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DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES

GEOLOGY AND GROUND-WATER RESOURCES OF THE EASTERN SHORE PENINSULA

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BULLETIN

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Prepared in cooperation with the Geological Survey, United States Department of the Interior
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Geology and Ground-Water Resources of the
Eastern Shore Peninsula, Virginia

by

Allen Sinnott and G. C. Tibbitts, Jr.

Abstract

The Eastern Shore lies in the northeastern part of the Virginia Coastal Plain province. It is at the lower end of the peninsula that extends southward from Maryland, the Delmarva Peninsula, that forms the eastern shore of Chesapeake Bay. The Atlantic Ocean borders the peninsula on the east. The area considered in this report consists of two counties, Accomack on the north and Northampton to the south.

Fieldwork for this investigation was carried out chiefly during the summers of 1948, 1952, and 1953.

The area is largely rural in character with no large cities. Among the largest towns are Kiptopeke, Cape Charles, Exmore, Onancock, Accomac, and Chincoteague. The terminal of the old ferry to Norfolk was located at Cape Charles. The Chesapeake Bay Bridge-Tunnel reaches the Eastern Shore just south of Kiptopeke. The town of Tangier is an island community in Chesapeake Bay. The principal industries on the Eastern Shore peninsula are truck farming, lumbering, fishing, and the canning of vegetable and fish products. There is an Air Force base near Chincoteague, and the National Aeronautics and Space Administration has facilities near Chincoteague, (Wallops Island).

The region has a mild climate with a mean annual temperature of 58°F and a mean annual precipitation of 43 inches. The entire peninsula has low relief and is veneered by Pleistocene deposits, largely sands and clays. The sandy aquifers supply water for most domestic supplies. The Pleistocene deposits are immediately underlain by deposits of Miocene age which furnish water supplies for the largest municipal and industrial installations. The still deeper Eocene, Paleocene and Cretaceous rocks have been penetrated by very few wells. On the Eastern Shore of Virginia, the deepest wells in use are those on Tangier Island. These wells end in Eocene sands and supply a number of domestic users with moderately mineralized water. No wells reach basement rocks which presumably lie about 3,000 feet below the surface.

Water in the shallow Pleistocene deposits is derived from local precipitation. A substantial part of the water in the underlying clayey and marly Miocene aquifers has also originated as local precipitation. The chemical characteristics of water in very deep Miocene aquifers suggests that they are in hydrologic continuity with the artesian water-bearing formations west of Chesapeake Bay.

Domestic water supplies are obtained largely from shallow wells ending in Pleistocene deposits. There are a few batteries of shallow wells that supply larger quantities of water, as at Chincoteague, where 140,000 gallons per day is pumped.

The larger ground-water supplies are ordinarily obtained from wells reaching Miocene aquifers. One such deep well at Exmore yielded 746 gallons per minute with 37 feet of drawdown at the time of its completion. A well at Cape Charles is pumped regularly at a rate of 645 gpm.

Water from both Pleistocene and Miocene deposits is generally of good quality. Moderate hardness is common and a few waters are high in iron. Fluoride is almost invariably very low or absent. Very deep wells in the Miocene yield a high bicarbonate water with a fairly high chloride content. A few shallow wells yield slightly brackish water, due to contamination by salt spray or by intrusion of ocean or bay waters.

There are as yet no areas where withdrawal is excessive and there appears to be ample additional water available for immediately foreseeable needs. An increase in use of ground water for irrigation may eventually create problem areas. Somewhat highly mineralized water from Eocene and older beds will necessarily be limited to special uses. Deep test drilling to date has been essentially unrewarding but it is thought that where highly mineralized water can be used, careful test drilling to considerable depths may be worthwhile.

GEOLOGY AND GROUND-WATER RESOURCES OF THE EASTERN SHORE PENINSULA, VIRGINIA

by Allen Sinnott and G. Chase Tibbitts, Jr.

INTRODUCTION AND ACKNOWLEDGMENTS

This report presents the results of a study of the ground-water resources of the Eastern Shore peninsula in Virginia, which was made by the U. S. Geological Survey in cooperation with the Virginia Department of Conservation and Economic Development, Division of Mineral Resources. The area comprises Accomack and Northampton Counties, and is the Virginia ~~portion~~ part of the so-called Delmarva Peninsula: the latter extends south from Pennsylvania, and includes ~~portions~~ parts of the States of Delaware, Maryland, and Virginia, marking the eastern shore of Chesapeake Bay. ~~Initially~~ The investigation was ~~carried out~~ started under the general direction of the late A. Nelson Sayre, former Chief of the Branch of Ground Water of the ~~Federal~~ U.S. Geological Survey, and the late William M. McGill, former State Geologist. It was discontinued in 1957 but ~~The work~~ was resumed in 1966 under the general direction of George E. Ferguson, Regional Hydrologist, and J. Wyatt Gambrell, District Chief, Water Resources Division, U. S. Geological Survey; and Marvin M. Sutherland, Director, Virginia Division of Conservation and Economic Development, and James L. Calver, State Geologist and Commissioner of the Virginia Division of Mineral Resources.

The area covered by this report is shown in Figure 1. Some

5a

Figure 1.--Map of the Virginia Coastal Plain, showing counties included in this report and location of the geologic sections on Plate 1.

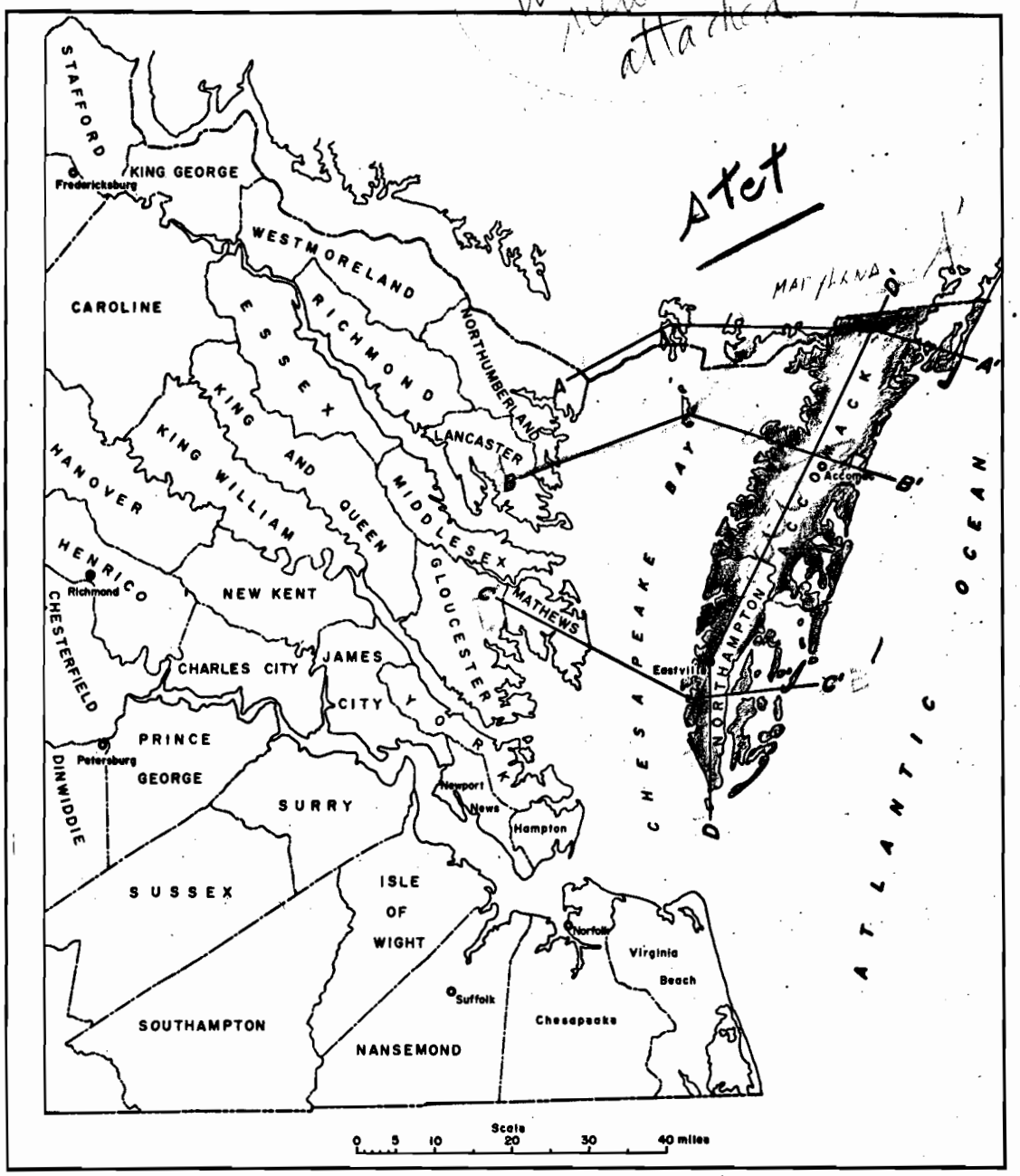

Figure 1.--Map of the Virginia Coastal Plain, showing the Eastern Shore peninsula and the location of the geologic sections on Plate 1 (in pocket).

ADD LONGITUDE AND LATITUDE NUMBERS

information was collected in the field on several occasions from 1942 to 1946 by D. J. Cederstrom of the U. S. Geological Survey, during work incidental to other cooperative ground-water studies in the Virginia Coastal Plain. Most of the well records shown in Tables 8 and 14 were obtained by the junior author. Some were collected during the summer of 1948 for an earlier draft of this report prepared in 1951 by the senior author. ~~Subsequently,~~ additional funds were made available in 1952, and many ~~additional~~ more wells were canvassed for information that summer, followed a year later by a test-drilling program.

6a Records of more than 300 wells have been obtained, and comprehensive, partial and preliminary chemical analyses of the water from more than 150 of these wells have been made in the Quality of Water Laboratories of the Geological Survey. Logs of wells were obtained whenever possible, and several sets of samples of drill cuttings were collected for study.

The writers acknowledge the assistance of the following well drillers and drilling contractors: John Scott & Son, of Melfa; William J. Porter, of Saxis; Shannahan Artesian Well Co., Inc. St. Michaels, Md.; Paul Schweitzer, of Norfolk, formerly President of the Layne-Atlantic Company; J. G. Perry, Virginia Machinery and Well Co., Richmond; Garland S. Sydnor, Garland S. Sydnor, Jr., and Guy E. Webb, of Sydnor Hydrodynamics, Inc., Richmond; James P. Prine, formerly of Norfolk, Va.; and Edgar C. Cusick, of Church Creek, Maryland. Information relating to irrigation in the area was supplied by T. W. Edminster, then of Blacksburg, James H. Lillard, of

Blacksburg, both with the U.S. Soil Conservation Service; George Davis, of the Department of Geography, University of Virginia, H. A. Stewart, of the Virginia Truck Experiment Station in Norfolk, and Alfred C. Walker, formerly Ground Water Geologist with the Virginia Geological Survey. The late Henry Jander supplied information on the old flowing well and other wells on Tangier Island, and collected samples from wells on Smith Island, Md. Otis D. Marshall and his successor, Leroy Jester, Jr., water superintendents of the town of Chincoteague, furnished data on the water system of that town. William J. Gillespie, Civil Engineer at what was then the Naval Aviation Ordnance Test Station, Chincoteague, supplied data on the wells at the Station, and W. G. Lewers has made periodic water-level measurements at the Federal observation well at the Station since March 1948. (That facility, since mid-1959, has been operated as Wallops Station, Main Base, of the National Aeronautics and Space Administration.) Mr. Lewers also assisted the writers in providing arrangements for a pumping test in the spring of 1954.

The late Julia A. Gardner, of the Branch of Paleontology and Stratigraphy of the Federal Survey, identified megafossils in cuttings from several wells, and Ruth Todd, I. G. Sohn, and F. Stearns MacNeil identified Foraminifera, Ostracoda, and megafossils from drill cuttings obtained during the 1953 test-drilling program. The Virginia State Chamber of Commerce furnished photographs for use in this report.

Many residents in the area freely furnished information on their wells during the course of the field work.

7b For assistance in various ways during the initial stage of the work, acknowledgment is here also made to John R. Drummond, of Nandua, Ralph E. Long, of Capeville, Ralph Onley, of Modest Town, and Harold Wescoat, of Eastville--all members of the Eastern Shore Board of Soil Conservation District Supervisors; John Rogers and Roy Nottingham, County Agricultural Agents for Accomack and Northampton Counties, respectively; and to John N. Selby, of Accomac, field representative of the U. S. Soil Conservation Service.

8 Purpose of the investigation

This investigation was undertaken to describe the occurrence of ground water on the Eastern Shore peninsula, and its relation to the sub-surface geology, ~~with particular reference to the quantity and quality of the water~~, so that this essential natural resource may be utilized in the best manner by municipalities, industries, and by domestic and irrigation users. From the data here presented, it is hoped that these users may be able to anticipate to a reasonable degree the availability and the character of the ground water to be expected at various places on the peninsula.

Methods of field work

During the field phases of this investigation, factual data were obtained on an adequate number of representative wells in the two counties. The wells were chosen partly on the basis of geographical distribution and partly for the purpose of obtaining typical wells which tap aquifers from various stratigraphic horizons at different

depths. The majority of the larger yield wells were visited in the field; selected wells were also visited among the many shallow dug and driven wells THAT supply~~ing~~ individual users throughout the two counties.

Many well owners furnished certain information. A few were able to furnish driller's logs, or could describe in a general way the formations penetrated during the course of construction of their wells. For the larger industrial or municipal wells, where relatively complete data had been compiled, all available recorded information was obtained. These records have been tabulated and are published in this report. (See Tables 8 and 14.)

The samples of water from a representative number of wells on the peninsula were collected for chemical analysis. Minimum determinations on all samples included the determination of chloride and fluoride content and the soap hardness. Samples from selected wells were also taken for "partial" analysis, which included, in addition to the constituent's mentioned, determinations of bicarbonate, sulfate, nitrate, and iron. Some of the most heavily pumped wells were sampled for comprehensive analysis. Nearly all of these analyses are listed in this report (Tables 11, 13, and 16).

Because of the large topographic contour interval on most maps available when field work was in progress and the low relief in the area, generally about 50 feet, an airplane altimeter was used during part of the work to estimate the altitude of the land surface at some of the wells. It is believed that the altitudes so determined are probably more reliable than would have been determined by simple inspection of ~~contour~~ topographic maps.

Previous investigations

The Eastern Shore Peninsula has low relief and consequently good exposures of deposits older than ~~Recent~~ age are scarce. Hence the early (1912) report by Clark and Miller, (p. 189) is entirely restricted to a description of the Pleistocene terrace cover. The only extended published discussion of ground-water conditions in the Eastern Shore counties is that by Sanford (1913) which is found in Virginia Geological Survey Bulletin 5. In spite of the limited information at his disposal Sanford wrote creditable sections on the ground-water conditions in Accomack and Northampton counties in that early bulletin.

Some information developed during the present study was published several years ago. Summaries of the geology and ground-water conditions on the peninsula, descriptions of wells, and stratigraphic correlations on selected wells were released in three circulars prepared by the present writers (Sinnott and Tibbitts, 1954; 1955; 1957).

In the Coastal Plain west of Chesapeake Bay detailed studies had been made on the subsurface geology by Cederstrom (1945a, 1945b, 1946a and 1946b), and Richards (1948). Geophysical investigations had been made by Ewing and others (1937). The ground-water work referred to was carried out in counties west of Chesapeake Bay. During the course of that work formation samples were obtained during the drilling of deep wells for relatively large municipal and industrial ground-water supplies. These

samples have afforded an excellent opportunity for paleontologic correlations, especially by means of microfossils.

Because very few wells deeper than about 300 feet have been constructed in the Eastern Shore counties, the characteristics of the Eocene and Cretaceous sediments must be largely inferred from their shallower occurrence on the mainland counties west of Chesapeake Bay. Practically all of the so-called deep wells on the Eastern Shore tap strata of Miocene age; consequently, most of this report is concerned with the occurrence of ground water in the Miocene aquifers and in the more readily accessible Pleistocene deposits.

12b ~~On~~ In the mainland counties, where many well logs and drill cuttings have been obtained, stratigraphic correlations can generally be carried out in some detail. On the Eastern Shore, however, such interpretation has been limited because of the scarcity of subsurface data. The exploratory test holes drilled in the Miocene formations during this investigation in 1953 have yielded substantial additional information, particularly in the relatively unknown depth range from 300 to 450 feet below the surface. The correlations for the deeper Eastern Shore wells, shown on the ~~cross~~ sections of Plate 1, have been based in large part on the test-hole information, including paleontologic studies, from the Crisfield Md., well and ~~also~~ in part on extrapolation of data on wells in the mainland Tidewater counties near the western shore of Chesapeake Bay. ~~Where appropriate, these mainland wells appear on some of the sections~~.

The microfauna contained in the subsurface samples obtained during the drilling of the four exploratory test holes have been

studied by ~~Federal~~ U.S. Geological Survey specialists. Significant data also have been obtained from the published work of other investigators based on subsurface data on wells in Maryland near the Virginia Eastern Shore.

Ruth Todd (1955) of the U. S. Geological Survey, determined the Foraminifera from the exploratory holes, and discussed the probable correlations and the environments of deposition; I.G. Sohn (1955), also of the Survey, studied the ostracodes. The late Julia A. Gardner (1948) of the Survey studied shells from drill cuttings from a well at Cheriton in Northampton County, and made tentative age assignments to the subsurface material.

Doris S. Malkin (Mrs. Doris Malkin Curtis) made a preliminary correlation of samples from a deep well drilled on Smith Island, Maryland, about 10 miles north of Tangier Island in Chesapeake Bay. Her correlation (Malkin, 1947) is included in this report (Table 10) by permission of Shell Oil Company. A paper by McLean (1950) contains stratigraphic correlations of samples from a deep well at Crisfield, M~~aryland~~d, near the Virginia-Maryland boundary. Wentworth (1930) discussed the geomorphic history of the Eastern Shore. A brief article on the Pleistocene terraces on the peninsula has been published by the writers (Sinnott and Tibbitts, 1961).

Following a study of the megafossils of drill cuttings from the exploratory test holes and certain other wells by F. Stearns MacNeil of the U.S. Geological Survey (~~personal~~ written communication, 1955), a circular on stratigraphic correlations on the Eastern Shore peninsula was published by the writers (Sinnott and Tibbitts, 1957).

A preliminary summary of the results of this investigation, and a report on factual information for selected wells in both counties, were published by the writers several years ago (Sinnott and Tibbitts, 1954 and 1955, respectively).

GEOGRAPHY

Area and population

The total land and water area of the Eastern Shore peninsula of Virginia is 959 square miles. Table 1 shows the area and population in 1940, 1950, 1960, and 1964 as given by the Virginia Division of Planning (1965).

Table 1.--Area and population of counties on the Eastern Shore peninsula, Virginia

County	Area (square miles) Land	Water	Total	Population 1940	1950	1960	1964
Accomack	470	132	602	33,030	33,832	30,635	29,971
Northampton	226	131	357	17,597	17,300	16,966	17,340
Total	696	263	959	50,627	51,132	47,601	47,311

Industry

15 Of the total active civilian work force in 1965, agricultural workers represented about 35 and 40 percent, respectively, in Accomack and Northampton counties (Table 2). In addition to civilian workers, there were more than 400 military personnel on the peninsula in 1965, according to the Virginia Division of Planning (1967); these are chiefly at the two Wallops Station facilities of the National Aeronautics and Space Administration, near Chincoteague; Fort Custis, near Kiptopeke; Cape Charles Air Force Base; and Cobb Island Coast Guard Station.

Table 2.--Civilian work force as of September 1965 for the Eastern Shore peninsula

(Data from Virginia Employment Commission)

Classification	Accomack County		Northampton County		Eastern Shore peninsula (both counties)	
	No. of workers	Percent of total	No. of workers	Percent of total	No. of workers	Percent of total
Agricultural	4,295	33.8	2,966	39.3	7,261	35.8
Nonagricultural	8,398	66.2	4,583	60.7	12,981	64.2
Total	12,693	100.0	7,549	100.0	20,242	100.0

Climate

17 The Eastern Shore area has a moderate north temperate climate. Because it is surrounded by bodies of water on all but the north side, its temperature range is not extreme. The rate of precipitation is well-suited to farming, although there is a drought hazard that is gradually being lessened by increased use of irrigation facilities.

Tables 3 and 4 below show the mean monthly and mean annual temperature and precipitation recorded at Onley and Painter, in Accomack County, and at Cheriton, in Northampton County, from published summaries of the U.S. Weather Bureau.

Table 3.--Mean monthly and mean annual temperatures, in degrees Fahrenheit, at U. S. Weather Bureau stations on the Eastern Shore peninsula, Virginia

Station	Altitude (feet)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean annual
Onley, Accomack County 1/	40	41.3	40.5	46.9	55.3	65.5	74.1	77.6	76.1	70.6	60.5	50.9	41.9	58.4
Cheriton, Northampton County 2/	11	41.2	42.6	47.9	57.9	67.2	75.2	78.9	77.7	72.4	62.6	52.4	42.6	59.9

1/ Record from 1931 to 1952, inclusive; station discontinued in 1955.
2/ Record from 1936 to 1960, inclusive.

Table 4.--Mean monthly and mean annual precipitation, in inches, at U.S. Weather Bureau stations on the Eastern Shore peninsula, Virginia

Station	Altitude (feet)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean annual
Onley, Accomack County 1/	40	3.64	3.44	3.97	3.51	3.36	3.43	4.35	4.76	3.51	2.96	3.03	3.13	43.09
Painter, Accomack County 2/	30	2.68	3.56	4.48	3.98	3.08	3.54	4.21	5.81	3.51	6.26	2.44	3.06	46.61
Cheriton, Northampton County 3/	11	3.39	3.59	3.78	3.23	3.14	3.24	4.93	4.64	4.06	3.47	3.35	2.88	43.70

1/ Record from 1918 to 1955, inclusive.
2/ Record from 1956 to 1960, inclusive.
3/ Record from 1936 to 1960, inclusive.

GEOMORPHOLOGY

The land forms of the Eastern Shore peninsula are subdued and generally inconspicuous--the total relief being only about 70 feet. However, the character of the shoreline is of interest in that ~~and~~ two fairly well developed terraces and associated scarps can be seen in southern Northampton County and, locally, elsewhere. Certain other features--the so-called "Carolina bays" (Prouty, 1932)--rarely appear on maps and are not usually apparent to ground observers, but many are readily discernible from the air and on aerial photographs.

The following brief discussion of some of these land forms is based largely on a section in an earlier report by the writers (Sinnott and Tibbitts, 1954).

Terraces

Workers in the Atlantic Coastal Plain have long noted a succession of broad plains or "terraces," each separated by a more or less distinct scarp, marking a shoreline, along its landward margin. The terraces are believed to have been developed during Pleistocene time when the sea stood at higher levels relative to the land than at present. Morphologic studies of the Pleistocene terraces also entail stratigraphic problems, which are treated briefly in a later section. (See under Quaternary System, Pleistocene Series.)

On the Eastern Shore peninsula, only the three youngest terraces are believed to be represented. (See Fig. 2.)

Stephenson (1912) first described the Pamlico terrace, whose shoreline is about 25 feet above sea level, in North Carolina. In Virginia, Wentworth (1930 p. 69), named the Dismal Swamp terrace as its equivalent in Virginia. He also found local development of a distinct lower terrace, whose shoreline is about 12 feet above sea level, which he named the Princess Anne terrace; it has been considered correlative with the widely-developed Silver Bluff terrace in Florida described by Parker and Cooke (1944) and others (Cooke, 1945; MacNeil, 1950). The Princess Anne terrace is believed to be a later phase of the Dismal Swamp terrace.

Wentworth's Chowan Terrace--probably the equivalent of the Talbot terrace in Maryland as defined by Shattuck (1906)--lies above the Dismal Swamp terrace, and has been shown by the writers (Sinnott and Tibbitts, 1961) to extend the entire length of the peninsula, flanked by remnants of the Dismal Swamp and Princess Anne terraces. The latter are less obscured by subaerial erosion along the bay side of the peninsula, in northern Accomack and southern Northampton counties. (See Fig. 3.)

Shorelines

The Chesapeake Bay area shows features typical of shorelines of submergence. It is evident that the base level of

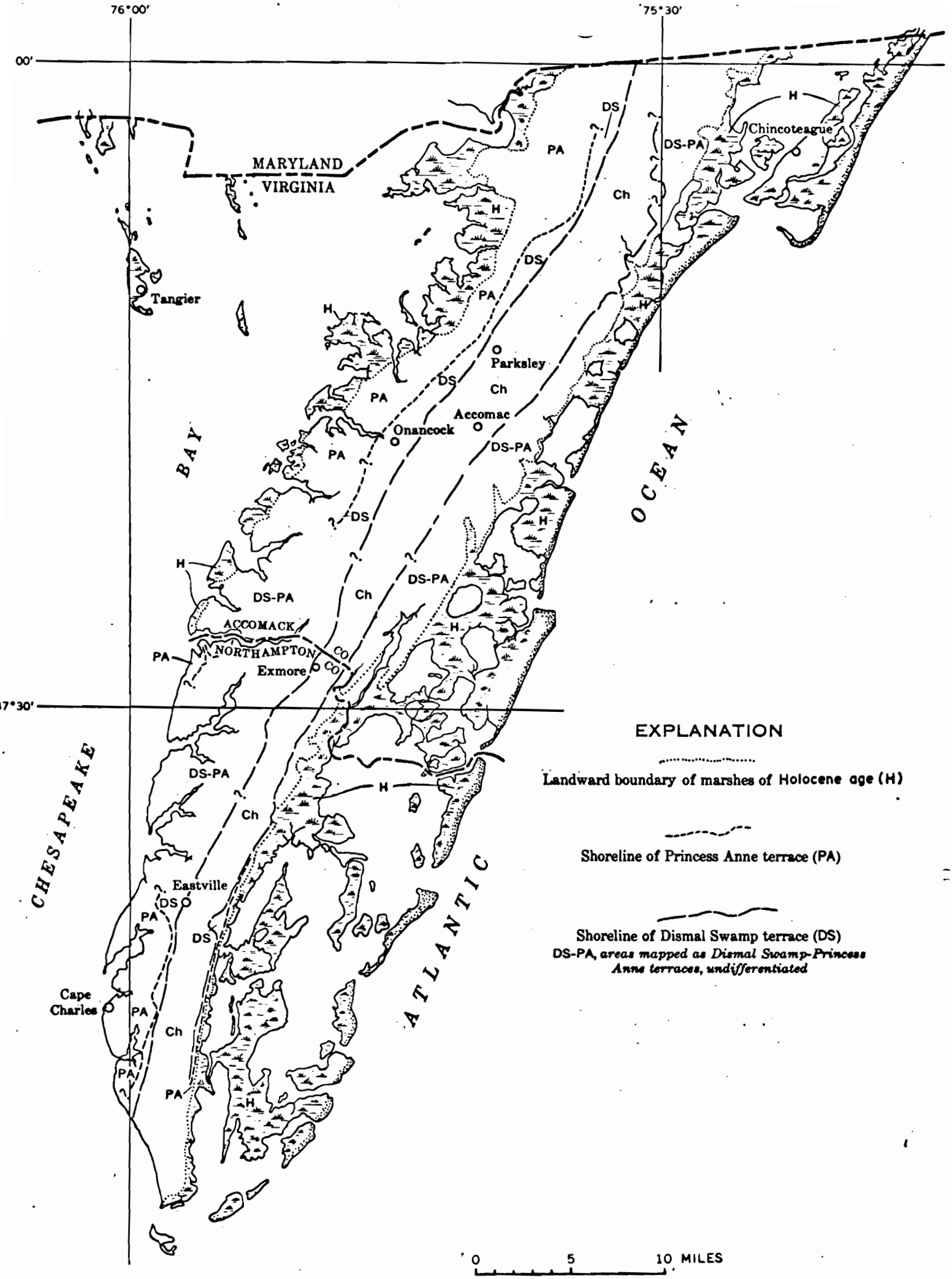

Figure 2.—Map of the Eastern Shore peninsula showing Pleistocene shorelines and related surfaces. (After Sinnott and Tibbitts, 1961.)

Figure 6.--Low wave-cut cliff truncating Princess Anne terrace on beach south of Occahannock Creek, about 6 miles west of Exmore, Northampton County. (After Sinnott and Tibbitts, 1961.)

erosion must have been at one time considerably lower than at present--probably during the close of the Pleistocene epoch at the time of the greatest expansion of the Wisconsin ~~glacial stage~~ Glaciation. Subsequently, the region has been progressively submerged, as ~~the~~ sea level gradually ~~advanced~~ rose to its present position.

Carolina Bays

In Accomack County, and to a lesser extent in Northampton County, many aerial photographs exhibit striking elliptical surface features, here referred to the so-called "Carolina bays" commonly prevalent in the Coastal Plain areas of the Carolinas. These "bays" are broad, shallow, elliptical sand-rimmed depressions, trending southeastward. Some of them are truncated by other similar depressions. Smaller basins of random orientation, occurring among the larger basins, have been described for the Eastern Shore of Maryland by Rasmussen and Slaughter (1955, p. 26-28, pl. 3).

The method of development of these features has been a matter of considerable geological controversy. Among the many theories of origin may be mentioned showers of meteorites, rotating currents, solution sinkholes, shoals of fish, stranded icebergs, and complex artesian-solution-lacustrine-eolian processes. (See Prouty, 1952, p. 167; Rasmussen and Slaughter, op. cit., p. 28.) Whatever their origin, they are of importance in the occurrence of ground water because they serve as catchment basins, assisting in the replenishment of the shallow ground-

water body, as pointed out by Rasmussen and Slaughter (op. cit., p. 27-28). They are most numerous in the Carolinas, but occur also from Florida to New Jersey (Prouty, op. cit., pl. 1). These landforms probably developed after the present general features of the Coastal Plain had already been formed--that is, during the Holocene Epoch of geologic time.

Geomorphic history

Prior to late Pleistocene time little or no land existed in the area of the Eastern Shore peninsula, according to Wentworth (1930, p. 114). During the advance of the sea that formed the Chowan terrace, "the combined action of wave and shore currents built spits and barriers across the shore reentrant from the vicinity of Snow Hill, Maryland, to eastern Gates County, North Carolina, thus forming an enclosed area of lagoons and marshes similar to Pamlico and Albemarle Sounds." In post-Chowan time, that is, after the retreat of the Chowan sea, "this barrier was sufficiently continuous to force the combined Potomac and Susquehanna drainage southward to its present outlet into the ocean." It was during this time that the principal features of the Chesapeake Bay and its tributaries were formed. The higher part of the Eastern Shore peninsula probably was modified also during this period, and during Dismal Swamp and Princess Anne time, to approximately its present form.

With the advance of the sea in Dismal Swamp time, the deposition of sediments took place, and the lower Dismal Swamp terrace was formed by the strand-line erosion against the remnant sediments beneath the Chowan terrace. The Princess Anne terrace, which is close to the present sea level, was probably formed during a pause or minor readvance of the Dismal Swamp sea during its retreat in late Pleistocene time. The Princess Anne terrace in Virginia averages about 10 to 12 feet above the present mean sea level, and the shoreline of the Dismal Swamp terrace about 25 feet above sea level.

During R[redacted]t time the present shoreline has been developed around the peninsula, and loose sand along the beaches has been locally gathered into dunes ~~(Figure 1).~~ (Figs. 4 and 5) Longshore currents have formed small spits, some of which have grown to form baymouth bars and associated lagoons. The "bays" or "basins" discussed above were superimposed on the surface of the peninsula also during this epoch.

Figure 4.-- Sand dunes on Savage Neck, 3 1/2 miles west-southwest of Eastville, south of Wilkins Beach, Northampton County. Position of water table, after recent rainfall, is marked by small pool at right.

Figure 3.--Sand and gravel pit, in deposits of the Columbia Group of Pleistocene age, east of Mappsville, Accomack County. Lake level indicates position of water table.

OCCURRENCE OF GROUND WATER

In the Virginia Coastal Plain, water enters the ground from the surface, usually by infiltration from rainfall, streams, and lakes. It is drawn downward by gravity, except a portion which adheres, by molecular attraction, to the walls of the grains composing the soil and rocks. Below a certain level the interstices of these rocks are completely filled with water. This is known as the zone of saturation. The top of this zone marks the approximate position of the water table.

The unsaturated rocks above the water table are in the zone of aeration. Immediately above the water table but within the zone of aeration is the capillary fringe, a zone where the finer interstices are filled with water drawn up by capillarity from the water table. This fringe may be ~~only a~~ less than foot or two thick in coarse sediments but as much as 10 ~~to 20 feet~~ thick in fine grained sediments. Where the land surface intersects the water table the latter becomes visible in the form of lakes or ponds (Fig. 5).

Ground water has been defined specifically by Meinzer (1923, p. 22) as the water in the zone of saturation, that is, water that can be withdrawn from the ground by wells.

The occurrence and availability of ground water is dependent on a source of supply for the water and on two important characteristics of the water-bearing portions of the rocks, porosity and permeability. The porosity of a sedimentary formation--the amount of open space it contains--depends to a large extent on the degree of packing and on the size distribution of the grains of which the formation is composed. It is important to note that the size of the component grains, other things being equal, has practically no effect on the porosity of the water-bearing material; thus, silt and clay are about as porous as sand and gravel.

A high degree of porosity alone, however, is insufficient for a sediment to be considered a good water-bearing formation (aquifer). A more important attribute is the hydraulic permeability of the material, or its capacity for transmitting water under gravity or pressure (Meinzer, 1923, p. 44). The size of the grains bears a very definite relationship to the permeability. Thus, a clay, which may have the same porosity as a sand, is almost impermeable to water because the openings are so small that the water is held in them by molecular attraction.

In some areas, a permeable formation may be overlain by a relatively impermeable layer, called a confining layer or aquiclude, and the water in the permeable layer may be under artesian pressure. This happens when the permeable rock is exposed at the surface at a somewhat distant higher elevation. When tapped by wells, water in the confined formation will rise above the base of the overlying impermeable bed. The level to which such water will rise is called the piezometric surface rather than the water table. If it rises above the land surface--as in certain low areas of the Eastern Shore--the wells tapping the formation will overflow. Where the land is higher or the pressure is low, wells will have to be pumped. In either case the well is artesian.

On the Eastern Shore, water in the very deep sedimentary formation is believed to be under sufficient artesian pressure so that any wells drilled to them would be flowing wells. So far as known, the only functioning deep wells reaching below the base of the Miocene are those on Tangier Island in the middle of Chesapeake Bay. Among these is the 860-foot flowing well (183) listed in Table 8. This well was flowing in 1948 at which time it was sampled for chemical analysis (Table 11).

Many of the 150- to 250-foot wells on low ground developed in Miocene aquifers also flow. Some flow only at high tide; others flow continuously but at an increased rate during high tide as ~~the~~ compression by tidal loading becomes effective. At least two other very deep wells have been drilled on the Eastern shore. One (90, Table 14) in Cape Charles was drilled in 1910 to a depth of 1,810 feet, the other at Cobb Island (180) to a depth of 1,001 feet at the Coast Guard facility. The height to which water would rise in these deep wells was not recorded. Neither well was put in service; the one in Cape Charles did not yield sufficient water, and the Cobb Island well produced only brackish water.

Water-Level Fluctuations

IV-4 Through arrangement with the Navy Department, an observation well was established in March 1948 at what was then the Naval Aviation Ordnance Test Station near Chincoteague. Subsequently, this well was designated as Federal Observation Well Va.-US-2, one of six such wells in eastern Virginia which are part of a network of observation wells established throughout the nation. This well is listed as number 8b in Table 8. Since ~~19~~ mid-1959, this facility has been operated by the National Aeronautics and Space Administration; it is designated as Wallops Station (Main Base).

Ground water in the vicinity of this station occurs under water-table conditions, although doubtless there are locally semi-perched water bodies. (See logs, wells 8a, 8d, 8h, and 8i, Table 9.)

A recording gage was installed in well 8b in 1948 and operated for about a year. Subsequently, measurements were made approximately weekly for several years, and then at somewhat less regular intervals to the present time. The recording gage did not operate satisfactorily, so that the better part of the record of the water level at Va.-US-2 is the period 1950 through 1958. Figure 6 is a graph showing the fluctuations in the water level at this well during the period of measurement from March 1948 to February 1967, together with the [redacted] total annual precipitation at Onley from 1948 through 1966.

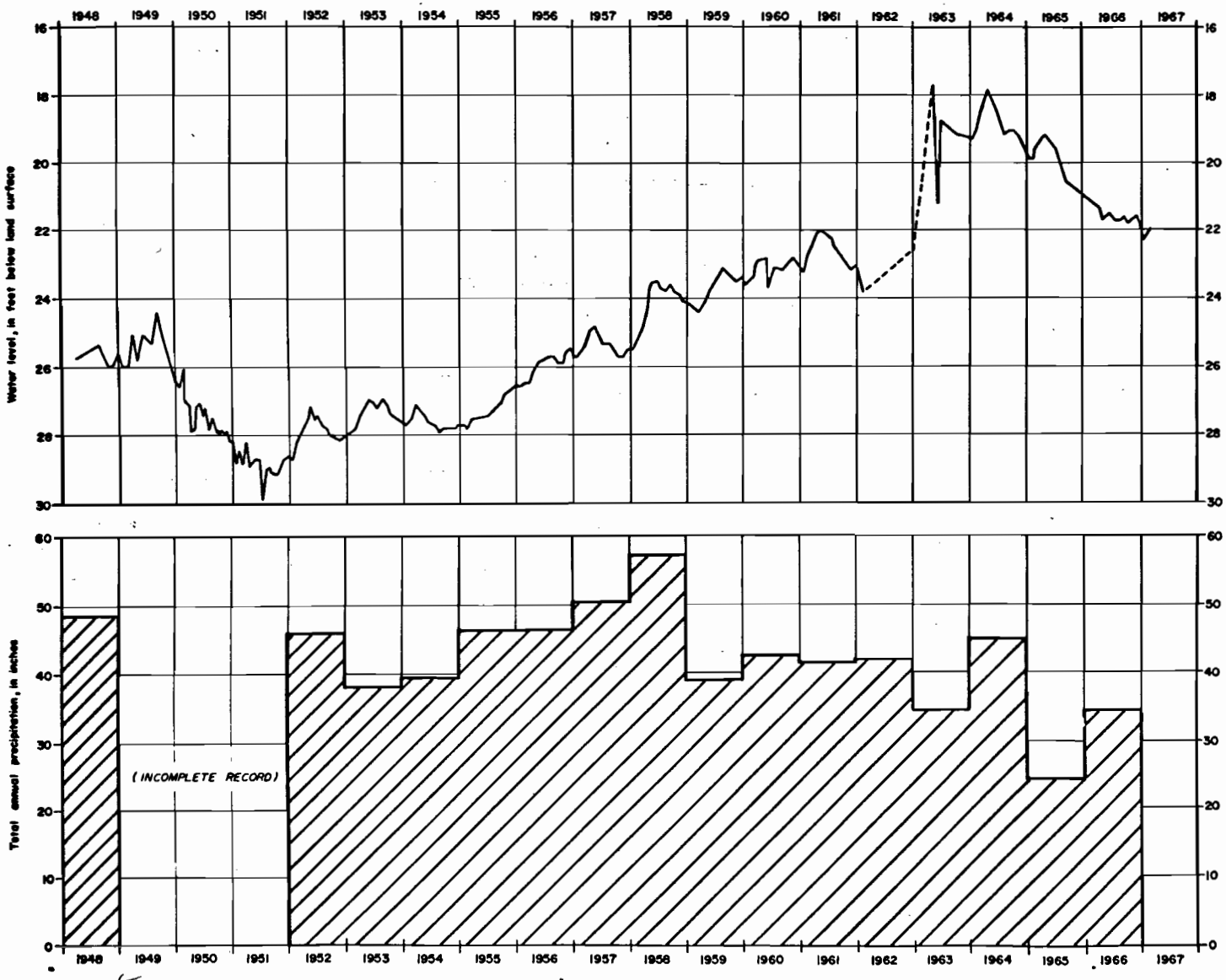

Figure 6.—Water level fluctuations in Federal Observation Well Va.-US-2 (well 8b, Accomack County), from 1948 through early 1967, and total annual precipitation at Onley from 1948 through 1966.

Although data on withdrawals at the station are not available, the early decline in water level in this well, from 1949 through late 1951, is inferred as reflecting an increase in water use resulting from greater activity during the Korean conflict. While water use probably remained at a relatively constant level from 1953 though 1958, the increase in precipitation, also shown in Figure 6, based on records farther south on the peninsula at Onley, is apparently reflected by a corresponding rise of nearly 5 feet in water level in the observation well. At about this time, the number of personnel at the station was reduced as the Navy gradually brought its operations to a close during the late fifties. This may account for the continued rise in water level in the observation well despite the drop in precipitation beginning in 1959.

The effect of the Northeast Drought of 1961-1966, which did not extend into Virginia until 1965, was apparently partly the cause of the 2-foot decline in water level from mid-1965 into 1967. This decline was probably augmented by increasing water use by the growing work force of the National Aeronautics and Space Administration's Wallops Station operations.

Owing to limitations and interruption of funds for this investigation, systematic water-level measurements have not been made elsewhere on the Eastern Shore peninsula. However, there are probably not many areas where, to date, water levels have been markedly affected by factors other than fluctuations in rainfall.

Many wells of moderately high yield are pumped only for short periods at certain seasons. Examples are wells 6a and 115 in Accomack County, where the water is used for canning and irrigation. There is thus ample time for replenishment of the ground-water reservoirs during the periods when such wells are not pumping.

There are a number of flowing wells on the peninsula, which are referred to in the county reports (Virginia Division of Planning, 1965a, b and 1967). Some of these are equipped with pumps, and the natural flow is shut off so that not all flowing wells are allowed to run "wild," and waste of water and consequent decline of artesian pressure are probably minimal.

The yield of some flowing wells shows a marked increase during high tide--for example, the 385-foot well at Wachapreague (160, Table 8, Fig. 7). Other wells flow only intermittently, ceasing to flow altogether during ebb tide. The increase in flow with rising tide is a mechanism known as "tidal loading," and is noted also in many other flowing wells throughout Tidewater Virginia. It is caused by the compression of the artesian aquifers by the weight of the advancing tidewater. This mechanism has two effects, one being to increase the flow of ground water from flowing wells, and the other to raise the piezometric or pressure surface, the level to which water will rise, in nonflowing artesian wells. As the tide recedes, the pressure is gradually released, and the flow from

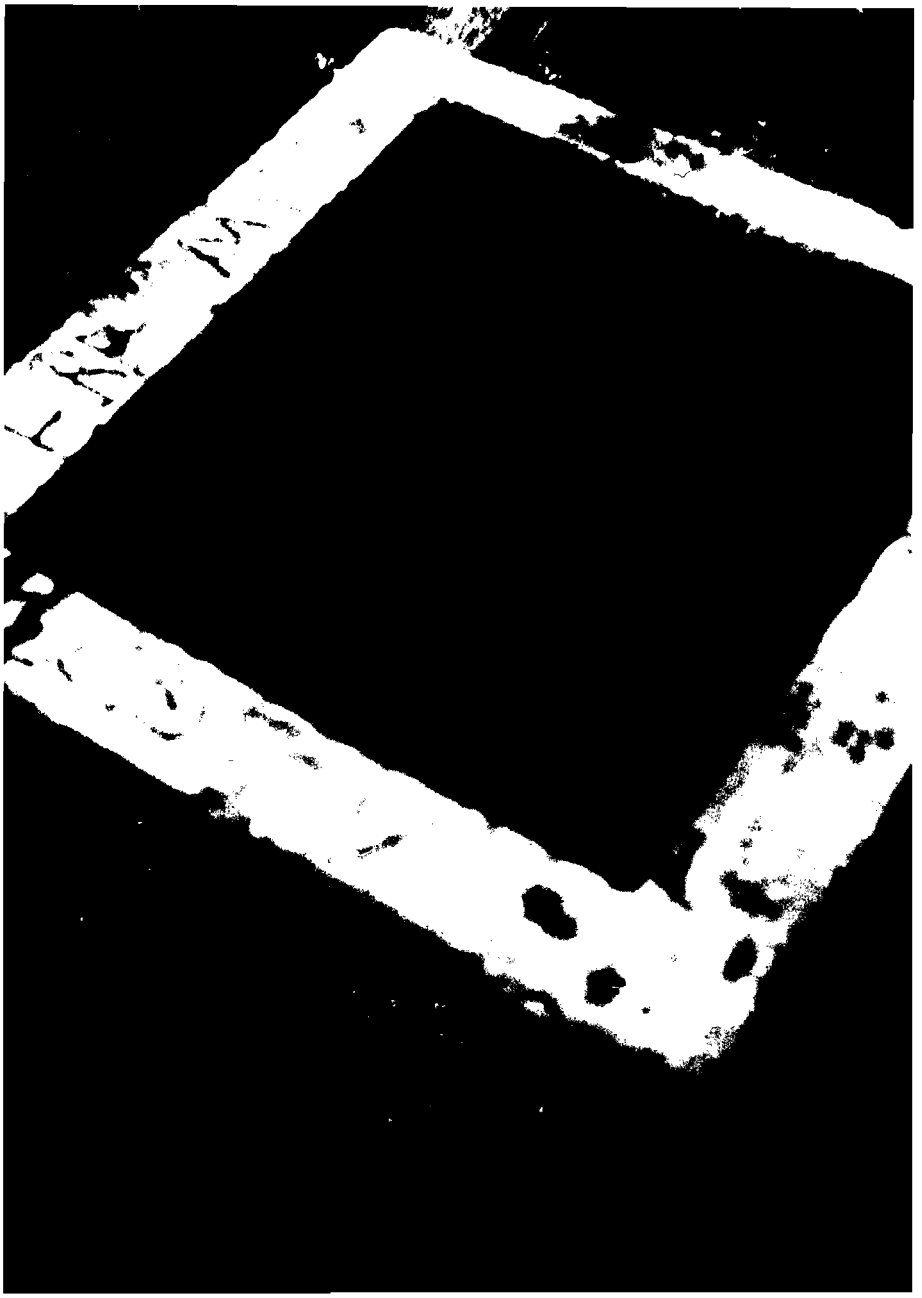

Figure 7.--Old public flowing well at Wachapreague, Accomack County. See well 160, Table 8.

the flowing wells diminishes ~~not~~ and the water level in non-flowing wells declines.

The demand for water in the Eastern Shore counties thus far has not been great and, in general, the water levels in places some distance away from actively pumped areas do not appear to be significantly different from the levels reported by Sanford in 1913.

EXPLORATORY DRILLING

In the spring of 1953 a contract for test drilling was awarded for exploratory holes to be drilled by the hydraulic rotary method on the Eastern Shore peninsula. In collaboration with local officials, public lands at several schools were selected as drilling sites. Owing to limited funds, one of the holes, at the high school in Machipongo, was held to about 100 feet in total depth when good water-bearing beds were encountered within that depth, in order that three other holes could be finished at total depths exceeding 400 feet. Thus, it was possible, within the funds available, to complete the test hole at the elementary school in Capeville, near the southern end of the peninsula, a depth of 470 feet and to drill two other test holes, at Central High School between Keller and Painter and at Atlantic High School just south of Oak Hall, near the Virginia-Maryland State line, to total depths of 450 and 451 feet, respectively.

~~Schlumberger~~ electric logs were made on each of the four test holes. These logs, in conjunction with the lithologic logs, were useful in the geologic correlations and in the determination of the water-bearing zones, and provided also some indication of the chemical character of the ground water in the formations penetrated.

As brought out elsewhere in this report, through the years a wealth of information had become available on relatively shallow wells. As a result of the test drilling referred to the first

300 feet of section can ~~now~~ be characterized as silty clay, clay and silt interbedded with water-bearing sand and small gravel. There are also numerous shell beds. Several apparently good water-bearing beds 10 to 40 feet thick occur in the depth range of 100 to 300 feet: many wells on the peninsula are finished in this depth range. However, below about 300 feet only thin beds of silty sand were ordinarily found. The potential of these beds was unknown and, therefore, it appeared desirable to test whether they might yield at least moderate supplies of ground water. Accordingly, 5 feet of screen was set in each of the three deep holes at places below 300 feet that seemed most likely to yield some water.

In July 1954, each of the test holes was extensively back-washed under high pressure in order to develop as fully as possible the water-bearing zones at the screen settings. Each hole was then test-pumped by air lift, using at the well head a device which allowed ready access to the well for measurement of water levels while pumping. (See photograph, Fig. 8.)

Although the most promising material encountered among the exploratory holes in the untested section below 300 feet was at Capeville, where 22 feet of sandy material (some of it coarse) was penetrated from 442 to 464 feet below the surface, even this well yielded less than 1 gpm ~~one~~ gallon per minute after extensive development. The other two deep holes, near Keller and at Oak Hall, yielded even less than did the Capeville well.

