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Soil Survey
of
The Freehold Area, New Jersey

By

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and
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Bureau of Chemistry and Soils

In cooperation with the
Department of Conservation and Development of New Jersey
and the New Jersey Agricultural Experiment Station

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SOIL SURVEY OF THE FREEHOLD AREA, NEW JERSEY[1]

By L. L. LEE, Department of Conservation and Development of New Jersey, in Charge, and J. E. TINE, United States Department of Agriculture

AREA SURVEYED

The Freehold area lies in the eastern part of New Jersey, the Atlantic Ocean forming its eastern boundary. (Fig. 1.) Its northern boundary, in part, is formed by the parallel 40° 28′ north latitude and in part by Raritan Bay; the western boundary by the meridian of 74° 20′ west longitude; and the southern boundary by the parallel of 40° 12′ north latitude. The area includes the northern part of Monmouth County and a small portion of the eastern part of Middlesex County. Freehold, the county seat of Monmouth County, in the southwestern part of the area, is 42 miles from New York City, 30 miles east of Trenton, and 70 miles northeast of Philadelphia. The area comprises 306 square miles, or 195,840 acres. The base map, on which the distribution of the soils is shown, was furnished by the Department of Conservation and Development of New Jersey.

FIGURE 1.—Sketch map showing location of the Freehold area, N. J.

The Freehold area lies wholly within the Atlantic coastal plain. Unlike, however, the greater part of the coastal plain stretching along the Atlantic coast, especially that part between Washington, D. C., and central Georgia, the relief in the Freehold area expresses the differences in resistance and structure of the underlying rocks. Between Washington and central Georgia the coastal-plain relief includes that of an older and younger plain modified in different degrees by dissection. New Jersey as a whole, and especially in the Freehold area, the cover of young deposits of recent geologic age, which seems to be responsible for the simplicity of the relief in the southern part of the coastal plain along the Atlantic, has been removed by erosion so that the underlying older rocks have been exposed and thus allowed to express themselves in the relief of the

[1] A soil survey of the Freehold area was made by Jennings and Dickey in 1913. By the time the survey of the State was approaching completion in 1923, it was realized that a resurvey on the basis of the accumulated experience up to that time would be desirable. The resurvey was made by Lee and Tine during that year and the report written by Lee completed in 1925. On account of a number of unavoidable circumstances this report was not published. After spending several days in a study of the area in 1931, the following more recent report, based on the detailed data accumulated by Lee and Tine and the results of his own studies in the region, was written by C. F. Marbut.

region. This is true for the whole of that part of the State of New Jersey which lies in the coastal plain but the expression is more clear in the Freehold area than in other parts of the State. These geologic formations are themselves essentially unconsolidated although much older than the cover of recent material which previously overlaid them but, notwithstanding that fact, the different beds differ in their resistance to erosion and thus express themselves physiographically.

Beginning with the lowest, these beds consist of a series in which clays are predominant, overlain by series in which greensand marls are predominant, themselves in turn overlain by sands and finally a small area, somewhat discordant with the rest, of gravels and sands occupying the northern part of the area. All these beds, except the last, dip gently southward or slightly southeastward and outcrop, therefore, in a series of approximately east-west belts. None of the beds are wholly uniform in character, and are unequal within themselves in their resistance to erosion. Consequently each belt includes a variety of features.

In general, five different physiographic belts cross the Freehold area from east to west. The area includes all the dominant physiographic belts in the coastal plain parts of New Jersey, and they are probably better expressed in the Freehold area than in the rest of the State. Beginning in the soutern part of the area the belts succeeding each other from south to north are as follows: (1) The Lakewood plain; (2) the Freehold-Colts Neck lowland; (3) the Mount Pleasant Hills belt; (4) the Keyport-Old Bridge lowland; and (5) the South Amboy upland.

Only a small part of the Lakewood plain extends into the Freehold area. In general, it lies slightly higher than the Freehold-Colts Neck lowland lying immediately north and expresses itself, therefore, as an upland. This characteristic, however, is definitely expressed only in the Hominy Hills lying immediately south of Colts Neck. Both eastward and southwestward from the Hominy Hills area the Lakewood plain is lower and only slightly higher than the Freehold-Colts Neck lowland. The Hominy Hills constitute an especially hilly area along the northern border of an otherwise smooth, slightly dissected plain covering the upland part of the southeastern part of the State.

The Freehold-Colts Neck lowland is definitely expressed as a lowland extending from Freehold northeastward to the coast. Southwest of Freehold, however, it is less definitely expressed but may be detected near the Monmouth-Ocean County boundary line near Tavern Springs, southwest of the Freehold area. In general, it is a narrow belt ranging from 1 to 5 miles in width and having an undulating relief, with an elevation of about 160 feet in the neighborhood of Freehold but descending practically to sea level at the head of the estuary called Shrewsbury River. The northern boundary of this belt is ill defined. Because of the increased dissection as the land rises toward the crest of the Mount Pleasant Hills, the so-called Freehold-Colts Neck lowland gradually rises as a dissected plain which constitutes in turn the southern slope of the Mount Pleasant Hills. The greater part of the Freehold-Colts Neck lowland is

underlain in the southern part by sandy beds and in the northern part by greensand marl beds, both of which are comparatively nonresistant to erosion.

The Mount Pleasant Hills belt extends from the Atlantic coast in the Highlands of Navesink westward and southwestward, leaving the Freehold area between Freehold and the village of Tennant. In the Highlands of Navesink it rises abruptly from sea level to a maximum elevation of about 275 feet. South of Matawan, in the region locally designated as the Mount Pleasant Hills, which constitutes an especially hilly part of the Mount Pleasant Hills belt, the maximum elevation is about 360 feet above sea level. Southwestward the elevation decreases and the relief becomes less hilly. Where the belt passes out of the Freehold area the elevation is only about 150 feet, but southwest of the area in the vicinity of Perrineville the belt expresses itself again in a series of hills rising to a little more than 250 feet above sea level. The northern slope of the hills is rather abrupt, but the southern slope is gentle. These hills are underlain by the greensand marl beds and are caused by the masses of segregated iron oxides which seem to be a feature of the outcrop of the beds. As the beds weather under the influence of podzolic weathering, some of the iron is dissolved and reprecipitated at slightly lower levels in the form of sesquioxide masses, and the resistance of the beds to erosion is increased by the presence of these masses.

The Keyport-Old Bridge lowland belt has developed partly on clays and partly on sand beds, both of which lie geologically below the greensand beds. Both the sands and the clays are comparatively nonresistant to erosion. This belt lies slightly above sea level along the coast of Raritan Bay to the west of the Highlands of Navesink, but rises to nearly 100 feet southwest of Matawan, and the elevation decreases to about 50 feet southwest of Cheesequake. Old Bridge lies a little more than a mile west of the western boundary of the area, nearly due west of Cheesequake. The lowland in that vicinity lies barely above sea level. It is apparent that this has been caused by the erosion of the clays by South River. Since erosion of the clays, the belt has been covered by sand deposits. Consequently, over a large part of the lowland belt the soils have been developed from sands rather than from clays.

The South Amboy upland occupies the extreme northwestern corner of the area and is a northeastern extension of an upland lying along the western part of the coastal plain area in New Jersey. It is an upland as compared with the Keyport-Old Bridge lowland, but since its elevation is less than 200 feet it is still a lowland as compared with the Mount Pleasant Hills belt. The South Amboy upland lies very little higher than the more elevated part of the Keyport-Old Bridge lowland in the vicinity of Morristown and Cheesequake.

These features give a variety of surface configurations to the country covered by the Freehold area soil map, which are wholly unlike the relief in the rest of that part of the coastal plain lying north of central Georgia. Geographically, therefore, this is a region unique in coastal-plain relief.

CLIMATE

The climate of the Freehold area is dominantly marine rather than continental. It is characterized by comparatively slight daily and monthly ranges of temperature, by a rather heavy precipitation, and by tempering ocean breezes throughout late spring, summer, and early fall. These cooling breezes are usually constant, even during the hottest days, and have been an important factor in making the coast beaches of the area popular as summer resorts.

The tempering influence of the sea is shown by the comparatively low ranges of temperature prevailing in that part of the area lying within 10 miles of the coast line. At New Brunswick, which lies beyond this 10-mile limit, maximum temperatures ranging up to 106° F. have been reached in four of the summer months and a minimum temperature of −15° has been reached in winter, whereas at Asbury Park, lying in the extreme southeastern part of the Freehold area, a temperature of 102° has been reached in only one month of the year and −10° is the lowest temperature recorded.

