11	Iron and Magnesia	1911/1913	W. T. Hilton & Sons.	
23	Forest Glen	National Park Seminary	300	6	..	?	....	?	11	....	1910	J. M. Birch.	
24	Gaithersburg	J. B. Diamond	70	6	..	30-70	....	—23	Large	....	1894	Columbia Well Drilling Co.	Abandoned.
25	Gaithersburg	J. B. Diamond	100	6	..	100	....	—20	Strong	Hard	1904	Burdette & Moxley.	
26	Gaithersburg	Ice Plant	101	6	80	101	....	—70 to —80	20	....	1913	Fisher.	
27	Garrett Park, ½ mi. W.	C. J. Corby	136	..	54	100+	....	—25	30	Soft	....	J. C. Hilton & Sons.	
28	Germantown	P. E. Waters	152	6	72	140	....	—100	2	Soft	1914	W. T. Hilton & Sona.	
29	Great Falls	Jas. H. Eckersley	95	6	56	80	....	—20	20	Soft	1915	Saunders.	
30	Laytonsville	J. C. Higgins	90	6	55	65-70	....	—45	15	Soft	....	Fisher.	
31	Martinsburg	Wm. Cramer	172	6	80	150	....	—60	15	Hard	1913	W. T. Hilton & Sons.	
32	Olney, 2 mi. S.	Edgar Riggs	84	6	60+	84	....	—25	25	Soft	1912	Fisher.	
33	Poolesville	A. P. Hechtell	110	6	60	110	....	....	Strong	Hard	1914	Hilton.	
34	Poolesville	Geo. D. Willard	120	6	15	70?	....	....	5	Soft	1912	Hilton.	
35	Poolesville, ½ mi. SE	Jacob Bodmer	115	6	10	112	....	—7	....	Soft	1915	Claggitt Hilton.	
36	Potomac	E. C. Cramer	48	6	18	40	....	—10	3	Hard	1913	Saunders.	
37	Potomac, 1¼ mi. NW	Arthur Myers	95	6	70	80	....	—30	20	Soft	....	Saunders.	
38	Potomac, ¼ mi. E.	M. & S. Harrison	92	6	73	82	....	—20	10	Soft	1916	Saunders.	
39	Redlands	Mr. Darby	106	6	106	106	80—85 cased off	—66	....	Soft	1910	Fisher.	
40	Rockville	Rockvl. Ice Plant, Clarence Andrews.	147	8	80	80	....	—5	3	Soft	1913	Saunders.	
41	Rockville	Town	225	10,8	90	225	....	—12	50	Soft	1897	Fisher	Two wells. Public supply.
42	Rockville	Town	289½	6	50	50-250	....	—30	30	Soft	1915	Fisher	Public supply.
43	Sandy Springs	J. Hillis Robinson	104	6	104	94	....	—35	15	Soft	1914	Edmondson.	
44	Silver Spring, ½ mi. NE	E. M. Ross	50	6	12	48	....	—15	4	Soft	1914	Saunders.	
45	Spencerville	Frank Murphy	65	5	..	65	....	—60	5	Good	1895	J. E. Robinson.	
46	Spencerville, 1½ mi.	The Misses Miller	230	..	5	....	....	—50	4½	Soft	....	Fisher.	
47	Wash. Grove, ½ mi. N.	J. M. Mornet	113	6	113	113	....	—30	....	Soft	1902	G. A. Fisher.	

* This well fluctuated with wet and dry seasons. It was a dug well 70 feet deep. Afterward an attempt was made to get more water by drilling deeper. Drilled to 180 feet with no increase.

limits from place to place. An 87-foot well at Barnesville pumps 100 gallons per minute and heads 25 feet below the surface.

The National Park Seminary at Forest Glen has two 6-inch wells, 287 and 300 feet deep, each yielding 11 gallons per minute. The municipality of Rockville with a daily consumption of 40,000 gallons obtains its supply from three wells, 225 to 290 feet deep.

A list of the wells of the county and such additional data as is available are given in the appended table and require no special discussion.

Non-Artesian Waters

Springs.—Springs are abundant and well distributed throughout the county, and are frequently untilized for domestic purposes throughout the rural districts. The waters of Carroll Springs at Forest Glen are sold as table water in Washington.

Shallow Wells.—Dug wells are commonly utilized for domestic supplies throughout the county, being usually dug down until the water which lies above the surface of the underlying unweathered rocks is reached. Such wells are sanitary throughout the thinly settled districts if they are located far enough away from outhouses and farm yards to prevent contamination. Such shallow wells in small towns are always liable to contamination and their use is not to be recommended.

Frederick County

Frederick County includes several different types of country. On the east are the series of minor ridges culminating in Parr's Ridge, made up of intensely folded and crumpled schists and gneisses, and with narrow valleys and heights of 500 to 600 feet. A remnant of the ancient highlands preserved from erosion by the hardness of the quartzite of which it is composed is Sugar Loaf Mountain in the southernmost corner of the county which reaches an elevation of 1281 feet. West of this is the broad and relatively level surface of the Frederick or Monocacy Valley with elevations of from 200 to 300 feet. The valley is bounded on the west by the rugged Catoctin Mountain which increases in elevation from about

1000 feet on the south to between 1600 and 1700 feet on the north and forms the line of division between the Piedmont type of country to the east and the Appalachian type of country to the west.

The country between Catoctin Mountain and the Blue Ridge, whose even-topped summit at an average elevation of about 2000 feet constitutes the western boundary of the county, is a rugged upland, particularly toward the north, where it is about 700 feet in elevation, declining farther to the north where it is about 500 feet and also becoming lower toward the Potomac.

TABLE OF ELEVATIONS

	Feet		Feet
Adamstown	300	Middletown	547
Blue Ridge Summit	1407	Monrovia	440
Braddock Heights	900	Mt. Pleasant	475
Brunswick	266	Mountville	620
Buckeystown	240	Myersville	780
Burkittsville	580	New London	400
Church Hill	346	New Market	575
Creagerstown	413	Pearl	375
Doubs	300	Petersville	524
Emmitsburg	450	Point of Rocks	230
Frederick	296	Rocky Ridge	400
Ijamsville	346	Sabillasville	1108
Jefferson	583	Thurmont	519
Kemptown	688	Thurston	300
Knoxville	800	Unionville	450
Lewistown	402	Urbana	468
Libertytown	524	Walkersville	320

GEOLOGY

That part of the county east of the Frederick Valley is underlain by the intensely folded, ancient crystalline rocks, including some gneiss and marble and a complex of acid and basic rocks partly volcanic and partly sedimentary in origin, the whole metamorphosed into schists. Toward the valley are narrow dikes of diabase, a dark, igneous rock here of Triassic age.

The Frederick Valley is underlain by the folded and faulted formations of the Shenandoah limestone (Cambrian and Ordovician) and by the red and gray sandstones and easily-eroded shales of the Newark formation, Triassic in age. It is the former which weathers to the heavy reddish lands that make the excellent farming lands for which the Frederick and Hagerstown valleys are famous.

Catoctin Mountain consists of Weverton quartzite which forms the cap rock that has prevented it weathering down to the general level. There are lesser exposures of Harpers shale and Loudon slates, limestones, shales, and sandstones. These are all ancient sedimentary rocks of Cambrian age. From Catoctin Mountain to the Blue Ridge the underlying rocks are igneous rocks, highly crystalline, and comprising granites, gneisses, and acid volcanics.

SURFACE WATERS

Small streams are well distributed throughout the county, but because of the dangers of contamination are not available for potable supplies unless the water is taken near their sources in thinly settled uplands like Catoctin Mountain, although they furnish small water powers that are utilized for local milling operations. The Potomac, which forms the southern boundary of the county, carries large amounts of water. While not available for domestic purposes without scientific filtration it furnishes a large amount of power which is practically not utilized. As measured at Point of Rocks, the mean annual flow from 1897 to 1906 was 10,575 second-feet per day. Measuring the horsepower at 80 per cent efficiency per foot of fall this would mean about 1000 horsepower per foot of fall.

The only large stream within the county is the Monocacy River which rises in Adams County, Pennsylvania, and flows southward to the Potomac in the Frederick Valley which is sometimes called the Monocacy Valley. The water is not suitable for public supplies because of more or less pollution. The flow as measured over a period of 10 years at Mount Pleasant, 4 miles northeast of Frederick, gives a mean annual discharge of 1130 second-feet a day.

UNDERGROUND WATERS

Artesian Waters

Because of the essentially agricultural occupation of the residents of Frederick County and the consequently thinly settled condition throughout most of the county, together with the abundance of springs and the ease with which water is obtained from shallow dug wells, the demand for artesian water has been slight. Consequently but few artesian wells have been put down, even large towns like Frederick relying largely on springs and streams on Catoctin Mountain for their municipal supplies. The Frederick authorities have drilled two deep wells, 996 and 1140 feet deep, in the Shenandoah limestone, about 4 miles west of the town, without striking very productive underground horizons, the yield being reported as 70 gallons per minute from the two. Other towns in the county that derive their supplies from wells are Blue Ridge Summit, which is just over the border in Pennsylvania, Braddock Heights, and Brunswick. At Blue Ridge Summit two wells, 100 and 312 feet deep, yield respectively 50 and 40 gallons per minute. At Braddock Heights an 8-inch well was drilled to a depth of 510 feet. At about 200 feet water was struck and rose to within 15 feet of the surface. The amount was small, however, the yield being but 10 gallons per minute.

Water seems to be more readily obtainable in the Triassic area in the western part of the county. The town of Brunswick utilizes a 315-foot well which pumps 100 gallons per minute, the water heading within 5 feet of the surface. There are a number of wells at Frederick, but with the exception of those mentioned none are of great depth and the yields are generally small and the water, as might be expected in a limestone country, is hard. The Frederick Abattoir Company has put down two wells, one 96 feet and the other 123 feet, and both furnish considerable water. The 96-foot well, which is 8 inches in diameter, heads 20 feet below the surface and pumps 100 gallons per minute. The 123-foot well, which is 4 inches in diameter, heads 70 feet below the surface and pumps 60 gallons per minute. The other wells throughout the county are all less than 200 feet in depth and the recorded yields are small.

Regarding the artesian prospects throughout the county no predictions can be made with confidence. The intricate folding of the strata and the frequent faulting and joining preclude continuous water beds so that a well may strike water at one level and another well a short distance away may be dry or find water at a totally different depth. In that part of the county underlain by the Triassic, as at Brunswick, water is apt to be more uniformly distributed, and supplies can be expected within 150 to 300 feet of the surface.

Non-Artesian Waters

SPRINGS.—Springs are abundant throughout the county, particularly in the broken uplands along Parr's Ridge, Catoctin Mountain, and Blue Ridge. They are extensively utilized for domestic and farm purposes, and a number of towns obtain their public supplies from this source which is frequently augmented by drawing from spring-fed mountain streams near their sources. The town of Frederick utilizes both of these sources on Catoctin Mountain, the water being carried by gravity to two reservoirs with a capacity of 12,000,000 gallons. Middletown, with a daily consumption of 8000 gallons, obtains its water from a spring on Catoctin Mountain. Braddock Heights draws from two springs and a well, the daily consumption in summer running up to 40,000 gallons, but declining to about one-fifth this amount during the winter season.

The Burkittsville Water Company and the Emmittsburg Water Company both utilize springs, and the Mechanicstown Water Company which supplies Thurmont draws its water from High Run Creek and six springs. Walkersville also uses both spring and stream water.

SHALLOW WELLS.—Shallow wells are common throughout the rural districts and in small towns. Water can usually be reached at no great distance below the surface in the mantle of unconsolidated materials overlying the rocky floor. The conditions vary from place to place, and such wells are liable to show great seasonal variation. If properly located with respect to drainage they may be used with safety in rural districts, but they are always dangerous in centers of population since it is almost impossible to prevent contamination.

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Depth to subordinate supply	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Adamstown	C. F. Carlin	36	6	15	20	....	—20	15-20	Hard	1916	May & Baker.	
2	Adamstown	R. H. Padgett	38	..	12	38	....	....	Good	Hard	1913		
3	Adamstown	W. T. Hilton & Son	99	..	16	....	....	....	....	......	....		
4	Blue Ridge Summit, Pa	Blue Ridge Water Co	312½	6	312½	312½	....	—104	40	Good	1905	George Zink	Public supply.
5	Blue Ridge Summit, Pa	Blue Ridge Water Co	100+	6	15	100	....	....	50	......	1915	....	Public supply.
6	Braddock Heights	Braddock Hghts. Water Co.	510	8	8	200±	....	—15	10	......	1913	G. A. Cullen	Public supply.
7	Brunswick	Town	315	8	12	315	25 gals. at 230	—5	100	......	1908	Harper	Public supply.
8	Brunswick	Hygeia Ice Co	150	6	60	150	....	—18 to —20	45	Hard	1912	Kugel.	
9	Buckeystown	W. G. Baker	70±	6	8	70±	....	....	....	Hard	1890	....	Another well near this place, 200 feet deep, is dry; still another well got some water at 50 feet.
10	Buckeystown, 1½ mi. SE	Buckeystown Ind. School	110	6	....	90?	....	—20	4-5	Hard	1904?		
11	Buckeystown, 2 mi. N	W. G. Baker	202	..	....	....	....	....	Fair	......	....		
12	Church Hill	Geo. E. Cook	44	6	5	?	13	—5	½	Medium	1909		
13	Creagerstown	Dr. Georgia Devilbliss	103	6	....	84	....	—10	....	Iron	....		
14	Creagerstown	....	117	6	12	117	....	....	....	Hard	....		
15	Frederick	Frederick City Packing Co.	178	6	25-30	178	....	—100	5-10	Hard	1910	W. M. Fogel.	
16	Frederick	Frederick Abattoir Co	96	8	90	96	....	—20	100	Hard	1912	Chas. Fogel.	
17	Frederick	Frederick Abattoir Co	123	4	118	123	....	—70	60	Hard	1911	Chas. Fogel.	
18	Frederick, 3 mi. N	Thomas J. Altman	50	..	....	50	....	—40	....	Hard	....		
19	Frederick, 4 mi. W	Town	996,1140	..	....	....	....	....	70	......	....	....	Two wells.
20	Graceham	J. C. Pyle	80	4	....	....	....	—20	....	Soft	....		
21	Jefferson	L. E. Summers	60	6	53	57	....	—45	15	Soft	1910	Corun & Gorun.	
22	Jefferson	Doty	62	6	40	50	....	—24	....	Soft	....		
23	Jefferson	Harry G. Summers	67	6	12	67?	....	—27	....	Soft	1915	W. E. Gonen.	
24	Kemptown	J. W. Williams	92	6	45	92	....	—62	Strong	Soft	....	J. H. Burdelle.	
25	Knoxville	Jos. A. Swope	47	6	47?	47?	....	—10	....	Very hard	....	G. A. Rice.	
26	Libertytown	Catholic Church	75	..	....	75	....	—10	Large	Hard	....	Green.	
27	Libertytown	R. W. Wright	32	6	4	21	....	—8	....	Hard	....	Frank Dorsey.	
28	Mt. Pleasant	Sparrows Pt. Sewer Co. at creamery.	115	6	10	....	....	—25	Large	Hard	1900	Sam Smith.	
29	Mt. Pleasant	John H. Etzler	74	6	6	70	....	—35	....	Hard	1903		
30	Myersville	Mr. Smith	115	6	10	115	....	....	....	Hard	1889		
31	New London	J. R. Brandenburg	57	6	....	....	....	—37	....	Hard	1895		
32	New Market	Hudson Winebury	38	6	18	35	20	—10	....	Hard	1906	F. W. Fogel.	
33	Pearl	J. L. C. Bopst	72	..	....	..	....	—20	....	Hard	....		
34	Woodsboro	J. M. Smith	30	5	....	30	....	—20	....	Hard	....		
35	Yellow Springs	Dennis F. Staley	71	6	2-3	40-50	....	—20	....	Soft	....	Wm. Fox	This is a dug well and supplies several houses.
36	Yellow Springs	D. H. Stone	80	6	....	70±	....	....	....	Soft	....	Fogel.	

COUNTIES OF WESTERN MARYLAND

GARRETT COUNTY

Garrett, the westernmost of the three Appalachian counties of Maryland, extends from the western boundary of the state to the North Branch of the Potomac and the arbitrary line running from the crest of Big Savage Mountain at the Pennsylvania line to the mouth of the Savage River.

Its surface features fall naturally into three groups—mountain ridges, the wide elongated valleys of an intermediate elevation, and narrower, steeper-sided valleys which the present streams have cut below the average valley levels. The highest ridge is the Great Backbone-Big Savage Mountain extending in a northeast-southwest direction the length of the county and with an average elevation of about 3000 feet. Parallel and at somewhat lower levels are the crests of Meadow Mountain, Roman Nose Range, Negro Mountain, Winding Ridge Range, and Snaggy Mountain. The main valleys are those of the Potomac and Georges Creek east of Great Backbone-Big Savage Mountain; the Savage Valley and Glades district lying between Great Backbone-Big Savage Mountain on the east and Meadow Mountain-Roman Nose Range on the west; Castleman Valley lying between Meadow Mountain-Roman Nose Range on the east and Negro Mountain on the west; and Youghiogheny Valley comprising the rest of the county lying northwest of Negro Mountain.

TABLE OF ELEVATIONS

	Feet		Feet
Accident	2395	Hoyes	2612
Altamont	2632	Hutton	2465
Bevansville	2550	Mountain Lake Park	2405
Bloomington	1040	Mouth of Savage River	1000
Crellin	2390	Oakland	2461
Crest of Great Backbone Mountain	2780–3400	Piney Grove	2649
Deer Park	2450	Sang Run	1989
Friendsville	1501	Selbysport	1424
Gorman	2312	Sunnyside	2500
Grantsville	2351	Swanton	2290
		Wilson	2500

GEOLOGY

With the exception of the narrow Pleistocene terraces and the Recent flood plains found along some of the larger streams, the rocks which form the surface of the county belong to the Paleozoic. These are all stratified sedimentary rocks and comprise sandstones, shales, coal beds, limestones, and conglomerates representing the Devonian, Carboniferous, and Permian periods. Originally laid down in an approximately horizontal position they have since been folded into a series of basins (synclines) and arches (anticlines) parallel with the present mountain ridges which have resulted from the varying degree of resistance to erosion or weathering of the different bands of rock thus brought to the surface.

SURFACE WATERS

Because of the rugged topography the streams of Garrett County are rapid and for the most part flow in narrow valleys.

The rainfall in Western Maryland is copious and Garrett County is accordingly well watered.

The North Branch of the Potomac River, flowing in a northeasterly direction, forms its southern boundary. This stream with its numerous short tributaries drains the southeast slopes of Backbone Mountain. These tributaries are in general only 5 or 6 miles in length, and come tumbling down as mountain torrents to add their water to the larger stream, itself a swift and precipitous river. Savage River breaks through the gap between Backbone Mountain and Savage Mountain, and with its numerous branches drains a large portion of the northeastern part of the county between Big Savage and Meadow mountains.

Rain falling upon the northwestern slope of the southern part of Backbone Mountain flows down the steep mountain sides in rivulets which unite to form the various tributaries of the Youghiogheny. That stream flowing due north drains all of the western part of Garrett County and flows into Pennsylvania, its waters finally reaching the Ohio and Mississippi rivers through the Monongahela.

The north central part of Garrett County between Negro and Meadow mountains is drained by the Castleman River, which flows to the north into Pennsylvania, and after a winding course joins the Youghiogheny and Laurel Hill Creek at Confluence, or Three Forks, as it was formerly called. Backbone and Meadow mountains and an irregular group of foot-hills connecting them, it will be seen, form a continental divide. Rain falling on the southeast side flows into the Potomac and reaches the Atlantic Ocean; while that falling on the northwest slopes of the divide, after a course of hundreds of miles through the Youghiogheny, Monongahela, Ohio, and Mississippi, reaches the Gulf of Mexico. It is a peculiar fact, at once apparent, that Garrett County receives practically no water from the surrounding territory, but is a collecting and conserving area for the large rivers to the north and south.

The mountain slopes are so steep and the valleys of all the streams in the county are so narrow that the precipitation quickly reaches the main streams, causing very marked fluctuations of flow. During rainy weather a very large percentage of the water flowing swiftly down the mountain sides does not have an opportunity to seep into the ground, so that during the dry season there is no ground storage to keep up the flow and the streams show a very small run-off in comparison to their drainage areas. Lakes and ponds which would store to some extent the waters of the wet season are also entirely lacking. For these reasons the low water-flow of streams in Garrett County in common with most of the upper tributaries of the Potomac is exceedingly small, and sudden rises to flood height are frequent. Most of the mountain slopes, however, are covered with a heavy growth of hardwood which acts to some extent as a water conserver.

The Potomac River

The headwaters of the North Branch proper are at the Potomac Spring, a short distance west of the Fairfax Stone, the starting point of the West Virginia and Maryland state line, at an elevation of about 3200 feet. From this point the river flows in a northeasterly direction for about 46 miles, forming the dividing line between Garrett County, Maryland,

and Grant and Mineral counties, West Virginia, to the confluence of Savage River, where the elevation is about 1000 feet.

Along the upper part of its course, down to Westernport, the most westerly town in Allegany County, the North Branch flows through a narrow, tortuous valley, the steep, wooded hillsides of which afford little opportunity for settlement. The roads are few and bad, and the lumbering and coal-mining industries are responsible for the principal small settlements.

Owing to its considerable fall along this section, which averages 46 feet per mile, but in some portions exceeds 60 feet per mile, the river assumes much the nature of a mountain torrent, presenting one continuous series of riffles and falls, the latter in some instances having a drop of 5 feet and over. There seems to be little opportunity for developing the water powers of this stream, however considerable they may be. Freshets are frequent and heavy, and would inflict serious damage to the cheaper forms of mill-dams. Stone and brush dams, crib dams, and loose-rock dams would either be swept away or would require incessant repairs and rebuilding. On account of the narrowness of the valley, waste-weirs would often be impracticable, and dams would have to be built to withstand the heaviest floods passing over them, which would render their construction elaborate and expensive.

The capacity of the river during the dry season is indicated by measurements made above the mouth of the Savage River during the severe drought of 1897, which give 102 second-feet and may be taken to represent the minimum capacity of the North Branch. These results, together with the large amount of available head and the fact that the river does not freeze over in winter, seem to indicate that there would be ample power at all times for average milling purposes.

The water of the North Branch of the Potomac, even near its head, is naturally somewhat dark in color, owing to the presence of decaying vegetable matter from the forests. This discoloration is further increased by the large amount of pollution from sawmills, tanneries, and coal mines.

The Savage River

The Savage River rises in the valley west of Backbone and Savage mountains and enters the North Branch of the Potomac about 2 miles above Westernport at the Garrett-Allegany line. It is a small stream of great purity. Only two small sawmills are located on its bank, so that the pollution is insignificant. This is important because the town of Piedmont, West Virginia, and part of Westernport in Allegany County are supplied with drinking water by a gravity system from a reservoir which is filled by pumping water from Savage River. The quantity pumped daily is estimated at 375,000 gallons. On October 27, 1897, a discharge measurement was made at the mouth of this stream above the intake of the Piedmont water supply, the discharge being 11.3 second-feet.

The Castleman River

The Castleman River drains the north-central portion of Garrett County and has an drainage area of much the same character as that of the Youghiogheny. On May 16, 1898, meter measurements were made of the discharge of the three rivers at Confluence, Pa. The discharges were found to be as follows:

	Second feet
Youghiogheny River	1745
Castleman River	698
Laurel Hill Creek	225

The drainage area of the Youghiogheny River at Confluence is 782 square miles.

The Youghiogheny River

The Youghiogheny River is the largest which actually flows through Garrett County. Its waters reach the Monongahela about 15 miles above Pittsburgh, Pa. The waters falling on the western slope of the Alleghany Mountains at a maximum elevation of 3400 feet unite to form the tributaries of the Youghiogheny. The main stream for 19 miles above its mouth has an average fall of about 2 feet per mile, but above that point it soon increases to an average fall of nearly 5 feet per mile. The average width of the river from its mouth to West Newton, Pa., is 546 feet. There are a number of points along this river, rapids and falls, which might be utilized for water power.

UNDERGROUND WATERS

Artesian Waters

Nearly all the potable water used in the county is obtained from shallow dug wells which do not penetrate the underlying rock floor, or from springs which are numerous in all parts of the county.

Some deep wells have been drilled, but the number is few, and while the underlying rocks, particularly the more porous sandstones, are undoubtedly water bearing, so much good water can be obtained at shallow depths or from springs that it is rarely profitable to extend the search downward to any great depths.

The town of Oakland has put down four wells to depths ranging from 150 to 250 feet. All of these struck water at about 80 feet below the surface from which they draw their principal supply, the water rising in the wells to within from 3 to 30 feet of the surface. One in which the yield is 78 gallons per minute is rather high in sulphur. The other three connected with one pump yield 35 gallons per minute of hard water.

Several wells in the town of Accident reach water at distances of from 50 to 90 feet below the surface. In one of these the water rises to within 3 feet of the surface and yields a strong flow.

There is a well at Deer Park that furnishes a soft water from 85 feet, the water rising 2 feet above the surface and flowing ½ gallon per minute.

A well at Crellin put down by the Kendall Lumber Company to a depth of 180 feet supplies the town. The water rises to within 20 feet of the surface and pumps 50 gallons per minute of rather hard water.

A 200-foot well at Gorman is said to pump from 250 to 300 gallons of hard water per minute.

There are several wells at Grantsville, one of which at the Victoria Hotel, only 32 feet deep, heads 8 feet below the surface and yields 5 to 10 gallons per minute. Two others put down by U. O. and V. S. Blodser to

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Accident	J. W. Bowman	54	6	20	49—50	......	—5	..	4	Hard	1915	John Taylor	Rock at 40 feet.
2	Accident	Mrs. Wm. Hartman	92	6	16	88	......	—45±	..	1	Soft	1915	John Taylor	Sandstone at 15 feet.
3	Accident	J. J. Robinson	68	6	65	68?	......	—3	..	Strong	......	....		
4	Bayard, W. Va	Helen V. Nugent	65	6	56	60	......	—25	..	1	......	1911		
5	Bayard, W. Va	M. W. Smith	47	6	18	20	Small supply at 47	—3	..	3-4	Slightly hard	1912	M. A. Browning.	
6	Corinth, W. Va	J. F. De Berry	65	6	10	45	Small supply at 20-40	—30	..	Strong	Soft	1902	Shaw	Rock at 10 feet.
7	Crellin	Kendall Lumber Co.	180	6	25	?	......	—20	..	50	Hard	1901		
8	Deer Park Hotel	B & O. Railroad	2010	6	30	85	......	+2	¼	......	Soft	1890	Jameson	Rock at 5 feet.
9	Deer Park	Oscar Harvey	70	6	5	50	......	—25	..	......	Hard	1896	Shaw	Rock at 6 feet.
10	Deer Park	George Mailey	63	6	10	25	......	30-35	..	?	Hard	1905	Shaw Bros.	Rock at 18 to 20 feet.
11	Deer Park	C. R. Savedge	90	6	20	90	......	0	1	Strong	Soft	1890		
12	Deer Park	J. W. Walter	70	6	..	70?	......	....	..	Strong	Hard	....	Shaw.	
13	Gorman, W. Va	M. Aronholt	50	6	20	25±	......	—10	..	Strong	Hard	1905	....	Rock at 20 feet.
14	Gorman, W. Va	Dr. W. D. Drinkwater	96	6	90	60	......	—20	..	Strong	Hard	1906	Shaw	Public supply.
15	Gorman, W. Va	T. A. Eger	53	6	..	36	......	—36	..	Fair	Hard	1905	Aikins & Delaney.	
16	Gorman, W. Va	J. G. Hoffman Sons Co., tannery.	200	6	30	?	15	....	..	250-300	Hard	....	....	Water at 15 feet cased off.
17	Gorman, W. Va	J. W. Van	48+	6	..	..	......	—20	..	Strong	Hard	1899		
18	Grantsville, 3 mi. N	Amish-Mennonite Childrens Home Assoc.	121	6	121?	119	40	—102	..	8	Hard	1916	....	Water at 40 feet cased off.
19	Grantsville	Bruce Bender	82	6-4	10	78	......	—15	..	Fair	Hard	....	W. Tressler	Rock at 10 feet.
20	Grantsville	Milton Yonkin	64	..	37	..	......	....	..	......	Hard	....		
21	Grantsville	Victoria Hotel, M. E. Bevans.	32	6	15	?	......	—8	..	5-10	Hard	....	W. Tressler.	
22	Grantsville, ¼ mi. S	U. O. & V. L. Blodser	600	6-2	..	200±	......	+1	35—40	......	Hard	1906	E. Livingood	These were test holes. Water not used.
23	Grantsville, ¼ mi. S	U. O. & V. L. Blodser	478	2	..	125?	......	0	20	......	Hard	1906	E. Livingood	
24	Grantsville	H. C. Bonig	37'6"	6	24	35	17	—15	..	Several	Hard	1910	A. Livingood	Water at 17 feet cased off.
25	Grantsville	F. H. McKenzie	35	6	20	27	......	?	..	Fair	Hard	1911	B. Livingood.	
26	Grantsville, ¼ mi. SE	U. M. Stanton	80	3	20	60	......	—60	..	?	......	1910	Kine & Livengood.	This was a test hole.
27	Grantsville, ½ mi. N	C. J. Yoder	40	6	30	30	......	—9	..	3	Medium	....	Block & Tressler	This well was originally 90 feet deep. Filled in and plugged to 40 feet.
28	Hutton	J. A. Cornell	68	6	35?	?	......	?	..	Strong	Hard	....		
29	Hutton	J. W. Morris	60	6	20±	Near bot.	......	?	..	......	Hard	1912	Shaw	
30	Hutton, ½ mi. S	Tioga Tanning Co.	50-60	6	30?	?	......	?	..	Est. 50	Soft	1893	Shaw	Water not fit for drinking. Polluted?
31	Hutton, ½ mi. S	Tioga Tanning Co.	102	6	30	30	......	—18	..	?	......	1900	Shaw.	
32	Mt. Lake Park, ¼ mi. NW.	Mrs. J. L. Campbell	65	6	?	?	......	?	..	?	Soft	1905	Shaw Bros.	
33	Mt. Lake Park	H. H. Jenkins	72	6	?	?	......	—20	..	5	Soft	1890		
34	Mt. Lake Park, ⅜ mi. S	Loch Lynn Hotel	230	6-4	35	?	......	—?	..	?	Medium	1910	Kelly	Two other wells here, 180 and 170 feet deep, yield small supplies.
35	Oakland	Hotel Franz, E. J. Franz	80+	6	30	80+	......	Flows at surface	20	......	......	....		
36	Oakland	Town	200	8	13	80	......	—6	..	78	Medium	1880	R. S. Jamison	Water is high in sulphur.
37	Oakland	Town	150	8	20	80	......	—3	..	......	......	....		These three wells connected on one pump.
38	Oakland	Town	165	8	20	80	......	—3	..	35	......	....	....	
39	Oakland	Town	250	6	..	..	......	—20	..	......	Hard	1908	R. S. Jamison.	
40	Oakland	D. E. Offutt & Son	60	6	25	60	......	—20	..	?	Hard	1895	R. S. Jamison.	
41	Oakland	H. C. Sincell	94	6	60+	90	......	—30	..	Strong	Soft	1907	Shaw.	
42	Sang Run	J. A. Friend	82	6	0	82	......	—30	..	5-10	......	1892	George Walls.	
43	Selbysport	W. Friend	60	6	26	40±	......	—30	..	Strong	Soft	1886		

depths of 478 and 600 feet head at the surface and flow 20 and 35 gallons per minute respectively. An 82-foot well at Sang Run taps a water horizon, the water rising to within 30 feet of the surface and furnishing 5 to 10 gallons per minute.

Another at Selbysport, 60 feet deep, yields an ample supply of soft water which rises to within 30 feet of the surface.

Non-Artesian Waters

The broken topography of Garrett County and the heavy rainfall unite to furnish nearly all parts of the county with innumerable springs which are much utilized for domestic purposes. Dug wells of shallow depths can usually be depended upon to yield abundant water, although there is a tendency of both springs and wells to fail during dry seasons. In thinly settled regions, such as is most of Garrett County, the water from shallow wells may be used with safety if care is taken in regard to its location and the immediate sanitary conditions. Such wells should always be as far as possible from outhouses and stables or barnyards, and never down the slope or near enough to be contaminated by seepage.