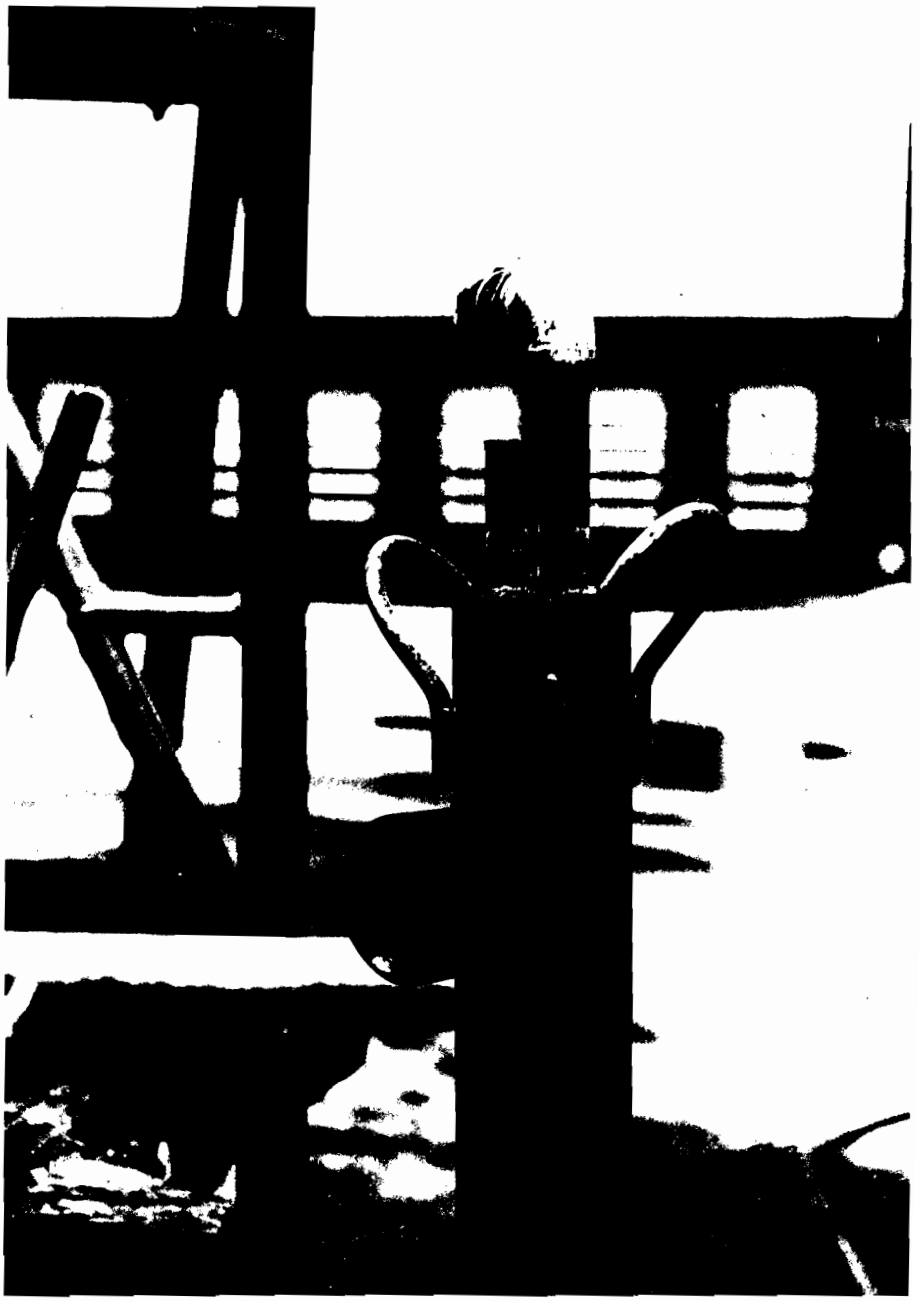

Figure 8.--Discharge head for pumping well by air lift. Shorter pipe at top of head allows access to well for measurement of water level.

On the other hand, the shallow test hole at Machipongo yielded a moderate supply of 16 gpm ~~gallons per minute~~ (Fig. 9) from an aquifer in which a 5-foot screen was set at 60 - 65 feet below the surface. A summary of the data pertaining to the four exploratory test holes is given in Table 5.

The geologic information obtained in the test-drilling program is incorporated elsewhere in this report--in the sections on the occurrence and lithology of the Miocene and Pleistocene rocks. Sample descriptions based on laboratory examination of the drill cuttings with a binocular microscope are given at the end of the well-log tables for each county (Tables 9 and 15).

Figure 9.-- U.S. Geological Survey Test Hole 2 at Machipongo while being pumped on test at 16 gallons per minute.

Table 5.--Descriptions of exploratory test holes drilled in the summer of 1953 for the U. S. Geological Survey under contract with Sydnor Pump and Well Co., Inc. (now Sydnor Hydrodynamics, Inc.), Richmond, Va.

Test hole no.	Location	Approximate altitude above sea level (feet)	Total depth drilled (feet)	Depth cased and screened (feet)	Diameter of casing (inches)	Screen setting (feet)	Geologic age	Stratigraphic unit	Approximate water level below (-) land surface when drilled (feet)	Approximate yield on test (gpm)
1	Northampton County: At Capeville Negro Elementary School, 0.3 mile S. of Capeville	20	470	465	3	460-465	Miocene	Chesapeake Group, Choptank Formation	-23	1/4
2	Northampton County: At Machipongo Negro High School in Machipongo	25	100	65	3	60-65	Pleistocene	Columbia Group	-11	16.2
3	Accomack County: 2 miles S. of Keller, at Central High School	30	450	420	3	415-420	Miocene	Chesapeake Group, Choptank Formation	-26	1/8
4	Accomack County: 0.5 mile S. of Oak Hall, at Atlantic High School	35	451	372	3	367-372	Miocene	Chesapeake Group, St. Marys Formation	-18	1/5

Hydrologic and physical properties of selected samples from the test holes

From the drill cuttings collected during construction of the four U.S. Geological Survey test holes, 23 samples were selected as possible water-bearing materials. Quantitative analyses were made of these samples at the Hydrologic Laboratory of the Ground Water Branch, U.S. Geological Survey, in Denver, Colo. The analyses included the determination of the coefficient of permeability in Meinzer's units, and grain-size analysis of each of the samples. Because the presence of fossils in some of the samples might influence the results and interpretation, an estimate was made of the percent by weight of fossils contained in each sample.

In Table 6, the results of the tests by the Hydrologic Laboratory are given, together with certain statistical parameters computed by the writers based on the cumulative weight-percent frequency curves prepared by the Laboratory.

The results indicate a range in permeability from 5 to 1,300 gallons per day per square foot (Meinzer's units). The samples from the relatively unexplored depths below about 300 feet, however, are relatively low in permeability, ranging from 17 to 180 Meinzer's units, as would be expected on inspection of the electric logs of the test holes. (See Plate 5.)

Table 6.--Permeability and statistical parameters of selected samples from U.S. Geological Survey test holes.

USGS Hydrologic Laboratory, Sample No.	Source	Depth range, feet	Estimated percentage of fossils	Coefficient of permeability, gallons per day per sq. ft. (Meinzer's units)	Median diameter (mm)	1st quartile (mm)	3rd quartile (mm)	Coefficient of sorting, So	$\log_{10}$So	Coefficient of skewness, Sk
S4 Va 1	USGS Test Hole No. 1, near Capeville	50 - 55	< 10%	260	1.2	0.45	3.4	2.75	0.439	1.06
" 2	do.	100 - 105	75%	1,300	1.7	.88	2.5	1.68	0.225	.76
" 3	do.	140 - 145	50%	1,300	1.35	.77	1.7	1.49	0.173	.72
" 4	do	180 - 185	80%	290	1.35	.35	2.35	2.59	0.413	.45
5	do.	255 - 260	10%	100	.91	.31	1.8	2.41	0.382	.68
6	do	315 - 320	70%	43	.99	.22	2.0	3.01	0.478	.45
7	do	450 - 460	< 10%	180	.30	.21	.41	1.40	0.146	.96
8	USGS Test Hole No. 2, Machipongo	20 - 25	< 5%	240	.36	.22	.65	1.72	0.235	1.10
9	do	50 - 55	-0-	270	.25	.20	.33	1.28	0.107	1.08
10	USGS Test Hole No. 3 between Keller and Painter	45 - 50	5%	300	.29	.22	.54	1.57	0.196	1.42
11	do	150 - 155	< 10%	220	.36	.24	.52	1.47	0.167	.94
12	do	190 - 195	60%	143	.47	.26	.84	1.80	0.255	.99
13	do	260 - 265	50%	20	.42	.14	1.25	2.84	0.453	.99
14	do	370 - 375	20%	54	.23	.15	.35	1.52	0.182	1.00
15	do	405 - 410	60%	35	.50	.16	1.46	3.0	0.477	.96
16	USGS Test Hole No. 4, near Oak Hall	35 - 40	0	473	.19	.16	.24	1.24	0.093	1.09
17	do	85 - 90	0	6	.24	.17	.55	1.80	0.255	1.65
18	do	125 - 130	10%	5	.25	.15	6.2	6.54	0.816	14.5
19	do	165 - 170	10%	22	.23	.14	.43	1.78	0.250	1.14
20	do	195 - 200	60%	15	.68	.22	2.1	3.09	0.490	1.00
21	do	220 - 225	50%	6	.36	.18	2.2	3.49	0.543	3.05
22	do	270 - 275	30%	40	.20	.15	.31	1.44	0.158	1.16
23	do 42	365 - 370	60%	17	.25	.19	1.55	2.85	0.455	4.74

GENERAL GEOLOGY AND WATER-BEARING CHARACTER OF THE ROCK FORMATIONS

The sedimentary rocks underlying the Eastern Shore peninsula are nearly horizontal; correlations indicate that they dip gently eastward at a rate of ~~about~~ 5 to 20 feet per mile. (See sections A-A' and B-B', Plate 1.) These strata consist of unconsolidated beds of sand, clay, and minor gravel lenses, which rest unconformably on a broadly undulating surface of crystalline granitic and metamorphic basement rocks. The sediments become progressively thinner westward on the mainland, and ~~disappear as~~ thin to a featheredge along the eastern border of the Piedmont province called the Fall Zone. In Virginia the Fall Zone extends through Fredericksburg, Richmond, Petersburg, and Emporia.

Along the Eastern Shore peninsula, the crystalline basement complex beneath the sediments lies at depths of several thousand feet below the surface. Farther east beyond the peninsula the sediments extend beneath the Atlantic Ocean for a distance of 60 to 70 miles to the edge of the continental shelf. According to Ewing and his associates (1937), ~~a~~ geophysical evidence indicates that about 60 miles east of Cape Charles the Coastal Plain sediments may exceed 12,000 feet in thickness.

In the sections that follow, each component of the geologic column that occurs on the Eastern Shore peninsula of Virginia is described, and its water-bearing properties discussed. It will be helpful also to refer to the accompanying geologic columnar section and table. (See Plate 2.)

BASEMENT COMPLEX

Occurrence and lithology

Beneath the sedimentary cover of the Coastal Plain sediments the character of the basement complex has only been inferred on the basis of the interpretation of geophysical studies by Miller (Ewing and others, 1937). So far as known, no deep wells on the Eastern Shore peninsula have penetrated bedrock. However, the basement complex, presumably chiefly gneiss and schist, underlies the entire Eastern Shore peninsula at a depth of probably more than 3,000 feet below sea level.

The basement rock slopes eastward at about 30 feet per mile, as known from deep borings at Mathews and at Ft. Monroe. This is in agreement with geophysical results which, according to Miller (op. cit., p. 809), show "a slope of about 30 feet per mile from the Fall Line in the vicinity of Petersburg, to a point about 20 miles east of Cape Henry." Spangler and Peterson (1950, Fig. 12, p. 82) and Anderson (1951, Fig. 124, p. 433) show contours on the basement rocks ranging from about 3,000 feet below sea level at the south end of the peninsula to more than 7,000 feet below sea level at the north along the Virginia-Maryland boundary.

Water-bearing properties

In this area, these rocks lie too deep to be considered as economic sources of ground water.

CRETACEOUS SYSTEM

Lower ~~Early~~ Cretaceous Series

Occurrence and lithology

Sedimentary rocks of Cretaceous age immediately overlie the crystalline basement rocks beneath the entire Coastal Plain. Their lithologic character and fossil fauna and flora indicate that they were chiefly laid down as terrestrial, lacustrine and fluviatile sediments (Clark and Miller, 1912, p. 62). These sediments are mostly unconsolidated; clay, sand and gravel. West of Chesapeake Bay these rocks have been penetrated in the drilling of deep wells and have been subdivided into deposits of Late and Early Cretaceous age.

The Lower Cretaceous Potomac group has been subdivided into the basal Patuxent formation overlain unconformably by the Patapsco formation. North of Potomac River, in Maryland, the Arundel formation underlies the Patapsco. Spangler and Peterson (1950, p. 69) consider the Patuxent formation to be of Early Cretaceous age and "equivalent to the lower part of the Tuscaloosa of North Carolina and lower part of the Raritan of New Jersey."

Water-Bearing Properties

Beds of the Potomac Group contain prolific water-bearing formations west of Chesapeake Bay. Presumably good aquifers, i.e., thick sandy to gravelly beds, may be present at depth beneath the Eastern shore. However, the extremely meager data at hand do not provide a basis for any conclusions in this respect. Further, it is altogether likely that beds of the Potomac Group will contain brackish to saline water.

Upper ~~Late~~ Cretaceous Series

Occurrence and lithology

In the counties west of Chesapeake Bay in Virginia the lower part of the Mattaponi formation is considered to be of Late Cretaceous age (Cederstrom, 1957, p. 17).

Foraminifera in cuttings from a well drilled for the town of Crisfield, Md., 16 miles west of New Church and near the northwest corner of Accomack County, have been studied by McLean (1950), who assigned the pre-Paleocene beds to the Upper Cretaceous. (See log of this well, Table 10.)

According to McLean, the Cretaceous-Paleocene contact is at 1,067 feet below the surface at a well at Crisfield, Md. Crisfield lies 12 miles northest of Tangier Island and 28 miles west of the northernmost part of the Eastern Shore Peninsula in Virginia. The section from 1,067 to 1,302--the maximum depth penetrated in this well--is assigned to the Monmouth formation of Late Cretaceous age. The rock is chiefly non-fossiliferous sand, the lower part consisting of "vari-colored sandy clay with pink and red shades." The sand from 1,125 to 1,142 feet in the Upper Cretaceous section is the principal aquifer tapped by the well. (The other aquifers are from 717 to 721 feet, and from 760 to 802 feet, according to the driller; these are of Miocene and late Eocene age, respectively.)

Doris S. Malkin has assigned the section from 800 to 840 feet in a well drilled on Smith Island, ~~Maryland~~, about 10 miles north of Tangier Island in Chesapeake Bay, tentatively to the Upper Cretaceous (table 10). Inasmuch as the beds referred to are unfossiliferous quartz sands occurring high in the section immediately below beds assigned (by Malkin) to the Aquia Paleocene, it may well be that these sands are of Paleocene age rather than Late Cretaceous.

The Cape Charles well (90, table 15) is believed to reach rocks of Late Cretaceous age at a depth of about 1,000 feet. Correlations are at best tentative and adequate samples from any future test drilling will no doubt result in considerable revision.

Water-bearing properties

The municipal well at Crisfield, Md., referred to above, taps water from sand at 1,125 to 1,142 feet below the surface, reported by McLean (1950) to be of Late Cretaceous age, in addition to Eocene and Miocene aquifers at shallower depths. This well yielded 300 gpm with a drawdown of about 100 feet; when drilled, it was a flowing well. Another well at Crisfield, completed in the spring of 1950, yielded about 200 gpm with a drawdown of about 50 feet, also from sands of Late Cretaceous age.

As shown by logs of the Crisfield wells (table 10) there are apparently relatively few potentially good water-bearing zones in the Cretaceous part of the stratigraphic section near the Maryland State Line.

Based on the meager information thus far made available, the only assurance that can be made regarding Cretaceous rocks is that moderate supplies of ground-water--up to about 300 gallons per minute per well--of fairly satisfactory quality might be developed from properly constructed wells finished in Late Cretaceous aquifers near the northern part of Accomack County.

As brought out elsewhere in this report, in the southern part of Accomack County and in all of Northampton County, water from the Cretaceous rocks is probably a high chloride water and therefore would be unsuitable for most ordinary purposes.

TERTIARY SYSTEM

Paleocene Series

Occurrence and lithology

The presence of Paleocene beds in Virginia was postulated in 1957 by Cederstrom who considered the beds beneath the typical Aquia formation along Potomac River and elsewhere to be Paleocene and ~~Upper~~ Late Cretaceous in age. These beds were named the Mattaponi Formation. Previously Bennett and Collins (1952) working in Maryland, had shown that the Brightseat Formation, which underlies the Aquia, is of Paleocene age. ~~Very~~ More recently Loeblich and Tappan (1957a, b) determined that the overlying typical Aquia itself is of Paleocene age rather than of ~~Lower~~ Early Eocene age as had been accepted up to that time.

Whether or not the Brightseat formation is in fact equivalent to the upper part of the Mattaponi formation is yet to be established. To avoid lengthy discussion that would not be fruitful insofar as this paper is concerned, the Virginia pre-Eocene section will be referred to simply, in descending order, as the Paleocene Aquia formation, as known from microfossils at Aquia Creek (Cushman, 1944), and the Mattaponi formation of Paleocene to Late Cretaceous age.

The Aquia formation, as seen in the type locality, appears to thin out eastward from the Fall Zone (Cederstrom, 1957, p. 24) and may not be present at depth beneath the Eastern Shore Counties. It is suggested that the Aquia of Malkin in the Smith Island well may be somewhat older than the Aquia of the type locality and, therefore, part of what is termed the Mattaponi formation to the west in Virginia.

The Crisfield well apparently penetrates 207 feet of beds assigned to the Paleocene. It may be noted in the log (table 10) that the Aquia, as well as the higher Nanjemoy formation of Eocene age, are absent insofar as McLean's findings are concerned.

It thus appears quite likely that the stratigraphic equivalent of the Mattaponi formation of Late Cretaceous and Paleocene age is represented in the subsurface of the Eastern Shore of Virginia. In the ~~cross~~ geologic section, Plate 1, the stratigraphic divisions are drawn at Cape Charles and Cobb Island much as given by McLean for the Crisfield well. The contacts drawn seem to make a good fit with the stratigraphy as presently understood in the lower York-James Peninsula. However, the logs (90 and 180, Table 15) are not sufficiently detailed to characterize the lithology properly or to show where the contacts occur in the section.

Water-bearing properties

The Mattaponi formation contains prolific water-bearing sands west of Chesapeake Bay. Sufficient test drilling has not been accomplished to show that it is similar in make-up on the Eastern Shore.

Eocene Series

Occurrence and lithology

The Eocene deposits of Virginia were named the Pamunkey formation by Darton (1891) before the turn of the century. This formation was later subdivided by other investigators into the Aquia Formation (Clark and Martin, 1901, p. 58) and Nanjemoy Formation (ibid., p. 64).

The Nanjemoy Formation is of Middle and ~~Lower~~ Early Eocene age but, as noted above, the Aquia has [redacted] been assigned to the Paleocene. In 1945 the presence of an Upper Eocene formation was described for the first time in Virginia (Cushman and Cederstrom, 1945; and Cederstrom, 1957, p. 28).

The Nanjemoy Formation ~~with~~ and its easily recognized foraminiferal fauna is well developed not far east of the Fall Zone but appears to thin and vanish eastward. The typical underlying Aquia Formation (Cushman, 1944) (now assigned to the Paleocene) also thins eastward (Cederstrom, 1957, Plate 1). The Upper Eocene formation, the Chickahominy, does not extend to the Fall Zone. It is present about as far inland as West Point but thickens from a few feet to more than 100 feet to the east. McLean assigns 100 feet of beds penetrated in the Crisfield well to the Chickahominy Formation~~s~~, and ~~He~~ considers the Nanjemoy to be absent. In the Smith Island well that lies west of the Crisfield well, Malkin notes the presence of at least 20 feet of Chicahominy Formation and assigns 50 feet of underlying section to the Nanjemoy. The writers accept McLean's and Cederstrom's thinking with reference to the Nanjemoy and assume that the formation is not present in the Eastern Shore counties. Smith Island is almost directly east of the Northern Neck Peninsula of Virginia where good faunal assemblages have been examined.

It may be noted that with reference to the beds assigned to the Nanjemoy Formation in the Smith Island well, Miss Shifflett has stated (1948, p. 27) "there is no evidence of Wilcox or Claiborne Eocene in the section."

Water-bearing properties

The Chickahominy Formation, the only Eocene formation believed to be present at depth on the Eastern Shore, is a predominantly clayey formation in the York-James Peninsula but along the Potomac it is somewhat sandy and yields water to some wells. In the Crisfield town well the Chickahominy Formation consists of 42 feet of somewhat glauconitic quartz sand. Hence, it is thought that in northern Accomac County late Eocene beds may be water-bearing but southward into Northampton County they may become less permeable. At Cape Charles only clay is reported in the interval where Eocene beds would be expected. However, from the appearance of the log, it seems likely that fast drilling accounts for the "lack" of sandy beds rather than any other reason. Sandy beds were reported in the Cobb Island well but the sands there are fine.

Just across the State line in Maryland, the upper Eocene rocks in the Bradshaw well on Smith Island and the upper 42 feet of the upper Eocene rocks in the Crisfield municipal well are reported to be sandy (Malkin, 1947; McLean, 1950; see Table 10.)

It might be expected that the beds lying deep beneath the Eastern Shore Peninsula would contain only brackish water. Cederstrom has delineated (1946 b, Plate 3) the area of brackish artesian waters west of Chesapeake Bay but does not show what might be expected in the more northerly part of the Eastern Shore.

In this light the data on the Tangier Island well is especially significant. The well, ~~8600~~ 800 feet deep, is ~~presumed~~ thought to penetrate about 100 feet of Chickahominy deposits. A sample collected in this investigation shows that the water contains only 115 ppm of chloride. Presumably the boundary of the high-chloride zone might now be drawn from Whitestone in southeastern Lancaster County through or just north of Tangier Island. In northernmost Accomac County water of about the same quality might be expected from Eocene beds but south from there the water obtained would become progressively more brackish. The only other specific data at hand is the report that the water from the Cobb Island well, from Eocene or Uppermost Paleocene beds, was brackish.

Referring again to the water obtained from the Tangier Island well, it may be pointed out that water containing 245 ppm supplied the City of Williamsburg for many years and at Ft. Eustis water containing more than 330 ppm (parts per million) of chloride was also used for many years.

Miocene Series

Subsidence of the Coastal Plain region at the beginning of Miocene time was accompanied by an advance of the Miocene sea over the older rocks. In the northern part of the Coastal Plain the westward transgression of the seas apparently was not as great as in the southern part, as pointed out by Clark and Miller (1912, p. 213, 214).

The Miocene rocks of Maryland were first designated as the Chesapeake Formation by Darton (1891), and shortly afterward extended to include other associated deposits of Miocene age in Virginia and defined as the Chesapeake Group by Dall (1892). The group, as it occurs in Maryland, was differentiated into the basal Calvert Formation, overlain by the Choptank and St. Marys Formations by Shattuck (1902), and later (Clark and Miller, 1906, p. 19) extended to include the overlying Yorktown Formation in Virginia.

The Chesapeake Group of formations is entirely covered by the Columbia Group of Pleistocene deposits in the Eastern Shore peninsula.

Occurrence and lithology

Calvert Formation.--The Calvert formation overlies the Eocene beds. As shown in outcrops elsewhere in the region, this formation is characteristically a light-colored, commonly greenish marl that contains much diatomaceous earth. Thus, it is notably different lithologically from the glauconite-bearing sands of the underlying Eocene beds.

Although the Calvert formation was penetrated by the deep wells drilled at Cape Charles and at Cobb Island, samples are not available for study, nor are they available from deep wells on Tangier Island. None of the three deeper Geological Survey test holes drilled during this investigation reached the Calvert formation.

Choptank Formation.--The Choptank formation, in surface exposures, was known with certainty only north of the Potomac River, in Maryland until fairly recently. In 1950, Spangler and Peterson (p. 78) described the Choptank at Nomini Cliffs, along the Potomac in Westmoreland County, Va., where it has a thickness of 50 feet.

V1-24 (cond.)

The Choptank Formation is described by McLean (1950) from the subsurface in the nearby Crisfield, Md., city well, assigning to it the interval from 320 to 392 feet below the surface. In the Bradshaw well west of Crisfield on Smith Island, Md., Mrs. Curtis (Malkin, 1947) correlates the section from 170 (?) to 300 feet tentatively as Choptank.

MacNeil [1/] states that the Choptank is present in U.S.G.S.

[1/] Personal commun~~ication~~, 1955

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test hole no. 1 at Capeville, in southern Northampton County, from about 425 feet below the surface to the bottom of the hole at 470 feet (Fig. 10). In test hole no. 3, near Keller, in southern Accomack County, he believes that the Choptank may have been reached at 311-315 feet, extending thence through to the bottom of the hole at 450 feet. In these two holes the Choptank consists of sandy green clay, dark gray clay, coarse quartz sand, thin beds of black chert, and scattered shells. In test hole no. 4 at Oak Hall in northern Accomack County, there is no certain evidence that the Choptank was reached in the total depth of 451 feet to which the well was drilled. (See log, end of Table 9.) MacNeil (ibid.) suggests that the gravel in the bottom sample may mark the base of the overlying St. Marys Formation.

(El. logs & correl.)

55a

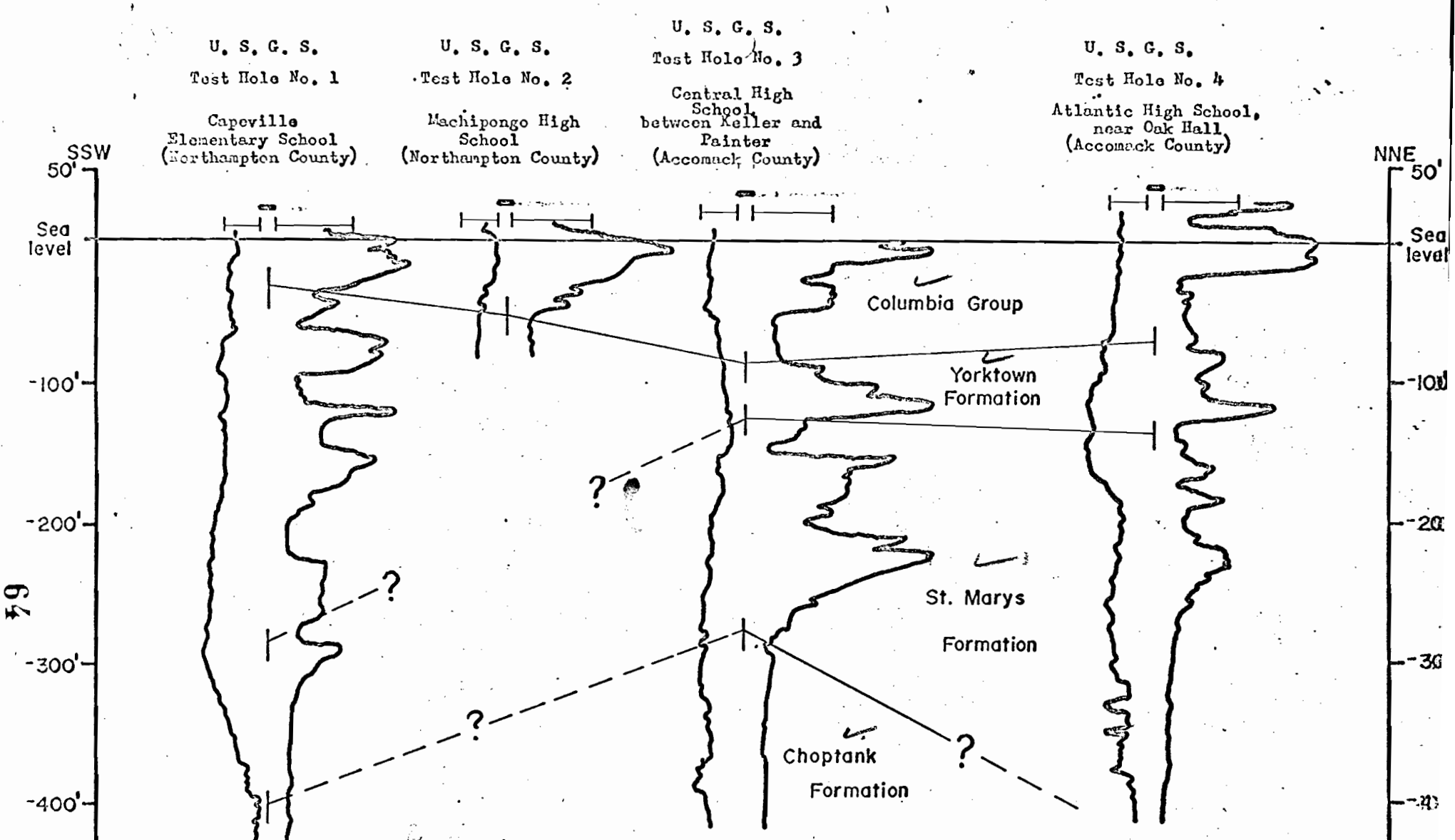

Figure 10.-- Diagrammatic correlation of U. S. Geological Survey test holes along the Eastern Shore peninsula, Virginia, showing electric logs. Scale for left curve (spontaneous potential) of each log indicates 50 millivolts; scale for right curve (resistivity), 100 ohms m^2/m. Stratigraphic correlations by F. Stearns MacNeil based on megafossils.

St. Marys Formation.-- The St. Marys Formation, in outcrop, is described by Clark and Miller (1912, p. 141) as chiefly gray to dark-blue clay, with minor layers of sand and shell marl, while diatomaceous beds are lacking. A well drilled to 317 feet (6a, Table 9) passed through coarse sand, with shell and clay layers. This formation, like other pre-Pleistocene rocks, is not exposed at the surface on the Eastern Shore of Virginia.

MacNeil (personal communication, 1955) found magafossil evidence for the St. Marys formation from 310 feet to about 425 feet below the surface in U.S. Geological Survey test hole no. 1 at Capeville; in test hole no. 3, between Koller and Painter, from 165 to about 310 feet; and in test hole no. 4, near Oak Hall, from about 175 feet to the bottom of the hole at 451 feet below the surface. (See Fig. 10; also, Section D-D', Plate 1.) It will be noted that this correlation is apparently at variance with the general lithologic pattern indicated by the electric logs in Figure 10. Differences in large part may be due to the inability to obtain truly representative samples during certain phases of a drilling operation, particularly rotary drilling.

Yorktown Formation.--According to Clark and Miller (1912, p. 158-159), the Yorktown Formation consists largely of beds of shells and shell fragments, in beds of sand and sandy clay. Like the other Miocene formations, it is not exposed at the surface on the Eastern Shore peninsula. McLean (1950, p. 134) assigns the zone from 174 to 320 feet to beds of Miocene age in the Crisfield well.

The late Julia A. Gardner (1948), of the Paleontology and Stratigraphy Branch of the U.S. Geological Survey, studied the ~~Ma~~ macrofossils obtained from cuttings from a well (76) at Cheriton in southern Northampton County, about 3 miles northeast of Cape Charles and summarized her findings as follows:

Geologic correlation	Depth, feet below the surface
Miocene, undifferentiated	106-110
Yorktown Formation (Miocene)	122-125
Yorktown Formation (Zone 1; Miocene)	158-164
Yorktown (?) Formation (Miocene)	175-190
Probably St. Marys (?) Formation (middle Miocene)	220

MacNeil (personal communication, 1955) found megafossil evidence for a nearly typical Yorktown section from 55 to about 310 feet below the surface in U.S. Geological Survey test hole no. 1 at Capeville. (Plate 2) This section is thicker than the Yorktown in the type locality and "its thickness in the Capeville well may be the greatest ever determined." At test hole no. 3, between Keller and Painter, the Yorktown Formation was found from 120 to about 165 feet, and in test hole no. 4 at Oak Hall "some or all of the interval between 105 and 175 feet may be Yorktown but the fossils are poorly preserved and fragmentary." The possibility that the apparent exceptional thickness at ~~Cheriton~~ Capeville may be due to Yorktown fossils washing down the hole at a greater depth than, say, 175 feet, should be considered.

Water-bearing properties

Wells at many of the larger homes, on farms, and for municipalities and industries on the Eastern Shore peninsula tap water from beds of Miocene age. They are generally about 100 to more than 250 feet deep, and are locally termed "deep" wells. Most of them have been constructed by the jetting method.

When larger quantities of water are required, as for municipal or industrial purposes, wells 6 inches or more in diameter drilled by the hydraulic-rotary or cable-tool method are generally employed, and many such wells are also constructed with a gravel envelope in order to obtain optimum development of the well and insure maximum capacity.

The quantity of ground water available from beds of Miocene age is moderate; under especially favorable conditions, however, large yields may be developed. The maximum yield of which there is record is 746 gpm (gallons per minute), made during a test of a well 270 feet deep and 8 inches in diameter, drilled some years ago by the Layne-Atlantic Company for the town of Exmore in the northern part of Northampton County (2 , Table 14.) However, this is an unusually large yield for a well in this area. During this test, the drawdown was 37 feet, indicating a specific capacity of about 20 (gpm per foot of drawdown; Meinzer, 1923, p. 62). The permanent pump installation at this well delivered about 310 gpm with a drawdown of 13 feet (specific capacity, 24). The well is gravel packed, and

The water is derived from coarse sand, and sand and gravel, in the Yorktown formation, from 165 to 238 feet below the surface.

In northern Accomack County, another well, 259 feet deep, and 8 inches in diameter (6a, Table 8), was constructed in 1947 for the Kelley cannery in New Church. It yielded on test 254 gpm with a drawdown of 79 feet, having therefore a specific capacity of 3.2 gallons per foot of drawdown. The water-bearing sands, believed to be the St. Marys formation, are thus not nearly so permeable as the sand and gravel of the Yorktown at Exmore, but the yield is satisfactory and the water is of good quality. A few years later, a second well was drilled for this cannery with a comparable yield. Each well is now pumped at about 180 gpm when the seasonal canning operations are under way.

QUATERNARY SYSTEM

Pleistocene Series

Occurrence and lithology

The Columbia Group of Pleistocene age (Plate 2) ~~(Fig. 4)~~, consists of a succession of nearly horizontal marine and estuarine deposits that form a mantle over the older sedimentary rocks of the Virginia Coastal Plain. These unconsolidated rocks are extensively developed on the mainland part of the Coastal Plain.

On the Eastern Shore peninsula, some general mapping of the Pleistocene terraces and their landward shoreline escarpments has been accomplished (Sinnott and Tibbitts, 1961). In much of the literature, each terrace has been regarded as the upper surface of a Pleistocene formation among the Columbia Group; the name of each terrace has been used also for an associated formation of the same name--from whence the term "terrace formation."

In recent years, the idea that each terrace is associated with a separate formation has come under scrutiny. In southeastern Virginia, Moore (1955[redacted]) presented evidence that more than one terrace has been developed on a single formation. Also in southeastern Virginia, investigations by Oaks and Coch (1963; also, Coch, 1965, and Oaks, 1965) ~~(1963), Coch (1965), and Oaks (1965)~~ have resulted in developing this idea still further, aided by many test borings and detailed examination of the lithology of the post-Miocene sediments. ~~Other recent work also has been carried out elsewhere in the Atlantic Coastal Plain--for example, that by Colquhoun (1963) in South Carolina, and Hoyt and Hart (1967) in Georgia.~~

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It is therefore evident that a great deal of study remains to be done in order to determine details of the Columbia Group. For the present purpose, however, such work was neither feasible nor necessary, and the formations of the Columbia Group have been treated in a general manner.

The Columbia Group on the Eastern Shore peninsula is represented by deposits consisting largely of unfossiliferous weathered clayey sands and gravels (Fig. 11). Locally, the gravel is very coarse, with pebbles ~~up to~~ as much as 6 inches long or more (Fig. 12). The sands are commonly distinctively yellow as compared with the grayer Miocene rocks which are likewise unconsolidated. The yellow color is attributed to the oxidation and hydration of iron released from ferromagnesian minerals in the sediments, which probably took place largely during the littoral and shallow marine or estuarine conditions under which the deposits were formed. The maximum range of thickness of the Columbia Group on the peninsula is believed to be from 60 to not much more than 100 feet, being thickest in areas of higher ~~elevation~~ land.

Water-bearing properties

There are many hundreds of shallow dug or driven wells on the Eastern Shore peninsula which tap the surface deposits of Pleistocene age. These wells yield small quantities of water--~~up to about~~ as much as 10 gpm. Among

Figure 11.--Columbia Group of Pleistocene age. Lens of fine gravel 4 inches thick (at handle of pick), overlain by 10 inches of well-sorted sand, in turn overlain by cross-bedded sand. In cliff, half a mile southeast of old ferry terminal, Kiptopeke Beach, Northampton County.

Figure 4.--Coarse gravel and boulders up to 6 inches long in gravel pit 1 1/2 miles west of Hallwood, Accomack County.

these wells, the shallowest generally yield water characteristically high in iron, and many of these are likely also to be polluted with organic wastes, as is suggested by high concentrations of nitrate.

There are a few extensive developments of water from the deeper horizons of the Columbia Group. One of these is the municipal well field supplying the Town of Chincoteague in northeastern Accomack County. This well field is 3-1/2 miles west of the town, on the peninsula proper. There 28 shallow wells 50 to 65 feet deep (9a, Table 8) have a combined yield of about 140,000 gallons of water per day. At the Main Base of Wallops Station, National Aeronautics and Space Administration, 5 miles west of Chincoteague, several 8-inch wells 54 to 65 feet deep pump from 50 to 85 gpm from Pleistocene aquifers (8a to 8i, Table 8). The quality of the water from the deeper Pleistocene beds is hard, but is otherwise low in dissolved mineral matter.

Holocene Series

Deposits of Holocene age on the Eastern Shore peninsula are represented by alluvium in creek beds and lagoonal deposits, and deposits forming dunes (Fig. 4), beaches, bars, and spits. Except for some of the beaches, the lateral extent of these deposits is limited and they are relatively thin.

So far as known, there are no wells in the area that tap ground water in ~~Recent~~ Holocene deposits, although small supplies could probably be developed in a few favorable places, particularly in the beach deposits well above high tide level. In order to guard against saline water intrusion, wells in the beach deposits should not be pumped long enough to cause a decline of the water table below mean sea level.

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QUALITY OF GROUND WATER

During the course of the investigation, more than 150 ground-water samples were collected for chemical analysis, including four samples collected from wells in the vicinity of the town of Ewell on Smith Island in Somerset County, Maryland. Among the analyses made of these samples, there are 18 comprehensive analyses and over 130 partial or preliminary analyses--most of them made in the laboratories of the Quality of Water Branch of the U. S. Geological Survey in Charlottesville, Va.

Ground water used in the Eastern Shore is generally withdrawn from rocks of Miocene age--from the so-called "deep" wells--and

from rocks of Pleistocene age. The following general discussion of the chemical quality of the ground water is given in greater detail in the chapters on each county later in this report.

Water from Cretaceous and Paleocene deposits

So far as known, the only well on Virginia's Eastern Shore drilled deep enough to reach beds of Cretaceous age is the old Cape Charles well (90, Northampton County). Late Cretaceous beds were probably reached at about 1,000 feet below the surface, as shown in Plate 1. An analyses of the water from this well is not available. Water from the Cobb Island well, presumably from Paleocene beds, was "brackish."

The well on Smith Island, Md., about 10 miles north of Tangier Island, probably ends in Paleocene deposits. Several flowing wells there, ranging in depth from 840 to 852 feet, yield a high sodium-bicarbonate water. However, the chloride content is very low in all these waters, 10 ppm ~~parts per million~~ or less. Sulfate in the water from these wells ranges from 14 to 35 ppm ~~parts per million~~ and fluoride up to 4.4 ppm ~~parts per million~~. (See Table 13.)

From the foregoing, it is clear that ground water of good chemical quality--except for the relatively high fluoride content--occurs in the Smith Island area. Hence, the zone of high-chloride

ground water, delineated by Cederstrom (1943, Plate 3), would be expected to exclude Smith Island, but to include virtually the entire Eastern Shore peninsula of Virginia. Until wells deeper than about 850 feet are drilled on the Eastern Shore and tested, it will be impossible to do more than to express a conviction that the deeper water-bearing horizons on the Eastern Shore peninsula probably will yield high-chloride ground water.

The relatively high fluoride content is characteristic of ground water from rocks of Cretaceous age elsewhere in the Coastal Plain of Virginia (Sinnott and Whetstone, 1962). It is therefore thought that water from the pre-Eocene deposits in Northampton County and in Accomack County would be likely to have relatively high fluoride and relatively high chloride concentrations.

Water from Eocene deposits

As already noted, very few wells have reached the Eocene deposits on the Eastern Shore peninsula; among these, the only one whose water thus far has been sampled for chemical analysis is the old fish factory well on Tangier Island, about 14 miles south-southwest of Crisfield, Md., in the middle of Chesapeake Bay. This 860-foot well (183, Accomack County) yields a very soft sodium-bicarbonate type water with a chloride concentration of 115 ppm, a sulfate concentration of 58 ppm, and a fluoride concentration of 3.2 ppm ~~(See analysis,~~ Table 11). The concentration of fluoride is about twice the maximum that is considered suitable for drinking water by growing children under 10 years of age. (See U.S. Public Health Service, 1962.)

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Water from Miocene deposits

As already discussed, nearly all of the so-called "deep" wells on the Eastern Shore tap ground water from rocks of Miocene age. The chemical quality of water from this part of the geologic column is therefore of particular interest from the standpoint of the economy of the Eastern Shore counties.

V1-39 In Accomack County, waters from Miocene aquifers generally are high in bicarbonate, averaging a little over 150 ppm (~~parts per million~~). The chloride content is generally less than 25 ppm, although there are a few well waters showing higher concentrations. Sulfate and fluoride concentrations ordinarily are low. Hardness commonly ranges between 80 and 150 ~~parts per million~~ throughout the county; a few well waters, however, ~~indicate~~ have a hardness of less than 50 ppm.

Bicarbonate concentrations in samples of water from wells tapping Miocene beds in Northampton County range mostly from 100 to 200 ppm. As in Accomack County, the chloride content is low with but few exceptions, and concentrations of sulfate and fluoride also are low.

Water from Pleistocene deposits

On the Eastern Shore peninsula of Virginia, Pleistocene rocks probably extend from the surface down to a maximum of about 100 feet, depending on the altitude of the land surface. Many shallow wells throughout the county tap these deposits, but in general the wells that yield water from Pleistocene beds are not heavily pumped, except as noted below. ~~with the exceptions noted below.~~

In Accomack County, the dissolved solids content in ground water from the Pleistocene deposits ranges from about 100 to 250 ppm,

although there are a few exceptions. Iron is present locally in excessive amounts, but chloride concentrations are low to moderate and fluoride is commonly absent. These waters are not generally as hard as those from the underlying Miocene rocks. Nitrate concentrations may be high in some well waters, in part because of improper well construction, especially in the case of dug wells. In some instances natural filtration of waters flowing from polluted surface waters to the aquifer may be incomplete.

In Northampton County, only a very few wells tapping Pleistocene deposits yield water with a hardness exceeding 120 ppm. Sulfate and bicarbonate concentrations are moderately low, and generally less than 100 ppm. Fluoride is either absent, or present only in concentrations of a few tenths of a part per million. Chloride is generally moderately low, but locally, as in three wells (40, 48, and 55) in the northern half of the county, may be as high as 80 ppm. As in Accomack County, nitrate may be high among certain well waters, for the same reasons. Iron also may be high. It ranges from less than 1 ppm to more than 5 ppm in the samples analyzed.

In some areas on the peninsula, however, water from the Pleistocene deposits is regarded as more suitable than water from deeper sources. For example, in a nursery operated until about 1966 by Mr. Harold Graham near Bobtown, about 5 miles south-southwest of Onancock, 12 wells (138, Table 8) spaced about 40 feet apart in two rows of six

wells each, yielded a total of about 110 ~~gallons per minute~~ from a depth of 20 to 22 feet below the surface. The wells are 1 1/4-inch drive points. According to Mr. Graham, water from deep wells is too highly mineralized for irrigation purposes, so that the shallow well system was developed. This system has been very satisfactory, and no lessening in yield was noted in a test of 3 days of continuous pumping. In this locality, a test hole was first sunk to a depth of 108 feet, but water from the sand and gravel between 70 feet and the bottom was reported to be unsatisfactory.

According to Mr. Otis D. Marshall, former Water Superintendent of the Town of Chincoteague, the municipal shallow well system, developed on the peninsula 3 1/2 miles west of the town, yields about 140,000 gallons per day of ground water, from a depth of about 65 feet. The water is of excellent quality. (See analysis, well 9a, Table 11.) The former Naval Aviation Ordnance Test Station near Chincoteague--now Wallops Station, Main Base, of the National Aeronautics and Space Administration--had sunk about 10 wells to a similar depth. Water of generally satisfactory quality has been obtained from these wells, as shown in analyses 8b, 8e, 8h, and 8i, Table 11.

Suitability of ground water for irrigation

In addition to the anticipated gradual industrial and municipal expansion on the Eastern Shore, a ~~promising~~ potential increasing use of ground water is for so-called supplemental irrigation. Both Accomack and Northampton counties are essentially farming communities, and irrigation is becoming of increasing importance for the control of crops during dry periods (~~See~~ Figs. 13 and 14). In times of prolonged drought it is likely that without irrigation from ground water many crops would be seriously damaged or fail outright.

There is thus an active interest in irrigation among the farmers of the peninsula. However, according to Mr. H. A. Stewart some years ago (~~personal~~ communication, 1950) it is impractical for many of the farmers to impound small streams to collect surface runoff because of the low relief on their farms, and they must therefore look to ground water as a source for the needed water. Moreover, the smaller streams are likely to cease flowing during dry periods. The suitability of the available ground water with respect to its quality for irrigation purposes thus becomes of immediate interest.

Figure 13.--Irrigation of crops by system of sprinklers; Eastern Shore peninsula.

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Figure 14.--Sprinkler irrigation of boxwood plants, about a mile south of Exmore, Northampton County.

More than 30 years ago, Scofield (1933) devised a scheme of classification of irrigation waters based on the percentage of sodium among the cations in the water. Further work, however, showed that not only the sodium percentage but also the total concentration of dissolved constituents was important in such a classification. Accordingly, a method of classification of waters was developed by Wilcox (1948) which takes also into consideration the degree of mineralization.

In a report by the U.S. Geological Survey (1954), a refinement of earlier methods, devised by the United States Salinity Laboratory Staff of the Department of Agriculture, is summarized.

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The United States Salinity Laboratory Staff (1954) recently released a classification that incorporates many of the desirable features of the early classifications together with more recent developments. Empirical equations are used in developing a diagram for the classification of irrigation waters. Although the classification embodies both research and field observations, it is tentative and should be used for general guidance only.

A. Salinity hazard.

Waters are divided into four classes: low salinity, medium salinity, high salinity, and very high salinity, the dividing points between classes being 250, 750, and 2,250 micromhos per centimeter. They range from water that can be used for irrigation of most crops on most soils to that which is not suitable for irrigation under ordinary conditions.

B. Sodium hazard.

The Salinity Laboratory introduces the term sodium-adsorption ratio (SAR), which is the relative proportion of sodium to other cations in an irrigation water and is defined by the equation:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

where the concentration of the constituents is expressed in milliequivalents per liter (or equivalents per million for most irrigation waters). It is reported that the sodium-adsorption ratio is more significant for interpreting water quality than percent sodium because it relates more directly to the adsorption of sodium by the soil.

Waters are divided into four classes with respect to sodium hazard, the dividing points being at SAR values of 10, 18, and 26. They range from low-sodium water that can be used for irrigation on almost all soils to very high sodium water which is generally unsatisfactory for irrigation.

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For maximum usefulness and clarity, the "salinity hazard" and the "sodium hazard" referred to in the preceding paragraphs are plotted on a ~~chart~~ diagram as shown in Figure 15.

In Table 7, representative wells on the Eastern Shore peninsula have been listed, together with determinations of the conductivity, the sodium-adsorption ratio (SAR), and the classification symbols of the ground water pumped from each. The classification symbols were found from the positions of the plots ~~of these parameters~~ on the classification ~~chart~~ diagram ~~developed by the Salinity Laboratory~~ S~~taffy~~ (~~See~~ Fig. 15).

Two additional factors of classification are suggested by the U.S. Salinity Laboratory Staff (1954), those for boron hazard and for bicarbonate ion hazard. For the purposes of this report, however, only the two most important elements, the sodium and salinity hazards, are considered here. The Salinity Laboratory Staff recommends that these be considered first, and that other factors, such as drainage and management practices, be taken into account when determining the applicability of a given classification of irrigation water.

Returning now to the ~~chart~~ diagram (Fig. 15) on which [redacted] the samples of ground water from aquifers of Miocene and Pleistocene age in each county are plotted, it is seen that most of them fall in the low sodium hazard (S1) and low to medium salinity (C1 - C2) categories. Water from five selected irrigation ponds are low-sodium and low-to medium-salinity types. These ponds were dug deeply enough to intersect the water table, and thus they derive water largely from the Columbia Group. However, some surface runoff also is collected in them.