At Asbury Park the average date of the first killing frost is October 28 and that of the last is April 15. Frost has been recorded, however, as early as October 3 and as late as May 29. In the western part of the Freehold area, however, the average dates of killing frost are April 23 and October 17, but killing frost has occurred as early as September 22. In the spring of 1913, the only parts of the area which escaped the destructive frosts of May 11 and 12 were the areas lying within a few miles of the coast.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Asbury Park, Monmouth County, N. J.*

[Elevation, 22 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1896)	Total amount for the wettest year (1898)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	35.0	67	−9	3.85	1.52	3.13	5.3
January	32.2	69	−7	3.57	1.65	3.97	8.6
February	31.4	71	−10	3.50	7.28	4.43	7.7
Winter	32.9	71	−10	10.92	10.45	11.53	21.6
March	39.0	81	7	4.23	4.89	4.12	6.1
April	48.5	90	20	3.69	1.77	3.27	1.3
May	58.8	96	32	3.58	3.67	6.68	0
Spring	48.8	96	7	11.50	10.33	14.07	7.4
June	67.4	99	44	3.62	3.59	1.73	0
July	72.4	102	50	4.54	4.25	11.72	0
August	71.8	99	45	5.06	.91	6.41	0
Summer	70.5	102	44	13.22	8.75	19.86	0
September	66.8	99	38	2.99	2.98	1.49	0
October	55.8	91	27	3.71	1.67	5.75	0
November	44.8	77	14	2.92	2.18	8.52	.9
Fall	55.8	99	14	9.62	6.83	15.76	.9
Year	52.0	102	−10	45.26	36.36	61.22	29.9

During the summer the humidity is relatively high. Most of the precipitation in summer falls as local showers and thunderstorms, and at times the rainfall for brief periods is very heavy. A monthly rainfall of 3 or 4 inches may be expected with marked regularity throughout the year. Snow constitutes a small part of the total annual precipitation. Winter storms, beginning as snow, frequently end as rain. The average annual snowfall at Asbury Park is 29.9 inches, but inland it is slightly less.

Tables 1 and 2, compiled from the Weather Bureau records, show the normal, monthly, seasonal, and annual temperature and precipitation for Asbury Park and Imlaystown. Imlaystown is about 10 miles southwest of the southwestern corner of the area. The record from the Asbury Park station shows conditions in the zone influenced by the sea, and that at Imlaystown shows climatic characteristics of the inland part of the area.

TABLE 2.—*Normal monthly, seasonal, and annual temperature and precipitation at Imlaystown, Monmouth County, N. J.*

[Elevation, 115 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1895)	Total amount for the wettest year (1889)	Snow, average depth [1]
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	32.9	68	−14	3.67	2.17	1.08	5.1
January	31.1	73	−9	3.54	3.60	6.82	8.0
February	30.0	71	−12	3.54	.73	2.18	9.5
Winter	31.3	73	−14	10.75	6.50	10.08	22.6
March	39.1	85	0	4.08	4.66	4.20	4.4
April	50 5	93	19	3.44	3.91	5.25	1.4
May	61.9	96	28	3.62	3.25	4.67	0
Spring	50.5	96	0	11.14	11.82	14.12	5.8
June	70.3	103	39	3.77	2.52	2.41	0
July	74.7	104	45	4.76	3.81	8.78	0
August	72.8	100	43	3.77	.66	7.30	0
Summer	72.6	104	39	12.30	6.99	18.49	0
September	66.3	99	33	3.82	1.47	11.29	0
October	55.1	92	23	3.86	2.63	3.49	0
November	42.8	78	12	3.20	2.74	7.19	1.2
Fall	54.7	99	12	10.88	6.84	21.97	1.2
Year	52.3	104	−14	45.07	32.15	64.66	29.6

[1] Snowfall data is for Hightstown, a short distance north of Imlaystown.

AGRICULTURE

Agriculture in the Freehold area is important and has been so for a long time. It had already reached important development prior to the outbreak of the Revolutionary War and has maintained its importance since, although the type of agriculture has changed with time. Originally its importance was owing primarily to the character of the soil. The relief of the land was favorable but it was no

more favorable within the Freehold area than in the regions surrounding it, but the soils were more favorable than in some of the surrounding regions. The climate has been a factor also, but this has affected the Freehold area in essentially the same way that it has affected the surrounding areas. Although it was shown under the brief discussion of climate that the range in length of growing season is a little greater in the Freehold area than that in the country surrounding it, the difference is not significant enough to render the type of agriculture carried on in the Freehold area different from that now carried on or which has been carried on in the surrounding region. During the last several decades the agricultural importance of the area has been determined to a great extent, and probably to an increasing extent, by its nearness to New York City and surrounding cities.

As a whole, the country within the boundaries of the Freehold area is less important agriculturally than an area of equal size immediately west or southwest of it. The agricultural importance of the Freehold area applies to a comparatively small part of it. The whole of the area described as the Lakewood plain is of very little agricultural value. The greater part of the area of the Keyport-Old Bridge lowland is of little value, and all the South Amboy upland has no agricultural importance. The important agriculture of the region is confined to the Freehold-Colts Neck lowland, the Mount Pleasant Hills belt, and the southeastern fringe of the Keyport-Old Bridge lowland.

The reason for the greater agricultural importance of the country lying immediately west of the Freehold area is due to the fact that in this direction the South Amboy upland widens and changes in character to such an extent that its soils become loamy and of comparatively high productivity, whereas the Keyport-Old Bridge lowland disappears entirely and the belt represented by the Freehold-Colts Neck lowland and the Mount Pleasant Hills belt maintain their width and relative importance. The Freehold area is reduced in agricultural importance because of the fact that the cover of sands and clays overlying the clay beds which underlie the Keyport-Old Bridge lowland has been removed over a large part of the Freehold area, whereas in the country to the west it has not been removed, and the cover overlying these beds develops into a more productive soil than in the part of the Freehold area from which the cover has been removed.

In an area of equal size, immediately west of the Freehold area, there is practically a complete absence of the Lakewood plain. A small part of the southeastern corner of such an area would contain a small area of this plain.

The importance of agriculture and the length of time during which it has played a leading part in the Freehold-Colts Neck Lowland and the Mount Pleasant Hills belt, is clearly shown by the character of the farmhouses, the general farm equipment, and the carefulness with which the land is cultivated. In only a few other places in the United States is the evidence of permanent agriculture shown more clearly than in this part of the Freehold area. One such place is in the limestone valleys of Pennsylvania, which are occupied by the Pennsylvania Germans who have determined the character of the agriculture.

The influence of the city on the agriculture of the area is shown in part by the type of agriculture and the crops grown and in part by the character of occupation of the land lying along the coast.

With the exception of tidal marsh, practically all the land lying along the coast line of the area is now utilized for residential purposes. This land forms a belt ranging in width from somewhat more than 1 mile to 3 miles. In a belt varying in width and lying parallel to and adjoining the coast-line belt, the greater part of the land is now uncultivated even in that part of the area where the character of the soil is good, because it is held by speculators for sale as residential sites. It is now occupied partly by isolated residences, but most of it comprises vacant lots which receive very little care and which present an unfavorable appearance because of the weed growth. Some of this area is used as refuse dumps for the residential area lying nearer the coast. These two belts together probably average between 3 and 4 miles in width. The western part of the vacant-lot belt is utilized locally for the production of truck crops for sale to the summer colonists. This, however, is not an extremely important phase of the agriculture of the area since most of the truck crops are grown in the northern half of the area.

There are very slight advantages in truck-crop growing on land near the residential section of the area, since railroad freight rates per unit of product are low, and delivery is very convenient to dealers in fresh vegetables. Because of the great facilities for transportation both by motor truck and by railway, local vegetable growing, not only in the Freehold area but elsewhere in the eastern part of the United States, has very little advantage over that in more distant localities.

Farther inland is what may be designated the general-farming area of the region. Within this area also is included the vegetable and truck-crop region already mentioned in the northern half of the area. The general farming of the area consists mainly of the production of corn, wheat, rye, hay and forage, and potatoes. The truck crops include a number of vegetables, but beets, asparagus, sweet corn, and tomatoes occupy by far the largest acreage.

Formerly, timothy hay constituted an important forage crop, but during the last few years the greater part of the hay produced has been alfalfa, clover hay, and sorghum hay. Alfalfa, through the development of dairying, has become a relatively important forage crop. The region has not been an important livestock region, at least for many years, but the farmers keep a few hogs, a few cattle, and some keep sheep. During the last few years, dairying has become locally somewhat important.

The income from the dairy industry and from all types of the livestock industry is small as compared with that from crops, especially truck crops and potatoes.

Along with general and truck farming the fruit-growing industry, consisting mainly of the growing of apples and peaches, is rather important. Apples are more important than peaches. Peaches are grown on the more sandy land and apples on the loams and sandy loams. Probably a larger proportion of summer apples is grown in this region than in apple-growing regions throughout the United States as a whole.

When this region was first settled, a general, self-sustaining type of agriculture prevailed. Because of the unfavorable character of the soils, however, general agriculture has been largely abandoned in the northwestern part of the area and at the present time is confined almost entirely to the Freehold-Colts Neck lowland belt and the Mount Pleasant Hills belt which includes the southeastern sandy fringe of the northwestern lowland.

The Colts Neck, Collington, and other loamy and sandy loam soils within the area are adapted to general farm crops and were used for these crops until the latter part of the nineteenth century. The sandy soils were also used at a comparatively early period for the growth of general farm crops, but since the development of farming in other parts of the United States, where the general-farming soils produce better yields than the sandy soils in this area, the sandy soils have been largely abandoned, except where they are used for truck crops and potatoes.