ALLEGANY COUNTY

Allegany County occupies a central position among the three mountainous counties of Western Maryland, extending from Garrett County on the west to Sideling Hill Creek, which separates it from Washington County on the east. Its surface features fall into two major divisions—the plateau district, an elevated area lying between the parallel crests of Dans and Big Savage mountains, and the ridge district comprising the mountainous country lying east of Dans Mountain. The plateau district has a rolling surface lying at an elevation of about 1900 feet at the Pennsylvania line but increasing southward to over 2400 feet in the southwestern corner of the county, and much dissected by the steep-sided stream valleys. The ridge district has a more broken topography than the plateau district, and consists of a series of parallel mountain ridges trending northeast and southwest, the most prominent of which are Wills Mountain 1870 feet, Martin Mountain 2000 feet, Warrior Mountain 2135 feet, Polish Mountain 1740 feet, and Town Hill 2000 feet. Minor ridges, such as the Devil's Backbone west of Wills Mountain and Shriver Ridge at Cumberland, sometimes subdivide the major valleys. These ridges decline in elevation as they approach the Potomac. The valleys are broad and rolling, lying at a mean elevation of about 900 feet and with narrow and steep stream valleys.

TABLE OF ELEVATIONS

	Feet		Feet
Barton	1320	Lonaconlng (G .C. & C. statlon)	1718
Charlestown	1775	Luke	1000
Corriganville	715	Mt. Savage (C. & P. station)	1206
Cresaptown	780	Oldtown	564
Cumberland (B. & O. statlon)	626	Pinto	780
Eckhart Mlnes	1720	Piney Grove	937
Ellerslie	732	Westernport (Md. W. V. C. R. R.; 1000 W. B.)	922
Flintstone	828	Wills Mountain	1877
Frostburg	1929		
Lonaconing (C. & P. station)	1560		

GEOLOGY

Except for scattered stream terrace deposits of Pleistocene age and the flood-plain deposits of recent streams, all of the rocks of the county are of Paleozoic age, and include the limestones, sandstones, shales, and coal beds of the Silurian, Devonian, Carboniferous, and Permian systems. These have been gently folded into long and narrow arches and canoe-shaped basins and outcrop as narrow bands approximately parallel to the mountain ridges, the latter owing their origin to the degree of resistance to weathering of their component rock materials. Thus Dans and Big Savage mountains are capped by the upturned and very resistant Pottsville sandstone.

The mantle of soil which forms the actual surface of so much of the county has resulted from the disintegration of the underlying rocks, forming a thin cover on the ridges and a deeper mantle in the valleys.

SURFACE WATERS

Allegany County borders the Potomac, the sinuous course of which forms the 93 miles of its southern boundary. It extends northward from the river a distance of from 5 to 15 or 20 miles, and all the numerous streams eventually find their way into the Potomac drainage.

The rainfall of Allegany County is ample, the ridges receiving 8 or 9 inches more per annum than the valleys. As the surface is much broken the slopes are relatively steep, and as there are no ponds or marshes and the merchantable timber in the original forest has long since been cut and much of the valley lands are cleared for cultivation, the run-off is rapid and the proportion of the rainfall percolating into the ground to reappear as springs and to feed the summer flow of the streams is consequently small. Hence all of the streams show marked seasonal fluctuation in their flow.

The North Branch, already much polluted above the mouth of Savage River by waste from sawmills, tanneries, and coal mines, receives additional impurities from the pulp-mill at Luke and woolen-mills and tanneries at Keyser. Georges Creek, badly polluted by the waste from the numerous coal mines of the Georges Creek Valley as well as the sewage of Frostburg, Lonaconing, Westernport, and other smaller towns, adds its load of impurities to the Potomac at Westernport which also receives the sewage of adjacent communities. From Westernport to Keyser there is little fall. From Keyser to Cumberland the river has a fall of 12 feet per mile and receives relatively little pollution.

At Cumberland the North Branch assumes a totally different aspect. A tight dam maintained across the river at this point by the Chesapeake & Ohio Canal Company for diverting the water of the river into the head of the canal, impounds the water over a distance of a mile, causing back water for about 3 miles up the river. Above this dam is the mouth of Wills Creek, which flows through the city, receiving a large quantity of sewage and refuse from a paper-mill, a brewery, a distillery, cement works, a tannery, dye works, and a gas plant. The city of Cumberland has a population of about 22,000. The mayor states that about one-half of the houses in the city are provided with sewers which drain directly or indirectly into the Potomac. A supply of 8,000,000 gallons of water is furnished daily to the people of the city, and the resulting drainage must be more than 4,000,000 gallons per day, most of which is discharged into Wills Creek. Along this stream are located a number of coal mines, the drainage of which also reaches the creek. A discharge measurement made September 28, 1897, above the paper-mill gave a discharge of 12½ second-feet. As may be expected, the refuse thrown into Wills Creek, the polluting substances carried by the waters of the North Branch as enumerated above, and the sewage from the city of Cumberland accumulate in the pond above the dam as if in a settling basin. This is the case especially in seasons of low water, when no water passes over the crest of the dam.

Wills Creek is one of the most important tributaries of the North Branch of the Potomac. It flows across the narrowest part of Allegany County, only about 6 miles of the main stream measuring from the mouth upward being included within its boundaries. It receives the drainage from portions of Somerset and Bedford counties, Pennsylvania. Much of the catchment area is open, cleared, or cultivated land, and there is a considerable population residing within the area deriving support from coal-mining, brick-making, and similar industries, as well as agriculture. The discharge of this creek, on September 28, 1897, was 12½ second-feet; on May 12, 1898, at Cumberland, the flow was 381 second-feet, and on the next day 368 second-feet. The waters are polluted by the drainage from about 20 coal mines and by the refuse from the Cumberland Paper Company, manufacturers of manila and fiber papers. The water is taken from Wills Creek for the digesters, but as it contains too much sulphur for the boilers a supply for steam purposes is obtained from Braddocks Run.

Below Wills Creek and down to the confluence with the South Branch near Oldtown two tributaries are received, Evitts Creek from the north, and Patterson Creek from the south. The discharge of the former at its mouth, on September 25, 1897, was 21 second-feet, and of the latter 12.3 second feet. There are a few small mills along these streams, but no indication of pollution of the water.

East of Evitts Creek is a small stream known as Frog Hollow, the water of which is taken under the canal above Lock No. 71 by a small culvert. The discharge, on September 25, 1897, was about 0.1 of a second-foot. During the summer the water disappears altogether.

Below the junction of the North and South forks is Town Creek, which receives the drainage of a considerable portion of the eastern part of Allegany County, its headwaters being in Bedford County, Pennsylvania. It is a clear, beautiful stream, its waters not being polluted. There are reported to be two mills on this creek, besides several good water powers as yet undeveloped. The discharge, on September 25, 1897, was 11 second-feet. Pursley Run, which discharges opposite Pawpaw, and 15-mile Creek, which discharges near Little Orleans, are small streams with turbid waters. Each of these creeks, on September 26, 1897, was flowing about ½ of a second-foot. The eastern boundary of the county is formed by Sideling Creek, which rises in Bedford County, Pennsylvania, and furnishes power to several grist and sawmills. Its waters are clear and not polluted. The discharge, on September 26, 1897, was 1 second-foot. Back water from a dam in the Potomac extends up the mouth of this creek, the measurement just noted being made above the head of this. Georges Creek is the only stream of importance whose drainage area is almost entirely included within the county. This small stream, which enters the river at Westernport, in its course of 17 miles receives the effluents of a number of coal mines, besides the drainage and sewage of several towns, the most important of which are Frostburg, Lonaconing, and Westernport.

When measured at Westernport, September 28, 1897, the discharge of Georges Creek was found to be 6 second-feet, a very low stage. The water, which is very clear, possesses such acidity that horses and cattle refuse to drink it, and no living organisms can be seen in it. An analysis shows acids as follows:

	Grams per liter
Combined sulphuric acid, as SO_3	0.7350
Free sulphuric acid, as SO_3	0.1047
Sulphurous acids and sulphites	None.

The water also contains a large quantity of alumina. The presence of the sulphuric acid and sulphates is due to the large percentage of ferric sulphate contained in the coal-mine effluent. Being an unstable compound it breaks up when acted upon by the oxygen of the air, parting with the iron which settles on the rocks in the bed, forming a coating of ferric hydroxide which gives to the entire stream a very rusty appearance.

UNDERGROUND WATERS

Artesian Waters

Although both the sandstones and limestones underlying Allegany County contain artesian waters, the bulk of the wells drilled do not penetrate great depths but tap local water horizons within 100 to 200 feet of the surface. The Survey has records of 61 wells from within the county. Thirty-two of these are in Cumberland. Cumberland is underlain by the rocks of the Upper Silurian and the Lower and Middle Devonian, all of which dip to the east and less steeply to the south. The Upper Silurian, which forms the surface in the western part of the city, consists of shales underlain by limestones. The Lower Devonian, consisting of limestones below (Helderberg) and sandstones above (Oriskany), forms the surface rock in the center of the city, while the eastern outskirts and South Cumberland are underlain by the shales and sandstones of the Middle Devonian. All of these formations contain local water horizons, but since the wells for the most part penetrate but short distances in the upturned flanks of the formations which are dipping to the southeast the horizons are not as definite or as well developed as they would be at greater depths farther down the slope of the beds.

The Cumberland wells are 4, 5, and 6 inches in diameter and 40 to 265 feet in depth. Three head at the surface; in the balance the head ranges from a few feet to 40 feet. Most of the wells have greater or less amounts of lime in solution and are therefore hard. A 5-inch well of the Cumberland Brewing Company at 100 feet reaches a stratum from which the water rises to within 25 feet of the surface and pumps 80 to 90 gallons of calcareous water per minute. A 4-inch well of the same company of same depth heads at surface and pumps 80 gallons per minute. The ice company has a 120-foot well which at 90 feet penetrates a water horizon which heads to within 7 feet of the surface and pumps 90 to 95 gallons of calcareous water per minute. The 108-foot well at Queen City Hotel strikes a very calcareous water which rises to within 25 feet of the surface and pumps about 200 gallons per minute. A 118-foot well at Queen City Brick and Tile Company, ¾ mile south of Cumberland, passes through small water horizons at 60 and 80 feet and yields about 50 gallons a minute from 118 feet, the water which is calcareous rising to within 12 feet of the surface. The 82-foot well of the Standard Oil Company at the Wills Narrows yields 20 gallons per minute of salty water which rises to within 10 feet of the surface.

Undoubtedly, wells sunk several hundred feet to reach the white sandstones of the Tuscarora which forms the capping of Wills Mountain would obtain abundant supplies of soft water of unquestionable purity.

At Eckhart Mines there are four wells 28 to 125 feet deep yielding fair amounts of hard, sulphurous water. Frostburg, which lies on the summit of the coal measures, has made several attempts to utilize artesian waters for municipal purposes. A 6-inch well was sunk to a depth of 1200 feet without striking a satisfactory supply. Another 700-foot well drilled in 1899 was entirely dry. The Frostburg Water Company sunk several wells in 1892, 2 miles west of the town, which struck a water horizon at 160 feet with a good head, but the water is hard and sulphurous. There are several wells at Keyser. One at the worsted mills, sunk to 280 feet, yields 60 gallons per minute and heads to within 20 feet of the surface. Another at the Richardson Furniture Company penetrates the same horizon at 214 feet, the water heading to within 10 feet of the surface and yielding 60 gallons per minute. At Lonaconing a 125-foot well pumps 50 gallons of hard water per minute. There are several wells at Mt. Savage. The Union Mining Company has put down four to depths of from 39 to 105 feet, all of which yield soft water under a slight head; one of the wells at 105 feet yielding about 75 gallons per minute.

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Barton	Dr. S. A. Boucher	72	6	40	?	—20	....	Fair	Medium. Strong in sulphur	1910	C. E. Wolfe.	
2	Barton	Wm. Green	70?	6	40	30	....	....	....	....	1910	C. E. Wolfe	Natural gas was encountered at the bottom of this well.
3	Corriganville, ½ mi. W.	W. A. Mathias	34	6	16	30	—10	....	Strong	Soft. Some sulphur	1908	West.	
4	Cresaptown	M. G. Van Meter	60	6	15	60?	—20	....	....	Hard	1905		
5	Cumberland	John Ayers	40	6	20	40	—8	....	10	Soft	1897	Wm. S. McElfish.	
6	Cumberland	Cumberland Brewing Co.	125	4	93	125	—10	....	15-20	Very hard	1893	Curry & West.	
7	Cumberland	Cumberland Brewing Co.	100	5	90±	100	—25	....	80-90	Hard	1900	Curry & West.	
8	Cumberland	Cumberland Brewing Co.	100	4	85	100	Flows at surface	?	80	Hard	1906	Curry & West.	
9	Cumberland	Cumberland Ice Mfg. Co.	120	6	70	90	—7	....	90-95	Hard	1892		
10	Cumberland	Edison Elec. Illum. Co.	256	6, 4½	80	80	—2	....	17	Very hard	1910	Hammersmith Bros.	Well not used.
11	Cumberland	German Brewing Co.	84	6	64	84	—6 to —8	....	100	Hard	1903	West	
12	Cumberland	German Brewing Co.	260	10	40	184-260	—10 to —12	....	300	Hard	1911	....	Two other wells, 72 and 83 feet deep. Not used on account of surface water.
13	Cumberland	Hammersmith Bros.	65	6	40	65	0	Slight flow	....	Hard	1910	Hammersmith Bros.	
14	Cumberland	John Hammersmith	56	6	22	40	+5	1/10	....	Hard	....	John Hammersmith.	
15	Cumberland	Frank Kesser	80	6	30	80	—15 to —20	....	15	Soft	....	Wm. S. McElfish.	
16	Cumberland	Klots Throwing Co. Silk Mills.	107	6	25	107	—20	....	39	Very hard	....	Wm. S. McElfish.	
17	Cumberland	Lamp & DeHaven	87	6	46	87	—30	....	12	Medium	....	Wm. S. McElfish.	
18	Cumberland	Mr. Litzenburg	164	6	23	140	—140	....	....	Hard	....	Hammersmith.	
19	Cumberland	Wm. S. McElfish	87	6	55	87	—18	....	15	Very hard	1911	Owner.	
20	Cumberland	Mr. Myers	42	6	18	42	—8	....	10	Very hard	1897	Wm. S. McElfish.	
21	Cumberland	Potomac Glass Co.	265	6	211	?	—11	....	....	....	....	J. Hammersmith.	
22	Cumberland	Queen City Hotel	108	6	75	108	—25	....	200+	Very hard	....		
23	Cumberland	Wm. Lashley	56	6	16	53	—10	....	15	Medium	....	Wm. S. McElfish.	
24	Cumberland	George Schramm	80±	6	30	80	—20	....	15	Hard	....	Wm. S. McElfish.	
25	Cumberland	Tri-State Milk Co.	225	6	30	40	—16	....	12	Medium	....	Wm. S. McElfish.	
26	Cumberland	Tri-State Milk Co.	40	6	18-20	40	—18 to —20	....	12	Medium	....	Wm. S. McElfish.	
27	Cumberland	N. & G. Taylor Tin Mills Co.	101	6	25	101	—8 to —10	....	10	Sulphur and magnesia	....	Wm. S. McElfish.	
28	Cumberland, ¾ mi. S.	Qn. City Brick & Tile Co.	118	6	10	118	—12	....	50±	Very hard	1899	Wm. S. McElfish.	
29	Cumberland, ¾ mi. S.	Jacob Handel	105	6	..	105	—12 to —15	....	....	Hard	....	Wm. S. McElfish.	Small supplies at 60 and 80 feet.
30	Cumberl'd, Wills Narrows.	Standard Oil Co.	82	6	20	82	—10	....	20	Salty	1911	McElfish.	
31	Cumberland	C. J. McKenzie	28	..	..	..	—8	....	....	Hard	....	....	Not used.

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
32	Cumberland	Harry Mattingly	106	6	54	90	—40	....	....	Medium	....		
33	Cumberland, ¼ mi. E....	Will Lang	227	6	25	35	—8	....	Fair	Hard	1915	John Hammersmith.	
34	Cumberland, 1½ mi. NE..	John Hammersmith	94	6	20	40	—20	....	Strong	Medium	1914	Owner.	
35	Cumberland, 2½ mi. NE..	E. W. Nave..............	55	8	35	?	?	....	Strong	Medium	1915	Hammersmith.	
36	Cumberland, 3 mi. E......	....	69	6	69	69	?	....	Strong	....	1907	Robt. West.	
37	Eckhart Mines............	Cumb. & Pa. R. R. Engine House	125	10	30	?	—20	....	Est. 100	Sulphur, bard	1889	R. Jamison.	
38	Eckhart Mines............	Perry Dudley	98	6	..	..	—76	....	Fair	Sulphur, hard	....	....	Not used.
39	Eckhart Mines............	Chaa. W. Porter..........	90	6	..	..	?	....	?	Sulphur, hard	....		
40	Eckhart Mines............	Owen Price, Sr...........	28	6	24	28	0	1½	....	Sulphur, hard	1892	W. B. Hopkins........	Water will rise to +6 feet.
41	Ellerslie	J. C. Albright............	80	..	60	..	—18	....	....	Sulphur, hard	1890	Ellett & Burley.	
42	Ellerslie	Ellerslie Pottery Co......	210	6	30	?	—40	....	Strong	Hard	....		
43	Ellerslie	U. B. Shockley...........	28	..	..	..	?	....	Strong	Sulphur, medium	....		
44	Flintstone	J. B. Willison............	31	6	15	..	—11	....	....	Hard	1896	Wm. S. McElfish.	
45	Frostburg	....	700	1½	..	..	....	....	Dry	....	1899		
46	Frostburg, 1 mi. NW.....	Town	1200	6	?	300?	0	1	....	Hard	....	....	Not used.
47	Frostburg (Allegany).....	Cumb. & Pa. Ry..........	200	..	..	..	....	....	....	Medium	....		
48	Frostburg, 2 mi. W........	Frostburg Water Co. H. Spriggs, 2 wells.	150 160	6	40	160	0	17 768	....	Sulpbur, hard	1892	Curry & West.........	There is a third well in this group, depth not known, has a slight flow.
49	Keyser, W. Va............	Patthett Worsted Co......	280	6	180	?	—20	....	60	Hard	....		
50	Keyser, W. Va............	Ricbardson Furniture Co..	214	8	75	214	—10	....	60	Sulphur, soft	1902	....	Water also at 160 feet. Being used.
51	Keyser, W. Va............	H. Steorts	100	6	40	60	—40	....	Strong	Hard	1911	....	Water was also found between 60 and 100 feet. Being used.
52	Lonaconing, Charlestown Reservoir.	Lonaconing	125	6	70	125	....	....	50	Hard	1908	R. West.	
53	Luke	W. Va. Pulp & Paper Co..	....	..	..	..	....	....	....	....	....		
54	Mt. Savage	Cumberland & Penn. Ry...	235	6	20	?	—7	....	Good	Medium	....	Curley.	
55	Mt. Savage	Cumberland & Penn. Ry...	200	6	15?	?	....	....	Strong	Hard	....	Curley.	
56	Mt. Savage	Union Mining Co..........	105	6	75	105	—30	....	75±	Soft	1900	West & Curley	
57	Mt. Savage	Union Mining Co..........	65	6	53	65	—12	....	10	Soft	1910	Erwin Bros.	
58	Mt. Savage	Union Mining Co..........	39	6	20±	39	—33	....	10	Soft	1910	Erwin Bros.	
59	Mt. Savage	Union Mining Co..........	98	6	22	98	—25	....	50	Soft	1910	Erwin Bros.	
60	Piedmont, W. Va.........	Piedmont Ice Co..........	285	6	..	..	—21	....	87	Soft	1913		
61	Westernport	Cumberland & Penn. Ry..	165	12	35	35	—10	....	Est. 100	Sulphur, hard	1912	Wolfe.	

Non-Artesian Waters

Allegany, like the other counties of Western Maryland, is well supplied with springs, some of the larger of which yield an abundance of good water; as for example, the springs on Savage Mountain that supply the town of Frostburg with a daily consumption of 400,000 gallons, or those from which Mt. Savage obtains a part of its public supply. The thinly settled agricultural regions in the valleys depend mainly upon dug wells for domestic purposes. These can usually be depended upon to yield water, and when care is taken to prevent contamination from the surface or nearby outhouses and stables can usually be used with safety. In more thickly settled districts, like the Georges Creek Valley with its large mining population, shallow dug wells are particularly liable to contamination and their use near centers of population is always dangerous. The State Board of Health have sanitary analyses of many of these wells, and almost without exception they show that the colon bacillus is present in greater or less amounts. This is especially true of many of the dug wells in the city of Cumberland.

WASHINGTON COUNTY

Washington County, the easternmost of the three counties of Western Maryland, extends from Sideling Hill Creek on the west to the crest of South Mountain on the east. Its northern boundary is the Mason and Dixon Line and the winding course of the Potomac separates it from West Virginia and Virginia on the south.

Topographically it is divided by North Mountain near the center of the county into an eastern part, the Great Valley, here called the Hagerstown Valley, and a western part made up of the Appalachian Ridges parallel with those of eastern Allegany County.

The Appalachian Ridges are narrow, even-crested mountain chains extending in a northeast-southwest direction across the western half of the county. The principal ridges are Sideling Hill 1600 feet, Tonoloway Ridge 1200 feet, Timber Ridge 1100 feet, and North Mountain 1400 feet. The valleys are often subdivided by minor ridges and are narrow, with a broken topography.

TABLE OF ELEVATIONS

	Feet		Feet
Antietam	320	Hancock	448
Beaver Creek	500	Hicksville	485
Big Pool	410	Highfield	142
Big Spring	440	Indian Springs	510
Cavetown	750	Keedysville	404
Cearfoss	505	Locust Grove	600
Chewsville	625	Maryland Heights	1468
Clear Spring	400	Millstone	420
Dargan	560	Pen Mar	1245
Dogtown	400	Pinesburg	360–400
Downsville	480	Pleasantville	500
Eakles Mills (408 B. & O.)	421	Rohrersville	624
Edgemont	960	Roundtop	1388
Ernstville	410	Shady Bower	520
Fort Frederick	465	Sharpsburg	413
Funkstown (B. & O. station ?)	524.08	Smithsburg	792–800
Gapland	620	Spielman	404
Hagerstown (B. & O.; 552 B. M.)	533	Williamsport	400
Halfway	539	Wilson	480

GEOLOGY

The western half of the county is similar geologically to Allegany County, rocks of Silurian and Devonian age forming the surface eastward as far as North Mountain, except for the capping of resistant Pocono sandstone on Sideling Hill and Tonoloway Ridge. North Mountain is capped by the nearly equally resistant Tuscorara quartzitic sandstone, with the easily eroded Martinsburg shale of Ordovician age in the valleys. The Great Valley owes its origin to the rapidity of weathering of the underlying rocks which comprise the various formations of the Shenandoah limestone together with some Martinsburg shale, all much folded and faulted and of Cambrian and Ordovician age. The Blue Ridge is capped by Cambrian quartzite, and its component rocks include some igneous rocks and the shales and sandstones of the Harpers, Weverton, Loudon, and Antietam formations of Cambrian age.

The Hagerstown Valley, a part of the Great Valley, elsewhere known as the Shenandoah or Cumberland Valley, extends from Pennsylvania to Alabama between the Blue Ridge on the east and the Alleghany Ridges on the west. It constitutes in Maryland a broad, fertile lowland with a gently rolling surface and an average elevation of between 500 and 600 feet, gradually increasing in elevation from the Potomac River to the Pennsylvania line. It is thus sharply marked off from the ranges of the Blue Ridge on the east and of North Mountain on the west. The eastern boundary of the Hagerstown Valley and consequently the extreme eastern part of Washington County falls in the Blue Ridge subprovince. The valley surface rises rapidly to form the western slope of the Blue Ridge. South Mountain, which at the Mason and Dixon Line reaches an elevation of 2000 feet, declines to about 1200 feet near Weverton overlooking the Potomac, where it is separated by the narrow Pleasant Valley from Elk Ridge, the northward continuation of the Blue Ridge of Virginia from which it is separated by the deep gorge of the Potomac at Harpers Ferry.

SURFACE WATERS

The Potomac River which forms the southern boundary of the county ultimately receives all of the drainage of the county. All of the larger streams of the county rise in Pennsylvania and flow southward across Maryland. The principal streams of the western mountainous half of the county are Tonoloway Creek and Licking Creek. Little Tonoloway Creek which originates on the eastern slope of Sideling Hill flows northward just west of Tonoloway Ridge, which it cuts through near the Pennsylvania line, flowing from thence southeastward and emptying into the Potomac at Hancock. The principal streams of the Hagerstown Valley are Antietam and Conococheague creeks, both of which rise in Pennsylvania and flow southward in deep, narrow, winding valleys, the Conococheague emptying into the Potomac at Williamsport and the Antietam at the town of that name.

UNDERGROUND WATERS

Artesian Waters

The number of artesian wells thus far drilled in Washington County is limited, and the majority only penetrate to shallow depths and go little if at all below the surface of the underlying rocks. Dug wells and springs furnish abundant supplies of water for ordinary domestic purposes, and the only incentive for drilling artesian wells is to obtain water under more sanitary conditions, as for municipal or manufacturing supplies. So much of the county, particularly the more thickly settled Hagerstown Valley, is underlain by calcareous rocks that the bulk of the well water from both artesian and dug wells is hard. The narrow western part of the county is underlain by prevailingly siliceous rocks, and the well water in this region is often more or less ferruginous.

There are seven drilled wells in and around Williamsport penetrating various distances into the folded and faulted Martinsburg shale and Shenandoah limestone. Various minor water horizons are struck about every 50 feet from the surface. W. D. Byron and Sons, Inc., have put down the two deepest wells in the town, one to 210 feet and the other to 487 feet. The former heads about 100 feet below the surface and pumps 25 gallons per minute, the latter heads 30 feet below the surface and yields 15 gallons per minute. These are the largest amounts furnished by any of the Williamsport wells.

There are five wells in and around Millstone put down in the Romney and Jennings formations which penetrate local water horizons in some of the more porous layers of these formations which are prevailingly shaly. A well of M. S. Bachtel reaches water at 85 feet, the water heading almost to the surface and said to yield a large amount of soft water. A well of the Millstone Orchard Company sunk 1¼ miles north of the town to a depth of 132 feet struck water at 128 feet. The water heads 50 feet below the surface, is said to be soft, and yields 10 gallons per minute. A well belonging to J. F. Weller, 1 mile west of the town, has a depth of 122 feet. At 112 feet water was reached. It heads 80 feet below the surface and yields 28 gallons per minute of medium soft water.

There are four wells at Sharpsburg, none of which is over 100 feet deep. The water is all calcareous and the wells head from 20 to 60 feet below the surface.

There are six wells at Indian Springs, all of which obtain small quantities of water within 128 feet of the surface. The head is poor and the water is calcareous or ferruginous.

There are five wells at Big Pool in the Potomac terrace deposits. The deepest of these is 60 feet and all obtain small quantities of water which probably comes from the surface of the underlying Devonian rocks.

There are 15 wells in and around Hagerstown. All are in the underlying Shenandoah limestone which is much folded and more or less faulted, and underground water conditions cannot be predicted with any degree of assurance. Water is usually to be had but it is always calcareous, sometimes excessively hard. The deepest well is that of the J. C. Roullette and Sons Knitting Company, which was sunk to 920 feet and obtained only 1 gallon per minute from near the surface. The Hagerstown Table Company has sunk an 8-inch 500-foot well which reached water at 323 feet. It heads 60 feet below the surface and yields 56 gallons per minute. The uncertainty regarding the yield of wells in this vicinity is well illustrated by the following records. The knitting company has four additional wells, 281, 323, and 325 feet deep. They are only cased a few feet, but their water is said to come from 60, 160, and 275 feet. In all four the water heads to within from 3 to 8 feet of the surface. The 60-foot and 160-foot horizons yield 18 gallons per minute each. The horizon around 275 feet yields in one well 200 gallons per minute, and in the other 116 gallons per minute. The Hagerstown Brewing Company has two wells, a 4-inch well 120 feet deep and a 6-inch well 137 feet deep. The water rises to within a few feet of the surface and the yield is respectively 150 and 200 gallons per minute. The Terminal Ice and Storage Company has two wells 193 and 160 feet deep. The head is good and the former pumps 180 gallons per minute from a water horizon only 40 feet below the surface, while the latter yields 150 gallons per minute from 154 feet below the surface.

There are 22 wells in or near Hancock. Most of these range between 38 and 150 feet in depth, and a large number obtain medium quantities of generally hard water within 100 feet of the surface, the water rising to the surface and overflowing 5 gallons per minute. This water comes from the surface of the underlying rock of the Romney formation of Middle Devonian age or from local more porous layers in this formation which is largely shale but contains intercalated beds of sandstone. The

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	Big Pool	N. E. Funkhouser	40	6	12	35	....	—30	..	Strong	Iron	1912	Beckley.	
2	Big Pool	Mrs. K. B. Kinsell	48	6	..	....	....	....	..	2-3	Soft	1904	Perth & Niemyer.	
3	Big Pool	H. L. Phillipy	50	6	12	40	....	—30	..	4	Iron	1913	Beckley.	
4	Big Pool	J. Rosenburg	30	6	20	30	....	—22	..	2	......	1914	Beckley.	
5	Big Pool	Lottie Shank	60	6	15	55	30	—20	..	....	Iron	1916	Beckley.	
6	Cavetown	Hoffman	81	6	6	....	....	....	..	....	Hard	1911	Niemayer.	
7	Downsville	Elias Clyde	27	6	8	20	....	—13	..	....	Hard	1911	Beckley.	
8	Downsville	Joe Davis	68	6	8	65	40	—40	..	3-4	Hard	1915	Beckley.	
9	Downsville, SW	David M. Strong	122	6	20	120	40	—40	..	....	Hard	1911	Beckley.	
10	Downsville, SW	David Strow	136	6	20	130	80	—80	..	....	Hard	1911	Beckley.	
11	Downsville, 2 mi. SE	Dr. Gainer	71	6	8	65	....	—40	..	4½	Hard	1911	Beckley.	
12	Fort Frederick	Scott Snooks	60	6	18	50	....	—45	..	3	Iron	1914	Beckley.	
13	Hagerstown	H. E. Bester	103	6	10	90	70	....	..	265	Hard	1912	S. A. Downin.	
14	Hagerstown	Cromer Silk Mills	111	6	13	102	30′ 13 gals. 60′ 8 gals.	....	..	55	Hard	1915	S. A. Downin.	
15	Hagerstown	Hagerstown Brewing Co.	120	4	..	120	....	—12	..	150	Hard	1904	S. A. Downin	Two old wells 108 and 151 feet. Abandoned.
16	Hagerstown	Hagerstown Brewing Co.	137	6	14	135	....	....	..	200	Hard	....	S. A. Downin.	
17	Hagerstown	Hagerstown Table Works	500	8	160±	325	....	—60	..	56	Very hard	1910	A. A. Zink.	
18	Hagerstown	J. C. Roulette & Sons Knitting Co.	910	6	20	22	....	—20	..	1	Hard	1911	S. A. Downin	Driller said well was practically dry below 22 feet
19	Hagerstown	J. C. Roulette & Sons Knitting Co.	281	6	8	275	....	—6	..	200	Hard	1911	S. A. Downin.	
20	Hagerstown	J. C. Roulette & Sons Knitting Co.	323	6	1½	60	120	—3	..	18	Hard	1911	S. A. Downin.	
21	Hagerstown	J. C. Roulette & Sons Knitting Co.	281	6	10	263±	15	—8	..	116	Very hard	1913	S. A. Downin.	
22	Hagerstown	J. C. Roulette & Sons Knitting Co.	326	6	5	160	40	—5	..	18	Hard	1913	S. A. Downin	Not in use.
23	Hagerstown	Terminal Ice & Storage Co.	193	6	..	40	70 & 60	—20	..	180	Hard	1910	S. A. Downin.	
24	Hagerstown	Terminal Ice & Storage Co	160	6	18	154	....	—20	..	150	Hard	1913	S. A. Downin.	
25	Hagerstown, 4 mi. S.	Elliott Long	38	6	12	30	....	—26	..	2	Hard	1916	Beckley.	
26	Hagerstown, 5 mi. S.	Isaac Rowland	87	6	15	80	....	—40	..	Large	Hard	1911	Beckley.	
27	Hagerstown, 3 mi. N.	Frank Shingle	46	6	18	38	....	—30	..	2	Hard	1911	Beckley.	
28	Halfway	Michael Beckley	70	6	8	65	30	—20	..	2-3	Hard	1916	Beckley.	
29	Hancock	George Anthony	101	6	22	90	....	—50	..	Strong	Hard	1916	Ramsburg Bros.	
30	Hancock	George A. Anthony	56	6	50±	56	....	—2	..	Strong	Sulphur, hard	1906	J. Schultz.	
31	Hancock	George Anthony	68+	6	60	60	....	....	..	....	Soft	1910	Ramsburg Bros	This was originally a good supply but it decreased very much, possibly due to filling in.
32	Hancock	Jack Easton	66	6	18	55	....	—36	..	15	Hard	1907	Ed. Montgomery.	
33	Hancock	Faith & Erline Hdwe. Store	65	6	30	55	....	—10	..	2	Iron & sulphur	1911	H. Hess.	
34	Hancock	Mrs. P. Groves	38	6	22	32	....	—1	..	12	Hard	1909	Ed. Montgomery.	
35	Hancock	Town	440	8	430	429-436	....	—90	..	200	......	1912	Thos. B. Harper & Co.	This is a public supply.
36	Hancock	Hancock Bank	148	6	20	125	....	—48	..	40±	......	1907	Ed. Montgomery.	
37	Hancock	Hancock Creamery	60	6	30	55	....	—3	..	100	Hard	1910	Ed. Montgomery.	
38	Hancock	Raymond Henderson	130	6	8	125	....	—80	..	15	Hard	1905	Ed. Montgomery.	
39	Hancock	P. McCandlish	101	6	20	85-90	55-60	—41	..	35-40	Hard	1910	Ed. Montgomery.	