Two well waters plotted outside the rectangular field of the ~~chart~~ diagram. Water from well 183 on Tangier Island from the Chickahominy formation, plotted above the top of the field with a classification of about C3 - S4. On the other hand, water in the Columbia Group from well 8i in Accomack County was of such low mineralization that its position was beyond the lower left corner of the field; its classification is C1 - S1. The one sample of water from the Choptank formation, not plotted on the ~~chart~~ diagram, has a classification of C2 - S3 (well 160, Accomack County, Table 7).

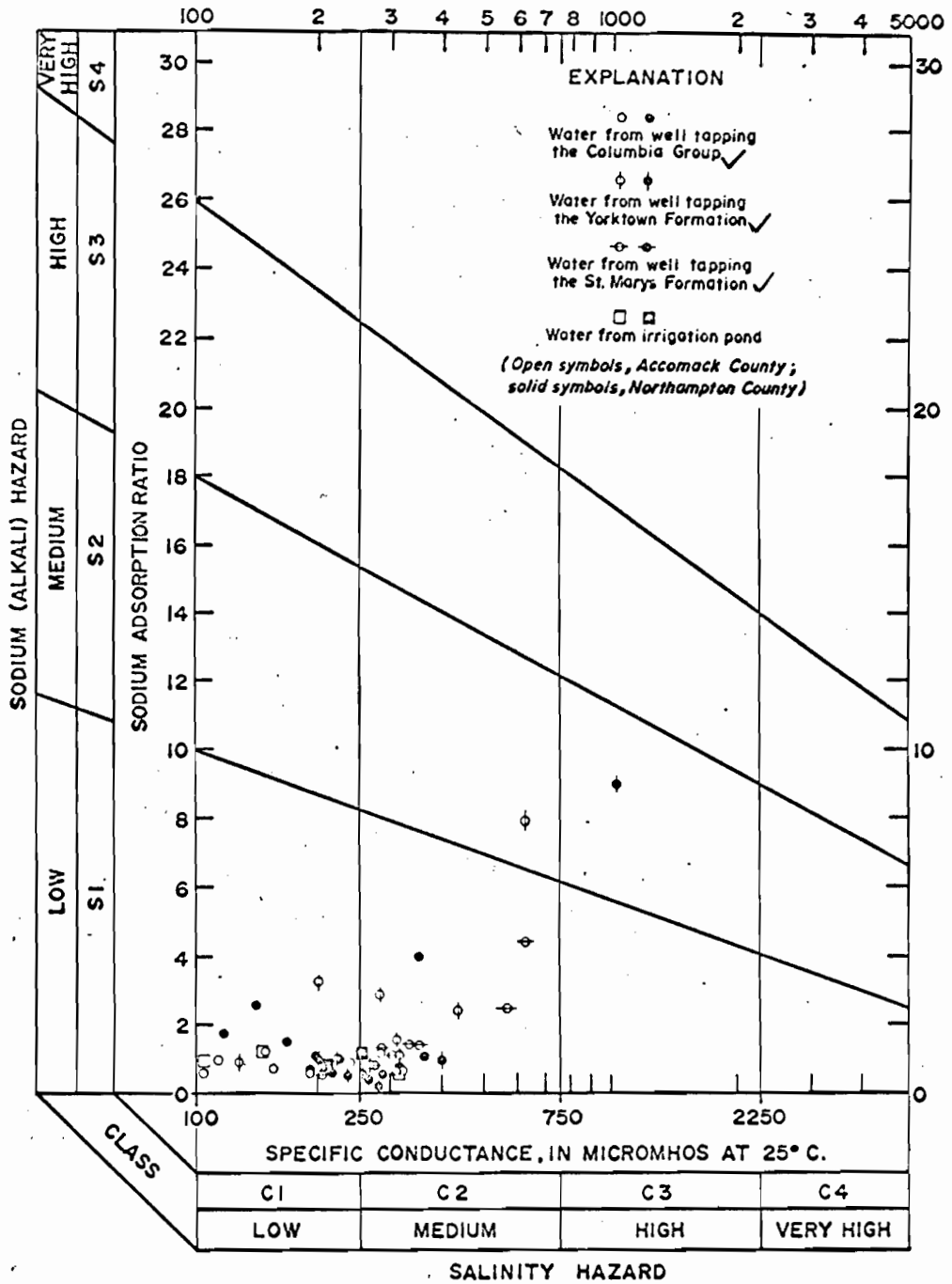

Figure 15. ~~Graph~~ Diagram showing classification of selected samples of ground water from the Eastern Shore peninsula, Virginia. See also Table 7, and discussion in text.

In Table 7, representative wells on the Eastern Shore peninsula have been listed, together with determinations of the conductivity, the sodium-adsorption ratio (SAR), and the classification symbols of the ground water pumped from each. The classification symbols were found from the positions of the plots of these parameters on the classification ~~chart~~ diagram (Fig. 15).

Table 7.--Classification of water for irrigation, for water pumped from selected wells in Accomack and Northampton counties, Virginia

($K \times 10^6$, specific conductance in micromhos at 25° C; SAR, sodium-adsorption ratio; see text for discussion of classification symbols)

[Asterisk (*) indicates SAR calculated from partial chemical analysis]

Well no.	Approximate location	Depth (feet)	Stratigraphic unit tapped	$K \times 10^6$	SAR	Classification
			Accomack County			
2	Greenbackville	45	Columbia Gr	105	* 0.41	C1-S1
4a	New Church	180	Yorktown Fm	322	* 0.9	C2-S1
5	W of New Church	127	Yorktown Fm	629	* 7.9	C2-S2
6a	New Church	259	St. Marys Fm	567	2.50	C2-S1
8i	6 mi. W of Chincoteague	65	Columbia Gr	74	.92	(See text.)
9a	Chincoteague	65	Columbia Gr	246	.98	C1-S1
22	Jenkins Bridge	123	Yorktown Fm	314	* 1.8	C2-S1
28	Saxis	112	Columbia (?) Gr	333	.42	C2-S1
35	NE of Temperanceville	174	Yorktown (?) Fm	201	* .35	C1-S1
47a	Hallwood	160	St. Marys Fm	199	.38	C1-S1
47b	Hallwood	250	St. Marys Fm	275	.79	C2-S1
49	Hallwood	240	St. Marys Fm	307	* 1.18	C2-S1
56	WSW of Hallwood	190	St. Marys Fm	645	* 4.43	C2-S1
58	SSE of Hallwood	199	Yorktown (?) Fm	224	* .82	C1-S1
65	NNE of Nelsonia	220	St. Marys Fm	209	* .62	C1-S1
76	WSW of Bloxom	138	Yorktown Fm	294	* 3.04	C2-S1
81	Hopkins	100	Yorktown Fm	271	* .83	C2-S1

(Continued)

Table 7.--Continued

Well no.	Approximate location	Depth (feet)	Stratigraphic unit tapped	Kx10^6	SAR	Classification
			Accomack County, Continued			
95	Greenbush	140	Yorktown Fm	209	* 0.76	C1-S1
101	S of Greenbush	272	St. Marys Fm	341	* 1.28	C2-S1
104	Accomac	73	Columbia Gr	163	.47	C1-S1
108c	Onancock	210	St. Marys Fm	290	1.52	C2-S1
126	SSW of Cashville	128	Yorktown Fm	444	* 2.56	C2-S1
151	Pungoteague	210	St. Marys Fm	358	1.35	C2-S1
160	Wachapreague	385	Choptank Fm	688	14.2	C2-S3
166	Craddockville	170	Yorktown Fm	134	* .8	C1-S1
167	Painter	98	Columbia Gr		* 1.12	C2-S1
*s checked 2/1 183	Tangier I.	860	Chickahominy(?) Fm	1,230	* 37.4	(see text.)
A (pond)	N of Mappsville	--	Columbia Gr.	148	1.05	C1-S1
B (pond)	E of Parksley	--	Columbia Gr.	313	.43	C2-S1
C (pond	Between Keller and Painter	--	Columbia Gr.	113	.92	C1-S1
			Northampton County			
21	Wardtown	22	Columbia Gr.	355	* 4.05	C2-S1
44b	Nassawadox	304	St. Marys Fm	316	.67	C2-S1
46	Nassawadox	82	Columbia Gr.	297	.48	C2-S1
51	SW of Bridgetown	98	Yorktown Fm	1,020	* 9.35	C3-S2
55	Machipongo	23	Columbia Gr.	141	* 2.72	C1-S1
60	ENE of Eastville	30	Columbia Gr.	122	* 1.92	C1-S1

more →

Table 7.--Continued

Well no.	Approximate location	Depth (feet)	Stratigraphic unit tapped	$K \times 10^6$	SAR	Classification
			Northampton County, Continued			
61	NE of Wilkins Beach	134	Yorktown Fm.	266	0.86	C2-S1
63	Eastville	165	Yorktown Fm.	207	.53	C1-S1
70	NE of Cobbs	22	Columbia Gr.	227	* .75	C1-S1
75	Cheriton	170	Yorktown Fm.	260	.51	C2-S1
81	Oyster	182	Yorktown Fm.	253	.65	C2-S1
82	W of Oyster	26	Columbia Gr.	230	*1.01	C1-S1
84	Oyster	185	Yorktown Fm.	311	* .71	C2-S1
111	Capeville	17	Columbia Gr.	197	* .69	C1-S1
124	WNW of Capeville	134	Yorktown Fm.	210	* .96	C1-S1
150	S of Townsend	90	Yorktown Fm.	288	* .16	C2-S1
154	SW of Townsend	87	Yorktown Fm.	242	* .42	C1-S1
159	ENE of Kiptopeke Beach	40	Columbia Gr.	188	*1.65	C1-S1
172	NE of Kiptopeke	42	Columbia Gr.	370	*1.15	C2-S1
178	Cape Charles Air Force Station	74	Yorktown Fm.	402	1.06	C2-S1
USGS T.H.-2	Machipongo	65	Columbia Gr.	201	1.15	C1-S1
D (pond)	W of Exmore	--	Columbia Gr.	215	.65	C1-S1
E (pond)	WNW of Birdsnest	--	Columbia Gr.	253	1.18	C2-S1

*'s checked OK AS 10/24/67

The Salinity Laboratory Staff (1954, p. 79-81) provides the following statements as to the significance and interpretation of the classification ratings shown by the points plotted on Figure 15:

Salinity Hazard

Low-salinity water (C1) can be used for irrigation with most crops on most soils with little likelihood that soil salinity will develop. Some leaching is required, but this occurs under normal irrigation practices except in soils of extremely low permeability.

Medium-salinity water (C2) can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.

High-salinity water (C3) cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.

SODIUM HAZARD

The classification of irrigation waters with respect to SAR is based primarily on the effect of exchangeable sodium on the physical condition of the soil. * * *

Low-sodium water (S1) can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium. * * *

Medium-sodium water (S2) will present an appreciable sodium hazard in fine-textured soils having high cation-exchange-capacity, especially under low-leaching conditions, unless gypsum is present in the soil. This water may be used on coarse-textured or organic soils with good permeability.

High-sodium water (S3) may produce harmful levels of exchangeable sodium in most soils and will require special soil management-good drainage, high leaching, and organic matter additions. * * *

The extreme classes--C4 and S4--are not quoted here because ground water on the Eastern Shore rarely reaches these levels.

It should be noted that many of the SAR determinations listed in Table 7 are based on calculations from partial chemical analyses. Among these partials, several lacked either the sulfate concentration or the nitrate concentration. Nevertheless, a few of these were retained for the SAR calculations, their selection being warranted by the likelihood that the sulfate or nitrate concentration would be low and thus would not seriously affect the SAR calculation.

Because the soils of the Eastern Shore peninsula are commonly sandy and relatively permeable, any possible adverse effect of irrigation water of higher salinity or alkali characteristics would be minimized. Thus, in summary, most waters yielded by existing wells on the Eastern Shore peninsula can be expected to be highly suitable for irrigation purposes.

WELL CONSTRUCTION

Ground water is discharged artificially by means of wells constructed so as to penetrate one or more water-bearing formations. The water is either pumped, or, in certain favorable areas, flows naturally at the surface. The various methods commonly used in well construction on the Eastern Shore peninsula are discussed briefly in this section.

Shallow Wells

Most of the shallow wells described in this report obtain water from deposits of the Columbia Group of Pleistocene age. Dug wells, to 35 feet in depth and from 2 to 6 feet in diameter, are common throughout both counties. Owing to the unconsolidated character of the Pleistocene deposits, dug wells are usually lined from top to bottom with some form of curbing such as wood, brick, tile, or cement pipe (See Fig. 16).

Dug wells are manually excavated, preferably several feet below the water table, and the curbing added as the digging progresses.

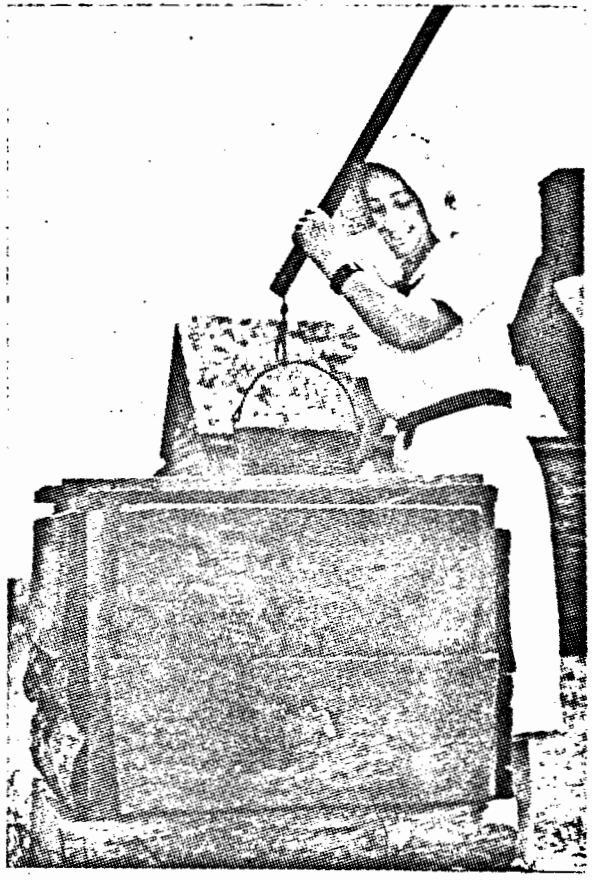

Figure 16.--A. Old bucket-lift well at Accomac.

B. Drawing water with bucket from dug well, Tangier Island

Such open wells, although picturesque, are nevertheless potentially unsanitary, and in many localities are yielding to the better-protected drilled wells equipped with pumps. Photographs courtesy Virginia State Chamber of Commerce.

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The cuttings are removed by means of a bucket, and any water that collects is pumped off. Puddled clay is sometimes poured into the space between the outside of the curbing and the wall of the hole in an effort to ~~prevent~~ deal off contamination from the surface.

In recent years the majority of shallow wells have been constructed by driving small diameter pipe equipped with drive-point strainers into the water-table aquifers. Driven wells are generally deeper than dug wells, having a practical depth limit of about 60 feet.

Some form of maul or simple triphammer is used to drive the pipe to the desired depth. The maximum diameter of pipe that can be used in this type of construction is 2-inch, and that only if the formations penetrated are soft and the well does not exceed about 30 feet in depth. Smaller pipe, from 3/4 to 1 1/2 inches in diameter, can be set at greater depths.

The chief disadvantage of shallow wells is the likelihood of

contamination from ~~sulfate~~ surface sources. Contamination is much more likely in dug wells because of the difficulty of effectively sealing the joints in the curbing. Driven wells are usually tightly sealed, but may be contaminated by infiltration through the shallow formations.

The Eastern Shore is an area of little relief and generally unsuited to impoundment of surface water for irrigation. In some places, however, large pits have been dug at topographically low points, not only to collect surface runoff but also to intersect the water table. Thus, these irrgation ponds are, in effect, large dug wells (Fig. 17). Although they are readily subject to organic pollution, they are nevertheless well suited as sources for irrigation supplies.

Water is drawn from dug wells by means of either bucket lifts or hand-operated suction lift pumps. Likewise, most driven wells are equipped also with hand pumps; where larger yields are desired they may be equipped with shallow-well jet pumps. Where local hydrogeologic conditions are favorable, batteries of driven wells (9a and 47a, Accomack County) are pumped as a unit to provide municipal and irrigation supplies.

Figure 17.--Widened and deepened channel of North Fork Creek, about 250 yards east of Route 13 (2 1/2 miles southeast of Parksley, Accomack County), developed for use as an irrigation pond.

DEEP WELLS

Wells more than about 60 feet in depth are ~~have~~ termed deep wells. On the Eastern Shore these wells obtain water from Miocene and lowermost Pleistocene deposits; a few reach deposits of Eocene age.

Yields of about 30 gpm (gallons per minute) are readily obtained by jetted wells, 2 and 3 inches in diameter; larger yields may be achieved by constructing large-diameter wells by either the cable-tool or rotary drilling methods.

On the Eastern Shore, the Miocene aquifers commonly contain confined water under artesian pressure which in some low-lying areas is sufficient to cause wells tapping them to flow above the land surface. On higher ground, the static levels of wells in these aquifers range between 5 and 20 feet below land surface and pumps are required. Shallow-well pumps can be used for small-diameter domestic wells where the static level is within 20 to 30 feet of the land surface. Larger diameter wells, with larger yields, however, require deep-well pumps because the drawdown caused by pumping usually lowers the water level below the limit of suction lift of shallow-well pumps--roughly about 30 feet.

Deep wells are not as subject to contamination from surface sources as shallow wells because of the greater depths to the aquifers and the consequent filtering action of the intervening beds. Moreover, the formation usually slumps tightly against the pipe after the well is constructed, greatly reducing the hazard of direct contamination ~~from the surface~~. along the outside of the casing.

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Jetting method

Most of the deep domestic wells on the Eastern Shore are constructed by the jetting method. In this method, hole is made by pumping water through a continuous line of hollow rods or "drill pipe" to which a bit is attached. The water is forced through constricted openings in the bit against the bottom and sides of the hole. The line of rods is activated up and down by means of a walking beam or eccentric arm and, at the same time, are given a slight rotary motion by manually twisting the string of drill pipe. The resulting hole is created largely by the force of the water and to a lesser degree, by the cutting action of the bit.

In drilling water passes down the hole through the string of pipes and returns to the surface in the annular space outside the rods and then flows into a system of pits in which the cuttings settle. The water is then picked up by the pump and recirculated. As the hole deepens, the operation is stopped temporarily and more pipe is added to the line of rods.

The casing is either advanced immediately behind the rods as the well is deepened or is "washed in" after an exploratory hole has been completed. The strainer or screen attached to the end of the casing may be washed in at the same time. The screen also may be installed after the pipe is in place. A lead seal extending above the top of the screen is wedged against the inside of the casing

in order to prevent sand from entering between the screen and the casing and plugging the well.

Jetted wells are developed by surging and pumping with air. Generally the surging or pumping action is gentle at first until all the mud and most of the fine sand have been removed from the aquifer around the screen, after which agitation is increased until all of the fines have been removed.

Although most jetted wells on the Eastern Shore are between 2 and 4 inches in diameter and from 100 and 300 feet in depth, it is possible to construct 6-inch wells to depths of 200 feet by this method and also to drill 2-inch wells to nearly 1,000 feet. Jetted wells are cheaply and quickly drilled and require only relatively simple equipment. For example, Mr. C. R. Bull drilled a 154-foot well (169, Northampton County) on his farm with a home-made rig. Moreover, a number of shallow wells in both counties have been "washed in" by pumping water through a small-diameter pipe and simply allowing the pipe to sink by its own weight as the material is loosened and washed out. The pipe used in this method of jetting is left in the hole and, therefore, serves as both drilling rod and casing.

Cable-tool method

Some of the older large-diameter municipal and industrial wells on the Eastern Shore probably were constructed by the cable-tool method.

not B~~ecause~~ in areas of unconsolidated sediments this method is slower than the jet or rotary methods of drilling, hence, most of the recent large-diameter wells on the peninsula have been constructed with rotary rigs.

In drilling by the cable-tool method, a heavy bit hung on a flexible steel cable is repeatedly raised and dropped. The cable passes over a pulley near the top of a tall mast and from there back down to a walking beam activated by the engine. Owing to the elasticity of the cable, the resulting blows have a whip-like snap that largely accounts for the breaking up of the formation.

Water is added to the hole and forms a thin clayey mud in combination with the cuttings. The mud and cuttings are removed at intervals with a bailer. In loose material, the casing closely follows or is driven slightly ahead of the hole, but in tight clay the hole may be left uncased for several tens of feet.

In water-bearing formations enough open hole can sometimes be made below the end of the casing in which to set the screen. However, in sandy formations where the hole caves, the casing is driven through the water-bearing stratum and the screen is set in place; the casing is then jacked back to expose the screen.

Cable-tool wells are developed by intermittently surging and pumping until the water pumped becomes clear. This process of development removes the fine material and leaves a natural residual envelope of coarse sand and gravel around the screen. This effectively increases the permeability of the formation around the screen permitting a greater inflow of water. In coarse gravel formations a cable-tool well may be completed without a screen, or with slotted pipe instead of a screen; however, this type of construction does not permit maximum development of the formation and, particularly in open-end development, the well eventually may become partly clogged.

Hydraulic-rotary method

Most of the municipal and industrial wells on the Eastern Shore have been drilled by the hydraulic-rotary method, as were the four U.S. Geological Survey test holes. Rotary drilling is particularly adapted to rapid construction of larger-diameter wells in areas of unconsolidated sediments. In such a hole electric logs can be made after the hole is completed in order to assist in determining the most favorable places at which to set the well screens. The casing with one or more screens can then be made up and installed in the well in one operation.

In the rotary method, hole is made by a bit attached to a continuous string of rapidly rotating hollow drill rods. A suitable

drilling mud, commonly consisting of bentonite clay mixed with water, is pumped from a mixing pit down through the hollow rods, and out through openings in the bit where the resulting washing action contributes to the cutting of the formations being drilled. The mud, with the suspended cuttings, then passes up the annular space between the rods and the wall of the hole, and flows into another pit where the cuttings settle out. From this pit, the mud returns to the mixing pit through a shallow connecting ditch and is recirculated by the pump.

The uppermost drill rod is a keyed steel bar known as a "kelly" which passes through the rotary table. The rotary table is powered by the motor and spins the kelly and attached drill rods, imparting the rotary motion for which the method is named. Additional rods are added below the kelly as the hole deepens. ~~Also~~ a constant downward pressure can be maintained on the line of rods by means of a hydraulic pulldown system. This pressure may be increased or decreased as required by the characteristics of the formation being penetrated.

The circulating drilling mud plasters the walls of the hole and prevents caving, usually allowing the entire hole to be drilled without casing. When the desired depth is reached, the drill rods are extracted and the casing, with appropriately spaced screens, is lowered into the hole. The annular space around each screen is sometimes filled with small gravel, forming a highly permeable artificial envelope around the screen and effectively increasing the yield of the well.

Rotary wells require more developing than wells constructed by other methods because initially the mud used in drilling penetrates the aquifer and largely seals off the water. This drilling mud in the aquifer around the screen must be removed in order to allow water to enter the well. Removal is accomplished by "backwashing," during which water is alternately forced into the well, and out through the screen into the aquifer, returning through the screen when the pressure is released. This surging action tends to clear the mud from water-bearing formation. The well is then pumped intermittently ("rawhided") in order to develop the aquifer. In recent years, detergents have been added during backwashing to break down the drilling mud that has penetrated the aquifer.

Most rotary wells on the Eastern Shore are equipped with electrically powered turbine pumps and are built to obtain the maximum yield possible from the formations penetrated. The majority tap several aquifers of Miocene age. An exception is the 63-foot irrigation well (115, Accomack County) on the Van Kesteren farm that yields 450 gpm from the Pleistocene Columbia Group.

USES OF GROUND WATER

The Eastern Shore peninsula in Virginia is largely an agricultural region with but little industrial development. Truck farming is widespread, and Irish potatoes and sweet potatoes are extensively raised (Fig. 18). Other crops, including strawberries, cabbage, lima beans, and string beans, are important in both Accomack and Northampton counties. These agricultural products are prepared for the market by local canneries and frozen food establishments. Likewise, seafood, ~~including~~ both fish~~ing~~ and oyster~~ing~~, are of considerable commercial importance; many of these products are canned or frozen on the peninsula. Lumbering is also an important industry in both counties.

Ground water is used extensively in these pursuits, the canning industries requiring large amounts, as does the preparation of fish and shell fish for the market or for canning or freezing. In addition, irrigation is becoming of increasing importance. The type of soil and the nature of the crops favor overhead sprinkling. Some surface water creeks are ponded for use in the irrigation of crops. However, the nature of the topography precludes extensive use of this method of collecting irrigation water, so that several of these ponds are filled by ground water pumped from wells. Moreover, at least one farmer irrigates his crops directly from well water without prior storage. Many of the farmers of the Eastern Shore are interested in installing irrigation systems in order to guarantee satisfactory production of many crops which would be destroyed or seriously damaged by prolonged dry periods, as well as to adjust the harvest time of the crops to labor conditions on the

Figure 18.--Potatoes, shown here being harvested, are one of the many important truck crops on the Eastern Shore.

peninsula. The effect of the quality of ground water used for irrigation has been discussed previously in the section on "Suitability of ground water for irrigation."

The towns and villages of the Eastern Shore peninsula depend entirely on ground water for their water supply. The supply systems are, in the main, municipally owned and operated. Inhabitants of the smaller communities that have no municipal system own ~~or~~ and operate wells individually. Many of these are shallow dug wells, with hand pumps, bucket lifts, or windmills; some are driven wells equipped with hand pumps. Many of the wells from 1 to 4 inches in diameter and 80 to 150 feet deep are equipped with electrically-driven pumps.

Tangier, in the middle of Chesapeake Bay, is an example of a community which as yet has no central municipal system. In addition to shallow wells, rain cisterns have been employed by many of the townspeople. Recently, several deep wells have been constructed, each serving nearby residents in the community.

In the town of Chincoteague, on Chincoteague Island on the ocean side of Accomack County, use of privately-owned shallow wells and rain cisterns has, since 1927, been gradually discontinued in favor of a municipal supply consisting of a group of 28 shallow jetted wells and drive points. These wells are pumped as a unit, and the water is carred by a pipeline from the well field 3½ miles west of town across the strait separating the island from the peninsula proper.

For domestic and farm supplies, most of the rural population on the peninsula obtain water from privately-owned wells. Domestic

supply wells are mostly of the type used in the smaller communities--shallow dug or driven wells. Many of these obtain water from the Columbia Group of Pleistocene age. More elaborate installations consist of wells jetted or driven into the Miocene rocks ~~and~~ that are equipped with electric pumps and pressure tanks and furnish water to the entire plumbing system of the larger households. A few of the wells are naturally flowing, and although most of these are equipped with pumps, some have sufficient flow so that they could serve without mechanical aid.

COUNTY DESCRIPTIONS

Introduction

In each of the two county chapters following, general information on Accomack and Northampton County is presented, followed by brief résumés of the geology of each county based on the more detailed treatment already presented in a previous section of this report. Next, a detailed discussion of the ground-water resources for each county is given, followed by tables describing factual data on wells based on information obtained during the well canvass, and material furnished by drillers, particularly drillers' logs. For selected wells for which drill cuttings were obtained, lithologic sample descriptions are given. Tables of chemical analyses show the quality of water available in the area and the formation from which the water was taken.

The locations of the wells listed in the tables are shown on the maps of Accomack and Northampton counties (Plates 3 and 4, respectively).

ACCOMACK COUNTY

LOCATION AND DEVELOPMENT

Ac-1 Accomack County lies in the northern part of the Eastern Shore peninsula of Virginia. It is bounded on the north by the State of Maryland, on the south by Northampton County, and on the east and west by the Atlantic Ocean and Chesapeake Bay, respectively. Its total land area is 470 square miles and the population in 1960, according to the U. S. Census was 30,635--a decrease of 3,197 since 1950. This county received the name originally given to the entire Eastern Shore by the Indians, meaning "the other side land."

The soil of the county is very productive, and it is one of the most important counties for the production of Irish potatoes and sweet potatoes. Lumbering is an important industry. Truck farms are also prominent, canning factories are important, and the poultry industry is increasing.

~~Transportation~~ Freight service is furnished by the Penn Central (formerly Pennsylvania) Railroad directly through the county from Maryland. The railway line is roughly paralleled by U. S. Highway 13. In addition, to U.S. Highway 13 there are several other important State highways, particularly 178, 316, and 175, the latter connecting the mainland with Chincoteague Island off the northeastern shore.

Among the larger towns are Accomac, the county seat, Onancock, Parksley, Wachapreague, Onley, Belle Haven, and Chincoteague.

Ac-2 Tangier, on a small island of the same name 10 miles offshore in the middle of Chesapeake Bay, is an isolated community gaining its livelihood chiefly from fish and shell fish products. Chincoteague is noted for oysters, and also for its ponies, which are

brought over from Assateague Island on the annual "pony penning day" in July. (See Fig. 19.)

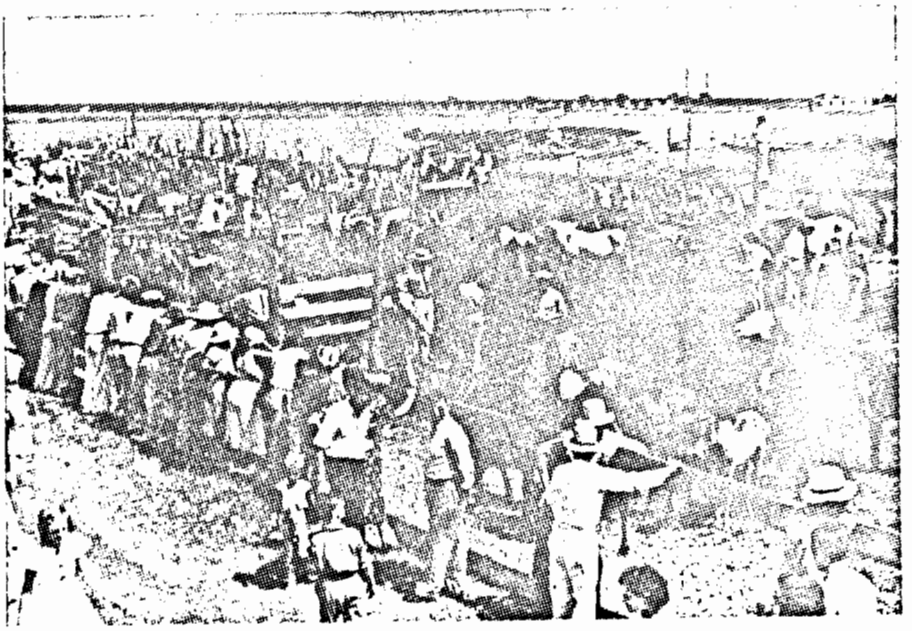
DRAINAGE AND TOPOGRAPHY

Ac-3 Like Northampton County, Accomack County has no major streams. Surface drainage is accomplished by many minor creeks flowing bayward or seaward from the almost imperceptible divide that passes longitudinally through the middle of the county. At the mouths of these creeks, particularly along the ocean side of the county, longshore currents have developed bay-mouth bars and lagoons. The aspect of the shoreline on both sides is one of submergence, as is also true of the Chesapeake Bay region as a whole.

Important creeks and tidal inlets on the Bay side are Deep Creek, northwest of the town of Accomack; Chesconnessex and Onancock creeks, west and northwest of Onancock; and Pungoteague, Nandua, and Craddock Creeks, in the southwest part of the county. Occahannock Creek is at the extreme southwest, and forms part of the boundary between Accomack and Northampton Counties.

On the ocean side, barrier beaches and bay-mouth bars have been developed opposite all the creeks. Chincoteague Bay is the longest of these, extending northeastward into Maryland, and is bounded on the east by Assateague and Chincoteague Islands. Among the lagoons lying southward from Chincoteague Bay are Bogues, Metomkin and Burtons bays. Bradfords, Swash, Revel Island, and Upshurs bays are four lagoons clustered behind Parramore Island in the southwest part of the county.

A



B

Figure 19.--

A, Round-up of wild ponies at Chincoteague. B, Selling the ponies at public auction. These ponies, thought to be descended from horses which swam ashore from wrecked Spanish galleons, roam wild on Assateague Island across a channel from Chincoteague Island. They are rounded up each July on Pony Penning Day. Photographs courtesy Virginia State Chamber of Commerce.

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A

Figure 19 A.--Round-up of wild ponies at Chincoteague.

B

Figure 19 B.--Selling the ponies at public auction. These ponies, thought to be descended from horses which swam ashore from wrecked Spanish galleons, roam wild on Assateague Island, which lies adjacent to Chincoteague Island. Photographs, courtesy of the Virginia State Chamber of Commerce.

Among the barriers enclosing the lagoons only Chincoteague Island is extensively inhabited. However, on Wallops Island, there is the Launch Area facility of the National Aeronautics and Space Administration, and there is a small settlement on Upshurs Neck at the southeastern part of the county.

The total relief in Accomack County is about 60 feet, the highest el~~evations~~ being in the vicinity of Melfa in the southern third of the county.

Although the entire surface of the county is nearly level, minor topographic features, including Pleistocene Terrace scarps and Carolina Bays, may be discerned from careful observation. These features have been discussed in earlier sections of this report. (See under Geomorphology; also, Quaternary System.)

GEOLOGY

Basement complex

The so-called basement complex of igneous and metamorphic rocks probably lies on the order of 4,500 to 7,500 feet below the surface in Accomack County. (Spangler and Peterson, 1950, Fig. 12.) The nearest well in Virginia that reached these rocks is the oil and gas test well drilled in 1929 at Mathews on the western shore. (See Plate 1, section C-C'.)

Cretaceous and Paleocene ~~Systems~~ Deposits

As shown in the log (Table 10), McLean (1950) described the Paleocene - Late Cretaceous section at the municipal well at nearby Crisfield, Md., as being largely clayey. The higher (Paleocene) beds are glauconitic and the deeper (Late Cretaceous) beds include varicolored clay. At Smith Island, Maryland, 10 miles north of Tangier Island in Chesapeake Bay, the lowermost 40 feet of unfossiliferous medium-grained white quartz sand is probably of Paleocene age. (See Table 10.)

Tertiary System

Eocene Series

Ac-8 With the exception of the early well on Tangier Island, (183, Plate 3 and table 8) rocks of Eocene age have not been penetrated by wells in Accomack County, so far as known. However, the character of the lithology is described for the two Maryland wells just discussed, and is probably similar in a general way to the Eocene section beneath at least the northern part of Accomack County.

McLean (1950, p. 136) places the Eocene between 760 and about 860 feet below the surface at Crisfield, Md., the rocks consisting chiefly of glauconitic coarse to medium sands. The entire Eocene section in this well is assigned to Late Eocene ~~(Jackson)~~ age, and therefore would be correlative with the Chickahominy Formation. ~~Mrs. Curtis,~~ in her descriptions of samples from the well up-dip on Smith Island, Malkin places the Eocene between 590 and 800 feet, and notes that the rocks are sand, shells, and glauconitic marl (~~see~~ table 10).

Miocene Series

Ac-9 Rocks of Miocene age in Accomack County do not crop out at the surface, being everywhere overlain by deposits of the Columbia Group of Pleistocene age. The several formations, designated as the Chesapeake Group, extend from a little more than 100 to as much as 700 feet below the surface. Consequently, most of the so-called "deep" wells in the county tap water from aquifers of Miocene age.

The character of the Miocene rocks is not uniform from place to place, and ~~nearby~~ closely spaced wells are likely to show considerable variation in the depth to water-yielding sandy beds.

Ac-10 The Chesapeake Group consists of four formations which are, from oldest to youngest, Calvert, Choptank, St. Marys, and Yorktown. ~~Of these,~~ no wells in Accomack County are known to have reached deposits of the Calvert Formation.

The Choptank Formation begins at about 310 feet below the surface in the U.S.G.S. test hole no. 3, extending through the entire depth of the hole to 450 feet (Tables 8 and 9 and Fig. 10). The deposits consist of silty sand and sandy clay with many shell fragments. There are no good water-bearing zones in this part of the Choptank at this locality.

Ac-11 The St. Marys Formation extends from about 175 feet below the surface in Accomack County, and reaches 310 feet at U.S.G.S. Test Hole no. 3 near Keller, but apparently thickens northeastward to at least 451 feet below the surface at Test Hole no. 4 near Oak Hall. Thus, as would be expected, more wells reach the St. Marys in the northern part of the county.

MacNeil not on list of references. p. 307.

Typically the lithology of the St. Marys Formation is interbedded blue sandy clay and silty sand ~~with~~ and abundant shell fragments.

The Yorktown Formation everywhere underlies the Pleistocene Columbia Group, and is thus more readily reached by wells deeper than about 100 feet in the county. Its thickness, according to MacNeil's study of the megafossils from the U.S.G.S test holes (Fig. 10), ranges from about 30 to 60 feet in Accomack County, although it is said to thicken to about 250 feet in southern Northampton County. The character of the material is generally sand and blue, black, or brown clay, ~~with~~ and shells.

A relatively deep well drilled at Onancock (108a) in 1890 penetrated gravel, sand, and shells from 150 to 175 feet, fine sand from 180 to 308 feet, "hard rock"--probably limestone--at 308 to 310 feet, and clay and sandy clay to 480 feet. Water was found at 90, 140 and 486 feet (Sanford, 1913, p. 125). Although this well has been abandoned, it is, to the writers' knowledge, the deepest for which there is any lithologic data on record in this county; the lowest part of the section probably approaches to within 100 to 200 feet of the Miocene-Eocene contact. Although the well thus evidently penetrated more than 150 feet ~~into~~ of the Choptank Formation, water was finally developed from the Yorktown Formation at 140 feet below the surface. Sanford also reports that another well was attempted at Onancock in 1895 and was drilled to a depth of about 600 feet, but was unsatisfactory. There is no record of the material penetrated.

The character of the Yorktown Formation at the south end of ~~the~~ Wallops Island, according to the log of well 61, consists of clay and sand from 99 to 133 feet, ~~underlain by~~ sand and shells to 145 feet, and 2 feet of gravel to about 147 feet.

Two well logs in the Harborton area in the southwestern part of the county, (132, 133, table 9) and Plate 3 show ~~indicate~~ a water-bearing sand ~~near the surface~~ in the Pleistocene ~~rocks~~ at a depth of less than ~~about~~ 15 feet, ~~deep~~, some water-bearing sand near 50 feet, probably also in the Pleistocene, and fairly good sand below about 125 feet in the Yorktown Formation. By contrast, the log of a well reaching the St. Marys at Pungoteague (151, table 9), about 2 1/2 miles to the south, indicates that almost the entire section is more or less water-bearing with only 3 feet of blue mud from 110 to 113 feet. These two sections demonstrate the variable character of the subsurface lithology of the Miocene and Pleistocene.

(1951 p 72)

Quaternary System

Pleistocene Series

Ac-14 The deposits at or near the surface in Accomack County constitute the Columbia Group of formations of Pleistocene age. ~~For reasons~~ As explained earlier, the several formations are ~~un~~not differentiated in this report.

The Pleistocene rocks in the Virginia Coastal Plain are generally yellowish or brownish in contrast to the usual white or gray color of the underlying Yorktown Formation of the Miocene Chesapeake Group. Locally, the Yorktown also may be yellowish, and because fossils are rare it is difficult to determine the position of the base of the Pleistocene. The total thickness of the Columbia Group probably ranges from about 30 to about 125 feet in Accomack County, depending on the topographic situation and on the pre-Pleistocene erosion surface on the top of the Yorktown on which the Columbia Group was laid down. The lithology of the Pleistocene deposits consists of yellow sands, sandy clays, and some gravel beds; the latter are not commonly of great lateral extent. Cross-stratification is widespread.

Ac-15 A brief petrographic study of samples across the biostratigraphic contact between the Miocene and Pleistocene section in U.S.G.S. test holes 3 and 4 ~~Delle and Accomack County~~ showed that heavy minerals also may be useful in determining the contact (Sinnott, 1955). Pyrite, garnet, and altered grains are more abundant in the Miocene, whereas zircon and kyanite are more abundant in the Pleistocene. ~~Further study of this method of correlation is needed on the Eastern Shore.~~

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GROUND-WATER RESOURCES

Water from Cretaceous and Paleocene deposits

The potential of this horizon as a water-bearing zone under favorable conditions ~~are~~ is indicated by the performance of a well drilled by the Layne-Atlantic Company for the Town of Crisfield, Md., about 16 miles west of New Church, Va. Although this well taps minor aquifers in the Miocene Calvert Formation and in beds of late Eocene (Jackson) age, the chief water-bearing zone reported was within Upper Cretaceous deposits. When completed, it was a flowing well, with a water level 4 feet above the surface. It was test-pumped at 330 gpm with a drawdown of 104 feet. Water is obtained principally from coarse to medium clear quartz sand at 1,125 to 1,142 feet. According to a mechanical analysis of this sand, 1/ the median

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1/ From basic data by James D. McLean, Jr., furnished by courtesy of Layne-Atlantic Co.

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diameter is 0.34 millimeter, and the coefficient of sorting is 1.35, indicating that the material is moderately well-sorted.

Several wells put down to depths of 840 feet or more on Smith Island, Maryland, in Chesapeake Bay about 10 miles north of Tangier Island, were all flowing wells with reported yields of up to 10

gallons per minute at the time of construction in the 1940's. These wells probably develop water from a quartz sand in the (upper) part of the Mattaponi formation which is considered to be of Paleocene age.

Water from Eocene deposits

So far as known, the only wells in Accomack County that reach deposits of Eocene age are those on Tangier Island. The old fish factory well (183, Table 8) was still flowing in 1948. However, there are several other wells of comparable depth that supply water to small groups of individuals.

Water from Miocene deposits

Most of the larger ground-water supplies in Accomack County are obtained from the two younger formations of the Chesapeake Group. In general, properly developed wells 6 inches or more in

diameter may be expected to have dependable yields of at least 100 gpm, whereas smaller diameter wells yield between 10 and 20 gpm. Discussion of the several formations of the Chesapeake Group follows.

Typist: Leave an additional space

Calvert and Choptank Formations

Ac-21 The oldest formation of the Chesapeake Group is the Calvert; there are no wells of record that were completed in this formation in Accomack County.

However, two wells of small yield--about 5 gpm--tap water from the overlying Choptank Formation (108a and 160). Of the two U.S.G.S. test holes in the county, the one near Keller (no. 3, Table 9) penetrated nearly 150 feet of the Choptank, but no good water-bearing zones were found.

From this meager amount of information, it appears that the Choptank Formation holds little promise as a potential future source of ground water in the county.

St. Marys Formation

Ac-22 The St. Marys is believed to be tapped by more than 50 wells in Accomack County. Although not as widely utilized as a source of ground water ~~than~~ as the overlying Yorktown Formation, it nevertheless supplies several important installations.

Most of the wells are 2 inches in diameter; these have yields averaging between 15 and 20 gpm. Among those of larger diameter, yields range from 115 gpm for two 4-inch diameter wells (51b and 108c), 140 gpm for a 6-inch diameter well (47a), to yields of

Ac-23 194 gpm and 254 gpm for 8-inch diameter wells (57b and 6a, respectively).

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Yorktown Formation

Ac-242

More than 60 wells for which data are available tap the Yorktown Formation for ground water in Accomack County. Of these, more than 80 percent are 2 inches in diameter; their average yield is about 16 gpm. Some of them, however, yield as much as 30 gpm (33, 83, and 91). Three wells are of larger diameter: well 61, at the Wallops Island Launch Area, National Aeronautics and Space Administration; well 87a, town of Parksley; and well 109b, town of Onancock. The~~ir~~ yield~~s~~, ~~are~~ respectively, 30, 50, and 100 gpm.

Many of the wells tapping Miocene beds are flowing wells, ~~although~~ such wells are necessarily ~~restricted to those~~ at relatively low altitudes--generally less than 10 feet above sea level. The largest flow reported was at well 160, which was finished in the Choptank Formation, owned by the Town of Wachapreague. This well is 385 feet deep, and is reported to flow at about 6 gpm ~~gallons per minute~~ at high tide and 3 gpm ~~gallons per minute~~ at low tide. The increase in flow is an effect known as "tidal loading," and is noted also in many other flowing wells throughout Tidewater Virginia. (See section entitled Water-level fluctuations earlier in this report.)

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Ac-24b

Other flowing wells tapping Miocene rocks [redacted] are well 56 (Table 8) west of Mearsville, which is 190 feet deep and flows 2 gpm (gallons per minute) from an aquifer in the St. Marys Formation, and well 81 at Hopkins, 100 feet deep, flowing 1 1/2 gpm from the Yorktown. A small flow from the St. Marys is reported for well 88, northwest of Greenbush, but this well is equipped with an electric pump for normal operation. Another flowing well (128a), east of Onley, drilled barely into the uppermost part of the Yorktown, is at a very low ~~elevation~~--approximately at sea level--and is submerged at high tide. It flows at about 1 ~~gallon per minute~~ gpm, but required installation of a pump for regular use. Well 166 at Craddockville in the Yorktown Formation was estimated to flow about 10 ~~gallons per minute~~ gpm in 1948, supplying a farm and a small pond. [redacted] the flowing wells mentioned here and entered in Table 8 may be considered representative of many similar wells in the county.

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Water from Pleistocene deposits

Columbia Group

Ac-25 Among the wells canvassed for information in the county, nearly 60 obtain water from the Pleistocene Columbia Group. Most of these are 1-1/4 to 2 inches in diameter, and their average yield is about 17 gpm per well. Most are jetted or driven wells, constructed to provide water from small farms and rural homes.

Ac-26 Besides the smaller diameter wells, there are several installations utilizing wells of larger diameter, ~~up to~~ as much as 8 inches, tapping these deposits, that yield substantially more water. Among these are well 86, operated by the town of Parksley, which yields 150 gpm, and well 115, 2 miles east-southeast of Onancock, which is 63 feet deep and yields 450 gpm with 56 feet of drawdown. This well has the largest sustained yield of any well in the county, and indeed on the entire peninsula, for which data are available. ~~The drawdown at this yield is 56 feet.~~ The well is used for irrigation, the water being distributed directly on the crops by a sprinkler system.

Although some of the wells in the Pleistocene deposits have poor yields, for example, well 124 near Onancock, which is said to require re-driving frequently, the most common difficulty concerns the chemical and possibly also the bacteriological quality of the water, [redacted] discussed in a later section.

At one locality, southwest of Craddockville, the owner reported that a 128-foot well struck "quicksand" and filled, necessitating abandonment in favor of a shallow driven well (171), 28 feet deep, which has proved satisfactory.

-Ac-27 In favorable localities, several shallow wells may be utilized together for larger supplies. In ~~this~~ such arrangement, they can be pumped separately or they can be pumped together as

a single composite well. The latter method is employed at the municipal water system plant (9a, Table 8) for the town of Chincoteague. At this plant, 28 wells, some driven and some jetted, are pumped as a unit, and yield 140,000 gpd gallons of water per day. The wells are on the peninsula proper, about 3-1/2 miles west of the town, and the water is piped across the straits, which connect Chincoteague Bay with the Atlantic Ocean, to the island community. These wells are 50 to 65 feet deep, and obtain water chiefly from Pleistocene sand, gravel, and shells near the bottom of the section penetrated. (See composite log, well 9a, Table 9) One of the wells yields water from similar water-bearing material of Miocene age at a depth of 230 feet; the water level in that well is reported to be at about 7 feet above sea level.

Formerly, residents in the town of Chincoteague obtained water individually from privately-owned shallow wells or rain cisterns. In 1948, Mr. Otis D. Marshall, then Water Superintendent, estimated that less than half a dozen shallow wells--12 to 15 feet deep--were still in use on the island. Water from the island wells was commonly brackish, and as the population of the town increased it became necessary to establish a municipal supply system. As of 1967, Mr. Leroy Jester, Jr., present Water Superintendent, reported that to his knowledge virtually no wells for individual use were in service on the island.

On Tangier Island there is no municipal supply as yet, although one had been under consideration a few years ago. More recently, several deep wells were drilled, privately financed,

Figure 20.--View showing the town of Chincoteague, on Chincoteague Island, in the northeastern part of the area. Photograph, courtesy of the Virginia State Chamber of Commerce.

each supplying a small sub-community. These wells were drilled more than 900 feet deep and probably reach the equivalent of the Mattaponi Formation of Late Cretaceous and Paleocene age. The old fish factory well in the Eocene deposits (183, Table 8), 860 feet deep and flowing as of 1948, is located at some distance from the main part of the town and is not used.

Prior to the construction of the deep wells, all residents of the island obtained water from shallow wells about 10 to 15 feet deep in the Pleistocene deposits, and from rain cisterns. A few of the shallow wells were more satisfactory than some others, and were used by several families more or less as common property.

QUALITY OF WATER

Water from Cretaceous and Eocene deposits

On the basis of available information, there are no wells in Accomack County that reach deposits of Cretaceous age.