The value of farms in this region still bears a definite relation to the character of the soil, notwithstanding the fact that the sandy soils are used extensively for the growth of crops of comparatively high acre value. The value of farmhouses in the different parts of the area expresses very well the relative importance of agriculture in this area.

In the townships of Atlantic, Marlboro, and Freehold, in Monmouth County, which are mainly in the Collington-Colts Neck belt, the total value of farmhouses ranges from $650,000 to $725,000. In Wall Township, Monmouth County, and Madison Township, Middlesex County, which lie in the region of sandy soils, the total value of farmhouses ranges from $400,000 to $420,000. These two townships together include about the same area as that in the three townships first mentioned.

The acreage of crops harvested also expresses a definite relation to the character of the soil. In Atlantic, Marlboro, and Freehold Townships the acreages ranged in 1929 from 6,000 to 9,000 acres.[2] In Wall and Madison Townships the range was from 1,800 to 3,000 acres.

In Table 3 various land statistics for a number of the important townships within the Freehold area are shown.

TABLE 3.—*Land area and utilization in a number of important townships within the Freehold area, New Jersey* [a]

Township	Land area	Farms	Land in farms	Crop land			Pasture			Woodland not used for pasture	All other land in farms
				Harvested	Crop failure	Idle or fallow	Plowable	Woodland	All other		
	Square miles	*Number*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Atlantic	32	150	13,072	6,114	149	1,062	1,730	134	783	2,110	990
Freehold	41	241	16,301	9,168	222	1,281	1,329	724	312	1,811	1,454
Marlboro	31	178	13,559	6,845	275	1,070	923	28	452	2,097	1,869
Madison	38	146	8,621	3,248	67	1,088	687	103	161	2,321	946
Shrewsbury	[b] 30	35	1,859	892	28	274	193	21	36	181	234
Wall	[b] 38	106	5,883	1,855	64	325	455	110	340	2,101	633

[a] Data from United States census reports for 1930.
[b] Approximately.

[2] Soil survey reports are dated as of the year in which the field work was completed. Later census figures are given whenever possible.

According to a grouping established in the United States census report for 1930, the largest number of farms is in the group of farms ranging in size from 20 to 100 acres.

Table 4 shows the production of corn, wheat, hay and forage, oats, rye, potatoes, and eggs in the census years of 1839, 1869, 1889, 1919, and 1929.

TABLE 4.—*Production of selected crops in Monmouth County, N. J., in stated years*

Crop	1839	1869	1889	1919	1929
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*
Corn	493, 554	760, 479	875, 847	858, 490	559, 247
Wheat	39, 368	176, 473	153, 471	63, 146	77, 753
Oats	144, 066	180, 461	96, 875	11, 283	1, 907
Rye	166, 013	46, 567	158, 443	198, 422	90, 324
Potatoes	273, 280	1, 263, 403	914, 280	4, 177, 438	1, 666, 628
				Tons	*Tons*
Hay and forage				44, 276	27, 187
				Dozens	*Dozens*
Eggs				1, 123, 120	3, 015, 066

As shown by Table 4, the total production of corn has fluctuated somewhat but has remained important throughout the whole period. Wheat production has ranged between about 40,000 bushels and 175,000 bushels. It is still, however, as shown by the statistics for 1929, relatively important. It is evident that wheat is not grown because it is profitable but largely because it fits well into a rotation where the soil is of such character, as are the soils in this region and in the region of podzolic soils in general, that they require a rotation in which clover or some other legume is one of the crops. Wheat is a crop in which legume seeding may be done comparatively cheaply and simply.

The oat crop has varied greatly, and in 1929 the production was very low. Rye has been more important than oats practically throughout the whole period. This reflects the rather large area of very sandy soils in the Freehold area.

Potatoes were comparatively important in 1839. They rose to high importance in 1869, declined slightly by 1889, but rose to very great importance in 1919. Since that time they have become less important but are still an important crop in the region.

Hay and forage are relatively unimportant, but studies within the area show that pasture, though not permanent, is of much importance. Eggs produced in 1919 amounted to more than a million dozens, and in 1929 there were nearly three times that number.

Livestock, other than poultry, has for a long time been of little importance in the area. Table 5 gives the number of livestock in Monmouth County in various census years since 1840.

TABLE 5.—*Number of livestock in Monmouth County, N. J., in census years*

Livestock	1840	1870	1890	1920	1930
	Number	*Number*	*Number*	*Number*	*Number*
Neat cattle	19, 592				
Milk cows		8, 033	10, 097	6, 330	5, 348
Other cattle		4, 189	2, 667		3, 537
Hogs	23, 241	10, 890	28, 149	9, 237	5, 832
Chickens				320, 717	317, 459

Truck crops are highly important in the Freehold area. More than 20 different kinds are produced to a more or less important degree, and a few kinds are produced in very large quantities. The most important in order of acreage in 1929 are sweet corn, with an acreage of 4,519 acres; tomatoes, with an acreage of 3,678 acres; asparagus, with an acreage of 1,063 acres; spinach, 606 acres; cabbage, 557 acres; snap beans, 403 acres; cucumbers, 296 acres; and peppers, 226 acres.

The acreage of asparagus was the same in both 1919 and 1929, but the acreages of sweet corn, of tomatoes, of cabbage, and of spinach have greatly increased since 1919.

The relatively large acreage of asparagus reflects the large area of sandy soils in the area and also the nearness to a large city market. The acreage of tomatoes reflects the nearness to a large city market but also indicates the presence of dark-colored soils with an abundant moisture supply, on which tomatoes do well. The sandy soils within the area also allow the production of very early sweet corn, as they are dry and warm in the spring so that the crop may be planted very early. The other truck crops of the area indicate that this is a region, lying within a few miles of an almost unlimited market, in which the soils are favorable to the production of a great variety of truck crops.

There are no highly specialized agricultural industries within the area. The products are sold as produced, or practically so, because of the nearness to a large city. Milk is sold as whole milk, and vegetables are sold fresh. The general-farm crops are grown almost exclusively as feed for work animals and dairy animals. There is no livestock-fattening industry in the area, nor is there any important livestock-raising industry. In other words, this is a region in which crops are grown and agricultural products are sold as produced without transformation through manipulation.

Intensive farming methods prevail generally within the Freehold area. In the region of general farming, which includes the largest acreage of farm land within the area, intensive methods are applied to the potato crop especially. Sweet corn production also is of considerable importance, and this crop must be regarded as one requiring intensive methods. Fruit growing also is important in the area of Collington and Colts Neck soils, on which intensive methods are practiced.

The average yield of potatoes in the county in 1919 was 169 bushels to the acre; of corn 38 bushels, and of wheat 18 bushels. There is no other area along the Atlantic seaboard from New York City southward, where the soils are naturally as productive as are the Colts Neck, Sassafras, and Collington soils in the Freehold area except in areas south of the Freehold area where the same soils cover comparatively important areas. Such areas, however, do not extend south of Prince Georges County, Md.

The farmers of the area have always used good implements and as much horsepower as was necessary to prepare and cultivate the land effectively. They have also used farmyard manure and commercial fertilizers in sufficient quantity to produce good yields on soils that are not naturally completely adapted to the growth of the corn crop. The soils of the region, like all podzolic soils throughout the world, are not naturally adapted to grain crops, but

they are better adapted to potatoes and vegetable crops. The production of good yields of grain on the podzolic soils, not only in this area but throughout the world, requires careful cultural methods and efficient fertilization.

Corn is planted on well-prepared land, is carefully cultivated with weeders and cultivators, and is liberally fertilized. In about 50 per cent of the area cultivated to corn, some other crop is followed, as a cover crop of rye, crimson clover, or cowpeas.

Potato planting, done with machines, begins about the first of April, depending on the season, and it is usually completed by April 15. Most of the seed stock is obtained from northern localities including Maine, Canada, and New York. For the second crop, which is sometimes grown, a large part of the seed comes from Virginia or the southern part of New Jersey. Certified seed potatoes are in demand and are being planted more extensively each year. Previous to 1922, the American Giant was the leading variety of potato grown, partly because it was scab resistant and partly because of the high yield. The tubers were large and attractive in appearance but not of high quality. The crop was dug in midsummer and sold very largely in the coal-mining regions of Pennsylvania. Since 1922 the American Giant has been largely replaced by the Irish Cobbler and Green Mountain varieties, as the farmers report that the American Giant has not produced good yields in recent years.

The local market potatoes are harvested before the first of August. Harvesting for New York and distant markets begins about the first of August and continues until about the first of October, the rapidity with which the crop is dug depending largely on market conditions and prices. A progressively longer marketing season is being developed among the most successful growers. Practically all the crop is harvested with potato diggers of the elevator types, more than half of which are equipped with gasoline engines.