No.	Location	Owner or Tenant	Depth	Diameter	Length of casing	Depth to principal supply	Depth to subordinate supply	Head	Volume of flow	Yield by pumping	Character of water	Date drilled	Driller	Remarks
40	Hancock	George McKibbin	128	6	..	90-95	....	+4	5	....	Hard	1906	Ed. Montgomery.	
41	Hancock	Monterey Inn	204	6	40	186	....	—174	..	¾	......	1909	Pittman & Hughes.	
42	Hancock	Spangler Hotel	112½	6	15	100±	....	—60	..	30-40	......	1904	Pittman & Hughes.	
43	Hsncock	Wm. Stetler	127	6	30	127	....	—47	..	80	Hard	1910	Ed. Montgomery.	
44	Hancock, ½ mi. W.	S. Rinehart Cohill	285	6	100	285	....	—185	..	Strong	Hard	1910	J. Schultz.	
45	Hancock, ½ mi. W.	S. Rinehart Cohill	173	..	..	....	....	....	..	....	Hard	1909		
46	Hancock, ½ mi. E.	Western Md. Csnning Fcty.	147½	6	22	135-138	....	—67	..	75	Hard	1009	Ed. Montgomery.	
47	Hancock, 2 mi. W.	Sweeny's Fruit Orchard	278	6	..	278	....	—178	..	50-75	Hard	1910	J. Schultz.	
48	Hancock, 5 mi. W.	Mrs. Martha Bishop	72	6	..	....	....	....	..	5	Hard	....	J. Hess.	
49	Hancock, 6 mi. W.	J. A. Morgan	127	..	125	125	....	....	..	....	Hard	....	Ed. Montgomery.	
50	Hancock, 7 mi. SW.	Ridersville Canning Co.	140	6	?	30?	....	—8	..	6	Iron & sulphur	1911	J. Schultz.	
51	Indian Springs	Vaughan Fruit Fsrm	200	6	48	128	....	—128	..	....	Hard	1913	Beckley.	
52	Indian Springs, W.	Jerry Bears	45	6	10	40	....	—20	2-3	....	......	1914	Beckley.	
53	Indian Springs, W.	C. B. Mason	90	6	40	85	....	—70	..	....	Medium	1915	Beckley.	
54	Indian Springs, W.	Franklin Murray	88	6	18	80	....	—60	..	2	Iron	1914	Beckley.	
55	Indian Springs, W.	Jas. Murray	85	6	—20	80	60	—60	..	....	Iron	1914	Beckley.	
56	Indian Springs, W.	Wensen Murray	50	6	16	50	....	—35	..	2	Iron	1914	Beckley.	
57	McCoy's Ferry	C. H. Bruns	65	6	18	60	....	—30	..	2	......	1912	Beckley.	
58	McCoy's Ferry	Amos Everts	85	6	20	70	....	—60	..	4½	Iron	1911	Beckley.	
59	McCoy's Ferry	James Grooms	54	6	15	50	....	—40	..	2	Iron	1911	Beckley.	
60	Maugansville	B. E. Stauffer	60	6	2	60	....	—20	..	3	Hard	1909	Bluebaker.	
61	Millstone	M. L. Bachtel	86	6	25	85	....	—1	..	Strong	Soft	1913	Pittman & Hughes.	
62	Millstone	Miss Fanny Lochs	57	6	16	35	....	—17	..	....	Hard	1895	Prater & Niemyer.	
63	Millstone	Robt. S. Moffit	33	6	..	22	16	—8	..	....	Soft ?	1916	Ramsburg.	
64	Millstone, 1 mi. W.	J. F. Weller	122	8	18	112	....	—80	..	28	Medium	1915	Schultz.	
65	Millstone, 1¼ mi. N.	Millstone Orchard Co.	132	6	20	128	Small, 100	—50	..	10	Soft	1912	J. Schultz	Another well here, 42 feet deep, has hard water.
66	Pen Mar	George Lutz	218	6	..	....	....	—20	..	5-10	......	....	S. A. Downin.	
67	Pinesburg	Jos. Staley	54	6	15	50	....	—35	..	5	Sligbtly hard	1911	Beckley.	
68	Shady Bower	Dallas Ward	71	6	12	65	....	—20	..	3-4	Hard	1916	Beckley.	
69	Sharpsburg	L. H. Weevil	77	6	20	77	....	—30	..	Strong	Hard	1913	Beckley	This place is between Sharpsburg and Hagerstown.
70	Sharpsburg	J. Harvey Sprecher	100	6	20	100	60	—60	..	3	Hard	....	Beckley	This place is between Sharpsburg and Hagerstown.
71	Sharpsburg	Hicks Ramsburg	50	6	18	50	....	—40	..	Good	Hard	1911	Beckley.	
72	Sharpsburg	John D. Ramsburg	100	6	30	80	....	—60	..	Good	Hard	1911	Beckley.	
73	Williamsport	W. D. Byron & Sons Inc.	487	6	20	450	Slight at 30' & 5'	—30	..	15	......	1905	Sam. Angle.	
74	Williamsport	W. D. Byron & Sons Inc.	210	6	..	210	....	—100±	..	25	......	1897	Beckholder	Abandoned. Needed place for boilers.
75	Williamsport	Cushwa's Brick Plant	141	0	..	....	....	....	..	9	......	....		
76	Williamsport	S. W. Lindsey	105	6	..	97	....	....	..	6	Hard	....		
77	Williamsport, N.	Isaac Grove	49	0	15	45	....	—26	..	2	......	1912	Beckley	
78	Williamsport, N.	Robert Wright	40	6	15	35	....	—30	..	2-3	Hard	1916	Beckley	
79	Williamsport, 2 mi. NE.	John B. Reynolds	150	6	20	142	....	—20	..	Strong	Hard	1910	Beckley	
80	Woodmont Club	Woodmont Club	85	6	..	85	....	....	..	....	Hard, strong in iron	1890	Swartz.	

only deep well in Hancock is the 8-inch well drilled for the town in 1912. This well, from which the municipal supply is obtained, was put down to a depth of 440 feet, passing through over 400 feet of the more or less impervious Romney shale. The well is cased to 430 feet and the 10 feet below the casing is in either the thin conglomerate at the base of the Romney or the porous sandstone of the underlying Oriskany formation which is here dipping to the southeast. The water heads to within 9 feet of the surface and pumps 200 gallons per minute. This same water horizon becomes deeper southeast of the town but nearer the surface northwest of the town.

Non-Artesian Waters

SPRINGS.—Small springs are numerous in the mountain valleys and ravines throughout the western half of the county and in the Blue Ridge district. Such springs and the resulting mountain streams are locally utilized for domestic purposes, and can usually be used with perfect safety if care is taken to prevent contaminating the source or the subsequent course above the point from which the supply is taken. In the western part of the county the west flank of Tonoloway Ridge and the east flanks of Warm Spring and Cove ridges where the porous Oriskany sandstone dips steeply under the impervious Romney shale, so that the water circulating under pressure in the sandstone finds an outlet at the contact, are especially favorable places for deep-seated, permanent springs. There are many of these, and some, as the Sulphur Spring 2 miles north of Hancock, are considered medicinal. Similar conditions across the Potomac result in the historic springs at Berkeley Springs, West Virginia, where the warm and slightly mineralized water comes up through the Oriskany sandstone from a great depth and has been utilized both for bathing and internally since the days of Lord Fairfax, the one-time owner of the property. At Indian Springs there is an historic spring on the old Baltimore turnpike. Clear Spring and Big Spring, both towns at the eastern foot of North Mountain, were named from the springs, the water of which probably comes up from great depths along fault planes.

The Buena Vista Spring Water Company sells about 162,000 gallons of table water in Baltimore each year which is obtained from the Buena Vista Spring near Edgemont on the western slope of the Blue Ridge. The ridge is capped by hard Cambrian sandstone, the strata of which dip to the west, and numerous springs, some of them undoubtedly obtaining their water from the depths, are found along the fault which separates the rocks of South Mountain from the limestones of the Great Valley.

SHALLOW WELLS.—Dug wells are numerous in the agricultural portions of Washington County, and these can usually be relied upon to strike water sufficient for domestic uses at shallow depths. Owners are frequently careless in locating these shallow wells with respect to nearby sources of contamination. Where care is taken in regard to the sanitary surroundings shallow wells can be used with safety in the rural districts, but the risks of contamination are always great in towns, and sooner or later municipal water systems are a necessity.

DISTRICT OF COLUMBIA[1]

SURFACE STREAMS AND SPRINGS.—The District of Columbia contains no surface streams that supply potable water. Springs were formerly numerous, especially on the broad terraces which border the Potomac River. In some places spring water appears to have been from local sources and to have accumulated in depressions on the surfaces of these terraces, and possibly a few of the springs may have come from sandbeds in the underlying formations of the Potomac group. In the city of Washington these springs are of historic interest only, as practically all of them have been covered during the development of the city. Near the southern boundary of the district there are still a few important springs, among them being the Red Oak Spring near Langdon, and the Gitchie Crystal Spring east of Bennings. Some of the springs near Langdon are highly charged with iron, but as yet this chalybeate water has not been placed on the market.

[1] Based on data collected and furnished by the U. S. Geological Survey.

At the present time the springs of the District of Columbia, with the exception of those mentioned above, are not used, and there is no probability of future development. Unless the springs are situated in some locality remote from habitations, or unless the water is clearly from deep-seated sources, their use should not be encouraged.

SHALLOW WELLS.—In the early history of the city of Washington shallow wells were very numerous, and they are reported to have been remarkably successful. The shallower wells were only about 25 to 30 feet deep, and deeper ones in some localities 80 feet or more. The source of the water for the shallow wells was undoubtedly the Pleistocene sands and gravels which form the terraces, and the absence of layers of clay above the water-bearing beds probably permitted a great deal of surface water to enter the wells without adequate filtration. Such wells as these have been entirely abandoned in the city and they are comparatively rare in the suburban districts. Many of the deeper wells doubtless obtain water from sand-beds in the older geological formations, and since the sand-beds are overlain by clays, surface water is excluded where the wells are properly cased. The casing used during the early history of the city was mostly wooden and was, of course, more or less likely to decay. Practically all of the old wells have long since passed out of use, but in recent years a number of artesian wells have been sunk to the water horizons in the older geological formations, and the water is extensively used for drinking purposes. The ease with which good water can be obtained at moderate depths and the wide distribution of the public water supply make it unnecessary to use the old-fashioned shallow wells of doubtful sanitary character.

ARTESIAN WELLS.—In the western part of the District of Columbia the crystalline rocks belonging to the Piedmont region lie near the surface, but toward the southeast they pass beneath the formations belonging to the Coastal Plain, and at the southern boundary of the district they are over 500 feet below sea level, or about 700 feet beneath the surface of the upland.

The dividing line between the Piedmont and the Coastal Plain provinces lies near Rock Creek, but the formations belonging to the latter are too thin to be important as sources of water near their western margin. Beginning near 16th Street, N. W., and extending to the south side of Anacostia River, the Patuxent formation of the Lower Cretaceous becomes increasingly valuable as a source of water for artesian wells. The Arundel and Patapsco formations appear in the high hills north of Anacostia River, and they thicken beneath the upland south of that stream. Above these formations on the south side of the river are others belonging to the Upper Cretaceous, the Eocene and the Miocene. Overlying all of the formations previously mentioned are deposits of Pleistocene age, and the highest hills near the southern boundary of the district are covered by deposits of Pliocene (?) age belonging to the Brandywine formation.

With the exception of the Pliocene (?) and Pleistocene formations the various formations overlie one another in the order mentioned, the Patuxent being at the bottom of the series and the Calvert (Miocene) at the top. These formations are in general composed of successive layers of sand, gravel, and clay resting one upon another. The Pleistocene formations, three in number, are relatively thin deposits of clay and sand forming broad terraces facing toward the principal streams. The lowest, known as the Talbot, lies nearest the streams, and the other two, the Wicomico and Sunderland, are successively higher. The Pliocene (?) Brandywine formation is a deposit of sand and gravel resting on the highest hills in Anacostia and vicinity.

The principal water-bearing beds are in the Patuxent formation, and to the presence of this formation the city of Washington and its suburbs owe the abundant supplies of artesian water so extensively used before the development of the present water system. The excellent quality of this underground water has caused its continued use from public wells, and most of the factories of the city rely upon private wells. Some of the younger formations in the southern part of the district yield water, but the number of wells that utilize these waters is limited, and some of those that have been drilled have obtained small supplies.

The number of water horizons in the Patuxent formation is variable, but where the formation is thickest there are usually two or more. The most widespread is the layer of sand and gravel forming the basal member of the formation and resting directly upon the crystalline rocks. This porous bed is not everywhere present, being locally replaced by clayey materials which do not yield water. Some distance above the base of the Patuxent formation there is another layer of sand which is extensively developed beneath the central and eastern portions of the District, but may, like the basal horizon, be replaced by clay in some localities. Other water-bearing beds appear at various places, but their continuity has not been established over wide areas.

The basal water horizon is the source of water for many wells in the District of Columbia ranging in depth from less than 75 feet to nearly 400 feet. The amount of water varies with the character of the beds at the base of the formation. Many of the wells drawing from this horizon have been abandoned since they were drilled; in some cases because the city water supply was more convenient, and in other cases because the supply from the well was inadequate. In places where the water horizon is thin it is necessary to pump wells to their maximum capacity if much water is required.

Flows can only be procured on very low ground and the head is quickly lowered by pumping. A flow was obtained from this horizon at a depth of about 360 to 382 feet near the river on the grounds of the Hospital for the Insane. Since the wells have been drilled the head at this locality has declined until it is now reported to be below 125 feet. Possibly some of this decline is due to clogging of the wells, though pumping was probably the principal cause. At the Eckington power-house a well 225 feet deep encountered the basal Potomac gravels above 150 feet and was continued into the crystalline rock. A small flow is reported from this well, but the accuracy of the statement could not be confirmed.

The quantity of water obtained by wells penetrating to the higher horizons in the Patuxent formation varies from place to place, but like the supply from the basal beds the quantity is seldom large. However, the upper horizons where well developed may yield considerable water. The head is only a few feet above sea level at most places, and flowing wells can only be procured on very low ground. A small overflow was obtained at the schoolhouse in Kenilworth. This well probably draws from a horizon over 150 feet above the basal beds, though its exact depth is uncertain. When first drilled there was a small overflow which soon ceased. Just across the district line in Maryland a number of flowing wells have been drilled, and from the vicinity of Kenilworth down to the Potomac River flows can probably be obtained in properly constructed wells except near those wells that have been pumped so heavily that the head of the underground water is reduced below its original level. At Bennings the Washington Slaughter and Cold Storage Company has three wells which are reported to be 180, 200, and 300 feet deep respectively. The accuracy of these figures could not be determined because the wells have been drilled a number of years and no record was kept. They are being pumped heavily, and flowing wells could probably not be obtained near them or in the vicinity of the Hospital for the Insane.

The quality of the water in the Patuxent formation differs from place to place, but there is a general freedom from large quantities of inorganic matter and analyses have shown the absence of deleterious organic matter. Judging from the changes in underground water elsewhere, there should be an increase in the amount of matter in solution toward the southeast. Too few analyses have been made to establish this fact as definitely as could be desired. However, the analysis of water from the basal horizon at 12th and V Streets, N. W., shows 78 parts per million of total solids, while the analysis of water from this horizon at the National Capital Brewing Company, O Street between 13th and 14th Streets, S. E., shows 177 parts; and the water from the wells at St. Elizabeth's Hospital for the Insane contains 311 parts. The well at 6th and B Streets, N. W., is excluded from this comparison because the principal water horizon is in the crystalline rocks. A larger number of analyses would probably show many local variations on account of local differences in the water-bearing beds, and the ones enumerated may show an abnormal rate of increase. The character of the water from the higher water horizons in the Patuxent formation may be judged by the analyses of samples from 8th and I Streets, S. E., and Corby's Bakery. There should be an increase in the quantity of inorganic matter in the water from the other horizons in this formation toward the southeast, but there are too few analyses to illustrate the change.

The quality of the matter in solution is shown by the tables of analyses. The substances generally found in underground water are present, but the amount of iron is comparatively high, though this fact is not shown by the tables because it was not estimated separately. The presence of the iron in the water may be detected by the taste and by a yellow deposit or an iridescent scum which forms on exposure to the air. The iron interferes with the use of the water in some industries, such as laundering, and it causes a yellow coating on condensers of ice factories.

The formations overlying the Patuxent contain water, but the number of wells supplied by them is small. A 206-foot well on Congress Heights encountered water in the upper part of the Potomac group, but the exact horizon is not known.

A well drilled for Theodore Diedrich procured water at a depth of 109 feet in some of the younger formations, possibly the Magothy. On Good Hope Hill an attempt was made to procure water by drilling to a depth of over 380 feet, but the supplies encountered were small and the quality was not entirely satisfactory. This well could probably have obtained water in the Patuxent formation, but drilling was stopped in one of the overlying formations. However, if drilling should be continued to the Patuxent group the water will probably not have sufficient head to bring it within easy pumping distance of the surface.

At the Congress Heights School a well was drilled to a depth of 411 feet. The log of the materials penetrated was furnished by Mr. H. M. Schneider of the Columbia Pump & Well Company:

WELL AT CONGRESS HEIGHTS

	Feet
Mixed clay	0–130
Blue clay	130–196
Water-bearing sand	196–202
Yellow clay	202–292
Red clay	292–377
Blue clay	377–400
Water-bearing sand	400–411

The water rises to within 230 feet of the surface, and the well has a capacity of 18 gallons per minute.

Mr. Schneider is also authority for the following logs of wells at the Stanton and Garfield schools:

WELL AT STANTON SCHOOLHOUSE, GOOD HOPE, D. C.

	Feet
Mixed clay	0–110
Blue clay	110–170
Mixed clay	170–248
Water-bearing sand	248–258

The water rose to within 180 feet of the surface, and the well will yield 12 gallons per minute.

WELL AT GARFIELD SCHOOL

	Feet
Gravel and sand	0–35
Dark blue clay	35–135
Mixed clay	135–235
Blue clay	235–265
Water-bearing sand	265–271

The water rose to within 190 feet of the surface, and the yield of the well is 4 gallons per minute.

These wells show that water can be obtained on the upland south of Anacostia River by drilling deep wells, but the level is so far below the surface that the wells are hard to pump. Probably a better supply could be obtained from deeper horizons or from the basal horizon of the Patuxent formation at depths of 700 to 800 feet beneath the hilltops, but it is doubtful if the head would be sufficient to bring the water near the surface.

The log (p. 476) of the materials penetrated at St. Elizabeth's Hospital for the Insane was prepared from samples of the rock preserved by the driller.

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
1	15th & E Sts. NE	American Ice Co.	..	150-180	2-5	160-180	160-180	Patuxent	....	400	Hard	1900	Geo. Patton	Includes 6 wells of different diameters and depths.
2	15th & E Sts. NE	American Ice Co.	..	90	8	100	100	Patuxent	....	....	Hard	1896	Geo. Patton	
3	4th & F Sts. NE	Washington Brewing Co.	..	115	4½	115	115	Patuxent	....	....	Hard	1898	Star Drilling Co.	An older well, 180 feet deep, abandoned because of decrease of supply.
4	4th & F Sts. NE	Washington Brewing Co.	..	150	4½	150	150	Patuxent	....	100	Hard	1898	Star Drilling Co.	
6	4th & F Sts. NE	Washington Brewing Co.	..	175	4½	175	175	Patuxent	....	....	Hard	1894	Star Drilling Co.	
6	15th & E Sts. NE	American Ice Co.	..	365	..	90-320	90-320	Patuxent	....	45	Hard	....	Geo. Patton	Crystallines at 350 feet. 30 gallons at 90 feet, 15 gallons at 320 feet.
7	4th & F Sts. NE	Washington Brewing Co.	..	275	4½	....	....	Patuxent	....	100	......	....	Star Drilling Co.	
8	4th & F Sts. NE	Washington Brewing Co.	..	300	4½	....	....	Patuxent	....	75	......	....	Star Drilling Co.	
9	G & N. Capitol Sts. NE.	....	..	96	..	87-96	87-96	Patuxent	....	....	......	....		
10	U bet. 4th & 5th Sts. NE.	....	..	150	..	40, 84	40, 84	....	....	....	......	....	....	Crystallinea at 127 feet.
11	4th St. & Md. Ave. NE	....	..	232	..	....	222	....	—45	8	......	....		
12	3d & ll Sts. NE	....	..	157	..	....	....	....	....	12	......	....		
13	Linc. & Prospect Sts. NE.	....	..	152	..	....	....	....	....	30	......	....		
14	14th & D Sts. SE	Natl. Capital Brewing Co.	..	320	10	310	310	Patuxent	—70	100-130	Hard	1891	....	Analysia Darton p. 158.
15	14th & D Sta. SE	Natl. Capital Brewing Co.	..	320	3	310	310	Patuxent	—70	200	Hard	1891		
16	10th & S. C. Ave. SE	....	..	147	..	....	141	Patuxent	—79	13	......	....	....	Subordinate supplies at 60 and 20 feet.
17	14th & C Sts. SE	....	..	149	..	....	146	Patuxent	—63	12½	......	....		
18	12th St. SE	Gas Works	..	290	..	....	....	Patuxent	....	....	......	....	Star Drilling Co.	
19	2d & M Sts. SE	....	..	223	..	....	223	Patuxent	—35	12½	......	....		
20	15th & Md. Ave. SE	....	..	197	..	....	187	Patuxent	—32	10	......	....		
21	2d & N. C. Ave. SE	....	..	234	..	....	....	Patuxent	—60	12	......	....		
22	8th & O Sta. SE	....	..	97	..	....	88	Patuxent	—60	8	......	....		
23	B & Warren Sts. SE	....	..	125	..	....	120	Patuxent	—57	8	......	....		
24	460 K St. NW	J. J. Bowles	80	100	6	100	100	Patuxent	—10	....	Hard	1906		
25	1st & M Sts. NW	Chapin Sachs Mfg. Co.	75	160	4½	160	160	Patuxent	—36	60	Hard	1901		
26	1st & M Sts. NW	Chapin Sachs Mfg. Co.	75	210	4½	210	210	Patuxent	....	12	Hard	....		
27	1st & M Sts. NW	Chapin Sachs Mfg. Co.	75	140	4½	140	140	Patuxent	....	15	Hard	....		
28	1st & M Sts. NW	Chapin Sachs Mfg. Co.	75	180	6	180	180	Patuxent	—36	25	Hard	1906		
29	11th & G Sts. NW	Palais Royal	..	97	6	97	97	Patuxent	—35	35	Hard	1893	Star Drilling Co.	Not used.
30	12th & U Sts. NW	Home Ice Co.	..	65	6	65	65	Patuxent	—10	....	Soft	1901	....	Company haa two other wells which are not used.
31	12th & U Sts. NW	Home Ice Co.	..	65	6	65	65	Patuxent	—10	85	Soft	1901		
32	12th & U Sts. NW	Home Ice Co.	..	65	6	65	65	Patuxent	—10	....	Soft	1904		
33	15th & M Sts. NW	Security Storage Co.	..	99	8	99	99	Patuxent	....	40	Hard	1894		
34	15th & M Sts. NW	Security Storage Co.	..	73-79	1-8	73-79	73-79	Patuxent	....	70	Hard	....	Star Drilling Co.	Not used. Crystallines at 99 feet.
35	Madison Pl. nr. H St. NW.	Lafayette Sq. Opera House.	..	70	2-6	70	70	Patuxent	....	16	......	....	....	Three wells.
36	20th & M Sts. NW	Heinrich's Brewery	..	900	..	....	....	Crystallines	....	7	......	....	Star Drilling Co.	
37	Conduit Rd. NW	J. P. Clarke	..	100	..	....	....	Crystallines	....	15	......	....		
38	Q & 16th Sts. NW	The Cairo	..	312	..	70	70	Pleistocene	....	15	......	....	Star Drilling Co.	
39	9th & New York Ave. NW.	The Mt. Vernon	..	183	..	183	183	Crystallines	....	40	......	....	Star Drilling Co.	70-312 feet in crystallines, no water.
40	15th & H Sts. NW	The Shoreham	..	....	..	110	110	Patuxent	....	25	......	....	Star Drilling Co.	133-183 feet in crystallines, good water.
41	14th & G Sts. NW	Riggs House	..	558	..	....	....	Crystallines	....	No water	......	....	Star Drilling Co.	Well was continued into crystallines without striking additional water.
42	11th & Penn. Ave. NW	....	..	60	..	....	48	Pleistocene	....	20	......	....		
43	21st & M Sts. NW	....	..	150	..	....	30	Pleistocene	....	15	......	....		
44	1st & N. Capitol Sts. NW.	....	..	158	..	....	158	Patuxent	—40	20	......	....	....	32-150 feet in crystallinea, no water.
45	Corcoran Bldg.	....	..	140	..	....	120	Patuxent	—25	Fair	......	....		
46	12th & U Sts. NW	....	..	135	..	....	60	Patuxent	....	60	......	....	....	120-140 feet in crystallines, no water.
47	13½ & 14th Sts. NW	....	..	68-78	..	....	78	Patuxent	....	125	......	....	....	120-135 feet in crystallines, no water.
48	18th & Virginia Ave. NW.	....	..	50	..	....	45	Patuxent	....	40	......	....	....	Ten wells.
49	14th & Virginia Ave. NW.	....	..	102	..	....	80-98	Patuxent	....	30-35	......	....	....	Crystallines at 50 feet.
50	721 M St. NW	....	..	120	..	....	120	Patuxent	....	30	......	....	....	Crystallines at 98 feet.
51	5th & L Sts. NW	....	..	110	..	....	110	Patuxent	....	40	......	....	....	Subordinate supply at 80 feet.
52	5th & L Sts. NW	....	..	120	..	....	120	Patuxent	....	20	......	....	....	

No.	Location	Owner or Tenant	Altitude	Depth	Diameter	Length of casing	Depth to principal supply	Geologic horizon	Head	Yield by pumping	Character of water	Date drilled	Driller	Remarks
53	450 K St. NW			75			75	Patuxent		30				
51	826 12th St. NW			75			75	Patuxent		20				
55	5th & L Sts. NW			124			106-124	Patuxent		100-125				
56	20th & Penn. Ave. NW			203½			65-85	Crystallines	—35	1½				Crystallines at 124 feet.
57	O bet. 6 & 7th Sts. NW			201			192-201	Crystallines	—35	12				Crystallines at 43 feet.
58	7th & M Sts. NW			151			143-151	Crystallines		12				Subordinate supply at 115 feet.
59	6th & B Sts. NW			140			135	Patuxent	—10	7½				Subordinate supply 46 and 120 feet.
60	1st & G Sts. NW			141						12				
61	N bet. 4th & 5th Sts. NW			150					—55	10½				
62	12th & M Sts. NW			149					—38	6¾				Subordinate supply at 84 and 102 feet.
63	4½ & O Sts. SW	Metropolitan R. R. Power House.		208			200	Patuxent		20				Crystallines encountered in a deeper well at 202 feet.
64	630 Virginia Ave. SW	N. Auth & Co.		100	8	100	100	Patuxent		60	Hard	1905		
65	9th St. & Wharf SW			90				Patuxent		60				
66	4½ & B Sts. SW			141			130-140	Patuxent		20				
67	3d & D Sts. SW			96			91	Patuxent		13				Subordinate supplies at 17, 88, and 110 feet.
68	2d & Virginia Ave. SW			146			144	Patuxent	— 15	12				Crystallines at 103 feet; 3 gallons at 151 feet.
69	14th & D Sts. SW			247			30	Pleistocene		6-8				
70	Anacostia	St. Elizabeth's Asylum		240-593	6		240-593	Patuxent	—128	130	Slightly hard			
71	Avalon Heights	Reform School		270				Patuxent		60				Twenty or more small wells. Yield doubled recently by flushing.
72	Bennings	Washington Slaughter & Cold Storage Co.		180	2½					?	Soft			
73	Bennings	Washington Slaughter & Cold Storage Co.		200	2½					?	Soft			
74	Bennings	Washington Slaughter & Cold Storage Co.		300	2½					180				
75	Bethesda Park			67				Crystallines		10				
76	Brightwood			146				Crystallines		20(?)			Star Drilling Co.	
77	Buena Vista			402			270	Crystallines	—202	4-8				
78	Congress Heights	Theo. Diedrich	160	109	6	109	109	Upper Cretaceous	—70	10				
79	Congress Heights			204					—60	4				
80	Congress Heights	Hebrew Cemetery		175			170-175		—85	8-10				
81	Eckington	Power House		225				Patuxent and crystallines		65				Crystallines encountered at 159 feet.
82	Highland Station			96	5			Patuxent		Large	Soft			
83	Hillsdale			185½			180	Patuxent		8				
84	Ivy City			175				Patuxent	—45	15				
85	Kenilworth	Schoolhouse		249	3			Patuxent		Small				Flowed originally 1 gallon per minute.
86	Langdon	Corby Bread Co.		207	6-3				—20			1900		Two wells. Water at 75 and 140 feet; 40 gallons per minute at 140 feet.
87	Langdon	Corby Bread Co.		126	6-3			Patuxent	—7			1900		
88	Langdon	Corby Bread Co.		86	6-3			Patuxent	—11			1900		
89	Langdon	Corby Bread Co.		71	6			Patuxent				1900		Two wells.
90	Langdon	George Dow		155	1½	150	150	Patuxent			Hard			
91	Lincoln Park			181			160,180	Patuxent	—70	10				
92	North Tacoma	Hotel		251				Crystallines		20				
93	Soldiers' Home			175-478				Crystallines					Star Drilling Co.	Crystallines at 40 feet.
94	Somerset Heights	W. H. Bolton		60				Crystallines		20				Five wells. Crystallines at about 165 feet.
95	Terra Cotta			183			183	Patuxent					Star Drilling Co.	
96	Woodridge			312						No water				Crystallines encountered at 183 feet.