An analysis of water obtained from Eocene deposits at the old fish factory well (183, Table 11) on Tangier Island shows that the water is a soft sodium-bicarbonate type ~~with~~ having a dissolved solids content of 857 ppm. The chloride content is moderately high, 115 ppm, and the fluoride content, 3.2 ppm, is more than twice the generally permissible maximum of 1.5 ppm (U.S. Public Health Service, 1962).

According to the map given in Bulletin 68 of the Virginia Geological Survey (Cederstrom, 1946b, Fig. 1) the boundary of the zone of high-chloride

artesian ground water should pass close to Tangier Island and just north of Accomack County. The chloride determination (183, Table 11) of 115 ppm in the water from the Tangier well [redacted] indicates that Tangier Island and northern Accomack County lie just within the high-chloride zone. As pointed out above, the deep well water at Tangier Island is not of optimum quality but does have a wide range of usefulness.

It is likely that ground water from Eocene and older aquifers in central and southern Accomack County contain much more than 115 ppm of chloride, as a consequence of which it would probably be unfit for most ordinary uses.

Water from deep wells tapping ~~Cretaceous~~ Paleocene rocks in Smith Island (Table 13), like that from Tangier Island, is a soft sodium-bicarbonate type with high fluoride content. The chloride content, however, is only about 10 ppm (parts per million).

The soft sodium-bicarbonate type water from the deep wells on Tangier and Smith Islands are similar to deep waters found elsewhere in the eastern part of the Coastal Plain.

Water from Miocene deposits

In the northern and middle parts of Accomack County, water from the Miocene aquifers is generally of the hard calcium-bicarbonate type. They are similar to waters from the somewhat shallow, characteristically limy Miocene formations elsewhere in Virginia (Cederstrom, 1946b, p. 43).

Calvert and Choptank Formations

As discussed earlier, no wells recorded here reach the Calvert Formation in the county, and only two wells obtain water from the Choptank. Of these, the 385-foot Wachapreague well was sampled in 1948. The analysis (160, Table 11) shows that the water is a soft sodium-bicarbonate type but which contains 93 ppm of chloride. This water is similar to that from the Eocene and Cretaceous aquifers elsewhere in the mainland part of the Coastal Plain. The character of the Wachapreague water suggests that deeper Miocene beds, like the Eocene and older aquifers, are recharged from the area west of Chesapeake Bay in contrast to shallower beds that are probably recharged only by local precipitation.

The other Choptank well, 108a in Onancock, was drilled in 1894 and soon abandoned. Water was found at 486 feet, but was not developed, possibly because of its undesirable chemical quality.

St. Marys and Yorktown Formations

Inasmuch as the chemical character of ground water from the two younger formations of the Miocene Chesapeake Group are similar, it is convenient to discuss them together.

In the northern third of Accomack County, water from the St. Marys and Yorktown Formations is generally of the hard calcium-bicarbonate type (4a, 6a, and 22, Table 11). Hardness of the water from these wells ranges from 81 to 168 ppm; chloride ranges from 11 parts in wells 4a

and 22, to 93 ~~parts~~ ppm, in well 6a at New Church. The fluoride content commonly is very low--less than 0.5 ppm.

Water from the 75-foot well (1, Table 11) at Franklin City is fairly high in chloride, 158 ppm. The hardness is also fairly high, 168 ppm. Although this well probably reaches the upper part of the Yorktown Formation, there evidently is hydraulic continuity with adjacent Chincoteague Bay, perhaps indirectly through Pleistocene sands. Contamination from salt water spray during storms may be possible. (See Hem, 1959, p. 107-110.) Chloride and hardness are both high also--64 and 180 ~~parts,~~ ppm, respectively--in water from well 61 developed in the Yorktown Formation at the Launch Area on Wallops Island, National Aeronautics and Space Administration. An even more highly mineralized water is that from the unused well (13) on Chincoteague Island. It is 102 feet deep and contains 693 ~~parts~~ ppm of chloride and 388 ~~parts~~ ppm of hardness. The aquifer tapped by this well probably is in the uppermost part of the Yorktown, but, again, hydraulic continuity with the overlying Pleistocene deposits and, in turn, with the brackish water of Assateague Bay seems indicated.

In the middle third of the county, from Bloxom to Onley, including Onancock and Accomac, the county seat, ground water from the Miocene aquifers also is hard and high in bicarbonate. A complete analysis of water from one of the municipal wells of Onancock (108c, Table 11) indicates that the water is moderately mineralized. ~~and~~ It contains 203 ppm of dissolved

solids and is moderately high in bicarbonate, 168 ppm. The chloride content is 15 ppm and most of the other constituents are low.

Other analyses available from this part of the county show that the water from the Miocene beds here ranges in hardness from 57 ppm, in well 76, that is 2 miles west-southwest of Bloxom, to 123 ppm ~~parts~~ in well 88, 3 miles northwest of Greenbush. Chloride is low, less than ~~under~~ 25 ppm, except in wells 88 and 93 near Chesconnessex, which had 48 and 92 ppm, respectively. The sulfate and fluoride concentrations are very low, the former averaging about 2 ppm ~~parts~~, and the latter about 0.1 ppm.

In the southern third of the county, a comprehensive analysis of water from a deep well at Pungoteague (151) is available (Sanford, 1913, p. 344-345). The well is 210 feet deep and ends in the St. Marys Formation. The water is moderately mineralized. It is only moderately hard (108 ppm) but is high in bicarbonate (218 ppm) and moderate to low in most of the other constituents. Also at Pungoteague, but tapping the shallower Yorktown Formation, is a well (153) yielding water of low mineralization. This well is 128 feet deep and yields water having only 18 ppm of bicarbonate and 36 ppm of hardness.

Among other deep wells in the southern part of the county, wells 166 at Craddockville and 177 at Belle Haven, yield water with chloride concentrations of 15 and 1 ppm, respectively, and hardness of 42 and 102 ppm. Both wells are believed to tap the Yorktown Formation.

Even though the general character of ground water in the St. Marys and Yorktown is similar, such a wide range of variation of particular constituents among individual wells probably is evidence of local hydraulic discontinuity between the two formations.

In summary, wells in Accomack County that tap aquifers of Miocene age yield water high in bicarbonate, averaging about 160 ppm in that constituent. The chloride content is generally ~~around~~ about 25 ppm, although in a few well waters it may exceed 100 ppm. Sulfate and fluoride are low--the latter averaging less that 0.3 ppm. Hardness ranges between about 70 and 125 ppm in samples from the Miocene throughout the county, with certain local exceptions.

Water from Pleistocene deposits

Shallow wells in the northern part of Accomack County tap water in the sand of the Pleistocene Columbia Group. A partial analysis of water from one of these, well 2 (Table 11) at Greenbackville, is low in all the constituents tested except iron, which is very high, 4.9 ppm. The group of wells pumped as a unit for the municipal supply for Chincoteague (9a) produces water of moderate mineralization--172 ppm of dissolved solids. The nitrate content is high, 18 ppm, suggesting organic pollution. Water from a 28-foot well at Hallwood (51c) is highly mineralized, having a specific conductance of 1,020 micromhos. Total dissolved solids content should be, therefore, about 700 ppm. However, the water is not hard (51 ppm) and the chloride content is only 16 ppm. Fluoride is apparently absent. Other constituents were not determined, although iron probably is rather high, as the owner reported an iron taste, and yellow stains are deposited on laundry. At Mappsville, an analysis of the water from a 21-foot well (60) shows 57 ppm of hardness and only 6 parts of chloride. Fluoride was not detected and the low specific conductance of 166 micromhos indicates that the concentrations of other constituents not determined are low.

In central Accomack County, two wells, each about 20 feet deep, one west of Bloxom (64) and the other east (66) of that town, yield a somewhat hard water of moderate mineralization. Water from a 40-foot driven well at Hopeton (78), between Bloxom and Parksley, is similiar. Well 99, north of Onancock, yields water that is reported to have an iron taste. In addition, the water contains 48 ppm of chloride. Fluoride is absent. A partial analysis from the 68-foot well at the County School at Accomac (102) shows that water is relatively soft containing 57 ppm of hardness. It is low in other constituents determined except iron. Iron is excessively high, 7.5 ppm.

In the southern part of the county, water from well tapping Pleistocene beds have a chloride content that ranges from 18 to 130 ppm. Hardness ranges from 45 to 108 ppm in the samples at hand. Fluoride was not detected. (See analyses, Table 11, wells 124, 171, 163, and 182.) Water from the well at Upshurs Neck (182) was reported "hard, with iron and saline taste." The chloride content is 130 ppm. Water from well 124, nearly 3 miles southwest of Onancock has a higher concentration of dissolved solids but the water is soft and the chloride content is only 18 ppm.

In summary, ground water from the Columbia Group in Accomack County is commonly low in dissolved solids. Iron may be present in excessive amounts but fluoride is characteristically low or absent and chloride is low to moderate. The ground water is generally not as hard as that from the underlying Miocene aquifers. Locally, however, nitrate may be excessive in water from open dug wells indicating pollution from surface drainage.

Summary of ground-water resources

Ground water of ample quantity is available from properly constructed wells of shallow to moderate depth in Accomack County for domestic, stock, and agricultural needs as well as for moderate-sized municipalities and industrial plants. The individual aquifers are commonly lenticular in character and discontinuous laterally so that, at least for the larger developments, inexpensive test wells should first be jetted down in order to determine the most favorable locations for permanent wells. The chemical quality of the water is generally satisfactory.

Below about 300 feet lowermost Miocene and older formations will yield water that is mineralized to a greater or lesser degree.

WELL RECORDS AND CHEMICAL ANALYSES

Records of wells in Accomack County, available logs of wells, and chemical analyses of water samples are given in Tables 8, 9 and 11 on the following pages. In addition, logs of selected deep wells on the Eastern Shore of Maryland near the Virginia State line are given in Table 10, and analyses of certain wells on Smith Island, Md., are given in Table 13. Chemical analyses of water from three selected irrigation ponds in Accomack County are given in Table 12.

The locations of the wells listed in Tables 8, 9, and 11 are shown on Plate 3, in the pocket at the end of this report.

eg "Table" on these Tables

Table 8.—Records of wells in Accomack County, Virginia

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, industrial; Irr, irrigation; PS, public supply; S, stock; Ab, abandoned; Obs, observation

gpm, gallons per minute
Temp., temperature (degrees Fahrenheit)
Fm, formation

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
1	E of Greenbackville, at Franklin City	W. F. Pulley			3	Dv	75	1¼	Miocene (?)	Yorktown (?) Fm	0	20	D	See analysis, [redacted]. Flows occasionally. Temp., 60° F.	1
2	Greenbackville ~~Greenbackville~~	John H. Selby		1938	6(?)	Dv	45	1¼	Pleistocene	Columbia Group	(−)	4	D	See analysis, [redacted]	2
3a	Do.	Rhodes	Wm. J. Porter	1954	4	J	217	2	Miocene	St. Marys Fm	−21½	30	D,S	See log, [redacted]	3a
3b	2.5 mi. NNW of Horntown	Frank Taylor	John Scott	1944?	30	J	189	2	Miocene	Yorktown Fm	−15		D,S	See analysis, [redacted]. Temp., 73° F.	3b
3c	1.5 mi. NE of Horntown, at Sinnickson	Nelson Collins	do	1945	4	J	62	2	Pleistocene	Columbia Group	nearly flows		I	See analysis, [redacted]. Temp., 61° F. Supplies oyster packing plant.	3c
4a	New Church	John F. Nelson, Jr.	Custis (?)	1915	23	J	180	2	Miocene	Yorktown Fm	(−)		D	See analysis, [redacted]	4a
4b	Horntown	A. R. Kelley		1953	30	DV	30	1¼	Pleistocene	Columbia Group			D	Water rusts well points.	4b
5	2.8 mi. W of New Church	E. Pardee	F. Kellam	1951	19	J	127	2	Miocene	Yorktown Fm	−12	15	D	See analysis, [redacted]. Water from coarse sand.	5
6a	New Church H.E.	E. R. Kelley & Co.	Layne-Atlantic Co.		25	D	259	10-8	Miocene	St. Marys Fm	(−)	254	I	See log, [redacted] and analysis, [redacted]. Temp., 59° F. Drilled to 317 ft. Another similar well at this location.	6a
6b	Do.	do			25	D	250	3	Miocene	St. Marys Fm	(−)		I	Used to supply reduced needs of plant during winter.	6b
7	1 mi. E of Oak Hall	Charles Brittingham	Wm. J. Porter	1953	25	J	265	2	Miocene	St. Marys (?) Fm	−13	25	D	Pumped sand when first developed.	7
8a	Wallops Station (Main Base), 6 mi. W. of Chincoteague Wallopes	National Aeronautics and Space Administration	Layne-Atlantic Co.	1947	30	D	65	8	Pleistocene(?)	Columbia (?) Group		70		See log, Table . Station well A-40. Drawdown 13 ft. when pumping 70 gpm. Well drilled to 101 ft.	8a
8b	Do.	do	do		35	D	62	8	Pleistocene	Columbia Group	(−)	60	Obs	See analysis, Table . Station well B-8. Federal observation well.	8b
8c	Do.	do	do		37	D	60	8	Pleistocene	Columbia Group	(−)	65	D	See analysis, Table . Station well B-43.	8c
8d	Do.	do	do	1947	30	D	60	8	Pleistocene	Columbia Group	(−)	70	D	See log, Table . Well drilled to 104 ft. Drawdown 9 ft. at 70 gpm. Station well B-49.	8d
8e	Do.	do	do		21	D	60	8	Pleistocene	Columbia Group	(−)	65	D	See analysis, Table . Station well D-36.	8e
8f	Do.	do	do		33	D	55	8	Pleistocene	Columbia Group	(−)	50	D	Station well D-37a.	8f
8g	Do.	do	do		31	D	64	8	Pleistocene	Columbia Group	(−)	60	D	Station well D-38.	8g
8h	Do.	do	do		33	D	54	8	Pleistocene	Columbia Group	(−)	54	D	See log, Table , analysis, Table . Drawdown 16 ft. at 100 gpm. Well drilled to 72 ft. Station well D-39.	8h

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Letters are not legible
a b c d e f g h

Table 8.—Records of wells in Accomack County, Virginia

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
81	Wallops Station (Main Base), 6 mi. W of Chincoteague	National Aeronautics and Space Administration	Layne-Atlantic Co.		22	D	65	8	Pleistocene	Columbia Group	(-)	85	D	See log, Table ; analysis, Table . Drawdown 17 ft. at 100 gpm. Well drilled to 77 ft. Station well D-40.	81
8j	Do.	do	do	1953	30	D	228		Miocene	St. Marys(?) Fm	-15	137	D	See log, Table 2. Drawdown 65 ft. Drilled to 346 ft.	8j
9a	4 mi. W of Chincoteague	Town of Chincoteague	Town		7	Dv, J	50-65		Pleistocene	Columbia Group	- 7		PS	Composite log, Table . See analysis, Table . 28 wells pumped as a unit. Combined yield 175,000 gpd in winter, 225,000 gpd in summer.	9a
9b	Do.	do	John Scott	1944	7	J	230	3½	Miocene	Yorktown Fm	land surface		Abs	Formerly pumped with shallow wells (9) as part of battery.	9b
9c	Do.	do	N.M Shannahan Jr	1964	7	D	244	8	Miocene	Yorktown Fm	-14	300	PS	Pumped etc. (9j) et. (do) See log	9c
10	Do.	do	Wm. J. Porter	1955	7	J	55	2	Pleistocene	Columbia Group	(-)		PS	13 wells pumped as unit.	10
11	2 mi. W of Horntown	Sidney H. Webb	Linton	1952	25	J	93	2	Pleistocene(?)				D,S	Drilled to 115 ft.	11
12	1.9 mi. SW of Horntown	L. L. Detwiler	Russell	1954	20	Dv	22	1½	Pleistocene	Columbia Group			D,S	Necessary to redrive often.	12
13	Chincoteague	Wilde Maddox	Wm. J. Porter		1	J	102	2	Miocene	Yorktown(?) Fm	flows		Abd	See log, Table ; analysis, Table . Equipped with 60-mesh screen. Water very saline.	13
14	Do. Withams	John M. Hurdles, Sr.	do	1952	3	J	120	2	Miocene	Yorktown Fm				See log, Table . Well abandoned. Another dry hole within 50 ft. at this location.	14
15	2 mi. W of Oak Hall, near Withams	B. Rantz Ranty	do		15	J	140	2	Miocene	Yorktown Fm	-13	20	D	See log, Table . Equipped with 60-mesh screen.	15
16	2.5 mi. W of Oak Hall, near Withams	R. Burton	do		15	J	140	2	Miocene	Yorktown Fm	-13	20	D	Water cloudy when well first used.	16
17	Oak Hall	Kellam Distributing Co.	John Scott	1949	25	J	230	2	Miocene	St. Marys Fm		134	D	See analysis, Table .	17
18	2 mi. E of Oak Hall, near Wattsville	B. Rantz	Wm. J. Porter	1953	20	J	173	2	Miocene	Yorktown Fm	-27	64	D	Furnishes two apartments.	18
19	0.1 mi. W of Jenkins Bridge	Dr. Fletcher	do	1952	10	J	133	2	Miocene	Yorktown Fm	- 3	11	D	Equipped with 60-mesh screen.	19
20	1 mi. NW of Jenkins Bridge	Taylor Grayson		1948	7	J	185	2	Miocene	St. Marys(?) Fm				Well abandoned; water very saline.	20
21	Do.	do			7	J	123	2	Miocene	Yorktown Fm	- 2		D,S	Near well no. 20, [redacted].	21
22	Jenkins Bridge	W. K. Colonna	Wm. J. Porter	1947	15	J	123	2	Miocene	Yorktown Fm	- 2		D	See analysis, Table . Screen set at 115-123 ft.	22
23	2 mi. E of Jenkins Bridge, near Makemie Park	Hilton Gladden	John Scott	1951	25	J	180	2	Miocene	St. Marys Fm	- 4	15	D	4 ft. drawdown in 2 hrs. pumping. [redacted]	23
24	0.3 mi. E of Oak Hall	Page Fisher	do	1949	30	J	250	2	Miocene	St. Marys Fm	-30	164	PS	See analysis, Table . Water from fine sand.	24

Table 8.—Records of wells in Accomack County, Virginia

[Capitalize Fm. and Group]
Place question mark directly after name

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
25	1 mi. S of Oak Hall	Andrew Hall	John Scott	1948	30	J	170	2	Miocene	St. Marys fm (?)		5	D	See analysis, Table .	25
26	Atlantic	Richard Thornton	do	1950	27	J	65	2	Pleistocene	Columbia group	-12	16+	D, S	Another similar well at this location.	26
27	Saxis	Luther Matthews	Wm. J. Porter		5	J	170	2	Miocene	Yorktown fm	-10	6	D	This is believed to be the only well at this depth in area.	27
28	28 Do.	Elementary School	do	1948	7	J	112	2	Pleistocene(?)	Columbia (?) Group	(-)		PS	See log, Table ; analysis, Table . Drilled to 115 ft.	28
29	Assateague Beach Coast Guard Station	U. S. Coast Guard	R. C. Scott	1955	2	J(?)	264	3	Miocene	St. Marys fm	(-)	20	D	See log, Table .	29
30	Saxis	Varnoa Drewer	Wm. J. Porter		5	J	190	2	Miocene	St. Marys fm	-3	41+	I	See log, Table . Small drawdown. Another similar well in this location.	30
31	SW tip of Saxis Island	F. Martin	do		3	J	125	2	Miocene	Yorktown fm	flows		D	Reported soft.	31
32	3.5 mi. NW of Hallwood	J. Myer Taylor		1936	7	J	90	1½	Pleistocene(?)	Columbia (?) Group	(-)		D, S	See analysis, Table . Temp., 66° F. Water from blue sand near bottom of well.	32
33	2 mi. N of Hallwood, near Makemie Park	James Byrd	Wm. J. Porter		5	J	162	2	Miocene	Yorktown fm(?)	-10	30	D, S	Water from coarse sand.	33
34	Do.	Neal Parker	do	1952	5	J	140	2	Miocene	Yorktown fm (?)	flows	2	D	Another similar well at this location.	34
35	1 mi. NE of Temperanceville	Norman Parks	John Scott	1949	25	J	174	2	Miocene	Yorktown fm (?)	-28	15	D	See analysis, Table . 2 ft. drawdown in 2 hrs. pumping. Water from gravel.	35
36	1 mi. SE of Atlantic	E. Taylor	Wm. J. Porter	1946	15	J	133	2	Miocene	Yorktown fm	-19	20-30	D	Water from sand and shells.	36
37	1.3 mi. SE of Atlantic	Willard Taylor	do	1946	15	J	99	2	Miocene	Yorktown fm	flows+5	10	D, S	Water from gravel.	37
38	0.3 mi. N of Temperanceville	Reed Onley	do		30	J	180	2	Miocene	Yorktown fm	(-)	25	D	See log, Table . Typical of 12 wells drilled by Porter in area.	38
39	Temperanceville	Roy Mears	John Scott	1948	27	J	174	2	Miocene	Yorktown fm	-30		D	Reported soft. [redacted].	39
40	Do.	Wm. Matthews	Wm. J. Porter	1948	40	J	176	2	Miocene	Yorktown fm	(-)		D	See analysis, Table . Screen set at 164-176 ft.	40
41	Do.	Pat Long	John Scott	1950	27	J	200	2	Miocene	St. Marys fm	-30	18+	D	See analysis, Table . 3-4 ft. drawdown in 3 hrs. pumping. Water from coarse sand.	41
42	1.3 mi. SE of Temperanceville	L. Chesser	L. Chesser		20	Dv	28	1½	Pleistocene	Columbia group			D, S	Water from fine sand. 32-ft. dug well at this location.	42
43	3 mi. ENE of Temperanceville, near Assawoman	Locate Conquest			5	J	82	2	Miocene	Yorktown fm (?)	flows		D, S	Necessary to redrill often. Water from fine sand.	43

Assawoman

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Table 8.—Records of wells in Accomack County, Virginia

Capitalize Z m Gnd Group

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
44	3 mi. ESE of Temperanceville, near ~~Assawoman~~ Assawoman	Lacate Conquest			5	J	180	2	Miocene	St. Marys Fm (?)	flows		D, S	Necessary to redrill often. Water from coarse sand and shell.	44
45	Between Hallwood and Rt. 13	Frederick Hall	John Scott	1949	30	J	265	2	Miocene	St. Marys Fm	-30	14+	D	See analysis, Table . 3-4 ft. of drawdown in 4 hrs. pumping.	45
46	Hallwood Hallwood	K. Gladden	do	1948	25	J	248	2	Miocene	St. Marys Fm	-1.5	25	D	Reported soft. Penetrated shale(?) at 248 ft.	46
47a	Do.	J. W. Tayler Packing Co.	M. A. Pentz	1948	25	J	160	6	Miocene	St. Marys Fm		140	I	See analysis, Table . Three 160-ft. wells pumped as unit.	47a
47b	Do.	do	Sydnor Pump & Well Co., Inc.	1954	25	D	246	14-8	Miocene	St. Marys Fm		194	I	See log, Table ; analysis, Table . 8-in. 40-slot screen from 226 to 246 ft. Drilled to 290 ft. Another 239-ft well used as standby.	47b
48	0.8 mi. W of Hallwood	Anna Roberts	John Scott	1948	25	J	232	2	Miocene	St. Marys Fm	-1.5	25	D	See analysis, Table . Equipped with 60-mesh screen.	48
49	Hallwood	Dewey Marshall	do	1950	25	J	240	2	Miocene	St. Marys Fm	-1.5	16+	D	See analysis, Table . 4 ft. of drawdown in 3-4 hrs. pumping.	49
50	Do.	Henry Davis	do	1951	30	J	237	2	Miocene	St. Marys Fm. Yorktown	-1.5	16+	D	See analysis, Table . 8 ft. of drawdown with two 4 gpm pumps after 2 hrs. pumping.	50
51a	Do.	Jas. A. Hall	L. B. Clark	1903	17	J(?)	186	1½	Miocene	~~St. Marys Fm~~	(-)			See log, table . From Bulletin 5, p. 129: 296-299.	51a
51b	Do.	J. W. Tayler Co.			12	D	250	4	Miocene	St. Marys Fm	(-)	115		Pumps continuously. Several 27-foot driven wells at this locality.	51b
51c	Do.	Brook Mears	Brook Mears	1945	12	Dv	28	2	Pleistocene	Columbia Group	-24	5½		Shells and gravel near bottom. Iron stains on laundry. Temp., 65° F.	51c
52	Do.	Melvin Toppin	John Scott	1948	25	J	231	2	Miocene	St. Marys Fm	-1.5	25	I	See analysis, table . Two similar wells at this location. Pumping reduces static head to -22½ ft. Water from very fine sand. Equipped with 60-mesh screen.	52
53	0.8 mi. S of Hallwood	Mock	do	1950	25	J	240	2	Miocene	St. Marys Fm	-1.5	16±	D	Reported soft.	53
54	Fishing Point, Assateague Island	Seaside Fish Co.		1935?	-1		412?	6	Miocene	~~Yorktown Fm~~	flows			Abandoned. Below tide level.	54
55	2.5 mi. ESE of Hallwood	John B. Gordy			40	J	130		Miocene	Yorktown Fm	(-)		D, S	See analysis, Table .	55
56	2.5 mi. WSW of Hallwood, ~~near Mearsville~~	May Adkins		1936	9	J	190	1½	Miocene	St. Marys Fm	+1.5 flows	2	D	See analysis, Table . Temp., 60° F.	56
57	2 mi. SW of Hallwood, ~~at Mears~~	Geo. E. Tayler	John Scott & Son	1936	9	J	258	2-1½	Miocene	St. Marys Fm	-1.5		D	See analysis, Table . Temp., 61° F.	57
58	2.5 mi. SSE of Hallwood	Samuel B. Groton		1946	25	J	199	2	Miocene	Yorktown Fm (?)	(-)		D	See analysis, Table . Temp., 61° F.	58
59	Mappsville	Blexom Auto Co.	John Scott	1951	25	J	255	2	Miocene	St. Marys Fm	-30	16+	D	See analysis, Table . 4-5 ft. of drawdown in 3 hrs. pumping.	59

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Table 8.—Records of wells in Accomack County, Virginia

Capitalize Fm and Group

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
60	Mappsville 2.5 mi. ENE of Mappsville	Fleming Bros.	W. Ewell	1948	25	Dv	21	2	Pleistocene	Columbia group	−2		D, S	See analysis, Table . Temp., 61° F. W. Ewell, tenant.	60
61	Wallops Island Launch Area	National ~~Advisory Committee for Aeronautics~~ Aeronautics and Space Administration	Virginia Machinery and Well Co.	1946	9	D	147	6-4½	Miocene	Yorktown Fm	−4	30	D	See log, Table ; analysis, Table . Pumps 30 gpm with 60-ft. drawdown.	61
62	Mappsville	Linwood D. Lewis	John Scott	1950	25	J	225	2	Miocene	St. Marys Fm	−32	16+	D	See analysis, Table . Water from coarse sand.	62
63	Do.	Metcalf	do	1952	25	J	255	2	Miocene	St. Marys Fm	−30	15	D	See analysis, Table .	63
64	1.5 mi. NW of Bloxom Bloxom	L. M. Jenkins	L. M. Jenkins	1945	16	Dv	23	1½	Pleistocene	Columbia group	(−)	1.5	D	See analysis, Table . Temp., 63° F.	64
65	2.5 mi. NNE of Nelsonia Nelsonia	H. W. Gillespie	John Scott & Son	1945	40?	J	220	2	Miocene	St. Marys Fm	−14		D	See analysis, Table . Shallow well nearby abandoned because water "very irony."	65
66	2.5 mi. E of Bloxom	John Castis	Frank Millburn		19	D	18	24	Pleistocene	Columbia group	−6		D, S	See analysis, Table . Temp., 68° F. Bucket lift.	66
67	0.5 mi. E of Bloxom	Preston Langford	John Scott	1951	25	J	265	2	Miocene	St. Marys Fm	−24	16+	D	See analysis, Table . 4 ft. drawdown in 2 hrs. pumping.	67
68	Nelsonia Nelsonia	Jack West	do	1950	23	J	240	2	Miocene	St. Marys Fm	−31	13+	D	See analysis, Table . Water from medium sand.	68
69	Do.	L. M. Bloxom	do	1948	25	J	230	2	Miocene	St. Marys Fm	−30	15	D	See analysis, Table . 6 ft. of drawdown in 8 hrs. pumping. Water from compact sand and shell.	69
70	Do.	Alva Bloxom	do	1952	25	J	255	2	Miocene	St. Marys Fm	−30	16+	D	Reported soft.	70
71	1 mi. W of Modest Town	Short Mason	do	1948	18	J	228	2	Miocene	St. Marys Fm	−30	16+	D	See analysis, Table . 9 ft. drawdown in 4 hrs. pumping. Water from compact sand and shell.	71
72	0.5 mi. S of Nelsonia	C. Mears	do	1951	25	J	230	2	Miocene	St. Marys Fm	−29		D	See analysis, Table .	72
73	0.8 mi. W of Modest Town	Abe Ewell	do	1951	25	J	230	2	Miocene	St. Marys Fm	−30	15	D	See analysis, Table .	73
74															
75	1 mi. SW of Nelsonia	G. R. Tayler	G. R. Tayler	1947	12	Dv	34	1¼	Pleistocene	Columbia group		50	D, S	Temp., 64° F. Water from sand and gravel from 30-34 ft.	75
76	2.5 mi. SW of Bloxom	Forrest Annis	Wm. Tayler	1935	6	D	138	1½	Miocene	Yorktown Fm	−1.5		D	See analysis, Table . Temp., 61° F. Struck water in sand and gravel below blue sand.	76
77	1 mi. W of Modest Town	B. Pickens	John Scott	1950	25	J	228	2	Miocene	Yorktown Fm (?)	−30	16+	D	6 ft. of drawdown in 3 hrs. pumping.	77

Table 8.—Records of wells in Accomack County, Virginia

Capitalize Fm and Group.
Place question mark after name.

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
78	Between Elaxum and Parksley, at Hopetown (Hopetown)	Milton R. Poulson		1944	21	Dv	40	1¼	Pleistocene	Columbia group		50	D	See analysis, Table . Temp., 65° F.	78
79	2.5 mi. SE of Elaxum, at Gargatha	Wm. S. Mears	Wm. S. Mears	1936	20	Dv	18	1¼	Pleistocene	Columbia group	−2		D	Temp., 66°F.	79
80	2 mi. W of Parksley	E. R. Costin	John Scott	1952	25	J	220	2	Miocene	St. Marys Fm	−16	15	D	5 ft of drawdown in 2 hrs. pumping. Water from fine sand.	80
81	Hopkins (Hopkins)	J. L. Copper		1914	7	Dv	100	1½	Miocene	Yorktown Fm	flows +1.25	1.5	D	See analysis, Table . Temp., 63° F.	81
82	1 mi. W of Hopkins, between Doe and Hunting Creeks	B. Watkinson	Wm. J. Porter		3	J	123	2	Miocene	Yorktown Fm	flows	2	D	See log, Table . Salt water at 70 ft.	82
83	Tobacco Island	Linwood Duncan	Wm. J. Porter		3	J	123	2	Miocene	Yorktown Fm (?)	−2	30	D	Soda taste(?).	83
84	2 mi. E of Parksley	C. B. Ross	John Scott	1950	28	J	228	2	Miocene	St. Marys Fm	−30	15	D	See analysis, Table .	84
85	Do.	Dicks	Wm. J. Porter		25	J	165	2	Miocene	Yorktown Fm (?)	−17	20	D	Water from blue sand.	85
86	Do.	Town of Parksley	Sydnor Pump & Well Co., Inc.	1947	30(?)	D	65	8	Pleistocene	Columbia group		150	PS	Town well no. 2	86
87a	Do.	do	do		30(?)	D	165	8	Miocene	Yorktown Fm (?)	(−)	50	PS	See log, Table . Town well no. 1. Drilled to 200 ft.	87a
87b	Do.	do	do	1951	30(?)	D	77		Pleistocene	Columbia group		100	PS	See log, Table . Town well no. 3. Drilled to 90 ft.	87b
88	1 mi. SSW of Hopkins	E. J. Richardson	John Scott & Son	1943	3	J	220	2	Miocene	St. Marys Fm	+1	5	D, S	See analysis, Table . Temp., 64° F. Flowing well, but pumped for use.	88
89	2.3 mi. NW of Greenbush	Walter Grosvenor	John Scott	1951	25	J	50	2	Pleistocene	Columbia group	−10	13+	D	See analysis, Table . 12 ft. drawdown after 3 hrs. pumping.	89
90	0.5 mi. NE of Chescomessex (Deep Creek)	Bailey East		1905	5	J(?)	137	1½	Miocene	Yorktown Fm	(−)		D, S	See log, [illegible] from Bulletin 5, p. 124.	90
91	0.3 mi. NE of Chescomessex	[illegible], Black	Wm. J. Porter	1951	7	J	160	2	Miocene	Yorktown Fm	−8	30	D	Water from sand and shells.	91
92	Chescomessex	W. Edwards	John Scott	1949	4	J	150	2	Miocene	Yorktown Fm	−6	15	D	See analysis, Table . 4 ft of drawdown in 4 hrs. pumping. Water from fine sand.	92
93	0.1 mi. SW of Chescomessex	Mrs. D. W. Marsh	W. Watson	1948	6	J	160	1½	Miocene	Yorktown Fm	−6		D	See analysis, Table .	93
94	2.3 mi. WNW of Greenbush	Milton Russell	John Scott	1948	25	J	123	2	Miocene	Yorktown Fm	−12	13+	S	Supplies mink farm. Reported soft.	94
95	Greenbush (Greenbush)	Methodist Church		1930	40	J	140	2	Miocene	Yorktown Fm			D	See analysis, Table . Temp., 65° F. Supplies three families.	95

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Table 8.—Records of wells in Accomack County, Virginia

Capitalize Fm and Group
Place question mark after name.

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
96	Greenbush Greenbush	J. E. Justice and H. C. Watson	John Scott	1951	20	J	265	2	Miocene	St. Marys Fm	−30	15	D	See analysis, Table . 5 homes and 2 stores use well.	96
97	Do.	W. Taylor and D. D. Mears	do	1948	23	J	267	2	Miocene	St. Marys Fm	−30	16+	D	See analysis, Table . 6 ft. drawdown in 3½ hrs. pumping.	97
98	Do	Vernon Beloto	do	1951	25	J	265	2	Miocene	St. Marys Fm	−32	15	D	See analysis, Table . 5 to 6 ft. drawdown 4 hrs. pumping.	98
99	2.5 mi. W of Greenbush	Bernard C. Evans	Bernard C. Evans	1944	16	Dv	28	1½	Pleistocene	Columbia group	−25		D	See analysis, Table . Temp., 68° F.	99
100	1.5 mi. WSW of Greenbush	H. A. West	John Scott	1952	25	J	220	2	Miocene	St. Marys Fm	−23	15	D	6 to 8 ft. drawdown in 3 hrs. pumping.	100
101	0.5 mi. S of Greenbush	Earnest A. Coard	do	1947	30	J	272		Miocene	St. Marys Fm	−23	40	D	See log, Table ; analysis, Table .	101
102	Accomac	School		1952	30	J	68	2	Pleistocene	Columbia group	−6	15	PS	See analysis, Table . Temp., 64° F.	102
103	3 mi. W of Onancock Onancock	Forrest Chandler	John Scott	1952	6	J	60	2	Pleistocene	Columbia group	−3	20	D	3 ft. of drawdown in 3 hrs. pumping.	103
104	Accomac	Accomack County Jail	do	1951	30	J	73	2	Pleistocene	Columbia group	−12	17+	PS	See analysis, Table . Similar wells at this location. Water from sand and gravel.	104
105	Do.	E. C. Watson	do	1952	30	J	75	2	Pleistocene	Columbia group			D	.	105
106	Do.	Dr. J. L. DeCormis	do	1950	30	J	160	2	Miocene	Yorktown Fm	−28	15	D	See analysis, Table . Supplies physician's office and house. Water from fine sand.	106
107	Do.	Dr. J. L. Tears	do	1950	30	J	161	2	Miocene	Yorktown Fm	−28	15	D	See analysis, Table . Supplies physician's office and home. Water from fine sand.	107
108a	Onancock Onancock	Town of Onancock	J. F. K. Shanmahan	1894	15		486		Miocene	Choptank Fm		5	Ab	See log, from Bulletin 5, p. 126; 300-301.	108a
108b	Do.	do	Castis		20	J	175		Miocene	St. Marys Fm	−12	26	PS	Two other similar wells here. All flow into underground tank.	108b
108c	Do.	do	M. A. Pentz	1927	20	D	210	4	Miocene	St. Marys Fm	−12	115	PS	See analysis, Table . Temp., 61° F. Two other similar wells here.	108c
109a	Do.	do	Berry	1929	20	X	40	38	Pleistocene	Columbia group	−12	80	PS	Two similar wells here. All three pumped as unit. (Bored well)	109a
109b	Do.	do	Sydnor Pump & Well Co., Inc.	1952	20	Dr	170	9	Miocene	Yorktown Fm (?)	(−)	100	PS		109b
110	1.5 mi. N of Cashville	Wm. Hundley	John Scott	1951	5	J	105	2	Miocene	Yorktown Fm	−4	15	D	4 ft. drawdown in 2 hrs. pumping.	110
111	1 mi. W of Onancock, at Finneys Wharf	Charles Johnson	do	1951	10	J	127	2	Miocene	Yorktown Fm	−6 - 8	16+	D	Pumping reduced static level 3 ft.	111
112	0.5 mi. W of Onancock, near Finneys Wharf	Mrs. Beeching	do	1951	5	J	99	2	Miocene	Yorktown Fm (?)	−4	16+	D	4 ft. of drawdown in 2 hrs. pumping.	112

Table 8.—Records of wells in Accomack County, Virginia

Capitalize Fm and Group.
Place question mark after name.

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
112	0.8 mi. E of Cashville	Robert Daley	John Scott	1951	11	J	105	2	Miocene	Yorktown Fm (?)	−10	25	D	Water from coarse sand.	113
114	0.5 mi. NNE of Cashville	Clyde Parker	do	1948	10	J	105	2	Miocene	Yorktown Fm (?)	−4	25	D		114
115	1.5 mi. E of Onancock	J. Van Kesteren	M. A. Pentz	1947	20	J	63	8	Pleistocene	Columbia group	−3	450	I	See log, Table 8. Drawdown, 56 ft. Specific capacity 8 gpm/ft of drawdown.	115
116	Onley	Parker Norfolk	John Scott	1950	25	J	50	2	Pleistocene	Columbia group	−12	20	D	Water from gravel.	116
117	Do.	Carroll Revell	do	1950	25	J	287	2	Miocene	St. Marys Fm	−23	15	D	Reported soft. Water from coarse sand.	117
118	0.5 mi. S of Onancock	Mrs. Doris C. Evans	do	1949	23	J	53	2	Pleistocene	Columbia group	−12	16+	D	Iron reported in water. 4 ft. of drawdown in 2 hrs. pumping.	118
119	0.1 mi. W of Onley	H. C. Watson	do	1949	25	J	187	2	Miocene	Yorktown Fm	−23	16+	D	4 ft. of drawdown in 3 hrs. pumping. Water from coarse sand.	119
120	Onley	R. C. Evans	do	1948	25	J	187	2	Miocene	Yorktown Fm	−28		D	Water from coarse sand. Equipped with 60-mesh screen.	120
121	1 mi. S of Onancock	L. F. Chandler	Wm. J. Porter	1949	23	J	90	2	Pleistocene	Columbia group	−5	20	D	See log, Table .	121
122	1 mi. SSW of Onancock	Guy Buckle	John Scott	1952	15	J	49	2	Pleistocene	Columbia group	−6	20	D	3 ft. of drawdown in 1½ hrs. pumping.	122
123	Do.	Guy Buckle, Jr.	do	1952	15	J	155	2	Miocene	Yorktown Fm		19	D	Reported soft.	123
124	1.5 mi. SSW of Onancock	C. C. Belote & Sons	White	1947	30	Dv	22	1½	Pleistocene	Columbia group	(−)		D	See analysis, Table . Temp., 68° F. Poor yield; necessary to redrive frequently.	124
125	0.5 mi. S of Cashville	Cashville Baptist Church	John Scott	1952	16	J	118	2	Pleistocene	Columbia group	−4	20+	D	Water from coarse sand.	125
126	1 mi. SSW of Cashville	L. C. Scott	John Scott & Son	1936	6	J	128	2	Miocene	Yorktown Fm	−1		D, S	See analysis, Table . Temp., 63° F. Used for poultry farm.	126
127	0.8 mi. S of Cashville	Thomas White	John Scott	1951	8	J	105	2	Miocene	Yorktown Fm	−4	15	D	Reported soft. Water from gravel.	127
128a	2 mi. SSE of Accomac	C. R. Bull	U.S. Coast Guard	1935	0+	J	90	1¼	Miocene	Yorktown Fm (?)	+2	1	D	See analysis, Table . Temp., 63° F. Well is submerged at high tide.	128a
128b	Mouth of Metomkin Inlet			1956	4		320		Miocene	St. Marys Fm			Ab	See log, Table .	128b
129	1 mile E of Onley	Parker Norfolk	John Scott	1951	25	J	62	2	Pleistocene	Columbia group	−13	16+	D	Water from gravel.	129
130	Onley	Mrs. D. Watson	do	1952	25	J	187	2	Miocene	Yorktown Fm	−23	13+	D	4 ft. of drawdown in 1 hr. pumping.	130
131	0.8 mi. WNW of Harborton	E. Hartley	do	1948	5	J	100	2	Miocene	Yorktown Fm	−4	16+	D	Reported soft.	131
132	Harborton	J. W. Adams	J. W. Adams	1905	8		140	1½	Miocene	Yorktown Fm	(−)		D	See log, Table . From Bulletin 5, p. 127; 298-299.	132

Harborton

128b Metomkin Inlet

155

Table 8.—Records of wells in Accomack County, Virginia

Capitalize Fm and Group

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
133	1.5 mi. E of Harborton, Bogg	H. Battail	L. B. Clark	1906	10		150	1½	Miocene	Yorktown fm	(−)		D	See log from Bulletin 5, p. 127; 298-299.	133
134	0.5 mi. WNW of Melfa Melfa	Catherine Warren	John Scott	1952	25	J	93	2	Pleistocene	Columbia group	-12	15	D	3 ft. of drawdown in 1 hr. pumping. Water from quartz sand.	134
135	1 mi. E of Locustville Locustville	Wilbur Millner, Jr.	do	1951	8	J	160	2	Miocene	Yorktown fm	flows	flows 5 pumps 16+	D	Water from fine sand.	135
136	0.3 mi. S of Harborton	Mr. Evans	do	1948	6	J	168	2	Miocene	Yorktown fm	0		D	Water from coarse gray sand. Equipped with 60-mesh screen.	136
137	Do.	John Brittingham	do	1949	6	J	168	2	Miocene	Yorktown fm	flows		D	Water from coarse gray sand. Equipped with 60-mesh screen.	137
138	2.5 mi. W of Melfa	R. M. Wyman	Harold Graham	1949	14	Dv	18-22	1½	Pleistocene	Columbia group	-6		Irr	Six wells pumped as unit for nursery; yield, 110 gpm.	138
139	Melfa	Wade Moore	John Scott	1948	25	J	194	2	Miocene	Yorktown fm	-12	15+	D	3 to 4 ft. of drawdown in 2 hrs. pumping. Well taps two aquifers; 1st 160 ft; 2d 184-194 ft.	139
140	Do.	Mrs. Frank Bull	do	1948	25	J	194	2	Miocene	Yorktown fm	-12	15+	D	3 to 4 ft. of drawdown in 2 hrs. pumping. Well taps two aquifers; 1st 160 ft; 2d 184-194 ft.	140
141	Do.	Mrs. Anna Grinalds	do	1948	25	J	93	2	Pleistocene	Columbia group	-9		D	4 ft. of drawdown in 1 hr. pumping. Water from coarse sand.	141
142	Do.	E. D. Phillips	do	1949	25	J	93	2	Pleistocene	Columbia group	-13	15	D	3 to 4 ft. of drawdown in 3 hrs. pumping. Water from coarse sand. Another similar well at this location.	142
143	East Point	R. Ebbs		1951	7	J	180	1½	Miocene	Yorktown fm		10	D	Water from sand and shells.	143
144	2 mi. SSW of Harborton	Harold Harrison	Harold Harrison	1941	5	Dv	11	1½	Pleistocene	Columbia group	(−)		D, S	Temp., 65° F. Typical of shallow wells in this locality.	144
145	1.5 mi. SSW of Locustville	M. Lehr	John Scott	1948	16	J	220	2	Miocene	St. Marys fm (?)	-12	16+	D	Water from "salt and pepper" sand.	145
146	Pungoteague Pungoteague	Rubin Bishop	do	1951	16	J	140	2	Miocene	Yorktown fm	-20	16+	D	Water from coarse sand and shell.	146
147	Do.	Geo. Drummond	do	1951	16	J	140	2	Miocene	Yorktown fm	-20	15+	D	13 ft. of drawdown after pumping. Water from coarse sand.	147
148	Do.	School	Wm. J. Porter		20	J	140	2	Miocene	Yorktown fm	-18	20	PS	Water from sand.	148

Table 8.—Records of wells in Accomack County, Virginia

Capitalize Fm and Group
Columbia Group is Pleistocene.

No. 156	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
149	Pungoteague	Upshur Dougherty	John Scott		16	J	110	2	Pleistocene(?)	Columbia Group	−23	15	D	8 ft. of drawdown after pumping. Water from coarse sand.	149
150	Do.	Mrs. Will Kellam	do	1951	16	J	110	2	Pleistocene(?)	Columbia Group	−6	15	D	Water from medium-fine sand.	150
151	Do.	S. W. Ames	L. B. Clark	1903	18		210	1½	Miocene	St. Marys fm	−10		D, S	See log, ~~Table~~ analysis ~~Table~~ from Bulletin 5, p. 128; 300-301.	151
152	Do.	G. Hoffman	John Scott	1951	16	J	222	2	Miocene	St. Marys fm	−20	16+	D	12 ft. of drawdown in 3 hrs. pumping. Water from coarse sand and shells.	152
153	Do.	School	Mr. Lord	1948	12	J	128	2	Miocene	Yorktown fm (?)	(−)		PS	See analysis, Table . Temp., 68° F.	153
154	1.8 mi. W of Pungoteague, on Nandua Creek	John R. Drummond, Jr.	Fred Kellam	1952	4	J	108	2	Pleistocene	Columbia group	flows		D, S	See log, Table ; analysis, Table .	154
155	Keller Keller	Charles Ballard	John Scott	1951	25	J	85	2	Pleistocene	Columbia group	−13	11+	D	12 ft. of drawdown in 5 hrs. pumping. Water from coarse sand.	155
156	Do.	John Campbell	do	1948	25	J	265	2	Miocene	St. Marys fm	−28	15	D	Water from fine white sand.	156
157	Do.	Eastern Shore Fire Insurance Co.	do	1949	20	J	265	2	Miocene	St. Marys fm	−30	15	D	Water from fine sand.	157
158	Wachapreague Wachapreague	Milton Dougherty	do	1949	6	J	120	2	Miocene	Yorktown fm	−8	14+	D	Supplies two houses.	158
159	Do.	School	Wm. J. Porter	1944	7	J	113(?	2	Pleistocene	Columbia group	−8	30	PS	See log, Table .	159
160	Do.	Town of Wachapreague		1900	5	D	385	4-2	Miocene	Chesapeake fm	(+)	3-6	PS	See analysis, Table . Temp., 61° F. Flows 3 gpm at low tide, 6 gpm at high tide. Used by fishing boats.	160
161	Do.	Wachapreague Volunteer Fire Dept.	John Scott	1950	7	J	83	2	Pleistocene	Columbia group	−4		PS	Fire station and store use well.	161
162	Do.	F. K. Dear	do	1952	7	J	94	2	Pleistocene	Columbia group	−4	13+	D	Water from fine sand.	162
163	2 mi. SE of Keller	Mrs. Priscilla A. Mears	Smith	1947	30	Dv	39	1½	Pleistocene	Columbia group	−34		D	See analysis, Table . Temp., 67° F. Supplies general store.	163
164	1 mi. N of Craddockville	Levin Johnson	John Scott	1950	11	J	63	3	Pleistocene	Columbia group	flows	32	Irr	Supplies irrigation pond. Not screened. Water from sand and gravel.	164
165	1.3 mi. NW of Craddockville	Milton Beasley	do	1951	5	J	127	3	Miocene	Yorktown fm	flows	3-4	D	3-in. casing to 63 ft.; no screen. Water from fine sand.	165
166	0.5 mi. N of Craddockville	L. T. Johnson			7	D	170	1½	Miocene	Yorktown fm	flows	10	D, S	See analysis, Table . Temp., 61° F. Supplies farm and small lake.	166

Table 8.—Records of wells in Accomack County, Virginia

Capitalize Fm and Group.
Place question mark after name.