Asparagus is one of the early crops in the Freehold area. One-year-old roots are purchased from nurserymen or local growers and planted at intervals ranging from 12 to 16 inches, in rows 6 feet apart. The roots are set at a depth ranging from 6 to 10 inches from the surface. Previous to setting the roots, the soil is well supplied with barnyard manure or enriched by plowing under green-manure crops. Superphosphate (acid phosphate) or bone meal is applied down the row at the time of setting, and during the cutting season the general practice is to broadcast from 1,000 to 1,500 pounds of high-grade fertilizer such as a mixture of 4–8–5.[3] Later in the cutting season an application of nitrate of soda is made. Another method of fertilization, rather extensively practiced, is a heavy application of 300 pounds of nitrate of soda in the spring, followed at plowing-off time, about July 1, by a complete fertilizer. This practice produces a heavier midsummer growth which is beneficial to the following year's crop.

Most of the varieties of asparagus grown are of Palmetto and Giant Argenteuil foundation stock but more rust-resistant varieties, such as Mary Washington and Martha Washington, are being developed. No crop is harvested from a planting of asparagus dur-

[3] Percentages, respectively, of nitrogen, phosphoric acid, and potash.

ing the first season, and only a small quantity is cut during the second. The third year's cutting continues over two-thirds of the regular season but beginning with the fourth year, full cutting is made. The cutting season continues from early spring until about July 1. The stalks are cut several inches below the surface of the ground with especially designed knives. Yields range from 1,000 to 1,800 bunches to the acre, and well-managed beds will continue to produce good crops for 15 years. Special methods are practiced in the cultivation of the crop. As soon as the plants begin to grow in the spring, the rows are ridged to a height ranging from 8 to 15 inches and the soil is thrown up from between the rows by special-type ridgers. This procedure bleaches the asparagus plant and produces a white stalk, but the rows are kept level if green stalks are desired. At the end of the cutting season the ridges are torn down and the crop is cultivated for the fall. Midsummer cover cropping is not practiced because it is believed such cover plants consume moisture which could be better left in the asparagus plant.

Early tomatoes are among the leading vegetable crops of the Freehold area. Plants are seeded in the greenhouses and many are potted and moved to coldframes. The plants are set out early in May in rows about 4 feet apart, approximately 2,500 plants covering an acre. The early varieties are grown on the sandy soils but the midsummer varieties may be grown on other soils. Earliana is the most popular early tomato, and the midseason crop consists of Bonny Best, Baltimore, and Stone varieties. Before planting, manure is broadcast on the land, usually after a cover crop has been plowed under. During the spring and summer the plants are carefully and cleanly cultivated and fertilized with an application ranging from 800 to 1,200 pounds of high-grade fertilizer. The earlier crop begins to mature about the first of July.

Peppers have been an important crop in the northern and eastern parts of the Freehold area for many years. They are seeded in the greenhouses and later moved to coldframes. The young plants are set in the field at intervals ranging from 15 to 20 inches, in rows 3 feet apart. The plants are fertilized with 700 to 1,500 pounds of high-grade commercial fertilizer to the acre, and the crop receives extensive cultivation during the growing season. The peppers are picked in both the green and red stages, and yields range from 150 to 400 barrels to the acre. Peppers are frequently damaged by frost, and much care must therefore be exercised to protect the late fall crop from injury both in the field and in storage houses. If properly stored and protected, marketing may continue even after the plants in the field have been killed. The principal varieties grown are Bull Nose, Pimento, and Finger.

The acreage of sweet corn has increased very rapidly within the last few years, and the crop is now grown in practically every part of the area. The increase is due, in part at least, to the decreased potato acreage. Planting begins in April, and successive plantings are made until the middle of July. From 400 to 600 pounds of high-grade fertilizer are applied to the acre, usually around the hills after planting and before the young shoots appear. Where the checkrow system is used, the seed is planted 3 feet apart, but where the corn is drilled, the rows stand 4 feet apart and the seed is planted at inter-

vals of 12 or 15 inches. The crop is cultivated frequently throughout the season. Yields range from 4,000 to 7,000 ears to the acre. The Newark and New York markets absorb most of the crop. A wide range of varieties are grown, including Golden Bantam, Howling Mob, Early Metropolitan, Long Island Beauty, Stowell's Evergreen, and Country Gentlemen.

Cucumbers have, in the past, constituted an important crop, but according to the census of 1929 the acreage has decreased to a great extent. The crop ripens in midsummer and gives fairly good results on a great variety of soils. Seed is planted sufficiently early in the spring to mature a crop between the first of July and the first of August. The later plantings seem to give the larger yields. The crop is fertilized with barnyard manure, high-grade fertilizer, or both. The fertilizer is put directly into the hill. Some growers apply a top-dressing of complete fertilizer after the plants have formed the third leaf. Yields of cucumbers range from 25 to 100 barrels to the acre.

The production of fruit, mainly apples with some peaches, is of considerable importance in the Freehold area, one of the regions of the United States in which summer apples are produced in comparatively large quantities. A good market for summer apples has been developed in Germany, and it is on this market that the apple growers of the region depend to a great extent. The principal varieties grown are Oldenburg (Duchess of Oldenburg), Wealthy, McIntosh, Delicious, Grimes Golden, English Codling, Stayman Winesap, and Rome Beauty.

SOIL SERIES AND TYPES

The well-drained soils throughout the Freehold area are light colored, ranging in the plowed fields from white to rich reddish brown. The poorly drained soils are darker but rarely black, the dark color being due to organic matter, decomposition of which has been prevented because of excessive moisture. The soils throughout the area as a whole, with the exception of the salt marshes, even the poorly drained soils, have developed under timber cover and have typical characteristics of such soils, consisting of a light-colored and comparatively light-textured surface soil and a somewhat heavier-textured and darker-colored subsoil, overlying parent materials which may range widely in texture. Within the Freehold area this material consists of unconsolidated sands, glauconitic sands, sandy clays, and clays.

In forested areas, the very sandy soils are gray or practically white beneath a thin cover of organic matter, but in cultivated fields they are white at the surface. The heavier soils are darker colored than the sands, ranging to rich reddish brown.

In general characteristics the soils of the Freehold area may be placed in four broad groups as follows: (1) Gray sands; (2) brown or reddish-brown sands, sandy loams, and loams, mainly sandy loams; (3) loams and sandy loams underlain at slight depths by clays; and (4) poorly drained, usually dark-colored soils.

The soils of each of these groups occupy their own distinctive area, or belt. Those of group 2, consisting of the reddish-brown sands, sandy loams, and loams, occupy the Freehold-Colts Neck lowland belt and the Mount Pleasant Hills belt. The gray sands oc-

cupy the area of the Lakewood upland and a large part of both the Keyport-Old Bridge lowland and the South Amboy upland in the northwestern part of the county. The poorly drained soils, with the exception of the comparatively small areas of salt marsh along the coast in the northern part, lie mainly in the northwestern part of the area in the southern part of the Keyport-Old Bridge lowland, and the sandy loams and loams, underlain by clays, occupy the northeastern part of the Keyport-Old Bridge lowland where the clay which underlies the whole area at various depths has not been covered by a thick layer of sand. The largest continuous area occupied by these soils lies just west of the city of Matawan. The general-farming land of the area, in fact that part of the area which has constituted the important farming region from the earliest times, is at present confined to the brown or reddish-brown sands, sandy loams, and loams, which constitute the naturally productive soils of the region. Compared with other soils of the eastern United States, these must be termed productive soils. When compared with the soils of the continent as a whole, they can not be considered naturally highly productive, but they are of such character that when well fertilized and cultivated they produce good crops. Those characteristics which favor their high productivity for the region are physical. They are friable soils, sandy enough to be easily cultivated and have no unfavorable subsoil characteristics. The subsoils are easily penetrated in all directions by roots and have good water-holding capacity. In general, the relief of the land on which these soils lie is favorable to careful cultivation and is not rough enough to cause destructive erosion where the land is properly cared for. Before clearing, the land was covered by a comparatively dense forest of oak, maple, and linden, together with some beech and poplar. The most important forest tree, however, was oak. The other soils of the area are poor actually and relatively. As will be shown in the following pages, the productive soils of the region are almost exclusively members of the Collington and Colts Neck series.

The Colts Neck soils and the Collington soils are derived from the same parent materials. They occupy the same general belt of country not only in the Freehold area but in other parts of New Jersey. They are closely associated both geographically and agriculturally. The differences between soils of the two series are not differences in fundamental characteristics of the soil but differences in the stage of weathering and the effects of the resultant weathering, not from any significant difference in chemical composition of the parent material but mainly from a difference in the relief of the land on which development has taken place.

The Colts Neck soils are red or reddish-brown soils and the Collington soils are brown. The Colts Neck soils are somewhat red both in the surface soil and subsoil, but the subsoil is somewhat deeper red than the surface soil. These soils occur mainly in the somewhat more hilly part of the greensand belt than that occupied by the Collington soils, and for this reason are somewhat less important agriculturally than the Collington soils, but the difference in many places is very slight. Because of their occurrence on somewhat more rolling relief than that on which the Collington soils occur, a somewhat larger proportion of the total rainfall is included

in run-off and a smaller proportion in the water that percolates into the soil. The Colts Neck soils, therefore, other things being equal, are somewhat more subject to drought than the corresponding type of soil in the Collington series. The soils of the Colts Neck series have been differentiated, according to texture of the surface soil, into a number of soil types corresponding to the types in the Collington series, the number being about the same in each series.