WELL AT ST. ELIZABETH'S HOSPITAL

	Feet
Arundel formation.	
Fine reddish yellow clay	40–50
Fine red clay containing blue streaks	50–60
Blue clay containing a few quartz pebbles	60–70
Brown sandy clay	70–80
Reddish brown sandy clay containing concretions of iron ore	80–120
Dark gray clay containing a little sand and a few concretions of iron ore and quartz pebbles	120–130
Patuxent formation.	
Light brown sandstone	130–140
Brown sandstone	140–150
Coarse gray pebbly sand	150–160
Brownish gray pebbly sand	160–170
Gray sandy clay	170–180
Light brown pebbly sand	180–190
Light gray sandy clay	200–210
Coarse light gray sand	210–214
Light brownish gray sandy clay	215–228
Light reddish brown sandy clay	228–230
Pink clay	230–240
Brown clay	240–250
Bluish gray sandy clay	250–260
Light brown sandy clay	260–270
Light brown sand	270–280
Bluish gray sandy clay	290–300
Bluish gray crystalline rock (probably boulders or cobbles of rock from the Piedmont formation)	310–330
Basal Patuxent sand.	
Coarse gray sand containing pebbles of quartz and crystalline rock	330–340
Fine gravel	340–350
Very coarse gravel with quartz and crystalline rock pebbles	370–379
Finer gravel	379–382
Piedmont.	
Fine gray arkosic sand, a weathering product of the underlying crystalline rock becoming harder towards the base	400–440
Gray crystalline rock	440–590

ARTESIAN WELL PROSPECTS.—The lists of wells shown in tabular form are the results of deep drilling in the District of Columbia. An examination of these lists will indicate the approximate depths to artesian water in different parts of the District, and in sinking wells drilling should usually be continued to the crystalline rocks unless satisfactory supplies are encountered from higher horizons. However, on the high hills south of Anacostia River deep drilling is apt to be disappointing because of the low head of the water.

WATER RESOURCES OF DELAWARE

INTRODUCTORY

The State of Delaware possesses an abundant supply of water throughout its entire territory. Most of this is underground, or in shallow streams which generally are of little or no service for power or drinking purposes. The waters themselves vary widely according to the underlying rocks and the topography.

RAINFALL

The rainfall in Delaware averages from 35 to 50 inches annually, and is distributed rather uniformly over the state throughout the year. No locality averages less than 2 inches per month and none more than 5. The maximum and minimum precipitation varies from place to place with the succeeding months and seasons, but in general there is less precipitation along the Atlantic at Rehoboth and Lewes and along the Delaware from Port Mahon to Wilmington than farther inland along the Chesapeake-Delaware divide and the shallow valley of the upper Nanticoke near Seaford and Laurel. The accompanying tables give the approximate average rainfall by months, seasons, and year for eight localities.

TABLE OF AVERAGE MONTHLY PRECIPITATIONS IN INCHES

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Wilmington	3–4	3–4	3–4	3–4	3–4	3–4	4–5	3–4	3–4	2–3	3–4	3–4
Newark	3–4	3–4	3–4	3–4	4–5	2–3	4–5	3–4	3–4	2–3	3–4	3–4
Newcastle	2–3	2–3	3–4	3–4	3–4	4–5	3–4	3–4	3–4	2–3	2–3	4–5
Dover	3–4	3–4	4–5	3–4	3–4	3–4	4–5	3–4	3–4	3–4	3–4	3–4
Milford	2–3	4–5	3–4	3–4	4–5	3–4	4–5	3–4	4–5	3–4	3–4	2–3
Lewes	4–5	3–4	4–5	1–2	1–2	2–3	2–3	3–4	2–3	2–3	2–3	2–3
Seaford	2–3	3–4	3–4	4–5	4–5	2–3	4–5	3–4	3–4	3–4	3–4	2–3
Millsboro	2–3	4–5	3–4	4	4–5	3–4	4–5	3–4	3–4	3–4	3–4	2–3

TABLE OF AVERAGE SEASONAL AND ANNUAL PRECIPITATIONS IN INCHES

	Spring	Summer	Autumn	Winter	Years
Wilmington	10–12	8–10	10–12	8–10	40–45
Newark	10–12	10–12	10–12	8–10	40–45
Newcastle	10–12	8–10	10–12	10	35–40
Dover	10–12	10–12	10–12	8–10	40–45
Milford	10–12	8–10	10–12	10–12	40–45
Lewes	6–8	8–10	6–8	8–10	30–35
Seaford	12–14	10–12	6–8	8–10	10–45
Millsboro	8–10	10–12	10–12	8–10	45–50

This annual rainfall represents about 100,000 gallons per acre per month which falls upon an unusually porous soil that retains more than the average amount, and yields the same quite regularly and easily through springs and wells in the Wicomico and Talbot terraces. Since practically all the waters, surface and underground, originate in catchment areas within the limits of Delaware and peninsular Maryland, the amount and seasonable distribution of the rainfall have more than usual immediate relation to the water resources of the state.

HYDROGRAPHIC AREAS

The state is divided into two major divisions by a line passing from the Delaware River through Wilmington and Newark to Elkton, Maryland. North of this line the topography is rugged and the underlying rocks highly metamorphosed crystalline schists, gabbro, and smaller bodies of limestone. South of this line the area is characterized by low relief, sluggish streams, and more or less unconsolidated clays, sands, and gravels. The former may be designated as the Piedmont area, the latter as the Coastal Plain area.

Piedmont Area

This area, bordered on the north by the circular boundary, on the south by the above-described line from Wilmington to Elkton (approximately parallel to the Baltimore & Ohio and Pennsylvania railroads), comprises approximately 150 square miles. It contains the remnants of the old base-leveled surfaces of the Piedmont and their seaward margins which have been dissected by the streams which cross the area into the

Coastal Plain. The general surface slopes from a general elevation of 400 feet in the interstream areas to 100 feet or less along the valleys of White Clay and Christiania creeks, where the crystalline rocks are covered by the gently dipping deposits of the terraces of the Coastal Plain. The area is trenched by the valleys of White Clay Creek, Red Clay Creek, Brandywine Creek, and Naaman's Creek and their tributaries. These streams flow in somewhat constricted rock-bound valleys with small flood plains. The streams furnish some power and water as will be described later.

The rocks of the area are divisible into two main divisions, the northwestern consisting of highly folded gneisses and mica schists with small masses of highly crystalline limestone or marble; the southeastern consisting of a V-shaped mass of holocrystalline igneous rocks, chiefly massive gabbro and its hornblendic derivatives. These rocks carry as high as 13 or 14 per cent of lime and might be expected to render percolating waters hard, but the character of the water derived from one well sunk to a depth of 300 feet in gabbro shows that this is not necessarily true. The use of the waters from streams traversing this area, particularly the Brandywine, will be discussed more fully in treating the water supply of Wilmington.

Coastal Plain Area

The Coastal Plain area is essentially a level plain extending from Christiana Creek to the southern boundary of the state. It comprises approximately 1800 square miles. At no point within the limits of the state does this area reach an elevation of 100 feet, and generally it is about 40 feet above tide, with ridges along the interstream areas and between the headwaters of the streams flowing into the Delaware and Chesapeake respectively, which rise 20 to 40 feet above the general level of the terrace. In consequence of the slight elevation of the terrane the streams are broad and sluggish, often emptying into extensive estuaries. At many points their waters are dammed either naturally or artificially, forming shallow lakelets and swampy areas. The banks are often low escarps cut in the Talbot or Wicomico terraces. The low elevation of this catchment area precludes the development of flowing wells at points much above sea level.

The most extensive topographic feature of the Coastal Plain area is the Wicomico terrace, a broad, level plain standing at an elevation of approximately 40 feet above the level of the sea and separated from the underlying formations, or the lower-lying Talbot terrace, by an escarp of from 5 to 15 feet in height. This terrace has an important bearing on the water supply of the Coastal Plain area, since at its base and along its outer margin is found the best and most-used water horizon of the state. The Coastal Plain portion of Delaware, including the Wicomico and Talbot terraces, is underlain by a series of seaward-dipping clays, sands, and gravels which are seldom exposed except along their northern limits where they rest unconformably upon the underlying crystallines extending out from the Piedmont area. In these seaward-dipping beds Darton and others have recognized certain relationships with the water horizons found in similar deposits in Maryland and New Jersey. Their conclusions, based on the records of even fewer deep wells than at present, apply in part to the Delaware district, but the relations are not as simple as were at first supposed.

WATER RESOURCES OF THE PIEDMONT

Surface Waters

The surface waters of the Piedmont area are used more or less extensively for power and water, both privately and by municipalities. They possess a greater fall and flow than the streams of the Coastal Plain, but are now subject to contamination, since the streams head in most instances in Pennsylvania beyond the control of Delaware authorities. Their banks at times are thickly populated, and more or less industrial waste finds its way into their waters.

When otherwise satisfactory they may carry considerable silt in suspension, due to the minute flakes of mica derived from the disintegrating mica schists and gneisses over which they pass before reaching the Delaware Coastal Plain.

The largest of these streams is Brandywine Creek, which is the source of supply for Wilmington. Similar use might be made of White Clay, Pike, Mill, and Red Clay creeks, but great care would be necessary to prevent contamination or remove that already present in case of the larger streams which head in Pennsylvania.

Underground Waters

The underground waters in the Piedmont are derived from the overlying mantle of disintegrated rock residuals or from cracks and crevices traversing the solid rock. As previously stated, the Piedmont area is underlain by crystalline rocks. These comprise gabbro, granite, gneiss, and limestone. Basic igneous rocks like gabbro, or the more siliceous igneous rocks like granite, in their unshattered form are practically impervious and without water-storage capacity. The gneisses are foliated, compact to fissile, and when unshattered hold variable amounts of water between their foliæ; smaller amounts when the rocks are compact, fresh and at a depth, larger amounts when strongly foliate, weathered and near the surface.

The line between the upper weathered, more or less open, portions and the lower unaltered compact portions is generally a zone of transition, but may be fairly well defined. When this is the case the line lies from 20 to 60 feet below the surface and is generally a good water horizon for domestic purposes and small supplies. It is, however, likely to become contaminated and insufficient.

When these crystalline rocks are shattered, as many of them are, and crossed by several series of joint cracks which bear fairly constant relations to each other with characteristic dips and strikes, the rocks may yield generous supplies of water. The storage capacity under these circumstances is almost entirely limited to the cracks, cavities, and underground channels. Where these water courses are interconnected and long there may be a fairly constant and sufficient supply. There is, however, no means of locating these favorable spots from surface indications. It is wholly a matter of chance, and the probabilities of success decrease rapidly below a depth of 200 feet.

The crystalline rocks in the Piedmont area may be reached without going through a cover of unconsolidated sediments. South of the Baltimore & Ohio Railroad they may be reached without excessive depth in a zone from 5 to 8 miles wide. The contact between the crystallines and the more porous overlying sediments is frequently a prolific water horizon. Below this the chances for getting water are as hazardous as in the compact rocks of the Piedmont proper.

The contact surface dips rather steeply, perhaps 50 to 75 feet to the mile, and the surface is quite irregular. It lies from 10 to 100 feet below the surface between Wilmington and Newark, 211 feet at Farnhurst, but was not reached in the Middletown well before a depth of 1478 feet.

Depth.—Generally from 50 to 100 feet in rural and suburban districts; from 200 to over 1000 feet at large industrial plants in the vicinity of Wilmington.

Static Head.—Generally from 25 to 50 feet below the surface; pumped; no hydraulic head.

Quantity.—Very variable. Wells driven to 1077 feet at the H. & F. Brewery, 400 feet at the Stoekle Brewery, 170 feet at the Wilmington Brewery, yielded 45, 17, and 10 gallons per minute respectively, and were regarded as unsuccessful. Similar wells driven to 200 feet at Hart and Bros. Packing Company, 301 feet at McCulloh Iron Works, and 357 feet at Bavarian Brewery, yielded 75, 75, and 50 to 75 gallons per minute respectively. These were regarded as entirely satisfactory and are still yielding what is required after more than 30 years of constant use in the first instance.

Quality.—This is regarded as satisfactory. That at the Bavarian Brewery is described as very soft, although coming from gabbro, and issues from the well at a temperature of 52° F. Generally, waters from granite and gneiss are soft, though likely to carry more or less fine micaceous sediment, while those from the gabbro and limestone may be hard and give some trouble in boilers.

WATER RESOURCES OF THE COASTAL PLAIN

The Coastal Plain area with its lack of relief may be visualized as a low-lying, sandy terrace crossed by numerous sluggish, broad, estuarine streams resting upon an alternating series of sands and clays, gently sloping seaward. The water resources of the state are intimately related to these three elements, the surface streams, the terrace waters, and the waters of the formations beneath the terraces.

Surface Waters

The evenly distributed rainfall of the Coastal Plain area falls upon the highly absorbent surfaces of the Talbot and Wicomico terraces and scarcely half of the water enters the streams immediately as "run-off." The topography though less than 100 feet in elevation divides this "run-off" between the Chesapeake, Delaware, and Atlantic watersheds, and these in turn are divided into shallow drainage basins.

The surface waters of the entire area are relatively unimportant above tide for either power or drinking purposes. The fall is too slight for the development of artificial head by damming, and the silty, sluggish flow renders the waters either unpleasant or actually unwholesome for drinking purposes. Locally, the surface waters are used for domestic purposes, but they are insufficient and unsuited for extensive utilization and are insignificant in comparison with the underground waters.

Underground Waters.

The Coastal Plain deposits lie superimposed on each other in the following order:

Names Employed in Maryland		Names Employed in New Jersey and Pennsylvania
Talbot.	.......Terraces.......	Cape May.
Wicomico.		Pensauken.
		Cohansey (Big Diatom).
St. Mary's.		
Choptank-Calvert.		Kirkwood.
Rancocas.		Rancocas-Vincentown-Hornerstown.
Monmouth.		Navesink-Mt. Laurel.
Matawan.		Wenonah-Marshalltown-Merchantville.
Magothy.		Magothy.
Raritan.		Raritan.
Patapsco.		Patapsco.
Arundel-Patuxent.		

Where exposed at the surface in passing southeastward from the Baltimore & Ohio Railroad they appear in the same succession, but in reversed order with the exception of the two terrace formations which together extend over the entire state, the Wicomico occurring at a level of 40 feet or more, the Talbot at an elevation of 30 feet or less bordering the shores of the Delaware and extending along the river courses into the crenulations of the Wicomico escarp.

The water resources of these formations are given in the following discussion.

Terrace Waters

WICOMICO AND TALBOT TERRACES.—At the base of these two terraces, which lies from 20 to 100 feet below the surface, there is almost without exception a flow of water sufficient at least for domestic purposes and frequently enough for industrial plants. The water level lies not far from the base of the Wicomico escarp, which is generally marked by springs and swampy lowlands. Since the base of the terraces probably slopes gently to the southeast the eastern escarp is probably better for well locations than the western which lies beyond the limits of Delaware except in the Nanticoke Valley about Seaford.

Depth.—30 to 100 feet, depending largely on height of location above tide.

Static Head.—2 to 20 feet below surface.

Quantity.—The quantity varies widely as is shown by the following examples: *Newcastle County:* A 6-inch well at Middletown driven in 1893 to a depth of 99 feet yielded 200 gallons per minute from a head of −20; two other wells driven in 1908 and 1909 to depths of 46 and 96 feet respectively were reported to give a combined yield of 150 gallons per minute. There are at present over a dozen wells drawing from this horizon for public supply. At Newcastle an 8-inch well driven in 1905 to a depth of 28 feet gave a yield of 400 gallons per minute from a level 10 feet below the surface. *Kent County:* At Clayton there are 14 wells driven to a depth of from 36 to 112 feet in which the water heads to 14 feet below the surface which give a combined yield of about 350 gallons per minute.

At Harrington four wells driven by the railroad to depths between 62 and 107 feet give a yield of 95 gallons per minute from a water level 10 feet below the surface, while wells driven by the Water and Light Company to a depth of from 40 to 75 feet are reported to give a yield of over 500 gallons per minute. At Milford an old well driven to a depth of 34 feet is reported to give a yield of 50 gallons per minute. At Ellendale are three wells which head to from —4 to —10 feet that give a combined yield of less than 50 gallons per minute. At Georgetown 12 wells driven by the water company to depths of from 80 to 128 feet give a reported yield of 400 gallons per minute from a water level 4 to 10 feet below the surface. *Sussex County:* In western Sussex County at Bridgeville, H. P. Cannon and Son have 12 wells with an average depth of 100 feet which supply from 80 to 100 gallons per minute per well. The flow is reported regular and practically unlimited since 20 hours' continuous pumping causes no apparent lessening of the supply. At the ice plant, near the south end of the town, a 4-inch well was driven to 420 feet, but the best results were obtained from the 100-foot horizon which is the one now used. At Seaford wells at a depth of 65 feet show a slight overflow and give a reported yield of 15 gallons per minute. At Laurel there are several wells in which the water stands about 18 feet below the surface. Their yield is said to be large. The water is obtained from two horizons of gravel approximately 70 feet below the surface (—55 feet above tide). At Delmar more than 30 wells have been sunk to depths of from 40 to 100 feet which give good yields of water. The chief water horizon appears to be between 50 and 60 feet and the water is hard. Individual wells yield from 15 to 60 gallons per minute. In eastern Sussex County there are a number of wells from the Wicomico and Talbot. At Milton a well 110 feet deep yields a small amount of hard water which rises to a level 28 feet below the surface. (This may come from a stray sand in the upper part of the St. Mary's formation.) In the vicinity of Lewes there are a number of wells with a depth of from 50 to 99 feet which yield a large supply of water. Some of them are reported "abandoned" because of difficulties with fine sand. At Millboro a well with ample supply is reported. At Rehoboth are several wells from 60 to 100 feet deep from which the supply varies from "ample" to small, and from soft to hard. It is possible that some of the deeper wells are in the upper part of the St. Mary's (or Cohansey ?) formation. At Selbysville are four wells from 80 to 92 feet deep which give a combined yield of 150 gallons per minute.

The foregoing summary shows clearly that wells from 50 to 100 feet deep in the Wicomico and Talbot terraces are reasonably eertain to yield water, while shallower wells may also yield good supplies. [The conclusion is drawn by Matson and others that the waters less than 25 feet are Talbot, those less than 40 feet are Wicomico waters. These limits do not allow sufficiently for the known thickening of the Pleistocene terraces from northwest to southeast.]

Quality.—The quality of the terraee waters is generally good in the rural districts and in many of the towns, but their nearness to the surface renders them especially liable to contamination and objectionable odor or taste due to infiltrated organie matter with consequent free hydrogen sulphide if iron sulphides are present. The chemical character of the water is shown in the table of chemical analyses.

Waters of Underlying Formations

Beneath the terraces, which are approximately horizontal, the beds dip gently to the southeast, the water horizons are more or less continuous, individual horizons lying from 10 to 15 feet deeper per mile. The horizons are in reality large lenses and not necessarily continuous across the state, so that the depths represent only the approximate horizon of the more prolific beds.

ST. MARY'S FORMATION.—This formation consists of sandy clays, clays, and marls, and underlies the southern part of Kent County and all of Sussex County, its northern limit lying along an irregular line from south of Bowers Beach on the Delaware to the Maryland boundary south of Hickman. Everywhere it is covered by later deposits of gravel and sand, and is best represented in the wells at Lewes, Milford, and Harrington (?).

The base of the formation dips from Milford to Lewes at the rate of 10 to 15 feet to the mile. The chief water-bearing horizon is at or near the base of the formation. Other horizons higher up have been noted in Delaware. They appear to be somewhat irregular and may be correlated with wells in Maryland and New Jersey.

Head.—From just below to just above surface.

Quantity.—At Lewes the yield from the 400-foot level in a 6-inch well was 15 gallons per minute. A well at Milford described by Darton yielded 4000 gallons per hour, the water rising 2 feet above the surface. The water horizon here was thought to be above his "300-foot diatomaceous clay bed" [Choptank].

Other horizons lying about 100 feet below the surface may belong in the upper part of the St. Mary's formation as suggested by others, but their persistent relationships with the topography rather than with the dip of the St. Mary's formation and the necessary increase in thickness of the St. Mary's formation is against such a correlation. The wells involved are discussed under Pleistocene waters.

Quality.—Probably somewhat high in alkalinity but not particularly injurious to boilers and uncontaminated. No analyses of waters from this special level in Delaware are available.

Prospects.—It is probable that water would be found near the base of the St. Mary's anywhere in Sussex or southern Kent at a depth below tide of from 150 to 500 feet, the depth increasing with the dip to the southeast and the elevation of the land. Since other waters are generally more available this stratum is not likely to be sought.

CHOPTANK AND CALVERT FORMATIONS.—These formations in Delaware consist of three series of alternating clays and sands of approximately 200 feet each. The uppermost is a relatively uniform sandy clay with characteristic diatoms, the middle series consists of more frequent alternations of clays and sands, and the lowest shows greater variability than the uppermost but less than the middle series. Any of the sandy layers are potential water horizons, but the supply and quality at individual horizons will vary largely from place to place. The uppermost bed has been a prolific source of water in New Jersey and has been tapped in the Lewes and Milford wells. The middle series yields water locally in variable amounts. The lowest series is one of the best horizons for moderately deep wells in Kent County and very deep wells in Sussex County.

The beds included in these formations are almost completely covered by Pleistocene terrace deposits in Delaware, but they are known to occur beneath this cover in a broad area extending southeastward from an irregular line passing across the state from south of Reedey Island to the Maryland line near Cypress Branch.

In passing southwestward from this line the lowest, middle, and upper series occur as bands 12 to 15 miles wide in which the beds dip approximately 15 feet to the mile.

Depth.—The water horizon of the highest series lies from 110 in the vicinity of Harrington, 200 feet at Milford, 250 feet at Bowers Beach, to 600 feet at Lewes. The water horizon of the lowest series lies from 157 feet at Dover, 440 feet at Port Mahon, 675 feet at Bowers Beach, to 1080 feet at Lewes.

Static Head.—Wells in these formations usually head from —2 feet to —20 feet, but in locations of lower altitude, as at Bowers Beach, they may flow at high tide.

Quantity.—At Clayton the deeper wells of the series described under the Wicomico and Talbot may be in the lower division of the Calvert, judging from the surface exposures, while deeper ones surely are. These wells generally yield about 30 gallons per minute. At the tile factory, 3 miles northeast of Clayton, a 1½-inch well driven to 172 feet gave a yield of 30 gallons per minute. At Dover several wells from 170 to 196 feet deep get water at a depth of 157 feet which flows with a head of 5 to 6 feet, and give a yield of from 200 to 300 gallons per minute when pumped. At Bowers there is a well-defined water horizon at a depth of 248 feet. The yield reported for one well is 200 gallons per minute. At Mahon River, wells to the middle member of this group gave variable results but flowed a fair amount. At Milford the city draws its supply from a series of wells driven to a depth of 228 to 245 feet and gets from 75 to 100 gallons per minute per well. At Lewes, water from this group of beds was encountered at 625, 750, 911 [and 1080 ?] feet. The water from the lowest two levels (911, 1080) was unsatisfactory. The yield from the lowest level (put by Woolman in the Eocene) is reported as only 15 gallons per minute.

Quality.—The water from these horizons apparently varies from soft to moderately hard, the increase in mineralization following the dip to the east and southeast. This increase in salinity in the lower beds, as at Lewes, renders the water unsatisfactory for drinking purposes. Occasionally the hardness of the water is due to magnesium salts, but generally it is the result of a mixture of iron, lime, magnesium, and chlorides.

EOCENE FORMATIONS.—Between the lowest Calvert strata and the uppermost Rancocas, both in New Jersey and in Maryland, there are greater or less thicknesses of glauconitic sands, marls, and clays of Eocene age. These have not been found outcropping in Delaware except in the upper valley of the Sassafras. Likewise these deposits have not been recognized in the well logs except at Middletown. This lack of evidence is largely due to the fact that the wells north of Middletown are beyond its probable distribution, while those south of this point, finding water at the base of the overlying formation have no occasion to penetrate it. The widespread development elsewhere makes it probable that this unit, which Darton described under the name Pamunkey, may be present in deep wells anywhere in the state south of Middletown.

Eocene waters, if present, will lie at considerable depth, and are likely to be variable and insufficient in quantity. When encountered, the wells should be continued into the underlying water-rich Rancocas sands.

UPPER CRETACEOUS FORMATIONS.—The Rancocas formation is one of the most important water horizons of the Coastal Plain. In New Jersey this group of beds has been more fully subdivided and water horizons have been recognized chiefly in the Vincentown sand. This formation may be reached at less than 500 feet in a small area between Reedy Island and Warwick, Maryland, on the north, and Bombay Hook and Marydel on the south. North of this area the horizon is lacking, while south of this area the horizon becomes unnecessary because of the Lower Calvert waters at a lesser depth.

Depth.—100 feet at Middletown. Since the wells encountering this stratum have gone deeper and use waters from lower horizons, nothing can be said about the head, quality, or quantity of this particular stratum.

MONMOUTH, MATAWAN AND MAGOTHY FORMATIONS.—These formations have not been utilized in Delaware, though water-bearing sands were encountered in a Middletown well at depths of 88 feet (Upper Matawan, Woolman), and 170 to 204 feet (Lower Matawan, Woolman). Waters from these horizons are likely to be of unpleasant taste and odor on account of the iron and sulphur present.

RARITAN FORMATION.—This consists of sands and plastic clays of continental, as distinguished from marine, origin. The local dips, thickness, and extent of the strata are therefore extremely variable from place to place. In general, however, it is safe to assume that away from the area of outcrop the general dip will be from 30 to 50 feet to the mile. Woolman and others have inferred a marked thickening of this formation as it passes southwestward into Delaware, but the log records suggest that the base of the Raritan has been overlooked and that the deeper portions of such wells are in the underlying Patapsco formation. The Raritan formation contains water at several horizons which are not as regular or as extensively continuous as the overlying marine sediments.

Depth.—25 feet at Newcastle to more than 1000 feet at Dover.

Static Head.—Surface to —52 feet.

Quantity.—A well at Fort Du Pont at an elevation of 11 feet, near Delaware City, entered a 54-foot bed of sand which yields from 120 to 130 gallons per minute at a depth of 680 feet. The water rises to within 4 feet of the surface and occasionally at high tide it becomes a flowing well. A second well at the same locality went to a depth of 900 feet without getting water. At Bakers Island a well 315 feet deep gave a small flow. At Reedy Island, opposite Port Penn, at an elevation of 10 feet, a well was sunk to a good water horizon at 574 feet. Water was also struck at 389-400, 498-505 feet. All three horizons are in fine to medium coarse white sand. The first gave little more than a "show"; the second a 6-gallon per minute overflow, and the deepest a 20-gallon per minute overflow of excellent water. The well was prospected to 593 feet without further results. At Middletown there is a well-defined water-bearing sand at about 540 feet which gave a yield of 330 gallons, the water standing at 50 feet below the surface. Other levels, as that at 820 feet, are referred to the Raritan by Woolman, with the assumption of a great increase in thickness, but this level is probably in the underlying Patapsco formation. One of these wells was carried to 1478 feet before encountering the underlying crystallines, though earlier work had indicated to Darton a basal contact 925 feet higher up, a conclusion accepted by Miller in his Dover Folio. No water horizons were noted below the 820-foot level.

An interesting feature of the wells at Middletown seems to be the fact that the lower horizons head at lower levels below the surface, thus:

Water at 100 feet heads 17 feet below surface.
Water at 500 feet heads 50 feet below surface.
Water at 866 feet heads 66 feet below surface.
Water at 1302 feet heads 75 feet below surface.

Quality.—The water of the Raritan formation is usually of good quality in the region where it is most available. When encountered in deeper wells it may be found to increase in hardness down the dip.

LOWER CRETACEOUS FORMATIONS.—The Patapsco formation consists largely of highly colored, variegated clays with lenses and irregular interstratified beds of cross-bedded arkosic sands. Its character suggests good local water horizons in the area between Christiana and Appoquinimink creeks. This formation, although well developed in Maryland and Delaware, is not described from New Jersey, and it is quite possible that it is there included under the term Raritan. For Delaware this formation as well as the underlying Arundel and Patuxent formations developed in Maryland must be of relatively little importance as sources of water, since the area of their availability is not great and their catchment area is small. Waters from these horizons are probably represented in the Hares Corner, Fort Du Pont, and Middletown wells.

Depth.—200 to 800 feet.

Static Head.—50 to 100 feet below the surface.

Quantity.—A well at Hares Corner driven to a depth of 228 feet gave an "inadequate supply." At Middletown the deep well found no satisfactory water horizon between the depths of 820 and 1478 feet from the surface. The small catchment area for these beds, the questionable continuity of their water-bearing horizons, and their relatively steep dip make the likelihood of satisfactory water conditions doubtful.

Quality.—The quality of the water, so far as it has been reported, is hard.

PUBLIC WATER SUPPLIES

Baltimore, Washington, and Wilmington, situated on the border between the Coastal Plain and the Piedmont, use surface waters for public supplies. This is made necessary by the quantity required within limited areas. The installation of filtration plants has insured the comparative purity of these supplies and has freed them from suspended matter which is carried by the surface streams. Well water is still used to a considerable extent for manufacturing purposes, and a much smaller amount is used for drinking. Throughout a large part of the Coastal Plain of Maryland the public supplies are drawn from wells, but in a few places near the margin surface water is used by small cities. This is the case at Takoma Park on the Western Shore, Elkton, Perryville, and Havre de Grace, near the head of Chesapeake Bay, and at various places in Baltimore County.

Throughout Central and Western Maryland the municipal supplies are largely furnished by springs or surface streams, although wells are being increasingly used to supplement the other sources. The following towns obtain their entire supplies from wells: Arlington, Howard Park, Taneytown, Union Bridge, Ellicott City, Rockville, Brunswick, Oakland, Blue Ridge Summit, and Hancock.

A number of towns in the central and western part of the state depend entirely on springs which are so abundant in this region. The following obtain their supplies from springs: Aberdeen, New Windsor, Burkittsville, Emmitsburg, Middletown, Frostburg, Deer Park, Mountain Lake Park, Boonsboro, Hagerstown, and Pen Mar. Springs also contribute part of the supply of Roland Park, Mount Savage, Frederick, Thurmont, and Walkersville.

Surface streams are utilized for the entire supply of Cumberland, Lonaconing, Midland, and Westernport, and furnish the bulk of the supplies for Frederick, Thurmont, and Walkersville. The streams used contain more or less sediment and are subject to possible pollution from dwellings located on their watersheds. In most places the water is filtered and its quality is greatly improved. Annapolis and Laurel obtain their water supplies from reservoirs fed by springs. Practically all of the other small cities of the Coastal Plain portion of the region rely upon wells. The use of shallow wells as sources of public supply has been reported in only a few places. The water obtained from these wells is commonly soft and gives fair satisfaction, but unless the wells are located at some place remote from possible souces of pollution their use cannot be commended. Fortunately it is possible to obtain an abundance of artesian water to supply most of the cities. This water, being free from danger of contamination, should be very satisfactory for domestic use.

In most places the amount of mineral matter is so small that the water can be used for manufacturing purposes. In a few of the cities an effort has been made to prevent the use of shallow wells and to require the inhabitants to use water from the city supply. Since the artesian water is less likely to become contaminated, such movements arc in the interest of public health. Most of the smaller city water systems are provided with standpipes which furnish pressure for ordinary use. In case of fire the mains leading to the standpipes are closed and pressure is transmitted directly from the pump. This makes it possible to improvc the efficiency of the city water system by increasing the pressure. In the larger cities it is necessary to use reservoirs and to supply all of the prcssure directly from the pumps.

BALTIMORE CITY

The city's chief water supply in the early days was the "City Spring" between Lexington and Centre streets. Baltimore abounded in springs, but as the population increased the City Council decided in 1797 to supplement the supply by appropriating $1000 "to erect and regulate pumps in the streets, lanes, and alleys."