No. 157 Painter	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
167	Painter	School			17	J	98	1½	Pleistocene	Columbia group	(−)	5	PS	See analysis, Table .	167
168	1.5 mi. W of Painter	S. Mason	John Scott	1952	23	J	173	2	Miocene	Yorktown fm (?)	−23	20	D	6 ft. of drawdown in 3 hrs. pumping. Water from gravel.	168
169	1.5 mi. WSW of Craddockville	F. Kellman	do	1953	7	J	150	2	Miocene	Yorktown fm	−13	13+	D	Reported soft. Water from fine sand.	169
170	2.8 mi. WSW of Craddockville	Royall	do	1948	7	J	123	2	Miocene	Yorktown fm	−4	16+	D	Water from coarse sand. Equipped with 60-mesh screen.	170
171	3.3 mi. WSW of Craddockville	Dr. W. B. Lingo	J. F. Lingo	1947	5	Dv	28	1½	Pleistocene	Columbia group	−8		D	See analysis, Table . Temp., 63° F. Well at this location sunk to 128 ft. in 1947, struck "quicksand," and filled.	171
172	2 mi. SW of Craddockville	Mr. McKay	John Scott	1951	5	J	115	2	Miocene	Yorktown fm	−13	15	D	Water slightly saline.	172
173	1 mi. S of Craddockville	Will Kellam	do	1948	12	J	190	2	Miocene	Yorktown fm	−30		D	[illegible] Water from fine sand and shells.	173
174	2 mi. S of Craddockville	E. S. Sturgis	do	1949	5	J	134	2	Miocene	Yorktown fm	−4 − 5	20	D	Reported soft. Water from coarse sand.	174
175	Belle Haven	G. J. Barfield	do	1950	23	J	160	2	Miocene	Yorktown fm	−24	15	D	5 ft. of drawdown in 4 hrs. pumping. Water from coarse sand.	175
176	Do.	Charles Byrd	do	1945	19	J	202	2	Miocene	Yorktown fm (?)	−34	16+	D	Supplies 3 houses and business.	176
177	Do.	George C. Duer		1933	30	J	198	1¼	Miocene	Yorktown fm (?)			D	See analysis, Table . Water from sand and shells near bottom.	177
178	Do.	Burleigh Mears	John Scott	1950	20	J	202	2	Miocene	Yorktown fm (?)	−30	15	D	Water from gravel and shell.	178
179	0.1 mi. E of Belle Haven	Kellam Distributing Co.	do	1951	25	J	200	2	Miocene	Yorktown fm (?)	−30	15	D	5 ft. of drawdown in 4 hrs. pumping. Water from coarse sand.	179
180	1.3 mi. ENE of Belle Haven	Levin Johnson	do	1949	23	J	202	2	Miocene	Yorktown fm (?)	−30	16+	D	Two houses use well. 8 ft. of drawdown in 5 hrs. pumping.	180
181	3.3 mi. SW of Quinby Quinby	W. Mapp	Wm. J. Porter	19[illegible]2	5	J	210	2	Miocene	Yorktown fm (?)	flows	flows 1½	D, S	See log, Table .	181
182	4.5 mi. S of Quinby on Upshurs Neck	John T. Pritchard	John T. Pritchard	1945	4	Dv	13	1¼	Pleistocene	Columbia group	−3	5	D, S	See analysis, Table . Temp., 69° F.	182
183	Tangier Island			1925 ?	2 ?		860		Late Eocene(?)	~~Jackson fm (?)~~ Chickahominy fm (?)	flows		Ab	See analysis, Table . Flowing in 1948. Former fish factory well.	183

Table 8.—Records of wells in Accomack County, Virginia

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
158	2 mi. S of Keller, at Central High School	United States Geological Survey (Test Hole No. 3)	Sydnor Pump & Well Co., Inc.	1953	30	D	420 (450)	3	Miocene	Chesapeake	-26		Test hole	See log, Table . Drilled to 450 feet. Several other water-bearing zones at shallower depths.	
	6.5 mi. S of Oak Hall, at Atlantic High School Oak Hall	United States Geological Survey (Test Hole No. 4)	do	1953	35	D	372	3	Miocene	St Marys	-18		Test hole	See log, Table 2. Drilled to 451 feet. Several other water-bearing zones at shallower depths.	

Table 9.--Logs of wells in Accomack County, Virginia

Well 3a, Greenbackville; Rhodes

(Generalized log by William J. Porter)

Altitude, 4 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil; clay	10	10
Sand; clay; gravels, coarse, mixed	20	30
Sand, beach; clay	32	62
Chesapeake Group (Miocene):		
Yorktown Formation:		
Shells; sand	10	72
Sand, blue, fine; possible water-bearing zone	21	93
Clay, black with sand interbedded in streaks	77	170
Sand; non-water-bearing	22	192
St. Mary's Formation:		
Clay, blue	18	210
Sand, coarse; water-bearing zone	7	217

Table 9.--Logs of wells in Accomack County, Virginia

Well 6a, New Church; H. E. Kelley & Company

(Log by Layne-Atlantic Co.)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Topsoil	2	2
Columbia Group (Pleistocene):		
Sand, loose, coarse; water of poor quality	36	38
Chesapeake Group (Miocene):		
Yorktown Formation:		
Sand, coarse; clay; medium-hard drilling	36	74
Clay, hard; sand	31	105
Sand, coarse; clay, trace	6	111
Sand, coarse; hard drilling	2	113
Sand, coarse; shell, trace; soft drilling	9	122
Sand, coarse; clay, trace	4	126
Sand; shells; very hard drilling	2	128
Sand, coarse; shells, trace; medium-hard drilling	7	135
Clay	1	136
Sand, coarse; shells, trace	12	148
Sand, coarse; clay layers	3	151
Clay, blue; sand, trace	11	162
Clay, blue; sand; shells, trace	20	182
Shells; sand; medium-soft drilling	32	214
St. Marys Formation:		
Shells; clay	2	216
Sand, fine; shells	3	219

No apostrophe in St. Marys

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 6a, New Church; H. E. Kelley & Company--Continued

	Thickness (feet)	Depth (feet)
St. Mary's Formation--Continued		
Shells; sand; medium-hard drilling	3	222
Shells; sand; soft; fast drilling	6	228
Shells; less sand; medium-fast drilling	31	259
Shells; sand; clay, blue, increases with depth	14	273
Clay, blue; sand, thin streaks	44	317

(Well finished at 259 feet for permanent production.)

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 8a, Wallops Station (Main Base); ~~National Aeronautics and Space Administration~~, NASA well A-40

(Log by Layne-Atlantic Company)

Altitude, 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay, red, hard, sandy	5	5
Sand, coarse; gravel; trace of white clay	13	18
Sand, brown, medium coarse	10	28
Sand, coarse; trace of white clay	11	39
Clay, red, white streaks	7	46
Sand, coarse; gravel; water-bearing zone	9	55
Sand, gray, medium coarse	6	61
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, brown, hard, sandy	6	67
Clay, blue	17	84
Clay, blue; sand, coarse	7	91
Clay, blue; trace of shells	10	101

Table 9 .--Logs of wells in Accomack County, Virginia--Continued

Well 8d, Wallops Station (Main Base); NASA ~~National Aeronautics and Space Administration~~, well B-49

(Log by Layne-Atlantic Co.)

Altitude, 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil; clay, red, sandy	4	4
Sand, coarse; trace of gravel	14	18
Sand, brown, coarse	11	29
Sand, brown, coarse; trace of gravel	6	35
Sand, brown, silty; clay	9	44
Sand, gray, coarse	11	55
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, brown, hard, sandy	8	63
Sand, fine, silty; clay, blue	22	85
Sand, medium-fine; clay; trace of shells	5	90
Sand, medium-coarse; clay, blue; trace of shells	14	104

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 8h, Wallops Station (Main Base); ~~National Aeronautics and Space Administration,~~ NASA well D-39

(Log by Layne-Atlantic Company)

Altitude, 33 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay, sandy	11	11
Sand, clean	22	33
Clay, white; trace of sand	2	35
Sand, hard	6	41
Clay	2	43
Sand	5	48
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, varicolored	5	53
Clay, blue; trace of sand	19	72

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 8i, Wallops Station (Main Base); NASA ~~National Aeronautics and Space Administration,~~ well D-40

(Log by Layne-Atlantic Company)

Altitude, 22 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil	6	6
Clay, sandy	5	11
Sand, loose	9	20
Sand, coarse, loose	15	35
Clay, white	3	38
Sand, free; shells	10	48
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, blue	17	65
Clay, blue; trace of sand and shells	12	77

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 8j, Wallops Station (Main Base); NASA; ~~National Aeronautics and Space Administration~~

(Log by Layne-Atlantic Co.)

Altitude, 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil; sand; clay	22	22
Clay, sandy; pebbles	10	32
Sand, coarse; clay	10	42
Clay, yellow; sand, fine	21	63
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, blue; shells	21	84
Shells; clay, blue, sandy	40	124
Clay, gray, sandy, soft	10	134
Clay, gray, sandy; some shells; hard streak at 140 feet to 143 feet	30	164
Gravel, hard streaks; clay, sandy	10	174
St. Marys Formation:		
Clay, soft	10	184
Clay, gray, sandy	16	200
Sand, coarse	15	215
Sand, coarse; shells	20	235
Sand; some shells	10	245
Sand, "salt and pepper;" fine	10	255
Sand, "salt and pepper," with shells	10	265
Sand, black, coarse; shells	10	275

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 8j, Wallops Station (Main Base); NASA. ~~National Aeronautics and Space Administration, Wallops~~--Continued

	Thickness (feet)	Depth (feet)
St. Marys Formation--Continued		
Sand, gray; shells	10	285
Sand, gray, fine; shells, thin hard layers	10	295
Sand, gray, fine; shells, in streaks	51	346

Table 9.--Logs of wells in Accomack County, Virginia--Continued ~~Well 9a.~~

Well 9a, Town of Chincoteague

(Generalized log reported by Otis D. Marshall, former Water Superintendent)

Altitude, 7 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay	4	4
Sand, yellow	36	40
Clay, white	2	42
Sand, coarse; gravel	8	50
Chesapeake Group (Miocene):		
Yorktown formation		
Clay, blue; shells	15	65

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 15, Withams; B. Rantz

(Generalized log by William J. Porter)

Altitude, 15 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay	10	10
Sand, white; water-bearing zone	20	30
Clay, blue; sand, fine	50	80
Sand, fine	5	85
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, blue	51	136
Sand, fine; shells, coarse	4	140

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 28, Saxis; Saxis Elementary School

(Log by William J. Porter)

Altitude, 7 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Sand, surface	12	12
Sand; water-bearing zone	8	20
Clay	15	35
Sand	25	60
Sand; water-bearing zone	15	75
Sand	5	80
Sand; clay	10	90
Sand, fine	7	97
Sand; shells	1	98
Sand	10	108
Chesapeake Group (Miocene):		
Yorktown Formation:		
Shells; sand	7	115

Table 3.--Logs of wells in Accomack County, Virginia--Continued

Well 29, Assateague Beach Coast Guard Station; U. S. Coast Guard

(Log by R. C. Scott)

Altitude, 2 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Sand, beach, medium	10	10
Sand, medium to coarse	15	25
Sand, fine; shell fragments	5	30
Sand; abundant shell fragments	12	42
Chesapeake Group (Miocene):		
Yorktown Formation:		
Shells, small; clay	15	57
Sand; clay	6	63
Sand, fine; abundant shells	21	84
Shells; sand; clay	12	96
Clay, sandy	14	110
Sand; shells; clay	30	140
Clay, sandy	20	160
Shells; abundant sand	5	165
St. Mary's Formation:		
Sand, fine; abundant shells	80	245
Sand, medium coarse; shells	10	255
Sand, medium coarse; gravel	9	264

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 30, Saxis; Vernon Drewer

(Generalized log by William J. Porter)

Altitude, 5 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay; soil	30	30
Sand, fine	25	55
Shells; water-bearing zone	5	60
Sand, blue	18	78
Sand, black, coarse; shells; water-bearing zone	6	84
Clay, blue	21	105
Sand, non-water-bearing	8	113
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, blue	37	150
Sand, fine	15	165
Shells; sulfur water (?)	5	170
Shells; sand, black; gravel, white	18	188
Sand; shells; good water-bearing zone	2	190

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 38, Temperanceville, Reed Onley

(Generalized log by William J. Porter)

Altitude, 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay; soil	3	3
Sand; gravel	14	17
Sand, fine; water-bearing zone	14	31
Clay, blue	29	60
Gravel, coarse; water-bearing zone	13	73
Chesapeake Group (Miocene):		
Yorktown Formation:		
Sand, blue, fine	40	113
Sand; shells; water-bearing zone	20	133
Clay, blue	5	138
Sand, fine	16	154
Sand, coarse; shells, larger with depth	26	180

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 47b, Hallwood; Taylor Packing Co.

(Log by Charles Mitchell, Sydnor Hydrodynamics, Inc.)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay; topsoil	4	4
Sand, blue; clay	6	10
Sand, white, coarse	17	27
Gravel, white, coarse	8	35
Sand; gravel, gray, coarse	24	59
Sand; clay, streaks, thin	6	65
Clay, gray; sand, streaks	42	107
Sand, gray, coarse	18	125
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay; sand streaks	20	145
Sand; gravel, gray, coarse	21	166
St. Mary's Formation:		
Clay; sand; coarse, trace	12	178
Clay, gray	7	185
Clay; sand; streaks, thin	37	222
Sand; shells	5	227
Shells, hard (rock?)	8	235
Sand; shells; water-bearing	10	245
Sand; shells, hard streaks	45	290

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 51[a], Hallwood; Jas. A. Hall

(Log by I. B. Clark, from Va. Geol. Survey Bulletin 5, page 129)

Altitude, 17 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil	1	1
Clay, pipe; sand; gravel; water-bearing below 10 feet	29	30
Sand, blue	80	110
Chesapeake Group (Miocene):		
Yorktown Formation:		
Sand, blue; shells; small yield of good water	40	150
St. Mary's Formation::		
Mud, blue	36	186

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 61, Wallops Station (Wallops Island Launch Area); National Aeronautics and Space Administration

(Log by Virginia Machinery and Well Co., Inc.)

Altitude, 9 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Sand, beach	12	12
Sand, fine; clay, light	18	30
Mud; sand	8	38
Clay, green-gray, stiff	21	59
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, dark, soft; vegetable matter	7	66
Clay, green-gray, stiff	33	99
Clay, green-gray; sand	20	119
Sand, gray, fine; clay	14	133
Sand, coarse; shells	12	145
Gravel, pea-size	2	147
Clay, green-gray at 147 feet		

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 82, Between Doe and Hunting Creeks, B. Watkinson

(Generalized log by William J. Porter)

Altitude, 3 feet

	Thickness (feet)	Depth (feet)
Columbia group (Pleistocene):		
Sand	30	30
Clay, blue	10	40
Sand, fine; clay	30	70
Sand; salt water	32	102
Chesapeake group (Miocene):		
Yorktown formation:		
Clay, blue	15	117
Sand, water-bearing zone	6	123

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 86, Parksley; Town of Parksley

(Log by Sydnor Hydrodynamics, Inc.)

Altitude, about 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay, brown, sandy	5	5
Sand, hard	20	25
Sand, hard, fine	17	42
Sand, medium-coarse	4	46
Sand, coarse; gravel	8	54
Sand; gravel	3	57
Sand, dirty; gravel	11	68
Clay, blue, sandy, at 68 feet		

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 87a, Parksley; Town of Parksley

(Log by Sydnor Hydrodynamics, Inc.)

Altitude, about 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil	2	2
Sand; gravel	67	69
Sand, blue; clay	25	94
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, gray; shells	33	127
Shells; sand, fine	18	145
Sand	25	170
Sand, blue	30	200

Table 8.--Logs of wells in Accomack County, Virginia--Continued

Well 87b, Parksley; Town of Parksley

(Log by Sydnor Hydrodynamics, Inc.)

Altitude, about 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Sand, dark; clay	9	9
Sand, white, fine	21	30
Sand, white; gravel	4	34
Sand, fine	9	43
Sand, yellow, fine, soft	7	50
Gravel, coarse; sand, fine	10	60
Sand, fine, soft; gravel	10	70
Sand; gravel; clay, trace	7	77
Mud, soft; grit	13	90

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 90. Deep Creek; Bailey East

(Log by owner, from Va. Geol. Survey Bulletin 5, page 124)

Altitude, 5 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil	1	1
Sand, yellow	19	20
Marsh mud, slate-colored	19	39
Sand, bluish-gray; little water	1	40
Loam, yellow-gray-black and white; pebbles, smooth; water-bearing zone at base	3	43
Sand, bluish; water-bearing zone at base	32	75
Gravel, coarse, no large stones; water-bearing	4	79
Chesapeake Group (Miocene):		
Yorktown Formation:		
Sand, bluish; shells at 95-99 feet; water-bearing zones at 57 and 100 feet	58	137

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 108a, Onancock

(Log by H. K. Shannahan; after Bulletin 5, page 126)

Altitude, 15 feet

	Thickness (feet)	Depth (feet)
Columbia group (Pleistocene)		
Undescribed	100	100
Chesapeake group (Miocene):		
Yorktown Formation:		
Undescribed	50	150
St. Marys Formation:		
Shells in gravel and sand	25	175
Undescribed	108	283
Fine sand; no water	25	308
Choptank Formation:		
Hard "rock" and clay	2	310
Clay and sand	23	333
Clay and sandy clay	147	480
Undescribed; water	6	486

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 101, Greenbush; Earnest A. Coard

(John Scott, driller; sample descriptions by A. Sinnott)

Altitude, 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Not sampled	50	50
Sand, yellow, quartz	20	70
Chesapeake Group (Miocene): Yorktown Formation:		
Silt, clayey; small shell fragments	30	100
~~Chesapeake Group (Miocene):~~		
~~Yorktown Formation:~~		
Sand, fine, silty; shells, broken	47	147
Sand, fine, well-sorted, chiefly quartz; scattered shell fragments	64	210
St. Mary's Formation:		
Clay, gravelly; shell fragments	20	230
~~Not sampled~~ Undescribed	30	260
Sand; gravel, clean; shell fragments	12	272

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 115, ~~1-1/2~~ 1.5 mi. east of Onancock; J. Van Kesteren

(Log by M. A. Pentz)

Altitude, 20 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Sand, fine; soil	19	19
Sand, coarse	9	28
Gravel	3	31
Sand, blue, fine	4	35
Sand, medium	16	51
Gravel, coarse	12	63

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 121, Onancock; L. F. Chandler

(Generalized log by William J. Porter)

Altitude, 23 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay; soil	5	5
Sand, white	35	40
Gravel	1	40
Sand, white	49	89
Gravel; water-bearing	1	90

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Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 28b, Metomkin Inlet Station; U. S. Coast Guard

(Log by Tidewater Well & Pump Co., Inc.)

Altitude probably less than 5 feet ~~[illegible] feet~~

		Thickness (feet)	Depth (feet)
0	Columbia Group (Pleistocene):		
6	Mud	40	40
	Sand, fine; mud	10	50
	Sand, medium hard	6	56
	Sand, fine; mud	4	60
0	Chesapeake Group (Miocene):		
3	Yorktown Formation:		
6	Shale rock	6	66
	Clay, hard; sand	14	80
	Rock (2½ hrs. drilling)	1	81
	Mud; shell; some medium sand	18	139
	Sand, gray; medium fine	24	163
	Sand, fine to medium	25	188
	Sand, medium; shells	9	197
3	St. Mary's (?) Formation:		
	Clay, hard, gray	21	218
	Sand, medium; shells	3	221
	Sand, medium; shells	4	225
	Shells, small (hard drilling) (possible water-bearing zone) (salt water)	10	235
	Mud; shells	3	238
	Clay, hard, gray; shells, scattered	66	238 304
	Clay, hard, gray; shells	11	315
	Shell rock, very hard	5	320

Table 9 .--Logs of wells in Accomack County, Virginia--Continued

Well 132, Harborton; J. W. Adams

(Log by owner; from Va. Geol. Survey Bulletin 5, page 127)

Altitude, 8 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil	1	1
Clay, red	4	5
Sand, yellowish-white; water at 12 feet	11	16
Creek mud, blue	24	40
Sand, gray; gravel; water	11	51
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, blue, tough	74	125
Sand, gray, fine at top, coarser below; shells, hard streaks; water	15	140

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 133, Boggs, near Harborton; H. Battail

(Log by I. B. Clark; from Va. Geol. Survey Bulletin 5, page 127)

Altitude, 10 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil	1	1
Clay, red	3	4
Sand, white; water of poor quality	6	10
Mud, blue	34	44
Sand, blue; very little water	1	45
Chesapeake Group (Miocene):		
Yorktown Formation:		
Mud, blue	59	104
Shells, bluish; "sand rock"	8	112
Marl, blue; shells; "sand rock"; (four layers of rock in all)	38	150

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 151, Pungoteague; S. W. Ames

(Log by I. B. Clark; from Va. Geol. Survey Bulletin 5, page 128)

Altitude, 18 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil	1	1
Sand, yellow	15	16
Sand, blue, at 40 feet and 60 feet; (slightly sandy, with a little water, at 60 feet); shells	94	110
Chesapeake Group (Miocene):		
Yorktown Formation:		
Mud, blue	3	113
Yorktown and St. Marys Formations, undifferentiated:		
Sand, bluish; shells; wood	95	208
Sand; good water	2	210

Mantua Creek

Table 9 .--Logs of wells in Accomack County, Virginia--Continued

Well 154, Nandua; John R. Drummond, Jr.

(Log by Fred Kellam)

Altitude, 4 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Undescribed	30	30
Mud	10	40
Clay, blue; sand	50	90
Sand; water-bearing zone	18	108

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 159, Wachapreague; Wachapreague School

(Generalized log by William J. Porter)

Altitude, 7 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil; clay	10	10
Sand; water-bearing zone	15	25
Sand, blue; clay, blue	80	105
Sand, fine; water-bearing zone	8	113

Table 9.--Logs of wells in Accomack County, Virginia--Continued

Well 181. Quinby; W. Mapp

(Generalized log by William J. Porter)

Altitude, 5 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay; soil	10	10
Sand	19	29
Gravel; water-bearing	1	30
Clay; sand	55	85
Sand, fine and coarse	14	99
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay; sand	101	200
Sand, white, coarse; scattered shells; water-bearing zone	10	210

Table 9.—Logs of wells in Accomack County, Virginia—Continued

U. S. Geological Survey test hole 3, Central High School, 1 mile north-northeast of Painter

(Drilled by Sydnor Hydrodynamics, Inc.)

(Sample descriptions ~~Log~~ by G. C. Tibbitts, Jr.; correlations by F. Stearns MacNeil)

Altitude 30 feet

	Thickness (feet)	Depth (feet)
Clay, gray, sandy; possibly fill from school excavation	7	7
Columbia group (Pleistocene):		
Soil, black, organic; possibly topsoil under fill.	2	9
Sand, iron-stained, quartz, fine to medium; black sand; organic material; scattered small gravels from 25 feet; streaks of dark-gray clay from 30 feet; shell fragments from 46 feet; water-bearing zone	51	60
Clay, gray-green, soft; abundant shell fragments; sandy	18	78
Clay, dark-gray, very hard	2/3	78-2/3
Sand, white to gray, quartz, medium; scattered shell fragments; black sand; water-bearing zone	11-1/3	90
Clay, dark-gray, heavy, sandy, silty; abundant shell fragments from 105 feet	27	117
Clay, dark-gray, heavy; interbedded with coarse quartz sand	5	122
Chesapeake group (Miocene):		
Yorktown formation:		
Clay, dark-gray, soft; abundant small gravels; black sand; gravel in lenses; possible water-bearing zone	3	125
Sand, gray, quartz, fine; abundant shell fragments; silt	5	130
Clay, dark-gray, soft; abundant shell fragments	5	135
Shells, white, fragments; silt; clay, water-bearing zone	15	150
Sand, gray-green, quartz, very fine; abundant silt; shell fragments; gray clay	10	160
St. Marys formation:		
Sand, gray-green, quartz, very fine; abundant silt; shell fragment; gray clay; streak of mud at 164 feet; organic specks from 160 feet	22	182
Clay, dark-gray, hard	1	183

Table 9.—Logs of wells in Accomack County, Virginia—Continued

U. S. Geological Survey test hole 3, Central High School, 1 mile north-northeast of Painter—Continued

Chesapeake group (Miocene):--Continued

St. Marys formation:--Continued	Thickness (feet)	Depth (feet)
Sand, blue-gray, quartz, very fine; abundant clay; shell fragments	7	190
Shells, white, broken; 15 percent dark-gray clay; possible water-bearing zone	21	211
Sand, gray, quartz, very fine; abundant silt; clay; abundant black sand	14	225
Shells, white, broken; trace clay and silt; organic specks; possible water-bearing zone	21	246
Sand, gray-green, quartz, very fine; abundant shell fragments; abundant silt and clay; marl streaks at 246, 250, 260, 263, 266, and 270 feet	65	311
Choptank formation:		
Chert, black, very hard	1	312
Sand, gray, quartz; very abundant silt; shell fragments; clay; 18 inches hard marl at 328 feet; 4-inch streak shells at 349-2/3 feet	38	350
Clay, dark-gray, sticky; shell fragments	10	360
Sand, gray, quartz, very fine, silty, clay; scattered shell fragments	16	376
Clay, dark-gray, sticky; abundant silt; abundant sand; scattered shell fragments from 395 feet	74	450

Table 9.--Logs of wells in Accomack County, Virginia--Continued

U. S. Geological Survey test hole 4, Atlantic High School, near Oak Hall

(Drilled by Sydnor Hydrodynamics, Inc.)

(Sample descriptions ~~Log~~ by G. C. Tibbitts, Jr.; correlations by F. Stearns MacNeil)

Altitude 35 feet

	Thickness (feet)	Depth (feet)
Columbia group (Pleistocene):		
Topsoil, light-yellow, fine sandy	7	7
Sand, iron-stained and white; quartz, fine to coarse; streaks of small gravels from 7 to 35 feet; black sand; scattered streaks of gray silt; layer of heavy blue clay 27 to 28 feet; specks of brown clay from 35 feet; water-bearing zone	46	53
Clay, gray-green, soft; abundant fine sand; abundant silt; black sand; scattered shell fragments from 60 feet	20	73
Clay, gray-green, soft; interbedded coarse iron-stained sand; scattered shell fragments	3	76
Clay, dark gray-green, solid; very fine quartz sand; shell fragments; solid streaks of shells 104 feet	29	105
Chesapeake group (Miocene):		
Yorktown formation:		
Clay, dark gray-green, solid; very fine quartz sand; shell fragments; silty from 110 feet; medium gravels from 115 feet; streak of large gravels at 129 to 130 feet, and 145 to 147 feet	45½	150½
Sand, white, medium; abundant shell fragments; clay; water-bearing zone	6½	157
Clay, gray-green, soft; abundant sand; 3-inch marl streak at 167 feet; scattered shell fragments from 175 feet; streaks of fine quartz sand from 150 to 175 feet	18	175
St. Marys formation:		
Clay, gray-green, soft; abundant sand; streaks of fine quartz sand from 175 to 195 feet; black organic specks; abundant black sand from 200 feet	30	205

Table 9.—Logs of wells in Accomack County, Virginia—Continued

U. S. Geological Survey test hole 4, Atlantic High School—Continued

	Thickness (feet)	Depth (feet)
Chesapeake group (Miocene):--Continued		
St. Marys formation:--Continued		
Shells, white, broken; abundant clay and silt to 215 feet; abundant black sand; black organic specks; 6-inch streak of marl at 227½ feet; possible water-bearing zone	35	240
Sand, gray-green, quartz, very fine; abundant silt and sand; shell fragments	58	298
Clay, gray-green, heavy; abundant sand; shell fragments; interbedded sand and clay 300 to 302 feet; streak of mud at 326 feet; streak of marl at 356 feet; black sand	67	365
Sand, gray, quartz, very fine; clay; abundant shell fragments; black sand; possible water-bearing zone	29-2/3	394-2/3
Chert, black, very hard	1/3	395
Sand, gray, quartz, very fine; clay; shell fragments; streak of marl at 402 feet; sand coarser from 410 feet; appearance of gas bubbles at 350 feet ...	56	451

Table 10.--Logs of selected deep wells in Maryland near the Maryland-Virginia boundary

Bradshaw well, Smith Island; Somerset County, Md.

(Lithology and Foraminifera by Doris S. Malkin, January 23, 1947; published by permission of Shell Oil Company)

	Thickness (feet)	Depth (feet)
Recent and Pleistocene Series, undifferentiated:		
Fine, medium, and coarse grained gray and buff quartz sand with shell fragments and rare Elphidium spp.	40	40
Chesapeake Group (?) (Miocene):		
Cohansey (?) Sand ~~Formation~~ (Yorktown (?) equivalent):		
Very fine-grained brownish-gray sand; no fauna.	20	60
Chesapeake Group (Miocene):		
St. Marys Formation:		
Gray galuconitic silty clay with shell fragments and rare foraminifera (Elphidium spp.)	110(?)	170(?)
Choptank (?) Formation:		
Gray glauconitic silty clay, argillaceous silt, and silty sand, with abundant shell fragments. Foraminifera rare in upper part, increasing below 240 ft., including Nonionella auris, Cibicides americanus, C. concentricus, Nonion pizzarense; abundant Nonion incisum and spp. at 240 ft.; Textularia cf. agglutinans, Eponides cf. frigida var. calida; 270-300 ft. Discorbis floridana, D. candeiana, D. valvulata, etc., with Textularia spp. and Bulimina gracilis.	130(?)	300
Calvert Formation:		
Glauconitic silty sand (Plum Point Member) to 470 ft.; diatomaceous silt (Fairhaven) 470-540 ft.; glauconitic silt with lignite, with rare fauna 540-590 ft.	290	590

Foraminiferal fauna abundant, including Discorbis spp., Valvulineria floridana, Nonion spp., Eponides cf. mansfieldi, Textularia mayeri, T. spp., Spiroplectammina sp., Cibicides concentricus; abundant specimens of Textularia spp. 370-400 ft.;

Age of Cohansey - Miocene (?) and Pliocene (?)
Age of Yorktown - Miocene

Table 10.--Logs of selected deep wells in Maryland near the Maryland-Virginia boundary----Continued

Bradshaw well, Smith Island; Somerset County, Md.---Continued

	Thickness (feet)	Depth (feet)
Chesapeake Group (Miocene)--Continued		
Calvert Formation--Continued		
abundant Siphogenerina lamellata - transversa 400-540 ft. Diatoms abundant 470-540 ft.; associated with abundant fauna including Siphogenerina and Uvigerina spp., etc.		
[Note: The subdivisions of the Miocene indicated above are provisional, subject to revision after study of surface samples and range charting. The validity of micropaleontologic criteria for these subdivisions has not yet been established.]		
Upper Eocene Series, undifferentiated:		
Medium-grained gray sand with shell fragments and rare foraminifera: Discorbis assulata	20	610
Middle Eocene Series:		
Nanjemoy Formation:		
Gray marly glauconitic sand and sandy marl. Marked increase in fauna; assemblage includes Cristellaria spp., Marginulina winniana, Alabamina obtusa, Ceratobulimina cf. eximia, Siphonina cf. clairbornensis, Discorbis forishi (?) Cibicides mauricensis, C. cf. westi, C. spp., Nonion planatum, Cyroidina cf. octocamerata, Bulimina pupoides, Globorotalia inconspicua, etc.	50	660
~~Lower Eocene and~~ Paleocene Series, undifferentiated:		
Aquia Formation:		
Glauconite and highly glauconitic marl, with fauna fairly abundant in most samples, including; Cibicides blanpiedi, C., hypoconoides, C. burlingtonensis, Parrella sp., Lenticulina degolyeri, Eponides cf. lotus, Gaudryina sp., Nodosaria affinis; below 710 ft. Vaginulinopsis brantlyi, Cibicides neelyi, Globorotalia wilcoxensis, etc. plus above. 740-800 ft. Paleocene? Fauna includes, in addition to above, very large Cristellaria sp., Hemicristellaria cf.	140	800

Table 10.--Logs of selected deep wells in Maryland near the Maryland-Virginia boundary--Continued

Bradshaw well, Smith Island; Somerset County, Md.--Continued

	Thickness (feet)	Depth (feet)
Paleocene Series, undifferentiated--Continued		
Aquia Formation--Continued		
rancocasensis, Anomalina spp. Robulus midwayensis, etc.		
Upper Cretaceous (?) Series: 3/		
Medium-grained white frosted sub-angular quartz sand; no fauna observed.	40	840

1/ Compare with log of Crisfield well

2/ The typical Aquia of Aquia Creek is considered to be absent in this area

3/ The sand here may be in the Paleocene ~~portion~~ part of the Mattaponi Formation

Table 10.--Logs of selected deep wells in Maryland near the Maryland - Virginia boundary--Continued

Crisfield, Somerset County; Town of Crisfield

Log by Layne-Atlantic Co., modified after published correlation and lithologic notes by McLean (1950, pages 133-136.)

Altitude, 10 feet

	Thickness (feet)	Depth (feet)
Columbia group (Pleistocene), 0-174 feet		
Beach sand and gravel	60	60
Soft clay	20	80
Medium hard clay	15	95
Soft clay	79	174
Chesapeake group (Miocene), 174-760 feet		
Yorktown and St. Marys formation:		
Shells	16	190
Brown and gray clay	58	248
Sandy clay and silt	72	320
Choptank formation:		
Sandy clay, shells, and hard sand	72	392
Calvert formation:		
Clay	246	638
Hard clay	79	717
Coarse sand	4	721
Hard clay and sand	39	760
Upper Eocene, 760-860 feet		
Chickahominy (?) formation:		
Glauconitic coarse to medium sand	42	802

Table 10.--Logs of selected deep wells in Maryland near the Maryland - Virginia boundary--Continued

Crisfield, Continued

	Thickness (feet)	Depth (feet)
Calcareous clay	58	860
Paleocene, 860-1,067 feet		
~~Midway (?) formation:~~ Midway not used in Md. and Va.		
Calcareous sandy glauconitic clay; glauconitic sand at base	207	1,067
Upper Cretaceous, 1,067-1,302 feet		
Monmouth (?) formation:		
Clay	58	1,125
Fine white sand	17	1,142
Clay	55	1,197
Fine mucky sand	15	1,212
Hard blue and red clay	90	1,302

Remarks: McLean's (1950) correlation given here is followed in the cross sections on Plate 1, with the exception of the base of the Pleistocene, which has been tentatively taken by the writers at 60 feet (about 50 feet below sea level).

Table 10.--Logs of selected deep wells in Maryland near the Maryland - Virginia boundary--Continued

Crisfield, Somerset County; Packers Ice and Cold Storage Company

(Log by Norman M. Shannahan, Jr.)

Altitude, 10 feet

	Thickness (feet)	Depth (feet)
Columbia group (Pleistocene):		
Shells	13	13
Mud	7	20
Hard clay	1	21
Sand	9	30
Soft clay	50	80
Free sand	7	87
Chesapeake group (Miocene):		
Clay and shell	177	264
Clay and shells, ½ foot of rock at base	70	334
Clay	41	375
"Rock"	2	377
Clay	21	398
"Rock"	2	400
Clay, crusty	20	420
Hard clay	64	484
Soft clay	229	713
Clay, crusty	15	728

Table 10.--Logs of selected deep wells in Maryland near the Maryland - Virginia boundary--Continued

Crisfield, Continued

	Thickness (feet)	Depth (feet)
Miocene, upper Eocene, and Paleocene, undifferentiated		
Clay	192	920
Paleocene (~~[illegible]~~):		
Sand	2	922
Tough clay	8	930
Clay	5	935
Sand	7	942
Clay	23	965
Sandy clay	31	996
Sand	32	1,028
Clay	14	1,042

Midway Group.
Midway is not used in Md. and Va.
VMD
G.W.C.

Σ - 82 Analyses; Accomack Co.

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Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia
(parts per million, except micromhos and pH)
[Analyses by U. S. Geological Survey]

Well number	1	2	3b	3c	4a	5
Location	Franklin City E of Greenbackville	Greenbackville	NNW of Horntown	E of Horntown ~~Sinnickson~~	New Church	W of New Church
Depth	75	45	189	62	~~11~~ 180	127
Geologic age	Miocene(?)	Pleistocene	Miocene	Pleistocene	Miocene	Miocene
Formation or Group	Yorktown Formation	Columbia Group	Yorktown Formation	Columbia Group	Yorktown Formation	Yorktown Formation
Date	Aug. 17, 1948	Aug. 17, 1948	Sept. 29, 1955	Sept. 29, 1955	Aug. 19, 1948	Apr. 16, 1953
Silica (SiO_2)	—	—	—	—	—	—
Iron (Fe)	4.1	4.9	.00	.39	.21	—
Calcium (Ca)	—	—	4.4	7.0	—	9.9
Magnesium (Mg)	—	—	2.2	1.0	—	6.6
Sodium (Na)	—	—	—	—	—	—
Potassium (K)	—	—	—	—	—	—
Carbonate (CO_3)	—	—	0	0	—	11
Bicarbonate (HCO_3)	232	34	342	447	186	289
Sulfate (SO_4)	1	6	—	—	1	—
Chloride (Cl)	158	10	7.2	11	11	55
Fluoride (F)	.0	.0	—	—	.0	.1
Nitrate (NO_3)	—	.2	—	—	.3	.4
Dissolved solids	—	—	—	—	—	—
Hardness as $CaCO_3$	168	36	20	22	120	52
pH	—	—	8.2	8.2	—	8.5
Specific conductance (micromhos at 25°C)	876	105	521	671	322	629

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Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(parts per million, except micromhos and pH)

Well number	6a	6a	8b	8c	8e	8h
Location	New Church	New Church	W of Chincoteague	W of Chincoteague	W of Chincoteague	W of Chincoteague
Depth (feet)	259	259	62	60	60	54
Geologic age	Miocene	Miocene	Pleistocene	Pleistocene	Pleistocene	Pleistocene
Formation or Group	St. Marys Formation	St. Marys Formation	Columbia Group	Columbia Group	Columbia Group	Columbia Group
Date	Aug. 19, 1948	May 30, 1955	Sept. 18, 1947	Sept. 18, 1947	Sept. 18, 1947	Sept. 18, 1947
Silica (SiO_2)	—	28	—	—	—	—
Iron (Fe)	.18	.64	4.0	0.15	0.1	4.0
Calcium (Ca)	—	28	—	—	—	—
Magnesium (Mg)	—	13	—	—	—	—
Sodium (Na)	—	64	—	—	—	—
Potassium (K)	—	14	—	—	—	—
Carbonate (CO_3)	—	0	—	—	—	—
Bicarbonate (HCO_3)	221	229	37	39	28	37
Sulfate (SO_4)	7	6.7	—	—	—	—
Chloride (Cl)	93	66	17	17	12	19
Fluoride (F)	.1	.2	—	—	—	—
Nitrate (NO_3)	.6	.9	—	—	—	—
Dissolved solids	—	345	—	—	—	—
Hardness as $CaCO_3$	123	124	39	31	19	24
pH	—	8.0	6.1	6.2	6.4	6.0
Specific conductance (micromhos at 25°C	650	567	—	—	—	—

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Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million, except specific conductance and pH)

Well number	8i	9a	13	17	22	24
Location	W of Chincoteague	W of Chincoteague	Chincoteague	Oak Hall	Jenkins Bridge	S of Oak Hall
Depth (feet)	65	50-65	102	230	123	250
Geologic age	Pleistocene	Pleistocene	Miocene (?)	Miocene	Miocene	Miocene
Formation or Group	Columbia Group	Columbia Group	Yorktown Formation	St. Marys Formation	Yorktown Formation	St. Marys Formation
Date	Aug. 17, 1948	Aug. 18, 1948	May 15, 1954	Apr. 16, 1953	Aug. 19, 1948	April 16, 1953
Silica (SiO_2)	11	17	—	—	—	—
Iron (Fe)	.06	.27	—	—	.18	
Calcium (Ca)	2.1	16	—	12	—	6.4
Magnesium (Mg)	2.2	9.4	—	12	—	3.4
Sodium (Na)	8.0	20	—	—	—	—
Potassium (K)			—	—	—	—
Carbonate (CO_3)	0	0	0	6	—	18
Bicarbonate (HCO_3)	12	40	650	220	176	247
Sulfate (SO_4)	4.5	38	—	—	1	—
Chloride (Cl)	10	25	693	178	11	14
Fluoride (F)	.0	0.0	—	.2	.2	.2
Nitrate (NO_3)	3.8	18	—	3.2	.6	2.2
Dissolved solids	52	172	—	—	—	—
Hardness as $CaCO_3$	14	79	388	77	81	30
pH	6.9	6.3	7.7	8.5	—	8.7
Specific conductance (micromhos at 25°C)	74 calc.	246 calc.	3,140	942	314	455

Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million except specific conductance and pH)

Well number	25	28	32	35	40	41
Location	S of Oak Hall	Saxis	NW of Hallwood	NE of Temperanceville	Temperanceville	Temperanceville
Depth (feet)	170	~~115~~ 112	90	174	176	200
Geologic age	Miocene	Pleistocene(?)	Pleistocene(?)	Miocene	Miocene	Miocene
Formation or Group	St. Marys (?) Formation	Columbia ~~(?)~~ Group	Columbia ~~(?)~~ Group	Yorktown(?) Formation	Yorktown Formation	St. Marys Formation
Date	April 16, 1953	Aug. 18, 1948	Sept. 2, 1948	Apr. 15, 1953	Aug. 19, 1948	Apr. 15, 1953
Silica (SiO_2)	—	42	—	—	—	—
Iron (Fe)	—	.97	—	—	—	—
Calcium (Ca)	30	56	—	29	—	22
Magnesium (Mg)	3.5	3.2	—	3.2	—	4.8
Sodium (Na)	—	12	—	—	—	—
Potassium (K)	—		—	—	—	—
Carbonate (CO_3)	0	0	—	0	—	0
Bicarbonate (HCO_3)	114	188	—	107	—	90
Sulfate (SO_4)	—	4.0	—	—	—	—
Chloride (Cl)	9.4	14	24	8.8	10	9.2
Fluoride (F)	.2	.3	.2	.1	.0	.2
Nitrate (NO_3)	.2	1.5	—	.5	—	.7
Dissolved solids	—	233	—	—	—	—
Hardness as $CaCO_3$	88	153	135	86	102	76
pH	8.3	7.7	—	8.1	—	7.6
Specific conductance (micromhos at 25°C)	207	333 calc.	866	201	209	182

Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million, except specific conductance and pH)

Well:	45	47a	47b	48	49	50
Location	Hallwood	Hallwood	Hallwood	W of Hallwood	Hallwood	Hallwood
Depth (feet)	265	160	~~250~~ 246	232	240	237
Geologic age	Miocene	Miocene	Miocene	Miocene	Miocene	Miocene
Formation or Group	St. Marys Formation	St. Marys Formation	St. Marys Formation	St. Marys Formation	St. Marys Formation	St. Marys Formation
Date	April 15, 1953	Apr. 6, 1955	Apr. 6, 1955	Apr. 14, 1953	Apr. 15, 1953	Apr. 14, 1953
Silica (SiO_2)	—	31	16	—	—	—
Iron (Fe)	—	.44	.06	—	—	—
Calcium (Ca)	23	25	23	23	23	23
Magnesium (Mg)	10	5.5	9.5	12	11	13
Sodium (Na)	—	8.0	18	—	—	—
Potassium (K)	—	2.1	7.0	—	—	—
Carbonate (CO_3)	0	0	0	0	0	0
Bicarbonate (HCO_3)	144	112	142	148	157	156
Sulfate (SO_4)	—	.5	1.0	—	—	—
Chloride (Cl)	8.0	7.8	17	15	20	15
Fluoride (F)	.0	.1	.1	.1	.1	.1
Nitrate (NO_3)	1.4	.2	.7	3.0	1.1	2.8
Dissolved solids	—	129	154	—	—	—
Hardness as $CaCO_3$	100	85	96	107	101	110
pH	8.1	8.1	8.3	8.1	8.1	8.1
Specific conductance (micromhos at 25°C)	250	199	275	272	307	279

Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million, except specific conductance and pH)

Well number	52	55	56	57	58	59
Location	W of Hallwood	ESE ~~WSW~~ of Hallwood	WSW of Hallwood	Mears	SSE of Hallwood	Mappsville
Depth (feet)	231	130	190	256	199	255
Geologic age	Miocene	Miocene	Miocene	Miocene	Miocene	Miocene
Formation or Group	St. Marys Formation	Yorktown Formation	St. Marys Formation	St. Marys Formation	Yorktown (?) Formation	St. Marys Formation
Date	Apr. 14, 1953	Aug. 18, 1948	Sept. 3, 1948		Sept. 2, 1948	Apr. 14, 1953
Silica (SiO_2)	—	—	—	—	—	—
Iron (Fe)	—	—	.12	—	.72	—
Calcium (Ca)	23	—	—	—	—	28
Magnesium (Mg)	11	—	—	—	—	5.2
Sodium (Na)	—	—	—	—	—	—
Potassium (K)	—	—	—	—	—	—
Carbonate (CO_3)	0	—	—	—	—	0
Bicarbonate (HCO_3)	146	—	166	—	125	118
Sulfate (SO_4)	—	—	6	—	1	—
Chloride (Cl)	13	9	101	10	10	13
Fluoride (F)	.1	.2	.2	.1	.1	.1
Nitrate (NO_3)	1.2	—	.4	—	.1	2.0
Dissolved solids	—	—	—	—	—	—
Hardness as $CaCO_3$	104	117	78	57	81	91
pH	8.0	—	—	—	—	8.1
Specific conductance (micromhos at 25°C)	269	218	645	267	224	214

Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million, except specific conductance and pH)

Well number	60	61	62	63	64	65
Location	Mappsville	Wallops Island	Mappsville	Mappsville	~~SW~~ NW of Bloxom	NNE of Nelsonia
Depth (feet)	21	147	225	255	23	220
Geologic age	Pleistocene	Miocene	Miocene	Miocene	Pleistocene	Miocene
Formation or Group	Columbia Group	Yorktown Formation	St. Marys Formation	St. Marys Formation	Columbia Group	St. Marys Formation
Date	Sept. 2, 1948	1946?	Apr. 14, 1953	Apr. 14, 1953	Sept. 3, 1948	Aug. 18, 1948
Silica (SiO_2)	—	—	—	—	—	—
Iron (Fe)	—	3.1	—	—	—	—
Calcium (Ca)	—	—	37	27	—	—
Magnesium (Mg)	—	—	8.9	6.2	—	—
Sodium (Na)	—	—	—	—	—	—
Potassium (K)	—	—	—	—	—	—
Carbonate (CO_3)	—	—	0	0	—	—
Bicarbonate (HCO_3)	—	180	162	122	—	112
Sulfate (SO_4)	—	2	—	—	—	2.0
Chloride (Cl)	6	64	13	13	10	8.0
Fluoride (F)	.0	—	.1	.1	.1	.0
Nitrate (NO_3)	—	1.5	1.9	2.1	—	.3
Dissolved solids	—	—	—	—	—	—
Hardness as $CaCO_3$	57	180	130	94	90	78
pH	~~166~~	—	8.1	8.4	~~271~~	~~209~~
Specific conductance (micromhos at 25°C)	166	—	283	220	271	209

Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million, except specific conductance and pH)

Well number	66	67	68	69	71	72
Location	E of Bloxom	E of Bloxom	Nelsonia	Nelsonia	W of Modest Town	Nelsonia
Depth (feet)	18½	265	240	230	228	230
Geologic age	Pleistocene	Miocene	Miocene	Miocene	Miocene	Miocene
Formation or Group	Columbia Group	St. Marys Formation	St. Marys Formation	St. Marys Formation	St. Marys Formation	St. Marys Formation
Date	Sept. 3, 1948	Apr. 18, 1953	Apr. 17, 1953	Apr. 17, 1953	Sept. 16, 1953	Apr. 17, 1953
Silica (SiO_2)	—	—	—	—	—	—
Iron (Fe)	—	—	—	—	—	—
Calcium (Ca)	—	22	27	23	23	20
Magnesium (Mg)	—	9.1	9.3	5.8	10	5.5
Sodium (Na)	—	—	—	—	—	—
Potassium (K)	—	—	—	—	—	—
Carbonate (CO_3)	—	0	12	0	9	0
Bicarbonate (HCO_3)	—	121	119	97	133	87
Sulfate (SO_4)	—	—	—	—	—	—
Chloride (Cl)	26	9.5	11	9.8	10	9.0
Fluoride (F)	.0	.0	.1	.0	.2	.1
Nitrate (NO_3)	—	.5	.5	.7	1.3	.6
Dissolved solids	—	—	—	—	—	—
Hardness as $CaCO_3$	102	94	107	80	80	72
pH	—	8.1	8.8	8.2	8.7	8.0
Specific conductance (micromhos at 25°C)	297	222	245	188	259	172

Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million, except specific conductance and pH)

Well number	73	76	78	81	84	88
Location	N of Modest Town	WSW of Bloxom	SSW of Bloxom ~~Hopeton~~	Hopkins	E of Parksley	SSW of Hopkins
Depth (feet)	230	138	40	100	228	220
Geologic age	Miocene	Miocene	Pleistocene	Miocene	Miocene	Miocene
Formation or Group	St. Marys Formation	Yorktown Formation	Columbia Group	Yorktown Formation	St. Marys Formation	St. Marys Formation
Date	Apr. 17, 1953	Sept. 3, 1948	Sept. 3, 1948	Sept. 3, 1948	Apr. 18, 1953	Sept. 4, 1948
Silica (SiO_2)	—	—	—	—	—	—
Iron (Fe)	—	.09	—	.12	—	—
Calcium (Ca)	24	—	—	—	27	—
Magnesium (Mg)	4.8	—	—	—	12	—
Sodium (Na)	—	—	—	—	—	—
Potassium (K)	—	—	—	—	—	—
Carbonate (CO_3)	7	—	—	—	0	—
Bicarbonate (HCO_3)	90	180	—	156	152	—
Sulfate (SO_4)	—	1	—	1	—	—
Chloride (Cl)	9.6	17	26	10	7.6	48
Fluoride (F)	.1	.3	.0	.1	.1	.0
Nitrate (NO_3)	.5	.1	—	.3	1.1	—
Dissolved solids	—	—	—	—	—	—
Hardness as $CaCO_3$)	81	57	99	102	116	123
pH	8.7	—	—	—	8.3	—
Specific conductance (micromhos at 25°C)	195	294	328	271	254	462

Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million, except specific conductance and pH)

Well number	89	92	93	95	96	97
Location	~~Gr~~ NW of Greenbush	Chesconessex	SW of Chesconessex	Greenbush	Greenbush	Greenbush
Depth (feet)	50	150	160	140	265	267
Geologic age	Pleistocene	Miocene	Miocene	Miocene	Miocene	Miocene
Formation or Group	Columbia Group	Yorktown Formation	Yorktown Formation	Yorktown Formation	St. Marys Formation	St. Marys Formation
Date	April 18, 1953	April 18, 1953	Sept. 4, 1948	Sept. 4, 1948	Apr. 18, 1953	April 18, 1953
Silica (SiO_2)	—	—	—	—	—	—
Iron (Fe)	—	~~1~~	—	.13	—	—
Calcium (Ca)	15	32	—	—	22	21
Magnesium (Mg)	3.9	10	—	—	15	12
Sodium (Na)	—	—	—	—	—	—
Potassium (K)	—	—	—	—	—	—
Carbonate (CO_3)	0	0	—	—	0	0
Bicarbonate (HCO_3)	28	234	—	113	181	132
Sulfate (SO_4)	—	—	—	1	—	—
Chloride (Cl)	15	17	92	10	23	9.9
Fluoride (F)	.0	.1	.1	.1	.2	.1
Nitrate (NO_3)	2.7	2.9	—	.1	4.6	1.7
Dissolved solids	—	—	—	—	—	—
Hardness as $CaCO_3$	53	123	72	75	116	100
pH	7.0	8.2	—	—	8.1	8.0
Specific conductance (micromhos at 25°C)	156	402	997	~~209~~ 210	350	236

Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million, except specific conductance and pH)

Well number	98	99	101	102	104	106
Location	Greenbush	N of Greenbush	S of Greenbush	Accomac	Accomac	Accomac
Depth (feet)	265	28	272	68	73	160
Geologic age	Miocene	Pleistocene	Miocene	Pleistocene	Pleistocene	Miocene
Formation or Group	St. Marys Formation	Columbia Group	St. Marys Formation	Columbia Group	Columbia Group	Yorktown Formation
Date	April 18, 1953	Sept. 5, 1948	Sept. 4, 1948	Sept. 4, 1948	May 29, 1953	May 29, 1953
Silica (SiO_2)	—	—	—	—	15	—
Iron (Fe)	—	—	.08	7.5	.04	—
Calcium (Ca)	22	—	—	—	17	21
Magnesium (Mg)	14	—	—	—	2.8	8.8
Sodium (Na)	60	—	—	—	8.2	—
Potassium (K)	—	—	—	—	.8	—
Carbonate (CO_3)	0	—	—	—	0	0
Bicarbonate (HCO_3)	181	—	191	55	27	130
Sulfate (SO_4)	—	—	1	6	22	—
Chloride (Cl)	31	48	14	15	17	10
Fluoride (F)	.1	.0	.3	.1	.1	.0
Nitrate (NO_3)	2.9	—	.1	.1	1.2	.4
Dissolved solids	—	—	—	—	107	—
Hardness as $CaCO_3$	114	132	111	57	54	88
pH	8.2	—	—	—	7.2	7.8
Specific conductance (micromhos at 25°C)	374	619	341	165	163	235

Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million, except specific colnductance and pH)

Well number	107	108c	124	126	128 a	151
Location	Accomac	Onancock	SSW of Onancock	SSW of Cashville	SSE of Accomac	Pungoteague
Depth (feet)	~~168~~ 161	210	22	128	90	210
Geologic age	Miocene	Miocene	Pleistocene	Miocene	Miocene (?)	Miocene
Formation or Group	Yorktown Formation	St. Marys Formation	Columbia Group	Yorktown Formation	Yorktown (?) Formation	St. Marys Formation
Date	May 29, 1953	Sept. 4, 1948	Sept. 5, 1948	Sept. 5, 1948	-	1906
Silica (SiO_2)	—	24	—	—	—	45
Iron (Fe)	—	.07	—	.12	—	.1
Calcium (Ca)	21	24	—	—	—	25
Magnesium (Mg)	8.6	8.5	—	—	—	11
Sodium (Na)	—	34	—	—	—	32
Potassium (K)	—		—	—	—	14
Carbonate (CO_3)	0	0	—	—	—	0
Bicarbonate (HCO_3)	128	168	—	237	—	218
Sulfate (SO_4)	—	6.5	—	1	—	1.6
Chloride (Cl)	9.8	15	18	25	8	12
Fluoride (F)	.0	.1	.0	.3	.1	—
Nitrate (NO_3)	.4	2.9	—	.1	—	3.6
Dissolved solids	—	203	—	—	—	250
Hardness as $CaCO_3$	88	95	45	102	81	—
pH	8.0	7.9	—	—	—	—
Specific conductance (micromhos at 25°C)	231	290 calc.	1,420	444	271	358 calc.

Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million, except specific conductance and pH)

Well number	153	154	160	163	166	167
Location	Pungoteague	Nandua	Wachapreague	SE of Keller	Craddockville	Painter
Depth (feet)	128	108	385	39	170	98
Geologic age	Miocene(?)	Pleistocene	Miocene	Pleistocene	Miocene	Pleistocene
Formation or Group	Yorktown (?) Formation	Columbia Group	Choptank Formation	Columbia Group	Yorktown Formation	Columbia Group
Date	Sept. 5, 1948	April 18, 1953	Sept. 7, 1948	Sept. 3, 1948	Sept. 5, 1948	Sept. 13, 1948
Silica (SiO_2)	—	—	14	—	—	—
Iron (Fe)	.62	—	.14	—	5.0	13
Calcium (Ca)	—	21	5.5	—	—	—
Magnesium (Mg)	—	7.5	3.8	—	—	—
Sodium (Na)	—	—	} 180	—	—	—
Potassium (K)	—	—		—	—	—
Carbonate (CO_3)	—	0	0	—	—	—
Bicarbonate (HCO_3)	18	116	346	—	28	166
Sulfate (SO_4)	7	—	4.0	—	23	1
Chloride (Cl)	7	10	93	24	15	10
Fluoride (F)	.2	.1	.7	.0	.2	.3
Nitrate (NO_3)	.9	.6	.8	—	.1	5.9
Dissolved solids	—	—	482	—	—	—
Hardness as $CaCO_3$	36	83	29	75	42	111
pH	—	7.7	8.1	—	—	—
Specific conductance (micromhos at 25°C)	88.1	216	688 calc.	263	134	293

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Table 11.—Chemical analyses of ground waters from wells in Accomack County, Virginia—Continued
(Parts per million, except for specific conductance and pH)

Well number	171	177	182	183
Location	WSW of Craddockville	Belle Haven	Upshurs Neck	Tangier Island
Depth (feet)	28	198	13	860
Geologic age	Pleistocene	Miocene	Pleistocene	Late Eocene (?)
Formation or Group	Columbia Group	Yorktown (?) Formation	Columbia Group	Chickahominy (?) Formation
Date	Sept. 5, 1948		Sept. 3, 1948	1948
Silica (SiO_2)	—	—	—	12
Iron (Fe)	—	—	—	—
Calcium (Ca)	—	—	—	—
Magnesium (Mg)	—	—	—	—
Sodium (Na)	—	—	—	} 339
Potassium (K)	—	—	—	
Carbonate (CO_3)	—	—	—	28
Bicarbonate (HCO_3)	—	—	—	579
Sulfate (SO_4)	—	—	—	58
Chloride (Cl)	20	1	130	115
Fluoride (F)	.0	—	.0	3.2
Nitrate (NO_3)	—	—	—	.4
Dissolved solids	—	—	—	857
Hardness as $CaCO_3$	54	102	108	15
pH	—	—	—	8.4
Specific conductance (micromhos at 25°C)	206	740	871	—

014

014

Table 12.--Chemical analyses of water from irrigation ponds in Accomack County, Virginia

	N of Mappsville	E of Parksley	Between Keller and Painter
Geologic age	Pleistocene	Pleistocene	Pleistocene
Formation or Group	Columbia Group	Columbia Group	Columbia Group
Date	Aug. 25, 1955	Sept. 28, 1955	Aug. 25, 1955
Silica (SiO_2)	11	6.4	4.9
Iron ; (Fe)	.03	.00	.06
Calcium (Ca)	7.6	37	5.2
Magnesium (Mg)	2.4	7.3	1.6
Sodium (Na)	13	11	9.4
Potassium (K)	3.3	3.1	3.5
Carbonate (CO_3)	0	0	0
Bicarbonate (HCO_3)	4	54	9
Sulfate (SO_4)	28	38	11
Chloride (Cl)	20	29	18
Fluoride (F)	.1	.1	.1
Nitrate (NO_3)	.4	2.4	.7
Dissolved solids	102	201	78
Hardness as $CaCO_3$	29	97	20
pH	5.9	7.2	6.6
Specific conductance (micromhos at 25°C)	148	313	113

Table 13.--Chemical analyses of waters from deep wells in Somerset County, Maryland
(Parts per million, except pH)
(Data from Rasmussen and Slaughter, 1955, Tables 35, 38, and 41)

Location	Smith Island	Smith Island	Smith Island	Smith Island
Owner	Lora C. Whitelock	Clayton Middleton	Harvey Bradshaw	Charlton Evans
Depth (feet)	841	850	820	852
Geologic age	Late Cretaceous	Late Cretaceous	Late Cretaceous	Late Cretaceous
Formation or Group	Magothy (?) Formation	Magothy (?) Formation	Magothy (?) Formation	Magothy (?) Formation
Date	Apr. 26, 1948	Apr. 26, 1948	Apr. 26, 1948	Apr. 26, 1948
Silica (SiO_2)	11	11	-----	-----
Iron (Fe)	.02	.02	-----	-----
Calcium	2.0	1.8	-----	-----
Magnesium (Mg)	.8	.7	-----	-----
Sodium (Na) Potassium (K)	241	217	-----	-----
Bicarbonate (HCO_3)	506	457	598	518
Carbonate (CO_3)	37	31	-----	-----
Sulfate (SO_4)	32	30	14	35
Chloride (Cl)	10	10	10	8.0
Fluoride (F)	3.0	2.8	1.4	4.4
Nitrate (NO_3)	1.5	.1	1.5	.2
Dissolved solids	588	522	-----	-----
Hardness as $CaCO_3$	8	7	10	9
pH	8.4	8.5	-----	-----

NORTHAMPTON COUNTY

LOCATION AND DEVELOPMENT

Northampton County occupies the southern part of the Eastern Shore peninsula in eastern Virginia. It is bounded by Accomack County on the north and by the Atlantic Ocean and Chesapeake Bay on the east and west, respectively. Its total land area is 226 square miles, and its population, according to the 1960 census, was 16,966--a decrease of 334 since 1950.

Its soil is very favorable for truck farming; Irish potatoes and sweet potatoes are large industries. General farm crops, strawberries, cabbage, lima beans, and snap beans are extensively raised. These agricultural products, together with much of the output of the important seafood industries, are prepared for the market by local canneries at Cheriton, Machipongo, and Exmore. Willis Wharf is a fishing and oystering center. The county seat is Eastville, in the central part; the largest community is Cape Charles.

Ferry service across Chesapeake Bay to Little Creek, near Norfolk, and Old Point Comfort, formerly left the Eastern Shore at Cape Charles. In about 1952, the ferry terminal on the peninsula was moved to Kiptopeke at the southern extremity, where it remained until the completion of the Chesapeake Bay Bridge-Tunnel in 1964. The bridge-tunnel connects U.S. Highway 13 on the Eastern Shore with the southerly continuation of that highway at Cape Henry across the mouth of Chesapeake Bay. State Highway 183 and 186 also

serve the county. Motor bus transportation is available along Highway 13. Railway freight service is provided by the Penn Central (formerly Pennsylvania) Railroad through the county as far south as Kiptopeke, with a spur line into Cape Charles.

DRAINAGE AND TOPOGRAPHY

Northampton County, like Accomack, has no major streams. It is drained by numerous small creeks which flow westward or eastward from ~~the~~ low-relief divide of which passes along the length of the peninsula. Along the eastern shore of Chesapeake Bay are several tidal inlets which mark the submerged mouths of the larger creeks draining the western part of the county: among the larger of these are Occahannock Creek at the north boundary, Nassawadox Creek, Mattawoman Creek, and Cherrystone Inlet near Cape Charles. ~~and other smaller inlets.~~ Along the eastern side of the county are many marshy islands which extend 9 miles east of the main shoreline. Both the eastern and western sides of the county are typically drowned shorelines. A few minor spits have been developed, which partly enclose the several "bays"--Hog Island Bay at the north, Cobb Bay, South Bay, and Magothy Bay at the south.

UNPUBLISHED RECORDS
SUBJECT TO REVISION

The relief in Northampton County ranges from sea level on the bay and ocean sides of the peninsula to nearly 50 feet on the subdued longitudinal ridge along the middle axis of the county; a maximum elevation of about 70 feet is reached on the truncated cliffs between Cheapside and Kiptopeke Beach at the south end of the peninsula. Carolina Bays, generally only visible from the air or on aerial photographs, may be noted in several places on the newer topographic maps of 10-foot contour interval, especially between Eastville and Cheriton, where their sand rims reach the 40-foot contour line. Minor scarps, believed to mark the position of shorelines developed during higher stands of sea level during the several stages of continental glaciation in Pleistocene time, may be noted particularly in the southern part of the county. (See Fig. 2 ; also, Sinnott and Tibbitts, 1961.)

GEOLOGY

Northampton County is underlain at depth by ~~the~~ a basement complex of igneous and metamorphic rocks, believed to be chiefly of Precambrian age. These rocks are overlain by successively younger unconsolidated beds of sand, gravel, clay, and shell marl, which are of Cretaceous, Paleocene, Eocene, Miocene, and Pleistocene age. (See columnar section, Plate 2.)

Basement complex

No wells, so far as known, have ever reached the basement complex in this county. The bedrock surface beneath the unconsolidated sediments in Northampton County probably lies at depths of from 2,800 to 4,200 feet below sea level (Spangler and Peterson, 1950, Fig. 12).

Cretaceous and Paleocene ~~systems~~ deposits

As shown in the ~~cross~~ section (Plate 1, section C-C') and as given in the log (90, Table 15) the old well at Cape Charles is believed to have penetrated the Potomac group of beds of Early (?) Cretaceous age. The line of separation of the Potomac Group of formations from the overlying Mattaponi Formation of Paleocene to Late Cretaceous age cannot be made on the basis of data at hand. The mottled clay reported between 1331 and 1585 feet is characteristic of the Mattaponi Formation west of Chesapeake Bay. However, it is not possible to subdivide the Mattaponi Formation in the Cape Charles well into its component units. "Green clay with black specks" noted at 890 to 950 feet might, insofar as lithology is concerned, be assigned anywhere in the Eocene or in the

~~Late~~ Upper Cretaceous part of the Mattaponi Formation. In view of the great uncertainties concerning the deep formations here, the Cape Charles log is subdivided as far as possible on the basis of McLean's correlation of strata present in the Crisfield well, making reasonable allowances for the fact that Cape Charles is a little up-dip from Crisfield. However, even with this assistance, the contact between the Mattaponi Formation and the Potomac group remains conjectural. Further, it should also be borne in mind that the assumption that Upper Cretaceous beds extend as far down as about 1,600 feet is based on extremely meagre data.

Presumably the Cobb Island well (180, Table 15) reached beds near the top of the Mattaponi Formation. The log gives no lithologic detail.

~~Tertiary System~~

Eocene Series

The two deep wells just mentioned, at Cape Charles and Cobb Island, are throught to have penetrated 100 to 150 feet of beds of late Eocene age. ~~Late~~ Upper Eocene beds assigned to the Chickahominy (?) Formation are reported by McLean in the Crisfield well and there is a reasonable probability that ~~Late~~ Upper Eocene beds are present in southern Northumberland County.

MIOCENE SERIES

Rocks of the Chesapeake Group, of Miocene age, do not crop out at the surface anywhere in the county, being overlain by the younger Pleistocene sediments. The top of the Yorktown Formation, which is the youngest of the group, lies at depths of about 25 to 100 feet below the surface in the county.

Except in a few places where adequate drill cuttings are available, it is difficult or impossible to differentiate among the several formations of the Chesapeake Group; most of what has been done thus far has been based on a study of the fossils contained in the deposits.

Although no wells tap the Calvert or Choptank Formations in Northampton County, the two deepest test holes of record, wells 90 and 180 at Cape Charles and Cobb Island, respectively, penetrate these formations. Material tentatively ascribed to these formations, according to the well logs (Table 15), are green and gray clay, mud, ~~and~~ fine sand, ~~with~~ and some shells. They show little promise as possible aquifers, as indeed was borne out by the test made at the time of drilling.

In U.S.G.S. test hole 1 at Capeville (Table 15), material ~~that was~~ correlated with the Choptank Formation by means of megafossils by MacNeil (personal communi~~cation~~, 1955) consists of soft sandy gray-green clay with scattered shell fragments, black chert, coarse (?) sand 22 feet thick, and dark gray silty clay. The sand yielded virtually no water.

St. Marys and Yorktown Formations

According to the drillers' logs which are available from wells drilled in Northampton County, that part of the Chesapeake group penetrated by the wells--chiefly the Yorktown Formation but including also the upper part of the St. Marys--consists generally of sand, sandy clay, and shell marl with minor lenses of gravel. There are usually several water-bearing beds separated by clayey layers.

For example, at Cheriton (well 76), the Yorktown Formation consists of shells and clay with some gravel; there are water-bearing beds from 122 to 125 feet, and from 158 to 164 feet, each consisting of shells and gravel.

In a 270-foot well at Exmore (2), the uppermost part of the Miocene section, in the Yorktown Formation, is largely clay. From 165 to 184 feet is a coarse sand, with 4 feet of "hard shell rock" at the base, underlain by 26 feet of clay, ~~another~~ A bed of gravel, sand and shells ~~bed~~ occurs from 210 to 238 feet, also in the Yorktown Formation. The underlying 32-foot section, consisting of shells and clay, down to the total depth of the well at 270 feet, is correlated with the St. Marys Formation. Another well at Exmore (9) penetrated

shells and clay of the Yorktown from 209 to 215 feet, and sand, shells, and clay of the St. Marys from 277 to 288.

~~QUATERNARY SYSTEM~~

PLEISTOCENE SERIES

The Columbia Group of formations of Pleistocene age occurs as a veneer, about 25 to 100 feet thick, upon the underlying Miocene deposits in Northampton County. The unconsolidated Pleistocene rocks are chiefly yellow sand, sandy clay, and minor lenses of gravel. Cross-bedding is common in the sandy formations. In many wells it is difficult to distinguish beds of the Columbia Group from the underlying Yorktown Formation except where fossil shells are present and where there is a color change from yellowish in the Pleistocene to gray in the Yorktown. Because individual Pleistocene beds commonly interfinger and are of limited areal extent, it is not usually possible to trace them laterally for more than a few hundred feet.

Ground-Water Resources

Water from Pre-Miocene ~~formations~~ deposits

The two deep wells in the county have failed to note the presence of good water-bearing sands at depth. According to Sanford (1913, p. 246), the driller "found no strongly water-bearing sand between 40 and 1,520 feet." at Cape Charles (90, Table 15) The well was never put into use. The Cobb Island well (180) was abandoned because when tested it produced only brackish water.

It is entirely likely that even if water in large quantity could be produced from the pre-Miocene formations, that water would be brackish and of very limited usefulness.

Water from Miocene deposits

Calvert and Choptank Formations

The two oldest formations of the Chesapeake Group are the Calvert and Choptank Formations. So far as the writers are aware, no wells in Northampton County are known to tap these deposits.

St. Marys Formation

The canvass of representative wells in the county lists seven wells that tap water-bearing materials in the St. Marys Formation. These range in yield from 15 gpm (43, at Bayford, 2 inches in diameter) to 275 gpm (9, at Exmore, 8 inches in diameter). Substantial yields were also obtained from two of the other 6-inch wells; 44 b, a public supply well at Nassawadox, yields 150 gpm, and a school well at Machipongo (54) is pumped at a rate of 60 gpm. This may be substantially lower than its potential capacity.

Comparatively smaller yields--up to about 30 gpm--are obtained from wells 2 inches in diameter (43, 68) and 3 inches in diameter (44a). In general, supplies of about 25 gpm can be expected from 2-inch diameter wells from the St. Marys Formation in Northampton County, whereas some assurance of maximum yields of over 100 gpm would be afforded by properly developed wells 6 inches or more in diameter.

Yorktown Formation

More than 90 of the wells canvassed in Northampton County draw water from aquifers in the Yorktown Formation. Most of these wells are 2 inches

in diameter, and their yield averages from 15 to 25 gpm. Three wells 3 inches in diameter (3, 4, and 89) have yields that range up to 100 gpm, and 4-inch wells (13, 14, 64) yield up to 200 gpm.

Well 93, a 4-inch well 175 feet deep drilled in 1927 for the town of Cape Charles, was reported to produce water "with some salt," and was abandoned, although it had a substantial yield of 110 gpm.

Two 8-inch wells (2, 10) produce 310 and 200 gpm, respectively.

One of the town wells at Eastville (63) formerly pumped 75 gpm from fine sand and shells in the Yorktown Formation. However, although it was reported to have a maximum yield of 200 gpm, it was abandoned some years ago because sand was being drawn into the screen, perhaps because it was pumped at a higher capacity than the capacity at which it was developed initially. It seems likely that the well might have been salvaged by installing a finer screen, followed by careful redevelopment or perhaps by simple redevelopment.

Well 31 at Willis Wharf, 142 feet deep, was reported ~~as~~ to be flowing at a rate of 28 ~~gallons per minute~~ gpm in 1948. The effect of loading ~~of~~ by ~~the~~ tidewater ~~is~~ was apparent [redacted] in that the flow was less at low tide. In 1946, well 83 b at Oyster flowed at a rate of about ~~1/2~~ half a gallon per minute.

In a 271-foot well (76) at Cheriton, the driller noted water-bearing beds of sand, shells, and gravel from 110 to 125 feet, shells and coarse gravel from 158 to 164 feet, and shells and silty clay from 177 to 190 feet below the surface. The yields from each of these zones was not recorded, but the middle zone was reported to be especially favorable.

The 8-inch town well at Exmore (2) [redacted] had the highest tested yield of record in the county and in the entire Virginia Eastern Shore at the time it was drilled in 1950 [redacted] It yielded 746 gpm with a drawdown of 37 feet at that time. The well draws water from coarse sand and very hard "shell rock," in the Yorktown Formation, from 165 to 184 feet below the surface. Its present pump has a capacity of 310 gpm.

A much higher yield from the Yorktown Formation--645 gpm--is delivered by well 92, one of the town wells of Cape Charles; this well has the highest operational yield (as distinct from tested yield) recorded during this study for any well in either county.

Summary:

In summary, the Miocene deposits, especially where they contain shells, yield water copiously to wells in many areas. The wells are commonly less than 200 feet deep but a few are deeper. As in Accomack County, however, the lenticular character of the formations make it impracticable to predict whether or not a new well at a particular site will provide an adequate supply of water. It seems advisable, therefore, before planning large developments, to jet down a few small-diameter test holes prior to drilling permanent production wells, in order to select those sites promising the greatest yield. Samples of ground water for chemical analysis also should be collected to insure against tapping high-chloride water which is present in some places in the Miocene.

Most waters (except those few that are brackish) ~~yield water that is~~ are of excellent quality for irrigation as well as for most other domestic and commercial uses.

Water from Pleistocene deposits

Many rural homes and farms obtain their water supply from shallow dug or driven wells which tap water from the sands and gravels that make up the Columbia Group of Pleistocene age. The wells are commonly 2 inches or less in diameter and most of them yield less than 5 gallons per minute.

In the group of 70 wells tapping the Pleistocene in the county that were visited during the field canvass, four are pumped at 25 gpm or more (wells 33, 36, 128, and 177). Two are irrigation wells, one (177) is at the Cape Charles Air Force ~~Station~~, and another (36) is a school well. The latter has the highest reported yield (37 gpm) from the Columbia Group in Northampton County.

Considering the availability of larger quantities of water from these beds, there is little doubt that large-diameter wells equipped with pumps of greater capacity might yield 50 to 100 gpm, or more, where the water-bearing material is coarse and there is a minimum of interference from nearby wells. It will be recalled, in the description of ground-water conditions in Accomack County, that the highest recorded tested yield for any well in the entire peninsula is from a well in the Pleistocene deposits. (See well 115, Accomack County, Table 8.)

Locally, as in low places near the shore on the ocean or bay side of the peninsula, prolonged heavy pumping may induce encroachment of the sea water into the shallow ground-water reservoirs. This would occur when the water table was lowered below sea level and the hydraulic gradient (slope of the water table) reversed. With the water table sloping towards, rather than away from, the land the flow of water would be landward. So far as known, the shallow Pleistocene beds are in hydraulic continuity with the ocean and bay water offshore.

In order to prevent, so far as possible, the encroachment of saline water into the shallow ground-water reservoirs, perhaps the most dependable arrangement for relatively large withdrawals of water from the Pleistocene aquifers is a battery of small-diameter shallow wells so disposed as to intercept the maximum natural ground water flow from the land to the sea, i.e., roughly parallel to the shoreline. such wells could be

(N-22-W cont'd.)

driven, jetted, or drilled, and should be spaced as widely apart as possible consistent with the requirements for unit operation. It is believed that under favorable conditions on the order of a million gallons of water per day might be obtained by such a system. Such an arrangement of wells is in operation in northeastern Accomack County for the town of Chincoteague, ~~which~~ and is discussed in the chapter for that county.

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QUALITY OF WATER

Water from Cretaceous, Paleocene and Eocene deposits

As stated previously, no wells produce water from deposits of Cretaceous age in Northampton County. The only wells that obtain water from the Eocene deposits are those on Tangier Island in Accomack County. The chemical quality of the ground water from the Cretaceous and Eocene deposits would be similar to that obtained at Tangier Island (183, Table 11) except the total dissolved solids would be greater nearly everywhere. Water from that well is a soft sodium-bicarbonate type somewhat high in chloride. The well at Cobb Island (180, ~~Table 15~~) yielded brackish water from Paleocene deposits.

The high-chloride ground water in the deeper aquifers in the eastern part of the Coastal Plain has been attributed by Sanford (1913, p. 114) to the presence of residual ocean water, which saturated the sediments during several post-Cretaceous marine advances, and which has since been only incompletely flushed out by the eastward migration of fresh artesian ground water from the recharge areas along the Fall Zone.

The high sodium-chloride (and sodium-bicarbonate) content that would be expected from the deep aquifers would therefore largely restrict their use to cooling and to certain other specialized applications. Use of the water for domestic purposes would be precluded as well as use for irrigation.

Deep somewhat saline ground water would be more economical to desalinize than sea water. However, careful ~~vigorous and intelligent~~ development of both shallow and moderately deep ground waters is at present a ~~far~~ more practicable approach to increasing the total available supply on the Eastern Shore than

desalinization. Further, there is ample opportunity for increasing ground water retention and availability by artificial recharge in this low-lying province in which a sandy cover is everywhere present. Such practices are already being carried out on a small scale by farmers who have established the "irrigation ponds" mentioned above.

Water from Miocene deposits

St. Marys Formation

Chemical analyses are available of waters from three of the seven wells recorded that tap the St. Marys Formation in Northampton County.

Well 9 at Exmore is 295 feet deep and yields water that is very high in chloride, 690 parts per million. (More than half the sodium is present as sodium chloride, the remainder as sodium bicarbonate. Less than half the bicarbonate is present as calcium and magnesium bicarbonate.) The origin of the water is obscure. In chemical characteristics it is similar to water in the Eocene and Cretaceous beds elsewhere in the Coastal Plain (Cederstrom, 1946 b). Thus it may have migrated eastward beneath the Bay through Miocene beds or initially through older beds after which it "leaked" upward into Miocene beds. Possible movement downward from surficial beds seems somewhat less likely.

Well 29, 240 feet deep, at Willis Wharf, half a mile southeast of Exmore, yields hard water with a chloride concentration of 101 ppm.

A 200-foot well (43) at Bayford is reported to yield "salty water" from fine dark gray sand in the St. Marys.

A comprehensive analysis was made of water from a well at the Northampton-Accomack Memorial Hospital at Nassawadox. (See analysis, well 44b, Table 16.) The well is screened in both the Yorktown and St. Marys Formations; the generally excellent character of the water suggests that it is derived principally from the Yorktown. It is a moderately hard calcium-bicarbonate water containing only 176 ppm of dissolved solids.

Yorktown Formation

Waters from wells 160 to 200 feet deep, tapping the Yorktown Formation in the vicinity of Exmore (12, 13, 14, Table 16) in the northern part of Northampton County, are moderately hard bicarbonate waters. Bicarbonate is 120 and 194 ppm in wells 13 and 14. Chloride is low, less than 20 ppm; nitrate, sulfate and fluoride are all low. Well 39 near Nassawadox, also in the

northern part of the county, was jetted to 90 feet and yields water with a chloride content of only 10 ppm and a hardness of 72 ppm. Although not determined, iron apparently is a problem, as staining of clothing is reported. Fluoride, ~~although tested~~, was not ~~detected.~~ present in the sample taken

N-28-Q About 3 miles southwest of Bridgetown, well 51, 98 feet deep ~~and tapping the Yorktown Formation,~~ yields water with 205 ppm of chloride. Its location near Hungars Creek suggests that there may be local hydraulic continuity between the aquifer and the brackish water of Chesapeake Bay, and that this may contribute to the high chloride content. The moderately high nitrate (4.1 ppm ~~parts~~) in the water from this well might be from organic pollution, although it is a driven well and presumably relatively safe from such pollution from surface sources. This well is pumped at a rate of only 5 gallons per minute.

At Eastville, near the middle of the county, an unused 146-foot well (63) in the Yorktown yields water having ~~with~~ a low chloride concentration of 17 ppm, and a dissolved solids content of 145 ppm ~~parts.~~

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Two cannery wells (75 and 76) that obtain water from the Yorktown at Cheriton, near the town of Cape Charles, are 170 and 250 feet deep, respectively. Water samples from both were low in chloride (22 and 4 ~~parts~~ ppm, respectively). The Nitrate content in water from well 75 is 5.3 ppm, pointing to the possibility of organic pollution. About 2 miles east of Cheriton, at Oyster, an old flowing well (83b), reported to be about 150 feet deep, yields a moderately hard calcium-bicarbonate water which is only moderately mineralized. Dissolved solids are 177 ppm and the chloride concentration is 18 ppm.

Near the south end of the county, a 65-foot well ~~(31)~~ 176 at ~~Fort Custis~~ Cape Charles Air Force Base, near Kiptopeke, yielded water with 24 ppm of chloride. Other constituents are low. Water of similar quality is obtained from well 151, 91 feet deep, near Townsend, 3 miles north of Kiptopeke.

<u>Summary</u>: Ground water from aquifers of Miocene age tapped by most wells in Northampton County are commonly high in bicarbonate, averaging

about 165 ppm. Chloride is generally low, less than 25 parts in water from most wells, among wells tapping the St. Marys Formation. Most samples from Miocene wells are only moderately mineralized.

Water from at least one very deep well in the Miocene in Northampton County is rather highly mineralized.

Water from Pleistocene deposits

In Northampton County, 35 shallow dug or driven wells tapping aquifers in the Pleistocene Columbia Group were sampled for chemical analysis. (See Table 16.) These wells range in depth from 12 to 82 feet and average about 30 feet in depth. In addition, two irrigation ponds obtaining water from these deposits were sampled (Table 17).

In the northern part of the county, wells 1, 21, 40, 42, and 48 yield water ranging in chloride from 21 to 79 ppm with hardness ranging from 42 to 165 ppm. Fluoride was not detected. Water from well 21 at Wardtown was found to have an unusually high nitrate content, 25 ppm, indicating that the well is probably polluted. All waters except that from well 16 were reported high in iron by the users. The moderately high chloride in these well waters and in other well waters elsewhere in the county noted below is believed to be derived largely from contamination of the shallow ground-water body by infiltration of salt spray from the ocean during storms. (See discussion by Hem, 1959, p. 107-110.)

Well 46 near Nassawadox was jetted to 82 feet, and yields a hard calcium-bicarbonate water with a chloride concentration of 24 ppm and a hardness of 140 ppm (Table 16).

At the north of Eastville, seven wells tapping the Columbia Group (50a, 52, 55, 57, 58, 60 and 66) were found to yield water ~~with~~ having a chloride content ranging from 11 to 63 ppm. Fluoride in these waters averages less than 0.1 ppm. In two of these wells (55 and 60), determinations for nitrate and sulfate were made and found to be low. Hardness ranges from 24 ppm at well 60, in Kendall Grove, to 138 ppm at well 58 near Eastville, although the hardness for the other shallow well samples near Eastville (66) was only 60 ppm.

Iron is very high in some waters from Pleistocene aquifers. Water from wells 21 and 55 contain, respectively, 5.5 and 5.7 ppm.

High nitrate, 36 ppm, strongly indicating organic pollution, was found in the sample from a 22-foot driven well (70) 3 miles northeast of Cheriton. (See Table 16.) Another driven well (82) yielding water with high nitrate, 37 ppm, is at Oyster; sulfate also is relatively high, with 46 ppm. Wells 97 and 111, near Seaview, yield water similar in quality, with moderately low hardness, and a chloride content of about 10 ppm. For one of these wells (111) sulfate and nitrate were determined and found to be 48 and 6 parts respectively. The high nitrate strongly suggests organic pollution. Bicarbonate in the sample from well 111 was very low, only 17 ppm. A 25-foot well near Townsend (136) yields water with 96 ppm of hardness and 37 ~~parts~~ ppm of chloride. Fluoride was not detected.

The two irrigation ponds sampled were found to contain water of moderately low mineralization. (See Table 17.)

Summary;

~~In summary,~~ about one-third of the shallow wells in Northampton County, tapping deposits of the Pleistocene Columbia Group, are likely to yield water with more than 30 ppm of chloride which probably originates from infiltration of salt spray from the ocean blown inland during storms. In general, the chloride concentration cannot be predicted with any certainty before a well is constructed. Some waters are ~~irony~~. high in iron.

Locally, nitrate may be a problem, and unusually high concentrations were found in water from several wells tapping the Columbia Group.

Summary of ground water resources in Northampton County

Ample supplies of ground water are available for the present and immediate future in Northampton County from properly constructed wells. A few wells ending in Miocene formations yield over 250 gpm and one well in the Pleistocene yields 200 gpm. For all ordinary uses the chemical quality of the water is generally excellent but hardness, iron and chloride are objectionably high in ~~some~~ a few well waters. Water from wells deeper than about 300 feet may be excessively high in chloride. Drilling of test wells should be considered before large permanent wells are constructed.

WELL RECORDS AND CHEMICAL ANALYSES

Records of wells in Northampton County, available logs of wells, and chemical analyses of water samples are given in Tables 14, 15, and 16 on the pages that follow. Chemical analyses of water from two selected irrigation ponds in Northampton County are given in Table 17. For locations of wells listed in Tables 14 through 16 see the map of Northampton County, Plate 4, in the pocket at the end of this report.

[redacted]

Table 14.—Records of wells in Northampton County, Virginia

Type of well: D, drilled; Dv, driven; J, jetted
Use of water: D, domestic; I, II industrial; Irr, irrigation; PS, public supply; S, stock; Ab, abandoned; Obs, observation

gpm, gallons per minute
Temp., temperature (degrees Fahrenheit)
Fm, formation

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
1	0.3 mi. W of Concord Wharf	Joseph H. Mears	Herbert Senn	1940	7	Dv	17	1¼	Pleistocene	Columbia Group	(−)		D	See analysis, [redacted]. Temp., 66° F.	1
2	0.1 mi. N of Exmore Exmore	Town of Exmore	Layne-Atlantic Co.	1950	38	D	270	8	Miocene	Yorktown Fm	−34	310	PS	See log, [redacted]. Screen, 160-190 ft. 13 ft. drawdown after pumping 310 gpm. Tested at 746 gpm with 37 ft. of drawdown.	2
3	Exmore	Roland Holeman	John Scott	1948	25	J	169	3	Miocene	Yorktown Fm	−32	30	D	Pulled pump line in 1952 to remove stuck jet. Water from gravel.	3
4	Do.	Herbert Senn	do	1948	25	J	164	3	Miocene	Yorktown Fm	−32	50	D	Reported soft. Two houses and one store use well. Water from coarse gravel.	4
5	Do.	L. Robins	do	1949	25	J	168	2	Miocene	Yorktown Fm	−34	16+	D	4 ft. of drawdown after 4 hrs. pumping 16 gpm. Water from gravel.	5
6	Do.	V. Bayly	do	1948	25	J	168	2	Miocene	Yorktown Fm	−34	16½	D	Two houses use well. Water from gravel and shells.	6
7	Do.	John H. Dulany and Son, Inc.	Sydnor Pump & Well Co., Inc.	1947	25	D	230	6-4½	Miocene	Yorktown Fm (?)		150	I		7
8	Do.	do	Shannahan Artesian Well Co., Inc.	1950	25	D	70	16-10	Pleistocene(?)	Columbia(?) Group		200	I	See log, [redacted]. 45 ft. of drawdown in 24 hrs. pumping 200 gpm. Gravel packed.	8
9	Do.	do	Sydnor Pump & Well Co., Inc.	1942	25	D	295	8	Miocene	St. Marys Fm		275	Ab	See log, [redacted] analysis, [redacted]. Collected in 1945(?); well later abandoned (1952) because of increasing saline contamination.	9
10	Do.	do	Shannahan Artesian Well Co., Inc.		25	D	194	16-8	Miocene	Yorktown Fm	−30	200	I	See log, [redacted]. 19 ft. of drawdown after 24 hrs. pumping at 200 gpm. Drilled to 230 ft.	10
11	0.8 mi. W of Exmore	J. E. Turner Estate	Turner	1953	25	Dv	12-18	1¼	Pleistocene	Columbia Group	(−)		D	Water contains iron.	11
12	Exmore	Eastern Storage Corp.		1900	25	J	200	6	Miocene	Yorktown fm (?)	(−)	100	I	See analysis, [redacted]	12
13	Do.	Coca Cola Bottling Co.	M. A. Pentz	1938	35	D	168	4	Miocene	Yorktown Fm	−22	45	I	See analysis, [redacted]. Another similar well at this location.	13
14	Do.	Dr. Pepper Bottling Co.	M. A. Pentz		35	D	175	4	Miocene	Yorktown Fm	−27	35	I	See analysis, [redacted]. Casing set in "rock."	14
17	Do.	T. C. Twyford	John Scott	1948	25	J	168	2	Miocene	Yorktown Fm	−34	15	D	Supplies 5 houses. Water from gravel.	17
18	Do.	E. Flax and E. C. Long	do	1948	25	J	169	2	Miocene	Yorktown Fm	−34	16+	D	Supplies 2 houses and motel. Water from gravel.	18

Table 14.—Records of wells in Northampton County, Virginia

Capitalize Group and Fm.

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
19	Exmore Exmore	Mrs. Elvy Outten	W. Watson and John Scott	1948	25	J	164	2	Miocene	Yorktown fm	-34	16+	D	Supplies 2 houses. 4 ft of drawdown after pumping 16 gpm.	19
20	Do.	Harry Tatum	John Scott	1949	25	J	168	2	Miocene	Yorktown fm	-34	16+	D	Aquifer consists of 9 ft. of gravel.	20
21	3 mi. W of Exmore, at Wardtown.	Harry H. Sturgis	William Starchie	1948	23	Dv	22	1½	Pleistocene	Columbia group	-17	4	D	See analysis, Table ___. Temp., 64° F.	21
22	1 mi. S of Exmore at Hadlock	~~D. Goldberg~~ P. C. Kellam	John Scott	1950	30	J	168	2	Miocene	Yorktown fm	-34	11+	D,I	Reported soft.	22
23	Willis Wharf	Ollie Robins	do	1950	10	J	95	2	Pleistocene(?)		-8	18½	D	Supplies two houses.	23
24	Do.	J. S. Robins	do	1949	8	J	99	2	Pleistocene(?)		-26	14	D	Shallow well at this location failed. Water from sand.	24
25	Do.	F. Calf	do	1948	12	J	123	2	Miocene	Yorktown fm	-4	25	D	1 ft. of drawdown after 1 hr. pumping 25 gpm.	25
26	Do.	F. C. Fillmon	do	1949	9	J	87	2	Pleistocene	Columbia group	-5	15	D	Another similar well at this location 83 ft. deep. Very little drawdown. Water from coarse sand.	26
28	Do.	Ballard Bros.	do	1950	6	J	160	2	Miocene	Yorktown fm	-23	13+	I		28
29	Do.	do	Custis	1930	6	J	240	2	Miocene	St. Marys fm			I	See analysis, Table ___.	29
30	Do.	J. E. Crowder	John Scott	1950	10	J	95	2	Pleistocene(?)		-6	25	D	Water from coarse sand and shells.	30
31	Do.	Terry		1946	2		142	2½	Miocene	Yorktown fm	flows	flows 28	I	Reported soft. Yields less at low tide.	31
32	0.3 mi. S of Willis Wharf	Bruce Mears	Wm. J. Porter	1950	7	J	210	2	Miocene	Yorktown fm	-23	13+	D	See log, Table ___.	32
33	2.5 mi. S of Exmore	Turner Bros.	John Scott	1950	25	J	49	3	Pleistocene	Columbia group	-12	25	I	Two other similar wells at this location, at depths of 51 ft. Water from gravel.	33
34	0.5 mi. SW of Jamesville	W. L. Chandler	Fred Kellam	1953	20	J	82	2	Miocene	Yorktown fm	(-)		D, S	Reported soft.	34
36	2 mi. S of Exmore	School	John Scott	1951	25	J	78	3	Pleistocene	Columbia group	-12	37	PS	Reported soft.	36
37	2.5 mi. NE of Silver Beach		Wm. J. Porter	1951	20	J	85	2	Miocene	Yorktown fm	-12	15	D		37
38	Do.	Sistan Siebam	do		20	J	60	2	Pleistocene(?)		-10	20	I	See log, Table ___. Five similar wells at this location.	38
39	2 mi. NW of Nassawadox	John S. Turner	John Scott	1947	30	J	90	1½	Miocene	Yorktown fm	(-)	4	D, S	See analysis, Table ___. Temp., 67° F. Stains clothes.	39

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Table 14.—Records of wells in Northampton County, Virginia

Capitalize Group and Fm

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
40	2.5 mi. S of Exmore	James G. Scanlan		1941	12		21	1¼	Pleistocene	Columbia Group			D	See analysis, Table	40
41a	Silver Beach	B. M. Mears	John Scott	1949	8	J	185	2	Miocene	Yorktown Fm	-30	16+	D	Supplies 7 cabins. Water from medium sand.	41a
41b	0.5 mi. S of Silver Beach	C. J. Prettyman	C. J. Prettyman	1954	8	Dv	40	1½	Pleistocene	Columbia Group	(-)		D	Reported soft.	41b
42	0.3 mi. NE of Bayford	Alex G. Mitchell		1934	11	Dv	18	1¼	Pleistocene	Columbia Group	-15	3	D	See analysis, Table. Temp., 65° F.	42
43	Bayford	Curtis Jones	John Scott	1949	7	J	200	2	Miocene	St. Marys Fm	-2	15	D	Reported saline. Pumps sand when heavily pumped. Water from fine dark gray sand.	43
44a	Nassawadox Nassawadox		do	1951	30	J	265	3	Miocene	St. Marys Fm	-28	33+		See log, Table. Test hole, not in use.	44a
44b	Do.	Northampton-Accomack Memorial Hospital	Layne-Atlantic Co.	1952	30	D	304	18-6	Miocene	Yorktown and St. Marys Fms	-21	150	PS	See log, Table; analysis, Table. Six screens between 160 ft and 300 ft. Drilled to 321 ft.	44b
45	Franktown	Dr. Wm. J. Sturgis	John Scott	1949	30	J	80	2	Pleistocene(?)		-8	16+	D	4 ft. of drawdown after 3 hrs. pumping 6 gpm.	45
46	Nassawadox	Northampton Lumber Co.		1946	30	J	82	4	Pleistocene	Columbia group			I	See analysis, Table. Water from sand and shells.	46
47	1 mi. S of Franktown	T. K. Burton	John Scott	1949	9	J	100	2	Miocene	Yorktown Fm		15	D	Water from coarse sand.	47
48	1.5 mi. SW of Franktown	Elton E. Gunter	Herbert Senn	1939	20	Dv	12	1½	Pleistocene	Columbia group	-7	4	D, S	See analysis, Table. Temp., 68° F.	48
49	2 mi. SSW of Nassawadox, near Kellam Field	C. Ward	John Scott	1949	30	J	128	2	Miocene	Yorktown Fm	-23	15	D	Seven ft. of drawdown after 5 hrs. pumping 15 gpm. Water from coarse sand.	49
50a	Bridgetown	Richard S. Floyd	Tiachara	1938	3	Dv	30	1½	Pleistocene	Columbia group	(-)		D	See analysis, Table. Temp., 65° F.	50a
50b	Birdsnest	Kellam	Wm. J. Porter	1950	25	J	172	2	Miocene	Yorktown Fm	-22	9	D	Supplies 2 houses.	50b
51	3 mi. SW of Bridgetown at Vaucluse	V. E. Minich	Long	1937	8		98	1¼	Miocene	Yorktown Fm	(-)	5	D, S Irr	See analysis, Table. Temp., 61° F.	51
52	1.5 mi. SE of Birdsnest	Eigenfritz Nursery Corp.			21	Dv	14	1½	Pleistocene	Columbia group			D, I, Irr	See analysis, Table.	52
53	Machipongo	Sydnor Test Hole	Sydnor Pump & Well Co., Inc.	1953	25	D	210		Miocene	Yorktown Fm				See log, Table. Test hole for well 54.	53
54	Do.	School	do	1953	25	D	365	6	Miocene	St. Marys Fm	-26	60	PS	See log, Table. Screen set at 210-220, 230-266, and 291-301 ft. Pump rod set at 195 ft.	54
55	Do.	do			25	J	23	1½	Pleistocene	Columbia group	(-)	15	PS	See analysis, Table. Temp., 71° F.	55