The Keyport soils, as they have been mapped in the eastern part of the United States, are predominantly imperfectly developed soils, the imperfect development being due to the short time during which the soils have been subjected to the processes of weathering. These soils occur in areas where the material has been above the water of Chesapeake Bay and its various branches only a comparatively short time, an insufficient time to allow the normal soil profile of the region to become well developed. In other words, the soils occur in low-lying areas and have been more or less subjected to the influences of ground water in the lower part of the soil profile during the period of their development. They have a normally developed profile in the surface soil and to a depth of a few inches in the upper part of the subsoil. They have, therefore, comparatively light-colored and light-textured surface soils and a thin subsoil that is heavier in texture and stronger in color than the surface soil.

The Keyport soils in a large part of the Freehold area are not identical with the Keyport soils in the typical Chesapeake Bay region. In the Freehold area they are thoroughly well-drained upland soils, lying 100 or more feet above tidewater, and they have been subjected to weathering for a period of time equal to that of most if not all of the upland soils in the region in which they occur. They are imperfectly developed soils, but the imperfect development is not due to the short time during which the soils have been exposed to weathering but to the heavy texture of the parent material, which has retarded the processes of weathering. Under such conditions the surface soils of the Keyport series in the Freehold area are more thoroughly leached than the normal Keyport soils in the Chesapeake Bay region. The Keyport soils here are also more highly developed than the normal Keyport soils.

It is apparent, however, that not all areas of Keyport soils in the Freehold area differ in characteristics or soil history from the normal Keyport soils of the Chesapeake Bay region. Most of the areas in the vicinity of Keyport are identical with those in the region as a whole. Some small areas, lying in the vicinity of Cheesequake Creek and between Cheesequake Creek and Keyport, seem to be typical Keyport soils. The soils of the largest area, however, one lying east of the village of Cheesequake and between that place and Matawan Creek, may be designated as abnormal Keyport soils.

The Sassafras soils occur on the Atlantic coastal plain from the mouth of Chesapeake Bay to Long Island. They are developed from coastal-plain materials consisting of sand and clay, free from lime carbonates or greensand. They have developed under good drainage and constitute the normally developed soils for the region in which they occur. They have normally gray or yellow surface soils of varying texture but everywhere lighter or containing more sand than the material below, underlain by yellowish-brown or faintly

reddish-brown sandy clay subsoils. These soils have no well-defined structure either in the surface soil or subsoil, but partly because of their more or less sandy character they are in all places friable throughout both layers. The subsoil is underlain by material which is lighter in texture than the subsoil and may or may not be lighter in texture than the surface soil. The Sassafras soils are thoroughly well drained and well oxidized but contain a comparatively low percentage of iron oxide.

The Sassafras soils occupy the northwest corner of the Freehold area, extending also eastward along the coast of Raritan Bay to the vicinity of Atlantic Highlands. An extreme type which is still retained in the series but whose characteristics are not ideal, Sassafras sand, extends eastward to the Highlands of Navesink. These soils occur in a few small spots in the southern part of the area, mainly in the vicinity of Freehold.

The Lakewood soils are very sandy, consisting of sand, predominately fine sand, with smaller areas of gravelly sandy loam. They cover a large area of southeastern New Jersey, but only the extreme northern part of this area extends across the southern boundary and into the Freehold area. In fundamental characteristics these soils are very similar to the sandy members of the Sassafras series. Practically the only difference between members of the two groups of sandy soils is that the gray surface layer of the Lakewood soils is thicker than the corresponding layer in the Sassafras soils. The Lakewood soils, therefore, as a whole are somewhat more droughty, somewhat more acid, and less productive than the Sassafras soils. They support a growth of scrub timber consisting mainly of pine and small oak trees, the pine timber growing predominantly in areas where it constitutes practically the only tree growth. In some comparatively small areas the stand is purely oak, and in many areas the tree growth is dominantly oak. Such areas represent land in which the soil material is finer in grain than elsewhere or in which the subsoil lies near the surface.

The Shrewsbury soils occur in a number of bodies, some of which are large, lying in a belt immediately northwest of the northwestern boundary of the Collington and Colts Neck soils, and in rather large areas on both sides of Shrewsbury River. The sandy members of the series, including the sandy loam and fine sandy loam, differ rather strikingly from the other two members. They are very much like the Sassafras soils, especially the heavier types of Sassafras, with which they are associated and, with the exception of a rather important difference in the characteristics of the subsoil drainage, they do not differ fundamentally from those soils.

The Keansburg soils are dark-colored poorly drained soils occurring in low situations. They are rather widely scattered over parts of the Freehold area and are associated with the Sassafras and Lakewood soils.

The Freneau soils are characterized by reddish-brown surface soils and red or mottled reddish-brown, yellow, and gray subsoils. They occupy first bottoms of streams and are subject to frequent overflows.

In addition to the soil series mentioned, five classes of miscellaneous material, tidal marsh, coastal beach, meadow, muck, and made land are mapped in the Freehold area.

In the following pages of this report, the soils of each series are described in detail and their agricultural adaptabilities discussed; their distribution in the area is shown on the accompanying soil map; and their acreage and proportionate extent are given in Table 6.

TABLE 6.—*Acreage and proportionate extent of the soils mapped in the Freehold area, New Jersey*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Collington loam	12,608	10.6	Sassafras fine sandy loam	8,512	4.3
Low greensand-content phase	8,192		Sassafras sand	12,608	6.4
Collington clay loam	704	.4	Sassafras loamy sand	10,240	5.2
Collington sandy loam	8,896	11.5	Sassafras fine sand	5,056	3.0
Deep phase	8,768		Rolling phase	768	
Low greensand-content phase	4,992		Sassafras coarse sand	1,856	.9
Collington fine sandy loam	2,880	3.7	Lakewood sand	7,232	3.7
Low greensand-content phase	4,288		Lakewood fine sand	4,544	2.3
Collington sand, low greensand-content phase	576	.3	Lakewood gravelly sandy loam	2,944	1.5
Collington loamy sand	1,728	4.1	Shrewsbury fine sandy loam	1,920	1.0
Low greensand-content phase	6,272		Shrewsbury sandy loam	1,088	.6
Colts Neck loam	2,944	1.5	Shrewsbury loam	768	.4
Colts Neck sandy loam	4,864	3.3	Shrewsbury silt loam	1,152	.6
Eroded phase	1,472		Keansburg sandy loam	3,392	1.7
Colts Neck fine sandy loam	192	.1	Keansburg fine sandy loam	5,888	3.0
Colts Neck loamy sand	5,504	2.8	Keansburg loam	640	.3
Colts Neck gravelly sand	1,024	.5	Keansburg sand	2,880	1.5
Keyport loam	1,984	1.0	Freneau loam	3,328	1.7
Keyport clay loam	1,280	.7	Meadow	14,080	7.2
Keyport sandy loam	2,752	1.4	Muck	3,392	2.0
Keyport fine sandy loam	1,088	.6	Shallow phase	576	
Sassafras loam	3,776	1.9	Tidal marsh	7,296	3.7
Sassafras sandy loam	4,288	2.7	Coastal beach	2,560	1.3
Deep phase	1,024		Made land	704	.4
Sassafras gravelly sandy loam	320	.2	Total	195,840	

COLLINGTON LOAM

The surface soil of Collington loam is brown and moderately heavy textured for a loam. It is faintly red in color, in most places having a green shade, and below a depth ranging from 10 to 14 inches it changes to greenish-brown moderately friable clay loam, clay, or sandy clay. In many places, as a depth of 3 feet is approached, the material becomes coarser in texture than that in the upper part of the surface soil and subsoil, but in some places this layer may consist of plastic sticky clay. In some places the deep clay or sandy material is more sandy than the surface soil. The percentage of green material, which consists of glauconite, increases with depth, and the parent material is definitely green, in many places strongly green, the intensity of color depending on the proportion of glauconite present.

In many places quartz gravel, ranging from one-half inch to 2 inches in diameter is distributed over the surface, but very little gravel is present in the subsoil, and in many areas the soil is gravel free. The gravel is not a constituent of the parent material from which the soil has developed but is a remnant of the cover of sand and gravel which originally overlaid the whole region and to which reference has already been made in the discussion of the physiography of the region.

In some spots mapped as Collington loam, the soil has not been developed directly from the underlying greensand material but has

developed from material washed into basins or small lowland areas from the surrounding higher beds of greensand material. It is well within the range of possibility that some areas mapped Collington contain very small percentages of glauconite, but are derived from remnants of the original cover just referred to.

The largest bodies of Collington loam lie in Holmdel Township in the vicinity of the village of Holmdel. A number of smaller bodies occur in other parts of the area, a comparatively important one lying immediately east of Freehold. It is apparent that the two bodies lying north of the village of Holmdel and in the basins in which the northern branches of Willow Brook head have developed largely from local wash and from some of the original cover deposited over the greensand beds. The area just southeast of Holmdel seems to have developed more directly from the greensand marl. All these areas, however, contain greensand material, all occupy smooth basins, and all are in farms and under a high state of cultivation.