Between 1787 and 1804 many unsuccessful attempts were made by the city to build a waterworks plant, but finally a private company was organized in 1804. Most of the early pipes were locust or pine logs with a 4-inch hole bored through them. The first contract for cast-iron pipe

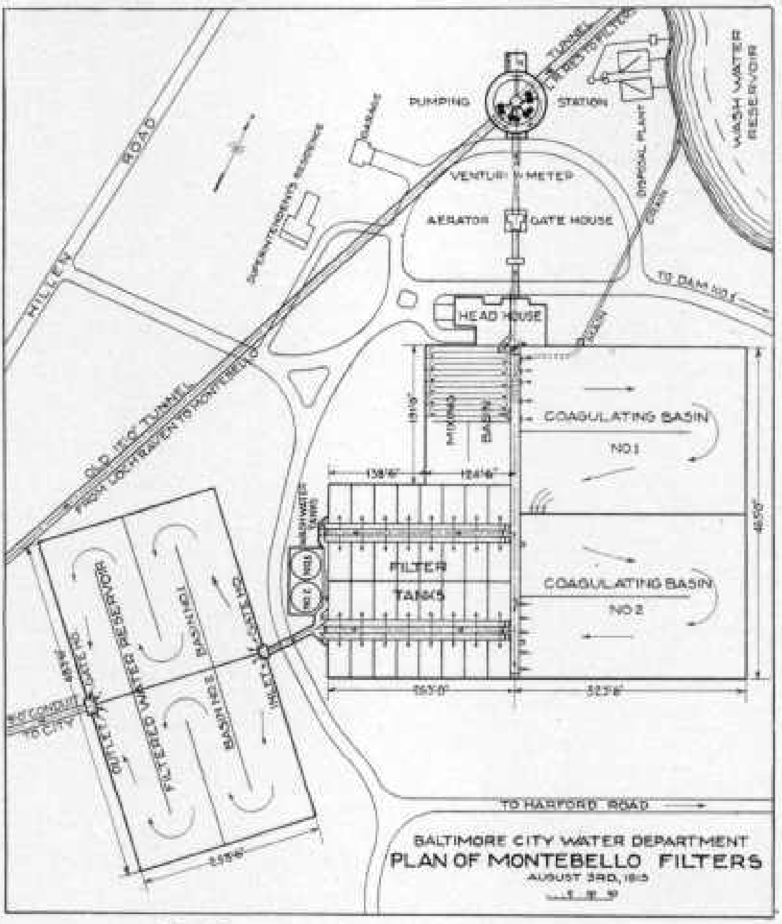

FIG. 91.—PLAN OF THE MONTEBELLO FILTERS.

was awarded in 1805. Thus Baltimore was one of the earliest cities in the world to lay iron water mains.

The first reservoir was located at the southwest corner of Calvert and Centre streets, and water was led to it from Jones Falls through an open

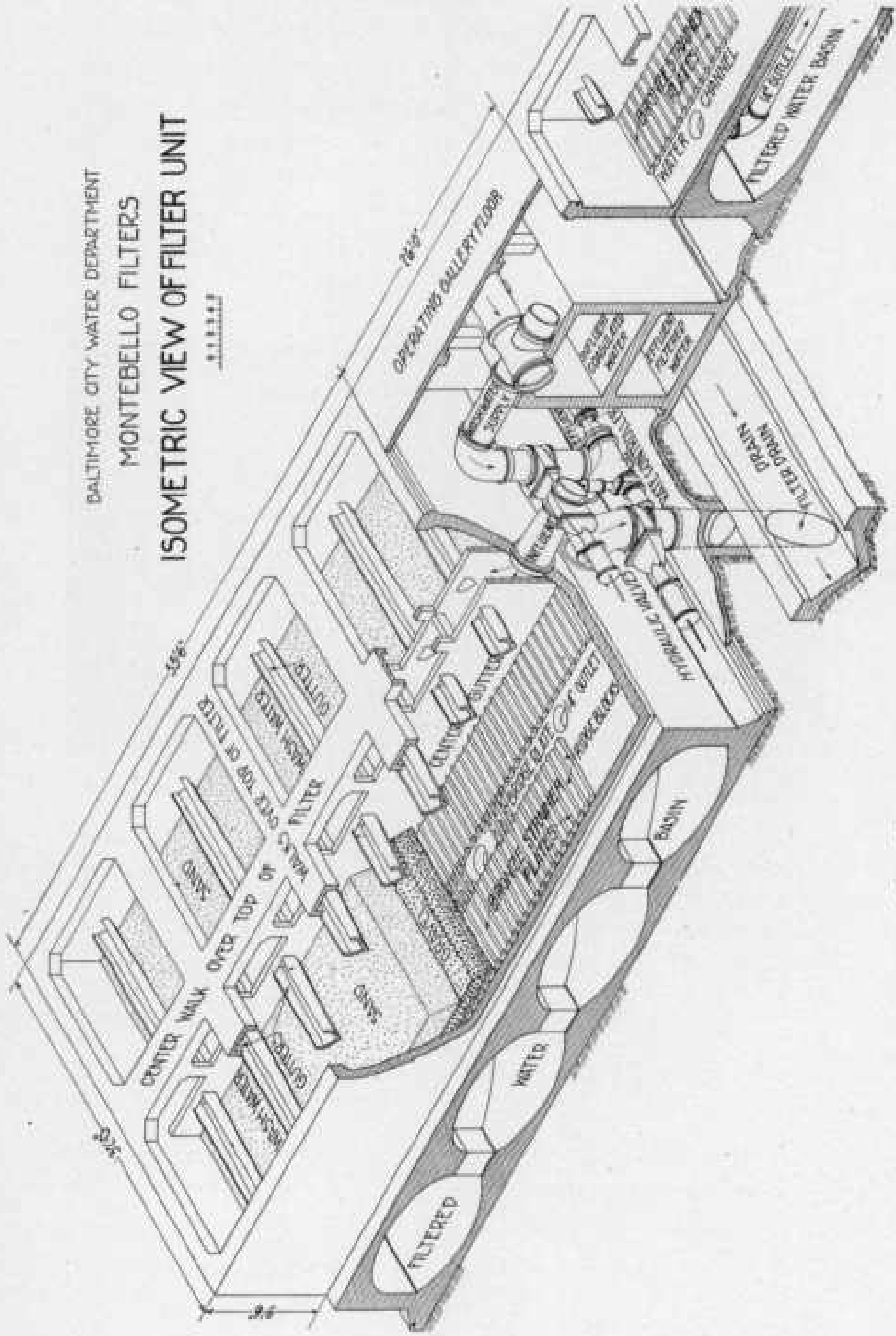

FIG. 92.—VIEW OF A MONTEBELLO FILTER UNIT.

canal from which it was lifted by a water wheel. As the population increased dissatisfaction with the water finally led to the city purchasing the property of the Baltimore Water Company in 1854 for $1,350,000.

After the city acquired the water company plant it built Lake Roland, Hampden, Druid Hill Lake, and the High Service reservoirs as well as large conduits and made various other improvements. But the increasing pollution of Jones Falls led to much agitation against its continued use, resulting in 1874 in the authorization for the use of the Gunpowder

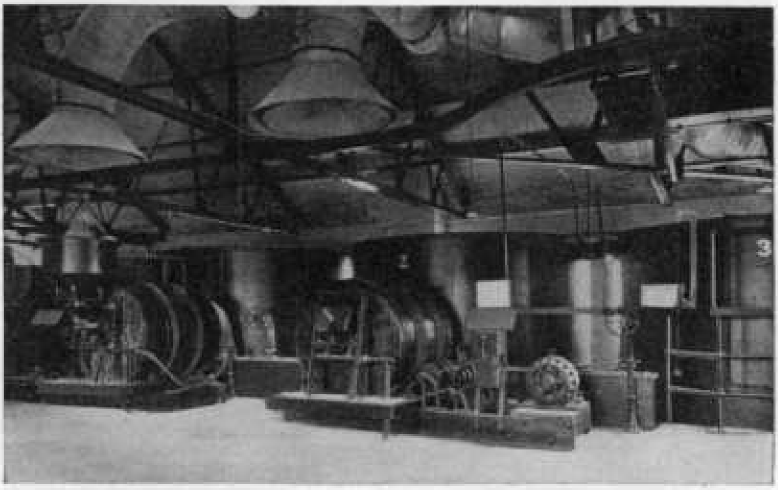

FIG. 93.—VIEW OF LIME MIXERS AND LIME TANKS.

River. After seven and one-half years' of construction, including the building of lakes Montebello and Clifton, the construction of the old Loch Raven Dam, and a 12-foot tunnel seven miles long, the new system was put in operation in 1881 at a cost to the city of $4,500,000.

In recent years the high typhoid rate and the growing dissatisfaction with the impurity of the water, especially that derived from Jones Falls, led in 1908 to the appropriation of $5,000,000 for increasing and improving the water supply. It was decided to enlarge the Gunpowder supply by constructing the new Loch Raven Dam and to improve it by building the present Montebello Filtration Plant.

The filters are of the mechanical type with a capacity of 125,000,000 gallons per acre per day, in contrast with the slow sand type of filter used by Washington and Philadelphia, whose capacity is only 3,000,000 to 6,000,000 gallons per acre per day. The water is led from Loch Raven through a 12-foot circular tunnel which is intercepted at the center of the pumping station by a 16-foot concrete shaft extending downward about 70 feet and acting as a suction chamber for the pumps which are

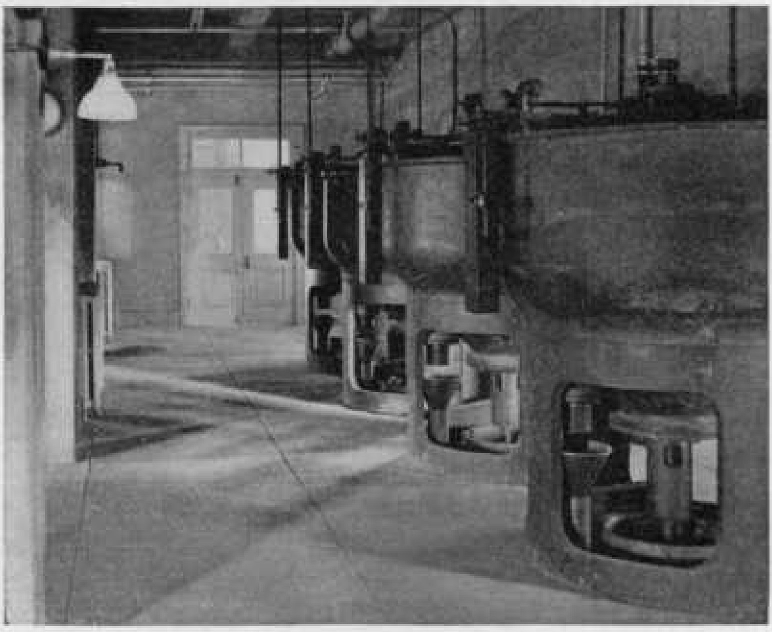

FIG. 94.—VIEW OF CHEMICAL FEED CONTROLLERS.

arranged around it radially. The water, after passing through the pumps, is conducted through a 6½-foot circular conduit discharging into a stilling chamber in the Head House. The pumping equipment comprises one 30-million, two 40-million, and one 50-million gallon per day pumps, operated by electricity derived from the hydro-electric plant at McCalls Ferry. An emergency supply can be obtained from the plant of the Consolidated Gas, Electric Light and Power Company by simply turning a switch in one of the substations.

On its way to the Head House the water passes through an 8-foot Venturi meter, which not only records the rate of flow but also regulates the application of chemicals. The Head House contains the administrative offices and laboratories, and here a constant watch is kept on the physical, bacteriological, and chemical condition of the water at all stages of its treatment. In this building are located all the apparatus for handling, storing, and mixing chemicals and for controlling their application. The

FIG. 95.—VIEW OF UPPER SERVICE PUMPING STATION.

chemical storage bins are 15 in number. The chemicals used are common lime, hypochlorite of lime, and sulphate of iron. The common lime is applied to the water as it leaves the stilling chamber of the Head House and enters the mixing basin, and the iron is added shortly afterward. The chemicals are thoroughly incorporated with the water in the mixing basin and cause the matter in suspension to be coagulated. The water then passes from the mixing basin to the coagulating basins where for several hours it is allowed to settle, this process precipitating the suspended

FIG. 96.—VIEW OF COAGULATING BASINS.

matter together with the bacteria. From the coagulating basins the water passes to the filter tanks, of which there are 32, each with a normal capacity of 4,000,000 gallons per day. These are of reinforced concrete, 55 feet 6 inches by 32 feet, and 9 feet deep. They are supported on concrete groined arches, the space beneath the arches forming three basins which hold about 2,500,000 gallons of filtered water and are directly connected with the filtered-water reservoirs from which the city draws its supply. Finally, a small amount of hypochlorite of lime is added for sterilizing purposes. The varying demands of the city during the day or night or in case of fires is met by having all the processes, both of filtration and chemical treatment, controlled automatically.

The two filtered-water reservoirs are built entirely of concrete and together hold 15,000,000 gallons. The reservoirs are covered by groined arches carrying a 2-foot depth of earth, thus keeping the water cool and shutting out the light which is otherwise the stimulus for the development of algæ—minute plants which give water a bad odor and taste.

The new Loch Raven Dam is about 2400 feet north of the old one. It has a length of 585 feet and a height of 48 feet above bed rock. It gives a storage capacity of 2,000,000,000 gallons. The foundations are, however, strong enough and wide enough to permit a subsequent increase in its height sufficient to store 21,000,000,000 gallons. The old 12-foot tunnel which was put in service in 1881 was not designed to carry water under pressure and hence it has been necessary to line it with steel. A new conduit 2465 feet long was built connecting the new dam with the old tunnel. This was 10 feet in diameter and built of steel lined with cement. A new 9-foot conduit connects the filtered-water reservoirs at Montebello with the city distributing system at Lake Clifton.

In order to meet the increased demands for a high-level service a pumping station has recently been built in Druid Hill Park. Two 4-million gallons per day pumps feed the West Arlington standpipe, discharging against a 200-foot head. The three other pumps have a capacity of 1,750,000 gallons each and feed the Roland Avenue standpipe, discharging against a 123-foot head. Eight main and several small reservoirs serve as balancing and distributing reservoirs.

STATISTICAL

Ownership: Municipality.
Source: Stream, Gunpowder River; Jones Falls in reserve.
Waterworks.
From what distributed: Two standpipes, eight main, and several small reservoirs.
Fire hydrants: 3850.
Mains.
Length, miles: 785.
Diameter, inches: 3 to 84.
Pressure.
House, lbs.: 40 to 110.
Fire, lbs.: 40 to 170.
Daily capacity of pump, gallons: 108,000,000.
Daily consumption, gallons: 85,000,000.
Percentage of population supplied: 100.
Remarks: Gravity to city through tunnel. Pumped to mains; to standpipes at West Arlington and Roland Avenue, 300,000 gallons each; to balancing and storage reservoirs, Guilford, Ashburton, and High Service. Lakes Druid, Montebello, Roland, Clifton, and Mt. Royal not in actual use but in reserve. Reserve storage, 1,500,000,000 gallons.

DISTRICT OF COLUMBIA

The public water supply for the District of Columbia is obtained from the Potomac River at Great Falls, Maryland, situated about 16 miles northwest of Washington. A short distance above Great Falls a diversion dam between the Virginia and Maryland shores of the river diverts the water into a conduit 9 feet in diameter, located on the Maryland side of the Potomac, through which the water flows to the District. For the major distance the conduit parallels the river and lies under Conduit Road. The elevation of the dam's crest is 150½ feet above mean tide level at the Washington Navy Yard.

The water, falling at the rate of 9 inches in 5000 feet, flows from the intake at Great Falls for a distance of 9 miles to the Dalecarlia Reservoir, situated on the northwestern boundary line of the District of Columbia and a short distance from the river. Here the first sedimentation takes place. This reservoir, which is lined with rough stone from a point just below the low-water line to the top of the banks, has a total capacity of 191,500,000 gallons, of which 141,300,000 gallons are available, and has its flow line at an elevation of 146½ feet.

At nearly the same grade the water continues on for about 2 miles to the Georgetown Reservoir, which has a total capacity of 174,600,000 gallons, an available capacity of 132,700,000 gallons, and a flow line at an elevation of 146 feet. This reservoir, which is approximately half way between the Dalecarlia Reservoir and Georgetown and between the banks of the Potomac River and the Conduit Road, affords a second opportunity for the storage and clarification of the water, and has its walls and banks lined throughout with stone and concrete. The floor and part of the walls of the sedimentation basin are of concrete.

The Preliminary Treatment Plant, which consists of a building for storing the coagulant, the pumps, piping, dissolving tanks, heating plant, and other apparatus for applying the coagulant, is located on the line of the conduit between the Dalecarlia and Georgetown reservoirs at a point just south of the eastern end of the Dalecarlia Reservoir. Here the water is treated with sulphate of alumina during the time of maximum turbidity of the river. This solution is admitted directly into the conduit and thoroughly mixed with the water in the course of its 2-mile travel to the sedimentation basin of the Georgetown Reservoir, where the coagulant and most of the foreign matter is precipitated.

From the Georgetown Reservoir the water flows through a lined tunnel under Washington to the McMillan Park Reservoir, located just south of the U. S. Soldiers' Home Grounds. This tunnel, approximately 10 feet wide, 9 feet high, and 4 miles long, starts at an elevation of 70 57/100 feet at the west connecting shaft of the Georgetown Reservoir, attains a depth of minus 29 45/100 feet under Rock Creek, rises again to an elevation of minus 14 23/100 feet at the east working shaft of the McMillan Park Reservoir and has along its line four shaft for making repairs, cleaning, etc., and three shafts for ventilation.

The McMillan Park Reservoir, total capacity 264,800,000 gallons, available capacity 179,500,000 gallons, with a flow line at 145 feet, is the last of the three reservoirs for the storage of raw water. The banks of this reservoir are lined from the floor to the top with stone. Total water in storage undergoing sedimentation is 630,900,000 gallons, of which amount

453,500,000 gallons, or approximately one week's supply under normal conditions, is available for use.

At the Washington Filtration Plant the water is lifted from that reservoir about 21 feet by means of three Worthington centrifugal pumps, each with a daily capacity of 40,000,000 gallons, directly connected to Harrisburg engines installed in the Pumping Station, and distributed to the 29 filter beds, each with a filter area of 1 acre. Here the water is filtered by the slow sand method. The water, settling through 4 feet of sand and gravel, is clarified of its impurities and sediment and then flows by gravity to the filtered-water reservoir in the Filtration Plant, flow line at 162 feet. This reservoir, like the filter beds, is entirely covered with earth over a groined-arched concrete roof and has a total capacity of 15,000,000 gallons, all of which is available. Besides the Pumping Station at the Washington Filtration Plant, there is also a sand-washing and storage system, a laboratory for testing water, and the necessary piping and valves for carrying the water and controlling the rates of filtration.

The filtered water now passes under the McMillan Park Reservoir through four 48-inch cast-iron pipes to the East Shaft Gate House on the west side of the reservoir, where the flow line is reduced to 147 feet above mean tide by means of controlling valves in the outlet mains from the filtered-water reservoir.

Up to this point the water, conduit, tunnel, reservoirs, purification plant, and everything pertaining to the supply and purification systems is the property of the United States Government and is under the supervision of the U. S. Engineer Corps, but from here on the water and all the properties pertaining to its distribution are owned by the District of Columbia, and are under the care of the Water Department.

Fifty-five and five-tenths per cent of the water flows by gravity through two 48-inch cast-iron trunk mains directly to the service water mains which supply the consumers in those parts of the city having ground elevations between 0 and 70 feet above mean tide level. The balance of the water flows by gravity through two 48-inch cast-iron trunk mains to the District Pumping Station, located on Bryant Street, N. W., between

2d and 4th Streets and just south of the McMillan Park Reservoir, where it is pumped to the higher elevations of the District. Daily average consumption of the gravity service is 30,453,000 gallons. The maximum pressure for this service is 60 pounds per square inch, the minimum pressure is 26 pounds per square inch, and the general pressure is between 45 and 50 pounds per square inch.

The pumped area is divided into the first high, second high, third high, and fourth high services, which supply those portions of the District west of the Anacostia River between the elevations of 70 and 140 feet, 140 and 210 feet, 210 and 350 feet, and 350 and 423 feet respectively.

The first high service is direct pumpage. There are no reservoirs on this service, the supply being controlled by automatic governing devices on the pumps to give a constant hydraulic head of 210 feet above mean tide level. Two pumping engines, each with a capacity of 20,000,000 gallons in 24 hours, supply the first high service; 31 33/100 per cent of the total filtered water goes to this service through a 48-inch cast-iron trunk main. Daily average consumption of the first high service is 17,332,000 gallons. Maximum pressure 65 pounds per square inch, minimum pressure 26 pounds per square inch, general pressure between 50 and 55 pounds per square inch.

The second high service is pumped through a 36-inch cast-iron trunk main to the Brightwood Reservoir, an equalizing reservoir with concrete floor and walls, having a capacity of 30,000,000 gallons, all of which is available, and a flow line at 276 feet. One pumping engine, capacity 12,000,000 gallons in 24 hours, supplies the second high service; 9 95/100 per cent of the total water goes to this service. Daily average consumption of the second high service is 5,506,000 gallons. Maximum pressure on this service is 81 pounds per square inch, minimum pressure 22 pounds per square inch, general pressure 40 pounds per square inch.

The third high service is pumped to the Reno Reservoir. This reservoir is similar in its functions and construction to the Brightwood Reservoir, and has a total available capacity of 4,500,000 gallons, with a flow line at 423 feet. One pumping engine, with a capacity of 2,500,000 gallons in

24 hours, supplies the third high service; 2 91/100 per cent of the total water is pumped to this service and is supplied through two 12-inch cast-iron trunk mains reduced from a 30-inch and a 20-inch main. Daily average consumption of the third high service is 1,607,000 gallons. The maximum pressure is 117 pounds per square inch, minimum pressure 24 pounds per square inch, general pressure between 50 and 60 pounds per square inch. There is one pumping engine, capacity 5,000,000 gallons in 24 hours, used as an auxiliary engine for the second and third high services.

Part of the water of the Reno Reservoir is lifted by means of auxiliary pumps, located at the reservoir in the Reno Pumping Station, to a steel tank in the Reno Tower, capacity 83,500 gallons, flow line at 485 feet. The water thus used constitutes the fourth high service and serves a territory of about 1½ square miles, constituting the highest ground in the District, through a 12-inch cast-iron trunk main. About 28/100 per cent of the total water goes to this service. Daily average consumption of the fourth high service is 152,000 gallons. The maximum pressure taken at the street level on fire hydrants is 69 pounds per square inch, minimum pressure is 28 pounds per square inch, and the general pressure is 40 pounds per square inch.

The gravity service from the city also supplies a portion of the territory east of the Anacostia River, lying between elevations of 0 and 70 feet through a 70-inch cast-iron trunk main. The maximum pressure on this service taken at the street level on fire hydrants is 50 pounds per square inch, the minimum pressure is 19 pounds per square inch, and the general pressure between 40 and 45 pounds per square inch.

Besides the gravity service, there were created in July, 1913, two new pumped services, which are termed the first and second high services, Anacostia, D. C. The water flows by gravity from the city to the Anacostia Pumping Station, situated at 18th Street and Minnesota Avenue, S. E. From here the first high service is pumped through 20-inch and 12-inch cast-iron trunk mains to two steel water towers with a capacity of 140,000 gallons each, one located at 13th and R streets, S. E., and the other at 11th Place and Alabama Avenue, S. E., each having a flow line of 246 feet. These two towers serve that area lying between the elevations of 70 and 170 feet above mean tide. About 48/100 per cent of the total water goes to this service. Daily average consumption of the first high service is 267,000 gallons. The maximum pressure taken at the street level on fire hydrants is 91 pounds per square inch, minimum pressure 19 pounds per square inch, and the general pressure between 40 and 55 pounds per square inch.

The second high service is pumped through a 12-inch cast-iron trunk main to a third steel water tower with a capacity of 140,000 gallons and flow line at 350 feet, situated on the Stanton School Grounds, 25th Street south from Good Hope Road, S. E. This tower supplies that area lying between the elevations of 170 and 310 feet, the highest ground in the District east of the Anacostia River. Daily average consumption of the second high service is small at the present time, and is included in the figure of the first high service, Anacostia, D. C. The maximum pressure taken at the street level on the fire hydrants is 103 pounds per square inch, the minimum pressure 32 pounds per square inch.

STATISTICAL

Ownership: Supply, U. S. Government under U. S. Engineer Corps. Distribution, Water Department of District of Columbia.
Source: Potomac River at Great Falls.
Fire Hydrants: 3166.
Mains.
- Length, miles: 574.
- Diameter, inches: 3 to 75.
- Pressure.
  - House, lbs.: 22 to 117.
  - Fire, lbs.: 22 to 117.
  - Daily capacity of pumps, gallons: 120,000,000.

Daily consumption, gallons: 57,282,000.
Percentage of population supplied: 100.
Reserve storage: 630,900,000 gallons.

PUBLIC SUPPLIES OF EASTERN AND SOUTHERN MARYLAND

CECIL COUNTY

Elkton

Ownership: Maryland Water Company of Cecil County.
Source: Stream, Big Elk Creek.
Waterworks.
  From what distributed: Reservoir.
  Elevation above source, feet: 145.
  Average elevation above town, feet: 145.
  How carried to reservoir: Pumped.
  Capacity of reservoir, gallons: 730,000.
  Fire hydrants: 56.
  Mains.
    Length, miles: 5½.
    Diameter, inches: 4, 6, and 8.
    Pressure.
      House, lbs.: 65.
      Fire, lbs.: 65.
      Daily capacity of pump, gallons: 1,200,000.
Percentage of population supplied: 75.

Perryville

Ownership: Perryville Water Compsny.
Source: Springs.
Waterworks.
  From what distributed: Reservoir.
  Elevation above source, feet: Level.
  Average elevation above town, feet: 300.
  How carried to reservoir: Gravity.
  Capacity of reservoir, gallons: 2,000,000.
  Fire hydrants: 11.
  Mains.
    Pressure.
      House, lbs.: 60.
      Fire, lbs.: 60.
Percentage of population supplied: 100.

Rising Sun

Ownership: Rising Sun Water Company.
Source: Wells.
Wells.
  Number: 4.
  Diameter, inches: 6.
  Depth, feet: 105-166.
Waterworks.
  From what distributed: Standpipe.
  Elevation above source, feet: 55.
  Average elevation above town, feet: 55.
  How carried to reservoir: Pumped.
  Capacity of reservoir, gallons: 60,000.
  Fire hydrants: 24.
  Mains.
    Length, miles: 1¾.
    Diameter, inches: 4, 6, and 8.
    Pressure.
      House, lbs.: 45.
      Fire, lbs.: 45.
Daily consumption, gallons: 25,000.
Percentage of population supplied: 75.

KENT COUNTY

Chestertown

Ownership: Municipality.
Source: Wells.
Wells.
  Number: 14.
  Diameter, inches: 4½ to 8.
  Depth, feet: 58 to 70.
Waterworks.
  From what distributed: Tank.
  Elevation above source, feet: 114.
  Average elevation above town, feet: 114.
  How carried to tank: Pumped.
  Capacity of tank, gallons: 100,000.
  Fire hydrants: 51.
  Mains.
    Diameter, inches: 3 to 6.
    Pressure.
      House, lbs.: 75.
      Fire, lbs.: 80.
      Daily capacity of pump, gallons: 410,000.
Daily consumption, gallons: 200,000.
Percentage of population supplied: 65.

Tolchester Beach

Ownership: Tolchester Company.
Source: Wells.
Wells.
  Number: 14.
  Diameter, inches: Dug.
  Depth, feet: 18 to 40.
Waterworks.
  From what distributed: Tsnk.
  Elevation above source, feet: 75.
  Average elevation above town, feet: 75.
  How carried to tank: Pumped.
  Capacity of tank, gallons: 12,000.
  Fire hydrants: 12.
  Mains.
    Length, miles: 6.
    Diameter, inchea: 1¼ and 2.
    Pressure.
      House, lbs.: 45.
      Fire, lbs.: 45.
      Daily capacity of pump, gallons: 432,000.
Daily consumption, gallons: 6000.
Percentage of population supplied: 100.

QUEEN ANNE'S COUNTY

Centerville

Ownership: Municipality.
Source: Wells.
Wells.
  Number: 2.
  Diameter, inches: 10.
  Depth, feet: 428.
Waterworks.
  From what distributed: Standpipe.
  Elevation above source, feet: 100.
  Average elevation above town, feet: 150.
  How carried to reservoir: Pumped.
  Capacity of reservoir, gallons: 58,640.
  Fire hydrants: 27.
  Mains.
    Diameter, inches: 6 and 8.
    Pressure.
      House, lbs.: 40 to 60.
      Fire, lbs.: 40 to 60.
      Daily capacity of pump, gallons: 300,000.
Daily consumption, gallons: 200,000.
Percentage of population supplied: 100.

CAROLINE COUNTY

Denton

Ownership: Municipality.
Source: Wells.
Wells.
  Number: 2.
  Diameter, inches: One 8 and 6; one 6 and 4½.
  Depth, feet: 285 and 270.
  Head, feet: one —11, one flows.
Waterworks.
  From what distributed: Tank.
  Elevation above source, feet: 75.
  Average elevation above town, feet: 75.
  How carried to reservoir, etc.: Pumped.
  Capacity of reservoirs, etc., gallona: 40,000.
  Fire hydrants: 23.
  Maina.
    Diameter, inches: 4, 6, and 8.
    Pressure.
      House, lbs.: 45.
      Fire, lbs.: 45.
Daily consumption, gallons: 33,000.
Percentage of population supplied: 65.

Federalsburg

Ownership: W. H. Davis.
Source: Wells.
Wells.
  Number: 2.
  Diameter, inches: 2.
  Depth, feet: 265.
  Head, feet: Flows.
Waterworks.
  From what distributed: Tank.
  Elevation above source, feet: 60.
  Average elevation above town, feet: 60.
  How carried to reservoir, etc: Pumped.
  Capacity of reservoirs, etc., gallons: 10,000.
  Fire hydrants: 4.
  Mains.
    Length, miles: .75.
    Diameter, inches: 1½, 2, and 6.
    Pressure.
      House, lbs.: 25.
      Fire, lbs.: 25.
      Daily capacity of pumps, gallons: 33,600.
Daily consumption, gallons: 30,000.
Percentage of population supplied: 65.

Greensboro

Ownership: C. D. Jarmian.
Source: Well.
Well.
  Number: 1.
  Diameter, inches: 6.
  Depth, feet: 160.
  Head, feet: Flows.
Waterworks.
  From what distributed: Tank.
  Elevation above source, feet: 85.
  Average elevation above town, feet: 55.
  How carried to reservoir, etc.: Pumped.
  Capacity of reservoir, etc.; gallons: 12,000.
  Fire hydrants: 4.
  Mains.
    Length, miles: 1.
    Diameter, inches: 2½.
    Pressure.
      House, lbs.: 27.
      Fire, lbs.: 27.
Daily consumption, gallons: 8000.
Percentage of population supplied: 15.

Ridgely

Ownership: Municipality.
Source: Wells.
Wells.
  Number: 12.
  Diameter, inches: 2.
  Depth, feet: 65-80.
Waterworks.
  From what distributed: Tank.
  Elevation above source, feet: 80.
  Average elevation above town, feet: 80.
  How carried to reservoir, etc.: Pumped.
  Capacity of reservoir, etc., gallons: 6500.
  Fire hydrants: 40?
  Mains.
    Diameter, inches: 4, 6, and 8.

Pressure.
House, lbs.: 45.
Fire, lbs.: 45.
Daily capacity of pump, gallons: 21,000.
Daily consumption, gallons: 20,000.
Percentage of population supplied: 10.

TALBOT COUNTY

Easton

Ownership: Municipality.
Source: Wells.
Wells.
Number: 7.
Diameter, inches: Six 6-inch; one 10-inch.
Depth, feet: 100 and 1012.
Waterworks.
From what distributed: Standpipe.
Elevation above source, feet: 110.
Average elevation above town, feet: 100.
How carried to reservoir: Pumped.
Capacity of reservoir, gallons: 87,000.
Fire hydrants: 44.
Mains.
Length, miles: 6.
Diameter, inches: 2, 4, 6, and 8.
Pressure.
House, lbs.: 50.
Fire, lbs.: 50.
Daily capacity of pump, gallons: 430,000.
Daily consumption, gallons: 250,000.
Percentage of population supplied: 85.

Oxford

Ownership: Municipality.
Source: Well.
Well.
Number: 1.
Diameter, inches: 4½.
Depth, feet: 360.
Waterworks.
From what distributed: Pumped by hand as needed.
Remarks: Well clogged up.

St. Michaels

Ownership: Municipality.
Source: Well.
Well.
Number: 1.
Diameter, inches: 6.
Depth, feet: 200.
Waterworks.
From what distributed: Tank.
Elevation above source, feet: 165.
Average elevation above town, feet: 165.
How carried to reservoir: Pumped.
Capacity of reservoir, gallons: 65,000.
Fire hydrants: 20.
Mains.
Pressure.
House, lbs.: 45.
Fire, lbs.: 45.
Daily capacity of pump, gallons: 216,000.
Daily consumption, gallons: 20,000.
Percentage of population supplied: 40.