Table 14.—Records of wells in Northampton County, Virginia

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
56	Machipongo	Wm. R. Shannonhouse	John Scott	1950	25	J	49	2	Pleistocene	Columbia Group	−15	20	I	Two other similar wells at this location at depths of 46 and 48 ft.	56
57	2.5 mi. W of Machipongo	Mrs. G. E. Coulbourn	E. P. Dryden	1947	28	Dv	20	1¼	Pleistocene	Columbia Group	(−)	2	D	See analysis, [redacted] Temp., 67° F.	57
58	2 mi. NW of Eastville	Wm. T. Savage	George Bradford	1945	20	Dv	22	1½	Pleistocene	Columbia Group	−14		D, S	See analysis, [redacted] Temp., 69° F.	58
59	1.9 mi. NW of Eastville	J. E. Johnston	White Brothers		20	J	95	2	Miocene	Yorktown Fm	(−)		D, S	See analysis, [redacted]	59
60	2.5 mi. ENE of Eastville, at Kendall Grove	Mrs. Serna Harmon		1944	19	Dv	30	1¼	Pleistocene	Columbia Group			D	See analysis, [redacted]	60
61	0.8 mi. NE of Wilkins Beach, Eastville	M. Acuff	Wm. J. Porter		2	J	134	1½	Miocene	Yorktown Fm	flows	2½	I	See log, [redacted] analysis, [redacted] Temp., 58° F. Slight organic odor.	61
62	0.8 mi. W of Eastville	Ben Mears	John Scott	1952	10	J	153	2	Miocene	Yorktown Fm	−13	15	D, S	Water from coarse sand.	62
63	Eastville	Town of Eastville	M. A. Pentz	1940	30	D	165	6	Miocene	Yorktown Fm	−46	75	PS	See analysis, [redacted] Well is not in use; screen filling with sand.	63
64	Do.	do	do	1952	30	D	138	4	Miocene	Yorktown Fm	−21	200	PS	See log, [redacted] Specific capacity, 2.5 gpm/ft of drawdown.	64
65	Do.	do	do		30	D	111	6	Miocene	Yorktown Fm	−19		PS	See log, [redacted] Specific capacity, 1.9 gpm/ft. of drawdown.	65
66	0.5 mi. E of Wilkins Beach	William Lawson		1947	30	Dv	14	1½	Pleistocene	Columbia Group	−4		D	See analysis, [redacted] Temp., 75° F. Stains cooking utensils.	66
67	Eastville	Ben Mears	John Scott	1951	30	J	189	2	Miocene	Yorktown Fm	−23	14	D	Water from fine reddish sand.	67
68	0.5 mi. S of Eastville	Hoovernale	Wm. J. Porter		30	J	302	2	Miocene	St. Marys Fm	−29	25	D	See log, [redacted] Drilled to 307 ft.	68
69	1.9 mi. S of Eastville	M. Moore			30	Dv	21	1¼	Pleistocene	Columbia Group			D	See analysis, [redacted]	69
70	1.8 mi. NE of Cobbs	Mrs. Harold C. Wise, Sr.		1948	20	Dv	22	1¼	Pleistocene	Columbia Group	−18		D	See analysis, [redacted]	70
71	0.1 mi. N of Cheriton	Geo. T. ~~[illegible]~~ Turner III	John Scott	1949	25	J	296	2	Miocene	Yorktown Fm	−13	15	D	Supplies 3 houses. Water from fine light gray sand.	71
72	Cheriton	C L Graysen Jones ~~George Jones~~	do	1948	30	J	80	2	Miocene	Yorktown Fm	−8	16+	I	2 other similar wells at this location; total pumpage 16+ gpm.	72
73	Do.	F. Rolley	do	1952	30	J	300	2	Miocene	Yorktown Fm	−13	20	D	Water from fine sand and shells.	73
74	Do.	L. Keller		1948	19	Dv	13	1¼	Pleistocene	Columbia Group			D	See analysis, [redacted]	74
75	Do.	G. L. Webster Canning Co.			20	D	170	18-8	Miocene	Yorktown Fm			I	See analysis, [redacted]	75

Table 14.—Records of wells in Northampton County, Virginia

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
76	Cheriton	G. L. Webster Canning Co.	Virginia Machinery & Well Co., Inc.	1946	20	D	271		Miocene	Yorktown	(−)		I	See log, Table.	76
77	Do.	Huff Brothers	Huff Brothers		20	Dv	63	2	Pleistocene	Columbia Group	(−)		D, S	See log, Table. From Bulletin 5, p. 245.	77
78	Do.	Paul Watson	Wm. J. Porter	1949	20	J	302	2	Miocene	Yorktown	(−)	33	D	Reported soft.	78
79	Do.	James			20	J	299	2	Miocene	Yorktown	(−)	21	D	Water from sand and shells.	79
80	Do.	C. Charnock		1951	20	J	299	2	Miocene	Yorktown	−14		D	Water from fine sand.	80
81	Oyster	Roberts(?)			0	J(?)	182	2	Miocene	Yorktown	flows	4	Ab	See analysis, Table. Yields less at low tide. Well covered by high tide.	81
82	0.3 mi. W of Oyster	William T. Taylor		1945	17	Dv	26	1½	Pleistocene	Columbia Group	−22		D, S	See analysis, Table.	82
83a	Oyster	Granville McCready	Wm. J. Porter	1949	5	J	185	2	Miocene	Yorktown	flows		I	See analysis, Table. Another similar well at this location, 183 ft. deep.	83a
83b	Oyster				5		150(?)	1	Miocene	Yorktown Fm	flows	½		See analysis, table .	83b
84	Do.	H. A. Smith	Tom Parks and Wm. J. Porter	1940	5	J	185	2	Miocene	Yorktown	flows		I	See log, Table ; analysis, Table . Two other similar wells at this location, both 185 ft. Water from sand and shells.	84
85	Do.	B. L. Bell	Wm. J. Porter		5	J	165	2	Miocene	Yorktown	(−)		D	Reported hard.	85
86	Do.	H. R. Steelman	John Scott	1946	5	J	185	2	Miocene	Yorktown	flows	flows 7	I	See analysis, Table. Two other similar wells at this location, both 185 ft. One drilled by Porter. Water from sand and shells.	86
87	N Bank, end of King Creek	Elmore Ballard	John Scott		7	J	185	2	Miocene	Yorktown	−18	15	D	Water from coarse sand.	87
88	0.5 mi. NE of Cape Charles	George Tinkham	do		10	J	300	2	Miocene	Yorktown	−6	16+	D, I	See log, Table. Necessary to redrill to 300 ft., originally 80 ft. Water from shells.	88
89	Cape Charles	N.Y., Philadelphia, & Norfolk RR Co.	T. M. Ward	1900	8		90	3	Miocene	Yorktown	−6	100	Ab	See log, Table. From Bulletin 5, Va. Geol. Survey, page 246.	89
90	Do.	do		1910	20	D	~~1,810~~ 1,810		Late Eocene	Potomac Pamunkey (?) Group			Ab	See log, Table. Test hole; never used.	90
91	Do.	Town of Cape Charles	Mayes-Atlantic Co.	1927	25	D	195		Miocene	Yorktown	−20	300	PS	See log, Table. Well relined March 1940	91
92	Do.	do	do	1938	25	Dr	210	M	Miocene	Yorktown	−13	645	PS	See log, Table. Drawdown 65 ft. while pumping 645 gpm.	92
93	Do.	do	do	1927	25		175	4	Miocene	Yorktown	−20	147	Ab	See log, Table. Contains some salt. No odor. 110 ft. drawdown while pumping 147 gpm.	93
94	Do.	do		1927	25	J	80	2	Miocene	Yorktown			PS	12 80-ft. wells in use, 1952.	94

Table 14.—Records of wells in Northampton County, Virginia

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
95	0.5 mi. N of Seaview	B. B. Downing	John Scott	1949		J	105	2	Miocene	Yorktown fm	-12	20	D	Water from shell bed.	95
96	0.3 mi. NE of Seaview	Otho Moore	do	1949		J	105	2	Miocene	Yorktown fm	-13	18+	D		96
97	Do.	Mrs. J. W. Cutten		1945	15	Dv	15	1¼	Pleistocene	Columbia group	-11		D	See analysis, Table [illegible] Temp., 69° F.	97
98	1.5 mi. W of Seaview, at Fairview	H. L. Gladden	H. L. Hart		19	Dv	25	1½	Pleistocene	Columbia group	-21		D, S	See analysis, Table [illegible] Temp., 65° F.	98
99	1.5 mi. SE of Cape Charles on E bank of Old Plantation Creek	B. A. Travis	B. A. Travis	1951	5	Dv	34	1¼	Pleistocene	Columbia group			D	Reported soft. Water from fine white sand.	99
100	2 mi. SW of Seaview	W. J. Goffigon	W. J. Goffigon	1951	20	Dv	16	1¼	Pleistocene	Columbia group			D	Four similar wells on farm; two pumped as unit to supply house.	100
101	0.5 mi. S of Seaview	Ralph Long	John Scott	1949	20	J	99	2	Miocene	Yorktown fm	-13	15	D	3 ft. of drawdown after pumping 2 hours at 15 gpm.	101
102	Do.	do	do	1949	20	J	160	2	Miocene	Yorktown fm	-12	12+	Irr	Supplies pond.	102
103	Do.	do	do	1948	20	J	105	2	Miocene	Yorktown fm		15	Irr	do	103
104	0.5 mi. SSE of Seaview	Scott	Wm. J. Porter	1953	20	J	115	2	Miocene	Yorktown fm	-12	40	D	Water from shells and sand.	104
105	2.3 mi. NNW of Capeville	Frank D. Scott	Ashby		20	Dv	27	1½	Pleistocene	Columbia group			D	Necessary to redrive often.	105
106	2 mi. NNW of Capeville	Kemper Goffigon		1952	20	J	140	2	Miocene	Yorktown fm	-34(?)	6+	D, S	See analysis, Table [illegible] Water from sand.	106
107	1.8 mi. NNW of Capeville	Richard Brown	Z. Rea	1949	20	Dv	40	1½	Pleistocene	Columbia group			D	See analysis, Table [illegible].	107
108	2 mi. NNW of Cheapside, near mouth of Old Plantation Creek	G. F. Parsons	Wm. J. Porter	1954	11	J	125	2	Miocene	Yorktown fm	-½	6+	D	Same aquifer as 109-110. Chert(?) bed at 60 ft. Drilled to 135 ft.	108
109	Do.	do	do	1951	4	J	101	2	Miocene	Yorktown fm	flows	20	Irr	See analysis, Table [illegible] Supplies small irrigation pond. No screen; open end. Water from shell bed.	109
110	Do.	do	do	1952	4	J	119	2	Miocene	Yorktown fm	flows		Irr.	See analysis, Table [illegible] Supplies small irrigation pond. No screen; open end. Water from shell bed.	110
111	1.8 mi. NNE of Capeville	Mrs. L. D. Bull	John Wilson	1936	6	Dv	17	1¼	Pleistocene	Columbia group			D	See analysis, Table [illegible] Temp., 67° F.	111
112	1.5 mi. NNW of Capeville	Martin Schorn	Martin Schorn	1952	20	Dv	30	1½	Pleistocene	Columbia group		6	D	Necessary to redrive every 2 years.	112
113	Do.	G. F. Parsons	Lee Hart	1948	20	Dv	25	1¼	Pleistocene	Columbia group			D	Requires water softner	113
114	1.5 mi. NW of Capeville	G. E. Scott		1946	20	Dv	27	1½	Pleistocene	Columbia group			D	Reported soft.	114
115	1.3 mi. N of Cheapside	Roland Belote	Roland Belote		20	Dv	20	1½	Pleistocene	Columbia group	-12	5	D	See analysis, Table [illegible]	115

Table 14.—Records of wells in Northampton County, Virginia

Capitalize group and fm.

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
116	1 mi. NNW of Capeville	A. H. Hunt	A. H. Hunt	1947	20	Dv	30	1¼	Pleistocene	Columbia group			D	Reported soft.	116
117	1 mi. N of Cheapside	Roland Belote	Roland Belote	1947	20	Dv	20	1¼	Pleistocene	Columbia group			D	Reported hard.	117
118	1.5 mi. NW of Capeville	Harvey Belote	Wm. J. Porter	1949	20	J	120	2	Miocene	Yorktown fm		7	D	See analysis, [redacted]. Shallow well at this location goes dry in summer. Water from sand.	118
119	1 mi. NW of Capeville	Capeville Lumber Co.	Fred Kellam	1951	20	J	144	2	Miocene	Yorktown fm	-16		D, I	See analysis, [redacted]. Water from sand and shells.	119
120	0.8 mi. N of Cheapside	Hume Dixon			20	Dv	30	1¼	Pleistocene	Columbia group			D, S	Reported soft.	120
121	1 mi. NW of Capeville	Tom Long	John Scott	1952	20	J	143	2	Miocene	Yorktown fm	-14	15	D		121
122	Do.	do	do	1953	20	J	115	2	Miocene	Yorktown fm	-14½	13+	D	Within 50 ft. of well 147. Screen set extreme upper part of aquifer.	122
123	0.8 mi. NW of Capeville	W. M. Martin	Lewis	1951	20	J	88	2	Miocene	Yorktown fm			D	See analysis, [redacted].	123
124	0.9 mi. WNW of Capeville	Mrs. Mary A. Polley	John Scott	1952	20	J	134	2	Miocene	Yorktown fm			D	See log, [redacted]; analysis, [redacted]. Water from shell bed.	124
125	0.8 mi. NNE of Cheapside	Wm. Parsons	Wm. J. Porter	1950	20	J	104	1½	Miocene	Yorktown fm	-18		D	See analysis, [redacted]. Water from black sand and fine shells.	125
126	0.8 mi. NW of Capeville	Frank Parsons	John Scott	1951	20	J	100	2	Miocene	Yorktown fm	-14	15	D	Water from shell bed.	126
127	0.3 mi. N of Capeville	E. Richardson	Wm. J. Porter	1952	20	J	101	2	Miocene	Yorktown fm			D	See analysis, Table .	127
128	0.1 mi. NW of Capeville	C. E. Oliver & Sons			20	J	53	2	Pleistocene	Columbia group	-10	25	I		128
129	Capeville	W. P. Wilkins		1938	20	Dv	12	1½	Pleistocene	Columbia group			D	Necessary to replace water pipe often.	129
130	0.3 mi. SE of Capeville	Hume Dixon	Dixon	1950	20	Dv	30	1½	Pleistocene	Columbia group			D	Reported soft. Necessary to redrive often.	130
131	0.8 mi. N of Townsend	M. C. Scott	Winder	1951	20	Dv	20	1¼	Pleistocene	Columbia group			D	Reported hard.	131
132	Do.	do		1920	20	Dv	102	1½	Miocene	Yorktown fm	flowed		Ab	Reported flowing in 1920. Well destroyed in 1930. Unusually deep for driven well.	132
133	0.5 mi. N of Townsend	Homer Elliott	John Scott	1951	20	J	100	2	Miocene	Yorktown fm	-13	15	D	Water from sand and gravel.	133
134	Do.	W. Wyatt		1951	20	Dv	21	1¼	Pleistocene	Columbia group			D	Went dry fall of 1951.	134
135	0.8 mi. SSW of Cheapside	L. T. Nottingham	Tom Parks		20	J	75	2	Miocene	Yorktown fm (?)	-31(?)		D, S	See analysis, [redacted].	135
136	1 mi. W of Townsend	Henry D. Warren	C. Charpark	1938	20	Dv	25	1¼	Pleistocene	Columbia group	-22		D, S	See analysis, [redacted].	136

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Table 14.—Records of wells in Northampton County, Virginia

Capitalize Group and Fm

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
137	0.3 mi. W of Townsend	Mrs. D. K. Long	John Scott	1952	20	J	117	2	Miocene	Yorktown fm			D	See analysis, Table . Replaces unsatisfactory shallow well. Water from sand and shells.	137
138	Do.	C. D. Whitehead			20	Dv	21	1½	Pleistocene	Columbia group	-10		D	Went dry in 1950. Reported hard. Water from sand.	138
139	0.3 mi. W of Townsend	Mary D. Wilkins	John Scott	1952	20	J	112	2	Miocene	Yorktown fm	-30		D	See analysis, Table . Shallow well at this location abandoned because of abundant iron in water. Water from sand and shells.	139
140	Townsend	Mrs. Parsons	Elliott		20	Dv	24	1¼	Pleistocene	Columbia group			D	Bitter taste reported.	140
141	0.3 mi. E of Townsend	Estella Moses	Hartman	1950	20	Dv	35	2	Pleistocene	Columbia group			D	See analysis, Table .	141
143	0.8 mi. E of Townsend	E. J. Steelman		1951?	6	Dv	42	1½	Pleistocene	Columbia group	-2		I	See analysis, Table .	143
144	Do.	do	Tom Parks	1947	6	J	72	2	Miocene	Yorktown fm (?)	-½		I	See analysis, Table . Water from small gravel.	144
146	0.3 mi. S of Townsend	Mrs. Kenneth Pusey			20	Dv	46	1¼	Pleistocene	Columbia group			D	See analysis, Table .	146
148	0.3 mi. SSE of Townsend	Jake Skidmore	John Scott	1952	20	J	90	2	Miocene	Yorktown fm			D	See analysis, Table . Supplies 2 houses.	148
149	0.3 mi. S of Townsend	Clay Skidmore	Clay Skidmore	1946	20	Dv	48	2	Pleistocene	Columbia group	-10		D	See analysis, Table . Well not in regular use.	149
150	0.5 mi. S of Townsend	Wm. Heath	John Scott	1950	20	J	90	2	Miocene	Yorktown fm			D	See analysis, Table . Water from shell bed.	150
151	1 mi. SE of Townsend	L. D. Bull	Wm. J. Porter	1948	6	J	91	2	Miocene	Yorktown fm	almost flows	1½	D, I	See analysis, Table . Another well at this location 96 ft. deep. Water from sand and shells 85-91 ft.	151
152	0.8 mi. SSE of Townsend	H. L. Hope	Eubank Bros.	1920	7	Dv	35	2	Pleistocene	Columbia group	-1		D	See analysis, Table .	152
153	0.5 mi. S of Townsend	C. Ward		1949	20	J	103	2	Miocene	Yorktown fm			D	See analysis, Table . Water from shell bed.	153
154	0.5 mi. SW of Townsend	U. S. Coast Guard	John Scott	1951	20	J	87	2	Miocene	Yorktown fm	-10			See analysis, Table . Used for fire control.	154
155	1.5 mi. ENE of Kiptopeke Beach	J. A. White	do	1949	20	J	130	2	Miocene	Yorktown fm	-18		D	See analysis, Table . 19 ft. of black mud above aquifer.	155
158	Do.	C. R. Elliott			20	Dv	20	1½	Pleistocene	Columbia group			D	See analysis, Table .	158
159	0.3 mi. ENE of Kiptopeke Beach	H. Kellam	Wm. J. Porter	1947	20	J	40	1½	Pleistocene	Columbia group	-37(?)		Irr	See analysis, Table . 3 other similar wells at this location supplying small irrigation pond. Water from white sand.	159
160	0.5 mi. ENE of Kiptopeke Beach	L. Mears	J. Mears	1952	20	Dv	22	1½	Pleistocene	Columbia group			D	Reported soft.	160

Table 14.—Records of wells in Northampton County, Virginia

Capitalize Group and Fm.

No.	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
161	0.5 mi. ENE of Kiptopeke Beach	Mrs. Whitehead		1948	20	Dv	12	1½	Pleistocene	Columbia Group			D	Reported soft.	161
162	0.8 mi. E of Kiptopeke Beach	Wm. Parsons		1951	20	Dv	15	1½	Pleistocene	Columbia Group	−3		D, S	Yield limited. Necessary to reirive often. Reported soft.	162
163	0.3 mi. E of Kiptopeke Beach	Walter Parsons	Wm. J. Porter	1951	20	J	60	1½	Pleistocene	Columbia Group			D, S	See analysis, Table . Another well 40 ft. deep at this location.	163
164	Kiptopeke Beach	Virginia Ferry Corporation	Layne-Atlantic Co.	1950	20	D	179	18-6	Miocene	Yorktown Fm	−23	50	I, PS	See log, Table . Specific capacity, 2.9 gpm/ft. of drawdown.	164
165	0.5 mi. SE of Kiptopeke Beach	J. P. Latimer		1949	25	J	93	2	Miocene	Yorktown Fm			D, S	See analysis, Table . Water from gravel. Shallow well at this location contaminated with oil from fuel tank.	165
166	0.8 mi. SE of Kiptopeke Beach	Mrs. J. H. Latimer		1951	25	J	55	1½	Pleistocene	Columbia Group			D, S	See analysis, Table . Several old wells at this location at depths from 38 to 40 ft.	166
167	1.5 mi. N of Kiptopeke	H. D. Spady	John Scott	1949	25	J	230	2	Miocene	Yorktown Fm	−23	10	D, S	See analysis, Table . Limited yield. Considerable difficulty encountered in drilling well.	167
168	Do.	Mrs. S. R. Bull			25	Dv	44	2	Pleistocene	Columbia Group			D, S	Reported hard.	168
169	2 mi. NE of Kiptopeke	Charles R. Bull	Charles R. Bull	1946	20	J	154	4	Miocene	Yorktown Fm	−7	25	D, S	See log, Table ; analysis, Table . 1½ ft. of drawdown after 8 hrs. pumping 25 gpm.	169
170	0.8 mi. N of Kiptopeke	Lucy and Sally Dixon	John Scott	1949	20	J	227	2	Miocene	Yorktown Fm			D	See analysis, Table . Shallow well water at this location was unsatisfactory because of abundant iron.	170
171	0.5 mi. NNE of Kiptopeke	Hume Dixon		1944	20	J	48	2	Pleistocene	Columbia Group	−20		D, S	See analysis, Table . Well deepened in 1951 because it went dry.	171
172	0.8 mi. NE of Kiptopeke	W. W. and Hure Dixon		1940	10	J	42	2	Pleistocene	Columbia Group	−12		D, S	See analysis, Table . Washed up shells from surface to 42 ft.	172
173	0.3 mi. E of Kiptopeke	Lucy Dixon	John Scott	1949	20	J	73	2	Miocene	Yorktown Fm (?)			D, S	See analysis, Table . Test hole drilled to 299 ft. No aquifer encountered after gravel and shells at 73 ft., however.	173
174	Do.	do	S. U. Grinalds	1951	20	Dv	28	1¼ ?	Pleistocene	Columbia Group	−16		D	The shallow aquifer in this location is fine white sand which fills the well screens in about one year.	174

Table 14 .—Records of wells in Northampton County, Virginia

No. 255	Location	Owner or tenant	Driller	Year completed	Approximate altitude above sea level (feet)	Type of well	Depth of well (feet)	Diameter of well (inches)	Principal water-bearing zone: Geologic age	Principal water-bearing zone: Stratigraphic unit or named aquifer	Approximate water level above (+) or below (−) land surface (feet)	Approximate yield (gpm)	Use of water	Remarks	No.
175	Cape Charles Air Force Station	U. S. Air Force	Layne-Atlantic Co.	1954	10	Dr	85		Miocene	Yorktown Fm	-7	27	D	See log, Table [redacted]. 14 ft. of drawdown while pumping 27 gpm. Station well 1.	175
176	Do.	do	do	1954	10	Dr	65		Miocene	Yorktown Fm	-8	40	D	See log, Table [redacted]; analysis, Table [redacted]. 15-ft. drawdown while pumping 40 gpm. Station well 2.	176
177	Do.	do	do	1954	10	Dr	58		Pleistocene	Columbia Group	-8	35	D	See log, Table [redacted]. 24-ft. drawdown while pumping 35 gpm. Station well 3.	177
178	Do.	do		1944	10	Dr	74	2	Miocene	Yorktown Fm			Ab	See log, Table [redacted]; analysis, [redacted]	178
179	Cape Charles Air Force Station (GATR site, 1.2 mi. ESE of Kiptopeke Beach, near Cedar Grove)	U. S. Air Force		1960	9	Dr	60	4	Eocene	Pamunkey(?) Group	-9		D	Station well 4.	179
180	Cobb Island	U. S. Coast Guard			9	D	1,001	18-6	[redacted]	[redacted]	flows		Ab	See log, Table [redacted]. Flows slightly during high tide. Well abandoned; water brackish.	180
	0.3 mi. S of Capeville at Capeville Elementary School	United States Geological Survey (Test hole 1)	Sydnor Hydrodynamics Inc.	1953	20	D	465	3	Miocene	Choptank	-23		Test hole	See log, Table [redacted]. Drilled to 470 ft. Several other water-bearing zones at shallow depths.	
	Machipongo High School	United States Geological Survey (Test hole 2)	do	1953	25	D	65	3	Pleistocene	Columbia Group	-11+	16	Test hole	See log, Table [redacted]; analysis, Table . Drilled to 100 feet.	

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 2, Exmore; Town of Exmore

(Log by Layne-Atlantic Co.)

Altitude, 38 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil; sand	25	25
Sand, coarse; gravel	20	45
Sand; shells, scattered	15	60
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay	70	130
Sand, hard, and clay, soft; interbedded	20	150
Sand; clay, mixed	15	165
Sand, coarse, tight	15	180
"Shellrock", very hard	4	184
Clay	26	210
Shell bed, tight	12	222
Shells; gravel; clay; sand, fine	16	238
St. Marys Formation:		
Clay, soft; shells	32	270

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 8, Exmore; John H. Dulany & Son, Inc.

(Log by Shannahan Artesian Well Co., Inc.)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Sand, fine, loose	20	20
Sand, gray	15	35
Sand, loose, scattered gravel	17	52
Sand, loose; clay, streaks	19	71
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay	4	75
Sand, white, loose; wood fragments	5	80
Clay, blue	10	90

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 9, Exmore; John H. Dulany & Son, Inc.

(Log by Sydnor Hydrodynamics, Inc.)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Undescribed	70	70
Chesapeake Group (Miocene):		
Yorktown Formation:		
Undescribed	139	209
Shells; clay	6	215
Undescribed	25	240
St. Marys Formation:[1]		
Undescribed	37	277
Sand; shell; clay	11	288
Undescribed	7	295

1/Approximate position of formation break based on other well logs.

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 10, Exmore; John H. Dulany & Son, Inc.

(Log by Shannahan Artesian Well Co., Inc.)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Sand; water-bearing zone	61	61
Sand; clay streaks	24	85
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, blue, tough	35	120
Clay; shells; hard bed at base	21	141
Sand, tight; clay	4	145
Sand; clay streaks	13	158
Sand, coarse; gravel	2	160
Sand, coarse; scattered gravel	15	175
Clay, sandy; shells	8	183
Sand; shells	17	200
Sand, tight; shells	5	205
Sand; shells	6	211
Sand; tough clay at 230 feet	19	230

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 32, Willis Wharf; Bruce Mears

(Generalized log by William J. Porter)

Altitude, 7 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay; soil	10	10
Sand; water-bearing zone	10	20
Sand; little water	40	60
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, blue; sand	20	80
Sand, fine; non-water-bearing	20	100
Clay; sand, interbedded; mud	80	180
Shells; silt, interbedded	18	198
Shells; sand; gravel; water-bearing	12	210

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 38, Silver Beach; Mr. Siebam

(Generalized log by William J. Porter)

Altitude, 15 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay; soil	10	10
Sand; water-bearing	8	18
Sand, fine	22	40
Gravel	20	60

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 44a, Nassawadox Hospital

(Log by John Scott)

Altitude, 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Shells; sand	80	80
Chesapeake Group (Miocene):		
Yorktown Formation:		
Shells; sand	85	165
Shells; water-bearing	20	185
Sand, coarse; water-bearing	40	225
St. Marys Formation:		
Mud; sand	40	265

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 44b, Nassawadox; Northampton-Accomack Memorial Hospital

(Log by Layne-Atlantic Co.)

Altitude, 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil; sand, coarse	42	42
Sand, gray, fine; shells	11	53
Clay, gray, soft; shells	7	60
Sand, coarse	16	76
Chesapeake Group (Miocene):		
Yorktown Formation:		
Shellrock, gray, hard	1	77
Sand, gray; shells	6	83
Shells; clay, gray	41	124
Sand, gray, fine, muddy	21	145
Sand, gray, loose; shells	20	165
Shells; clay, gray; medium-hard drilling	17	182
Sand, gray, coarse	5	187
Clay, gray; shells	26	213
Shells; sand, gray, fine	14	227
St. Marys Formation:		
Shells, gray, fine, muddy	20	247
Sand, gray, fine; shells	23	270
Shells; sand, gray, fine	10	280
Sand, gray; shells	5	285
Sand, gray, fine; shells	24	309
Shells; sand, gray, fine	12	321

Table 15--Logs of wells in Northampton County, Virginia--Continued

Well 53, Machipongo; Machipongo High School (Sydnor test hole, 100 feet from U.S.G.S. test hole 2)

(Drilled by Sydnor Hydrodynamics, Inc.)

(Sample descriptions by G. C. Tibbitts, Jr.; correlations by F. Stearns MacNeil)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil, reddish, fine, sandy	7	7
Sand, iron-stained, quartz, fine to coarse; streak of brown clay at 25 feet; streak of dark-gray clay at 56 feet, water-bearing zone	62	69
Clay, dark-gray; interbedded with coarse quartz sand streaks; black organic specks	11	80
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, dark-gray, solid; scattered shell fragments from 90 feet	50	130
Clay, gray, solid; interbedded coarse sand and shells	10	140
Shells, white, broken; traces of clay and fine sand; water-bearing zone	27	167
Clay, dark-gray, solid, silty, sandy; shell fragments	13	180
Yorktown(?) Formation:		
Clay, dark-gray, solid, silty, sandy; shell fragments; trace of hard chert gravels at 190 feet	20	200
Sand, gray, very fine, clayey; streaks of shell fragments	10	210

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 54, Machipongo; Machipongo School Well

(Log by Sydnor Hydrodynamics, Inc.)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Undescribed	69	69
Chesapeake Group (Miocene):		
Yorktown Formation:		
Undescribed	96	165
Sand, gray, fine; shells	22	187
Sand, gray, fine; clay layer	23	210
Sand, gray; shells	9	219
Clay, blue	7	226
St. Marys Formation:		
Shells; clay, blue	14	240
Shells; sand, fine; clay layer	9	249
Sand, gray, fine; shells	11	260
Clay; shells	5	265
"Shellrock", soft	10	275
"Shellrock", hard	5	280
Clay; shells	11	291
Sand, gray, fine; clay interbedded	10	301
Clay, blue; shells, interbedded	64	365

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 61, Eastville; M. Acuff

(Generalized log by William J. Porter)

Altitude, 2 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Sand	35	35
Chesapeake Group (Miocene):		
Yorktown (?) Formation:		
Mud; sand, blue; clay, blue	85	120
Shells; sand, fine; water-bearing	13	133

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 64, Eastville; Town of Eastville

(Log by M. A. Pentz)

Altitude, feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil; sand, white	32	32
Sand, gray, fine	42	74
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, soft; sand	16	90
Sand, fine	31	121
Sand	17	138

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 65, Eastville; Town of Eastville

(Log by M. A. Pentz)

Altitude, 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil; sand	21	21
Mud, blue, soft	23	44
Clay, blue	17	61
Sand	10	71
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, blue	9	80
Sand, fine	12	92
Sand, medium-coarse; water-bearing; (underlain by fine sand at 111 ft.)	19	111

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 68, Eastville; Mr. Hoovermale

(Generalized log by William J. Porter)

Altitude, 30 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay; sand	8	8
Sand; gravel, small; water-bearing	7	15
Sand; little water	25	40
Gravel, coarse; water contains iron	10	50
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, blue; sand	50	100
Sand, fine	50	150
Shells; sand; gravel; little water	40	190
Sand, fine; clay	35	225
Sand; little water	15	240
Sand, black, fine	50	290
Sand; clay; interbedded	5	295
St. Marys Formation:		
Shells; water-bearing	12	307

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 76, Cheriton; G. L. Webster Canning Co.

(Log by Virginia Machinery & Well Co., Inc.)

Altitude, 20 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Sand, yellowish-brown, fine	20	20
Sand, white, fine	20	40
Sand, yellow (slightly coarser than sand from 20 to 40 feet)	10	50
Sand, light yellow, fine	15	65
Chesapeake Group (Miocene):		
Yorktown Formation:		
Marl, blue	5	70
Marl, blue, silty	36	106
Sand, blue, medium; pebbles, small; small scattered shells	4	110
Sand, fine; clay streaks; water-bearing	12	122
Gravel, blue to gray; shells, sand; water-bearing	3	125
Clay, blue, silty	25	150
Sand, blue, clayey; gravel	8	158
Shells; gravel, coarse; water-bearing	6	164
Sand, yellowish-brown, medium to fine; few shells	13	177
Shells; clay, silty; water-bearing zone	13	190
Shells, coarse; clay; some water	10	200
Clay, gray, sandy	5	205
Shell bed; clay; sand; black sand	5	210

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 76, Cheriton; G. L. Webster Canning Co.--Continued

	Thickness (feet)	Depth (feet)
Chesapeake Group (Miocene)--Continued		
Yorktown Formation--Continued		
Sand; shells	4	214
Sand, medium to coarse; shells, small	4	218
Sand, blue; scattered shells	2	220
Sand, fine, loose	4	224
Shells; sand	6	230
Sand, fine, loose	8	238
Shells; sand	2	240
Shell bed	5	245
Shells; sand	3	248
Sand; shells, fine	2	250
Sand, gray, fine, loose	19	269
Clay, blue	1	270
Sand, fine; some shells	1	271

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 77, Cheriton; Huff Brothers

(Log by Owners; from Va. Geol. Survey Bulletin 5, page 245)

Altitude, 20 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil	1	1
Sand, yellow and gray; water-bearing zones at 14, 16, and 29 feet	29	30
Mud, marsh; blue	32	62
Sand, shells; water of poor quality	1	63

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 84, Oyster; H. A. Smith

(Generalized log by William J. Porter)

Altitude, 5 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay	5	5
Sand	15	20
Sand; mud; clay; interbedded	30	50
Chesapeake Group (Miocene):		
Yorktown Formation:		
Mud; clay; sand, fine; interbedded	103	173
Sand, white and black; abundant fine shell fragments; water-bearing	12	185

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 88, near Cape Charles; George Tinkham

(Log by John Scott)

Altitude, 10 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Undescribed	80	80
Shells; sand, white; some glauconite	10	90
Chesapeake Group (Miocene):		
Yorktown Formation:		
Shells, broken	10	100
Shells, broken; some sand	10	110
Sand, white, quartz; abundant shell fragments	10	120
Sand, gray-white, quartz; large shell fragments	10	130
Sand, white; abundant shell fragments	10	140
Clay, gray, glauconitic; sand; shell fragments	25	165
Sand, "salt and pepper" (dark black glauconite and quartz); shell fragments	6	171
Sand, white, quartz; shells	12	183
Sand, gray-white, medium; some shell fragments; water-bearing	18	201
Shells, large fragments	16	217

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 89, Cape Charles; former New York, Philadelphia, and Norfolk Railroad Co.

(From Va. Geol. Survey Bulletin 5, page 246)

Altitude, about 20 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil	1	1
Clay, buff, sandy	4	5
Sand, yellow; water-bearing	10	15
Sand, white, very loose; possibly water-bearing	25	40
Gravel, white, red and black	3	43
Chesapeake Group (Miocene):		
Yorktown Formation:		
Marl, light green	10	53
Mud, black; wood fragments	17	70
Shells; sand; water-bearing	25	95

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 90, Cape Charles; former New York, Philadelphia, and Norfolk Railroad Co.; test hole drilled in 1910

(Log from files of ~~Pennsylvania~~ Penn Central Railroad)

Altitude, 20 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay, yellow, sandy	6	6
Sand, yellow; water-bearing zone	34	40
Sand, dark gray; clay	6	46
Chesapeake Group (Miocene):		
Yorktown Formation:		
Marl, greenish; shells; sand	54	100
Sand, dark gray, fine; shells	45	145
Clay, blue	17	162
Marl, green	13	175
Sand, gray; shells	12	187
Clay, gray	2	189
Sand, loose; black specks; yields 5 gpm	15	204
Sand, very fine; black specks	18	222
Clay, green; abundant shells	16	238
"Shellrock"	1	239
St. Marys Formation:		
Sand, gray, loose; water (5 gpm)	39	278
Clay, dark gray	3	281
Sand, dark gray	29	310
Clay, dark gray; boulders at 324, 337, 340, and 365 feet	70	380

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 90, Cape Charles--Continued

	Thickness (feet)	Depth (feet)
Chesapeake Group (Miocene)--Continued		
Choptank (?) and Calvert (?) Formations, undifferentiated:		
Clay, light green sticky	95	475
Clay, dark green; sand, fine	20	495
Undifferentiated		
Clay, dark green, somewhat tough; boulder at 502 feet	395	890
Clay, green; black specks	60	950
Clay, light green; boulder at 980 feet	150	1,100
Clay, light green	32	1,132
Clay, gray	1	1,133
Clay, gray, soft	15	1,148
Clay, gray, harder than above	17	1,165
Sand, greenish, compact	65	1,230
Rock, gray, compact	7	1,237
Sand, gray, compact; gravel	13	1,250
Clay, brown and gray, sandy	20	1,270
Sand, greenish, hard	49	1,319
Sand; gravel; clay, mixed	12	1,331
Clay, mottled; gravel; sand	254	1,585
Clay, greenish, compact, sandy	22	1,607
Clay, pale-pink, sandy	73	1,680
Clay, dark gray; crusts of sandstone	60	1,740
Clay, reddish-brown, sticky	70	1,810

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 91, Cape Charles; Town of Cape Charles

(Log by Layne-Atlantic Co.)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Soil; clay	40	40
Sand	15	55
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, sandy	47	102
Sand, blue	20	122
Sand, yellow	30	152
Sand, hard, silty	7	159
Sand, blue; shells	26	185
Sand; shells	5	190
Clay, sandy	5	195

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 92, Cape Charles; Town of Cape Charles

(Log by Layne-Atlantic Co.)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil	1	1
Clay, red	3	4
Sand; shells	40	44
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay	44	88
Sand; shells	7	95
Clay	27	122
Sand, fine	21	143
Clay	29	172
Sand, "salt and pepper"	38	210

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 93, Cape Charles; Town of Cape Charles

(Log by Layne-Atlantic Co.)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Fill	4	4
Sand, fine	38	42
Chesapeake Group (Miocene):		
Yorktown Formation:		
Sand; clay	28	70
Sand, fine, hard	30	100
Sand	10	110
Sand, streaks; clay; shells	15	125
Sand	20	145
Sand; clay; shell streaks	30	175

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 164, Kiptopeke; formerly, Virginia Ferry Corporation

(Log by Layne-Atlantic Co.)

Altitude, 20 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay, sandy	10	10
Sand, coarse; some gravel	20	30
Sand, medium	5	35
Gravel; some shells	10	45
Shells; sand, coarse	10	55
Sand; gravel; shells; clay	5	60
Chesapeake Group (Miocene):		
Yorktown Formation:		
Shells; sand, medium	7	67
Shells; sand, fine; mud	18	85
Shells; sand, fine; clay	6	91
Shells; clay	12	103
Clay, blue	50	153
Shells; sand, coarse; water-bearing	23	176
Clay, blue	3	179

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 169, Townsend; Charles R. Bull

(Generalized log by owner)

Altitude, 20 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Clay	6	6
Sand; gravel	34	40
Sand; wood fragments	6	46
Sand; gravel	12	58
Chesapeake Group (Miocene):		
Yorktown Formation:		
Shell bed	20	78
Mud, blue; (4-inch layer of white sand near bottom of blue mud)	60	138
Shell marl, hard	16	154

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 175, Cape Charles Station, U. S. Air Force

(Log by Layne-Atlantic Co.)

Altitude, 10 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil	5	5
Sand, fine	13	18
Sand, medium	8	26
Clay, blue; gravel; shells	29	55
Gravel; shells	5	60
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, blue; shells	20	80
Clay, blue	5	85

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 176, Cape Charles Station, U. S. Air Force

(Log by Layne-Atlantic Co.)

Altitude, 10 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil	5	5
Sand, medium	15	20
Gravel; shells	4	24
Shells; clay	15	39
Sand, medium	5	44
Sand, coarse	14	58
Chesapeake Group (Miocene):		
Yorktown Formation:		
Clay, blue, soft	9	67

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 177, Cape Charles Station, U. S. Air Force

(Log by Layne-Atlantic Co.)

Altitude, 10 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Sand, yellow; clay	5	5
Sand; gravel; shells	21	26
Shells; sand, medium	7	33
Sand, fine	7	40
Sand, medium	18	58

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 178, Cape Charles Station, U. S. Air Force

(Log by D. J. Cederstrom)

Altitude, 10 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil	4	4
Sand, brown, medium coarse; gravel streaks	28	32
Sand, blue, clayey; clay streaks; (rock at 36 feet)	16	48
Sand, very light gray; soft	5	53
Sand, very light gray; hard	3	56
Sand, white, coarser at base; clay, thin streaks	9	65
Chesapeake Group (Miocene):		
Yorktown Formation:		
Sand, bluish-gray, clayey, hard, fine; water-bearing	9	74

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well 180, Cobb Island Station, U. S. Coast Guard

~~(Log by D. J. Cederstrom; tentative correlations by the writers, based on available information on other wells in southern Northampton County)~~

Altitude, about 9 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Mud	30	30
Mud; sand, fine	5	35
Mud	34	69
Mud; sand, fine	2	71
Chesapeake Group (Miocene):		
Yorktown Formation:		
Mud; shells; small grit	11	82
Clay, bluish-gray	49	131
Mud, soft; sand, fine	178	309
St. Marys Formation:		
Shells, broken	1	310
Shells; mud; sand, fine	23	333
Sand, fine; mud	97	430
Mud; shells	55	485
Choptank (?) Formation:		
Mud; shells	11	496
Choptank (?) and Calvert (?) Formations, undifferentiated:		
Clay, gray	153	649
Clay; sand; shells	120	769
undifferentiated Clay; sand, fine	131	900
~~Chickahominy (?) Formation (Upper Pliocene):~~		
Clay, sand, fine	101	1,001

Table 15.—Logs of wells in Northampton County, Virginia

U. S. Geological Survey test hole 1, Capeville Elementary School, at Capeville

(Drilled by Sydnor Hydrodynamics, Inc.)

(Sample descriptions by G. C. Tibbitts, Jr.; correlations by F. Stearns MacNeil)

Altitude, 20 feet

	Thickness (feet)	Depth (feet)
Columbia group (Pleistocene):		
Topsoil, reddish; traces of fine sand; silt; abundant clay	7	7
Sand, iron-stained, brown to white, coarse to medium, quartz; black sand from 35 to 53 feet; 18-inch to ¼-inch iron-stained quartz gravels throughout; water-bearing zone	46	53
Chesapeake group (Miocene):		
Yorktown formation:		
Clay, medium-gray, sticky, silty; scattered shell fragments; rough limestone chips	9	62
Clay and shells, gray and white, silty; abundant mica; quartz pebbles from 70 to 90 feet; shark teeth	28	90
Shells, white, fragments; traces of clay and silt; hard chert chips from 110 to 130 feet; varicolored quartz pebbles from 115 to 125 feet; clear quartz pebbles from 125 to 130 feet; greenstone pebbles up to 1/8-inch in diameter, from 125 to 130 feet; water-bearing zone	40	130
Clay, gray-green, soft; very abundant shell fragments, interbedded (shells possibly 50%); sandy, hard clay bed from 137 to 138 feet; silty; iron-stained quartz pebbles at 145 feet	30	160
Silt, gray-green, clayey; scattered shell fragments	10	170
Shells, white, broken; trace of clay and silt; quartz sand at 180 feet; water-bearing zone	35	205
Clay, gray-green, soft; very abundant shell fragments	10	215
Sand, gray, quartz, very silty; scattered shell fragments; scattered quartz pebbles; black sand; clay	25	240
Clay, dark-gray, heavy glauconitic; scattered quartz pebbles	7	247
Sand, black, fine; abundant shell fragments; clay; scattered quartz pebbles; possible water-bearing zone	45	292
Clay, gray-green, heavy; scattered shells; black sand; sand lens from 306-308 feet; 6-inch marl streak at 310 feet	18	310

Table 15.—Logs of wells in Northampton County, Virginia—Continued

U. S. Geological Survey test hole 1, Capeville Elementary School, at Capeville—Continued

Chesapeake Group (Miocene)—Continued	Thickness (feet)	Depth (feet)
St. Marys formation:		
Sand, gray, quartz, fine; abundant clay; abundant shell fragments; marl streaks at 311 and 314 feet ...	15	325
Sand, dirty white, quartz, very fine, glauconitic; trace of clay; abundant shell fragments; possible water-bearing zone	25	350
Clay, gray-green, soft, very sandy; scattered shell fragments; wood chips; streak of marl at 376 feet; beds of very hard marl from 405-408 feet	75	425
Choptank formation:		
Clay, gray-green, soft, very sandy; scattered shell fragments; wood chips; very hard marl from 435-439 feet	15	440
Chert, black, very hard	2	442
Sand, iron-stained, quartz, coarse; trace of clay; scattered shell fragments; possible water-bearing zone	22	464
Clay, dark-gray, heavy, silty; scattered shell fragments	6	470

Table 15.--Logs of wells in Northampton County, Virginia--Continued

Well (U.S.G.S. test hole 2); Machipongo; Machipongo High School

(Drilled by Sydnor Hydrodynamics, Inc.)

(Sample descriptions by G. C. Tibbitts, Jr.; correlations by F. Stearns MacNeil)

Altitude, 25 feet

	Thickness (feet)	Depth (feet)
Columbia Group (Pleistocene):		
Topsoil, reddish; fine sand; clay; silt	6	6
Sand, white and iron-stained; quartz; fine to medium coarse; 1/16-inch diameter iron-stained gravels from 20 to 67 feet; accessory black chert fragments from 10 feet; appearance of glauconitic sand at 55 feet; very abundant gray silt from 60 to 67 feet; water-bearing zone	61	67
Clay, dark-gray, hard	1/2	67-1/2
Sand, gray, fine, glauconitic; abundant silt	10-1/2	78
Marl, green, hard	1/3	78-1/3
Sand, light-gray, fine, glauconitic; abundant silt	4-2/3	83
Clay, dark-gray, soft, sandy; silt; scattered small gravels; shell fragments from 90 feet; harder drilling from 90 feet	17	100

78 analyses Nn Co.

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Table 16.—Chemical analyses of ground waters from wells in Northampton County, Virginia
(Parts per million, except specific conductance and pH)
[Analyses by U.S. Geol. Survey]

Well number	1	9	12	13	14	21
Location	N of Concord Wharf	Exmore	Exmore	Exmore	Exmore	Ward~~ton~~ town
Depth (feet)	17	295	290	168	175	22
Geologic age	Pleistocene	Miocene	Miocene	Miocene	Miocene	Pleistocene
Formation or Group	Columbia Group	St. Marys Formation	Yorktown (?) Formation	Yorktown Formation	Yorktown Formation	Columbia Group
Date	Sept. 11, 1948		Sept. 1948			
Silica (SiO_2)	—	—	—	—	—	—
Iron (Fe)	—	—	—	.36	—	5.5
Calcium (Ca)	—	81 4	—	—	—	—
Magnesium (Mg)	—	112 9.2	—	—	—	—
Sodium (Na)	—	—	—	—	—	—
Potassium (K)	—	—	—	—	—	—
Carbonate (CO_3)	—	—	—	—	—	—
Bicarbonate (HCO_3)	—	268 4.7	—	120	194	106
Sulfate (SO_4)	—	16 .3	—	1	1	23
Chloride (Cl)	35	690 19	19	10	16	30
Fluoride (F)	.0	—	.0	—	.18	.0
Nitrate (NO_3)	—	—	—	.6	1.7	25
Dissolved solids	—	—	—	—	—	—
Hardness as $CaCO_3$	165	193	141	81	135	42
pH	—	—	—	—	—	—
Specific conductance (micromhos (25°C)	500	—	355	—	—	355

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(N-Ac Mem. Hosp.)