On account of the rather heavy texture of the surface soil and the slow absorption of rain water, this soil is somewhat subject to erosion, but because of the high state of cultivation and the care with which the farms are maintained very little serious erosion has taken place. Protection from erosion requires more care, however, on this soil than on the more sandy soils of the area.

This is one of the best soils in the area and is used mainly in the production of general-farm crops and potatoes. Although it is a podzolic soil, and therefore comparatively poor when compared to the naturally rich grassland soils of the West, its physical character is such that when organic matter and plant foods in the form of fertilizers have been applied, it produces good crops. Through the application of good quantities of barnyard manures and fertilizers, a yield of corn amounting to as much as 100 bushels an acre may be obtained. Moderately high wheat yields may also be obtained under the same conditions. Yields ranging from 60 to 90 sacks of potatoes, especially of the Irish Cobbler variety, are commonly obtained. In favorable seasons from 1½ to 2½ tons of hay to the acre may be obtained. Alfalfa does well where the soil has been limed and an abundance of plant food has been supplied by barnyard manure and fertilizers.

The common practice in the handling of this soil, where potatoes constitute an important crop in the rotation, is to apply lime to the land with the grain or when the grass crop is seeded in the fall. By applying lime in this way, its effect in causing potato scab is reduced to a minimum, and at the same time the land produces higher yields of the general-farm crops and may also be used for the production of alfalfa. Where the acreage of potatoes on any given farm is not excessively high, wheat or some other small-grain crop usually follows potatoes. Clover or grass is sown with the small grain and, following the grass crop which, unless it is alfalfa, stands not more than two years, corn is planted, and through cultivation of this crop the land is cleaned of weeds. Potatoes follow the corn crop, receiving liberal applications of fertilizers.

On some farms, however, potatoes are grown continuously for two or three years or longer. When this is done, the land is planted to crimson clover, rye, wheat, or vetch as soon as the potato crop has

been removed, and in the following spring the cover crop is plowed under before the potatoes are planted. In this way the supply of organic matter is maintained in the soil and the potato yields are good.

Most of the land is used for the production of general-farm crops, including potatoes, and little attention is given to raising livestock. During recent years, however, the price of potatoes has declined and more attention is being given to dairying. As dairying develops, the growth of alfalfa becomes more important. Little attention is paid, however, to livestock other than dairy animals.

Land values, until the recent serious agricultural depression, on farms on which Collington loam is an important soil, have been considered high, but on account of the high yields of crops and the ability of the soil to produce a wide variety the price can not be considered unreasonable. Up to a few years ago more than $150 an acre was not considered an excessive price. The farm buildings are of good size, and these as well as the farm fences are kept well repaired.

Collington loam, low greensand-content phase.—A large area of the low greensand-content phase of Collington loam has been mapped in the Freehold area. In the previously published soil survey report of the Freehold area, a large area of soils in the vicinity of Freehold was mapped as Sassafras. A more complete knowledge of the character of the Sassafras soils has shown that these soils do not belong in the Sassafras series but that their characteristics are identical with those of the Collington soils in all respects except that the content of greensand in the soil to a depth of 3 feet is very small. Therefore, such areas are now identified as the low greensand-content phase of Collington loam. The largest area is the one just referred to, lying in the vicinity of Freehold. A number of small areas are scattered throughout the Collington and Colts Neck belt running northeastward from Freehold, and a number of important areas extend along the middle of the neck of land lying between Navesink River and Shrewsbury River to which the name of Rumson Hill is sometimes applied. Another large area is in the vicinity of Long Branch, but on account of the utilization of this land for residential purposes it has no present agricultural importance.

An analysis of Collington loam from a point west of the village of Chatsworth, southwest of the Freehold area where the soil is typical and in all noticeable respects identical with the soil in this area, showed the presence of 2 per cent of potash in the surface soil and about 2½ per cent in the subsoil. It showed also a percentage of 0.32 per cent of phosphoric acid in the surface soil and 1.71 per cent in the subsoil. The latter percentage must be regarded as extremely high whereas the former, that of the surface soil, may be considered as good. The percentage of organic matter in the surface soil, according to this analysis, is about 5 per cent. This also may be considered high for a soil that developed under timber cover, but is undoubtedly due in part to the good state of cultivation in which this soil has been maintained.

None of the soils of this region contain carbonate of lime but the percentage of calcium oxide in the Chatsworth sample is about 0.5 per cent in the surface soil and subsoil. This must be considered low

for a productive soil and signifies that, for the production of crops requiring a sweet soil, liming is necessary.

A description of the soil and subsoil of this phase of Collington loam is unnecessary, since it would consist of a repetition of the description of Collington loam with the exception of the absence of the green color caused by the presence of visible grains of greensand. There can be no question that this soil has developed from the same material as that from which typical Collington loam has developed, but weathering has progressed a little farther and the greensands have been more thoroughly decomposed. It is possible also that because of more or less shifting and redeposition of this material, to which reference has been made, weathering has been favored. No detailed chemical analysis of this soil has been made so that it is not possible to compare it with the typical loam on such a basis, but the physical characteristics of the phase are equally favorable with those of the typical soil, and since these constitute the most important factors in the productivity of the soils it is apparent that the phase may be considered essentially as productive as the typical soil.

COLLINGTON CLAY LOAM

Collington clay loam is an extremely unimportant soil in the Freehold area so far as extent is concerned. It occupies a few small patches in the vicinity of Freehold. It is used for the production of general-farm crops in exactly the same way as Collington loam. It is associated geographically with the loam and sometimes occurs on the same farms. On account of its heavier texture it is less easily managed and its moisture supply is less favorable than the loam. The color of the surface soil ranges from brown or greenish brown to dark green, and that of the subsoil from yellowish green to green or bright green. The clay loam surface soil is about 5 or 6 inches thick and is underlain by clay which when wet is plastic and sticky and when dry is only moderately friable. The subsoil material, as described, continues in most places to a depth of 36 inches without essential change other than an increasing intensity of the green color. In the virgin condition a thin surface layer was lighter in texture than the clay loam, but as the depth of plowing was greater than the thickness of this layer the heavier underlying clay has been plowed up into the surface soil, giving the whole surface soil a clay loam texture. On account of its heavy texture, the soil becomes hard and compact when dry and is difficult to maintain in good tilth. These unfavorable conditions are increased if the land is plowed when wet.

COLLINGTON SANDY LOAM

The surface soil of Collington sandy loam to a depth of about 8 inches is brown or light-brown sandy loam which is underlain by greenish-brown or brown heavy sandy loam, and this in turn grades into greenish-brown friable sandy clay loam which extends to a depth of about 30 inches. Below this the texture of the material is light sandy loam which is somewhat more friable because of its lighter texture than the overlying material. The color is about the same as that of the subsoil. Like in the loam, a small quantity of rounded quartz gravel may be present in the surface soil but usually not in the subsoil. Because of the more sandy texture of the surface

soil this soil absorbs moisture more readily than Collington loam or Collington clay loam.

The sandy clay subsoil is capable of holding a good supply of moisture. Consequently moisture conditions as well as ease of working the soil are somewhat more favorable in the sandy loam member than in the clay or clay loam.

Collington sandy loam is an important soil in the Freehold area. However, it does not occur in any single large body but in a great many comparatively small ones throughout the belt of Collington soils which occupy the Freehold-Colts Neck lowland belt and the Mount Pleasant Hills belt. The sandy loam is closely associated with the loam and other members of the Collington series as well as with soils of the Colts Neck series. It usually occupies more level areas than the Colts Neck soils, the relief being about the same as that of other members of the Collington series.

Practically all the areas of this soil are cleared and are utilized both for general and intensive farming. The soil is more easily worked than the heavier members of the series, and earlier planting of crops is possible. This is a better soil for potatoes than Collington clay loam, and a large acreage is devoted to this crop, especially in the vicinity of Marlboro.

As a rule, corn does as well on the sandy loam as on the loam. Wheat and grass are also grown but the yields are somewhat less than on the heavier soils. Aside from potatoes, the truck crops best adapted to this soil are peas and Lima beans. Locally considerable attention is given to the production of tree fruits, including both peaches and apples. The acreage of peaches on the sandy soils of the region is somewhat greater than on this soil or the heavy members of the Collington series, and apples predominate on the Collington soils.

As on other Collington soils, heavy applications of fertilizer are made for potatoes which are sometimes grown for several years in succession. With each succeeding crop it is common practice to seed the land to a cover crop and plow this under the following spring. The cover crops are dominantly crimson clover, vetch, rye, and wheat, mainly rye. On farms where potatoes form part of the rotation, the rotation consists of wheat, grass, corn, and potatoes. The prices of land on farms consisting largely of Collington sandy loam are essentially the same as on farms where Collington loam is an important soil.

The chemical composition of a sample of Collington sandy loam, collected 2 miles east of Auburn in Salem County, N. J., is shown in Table 7.