DORCHESTER COUNTY

Cambridge

Ownership: Dorchester Water Company.
Source: Wells.
Wells.
Number: 6.
Diameter, inches: 8 to 12.
Depth, feet: 365.
Head, feet: Flow.
Waterworks.
From what distributed: Standpipe.
Elevation above source, feet: 120.
Average elevation above town, feet: 100.
How carried to reservoir, etc.: Pumped.
Capacity of reservoir, gallons: 143,000.
Fire hydrants: 40.
Mains.
Length, miles: 11.
Diameter, inches: 4 to 10.
Pressure.
House, lbs.: 54.
Fire, lbs.: 54.
Daily consumption, gallons: 400,000.
Percentage of population supplied: 90.
Remarks: Supply decreased.

East New Market

Ownership: Municipality.
Source: Well.
Well.
Number: 1.
Diameter, inches: 6.
Depth, feet: 290.
Waterworks.
From what distributed: Tank.
How carried to reservoir, etc.: Pumped.
Capacity of reservoir, gallons: 25,000.
Fire hydrants: 2.
Percentage of population supplied:
Remarks: Installed in July, 1916.

Hurlock

Ownership: W. C. Bradley.
Source: Wells.
Wells.
  Number: 13.
  Diameter, inches: 1½ and 1¼.
Waterworks.
  From what distributed: Tank.
  Elevation above source, feet: 56.
  Average elevation above town, feet: 56.
  How carried to reservoir, etc.: Pumped.
  Capacity of reservoir, gallons: 12,000.
  Fire hydrants: 9.
  Mains.
    Length, miles: 1.
    Diameter, inches: 3 and 4.
    Pressure.
      House, lbs.: 23.
      Fire, lbs.: 60.
      Daily capacity of pump, gallons: 268,000.
Daily consumption, gallons: 20,000.
Percentage of population supplied: 35.

WICOMICO COUNTY

Delmar

Ownership: Delmar Water Company.
Source: Wells.
Wells.
  Number: 3.
  Diameter, inches: 3 and 4½.
  Depth, feet: 85 to 140.
Waterworks.
  From what distributed: Standpipe.
  Elevation above source, feet: 115.
  Average elevation above town, feet: 115.
  How carried to reservoir: Pumped.
  Capacity of reservoir, gallons: 100,000.
  Fire hydrants: 43.
  Mains.
    Diameter, inches: 4, 6, and 8.
    Pressure.
      House, lbs.: 43.
      Fire, lbs.: 43.
Daily consumption, gallons: 60,000.
Percentage of population supplied: 75.

Salisbury

Ownership: Salisbury Water Company.
Source: Wells.
Wells.
  Number: 10.
  Diameter, inches: 3 and 4½.
  Depth, feet: 50 to 80.
Waterworks.
  From what distributed: Standpipe.
  Elevation above source, feet: 112.
  Average elevation above town, feet: 112.
  How carried to reservoir: Pumped.
  Capacity of reservoir, gallons: 100,000.
  Fire hydrants: 48.
  Mains.
    Diameter, inches: 4, 6, and 8.
    Pressure.
      House, lbs.: 55.
      Fire, lbs.: 55.
      Daily capacity of pump, gallons:
Daily consumption, gallons: 200,000.
Percentage of population supplied: 30.

WORCESTER COUNTY

Berlin

Ownership: Municipality.
Source: Wells.
Wells.
  Number: 4.
  Diameter, inches: 4½ and 8.
  Depth, feet: 100.
Waterworks.
  From what distributed: Standpipe.
  Elevation above source, feet: 125.
  Average elevation above town, feet: 125.
  How carried to reservoir: Pumped.
  Capacity of reservoir; gallons: 115,000.
  Mains.
    Pressure.
      House, lbs.: 54.
      Fire, lbs.: 75.
Daily consumption, gallons: 50,000.
Percentage of population supplied: 40.

Ocean City

Ownership: Municipality.
Source: Wells.
Wells.
  Number: 3.
  Diameter, inches: 6.
  Depth, feet: 125 and 300.
Waterworks.
  From what distributed: Standpipe.
  Elevation above source, feet: 125.
  Average elevation above town, feet: 125.
  How carried to reservoir: Pumped.
  Capacity of reservoir, gallons: 65,000.
  Fire hydrants: 100?
Daily consumption, gallons: 150,000, summer.
Percentage of population supplied: 85.

Pocomoke City

Ownership: Municipality.
Source: Wells.
Wells.
  Number: 6.
  Diameter, inches: 4½ to 12.
  Depth, feet: 130.
Waterworks.
  From what distributed: Standpipe.
  Elevation above source, feet: 108.
  Average elevation above town, feet: 108.
  How carried to reservoir: Pumped.
  Capacity of reservoir, gallons: 86,000.
  Fire hydrants: 43.
  Mains.
    Length, miles: 6.
    Diameter, inches: 4, 6, and 8.
    Pressure.
      House, lbs.: 50.
      Fire, lbs.: 50.
Daily consumption, gallons: 85,000.
Percentage of population supplied: 80.

Snow Hill

Ownership: Municipality.
Source: Wells.
Wells.
  Number: 2.
  Diameter, inches: 8 and 6.
  Depth, feet: 267 and 340.
Waterworks.
  From what distributed: Standpipe.
  Elevation above source, feet: 110.
  Average elevation above town, feet: 95.
  How carried to reservoir: Pumped.
  Capacity of reservoir, gallons: 25,700.
  Fire hydrants: 40.
  Mains.
    Diameter, inches: 3 to 6.
    Pressure.
      House, lbs.: 35.
      Fire, lbs.: 35.
Percentage of population supplied: 60.

SOMERSET COUNTY

Crisfield

Ownership: Municipality.
Source: Wells.
Wells.
  Number: 2.
  Diameter, inches: 6.
  Depth, feet: 225 and 1028.
  Head, feet: Flow.
Waterworks.
  From what distributed: Standpipe.
  Elevation above source, feet: 100.
  Average elevation above town, feet: 100.
  How carried to reservoir: Pumped.
  Capacity of reservoir, gallons: 150,000.
  Mains.
    Diameter, inches: 4, 6, and 8.
    Pressure.
      House, lbs.: 25.
      Fire, lbs.: 46.
      Daily capacity of pump, gallons: 96,000.
Daily consumption, gallons: 60,000.
Percentage of population supplied: 20.
Remarks: Will have to increase supply.

Princess Anne

Ownership: Municipality.
Source: Wells.
Wells.
  Number: 8.
  Diameter, inches: 2.
  Depth, feet: 50.
Waterworks.
  From what distributed: Standpipe.
  Elevation above source, feet: 110.
  Average elevation above town, feet: 110.
  How carried to reservoir: Pumped.
  Capacity of reservoir, gallons: 75,000.
  Fire hydrants: 27.
  Mains.
    Length, miles: 1½.
    Diameter, inches: 4 and 6.
    Pressure.
      House, lbs.: 40.
      Fire, lbs.: 40.
Percentage of population supplied: 65.
Remarks: Two wells used in emergencies.

ANNE ARUNDEL COUNTY

Annapolis

Ownership: Municipality.
Source: Stream, branch of Broad Creek.
Waterworks.
  From what distributed: 2 reservoirs.
  Elevation above source, feet: 80.
  Average elevation above town, feet: 200.
  How carried to reservoirs: Pumped.
  Capacity of reservoirs, gallons: 7,500,000.
  Fire hydrants: 59.
  Mains.
    Length, miles: 18.
    Diameter, inches: 4 to 16.
    Pressure.
      House, lbs.: 25 to 50.
      Fire, lbs.: 25 to 50.
      Daily capacity of pump, gallons: 2,000,000.

Daily consumption, gallons: 1,500,000.
Percentage of population supplied: 100.
Remarks: Five wells used in extreme drought.

East Brooklyn

Ownership: Martin Wagner Company.
Source: Wells.
Wells.
  Number: 3.
  Diameter, inches: 6, 6, and 8.
  Depth, feet: 100, 170, and 200.
  Head, feet: — 7.
Waterworks.
  From what distributed: Tank.
  Elevation above source, feet: 60.
  Average elevation above town, feet: 60.
  How carried to tank: Pumped.
  Capacity of tank, gallons: 20,000.
  Fire hydrants: 12.
  Mains.
    Length, miles: 1.
    Diameter, inches: ¾ to 4.
    Pressure.
      House, lbs.: 75.
      Fire, lbs.: 75.
      Daily capacity of pump, gallons: 100,000.
Daily consumption, gallons: 40,000.
Percentage of population supplied: 100.

Glenburnie

Ownership: Curtis Creek Manufacturing and Mining Company.
Source: Well.
Well.
  Number: 1.
  Diameter, inches: 6.
  Depth, feet: 65.
  Head, feet: — 28.
Waterworks.
  From what distributed: Tank.
  Elevation above source, feet: 40.
  Average elevation above town, feet: 40.
  How carried to tank: Pumped.
  Capacity of tank, gallons: 10,000.
  Fire hydrants: 2.
  Mains.
    Length, miles: 1/5.
    Diameter, inches: 2.
    Pressure.
      House, lbs.: 60.
      Fire, lbs.: 60.
      Daily capacity of pump, gallons: 25,000.
Daily consumption, gallons: 1000.
Percentage of population supplied: 5.
Remarks: Supply just being installed when figures were secured.

South Baltimore

Ownership: Brooklyn and Curtis Bay Light and Water Company.
Source: Wells.
Wells.
  Number: 9.
  Diameter, inches: 6 and 8.
  Depth, feet: 109 to 400.
Waterworks.
  From what distributed: Standpipe.
  Elevation above source, feet: 100.
  Average elevation above town, feet: 85.
  How carried to standpipe: Pumped.
  Capacity of standpipe, gallons: 100,000.
  Fire hydrants: 35.
  Mains.
    Length, miles: 2.
    Diameter, inches: 4 to 8.
    Pressure.
      House, lbs.: 85.
      Fire, lbs.: 85.
      Daily capacity of pump, gallons: 1,008,000.
Daily consumption, gallons: 1 to 300,000.
Percentage of population supplied: 100.

PRINCE GEORGE'S COUNTY

Hyattsville

Ownership: Municipality.
Source: Wells.
Wells.
  Number: 6, 50 ft. apart.
  Diameter, inches: Two 8, four 6.
  Depth, feet: 218, 212, four 242.
  Head, feet: Flow slightly.
Waterworks.
  From what distributed: Tank.
  Elevation above source: 185.
  Average elevation above town, feet: 180.
  How carried to reservoir: Pumped.
  Capacity of reservoir, gallons: 100,000.
  Mains.
    Length, miles: 5.
    Diameter, inches: 4, 6, and 8.
    Pressure.
      House, lbs.: 60.
      Fire, lbs.: 60.
      Daily capacity of pump, gallons: 500,000.
Daily consumption, gallons: 110,000.
Percentage of population supplied: 100.
Remarks: Will add new pumping station.

Laurel

Ownership: Municipality.
Source: Spring-fed lake.

Waterworks.
From what distributed: Standpipe.
Elevation above aource, fect: 50.
Average elevation above town, feet: 70.
How carried to reservoir: Pumped.
Capacity of rservoir, gallons: 150,000.
Fire hydranta: 40.
Mains.
Length, miles: 8.
Diameter, inches: 6 and 8.
Pressure.
House, lba.: 70.
Fire, lbs.: 70.
Daily capacity of pump, gallons: 1,000,000.
Daily consumption, gallons: 80,000.
Percentage of population supplied: 75.
Remarks: Will add new filtration plant, settling tank, and aand filter.

Takoma Park

Ownership: Municipality.
Source: Stream, Sligo Creek.
Waterworks.
From what distributed: Tank.
Elevation above source: 170.
Average elevation above town, feet: 140.
How carried to reaervoir: Pumped.
Capacity of reservoir, gallona: 50,000.
Fire hydrants: 60.
Mains.
Length, milea: 5.
Diameter, inches: 4 to 6.
Pressure.
House, lbs.: 90.
Fire, lbs.: 90.
Daily capacity of pump, gallons: 770,000.
Daily consumption, gallons: 100,000.
Percentage of population supplied: 75.

CHARLES COUNTY

La Plata

Ownership: Municipality.
Source: Well.
Well.
Number: 1.
Diameter, inches: 6.
Depth, feet: 560.
Head, feet: — 125.
Remarka: Incomplete.

PUBLIC SUPPLIES OF CENTRAL MARYLAND

HARFORD COUNTY

Aberdeen

Ownership: Municipality.
Source: Spring.
Waterworks.
From what distributed: Standpipe.
Elevation above source, feet: 44.
Average elevation above town, feet: 110.
How carried to reaervoir: Pumped.
Capacity of reaervoir, gallons: 50,000.
Fire hydrants: 32.
Mains.
Length, milca: 2.
Diameter, inches: 4, 6, and 8.
Pressure.
House, lbs.: 50 to 60.
Fire, lbs.: 50 to 60.
Daily consumption, gallons: 50,000.
Percentage of population supplied: 90.
Remarks: Will probably drill a well to supplement the spring.

Belair

Ownership: Belair Water and Light Company.
Source: Wallis Spring and wells.
Wells.
Number: 2.
Diameter, incbes: 6.
Depth, feet: 300 and 333.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: — 6.
Average elevation above town, feet: 97.
How carried to reservoir: Gravity and pumped.
Capacity of reaervoir, gallons: 1,300,000.
Fire hydrants: 40.
Mains.
Length, miles: 3.
Diameter, inchea: 4 and 8.
Pressure.
House, lbs.: 42.
Fire, lba.: 42.
Daily consumption, gallons: 270,000.
Percentage of population aupplied: 100.

Havre de Grace

Ownership: Havre de Grace Water Company.
Source: Stream, Susquehanna River.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: 245.
Average elevation above town, feet: 220.
How carried to reservoir: Pumped.
Capacity of reservoir, gallons: 6,000,000.
Fire hydrants: 56.
Mains.
Diameter, inchea: 4 to 10.

Pressure.
House, lbs.: 100.
Fire, lbs.: 100.
Daily consumption, gallons: 300,000.
Percentage of population supplied: 90.

Cardiff

Ownership: Delta, Pennsylvania.
Source: Wells.
Wells.
Number: 2.
Diameter, inches: 6.
Deptb, feet: 200 and 230.
Waterworks.
From what distributed: Two tanks.
Elevation above aource, feet: 15.
How carried to tanks: Pumped.
Capacity of tanks, gallons: 50,000 each.
Fire hydrants: None.
Mains.
Pressure.
House, lbs.: 100.
Fire, lbs.: 100.
Daily consumption: Supplies 50 people in Cardiff.

BALTIMORE COUNTY

Eastern District

Ownersbip: Baltimore County Water and Electric Company.
Source: Stream, Herring Run.
Waterworks.
From what distributed: 4 reservoirs, 2 standpipes.
Elevation above aource, feet: 90 to 500.
Average elevation above town, feet: 90 to 500.
How carried to reservoira: Pumped and gravity.
Capacity of reservoirs, etc., gallons: 94,000,000 and 385,000.
Fire hydrants: 439 (includes those in Western and Northern Districts).
Mains.
Length, miles: 145 (includea Western and Northern Districts).
Diameter, inches: 1 to 20.
Pressure.
House, lbs.: 20 to 300.
Fire, lbs.: 20 to 300.
Daily capacity of pumps, gallons: 10,000,000.
Daily consumption, gallons: 5,500,000.
Percentage of population supplied: 40.

Western and Northern Districts

Ownership: Baltimore County Water and Electric Company.
Source: Stream, Patapsco River.
Waterworks.
From what distributed: 2 reservoirs, 2 standpipes.
Elevation above aource, feet: 90 to 500.
Average elevation above town, feet: 90 to 500.
How carried to reservoirs: Pumped and gravity.
Capacity of reservoira, etc., gallons: 12,400,000.
Fire hydrants: 439 (includea those in Northern District).
Mains.
Lengtb, miles: 145 (includes Northern District).
Diameter, inches: 1 to 20.
Pressure.
House, lbs.: 20 to 300.
Fire, lbs.: 20 to 300.
Daily capacity of pumps, gallons: 10,000,000.
Daily consumption, gallons: 1,250,000.
Percentage of population supplied: 40.

Arlington

Ownership: The Suburban Water Company.
Source: Wells.
Wells.
Number: 7.
Diameter, inches: 8.
Depth, feet: 70 to 175.
Waterworks.
From what distributed: Standpipe and tank.
Elevation above source, feet: 20.
How carried to reservoir, etc.: Pumped.
Capacity of reservoira, etc., gallons: 100,000.
Fire hydrants: 18.
Mains.
Length, miles: 12.
Diameter, inches: 1 to 8.
Pressure.
House, lbs.: 60.
Fire, lbs.: 60.
Daily capacity of pumps, gallons: 500,000.
Daily consumption, gallons: 300,000.
Percentage of population supplied: 75.

Howard Park

Ownership: The Artesian Water Company.
Source: Wells.

Wells.
Number: 5.
Diameter, inches: 6.
Depth, feet: 117 to 200.
Waterworks.
From what distributed: Tank.
Elevation above source, feet: 90.
Average elevation above town, feet: 80.
How carried to reservoir, etc.: Pumped.
Capacity of reservoirs, etc., gallons: 50,000.
Fire hydrants: 18.
Mains.
Length, miles: 8.
Diameter, inches: 4 to 6.
Pressure.
House, lbs.: 30.
Fire, lbs.: 30.
Daily capacity of pumps, gallons: 180,000.
Daily consumption, gallons: 72,000.
Percentage of population supplied: 96.

Roland Park

Ownership: The Roland Park Water Company.
Source: Springs and wells.
Wells.
Number: 25.
Diameter, inches: 6.
Depth, feet: 95 to 500.
Waterworks.
From what distributed: 2 reservoirs, 2 standpipes.
Elevation above source, feet: 160.
Average elevation above town, feet: 220.
How carried to reservoir, etc.: Pumped.
Capacity of reservoirs, etc., gallons: 142,000 and 400,000.
Fire hydrants: 120.
Mains.
Length, miles: 17½.
Diameter, inches: 4 to 10.
Pressure.
House, lbs.: 32 to 107.
Fire, lbs.: 32 to 107.
Daily consumption, gallons: 243,000.
Percentage of population supplied: 100.

OARROLL COUNTY

New Windsor

Ownership: Municipality.
Source: Springs on Parrs Ridge.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: Level.
Average elevation above town, feet: 75.
How carried to reservoir: Gravity.
Capacity of reservoir, gallons: 350,000.
Fire hydrants: 32.
Mains.
Length, miles: 4.
Diameter, inches: 4, 6, and 8.
Pressure.
House, lbs.: 60.
Fire, lbs.: 65.
Daily consumption, gallons: 50,000.
Percentage of population supplied: 100.

Taneytown

Ownership: Municipality.
Source: Wells.
Wells.
Number: 2.
Diameter, inches: 6.
Depth, feet: 127 and 187.
Waterworks.
From what distributed: Standpipe.
Elevation above source, feet: 80.
Average elevation above town, feet: 30.
How carried to reservoir: Pumped.
Capacity of reservoir, gallons: 57,562.
Fire hydrants: 41.
Mains.
Diameter, inches: 4, 6, and 8.
Pressure.
House, lbs.: 35.
Fire, lbs.: 35.
Daily capacity of pump, gallons: 143,000.
Daily consumption, gallons: 18,000.
Percentage of population supplied: 50.

Union Bridge

Ownership: Union Bridge Water Company.
Source: Wells.
Wells.
Number: 5.
Diameter, inches: 6.
Depth, feet: 50 to 464.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: 135.
Average elevation above town, feet: 100.
How carried to reservoir: Pumped.
Capacity of reservoir, gallons: 425,000.
Fire hydrants: 21.
Mains.
Length, miles: 2¼.
Diameter, inches: 4, 6, and 8.
Pressure.
House, lbs.: 60.
Fire, lbs.: 80.
Daily capacity of pump, gallons: 504,000.

Daily consumption, gallons: 150,000.
Percentage of population supplied: 100.

Westminster

Ownership: Consolidated Public Utilities Company.
Source: Springs snd wells.
Wells.
Number: 24.
Diameter, inches: 8.
Depth, feet: 50 to 350.
Waterworks.
From what distributed: 2 reservoirs.
Elevation shove source, feet: 150.
Average elevation ahove town, feet: 25.
How carried to reservoir: Pumped.
Capscity of reservoirs, gallons: 1,000,000 each.
Fire hydrants: 125.
Mains.
Length, miles: 19¾.
Diameter, inches: 1 to 10.
Pressure.
House, lhs.: 60.
Fire, lhs.: 110.
Daily capacity of pump, gallons: 576,000.
Daily consumption, gallons: 350,000.
Percentsge of populstion supplied: 100.
Remarks: Filtrstion plant to he installed.

HOWARD COUNTY

Ellicott City

Ownership: Ellicott City Wster Company.
Source: Wells.
Wells.
Number: 3.
Dismeter, inches: 6¾.
Depth, feet: 265, 268, and 303.
Waterworks.
From whst distrihuted: 2 reservoirs.
Elevation above source, feet: 150.
Average elevstion ahove town, feet: 125.
How carried to reservoirs: Pumped.
Cspacity of reservoirs, gallons: 196,000.
Fire hydrants: 6.
Mains.
Length, miles: 2.
Dismeter, inches: 1½ to 6.
Pressure.
House, lhs.: 50.
Fire, lhs.: 50.
Daily cspscity of pump, gsllons: 216,000.
Daily consumption, gallons: 60,000.
Percentage of population supplied: 40.

MONTGOMERY COUNTY

Rockville

Ownership: Municipality.
Source: Wells.
Wells.
Numher: 3.
Dismeter, inches: Two 8-inch, one 6-inch.
Depth, feet: 225 and 281.
Waterworks.
From whst distributed: Stsndpipe.
Elevstion shove source:
Aversge elevstion above town, feet: 180.
How carried to reservoir: Pumped.
Capscity of reservoir, gallons: 52,000.
Fire hydrsnts: 36.
Mains.
Length, miles: 4.
Pressure.
House, lhs.: 40 to 80.
Fire, lhs.: 40 to 80.
Daily capacity of pump, gallons: 100,000.
Daily consumption, gallons: 40,000.
Percentage of populstion supplied: 100.

FREDERICK COUNTY

Braddock Heights

Ownership: Brsddock Heights Water Company.
Source: 2 springs and well.
Wells.
Number: 1.
Diameter, inches: 8.
Depth, feet: 530.
Waterworks.
From what distrihuted: Tank and storage reservoir.
Elevation shove source, feet: 275.
Average elevation above town, feet: 150.
How carried to reservoir, etc.: Pumped.
Capacity of reservoir, gallons: 9,000 (tsnk); 70,000 (reservoir).
Fire hydrants: 19.
Mains.
Length, miles: 2.
Diameter, inches: 2, 4, and 6.
Pressure.
House, lhs.: 14 to 52.
Fire, lhs.: 14 to 52.
Daily capscity of pump, gsllons: 504,000.
Daily consumption, gallons: 40,000 summer; 8000 winter.
Percentsge of populstion supplied: 100.

Brunswick

Ownership: Municipality.
Source: Well.
Well.
Number: 1.
Diameter, inches: 8.
Depth, feet: 315.
Head, feet: Flow.
Waterworks.
From what distributed: Tank and reservoir.
Elevation above source, feet: 100.
Aversge elevation above town, feet: 100.
How carried to reservoir, etc.: Pumped.
Capscity of reservoir, gallons: 80,000 (tank): 240,000 (reservoir).
Fire hydrants: 39.
Msins.
Length, miles: 4.
Diameter, inches: 4, 6, and 8.
Pressure.
House, lbs.: 75.
Fire, lbs.: 75.
Daily consumption, gallons: 55,000.
Percentage of population supplied: 50.
Remarks: Well does not supply enough water.

Burkittsville

Ownership: Burkittsville Water Company.
Source: Springs.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: —10.
Elevation above town, feet: 225.
How carried to reservoir, etc.: Gravity.
Capacity of reservoir, gallons: 10,000.
Fire hydrants: None.
Mains.
Lengtb, miles: 1¼.
Diameter, inches: 4.
Pressure.
House, lbs.: 100.
Fire, lbs.: 100.
Daily consumption, gallons: 10,000.
Percentage of population supplied: 40.

Emmitsburg

Ownership: Emmitsburg Water Company.
Source: Springs.
Waterworks.
From what distributed: 2 reservoirs.
Average elevation above town, feet: 265.
How carried to reservoir, etc.: Gravity.
Capacity of reservoir, gallons: 1,000,000.
Fire hydrants: 20.
Mains.
Length, miles: 5.
Diameter, inches: 4 and 6.
Pressure.
House, lbs.: 86.
Fire, lbs.: 86.
Daily consumption, gallons: 50,000.
Percentage of population supplied: 100.

Frederick

Ownersbip: Municipality.
Source: Springs and streams on Catoctin Mountain.
Waterworks.
From what distributed: 2 reservoirs.
Elevation above source, feet: —135.
Average elevation above town, feet: 66.
How carried to reservoir: Gravity.
Capacity of reservoir, gallons: 12,000,000.
Fire hydrants: 172.
Mains.
Length, miles: 28.
Diameter, inches: 10 and 12.
Pressure.
House, lbs.: 40.
Fire, lbs.: 40.
Daily consumption, gallons: 800,000.
Percentage of population supplied: 100.

Middletown

Ownership: Municipality.
Source: Spring on Catoctin Mountain.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: —362.
Average elevation above town, feet: 98.
How carried to reservoir: Gravity.
Capacity of reservoir, gallons: 650,000.
Fire hydrants: 23.
Mains.
Length, miles: 4½.
Diameter, inches: 4 and 6.
Pressure.
House, lbs.: 14.
Fire, lbs.: 14.
Daily capacity of pumps, gallons: 86,400.
Daily consumption, gallons: 8000.
Percentage of population supplied: 100.

Thurmont

Ownership: Mechanicstown Water Company.
Source: Stresm, Higb Run Creek, and 6 springs.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: —600.
Average elevation above town, feet: 300.
How carried to reservoir: Gravity.

Capacity of reservoir, gallons: 600,000.
Fire hydrants: 23.
Mains.
Length, miles: 8½.
Diameter, inches: 4 and 6.
Pressure.
House, lbs.: 80.
Fire, lbs.: 80.
Daily consumption, gallons: 100,000.
Percentage of population supplied: 90.

Walkersville

Ownership: Walkersville Water Company.
Source: Springs and streams.
Waterworks.
From what distributed: Reservoir.
Average elevation above town, feet: 140.
How carried to reservoir: Gravity.
Capacity of reservoir, gallons: 1,500,000.
Fire hydrants: 27.
Mains.
Length, miles: 6.
Diameter, inches: 4, 6, and 8.
Pressure.
House, lbs.: 38.
Fire, lbs.: 58.
Daily consumption, gallons: 10,000.
Percentage of population supplied: 90.

PUBLIC SUPPLIES OF WESTERN MARYLAND

ALLEGANY COUNTY

Cumberland

Ownership: Municipality.
Source: Stream, Evitts Creek in Pennsylvania.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: —29.
Average elevation above town, feet: 250.
How carried to reservoir, etc.: Gravity.
Capacity of reservoir, etc., gallons: 5,000,000.
Fire hydrants: 250.
Mains.
Diameter, inches: 12 to 36.
Pressure.
House, lbs.: 110.
Fire, lbs.: 110.
Daily consumption, gallons: 8,000,000.
Percentage of population supplied: 100.

Frostburg

Ownership: Municipality.
Source: Mountain springs on Savage Mountain.
Waterworks.
From what distributed: 4 reservoirs.
Elevation above source, feet: —100.
How carried to reservoirs, etc.: Gravity and pumped.
Capacity of reservoir, etc., gallons: 3,250,000.
Fire hydrants: 63.
Mains.
Length, miles: 7.
Diameter, inches: 2 to 10.
Pressure.
House, lbs.: 70.
Fire, lbs.: 70.
Daily consumption, gallons: 400,000.
Percentage of population supplied: 100.

Lonaconing

Ownership: Lonaconing Water Company.
Source: Mountain streams (Koontz Run, Orr's Run, Jackson's Run).
Waterworks.
From what distributed: 2 reservoirs.
Elevation above source: Below.
Average elevation above town, feet: 300 and 500.
How carried to reservoirs: Gravity.
Capacity of reservoirs, gallons: 4,000,000.
Fire hydrants: 35.
Mains.
Length, miles:
Diameter, inches: 4 to 12.
Daily consumption, gallons: 150,000.
Percentage of population supplied: 100.

Midland

Ownership: Midland-Elk Lick Water Company.
Source: Stream, Elk Lick Run.
Waterworks.
From what distributed: Reservoir.
Elevation above source: Below.
Average elevation above town, feet: 200.
How carried to reservoir: Gravity.
Capacity of reservoir, gallons: 3,000,000.
Fire hydrants: 10.
Mains.
Diameter, inches: 2 to 12.
Pressure.
House, lbs.: 90.
Fire, lbs.: 90.
Percentage of population supplied: 85.

Mt. Savage

Ownership: Union Mining Company.
Source: Springs and wells.
Wells.
Number: 4.
Diameter, inches: 6.
Depth, feet: 30, 40, 80, and 100.
Waterworks.
From what distributed: Reservoir.
Elevation above source: Level.
Average elevation above town, feet: 300.
How carried to reservoir: Gravity.
Capacity of reservoir, gallons: 10,000.
Fire hydrants: 1.
Mains.
Diameter, inches: 2 and 3.
Percentage of population supplied: 60.

Luke—Westernport

Ownership: Piedmont, West Virginia.
Source: Stream, Savage River.
Waterworks.
From what distributed: Reservoir.
Average elevation above town, feet: 275.
How carried to reservoir: Gravity.
Capacity of reservoir, gallons: 500,000.
Fire hydrants: 40.
Mains.
Diameter, inches: 2 to 10.
Pressure.
House, lbs.: 105.
Fire, lbs.: 105.
Daily capacity of pump, gallons: 2,150,000.
Daily consumption, gallons: 300,000.
Percentage of population supplied: 75.

GARRETT COUNTY

Deer Park

Ownership: Baltimore and Ohio Railroad Company.
Source: "Boiling Spring."
Waterworks.
From what distributed: 2 tanks.
Elevation above source, feet: —120.
Average elevation above town, feet: 170.
How carried to tanks: Gravity.
Capacity of tanks, gallons: 50,000 each.
Fire hydrants: 25.
Mains.
Diameter, inches: 4 and 6.
Pressure.
House: lbs.: 90 to 100.
Fire, lbs.: 90 to 100.
Daily consumption, gallons: 100,000.
Percentage of population supplied: 100.
Remarks: Furnished free.

Mountain Lake Park

Ownership: Mountain Lake Water and Light Company.
Source: Spring.
Waterworks.
From what distributed: Direct from spring.
Average elevation above town, feet: 110.
How carried: Gravity.
Fire hydrants: 3.
Mains.
Length, miles: 3.
Diameter, inches: 6.
Daily consumption, gallons: 200,000.
Percentage of population supplied: 100.

Oakland

Ownership: Municipality.
Source: Wells.
Wells.
Number: 4.
Diameter, inches: 8.
Depth, feet: 150 to 250.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: 200.
Average elevation above town, feet: 150.
How carried to reservoir: Pumped.
Capacity of reservoir, gallons: 312,000.
Fire hydrants: 40.
Mains.
Diameter, inches: 4, 6, and 8.
Pressure.
House, lbs.: 100.
Fire, lbs.: 100.
Daily capacity of pump, gallons: 125,000.
Daily consumption, gallons: 20,000.
Percentage of population supplied: 75.

WASHINGTON COUNTY

Blue Ridge Summit

Ownership: Blue Ridge Water Company.
Source: Wells.
Wells.
Number: 2.
Diameter, inches: 6.
Depth, feet: 512 and 100.
From what distributed: Reservoir.
Waterworks.
Elevation above source, feet: 31.
Average elevation above town, feet: 200.
How carried to reservoir: Gravity.

Capacity of reservoir, gallons: 150,000.
Fire hydrants: 1.
Mains.
Length, miles: 3.
Diameter, inches: 2 and 4.
Daily consumption, gallons: 20,000.
Percentage of population supplied: 100.