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Table 16.--Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	29	39	40	0.3 mi N NE of Bayford, NE of Nassawadox 42	44b	46
Location	Willis Wharf	NW of Nassawadox	S of Exmore		Nassawadox	Nassawadox
Depth (feet)	240	90	21	18	304	82
Geologic age	Miocene	Miocene	Pleistocene	Pleistocene	Miocene	Pleistocene
Formation or Group	St. Marys Formation	Yorktown Formation	Columbia Group	Columbia Group	Yorktown and St. Marys Formations	Columbia Group
Date	Sept. 13, 1948	Sept. 11, 1948	Sept. 13, 1948	Sept. 11, 1948	Apr. 15, 1955	Sept. 14, 1948
Silica (SiO_2)	—	—	—	—	17	19
Iron (Fe)	—	—	—	—	.0	1.1
Calcium (Ca)	—	—	—	—	28	53
Magnesium (Mg)	—	—	—	—	9.2	2.0
Sodium (Na)	—	—	—	—	16	13
Potassium (K)	—	—	—	—	2.5	
Carbonate (CO_3)	—	—	—	—	0	—
Bicarbonate (HCO_3)	—	—	—	—	131	142
Sulfate (SO_4)	—	—	—	—	3.5	17
Chloride (Cl)	101	10	68	21	29	24
Fluoride (F)	.0	.0	.0	.0	.1	.0
Nitrate (NO_3)	—	—	—	—	2.0	.4
Dissolved solids	—	—	—	—	176	208
Hardness as $CaCO_3$	108	72	48	75	108	140
pH	—	—	—	—	8.0	7.9
Specific conductance (micromhos at 25°C)	666	187	668	287	316	297 (calc)

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Table 16.--Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	48	50a	51	SE 52	55	57
Location	SW of Franktown	Bridgetown	SW of Bridgetown	~~SW~~ of Birdsnest	Machipongo	W of Machipongo
Depth (feet)	12	30	98	14	23	20
Geologic age	Pleistocene	Pleistocene	Miocene	Pleistocene	Pleistocene	Pleistocene
Formation or Group	Columbia Group	Columbia Group	Yorktown Formation	Columbia Group	Columbia Group	Columbia Group
Date	Sept. 12, 1948	Sept. 11, 1948	Sept. 12, 1948	Sept. 14, 1948	Sept. 12, 1948	Sept. 12, 1948
Silica (SiO_2)	--	--	--	--	--	--
Iron (Fe)	--	--	1.8	--	5.7	--
Calcium (Ca)	--	--	--	--	--	--
Magnesium (Mg)	--	--	--	--	--	--
Sodium (Na)	--	--	--	--	--	--
Potassium (K)	--	--	--	--	--	--
Carbonate (CO_3)	--	--	--	--	--	--
Bicarbonate (HCO_3)	--	--	194	--	14	--
Sulfate (SO_4)	--	--	6	--	4	--
Chloride (Cl)	79	11	205	17	63	28
Fluoride (F)	.0	.1	.5	.0	.1	.0
Nitrate (NO_3)	--	--	4.1	--	.1	--
Dissolved solids	--	--	--	--	--	~~117~~
Hardness as $CaCO_3$	108	69	69	81	30	--
pH	--	--	--	--	--	--
Specific conductance (micromhos at 25°C)	465	129	1,020	236	141	390

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Table 16.--Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	58	59	60	61	63	66
Location	NW of Eastville	NW of Eastville	ENE of Eastville	NE of Wilkins Beach	Eastville	E of Wilkins Beach
Depth (feet)	22	95	30	134	165	14
Geologic age	Pleistocene	Miocene	Pleistocene	Miocene	Miocene	Pleistocene
Formation or Group	Columbia Group	Yorktown Formation	Columbia Group	Yorktown Formation	Yorktown Formation	Columbia Group
Date	Septh 12, 1948	May 26, 1952	Sept. 14, 1948	May 26, 1954	Sept. 2, 1948	Sept. 12, 1948
Silica (SiO_2)	—	—	—	46	39	—
Iron (Fe)	—	—	.75	.23	.04	—
Calcium (Ca)	—	—	—	31	26	—
Magnesium (Mg)	—	—	—	3.4	3.7	—
Sodium (Na)	—	—	—	19	11	—
Potassium (K)	—	—	—	2.7		—
Carbonate (CO_3)	—	0	—	—	0	—
Bicarbonate (HCO_3)	—	54	38	131	96	—
Sulfate (SO_4)	—	—	18	4.1	1.2	—
Chloride (Cl)	21	8.8	15	20	17	49
Fluoride (F)	.0	—	.0	.0	.1	.1
Nitrate (NO_3)	—	—	.1	1.0	.2	—
Dissolved solids	—	—	—	187	145	—
Hardness as $CaCO_3$	138	44	24	91	80	60
pH	—	7.5	—	7.8	8.0	—
Specific conductance (micromhos at 25°C)	431	138	122	266	207 (calc.)	--

Table 16.--Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	69	70	74	75	76	81
Location	S of Eastville	NE of Cobbs	Cheriton	Cheriton	Cheriton	Oyster
Depth (feet)	21	22	13	170	271	182
Geologic age	Pleistocene	Pleistocene	Pleistocene	Miocene	Miocene	Miocene
Formation or Group	Columbia Group	Columbia Group	Columbia Group	Yorktown Formation	Yorktown Formation	Yorktown Formation
Date	Sept. 1948	Sept. 14, 1948	Sept. 1948	Mar. 1946	July 1, 1946	Mar. 5, 1946
Silica (SiO_2)	—	—	—	26	—	32
Iron (Fe)	—	.09	—	.14	.11	.04
Calcium (Ca)	—	—	—	33	—	29
Magnesium (Mg)	—	—	—	5.6	—	10
Sodium (Na)	—	—	—	} 12	—	} 16
Potassium (K)	—	—	—		—	
Carbonate (CO_3)	—	—	—	0	9 ← ~~8.99~~	0
Bicarbonate (HCO_3)	—	20	00	81	381	144
Sulfate (SO_4)	—	13	—	29	1.0	.8
Chloride (Cl)	15	16	24	22	4.0	18
Fluoride (F)	.0	.0	.0	.1	--	.2
Nitrate (NO_3)	—	36	--	5.3	.1	.6
Dissolved solids	—	--	--	182	--	177
Hardness as $CaCO_3$	51	54	108	105	24	113
pH	—	—	--	7.5	8.9	7.3
Specific conductance (micromhos at 25°C)	147	227	381	E 260 ~~(calc.)~~ (see note)	--	253 (calc.)

Table 16.—Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	82	83a	84	86	97	98
Location	W of Oyster	Oyster	Oyster	Oyster	NW of Seaview	W of Seaview
Depth (feet)	26	185	185	185	15	25
Geologic age	Pleistocene	Miocene	Miocene	Miocene	Pleistocene	Pleistocene
Formation or Group	Columbia Group	Yorktown Formation	Yorktown Formation	Yorktown Formation	Columbia Group	Columbia Group
Date	Sept. 14, 1948	Dec. 16, 1952	Dec. 16, 1952	Dec. 16, 1952	Sept. 13, 1948	Sept. 13, 1948
Silica (SiO_2)	—	—	—	—	—	—
Iron (Fe)	0.26	—	—	—	—	—
Calcium (Ca)	—	—	—	—	—	—
Magnesium (Mg)	—	—	—	—	—	—
Sodium (Na)	—	—	—	—	—	—
Potassium (K)	—	—	—	—	—	—
Carbonate (CO_3)	—	—	—	—	—	—
Bicarbonate (HCO_3)	28	157	150	157	—	—
Sulfate (SO_4)	46	1	1	1	—	—
Chloride (Cl)	10	20	24	20	9	12
Fluoride (F)	.1	.3	0.4	~~.03~~ .3	.0	.0
Nitrate (NO_3)	37	—	—	—	—	—
Dissolved solids	—	—	—	—	—	—
Hardness as $CaCO_3$	72	126	120	126	60	72
pH	—	—	7.7	7.8	—	—
Specific conductance (micromhos at 25°C)	230	302	311	302	154	211

Table 16.—Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	106	107	108	109	~~113~~ 111	~~115~~ 115	118
Location	NNW of Capeville	NNW of Capeville	NNW of Cheapside	NNW of Cheapside	NNE of Capeville	N of Cheapside	NW of Capeville
Depth (feet)	140	40	125	101	~~17~~ 17 ~~25~~	~~120~~ 20	120
Geologic age	Miocene	Pleistocene	Miocene	Miocene	Pleistocene	Pleistocene	Miocene
Formation or Group	Yorktown Formation	Columbia Group	Yorktown Formation	Yorktown Formation	Columbia Group	Columbia Group	Yorktown Formation
Date	Oct. 22, 1952	Oct. 22, 1952	Sept. 5, 1952	Sept. 5, 1952	Sept. 13, 1948	Oct. 18, 1952	Oct. 18, 1952
Silica (SiO_2)	--	--	--	--	--	--	--
Iron (Fe)	--	--	--	0	.79	--	--
Calcium (Ca)	--	--	--	--	--	2	--
Magnesium (Mg)	--	--	--	--	--	12	--
Sodium (Na)	--	--	--	--	--	--	--
Potassium (K)	--	--	--	--	--	--	--
Carbonate (CO_3)	--	--	0	--	--	--	--
Bicarbonate (HCO_3)	83	13	107	104	17	29	72
Sulfate (SO_4)	24	110	12	20	48	140	52
Chloride (Cl)	8.2	58	13	13	10	30	17
Fluoride (F)	.1	.2	.2	.2	.1	.1	.3
Nitrate (NO_3)	--	--	--	--	6	--	--
Dissolved solids	--	--	--	--	--	--	--
Hardness as $CaCO_3$	78	184	99	98	57	79	93
pH	7.5	6.5	7.6	7.7	--	6.3	7.8
Specific conductance (micromhos at 25° C)	191	417	223	221	197	248	225

Table 16.--Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	119	123	124	125	127	135
Location	NW of Capeville	NW of Capeville	WNW of Capeville	NNE of Cheapside	N of Capeville	SSW of Cheapside
Depth (feet)	144	88	134	104	101	75
Geologic age	Miocene	Miocene	Miocene	Miocene	Miocene	Miocene (?)
Formation or Group	Yorktown Formation	Yorktown Formation	Yorktown Formation	Yorktown Formation	Yorktown Formation	Yorktown Formation
Date	Oct. 19, 1952	Oct. 19, 1952	Sept. 10, 1952	Sept. 10, 1952	Sept. 10, 1952	Sept. 11, 1952
Silica (SiO_2)	--	--	--	--	--	--
Iron (Fe)	--	--	--	--	--	--
Calcium (Ca)	42	--	--	--	--	--
Magnesium (Mg)	9.2	--	--	--	--	--
Sodium (Na)	--	--	--	--	--	--
Potassium (K)	--	--	--	--	--	--
Carbonate (CO_3)	--	--	--	--	--	--
Bicarbonate HCO_3)	118	61	84	90	121	92
Sulfate (SO_4)	48	23	52	50	20	23
Chloride (Cl)	32	7.2	9.2	12	10	12
Fluoride (F)	0.2	0.1	0.2	.3	.2	.2
Nitrate (NO_3)	--	--	--	--	--	--
Dissolved solids	--	--	--	--	--	--
Hardness as $CaCO_3$	143	88	91	93	98	86
pH	7.6	7.6	7.7	7.7	7.9	7.8
Specific conductance (micromhos at 25°C)	360	245	210	214	231	209

Table 16.--Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	136	137	139	141	143	144
Location	W of Townsend	W of Townsend	E of Townsend	E of Townsend	E of Townsend	E of Townsend
Depth (feet)	25	117	112	35	42	72
Geologic age	Pleistocene	Miocene	Miocene	Pleistocene	Pleistocene	Miocene (?)
Formation or Group	Columbia Group	Yorktown Formation	Yorktown Formation	Columbia Group	Columbia Group	Yorktown Formation
Date	Sept. 13, 1948	Sept. 6, 1952	Sept. 6, 1952	Sept. 6, 1952	Sept. 8, 1952	Sept. 8, 1952
Silica (SiO_2)	--	--	--	--	--	--
Iron (Fe)	--	--	--	--	--	--
Calcium (Ca)	--	--	--	--	--	--
Magnesium (Mg)	--	--	--	--	--	--
Sodium (Na)	--	--	--	--	--	--
Potassium (K)	--	--	--	--	--	--
Carbonate (CO_3)	--	--	--	--	--	--
Bicarbonate (HCO_3)	--	92	78	59	100	97
Sulfate (SO_4)	--	13	65	105	46	23
Chloride (Cl)	37	29	20	36	9.8	9.8
Fluoride (F)	.0	0.2	.2	.2	.2	.2
Nitrate (NO_3)	--	--	--	--	--	--
Dissolved solids	--	--	--	--	--	--
Hardness as $CaCO_3$	96	107	112	118	86	86
pH	--	7.9	7.6	6.8	7.9	7.7
Specific conductance (micromhos at 25°C)	390	261	256	332	211	214

Table 16.--Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	146	148	149	150	151	152
Location	S of Townsend	SSE of Townsend	S of Townsend	S of Townsend	SE of Townsend	SSE of Townsend
Depth (feet)	46	90	48	90	91	35
Geologic age	Pleistocene	Miocene	Pleistocene	Miocene	Miocene	Pleistocene
Formation or Group	Columbia Group	Yorktown Formation	Columbia Group	Yorktown Formation	Yorktown Formation	Columbia Group
Date	Sept. 4, 1952	Sept. 4, 1952	Sept. 4, 1952	Aug. 16, 1952	Sept. 13, 1948	Sept. 5, 1952
Silica (SiO_2)	--	--	--	--	--	--
Iron (Fe)	--	--	--	--	--	--
Calcium (Ca)	25	--	5.0	--	--	--
Magnesium (Mg)	7.6	--	8.3	--	--	--
Sodium (Na)	--	--	--	--	--	--
Potassium (K)	--	--	--	--	--	--
Carbonate (CO_3)	--	--	--	--	--	--
Bicarbonate (HCO_3)	29	88	27	112	84	58
Sulfate (SO_4)	23	24	11	13	22	13
Chloride (Cl)	44	13	34	19	13	14
Fluoride (F)	.2	.2	.2	.2	.2	.2
Nitrate (NO_3)	--	--	--	--	--	--
Dissolved solids	--	--	--	--	--	--
Hardness as $CaCO_3$	94	91	47	124	93	56
pH	6.8	7.7	6.6	7.6	7.7	7.0
Specific conductance (micromhos at 25°C)	344	212	205	288	205	160

Table 16.--Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	153	154	156	158	159	163
Location	S of Townsend	SW of Townsend	ENE of Kiptopeke Beach	ENE of Kiptopeke Beach	ENE of Kiptopeke Beach	E of Kiptopeke Beach
Depth (feet)	103	87	130	20	40	60
Geologic age	Miocene	Miocene	Miocene	Pleistocene	Pleistocene	Pleistocene
Formation or Group	Yorktown Formation	Yorktown Formation	Yorktown Formation	Columbia Group	Columbia Group	Columbia Group
Date	Sept. 4, 1952	Sept. 4, 1952	Aug. 15, 1952	Aug. 15, 1952	Sept. 11, 1952	Aug. 14, 1952
Silica (SiO_2)	--	--	--	--	--	--
Iron (Fe)	--	--	--	--	--	--
Calcium (Ca)	--	--	--	--	--	--
Magnesium (Mg)	--	--	--	--	--	--
Sodium (Na)	--	--	--	--	--	--
Potassium (K)	--	--	--	--	--	--
C						
Carbonate (CO_3)	--	--	--	--	0	--
Bicarbonate (HCO_3)	99	81	109	19	26	106
Sulfate (SO_4)	7	24	6	2	46	110
Chloride (Cl)	16	22	14	2.4	24	29
Fluoride (F)	.2	.2	.5	.4	.2	.3
Nitrate (NO_3)	--	--	--	--	--	--
Dissolved solids	--	--	--	--	--	--
Hardness as $CaCO_3$	89	102	96	12	47	162
pH	7.8	7.5	7.5	7.0	6.8	7.5
Specific conductance (micromhos at 25°C)	211	242	228	38.8	188	426

Table 16.--Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	165	166	167	169	170	171
Location	SE of Kiptopeke Beach	SE of Kiptopeke Beach	N of Kiptopeke	NE of Kiptopeke	N of Kiptopeke	NNE of Kiptopeke
Depth ;(feet)	93	55	230	154	227	48
Geologic age	Miocene	Pleistocene	Miocene	Miocene	Miocene	Pleistocene
Formation or Group	Yorktown Formation	Columbia Group	Yorktown Formation	Yorktown Formation	Yorktown Formation	Columbia Group
Date	Aug. 14, 1952	Aug. 12, 1952	Aug. 14, 1952	Aug. 12, 1952	Aug. 12, 1952	Aug. 12, 1952
Silica (SiO_2)	--	--	--	--	--	--
Iron (Fe)	--	--	--	--	--	--
Calcium (Ca)	--	47	--	--	--	28
Magnesium (Mg)	--	15	--	--	--	5.4
Sodium (Na)	--	--	--	--	--	--
Potassium (K)	--	--	--	--	--	--
Carbonate (CO_3)	--	--	0	--	--	--
Bicarbonate (HCO_3)	99	79	121	121	113	89
Sulfate (SO_4)	23	110	5	5	5	8
Chloride (Cl)	26	40	15	15	13	51
Fluoride (F)	.2	.3	.4	.4	.4	.2
Nitrate (NO_3)	--	--	--	--	--	--
Dissolved solids	--	--	--	--	--	--
Hardness as $CaCO_3$	128	179	98	98	87	92
pH	7.4	7.2	7.7	7.8	7.6	7.3
Specific conductance (micromhos at 25°C)	335	456	243	243	253	324

Table 16.--Chemical analyses of ground waters from wells in Northampton County, Virginia--Continued
(Parts per million, except specific conductance and pH)

Well number	172	173	176	178	USGS Test Hole No. 2
Location	NE of Kiptopeke	E of Kiptopeke	Cap Charles Air Force Station	Cape Charles Air Force Station	Machipongo
Depth (feet)	42	73	65	74	65
Geologic age	Pleistocene	Miocene (?) should there be query after Miocene?	Miocene	Miocene	Pleistocene
Formation or Group	Columbia Group	Yorktown (?) Formation	Yorktown Formation	Yorktown Formation	Columbia Group
Date	Aug. 12, 1952	Aug. 12, 1952	May 6, 1942	Sept. 27, 1955	May 25, 1954
Silica (SiO_2)	--	--	--	18	19
Iron (Fe)	--	--	.5	.0	.06
Calcium (Ca)	38	--	--	41	9.9
Magnesium (Mg)	10	--	--	7.0	5.1
Sodium (Na)	--	--	--	28	18
Potassium (K)	--	--	--	2.1	1.6
Carbonate (CO_3)	--	--	--	0	--
Bicarbonate (HCO_3)	26	72	98	120	6
Sulfate (SO_4)	130	21	3	24	41
Chloride (Cl)	32	12	24	54	27
Fluoride (F)	.3	.3	--	.0	.0
Nitrate (NO_3)	--	--	.4	.2	.1
Dissolved solids	--	--	--	230	131
Hardness as $CaCO_3$	136	74	84	131	46
pH	6.6	7.5	--	7.9	5.7
Specific conductance (micromhos at 25°C)	370	190	--	402	201

Table 17.—Chemical analyses of water from irrigation ponds in Northampton County, Virginia

	W of Exmore	WNW of Bridsnest
Geologic age	Pleistocene	Pleistocene
Formation or Group	Columbia Group	Columbia Group
Date	Sept. 28 1955	Sept. 28, 1955
Silica (SiO_2)	8.3	2.2
Iron ; (Fe)	.27	.04
Calcium (Ca)	17	7.9
Magnesium (Mg)	5.3	9.8
Sodium (Na)	12	21
Potassium (K)	2.4	3.4
Carbonate (CO_3)	0	0
Bicarbonate (HCO_3)	22	26
Sulfate (SO_4)	38	29
Chloride (Cl)	25	42
Fluoride (F)	.1	.3
Nitrate (NO_3)	3.2	.3
Dissolved solids	154	145
Hardness as $CaCO_3$	64	60
pH	7.3	7.1
Specific conductance (micromhos at 25°C)	215	253

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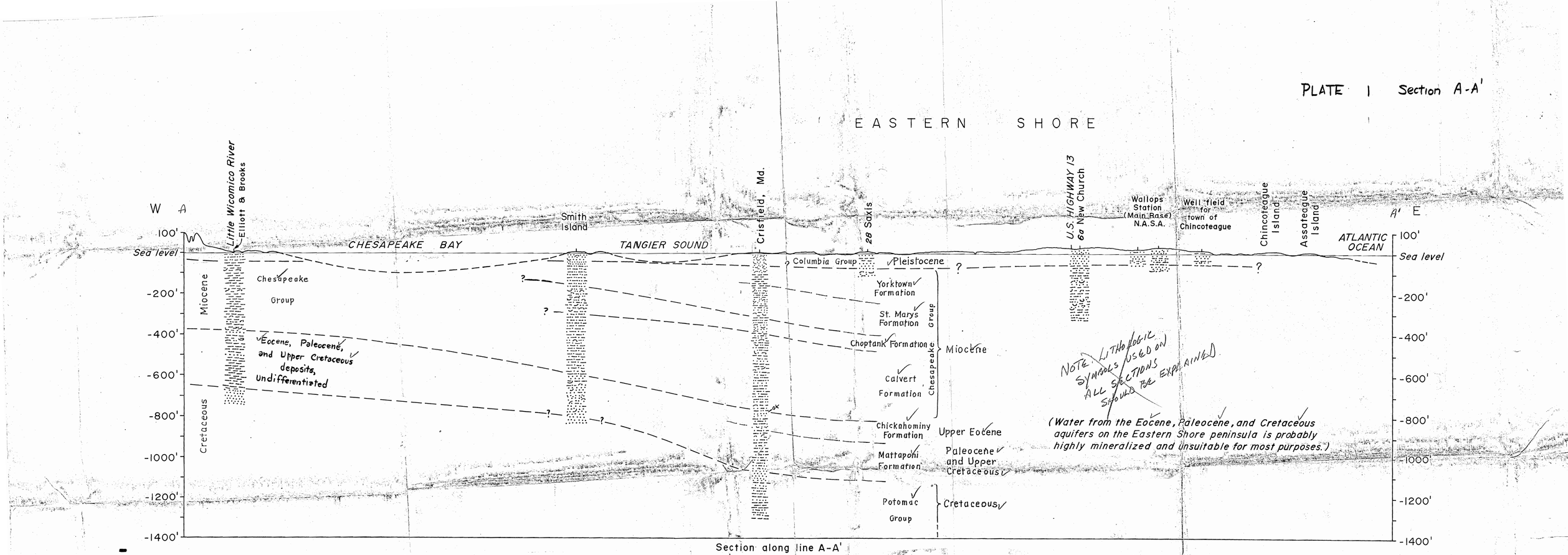
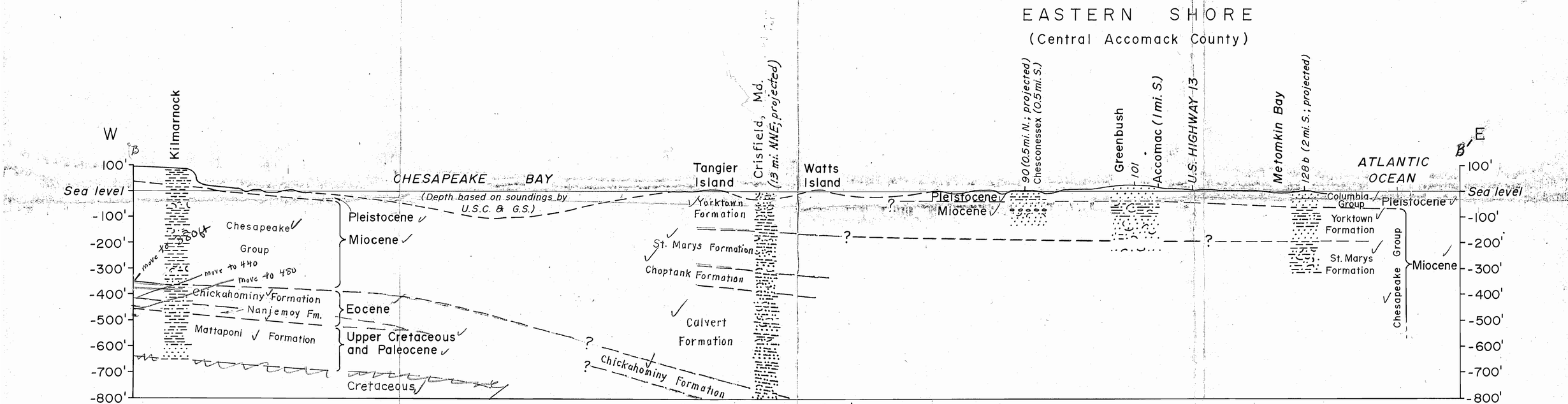
PLATE 1 Section A-A'



Section along line A-A'

GHZ/WRD

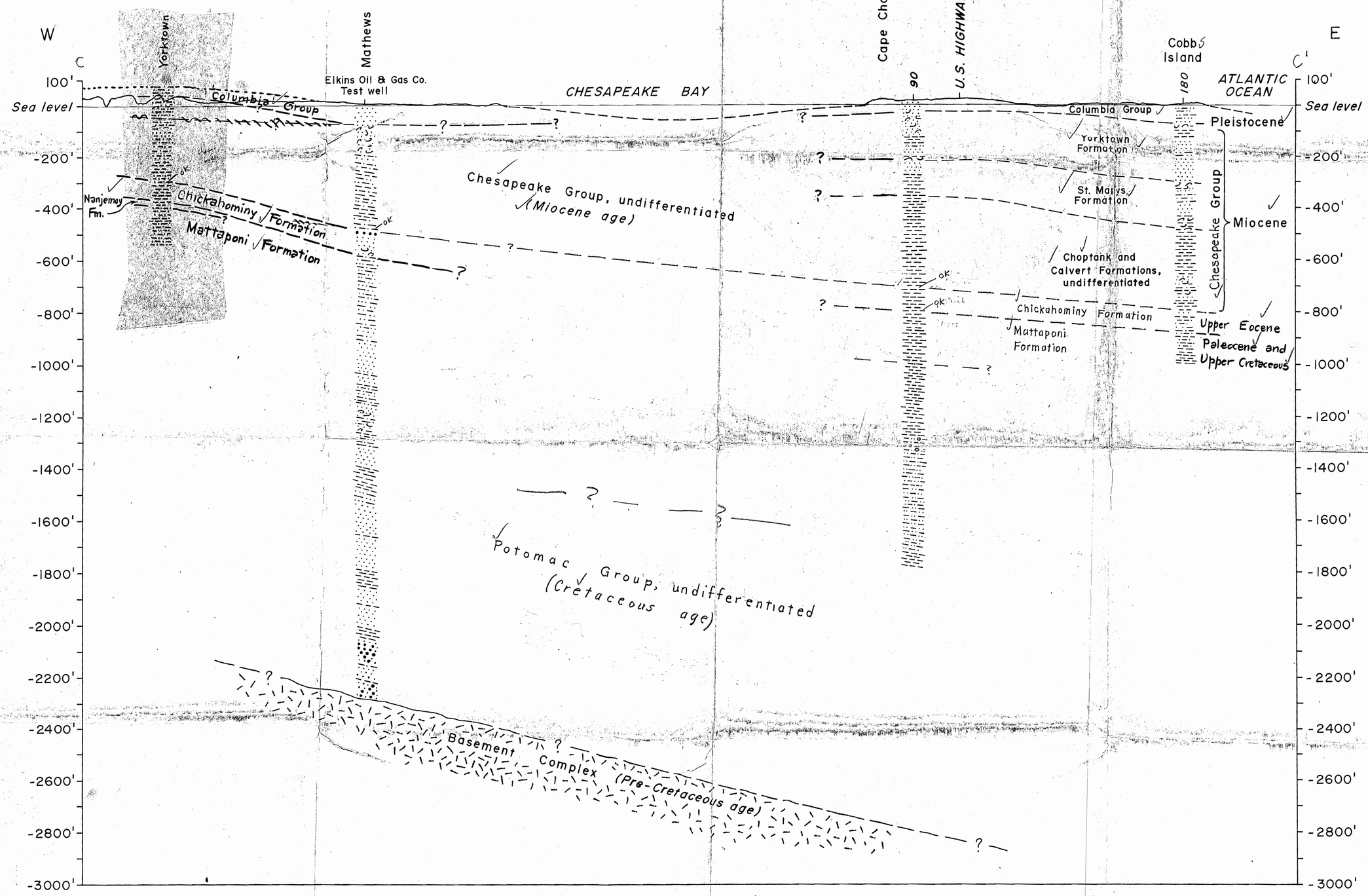
PLATE 1 Section B-B'



Section along line B-B'

GMG/WRD

PLATE I Section C-C'



Section along line C-C'

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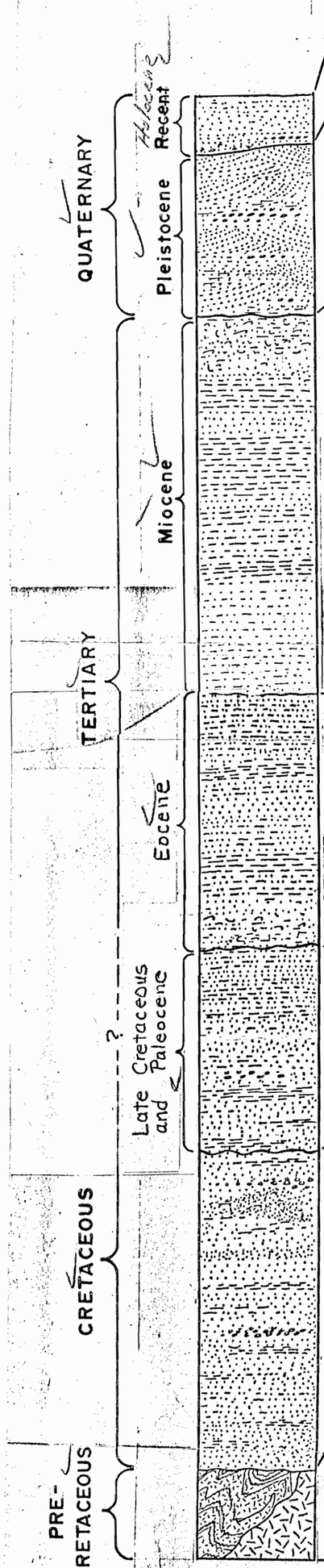
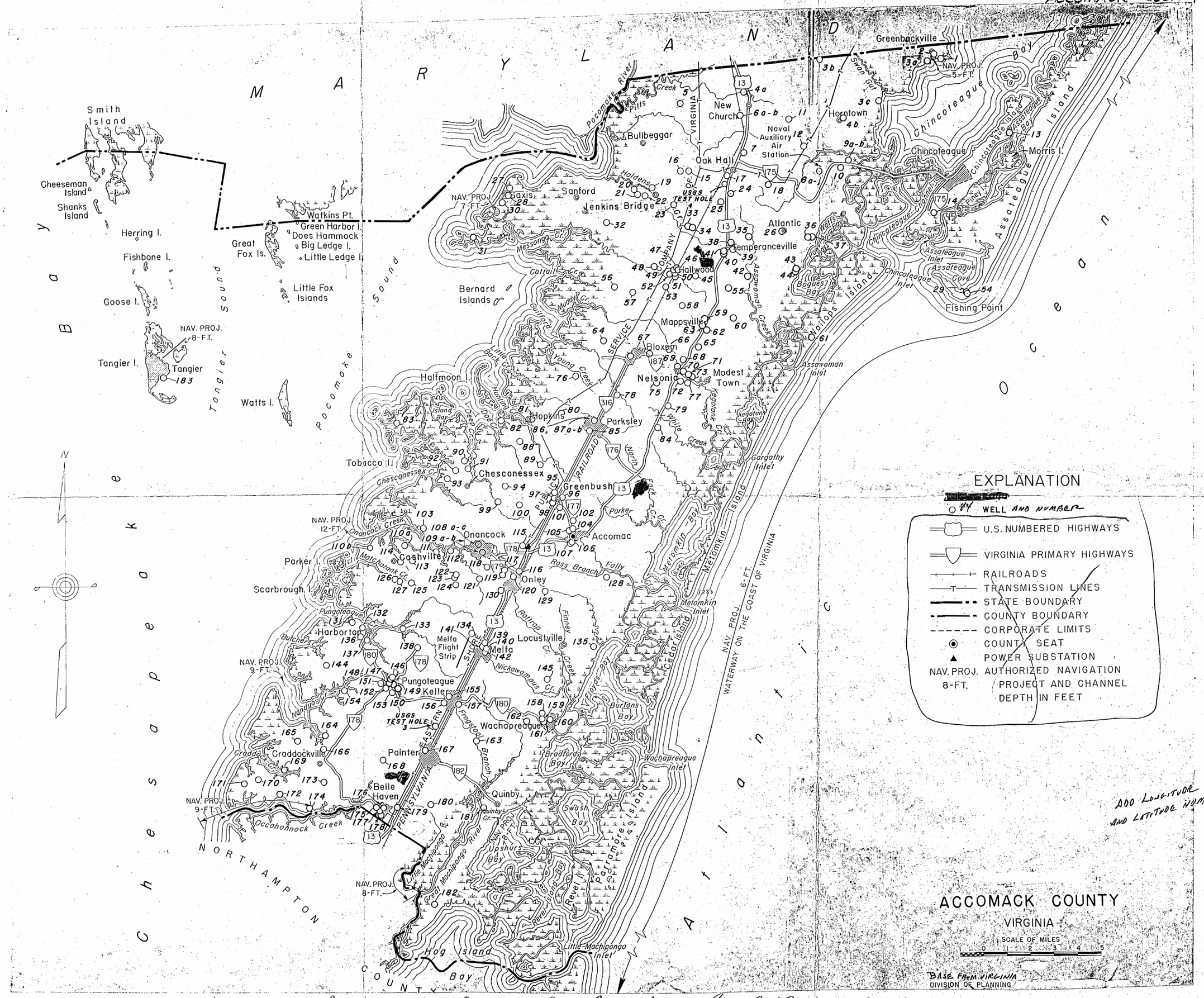


Formations and lithology	Origin	Distribution	Water-bearing character
Unnamed silts, sands and gravels.	Wind deposits; beach, littoral, and shallow marine deposits; minor stream deposits.	Dunes; beaches, bars, and spits; deposits in creek beds.	In limited areas, and in favorable topographic situations, beach and bar deposits may yield small quantities of ground water of fair quality.
The Columbia Group consists largely of unconsolidated yellowish cross-bedded clayey sands and gravels. In places, may reach about 100 feet in thickness. The formations have not been differentiated in this report.	Marine and estuarine shallow water deposits.	Underlies entire area; exposed at the surface everywhere except where covered by dunes, beach deposits, or other deposits of Recent age.	Supplies small quantities of ground water to many shallow dug and driven wells throughout area. Quality good, but locally high in iron. At least one municipality (Chincoteague) obtains practically its entire water supply from these deposits.
The Chesapeake Group consists of sands, clays, and marls. Shells are abundant in the Yorktown Formation, the youngest of the Group; the St. Marys Formation is largely gray and dark blue clay; the Choptank Formation is green and dark gray sandy clay, with quartz sand and chert; basal Calvert Formation is chiefly light-colored and characteristically contains much diatomaceous earth. The Chesapeake Group is probably on the order of 500-900 feet thick in the area.	Formed by marine deposition. Seas submerged entire area of the present Coastal Plain, and in places may have extended a few miles west of the present Fall Zone.	The Group underlies entire Eastern Shore peninsula. Not exposed at the surface.	Tapped for ground water by nearly all of the deep wells in the area. Generally not tapped below about 300 feet, however, owing to high chloride content of deeper beds. Most of the wells probably tap the Yorktown and St. Marys Formations.
The Eocene formations consist of sands and clays of the Chickahominy Formation of Late Eocene age, possibly underlain by as much as 20 feet of beds of the Nanjemoy Formation of middle and early Eocene age.	Deposited in marine waters.	These formations underlie the entire Eastern Shore peninsula. Not exposed at the surface; known only from logs of wells at Crisfield, Md., Cape Charles, and on Cobbs Island.	Although important sources of water on the Virginia mainland, these formations have been reached by very few wells on the Eastern Shore peninsula. Water from deep wells on Tangier Island is somewhat mineralized.
The Mattaponi Formation, of Paleocene and Late Cretaceous age, is represented by clays and minor fine sands. At Cape Charles, this formation may be as much as 500 feet thick.	Deposited under shallow-water marine and estuarine conditions.		Water from the well on Cobbs Island is reported brackish.
The Potomac Group consists of sands, clays, and minor gravel lenses. Not differentiated into formations in this report. May exceed 1,500 feet in thickness.	Deposited by streams, chiefly as deltaic deposits; contains plant fossils.	Underlies entire area. Not exposed at the surface.	Tapped by wells in Crisfield, Md., near the Maryland-Virginia State line. Also, reached, but not tapped for water, in an early test hole at Cape Charles. Ground water is likely to be high in fluoride and chloride.
Crystalline basement rocks, including metamorphic rocks and igneous bodies, in places cut by later igneous intrusives. Probably lies at depths ranging from 7,000 feet or more near the Maryland-Virginia State line to about 3,000 feet at the south end of the peninsula.	Metasediments, including schists and gneisses; igneous intrusives.	Underlie entire area. Not exposed at the surface.	Not practicable as sources of ground water.

PLATE 2: Diagrammatic columnar section, and table describing the principal geologic formations of the Eastern Shore peninsula of Virginia.

Gamford

PLATE 3
ACCOMACK COUNTY



ADD LONGITUDE AND LATITUDE NUMBERS

PLATE 3: Map of Accomack County showing location of wells listed in Table 8

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PLATE 4
NORTHAMPTON COUNTY

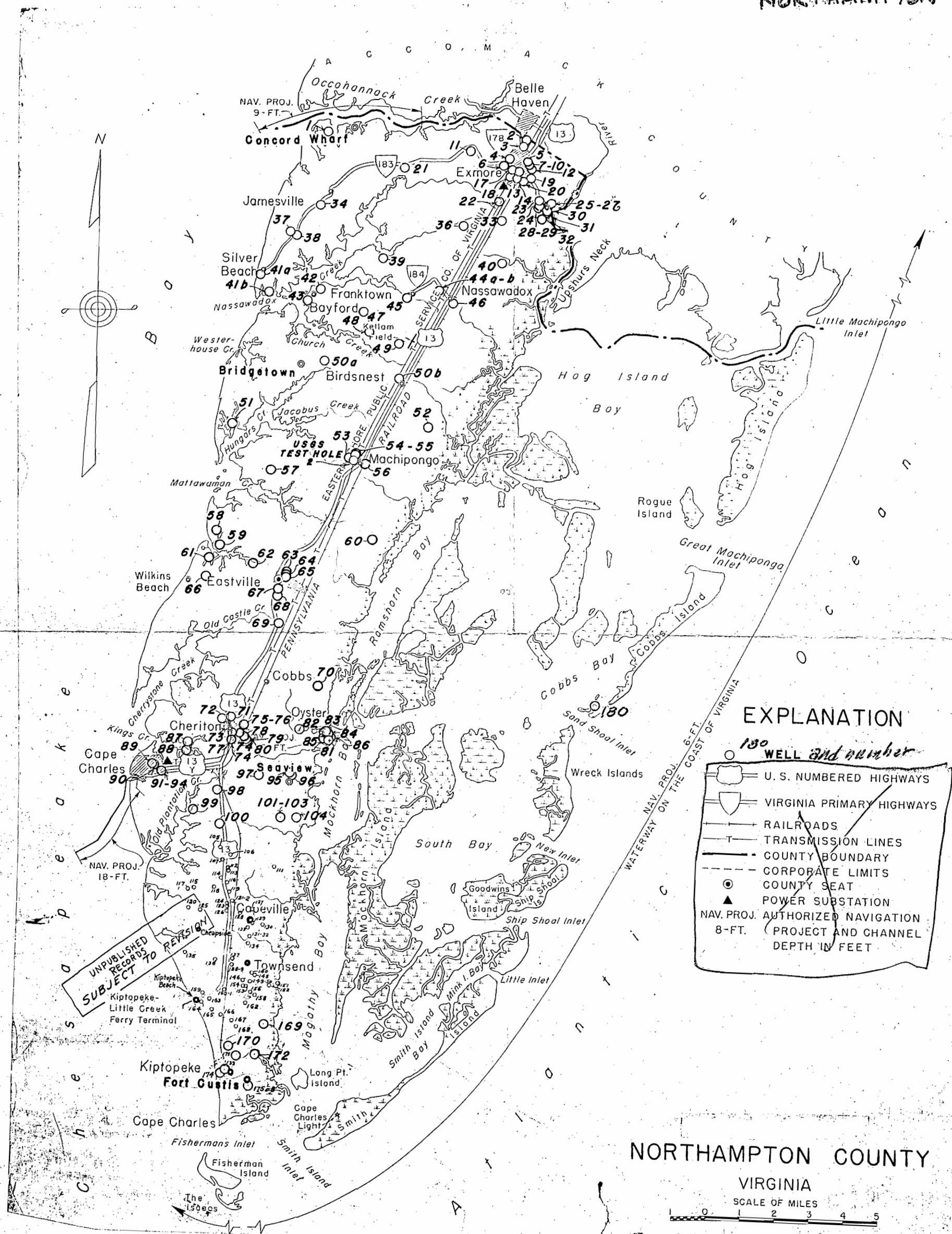

PLATE 4: Map of Northampton County showing location of wells listed in Table 14.

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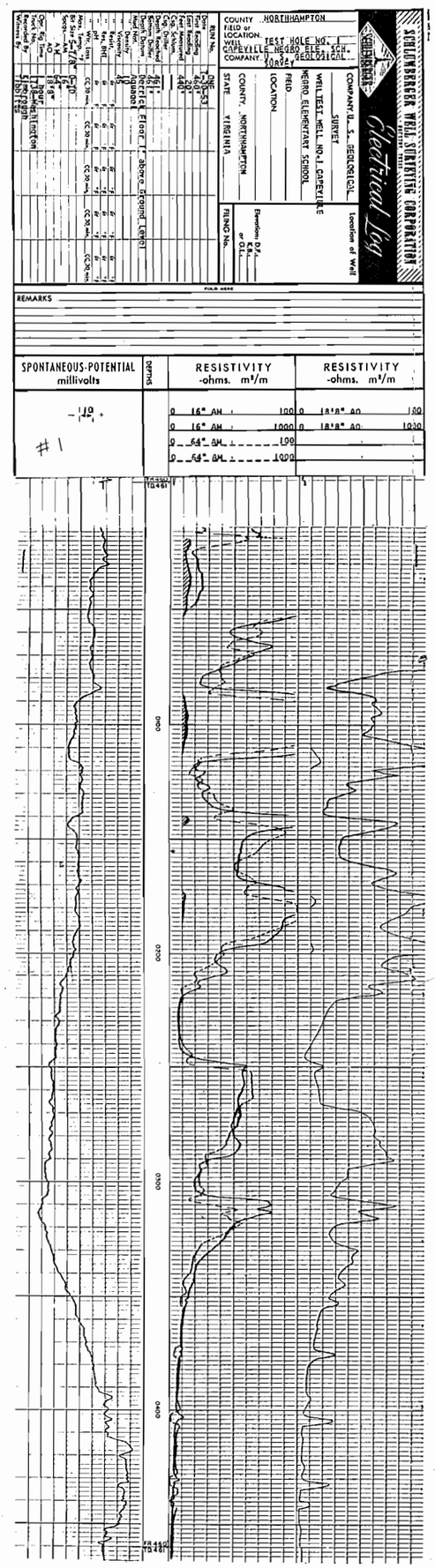
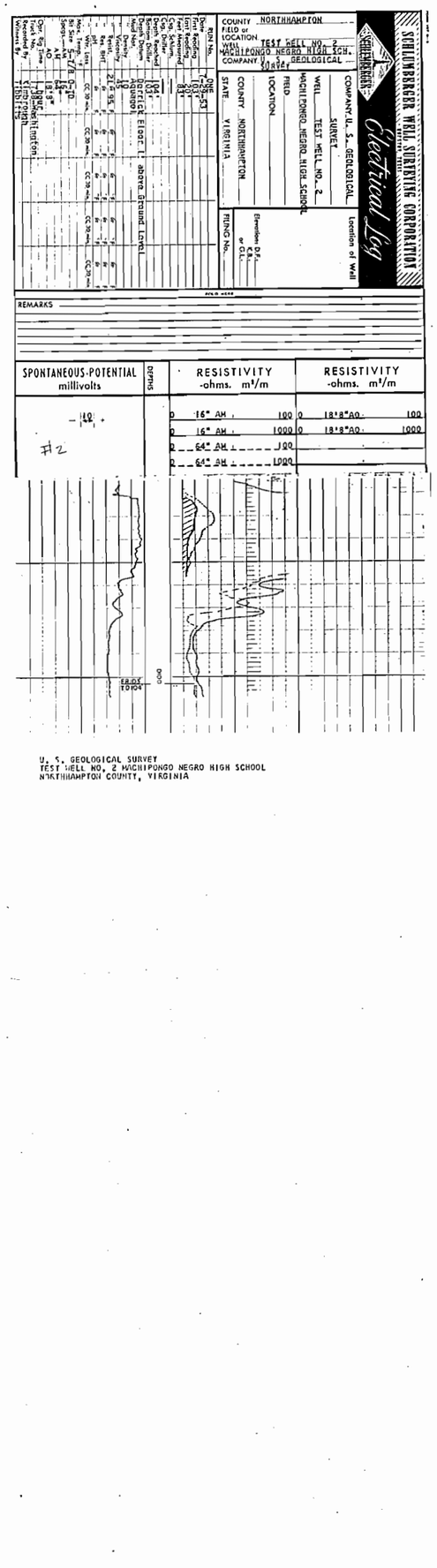
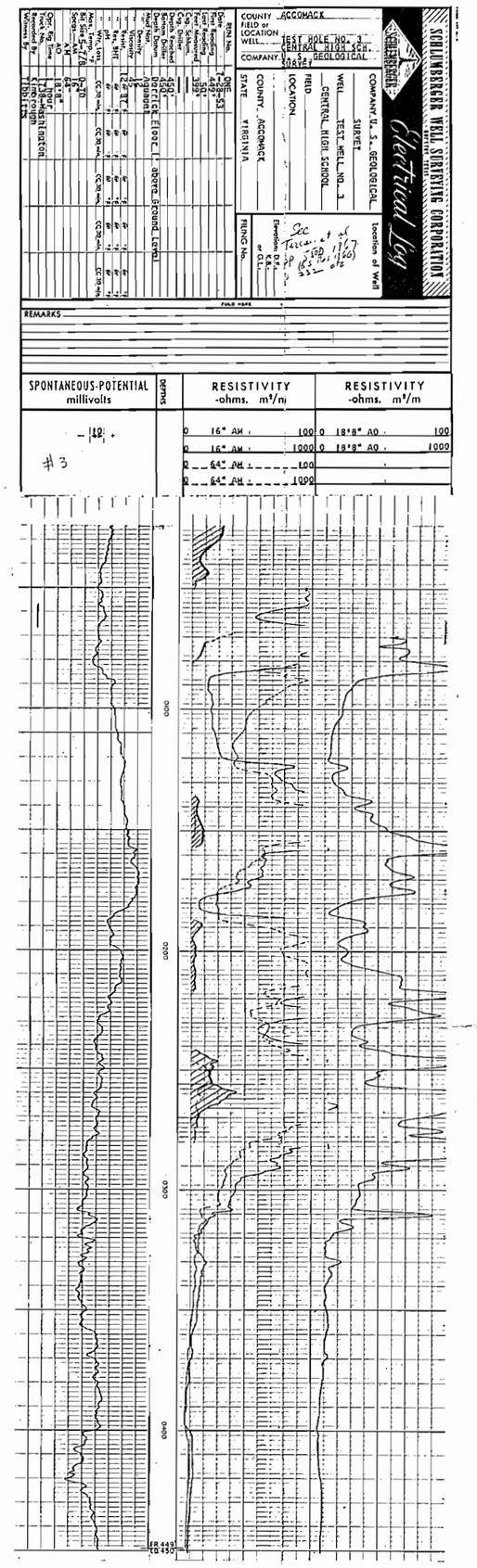
PLATE 5
(Electric Logs)



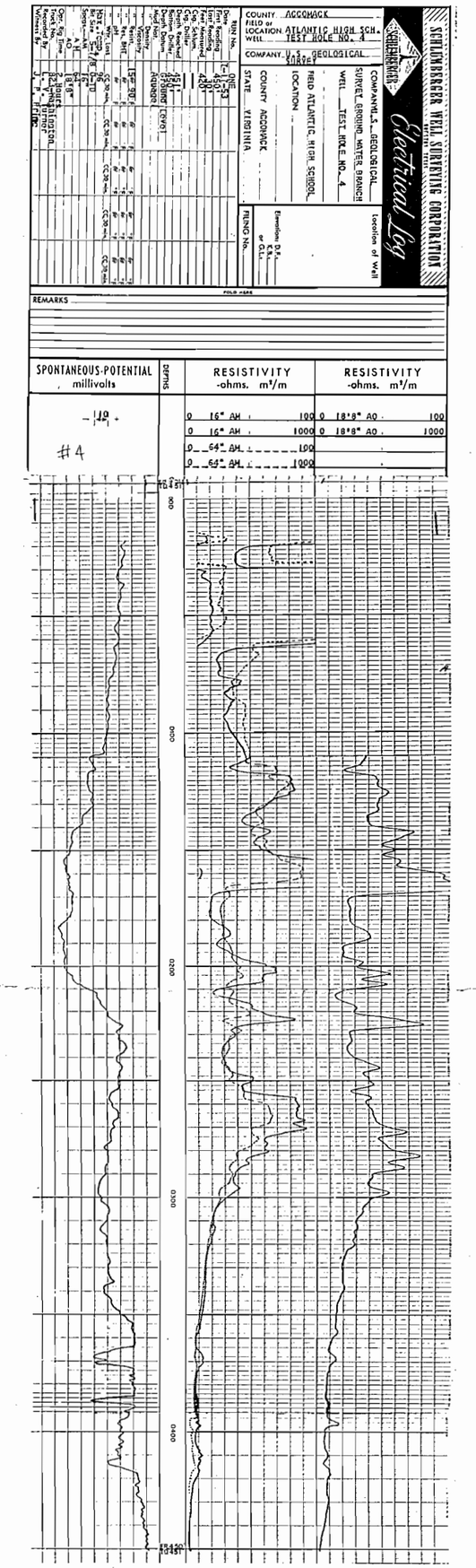
U. S. GEOLOGICAL SURVEY
TEST HOLE NO. 1 CAPEVILLE NEGRO ELEMENTARY SCHOOL
NORTHHAMPTON COUNTY, VIRGINIA



U. S. GEOLOGICAL SURVEY
TEST WELL NO. 2 MACHIPONGO NEGRO HIGH SCHOOL
NORTHHAMPTON COUNTY, VIRGINIA



U. S. GEOLOGICAL SURVEY
TEST WELL NO. 3 CENTRAL HIGH SCHOOL
ACCOMACK COUNTY, VIRGINIA



U. S. GEOLOGICAL SURVEY
GROUND WATER BRANCH
TEST HOLE NO. 4
ATLANTIC HIGH SCHOOL
ACCOMACK COUNTY, VIRGINIA

PLATE 5: Electric logs of the four U.S. Geological Survey test holes.

GME/WRD