TABLE 7.—*Chemical analyses of samples of Collington sandy loam collected 2 miles east of Auburn, Salem County, N. J.*

Sample No.	Depth	SiO_2	TiO_2	Fe_2O_3	Al_2O_3	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	N	H_2O at 110° C.
	In.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
29454	1–12	93.80	0.65	2.12	1.54	0.009	0.18	0.13	0.38	0.11	0.01	0.05	1.25	100.23	0.02	0.31
29455	16–33	89.50	.23	5.21	2.63	.010	.26	.21	.61	.12	.02	.05	1.41	100.26	.02	.51
29456	33–48	79.09	.59	9.50	6.02	.011	.23	.31	1.29	.17	.04	.05	3.02	100.32	.03	1.23

Collington sandy loam, deep phase.—The difference between Collington sandy loam, deep phase, and the typical soil lies in the occurrence in the phase of a layer of sandy material extending from the surface to a depth ranging to about 12 inches. This layer is about 50 per cent thicker and usually lighter textured than the sandy surface layer of the typical sandy loam, and for this reason, areas of this kind were differentiated as a deep phase. The surface soil also is somewhat paler in color than the surface soil of the typical soil and in most places contains a slightly higher percentage of sand. The percentage of greensand in the subsoil and parent material, as well as the percentage of clay in the subsoil, varies from place to place. This, however, is equally true of the typical soil. In no place, however, is the heaviness of the sandy clay subsoil sufficient to warrant differentiation of the soil into a different series, and in no place does the subsoil become a claypan. Drainage is good throughout.

When fertilized this deep soil produces good crops, but it is less well adapted to wheat and grass than the loam member of the series.

Collington sandy loam, low greensand content phase.—This phase of Collington sandy loam, like the typical soil, is widely distributed over the belt occupied by the Collington soils. There are no large areas, although some important areas lie west of Freehold.

This soil is identical in general physical characteristics with the typical soil, differing only in the absence, practical absence, or low percentage of visible glauconite. The soil seems practically as productive as the typical soil. Very careful chemical analysis would possibly show that this soil, where it has not been changed by the application of lime or fertilizers, is a little more acid and possibly contains a slightly lower percentage of potash. Since, however, its productivity to a great extent is owing to its highly favorable physical characteristics, it must be considered a good soil.

COLLINGTON FINE SANDY LOAM

The 8-inch surface soil of Collington fine sandy loam consists of brown fine sandy loam. It is underlain by an upper subsoil layer of yellowish-brown fine sandy loam which is similar to the lower subsoil layer in texture but in most places a little heavier, and it ranges from a few inches to 18 inches in thickness. In both the surface soil and the upper subsoil layer a faint green color is evident, showing the presence of grains of greensand. The upper subsoil layer is underlain at a depth ranging from 18 to 24 inches by fine sandy loam containing a much larger quantity of greensand than is present in the surface soil. As in the other soils of the Collington series, a small amount of rounded quartz gravel may be present.

This soil, in both physical and chemical characteristics, is essentially like Collington sandy loam with the exception of a higher content of fine sand and a lower content of medium or coarse sand. In texture it is intermediate between the sandy loam and the loam. It has somewhat better water-holding capacity than the sandy loam and is more easily cultivated than the loam. Where fertilized and well cultivated it is a highly productive soil as are all the Collington soils.

The largest bodies of Collington fine sandy loam lie between Tinton Falls and Eatontown in the eastern part of the area. A few bodies occur in other parts of the Collington belt, two lying northwest of Freehold and others in the vicinity of Marlboro.

In the vicinity of Eatontown this soil is used with good results for growing nursery stock. Where it is used for growing general farm crops, good yields are obtained, but Collington loam is somewhat more productive for such crops as wheat and alfalfa. Cultural methods do not differ radically from those used on the sandy loam. A large variety of crops is grown. Potatoes yield slightly less than on the loam, producing about 65 sacks to the acre where fertilized with 1,500 to 2,000 pounds of fertilizer. All sorts of tree fruits thrive on this soil.

The chemical composition of material from a profile of Collington fine sandy loam, taken from a spot 2 miles southeast of Auburn in Salem County, is shown in Table 8.

TABLE 8.—*Chemical analyses of samples of Collington fine sandy loam collected 2 miles southeast of Auburn, Salem County, N. J.*

Sample No.	Depth	SiO_2	TiO_2	Fe_2O_3	Al_2O_3	MnO	CaO	MgO	K_2O	Na_2O	P_2O_5	SO_3	Ignition loss	Total	N	H_2O at 110° C.
	In.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
29441	0–1	88.58	0.62	1.49	1.74	0.02	0.36	0.15	0.68	0.46	0.11	0.22	6.42	100.85	0.23	1.17
29442	1–3	91.58	.53	1.41	1.52	.01	.21	.25	.12	.34	.08	.23	3.57	99.85	.10	.68
29443	3–24	95.19	.62	2.11	.50	.01	.31	.18	.22	.52	.09	.15	.95	100.85	.05	.25
29444	24–36	87.24	.50	1.28	7.10	.01	.19	.33	.36	.56	.36	.21	1.51	99.65	.04	.49
29445	30–60	64.76	.67	13.54	9.30	.035	.04	2.06	4.37	.97	.11	.07	4.37	100.29	.01	3.15

Collington fine sandy loam, low greensand-content phase.—This soil, like similar phases of the sandy loam and loam, constitutes a soil which does not differ in essential characteristics from the typical soil except in the total absence of, or the presence of a very low percentage of greensand. Because of the small area of this soil within the Freehold area, it is agriculturally unimportant. A few small bodies are scattered throughout the belt of Collington soils, the largest being about 4 miles southeast of Freehold, close to the boundary between the Collington and the Lakewood soils. Since it is well known that Lakewood material is present in the Collington soils along this border the low content of greensand in this small area of the Collington soil shows without doubt that the area contains a rather large percentage of Lakewood material. Because of this fact, the low greensand-content phase is a somewhat less productive soil than typical Collington fine sandy loam. The surface soil is also lighter in color, shading to gray.

COLLINGTON SAND, LOW GREENSAND-CONTENT PHASE

The main reason for grouping this soil in the Collington series is its occurrence within the Collington belt. It differs from the low greensand-content phases of the other soils in the area to the extent that even in the deep subsoil or parent material of the sand, glauconite is practically absent, whereas in the other soils already described the parent material immediately underlying the subsoil contains perceptible amounts of greensand.

A sand in the Collington series is somewhat of an inconsistency. In sandy material the glauconite, which decomposes rather easily, should have weathered so thoroughly as to have disappeared in a comparatively short time. Owing to the fact that the two areas in which this soil has been mapped have both been correlated as the low greensand-content phase, it is apparent that the greensand has practically disappeared.

This phase of Collington sand is brown, light brown, or even faintly reddish brown to a depth of about 10 inches, and it is underlain by reddish-yellow loose sand. It contains an extremely small quantity of glauconite. Had this soil occurred in the northwestern part of the county it would undoubtedly have been mapped as Sassafras sand as it is essentially identical in physical characteristics with Sassafras sand. It does not differ very greatly from Lakewood sand. One of the areas mapped is north of Lincroft, and the other is southwest of Wickatunk.

COLLINGTON LOAMY SAND

The surface soil of Collington loamy sand consists of brown loamy sand to a depth of about 8 inches. It is underlain by yellowish-brown incoherent loamy sand having a faint green shade. Below a depth ranging from 24 to 30 inches, greenish-brown or green loamy sand or sand is present.

This soil is widely distributed over the eastern and northern parts of the Collington belt. The significance of this occurrence is that it lies in that part of the Collington belt where the parent materials are sandy. In the eastern part the sand is derived from the sands of the Lakewood plain and in the northern part from the sands which underlie the greensand beds.

On the soil map of the Freehold area published in 1913 the greater part of this soil was mapped as Sassafras sand. On closer examination, however, it has been found to contain a small percentage of glauconite and has therefore been identified as a member of the Collington series. Because of the presence of a small amount of clay its texture is more accurately described as loamy sand than sand.

This soil occurs in smooth or nearly level areas and is therefore favorable for the production of very early crops. It is used rather extensively for the production of asparagus, watermelons, cantaloupes, early tomatoes, and peppers. Sweetpotatoes also are grown to a considerable extent and produce goods yields of high quality. Asparagus is probably the most important crop, as the clean sandy character of the soil furnishes a stalk free from dirt. Melons do well. Because of the very low percentage of organic matter and plant food, the production of any crop on this soil is dependent on the use of organic matter and fertilizers. Barnyard manure is of special value on this soil for most crops.

Collington loamy sand, low greensand-content phase.—The greater part of the area of Collington loamy sand has been identified as the low greensand-content phase. This is logical because of the rapid weathering that necessarily takes place in material as sandy as this. The glauconitic material decomposes with comparative rapidity and, because of the leachy character of the sand, it is soon removed. There is no essential difference in productivity, however, between the

low greensand-content phase and the typical soil, as both soils require fertilizer for the production of any crop. These soils also return better yields when irrigated, but irrigation is not absolutely necessary except for crops which are grown under a highly intensive system. It is barely possible that if farming could be done mathematically, the typical soil would require a little less fertilizer than the phase.