Boonsboro

Ownership: Boonsboro Water Company.
Source: Springs on South Mountain.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: Level.
How carried to reservoir: Gravity.
Fire hydrants: 25.
Mains.
Pressure.
House, lbs: 120.
Fire, lbs.: 120.
Percentage of population supplied: 90.

Hagerstown

Ownership: Washington County Water Company.
Source: Spring on South Mountain.
Waterworks.
From what distributed: 3 reservoirs.
Elevation above source, feet: Below.
Average elevation above town, feet: 134.
How carried to reservoir: Gravity.
Capacity of reservoir, gallons: 40,000,000.
Fire hydrants: 216.
Mains.
Length, miles: 65.
Diameter, inches: 4 to 20.
Pressure.
House, lbs.: 55.
Fire, lbs.: 55 to 85.
Daily consumption, gallons: 3,250,000.
Percentage of population supplied: 100.
Remarks: Will add new reservoir.

Hancock

Ownership: Municipality.
Source: Well.
Well.
Number: 1.
Diameter, inches: 8.
Depth, feet: 440.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: 200.
Average elevation above town, feet: 200.
How carried to reservoir: Pumped.
Capacity of reservoir, gallons: 300,000.
Fire hydrants: 22.
Mains.
Length, miles: 3.
Diameter, inches: 4 to 8.
Pressure.
House, lbs.: 86.
Fire, lbs.: 86.
Daily consumption, gallons: 15,000.
Percentage of population supplied: 35.

Pen Mar

Ownership: Western Maryland Railroad Company.
Source: Glen Afton Spring.
Waterworks.
From what distributed: Reservoir.
Elevation above source, feet: Level.
Average elevation above town, feet: Below.
How carried to reservoir: Pumped.
Capacity of reservoir, gallons: 500,000.
Fire hydrants:
Mains.
Length, miles: 2.
Diameter, inches: ¾ to 4.
Pressure.
House, lbs.: 120.
Fire, lbs.: 120.
Daily capacity of pump, gallons:
Daily consumption, gallons: 60,000.
Percentage of population supplied: 100.

PUBLIC SUPPLIES OF DELAWARE

According to the census of 1910 there is in Delaware only one city (Wilmington) with over 5000 inhabitants, and only three others (Dover, Milford, and Newcastle) with over 2500. All of these, especially Wilmington, are larger in 1917 than in 1910, but the fact that the population is rural or in small towns and not congested in cities renders the development of municipal water plants comparatively small, except in Wilmington. Fourteen towns or municipalities have some sort of public supply. Most of these are based on wells tapping the underground supply, but two at least utilize surface waters.

BRIDGEVILLE has a little municipal water plant which consists of a series of 3-inch wells driven to a depth of 100 feet and yielding from 80 to 100 gallons per minute per well. The water is rather soft, of good taste, but giving more or less evidence of iron.

DELAWARE CITY has a water system which is reported to be supplied from springs occurring at the base of the Wicomico. This supply may be augmented by water drawn from shallow wells in the Talbot terrace.

DOVER has a series of wells from 4 to 12 inches in diameter and from 145 to 196 feet deep. The water horizon is probably in the lower Calvert formation (Miocene). Most of the wells are flowing wells with a head of from 1 to +6 feet. By pumping they may yield 200 to 300 gallons per minute per well. The "direct-pressure" system is used, by which the water is conveyed directly to the consumer without the intervention of standpipe or tank reservoir. According to Matson the water horizons of the Calvert did not give sufficient water, and they are now using shallow wells.

MIDDLETOWN.—The supply is from a series of wells varying from 6 to 10 inches in diameter and from 88 to 1478 feet in depth. Some of the wells have been abandoned on account of quicksands at 538 and 820 feet. The deepening of wells below 820 feet shows no additional water horizons, and most of the water is now derived from higher levels. The water is abundant and of good quality.

MILFORD.—The supply comes from a series of artesian wells which flow from three horizons at depths of 40 to 45, 185 to 190, and 210 to 229 feet below the surface, with a head approximately 8 feet above the surface. The waters from the 40-foot and 200-foot horizons are almost chemically pure, while that from the intervening horizon is highly impregnated with magnesia and lime. The deeper strata give an ample supply of water, but the upper ones less.

NEWARK.—The geological conditions are rather unfavorable on account of the fine sand encountered, the restricted character of the catchment basin, and the irregularity of the water-bearing strata overlying the crystalline rocks. Two shallow wells at depths of 40 and 75 feet together pump 250 gallons per minute which is hardly sufficient. The water is said to be soft and to rise in the well to within 8 feet of the surface. A special report on the water supply of Newark, including private wells and municipal supply, was published by the Delaware Board of Health in 1904. A series of analyses of the water from the public well covering the period September, 1903, to April, 1904, showed the following range in parts per million:

Temporary hardness	15–25
Permanent hardness	118–168
Chlorine	36–41
Free ammonia	.014–.028
Albuminoid ammonia	.012–.031
Nitrites	.003–.040
Nitrates	12.5–25.

The normal chlorine content is stated to be about 38. The bacterial content per cubic centimeter varied from 12 to 36.

NEWCASTLE.—The reports from Newcastle differ widely. One correspondent states: "The main supply is pumped from a small stream about 2 miles north of the city, and this stream of water cannot be otherwise than polluted on account of cattle wading through and other contaminating influences." The supply is not abundant, and the water shortage, with its consequent increase in fire risks and likelihood of epidemics, is a serious menace to the town's development. The Delaware Water Improvement Company furnishes water to the Pennsylvania Railroad on the Newcastle cut-off north of Newcastle from a standpipe 110 feet high, 20 feet in diameter, and 49 pounds pressure, and the supply is said to be "unlimited."

REHOBOTH has no public supply, but the hotels are supplied by private wells about 100 feet deep. The supply of water appears to be ample, but the porous character of the soil and the shallowness of the wells make them susceptible to contamination.

SMYRNA is supplied by shallow wells, chiefly one large one 15 feet in diameter and perhaps twice as deep. The water is conveyed to a standpipe and distributed by a piping system.

WILMINGTON.—The water supply of Wilmington is drawn from the Brandywine River, the present intake being 4800 feet upstream from the pumping station.

The first use of the Brandywine dates from 1827, when water was pumped from an intake near the present pumping station to a 1,000,000-gallon reservoir on the present site of the court-house, and a large (Cool Spring) low-service reservoir of 40,000,000 gallons capacity in 1873-77.

With the improvements made up to date, the system consists of pumping the raw water from a preliminary filter plant on 16th Street to the Porter reservoirs (elevation 286-256 feet, capacity 35,000,000 gallons), thence by gravity to slow sand filter and filtered-water reservoir situated beneath the filter beds (elevation 256 feet), thence pumped to Rockford standpipe (elevation 320-250 feet), or by gravity to Rodney Street[1] (elevation 245 ± feet) and Cool Spring (elevation 145 feet).

On the basis of 12,000,000 gallons daily supply the approximate division is as follows:[2]

	Gallons
Rockford Tower	300,000
Rodney Street	4,000,000
Weldin Farm (Porter)	2,700,000
Cool Spring	5,000,000
	12,000,000

The average daily consumption in 1914-1915 was 9,729,290 gallons.

The average daily consumption per capita (95,000 population) was 102 gallons. At the same rate with the present population the average daily consumption approximates 11,000,000 gallons.

Quality.—The water is drawn from the Brandywine which heads in Pennsylvania some 35 miles above the intake, and from a drainage area of approximately 335 square miles, two-thirds of which is in Pennsylvania beyond the control of the city authorities. The water as it enters the intake is therefore likely to be hygienically unsafe for drinking purposes. Since the introduction of means for bacterial removal, however, the typhoid death rate has been reduced to 12 per 100,000 (in 1913).

[1] Nearing completion, June, 1917.
[2] From report of Grow Fuller, 1916.

	The Average Bacteria Per C. C.		*B. Coli-communis* in Ice; Positive Presumptive Tests	
	High Service	Low Service	High Service	Low Service
1913–1914	.45	1.462	1.3%	4.9%
1914–1915	.24	1.449	1.0%	3.4%

Examinations of the effluent from filtration plant after treatment showed ½ per cent *Coli-communis,* or practically 100 per cent removal.

COMPLETE SANITARY EXAMINATIONS OF THE WATER SHOWN IN PARTS PER MILLION

	Creek		Effluent	
	I	II	I	II
Taste	None	Earthy	None	None
Odor	None	Earthy	None	None
Color	18.00	20.00	5.00	3.00
Sediment	Small	Small	None	None
Turbidity	8.00	8.50	None	None
Free Ammonia	.0840	.0700	.0100	.0160
Alb. Am.	.0960	.1040	.0420	.0440
Chlorine	11.00	8.00	10.00	7.00
Nitrogen as Nitrates	1.50	.80	2.00	1.00
Nitrogen as Nitrites	.006	.018	None	.001
Required Oxygen	2.00	1.75	1.15	.85
Hardness, soap test	65.80	44.80	61.60	42.00
Alkalinity	50.00	38.00	45.00	35.00
Carbon Dioxide	2.00	1.00	3.00	2.00
Iron	.60	.40	Trace	.20
Total Solids	123.00	113.00	95.00	93.00
Loss on Ign.	60.00	70.00	45.00	43.00
Bacteria per c. c.	3500.00	4000.00	26.00	11.00
B. *Coli-communis* 1 c. c.	5.5%	5.5%	0.5%	0.5%

I = August 10, 1914. II = May 5, 1915.

THREE ANALYSES OF THE COMBINED EFFLUENT IN PARTS PER MILLION

	8/11/13	8/10/14	5/19/15
SiO_2	8.40	5.86	6.33
Al_2O_3	.66	.33	.38
Fe_2O_3	.14	Trace	.28
MgO	1.91	3.73	2.71
CaO	22.50	26.50	20.83
Na_2O	7.00	8.74	12.28
SO_3	7.13	9.98	7.14
CO_2	13.50	19.80	15.40
Cl	8.00	10.00	7.00

NEWCASTLE COUNTY

Place	Turb.	Color	Odor	Alb. am.	Free am.	Ni-trites	Ni-trates	Chl.	Total res.	MgO	CaO	SO_3	CO_2	Soda ash	Prob. inc.	Cl.	Fe.	MG.	CO_2
Middletown 5/20/95								6.8	177.4		Some	Little	Some		124.6			Little	
Middletown 6/20/95				.006	.02	0	0	7	117.9								Little		
535′ Middletown 4/3/97				.006	.01			7.1	’71.5	Small	Some	Some	Some	.066	143.6		Tr.		0
Middletown 11/1/97				Tr.		Tr.	10	7.1	148.6	Some	Some	Some	Some		133.5	Some			
Townsend 3/22/01	0							44.8	209.4	Some	Some	Some	Tr.		127.2		Tr.		
Townsend 7/19/02	0							47.8	229.3	0	Some	Some	Small	.38	103.1	Tr.			
Delaware City 10/30/98								56.4	250.1	Some	Tr.	Some	0		80.3		Little		0
Wilmington 4/10/94								41.7	2126.2		Some	Some			1926.1		Very large		
Raw 10/8/14	8.00	18.0	None	.096	.084	1.5	.006	11.0	123.				2.0				.60		
Raw 5/5/15	8.50	20.0	Earthy	.104	.07	.8	.018	8.0	113.				1.0				.40		
Filtered 11/8/14	None	5.0	None	.042	.010	2.0	None	10.0	95.				3.0				Tr.		
Filtered 5/5/15	None	5.0	None	.044	.016	1.0	.001	7.0	93.				2.0				.20		

KENT COUNTY

Place	Turb.	Alb. am.	Free am.	Nitrites	Ni-trates	Chl.	Total res.	MgO	CaO	SO_3	CO_2	Soda ash	Prob.	Cl.	Fe.	$MgCl_2$	$CaCl_2$
Clayton 20′ 10/19/96...	......	....	....	....	....	13.7	107.7	Some	Some	Some	0	....	59.8	......	......	......	......
Clayton 83′ 10/28/97...	Slight	.03	.026	0	0	7.1	133.9	......	......	......	......	....	......	......	......	......	......
Clayton 121′ 11/1/97....	Slight	.138	.014	0	.20	7.1	168.	Some	0	Some	0	....	155.4	Small	......	......	......
Clayton 100′ 11/1/97....	Some	.054	.016	0	.30	7.1	210.	Small	Much	Some	Tr.	....	199.3	Small	Some	......	......
Clayton 22′ 11/3/97....	......	.012	.024	Sl. tr.	3.40	27.8	159.9	Much	0	Some	Tr.	....	91.8	......	......	......	......
Clayton 83′ 11/3/97....	......	....	....	....	....	7.1	133.5	Some	......	Some	0	....	111.6	Small	......	......	......
Clayton 7/17/02....	......	....	....	....	....	21.1	110.9	0	Some	Some	0	.29	72.1	......	......	......	......
Dover 180′ 12/11/93.....	0	Tr.	Tr.	Tr.	.4	7.	186.	Tr.	......	Little	Cons.	....	160.	......	......	......	......
Dover 186′ 8/6/94.......	0	.010	Tr.	.148	Tr.	....	212.7	Little	......	Little	......	....	174.9	......	......	......	......
Dover 10/28/97.....	Some	.364	.150	Sm. amt.	1.10	31.4	243.9	......	......	......	......	....	......	......	......	......	......
Dover 17′ 11/3/97......	Slight	.110	.048	Sm. amt.	1.60	28.	145.9	Some	Much	Some	0	....	89.7	Some	Tr.	......	......
Dover 45′ 6/22/99......	......	....	....	....	....	17.1	129.2	Much	Some	Much	0	....	62.7	......	......	......	......
Dover 7/12/02......	0	....	....	....	....	23.9	......	Small	Some	Some	0	....	46.8	......	......	......	......
Harrington 16′ 10/28/97.	Slight	.034	.134	Tr.	8.56	45.1	213.9	Some	Some	Some	......	....	143.6	Tr.	......	......	......
Harrington 57′ 10/28/97.	Some	.082	.008	0	.86	7.1	80.	......	......	......	......	....	......	......	......	......	......
Harrington 18′ 3/7/98...	......	.038	.134	Sl. tr.	7.20	49.3	215.	Some	Some	Some	0	....	84.8	Some	......	......	......
Harrington 3/10/98..	......	....	....	....	....	32.8	197.7	0	Some	Some	0	.27	......	......	......	......	......
Harrington 7/9/02...	......	....	....	....	....	Tr.	175.4	Some	Some	Little	Some	....	49.0	......	Tr.	Small	Some
Milford 12/11/93.......	......	....	....	....	....	....	......	......	......	......	......	....	155.6	......	Little	......	......

SUSSEX COUNTY

Place	Turb.	Alb. am.	Free am.	Nitrites	Nitrates	Chl.	Total res.	MgO	CaO	SO_4	CO_2	Soda ash	Prob. inc.	Cl.	Fe.
Delmar 90' 7/17/99	0	....	....	....	....	10.2	96.9	0	Some	Much	0	.04	61.5	......	0
Delmar 90' 8/7/99	0	Tr.	....	0	1.1	10.3	97.4	......	......	......	......	....	......	......	0
Delmar 2/18/00	0	.028	.014	0	2.9	12.	163.	Some	Some	Some	......	....	64.9	Tr.	0
Delmar 7/19/02	0	....	....	....	....	8.0	112.1	Some	Some	Some	0	.15	66.0	......	Some
Ellendale 10' 10/28/97	......	....	....	....	....	7.0	131.4	Some	Some	Much	Small	....	75.7	Tr.	......
Ellendale 40-80' 8/3/98	None	Tr.	Tr.	Tr.	2.8	20.8	98.7	Some	Some	Some	0	....	39.6	......	......
Georgetown 40-80' 12/12/96	0	.004	.04	0	5.2	27.9	128.	Much	Some	Some	0	....	55.9	Some	......
Lewes 12/12/96	......	....	....	....	....	34.7	236.3	Some	Some	Some	Some	....	109.7	Some	......
Lewes 7/14/02	0	....	....	....	....	40.8	214.4	Some	Some	Some	Small	.55	94.2	Tr.	......
Seaford 7/9/02	0	....	....	....	....	7.0	57.4	Tr.	Some	Some	Small	0	38.3	Small	......

SANITARY AND CHEMICAL CHARACTER OF WATER

PURE WATER.—Since absolutely pure water is never found in nature, the term "pure water," so frequently used, implies little more than that the water is free from harmful constituents in the particular use to which it is put. Thus a "pure" water chemically may mean one containing no substances which would limit its suitability in the industrial use to which it is put. A water described as "pure" bacteriologically may be one free from harmful bacteria, but one carrying harmless bacteria, or impure chemically. Water free from bacteria may be "pure" but unpalatable. A potable or drinking water must not only be free from pollution but pleasing to the taste, because of its contained chemical salts or harmless organisms. A perfectly pure distilled water tastes flat and insipid, while water with impurities may be pleasing to the taste without being harmful. A water may be "pure" to the sanitary engineer if it is free from human or animal pollution.

The characteristics of "pure" water according to use may be summarized as follows:

Drinking.—Pleasant, potable, free from color or turbidity, not too hard, free from absorbed poisonous metals or disease-bearing organisms.

Domestic Use.—Such that it can be used for cooking and laundry, *i. e.*, relatively soft, unpolluted, free from iron which stains, or from soluble salts of lime or magnesia which require more soap and yield insoluble precipitates.

Manufacturing.—In the production of steam the water should be free from constituents causing "scale" or "foaming." Special industries such as brewing, dyeing, etc., have their own requirements as to water.

In general, the character of the water and its impurities differ according to the source—whether meteoric or ground.

Meteoric waters, including rain, snow, hail, or dew, vary with the season, physical conditions and location. Along the coast the rainwater contains more or less chlorine, due to the sodium chloride or salt carried inland from the sea. In the neighborhood of cities or manufacturing centers the air is full of various by-products, like carbon dioxide, ammonia, sulphuric acid, and other compounds which are absorbed by the rain in falling.

Ground water derived from wells and springs also varies with locality and depth. The rainwater as it enters the ground or seeps slowly through the more or less porous strata takes up many impurities which affect the appearance, odor, taste, or healthfulness, as it emerges in springs and shallow or deep wells. On first entering the ground the rain is freed from most of the impurities which it has absorbed in the air and in the course of its passage through the ground it takes up fine particles of clay, soluble compounds of iron, manganese, magnesia, and lime, organic material, often called "humus," or bacteria which affect its turbidity, odor or usefulness.

The organic matter of the ground water is usually either carbonaceous or nitrogeneous. The latter is more important since it is so closely associated with the life of the bacteria that the quantity present may be indicative of the bacterial content of the water. In general, the albuminoid ammonia is indicative of the living matter, the free ammonia and nitrites of the material which has been oxidized by the bacteria.

ODOR.—Although the good taste of water may be due in part to odors, the latter are so faint as to be unnoticeable. Waters when yielding an odor strong enough to be detected are usually unpalatable and possibly harmful. The various odors generally described and their probable causes may be summarized as follows:

Peaty, swamp-like or vegetable odor caused by vegetable matter in solution.

Moldy, musty, disagreeable or offensive odors caused by decomposition, or pollution by sewage. Unpleasant odor probably due to decomposition of vegetation, disagreeable odor due to decomposition of animal matter and offensive odors due to sewage or decomposition of minute fresh-water algæ ("pig-pen" odor). "Aromatic," "grassy," or "fishy" odors are probably due to microscopic organisms and are not necessarily indicative of pollution but show abundance of food substance in case of infection with pathogenic varieties.

TURBIDITY, due to suspended matter in the water, is measured by comparison of the depths to which a wire can be seen in the sample and in a standard suspension of fine diatomaceous earth, taken as 100. Turbidity following rains suggests surface sources, while that arising after standing may be due to the precipitation of iron or lime through loss of gas.

Bacteria are normally found to a greater or less degree in all surface and most ground waters. The number of bacteria in the water has only a general value as an indicator of its character. The presence of nitrites or even large numbers of bacteria are indicative of conditions favorable to the rapid growth of disease-producing bacteria, but the water may be harmless if the pathogenic germs are lacking.

In general, the number of bacteria in the ground or ground water decreases rapidly with depth. Near the surface in the woods there may be several million bacteria per c. c., and less than 100 per c. c. at depths of over 5 feet. From this it may be seen that uncontaminated waters from deep wells and wells of moderate depth should show few bacteria. This is borne out by the tables following.

HARDNESS.—Hard waters are those which cause precipitation of soap or irritation of the skin. They are usually unsuitable for washing, steam-making, etc. The hardness is due primarily to the presence of chemical substances which form insoluble compounds with the soap, or dyes in fabrics. Hardness which is lost on boiling the water is only temporary, since during boiling the bicarbonates are broken down and the carbonates present precipitated. Hardness which remains after boiling is permanent and is due to carbonates which remain in solution. The total hardness, temporary and permanent, may be expressed in several ways and in different scales, but the ideas of hardness vary in different parts of the country according to the general experience of the populations. Thus, water which would be called hard in the Piedmont district would be considered relatively soft in the Shenandoah Valley, which is underlain by limestone.

The scale of hardness used in this report is based on the parts of lime carbonate (including the magnesium carbonate) per million. In general, the hardness may be estimated according to the scale:

	P. p. m.	Grains per U. S. gal.
Very soft	0–70	0–4
Soft	70–150	4–9
Fair	150–250	9–14.6
Hard	250–400	14.6–23.3
Very Hard	Over 400	Over 23.3

Water analyses are of several parts, and have for their aim the determination of the healthful character and chemical composition.

The former are called sanitary analyses, the latter ultimate analyses. Through the courtesy of the State Department of Health the following tables of selected sanitary analyses are published to show the character of extensively-used waters from public and private supplies in different parts of the state. Although over a thousand such analyses have been studied it has seemed best to publish only those showing conditions during the last year or two. The use of "average" analyses, while of little or no technical value, has been found serviceable in presenting the general character of a given water supply.

Chlorine is generally present in variable proportions in both surface and ground waters. Some of it comes from the salt-bearing moist winds along the coast, some comes from mineral chlorides in the ground, and some from sewage or household waste. Because of its stability and the ease with which it permeates the ground, its presence in quantity has been used as an indicator of possible pollution. To use the chlorine content of water in this way it is necessary to know the "normal chlorine" value for the specific locality. While the distribution of these values seems to be reasonably regular in New England, a study of over 500 determinations from different parts in Maryland did not reveal any such general relationship, although there appear to be some local differences due to the character of the underlying geological formations. Even more marked is the increase in chlorine content with the depth of the wells. From this it is evident that the chlorine content is more influenced by its source than by surface contamination. A comparison of the chlorine content and the bacterial count shows no well-defined relationship of waters with high chlorine showing bacteria and others with less than part per million of chlorine showing thousands of bacteria per cubic centimeter. In general, if the chlorine runs over 5. p. p. m. the water should be watched unless its source is deep.

Nitrogen.—Since the sources of danger in waters are of organic nature, and the most dangerous are those resulting from decomposition of animal matter and human waste which carry nitrogeneous compounds, the determination of the amount of nitrogen present is of prime importance. This element is found in various combinations of different significance. The most commonly determined are ammonia, free or albuminoid, and nitrates or nitrites. The albuminoid and free ammonia, often associated or derived from sewage, represent the nitrogen in the earlier stages of decomposition, the nitrites and nitrates in compounds due to bacterial action. High content of albuminoid ammonia is indicative of surface pollution; a high ratio of albuminoid to free ammonia combined with low chlorides and nitrates characterizes vegetable pollution, while high free ammonia with an excess of chlorides suggests the presence of animal matter.

Nitrites and nitrates are of varying significance. Nitrites usually signify pollution and bacterial activity, and if present in considerable quantities (over .05 p. p. m.) are unfavorable symptoms. They may, however, be due to chemical reactions with the iron or similar mineral compounds. High nitrites combined with high free ammonia usually denote sewage pollution.

Nitrates are the more stable final products of decomposition and bacterial action which accumulate in the soil when not taken up by plants. Thus the nitrates, which may be relatively high in waters from deep wells, indicate a past pollution without present significance. If accompanied by free ammonia or considerable nitrites there is the suggestion of considerable animal matter which has not been thoroughly decomposed.

The constituents of normal waters vary from place to place in quantity and character, but it is probably safe to say that a water free from mineral and organic contamination should not show more than the following parts per million in the several determinations:

		P. p. m.
Total residue	less than	500
Lime and magnesium (Ca and Mg)	" "	150
Chlorine (Cl)	" "	25
Sulphates (SO_4)	" "	125
Nitrates	" "	5
Nitrites	" "	.01
Free ammonia	" "	10
Albuminoid ammonia	" "	.05

150 RECENT SANITARY ANALYSES SELECTED FROM RECORDS OF THE MARYLAND STATE DEPARTMENT OF HEALTH (PARTS PER MILLION)

PUBLIC WATER SUPPLY

Locality	Residue on Evaporation	Ammonia		Chlorine	Nitrogen as		Hardness	Alkalinity	Iron	Bacteria per c.c.	Remarks
		Free	Albuminoid		Nitrates	Nitrites					
Allegany County											
Lake Gordon Intake, Cumberland	121	.03	.08	2.83	1.30	.00	49	38	.02	5,879	Av. of 10.
Tapwater, Cumberland	110	.01	.06	2.41	.20	.00	52	47	Tr.	140	Av. of 6, 1915/16.
Springs 1-26, Frostburg	62	Tr.	.01	.62	.00	.00	64	39	Tr.	3	Av. of 26 Springs.
Tapwater, W. Md. R. R. Station, Frostburg	84	.03	.06	4.40	.15	.00	8	35	.00	14	
Elk Lick Run, Midland	44	.04	.04	1.80	.00	.00	20	10	.00	.....	
Savage River Intake, Westernport	56	.03	.06	1.10	.00	.00	20	12	.00	.....	1917.
Camp Meade, Anne Arundel County											
Dorsey River, above Lake Patuxent	98	.21	.12	12.50	.80	Tr.	13	16	1.60	2,220	1917.
Lake Patuxent, above Dorsey River	215	.04	.32	6.60	.50	Tr.	15	27	.70	93,300	1917.
Lake Patuxent, below Dorsey River	404	.04	.29	8.00	.30	Tr.	15	26	.60	4,883	1917.
Lake Patuxent, above Savage	220	.03	.19	5.60	.40	Tr.	16	34	.90	3,018	1917.
Annapolis, Res. No. 1	39	.01	.05	2.10	.00	.00	17	15	1.10	100	Av. of 3, 1916/17.
Annapolis, Res. No. 2	136	.07	.08	3.50	.03	.00	18	11	2.70	616	Av. of 3, 1916/17.
Annapolis, Res. No. 3	103	.05	.08	2.90	.05	.00	20	14	1.70	600	Av. of 2, 1916.
Baltimore District	*Bottled Waters and Private Water Cos.*										
Caton Spring Water Co	116	.00	.02	6.50	.30	.00	62	63	.00	521	Av. of 6, 1916.
Chattolanee Spring Water Co	129	.00	.01	2.20	.10	.00	46	80	.00	19	Av. of 5, 1916.
Gneiss Rock Water Co	77	.00	.00	2.40	Tr.	.00	34	39	.00	139	Av. of 4, 1916.
Brooklandwood Water Co	47	.00	.03	2.50	.00	.00	11	18	.00	4	Av. of 4, 1916.
Denmore Water Co	185	.00	Tr.	6.46	1.00	.00	84	85	.10	13	Av. of 7, 1916.
Suburban Water Co	179	Tr.	.01	7.00	1.90	.00	79	85	.20	7	Av. of 15, 1916/17.
Mountain Rock, Govans	52	.00	.02	6.95	.70	.00	16	5	.00	2	Av. of 1, 1916.
Howard Park Wells	147	.00	.02	3.60	.40	.00	44	86	.00	3	Av. of 4, 1916/17.
Purity Spring Water Co., Loreley	44	.00	.03	4.90	.10	.00	16	6	.00	15	Av. of 1, 1917.
Wells Combined, St. Helena	206	.48	.04	4.40	11.60	Tr.	108	10	.20	40	Av. of 1, 1916.
Wells Combined, Sudbrook Park	160	.00	.03	6.90	.90	....	38	48	.20	55	Av. of 5, 1916.
Roland Park Water Co	186	.01	.01	21.90	.60	.00	86	66	.01	33	Av. of 29, 1916/17.
Herring Run	121	.07	.09	10.60	.60	Tr.	45	42	.28	344	Av. of 5, 1916.

150 RECENT SANITARY ANALYSES SELECTED FROM RECORDS OF THE MARYLAND STATE DEPARTMENT OF HEALTH (PARTS PER MILLION)—Continued

PUBLIC WATER SUPPLY

Locality	Residue on Evaporation	Ammonia		Chlorine	Nitrogen as		Hardness	Alkalinity	Iron	Bacteria per c.c.	Remarks
		Free	Albuminoid		Nitrates	Nitrites					
Baltimore City											
Montebello Reservoir	57	.02	.04	1.70	.20	Tr.	72	37	1.00	535	Av. of 7, 1916/17.
Montebello Effluent Basin No. 1	100	.04	.06	3.20	.27	Tr.	37	43	1.00	39	Av. of 7, 1916.
Montebello Effluent Basin No. 2	103	.04	.04	3.20	.02	Tr.	40	53	1.06	28	Av. of 5, 1916.
Montebello Combined Effluent Untreated	96	.01	.04	3.50	.22	Tr.	41	49	.40	34	Av. of 7, 1916.
Montebello Combined Effluent Treated	110	.00	.01	3.30	.16	.00	56	44	.02	10	Av. of 6, 1916.
Clifton	91	.01	.04	3.80	.40	.00	39	48	.27	3	Av. of 7, 1916.
Hamden Intake	265	.00	.06	6.40	.18	.00	74	77	.40	45	Av. of 5, 1916.
Hamden Outlet	136	.02	.07	5.50	.28	Tr.	62	72	....	64	Av. of 5, 1916.
Hamden Gatehouse	135	.02	.08	5.10	.03	Tr.	63	71	.07	142	Av. of 8, 1916.
Caroline County											
New Well, Denton,	390	.25	.03	2.40	.10	.00	48	242	.20	3	1917.
Station 3, Wells (Comb.) Federalsburg	230	.14	.00	2.80	.00	.00	180	165	.00	840	1915.
Tap, Greensboro	506	.08	.01	5.75	.04	.00	60	405	.40	40	1916.
Pumping Station, Preston	124	.00	.00	12.00	8.45	.00	28	11.5	.00	5	1915.
Pumping Station, Ridgeley	104	.00	.00	13.80	4.00	.00	12	6	.10	20	1916.
Tap, Ridgeley	96	.00	.00	13.60	5.50	.00	20	6	.00	5	1916.
Carroll County											
Tap, New Windsor	128	.00	.03	3.60	2.00	.00	48	96	.00	150	1917.
Tap, Taneytown	152	.00	.04	5.00	.80	none	48	117	.00	20,000	1917.
Well No. 6, Union Bridge	60	.00	.02	73.60	7.00	absent	284	195	.00	120	1917.
Tap on Force Main, Union Bridge	578	.02	.02	74.60	6.00	absent	264	191	.00	20	1917.
Tap, W. Md. Station, Union Bridge	442	.00	.00	65.00	11.00	Tr.	264	194	.00	10	1916.
Reservoir Citizens Water Co., Westminster	68	.00	.01	2.80	.60	.00	...	....	....	15	1916.
Flohr Spg., Citz. Water Co., Westminster	52	.00	.01	2.50	.60	.00	...	....	....	5	1916.
Routzohn Well, Westminster Water Co	92	.01	.02	4.30	4.00	.00	...	....	....	10	1916.
Routzohn Well, Westminster Water Co	90	.00	.00	4.30	4.30	.00	48	22	.00	50	1917.
Tap, Old Supply, Westminster Water Co	70	.01	.03	3.40	2.90	.00	26	14	.01	70	Av. of 3, 1916/17.
Reservoir, Westminster Water Co	62	.01	.05	3.40	2.20	Tr.	28	15	.00	20	1917.
Cranberry Br., Westminster Water Co	278	.05	.23	3.60	.80	Tr.	36	26	1.60	....	Av. of 6, 1917.

150 RECENT SANITARY ANALYSES SELECTED FROM RECORDS OF THE MARYLAND STATE DEPARTMENT OF HEALTH (PARTS PER MILLION)—Continued

PUBLIC WATER SUPPLY

Locality	Residue on Evaporation	Ammonia		Chlorine	Nitrogen as		Hardness	Alkalinity	Iron	Bacteria per c. c.	Remarks
		Free	Albuminoid		Nitrates	Nitrites					
Cecil County											
Elk River	119	.01	.07	4.30	.70	Tr.	19	21	.60	1425	Av. of 4, 1916/17.
Reservoir, Elkton	150	.09	.19	5.10	.20	.00	54	18	1.10	160	Av. of 2, 1917.
Wells 1, 2 and 3 (Comb.), Elkton	84	.04	.04	7.00	.00	.00	32	24	.60	1	1917.
Tap in Elkton	80	.01	.07	7.90	.50	.00	....	....	....	110	Av. of 2, 1917.
Intake, Reservoir, Perryville	48	.03	.10	2.90	.00	Tr.	18	10	.20	248	Av. of 5, 1916/17.
Intake, Reservoir, Port Deposit	80	.04	.23	2.40	.40	Tr.	29	15	.20	103	Av. of 3, 1916/17.
Rock Run, Port Deposit	76	.00	.02	3.20	.30	.00	35	20	.00	308	Av. of 6, 1916.
Tap, Tome Inst., Port Deposit	67	.00	.05	2.70	.30	.00	28	14	.00	3	Av. of 2, 1916/17.
Tap, Rising Sun	29	.01	.05	2.60	1.10	Tr.	50	37	.01	....	Av. of 3, 1916/17.
Charles County											
Marshall Hall	126	.03	.00	5.20	2.00	Tr.	46	59	.30	....	Av. of 3, 1916.
Dorchester County											
East New Market	232	.02	.02	4.80	.00	Tr.	136	152	.20	15	1917.
B. C. & A. R. R., Hurlock	93	.00	.01	9.80	4.00	.00	20	9	.00	3	Av. of 2, 1916.
Frederick County											
M. F. Berely, Sabillasville	82	.00	.01	6.55	.10	.00	....	....	....	40	1916.
Springs, Braddock Heights	103	.00	.00	8.16	1.00	.00	60	28	....	22	Av. of 3, 1916.
Well, Brunswick	214	.00	.01	11.20	.00	Tr.	88	72	.00	5	1916.
Catoctin Creek, Brunswick	110	.00	.05	3.00	1.34	Tr.	65	25	Tr.	280	Av. of 4, 1915.
Little Catoctin Creek, Brunswick	107	.01	.05	13.00	1.30	Tr.	19	28	2.50	1912	1915.
Cool Spring, Burkittsville	44	.00	.05	2.60	.00	.00	52	5	.00	10	1916.
Reservoir, Emmittsburg	26	.00	.02	1.35	.00	.00	16	13	.00	1	1916.
Tap, B. & O. Yards, Frederick	26	.00	.01	1.30	.00	.00	16	5	.00	40	1916.
High Knob Spring, Middletown	52	.00	.00	1.80	.00	.00	44	47	.00	10	1916.
Reservoir, Middletown	54	.00	.01	1.80	.00	.00	32	21	.00	20	1916.
North Stream, Myersville	50	.00	.02	2.20	.00	.00	40	8	.30	200	1916.
South Stream, Myersville	44	.00	.08	1.70	.00	.00	8	7	.30	200	1916.
Reservoir, Thurmont	30	.00	.00	1.25	.00	.00	16	10	.00	20	

150 RECENT SANITARY ANALYSES SELECTED FROM RECORDS OF THE MARYLAND STATE DEPARTMENT OF HEALTH (PARTS PER MILLION)—Continued

PUBLIC WATER SUPPLY

Locality	Residue on Evaporation	Ammonia		Chlorine	Nitrogen as		Hardness	Alkalinity	Iron	Bacteria per c. c.	Remarks
		Free	Albuminoid		Nitrates	Nitrites					
Garrett County											
Reservoir, Oakland	94	.00	.00	2.90	1.0	Tr.	24	43	.0	....	1916.
Tap, Oakland	104	.00	.03	3.80	1.2	.00	28	38	.1	....	1917.
Sta. Well, Oakland	176	.08	.07	13.20	.0	.00	20	88	.4	....	1917.
Montgomery County											
Well, Bradley Hill	86	.00	.04	2.80	.0	.00	20	44	Tr.	20	1917.
Well No. 1, Sec. 4, Chevy Chase	122	.00	.07	9.30	5.5	none	52	45	2.0	0	1917.
Well No. 3, Sec. 4, Chevy Chase	76	.05	.12	4.30	.3	none	52	38	Tr.	1	1917.
Well No. 4, Sec. 4. Chevy Chase	100	.00	.05	3.80	.5	.00	28	40	.2	3	1917.
Well No. 7, Sec. 4, Chevy Chase	74	.00	.09	4.40	.0	.00	24	37	Tr.	0	1917.
Well No. 8, Sec. 4, Chevy Chase	76	.00	.13	4.20	.1	.00	40	55	.4	0	
Well No. 9, Sec. 4, Chevy Chase	64	.00	.07	4.30	.1	.00	44	37	Tr.	30	
Well No. 12, Sec. 4, Chevy Chase	82	.00	.03	4.20	.0	.00	4	51	.2	3	
Well No. 13, Sec. 4, Chevy Chase	64	.00	.05	5.30	.7	.00	8	28	Tr.	1	
Well No. 1-12, Sec. 4, Chevy Chase	90	.00	.07	5.60	1.4	.00	64	40	Tr.	....	
Well No. 1, Sec. 5, Chevy Chase	90	.00	.05	7.20	1.0	.00	4	38	Tr.	30	
Well No. 2, Sec. 5, Chevy Chase	86	.00	.11	7.50	1.0	.00	8	42	.1	2	
Well No. 1, Sec. 2, Chevy Chase	62	.00	.02	3.60	.2	.00	40	46	Tr.	70	
Well, Chevy Chase Park	87	.00	.05	3.45	.0	.00	6	36	Tr.	4	1917.
Reservoir, Glen Echo	118	.03	.05	4.80	.1	.00	28	14	1.2	100	
Well, Kembrouth	91	.00	.50	5.50	4.1	.00	12	18	Tr.	240	Av. of 2, 1917.
Wells 1 and 2 Combined, Kensington	82	.00	.03	2.90	1.0	.00	....	....	....	12	Av. of 2, 1917.
Well, Norwood Heights	409	.05	.08	81.00	17.0	Tr.	180	52	.6	....	Av. of 2, 1917.
Well No. 1, Rockville	90	.00	.03	9.70	.8	.00	56	41	.2	20	1917.
Well No. 2, Rockville	94	.00	.04	9.55	1.4	.00	8	26	.2	25	1917.
Well No. 1, Somerset	118	.00	.04	5.40	.3	.00	60	47	.4	15	1916.
Well No. 2, Somerset	152	.00	.00	4.20	.0	.00	120	98	.4	15	1916.
Well No. 3, Somerset	120	.00	.01	4.60	2.2	Tr.	24	50	Tr.	30	1917.
Filter Effluent, Takoma Park	60	.00	.04	3.30	.0	.00	16	12	.0	40	1917.
Tap, Force Main, Takoma Park	77	.00	.01	3.40	.2	.00	37	18	.1	391	Av. of 4, 1916.

150 RECENT SANITARY ANALYSES SELECTED FROM RECORDS OF THE MARYLAND STATE DEPARTMENT OF HEALTH (PARTS PER MILLION)—Continued

PUBLIC WATER SUPPLY

Locality	Residue on Evaporation	Ammonia		Chlorine	Nitrogen as		Hardness	Alkalinity	Iron	Bacteria per c. c.	Remarks
		Free	Albuminoid		Nitrates	Nitrites					
Prince Georges County											
Well, Brentwood	84	.00	.03	4.40	.0	.0	64	35	.20	2	1917.
Well, Cottage City	257	.00	.02	6.35	.0	.0	43	42	1.20	188	Av. of 4, 1916/17.
Teckwa Well, Hyattsville	76	.00	.01	8.00	.0	.0	40	8	3.00	8	1917.
Well, Hyattsville	111	.00	.05	11.80	.0	Tr.	40	41	1.30	22	Av. of 2, 1917.
Intake Reservoir, Laurel	65	.04	.09	3.00	Tr.	.0	31	10	.31	3912	Av. of 4, 1916.
Coagulated Reservoir, Laurel	70	.03	.07	4.26	.1	.0	40	4	.70	745	Av. of 7, 1916.
Effluent, Filter No. 1, Laurel	55	.02	.05	2.54	Tr.	.0	24	4	.10	1087	Av. of 6, 1916/17.
Effluent, Filter No. 2, Laurel	54	.03	.05	2.60	.01	.0	19	3	.30	55	Av. of 7, 1916/17.
Spring, Mt. Ranier	52	.00	.04	3.30	2.1	.0	7	11	Tr.	24	Av. of 3, 1917.
Well No. 1, Riverdale	56	.00	.01	7.05	.1	.0	20	10	.30	cont.	Av. of 2, 1916/17.
Well No. 2, Riverdale	115	.00	.01	6.39	.1	.0	34	52	1.70	cont.	Av. of 3, 1916/17.
Queen Anne County											
Well, Centerville	212	.50	.08	2.30	.0	.0	44	138	.20	60	1917.
Tap, Centerville	213	.50	.05	2.30	.1	.0	48	140	.20	37	Av. of 2, 1917.
Well, Love Point	162	.00	.03	12.60	.5	.0	4	10	1.80	10	1917.
M. D. & V. R. R., Love Point	255	.02	.03	43.80	1.2	Tr.	24	40	.20	25	Av. of 2, 1917.
Somerset County											
Well No. 1, Crisfield	1120	1.50	.07	37.80	.1	.0	124	419	.20	10	1917.
Well No. 3, Crisfield	1088	.70	.00	13.40	.2	.0	12	704	.10	2	1916.
Well No. 6, Crisfield	129	.75	.04	14.70	.2	Tr.	47	793	.10	10	Av. of 2, 1916/17.
Tap in Tower, Princess Anne	140	.02	.02	18.70	.3	.0	32	37	1.40	30	1917.
70-foot Well No. 1, Princess Anne	284	.00	.01	41.90	6.0	.0	124	96	.40	0	1916.
55-foot Well No. 2, Princess Anne	104	.01	.01	7.75	.1	.0	16	36	1.20	5	1916.

150 RECENT SANITARY ANALYSES SELECTED FROM RECORDS OF THE MARYLAND STATE DEPARTMENT OF HEALTH (PARTS PER MILLION)—Continued

PUBLIC WATER SUPPLY

Locality	Residue on Evaporation	Ammonia		Chlorine	Nitrogen as		Hardness	Alkalinity	Iron	Bacteria per c. c.	Remarks
		Free	Albuminoid		Nitrates	Nitrites					
Talbot County											
Wells, Collecting Reservoir, Easton	278	.00	.07	8.60	.20	.00	16	31	.10	20	1917.
Tap, Collecting Reservoir, Easton	296	.00	.08	6.60	.10	.00	16	141	.80	20	1917.
Emergency Reservoir, Easton	338	.00	.07	11.00	.30	.00	16	129	1.20	200	1917.
Tap, St. Michaels	464	.37	.01	34.30	.30	Tr.	248	252	.80	50	1916.
B. C. & A., Claiborne	358	.17	.03	61.00	.10	Tr.	100	197	.30	28	Av. of 2, 1917.
Washington County											
Well No. 4, Blue Ridge Summit	32	.00	.00	2.95	.00	.00	48	9	.00	13	1916.
Reservoir, Boonsboro	42	.00	.00	1.65	.00	.00	24	12	.00	30	1916.
Intake, Antietam Company, Hagerstown	244	.05	.07	4.30	.60	Tr.	104	176	.70	200	1916.
Effluent, Filter Plant, Hagerstown	228	.04	.07	2.90	.50	.00	184	185	.44	35	1916.
Intake, Settling Dam, Hagerstown	66	.00	.07	2.25	.00	Tr.	24	21	.60	30	1916.
Outlet, Settling Dam, Hagerstown	77	.00	.04	1.76	.10	Tr.	27	22	.20	70	Av. of 3, 1916.
Diffendal Station, Hagerstown	52	.04	.05	2.45	.00	.00	8	10	.10	100	1917.
Tap, B. & O. Station, Hagerstown	58	.00	.01	1.85	.00	.00	28	23	.00	50	1916.
Tap, Pen Mar	54	.00	.01	2.55	.00	.00	20	19	.60	10	1916.
Wicomico and Worcester Counties											
Tap, Salisbury	164	.03	.05	22.90	3.50	.00	60	30	.20	10	1917.
Well, Berlin	84	.00	.02	11.90	3.60	.00	12	28	.20	5	1917.
Well, Ocean City	278	.36	.08	38.80	.10	.00	88	116	.60	208	Av. of 2, 1917.
Tap, Ocean City	298	.07	.06	36.60	.20	Tr.	180	173	6.00	250	1916.
Well, Pocomoke City	372	.45	.02	83.00	.00	.00	132	150	3.20	5	1917.
Tap, Pocomoke City	624	.50	.08	14.00	.00	.00	76	256	1.60	50	1917.
Well, Snow Hill	384	.18	.04	47.80	.00	Tr.	76	228	.40	30	1917.
Ice Plant, Snow Hill	96	.00	.03	7.30	2.40	.00	16	81	.10	5	1917.
Isle of Wight	5261	4.10	.19	26.51	.50	Tr.	463	488	3.30	5373	Av. of 3, 1916.

ANALYSES OF RESIDUES FROM MARYLAND WATERS MADE BY PENNIMAN & BROWNE FOR THE MARYLAND GEOLOGICAL SURVEY (PARTS PER MILLION)

Location	Number	SiO_2	Al_2O_3	Fe_2O_3	Mg	Ca	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	Turbidity	Alkalinity	Hardness	Suspended matter	Total dissolved solids	Source
Allegany Co.																			
Cumberland	54	10.2	.20	.01	27.8	122.4	10.6	....	....	264.8	189.5	10.4	15.8	20	22.0*	421.8	13.0	559.0	Brewery Well.
Cumberland	52	9.8	.20	.01	12.4	65.8	3.2	....	....	244.0	18.4	2.7	1.2	....	20.0	216.1	......	231.0	Dickens Run.
Cumberland	51	11.6	1.20	.01	6.0	48.6	4.4	....	....	154.9	16.7	3.2	13.2	....	12.7	146.5	......	168.4	Dye Works.
Cumberland	53	14.8	.20	.01	24.1	106.9	94.3	....	....	250.1	129.1	166.4	15.8	....	20.5	367.6	......	675.0	Brewery Well.
Cumberland	55	12.0	.40	.01	23.7	124.9	64.4	....	....	313.5	101.9	96.0	56.2	—10	25.7	412.0	4.4	634.0	Ice Plant.
Cumberland	47	21.4	1.00	.01	30.7	88.1	34.8	....	....	152.6	170.3	84.3	2.8	60	13.9	348.0	14.6	567.0	Hotel Well.
Cumberland	56	22.8	.70	.01	35.4	89.6	43.7	....	....	310.7	171.7	21.3	....	30	25.4	371.0	9.0	595.0	Silk Mills.
Cumberland	46	9.4	.20	.01	2.9	17.2	6.0	....	....	45.1	18.5	22.0	11.1	70	3.7	55.0	5.6	87.0	Water Works.
Evitts Creek	48	5.4	.40	.01	2.2	17.3	3.2	....	....	64.5	3.7	1.4	....	....	5.3*	52.3	......	62.0	Evitts Creek.
Frostburg	49	6.1	.40	.01	5.9	39.2	2.2	....	8.4	126.9	8.5	1.6	1.1	—10	11.1	120.5	2.8	129.0	Tap.
Lonaconing	43	8.0	.80	.01	2.4	8.0	3.2	....	....	36.6	3.6	1.0	1.1	20	3.0*	30.0	5.0	44.0	Pub. Supply.
Mt. Savage	44	8.6	.50	.01	14.2	13.6	3.8	....	....	72.0	7.4	2.5	2.3	20	5.9*	51.5	......	77.0	Pub. Supply.
Rice's Spring	..	11.2	.70	.01	4.4	40.3	3.7	....	....	134.2	11.9	1.6	1.7	....	11.0*	119.2	......	134.4	Rice's Spring.
Anne Arundel Co.																			
Annapolis	29	8.6	.50	Tr.	1.5	3.1	5.0	....	....	17.1	3.4	2.5	5.5	30.0	1.4*	14.0	10.5	41.2	Pub. Supply.
Brooklyn Water Co.	2	5.9	.16	.15	.4	1.3	2.2	....	....	7.2	......	3.1	Tr.	500	.6*	4.7	766.5	20.2	Wells.
Camp Parole	30	14.7	.70	Tr.	1.1	2.9	7.1	....	....	23.2	2.9	3.4	....	....	1.9*	12.0	......	42.2	Spring.
Eastport	19	10.7	3.90	2.35	5.4	18.9	2.8	....	....	39.0	43.4	2.3	....	100	32.0	69.8	......	112.0	Well.
Galloways	11	34.4	.40	.30	11.3	83.3	9.5	....	....	224.5	45.4	31.9	....	....	18.4	255.6	......	359.0	Art. Well.
Baltimore Co.																			
Fort Howard	3	9.5	.40	7.84	1.7	12.8	2.7	....	....	14.6	10.3	1.0	Tr.	70	1.2	14.2	12.0	47.0	Well.
Loch Raven	..	31.4	1.80	.01	3.9	18.3	13.0	....	....	92.6	4.9	3.3	3.3	70	7.6	62.0	45.4	115.0	Daily Sample, 5/1-6/1, '12
Patapsco River	..	27.6	1.40	.01	3.4	14.0	6.5	....	....	5.3	5.9	3.7	3.1	190	4.4	4.9	168.0	85.2	Daily Sample, 5/1-6/1, '12.
South Balto.	1	5.5	.48	.05	.6	1.2	2.5	....	....	7.2	......	2.5	3.3	....	.6	5.9	......	22.7	
Turner Sta.	61	8.4	6.60	.48	.9	2.0	4.6	....	....	12.2	4.9	3.6	....	....	1.0	8.7	......	39.6	Well.

* Values given at fiftieth normal, all others at one hundredth normal.

ANALYSES OF RESIDUES FROM MARYLAND WATERS MADE BY PENNIMAN & BROWNE FOR THE MARYLAND GEOLOGICAL SURVEY (PARTS PER MILLION)—Continued

Location	Number	SiO_2	Al	Fe	Mg	Ca	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	Turbidity	Alkalinity	Hardness	Suspended matter	Total dissolved solids	Source
Carroll Co.																			
Mt. Airy	97	11.8	.30	...	3.1	4.6	3.3	...	...	21.0	.5	4.0	6.4	10	3.6	19.0	...	56.0	Well.
New Windsor	94	11.4	1.10	.10	7.4	28.8	4.4	...	...	114.7	10.5	3.4	9.0	...	18.8*	103.0	...	118.8	
Westminster	89	14.0	.50	...	2.0	4.0	3.9	...	...	15.9	1.3	2.9	12.4	...	2.6*	18.5	...	52.0	Springs.
Westminster	90	12.6	.90	...	2.1	5.7	3.7	...	...	23.7	1.7	2.6	8.0	...	3.8*	23.0	...	49.0	Wells.
Westminster	91	9.4	.60	.01	3.4	10.6	4.0	...	...	26.8	4.7	3.1	22.5	...	2.2	40.7	...	80.2	Wells.
Westminster	92	7.2	.80	.01	.4	4.0	3.4	...	...	17.1	2.8	2.1	4.9	...	2.8*	11.7	...	30.0	Pub. Supply.
Westminster	93	2.00	2.40	...	4.7	26.3	3.7	...	...	92.7	2.3	5.0	18.0	—10	7.6	85.2	40.0	128.0	Well.
Calvert Co.																			
Solomon's Island	12	52.1	.60	.01	10.5	18.4	37.4	...	22.8	143.9	6.0	2.6	1.3	...	15.6	89.7	...	221.0	
Cecil Co.																			
Elkton	4	13.0	.60	.30	2.0	5.2	6.6	...	...	29.3	1.8	4.4	3.7	...	2.4	21.5	9.4	56.6	Stream.
Perryville	5	11.7	.40	.05	1.3	2.3	4.5	...	...	17.1	1.4	3.2	3.8	10	1.4	11.7	21.0	37.2	Stream.
Charles Co.																			
Allens Fresh	14	19.0	.72	.10	5.6	14.3	35.7	...	...	156.1	8.2	1.5	1.2	20	12.8	59.2	...	162.0	Well.
Newport	25	15.3	.05	...	5.6	12.3	35.0	...	...	146.4	7.9	1.5	...	10	12.0	54.4	...	153.0	Well.
Dorchester Co.																			
Hurlock	15	16.1	.01	.05	1.0	1.8	6.6	...	...	17.0	...	5.9	...	...	1.4	8.5	...	48.0	
Cambridge	18	26.9	.13	.02	4.6	8.4	154.8	...	24.0	392.8	9.0	8.0	...	10	36.2	39.3	...	509.0	Well.
Frederick Co.																			
Braddock Hts.	81	19.8	.40	...	4.1	8.6	5.3	...	...	43.9	2.6	5.3	12.3	...	7.2	38.0	...	46.0	
Brunswick	78	37.0	.20	.01	10.4	29.0	6.2	...	...	126.9	18.2	8.6	...	...	10.4	115.7	...	178.0	Tap.
Catoctin	83	14.4	.40	...	5.6	13.2	6.9	...	...	69.5	18.1	8.4	2.2	50	11.4	56.2	...	105.0	Catoctin Creek.
Keedysville	72	31.4	1.50	.01	10.9	50.2	7.7	...	...	202.5	11.8	5.7	14.3	250	33.2*	180.8	241.0	...	Big Antietam R.
Frederick	79	4.0	1.00	.10	.1	2.1	3.0	...	...	14.6	.2	1.6	...	...	2.4*	5.2	...	20.0	Fishing Creek.
Frederick	86	11.6	.20	...	3.8	29.2	6.0	...	3.6	98.8	7.2	4.0	12.6	20	8.4	89.0	19.4	128.4	Monocacy.
Frederick	80	3.6	.60	.01	.9	1.4	3.2	...	...	12.2	1.8	1.9	...	...	1.0	7.5	...	14.6	Tuscarora Cr.
Frederick	87	15.4	1.00	...	10.4	99.2	9.9	...	...	194.0	100.9	13.9	40.8	...	31.8*	291.0	...	330.0	Well.

* Values given at hundredth normal, all others at one fiftieth normal.

ANALYSES OF RESIDUES FROM MARYLAND WATERS MADE BY PENNIMAN & BROWNE FOR THE MARYLAND GEOLOGICAL SURVEY (PARTS PER MILLION)—Continued

Location	Number	SiO_2	Al	Fe	Mg	Ca	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	Turbidity	Alkalinity	Hardness	Suspended matter	Total dissolved solids	Source
Fredr'k. Co. (Cont.)																			
Emmitsburg	88	8.4	1.00	....	2.6	4.3	3.0	....	....	25.6	1.6	1.3	4.50	10	2.1	21.7	....	32.8	Tap.
Fiddlesburg	73	16.8	1.00	.01	15.4	47.2	6.4	....	....	195.2	10.1	4.2	9.00	50	16.0	182.0	30.6	.....	Little Antietam.
Middletown	82	17.4	1.10	.10	3.2	8.0	4.4	....	....	45.5	.....	2.0	3.30	—10	8.2*	35.5	....	59.0	Pub. Supply.
Thurmont	77	6.0	.80	.01	1.1	1.6	2.5	....	....	12.0	2.0	1.0	......	—10	1.0	8.7	1.2	19.6	Tap.
Woodsboro	84	41.2	1.00	....	15.2	132.4	14.5	....	....	383.1	25.2	43.4	14.40	....	62.8*	395.0	....	525.0	Well.
Garrett Co.																			
Crabtree Run	63	3.4	2.90	.02	2.3	8.7	4.1	....	....	31.7	10.8	2.1	......	....	2.6	31.2	....	54.0	
Deer Park Hotel	36	10.4	.80	.02	2.9	26.3	3.8	....	....	98.8	2.2	1.0	2.00	....	8.1	77.8	....	97.0	Tap.
Mountain Lake Pk.	37	3.5	.10	.01	.5	.9	1.8	....	....	8.5	.7	1.0	......	....	.7	4.2	....	13.0	Crystal Spring.
Mountain Lake Pk.	38	8.2	.50	.01	2.5	20.0	3.3	....	....	73.2	3.4	1.8	......	....	6.0	60.0	....	70.0	Tap.
Oakland	39	9.0	.30	.01	5.6	13.4	8.7	....	....	13.4	12.8	17.1	44.20	....	1.1	56.8	....	132.0	Well.
Oakland	32	13.0	.80	.01	3.0	7.9	39.6	....	....	106.1	12.9	16.1	2.30	....	8.7	32.2	....	147.0	Well.
Potomac River	41	5.8	.40	.01	2.0	4.4	4.3	....	....	19.5	10.6	1.2	......	50	1.6	19.0	28.8	52.2	
Potomac River	42	5.6	.90	.01	1.3	5.0	3.2	....	....	14.6	9.6	1.0	......	50	1.2	17.9	26.6	55.0	
Sang Run	34	11.6	.70	.01	6.5	104.8	20.3	....	....	265.9	23.0	35.5	73.80	....	21.8	289.0	....	438.0	
Savage River	40	8.0	.40	.01	3.3	9.5	4.1	....	....	31.7	16.2	1.6	.70	50	2.6	37.5	14.0	59.0	
Savage River	62	1.2	.60	.01	1.6	9.0	3.7	....	....	35.4	2.9	2.3	......	—10	2.9	29.5	....	43.0	
Youghiogheny R.	35	5.6	1.70	.02	1.2	4.6	2.8	....	....	24.4	.9	.2	2.30	30	2.0	16.5	1.5	37.9	
Harford Co.																			
Bel Air	98	14.8	1.00	.01	1.7	6.0	4.6	....	....	24.4	.....	3.2	1.80	10	4.00	22.0	....	52.0	
Havre de Grace	6	17.5	.40	.11	8.4	10.3	12.0	....	....	17.1	2.9	42.2	26.30	10	1.40	60.1	....	167.0	Textile Mill Well.
Havre de Grace	7	8.8	1.22	.34	7.5	31.6	9.2	....	....	62.2	68.5	19.4	2.10	30	5.10	111.0	....	212.0	Intake, Pub. Sup.
Havre de Grace	8	3.4	.20	.13	10.5	32.0	9.2	3.9	....	58.6	77.9	16.3	1.60	20	4.80	123.7	14.0	196.0	Composite Sample, Public Supply.
Howard Co.																			
Ellicott City	96	22.0	2.00	.10	3.0	10.2	6.9	....	....	52.4	.9	4.4	2.20	....	8.6*	38.0	....	68.0	Public Supply.
Kent Co.																			
Chestertown	26	9.1	.36	.02	3.0	9.6	15.1	....	....	63.4	8.2	12.4	......	70	5.2	34.6	5.6	98.0	
Chestertown	27	11.3	7.20	.69	24.4	95.1	386.1	....	....	15.9	3.5	820.8	......	75	1.3	339.7	9.2	1350.0	
Rock Hall	13	9.8	6.30	.11	2.9	8.0	14.4	....	....	48.8	18.2	5.3	......	....	4.0	32.0	....	95.9	

* Values given at hundredth normal, all others at one fiftieth normal.

ANALYSES OF RESIDUES FROM MARYLAND WATERS MADE BY PENNIMAN & BROWNE FOR THE MARYLAND GEOLOGICAL SURVEY (PARTS PER MILLION)—Continued

Location	Number	SiO_2	AlO	Fe	Mg	Ca	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	Turbidity	Alkalinity	Hardness	Suspended matter	Total dissolved solids	Source
Montgomery Co.																			
Rockville	95	16.6	.80	.10	2.8	9.8	7.4	....	....	56.1	3.7	5.0	....	....	9.2	23.4	....	90.0	Wells.
Prince George's Co.																			
Laurel	31	5.1	.70	Tr.	1.0	1.8	7.7	....	....	12.2	1.7	3.0	12.4	90	1.0	8.6	15.8	46.5	Public Supply.
Upper Marlboro	16	26.1	.80	.02	6.0	66.1	5.1	....	....	205.0	13.9	2.7	....	....	16.8	177.6	....	211.0	
Talbot Co.																			
Easton	9	41.4	1.30	.06	4.6	26.5	36.8	11.7	9.6	217.0	8.3	5.5	....	....	18.6	85.4	....	250.0	Well.
Easton	10	44.0	.95	.23	8.8	28.3	43.5	3.9	12.0	214.7	7.7	5.3	....	....	19.6	107.6	....	262.0	Well.
Washington Co.																			
Blue Ridge Water Co.	71	26.7	.80	....	8.1	20.4	6.2	....	....	100.0	3.9	4.8	11.2	....	16.4	84.8	....	126.6	
Clearspring	74	28.2	1.10	....	10.7	49.8	6.0	....	4.8	187.8	2.7	32.0	22.4	....	31.2*	168.9	....	214.0	Big Spring.
Hagerstown	65	10.0	2.00	.01	29.3	155.0	10.9	....	....	314.6	233.3	11.2	32.1	....	24.8	509.7	....	661.8	Art. Well.
Hagerstown	66	9.6	.10	.01	6.4	71.2	12.4	....	....	202.5	25.4	18.2	12.3	....	16.6	204.5	....	253.0	Brewery.
Hagerstown	69	15.6	.80	....	2.0	5.0	3.7	....	....	31.7	1.5	1.9	.7	....	5.2*	21.0	....	50.0	Edgemont Reserv.
Hagerstown	64	16.0	.70	.01	12.2	114.2	21.2	....	....	351.4	32.5	33.2	34.6	60	28.8	336.2	....	436.8	Art. Well.
Hagerstown	68	17.0	1.10	....	.5	7.8	4.1	....	....	305.0	1.6	1.7	1.1	—10	5.0*	21.0	....	61.0	Smithburg Reserv.
Hancock	..	14.2	4.50	Tr.	9.1	92.2	4.4	....	....	231.0	79.6	2.9	....	....	18.9	268.4	....	334.0	Well.
Hancock	57	12.0	.10	.01	13.1	101.9	4.6	....	....	136.6	197.1	2.1	....	90	11.2	309.3	67.4	421.0	
Hancock	58	15.2	1.00	.01	17.8	55.6	46.5	....	....	92.7	81.9	52.2	149.9	—10	7.6	213.2	.2	415.0	Monterey Inn.
Hancock	59	14.4	.70	.01	13.0	113.8	6.4	....	....	291.6	101.8	2.9	....	10	23.9	337.6	5.6	391.0	Well.
Hancock	60	18.0	.10	.01	20.8	48.2	100.7	....	....	172.0	44.3	136.3	46.4	70	14.1	207.1	27.8	545.0	Well.
Pen Mar	70	3.0	.20	.01	1.0	1.4	3.9	....	....	12.2	2.1	2.9	....	....	1.0	7.5	....	17.0	Glen Afton Spring.
Williamsport	76	5.0	.20	.01	9.4	23.3	6.2	....	3.6	107.4	9.3	5.0	1.8	10	9.1	97.5	9.0	117.6	Conocheague.
Williamsport	75	21.6	.10	.01	82.4	253.6	224.5	....	....	287.9	37.9	850.6	....	20	23.6	977.5	5.4	180.3	Well.
Wicomico Co.																			
Salisbury	17	21.1	.20	.30	4.4	11.6	23.7	....	....	14.6	5.0	34.2	40.1	....	1.2	47.1	....	184.0	Public Supply.
Worcester Co.																			
Pocomoke City	22	19.5	1.10	.01	3.4	6.0	676.5	....	21.6	1046.8	54.5	385.7	2.2	....	89.4	19.2	....	165.6	Pub. Well.
Pocomoke City	23	33.0	2.70	.13	8.2	37.9	66.6	....	....	208.6	8.2	65.4	1.0	.30	17.1	87.9	25.0	326.0	Pub. Well.
Pocomoke City	28	32.8	.90	1.70	8.0	38.0	44.1	....	....	202.5	9.8	41.4	....	....	16.6	128.3	....	272.0	Well.
Snow Hill	21	17.7	.90	.01	6.8	17.1	93.6	....	2.4	251.3	1.3	43.8	1.1	....	21.0	70.8	....	353.0	Public Supply.

* Values given at hundredth normal, all others at one fiftieth normal.

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