COLTS NECK LOAM

The surface soil of Colts Neck loam is red or brownish-red loam to a depth of 7 or 8 inches. The subsoil is red or reddish-brown friable sandy clay loam or sandy clay. In the lower part of the subsoil, usually below a depth of 30 inches, the texture becomes somewhat lighter, the structure somewhat more porous, and the color less red, changing gradually to yellowish red.

In general, the Colts Neck soils are characterized by the presence of a certain amount of ferruginous fragments consisting usually of what are known as clay ironstones or impure oxide of iron. The range in quantity as well as in the shape and character of the fragments is great. In the smoother areas of Colts Neck loam the content is small and the fragments are very small resembling fragments of shale in soils derived from shale material. In other localities the content of this material is large, ranging up to as much as 30 or 40 per cent of the soil mass, and the fragments may attain a weight of several hundred pounds. In many places, before these fragments have been broken, on being brought to the surface and subjected to weathering, they consist of plates. The plates occur with warped surfaces of many different kinds, some of them producing a mass of material similar to the masses of slaglike iron oxide occurring in the lateritic soils of the Tropics.

The Colts Neck soils lying in the more hilly areas of the north-central part of the greensand belt, contain a larger percentage of iron oxide fragments than those in the southern part.

Colts Neck loam is rather widely distributed over the greensand belt. In many places it is associated with Collington loam, especially where the surface is more uneven than that of Collington loam and where oxidation and dehydration have been more effective in giving the iron-oxide content of the soil a strong red color. Colts Neck loam does not occur in large bodies in any part of the area. Probably the largest lie slightly south of the direct line between Middletown and Crawfords Corner. A light-colored phase of this soil occurs in the vicinity of Hillsdale and also on Rumson Neck, but on account of its small extent is included with the loam in mapping.

Practically all the Colts Neck loam is under cultivation. It is considered one of the best soils in the area and is adapted to a wide variety of general farm crops. If plowed when it contains an optimum amount of moisture, good tilth is obtained. Potatoes are produced successfully on this soil. They are grown most extensively in the vicinity of Colts Neck. Other general farm crops, such as alfalfa, timothy, clover, corn, and wheat, return good yields. Peach trees do well, succeeding better on this soil than on Collington loam because of better drainage and aeration. The danger of injury from frost is less than on Collington loam because of the occurrence of Colts Neck loam in the hillier areas of the county where air drainage

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is good. Apple trees do equally well on the two soils, and the apple crop is equally as well assured as the peach crop.

Probably no farm is composed entirely of this soil. Farm land composed of it is usually held at somewhat lower prices than that in which Collington loam is the dominant soil. This is owing to the somewhat more hilly character of the land and to the slightly greater liability of the crop to injury from drought.

The results of mechanical analyses of samples of the surface soil and subsoil of Colts Neck loam are shown in Table 9.

TABLE 9.—*Mechanical analyses of Colts Neck loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
170431	Surface soil, 1 to 6 inches	1.7	10.0	13.4	16.2	10.4	26.5	22.1
170432	Subsoil, 7 to 36 inches	2.4	11.0	15.0	16.8	8.4	24.6	21.9

COLTS NECK SANDY LOAM

The surface soil of Colts Neck sandy loam consists of brownish-red loamy sand or light sandy loam about 15 inches thick. It is underlain by red moderately friable sandy clay. The percentage of iron oxide, which imparts the red color to both surface soil and subsoil, varies slightly from place to place, but this variation has not been taken into consideration in mapping, as it does not affect either the physical character or productivity of the soil. The percentage of ironstone fragments varies also, but in general the quantity is less and the fragments are smaller than in the lighter-textured Colts Neck soils.

In the somewhat more hilly areas, where leaching has been more extensive, the surface soil is a little lighter in color than in the typical soil. This soil, like the other types of the Colts Neck series, is locally called "red land." On account of the coarseness of the surface soil and the slightly coarser substratum, drainage is everywhere good. This is advantageous during seasons of wet weather, but it has its disadvantage during droughts. However, this is not considered a droughty soil.

The largest bodies of Colts Neck sandy loam lie between Freehold and Colts Neck, extending almost continuously from about a mile northeast of Freehold northeastward to a mile northeast of Colts Neck. This is one of the largest bodies of a single soil type occurring in the Freehold area.

Colts Neck sandy loam is likely to suffer from erosion to a greater extent than most of the other soils of the area, probably because of its occurrence on the hilly parts of the area.

The land is utilized for the production of a large number of crops, but it is more important for general agriculture, including potatoes, than for truck crops. However, it is used locally for a number of truck crops. Under favorable moisture conditions and careful management it is a good general-farm soil. It has the disadvantage of all the other soils of the area in that it has developed under highly humid conditions and a timber cover. It is one of the important agricultural soils of the eastern part of the United States and pro-

duces a wide range of crops under good conditions of cultivation and fertilization.

Farm land, composed largely of Colts Neck sandy loam, varies in price, depending on location, improvements, and state of cultivation.

Colts Neck sandy loam, eroded phase.—In a few places Colts Neck sandy loam has been subjected to noticeable erosion. This is not serious enough to decrease the productivity of the soil to a great extent, but the land requires more careful handling than soils such as Collington loam and others, which occur in smoother parts of the area. The most severely eroded bodies are in the southwestern part of the area in the vicinity of Freehold.

COLTS NECK FINE SANDY LOAM

This soil is essentially identical in all characteristics with Colts Neck sandy loam except in the surface soil which contains a higher percentage of fine sand and a lower percentage of medium sand than the sandy loam. The heavier texture of the surface soil may have a slight influence on the yield and character of the crops grown. If the soil itself were the only factor in agricultural production, such slight differences as those between the sandy loam and fine sandy loam of the Colts Neck series would possibly deserve rather important consideration, but the great number of other factors, all of which are important, renders such slight differences comparatively unimportant.

This soil occurs only in a few very small bodies in the northeastern part of the area.

COLTS NECK LOAMY SAND

The surface soil of typical Colts Neck loamy sand is dark-red or brownish-red loamy sand to a depth of 5 or 6 inches. The subsoil is bright-red loamy sand containing a little more clay than the surface soil, the clay giving the material a somewhat loamy texture. The loamy material may extend to a depth of 3 feet without change, or the lower part may be rust iron in color and slightly heavier in texture. The brown color of the surface soil is caused by organic matter which is mixed with finely divided material containing much iron oxide. As a general rule the material below a depth of 3 or 4 feet is lighter in texture than the subsoil and may also be lighter in color. Some small areas, composed of water-laid material, occupying an apparent terrace position along Swimming River, have been included with mapped areas of this soil.

Several bodies of this soil border a large area of Colts Neck sandy loam. The higher-lying areas occupy low ridges and gentle slopes to the larger streams. Drainage is good in most places, and in some of the higher areas the soil is somewhat too well drained and is somewhat droughty. The timber growth is predominantly oak but originally included some chestnut.

Because of the very sandy character of the surface soil, Colts Neck loamy sand may be cultivated practically at any time without danger of puddling and for this reason is one of the best soils in the area for early truck crops. Fertilization, especially where organic material is applied, is highly beneficial, in fact, a necessity for the production of a good crop. Lime and green-manure crops give good

results, and winter cover crops are valuable not only in the production of organic matter for the soil but also in protection of the soil from erosion or drifting by wind. This soil is more important as a truck-crop soil than as a general farm soil.

Watermelons, cantaloupes, and sweetpotatoes are among the main crops, but asparagus is a more successful crop on this than on any other Colts Neck soil. Sweet corn may be produced, and, with sufficient liming and fertilization, alfalfa may also be grown. Peach trees do exceptionally well.

The price of land on farms where this soil is extensive is about the same as that for Colts Neck sandy loam. Some exceptionally good truck farms, favorably located, sell for somewhat higher prices.

This is a fairly extensive soil in the Freehold area. It occupies some rather large areas, one lying in the vicinity of Lincroft. Some important areas are in the vicinity of Vanderburg, bordering the large area of Colts Neck sandy loam which occurs in this region. Other important areas lie southeast and southwest of Marlboro and southwest of Middletown. Smaller areas are scattered over the region occupied by Collington and Colts Neck soils.

COLTS NECK GRAVELLY SAND

The surface soil of Colts Neck gravelly sand differs in no fundamental respect from the surface soil of the loamy sand except locally where it lies in close association with Sassafras soils and is lighter in color. The subsoil is red, the shade varying considerably from place to place as in the loamy sand. The designation of this soil as a gravelly sand is owing to the presence of a large number of iron-oxide fragments which, as has already been stated, are a distinctive feature of the Colts Neck soils. The percentage in the gravelly sand is larger than in the other members of the Colts Neck series.

The largest areas of the gravelly sand occur in the Highlands of Navesink where this soil constitutes practically the only soil in the locality with the exception of gray soils capping the hills and mapped as members of the Sassafras series. The gravelly sand occupies the lower slopes. Smaller areas occur in the western extension of the hills from the highlands, but no important areas are west of this.

This soil is used mainly for residential sites. It has characteristics very similar to those of the loamy sand, but because of its lighter texture, the higher percentage of sand, and the hilly character of the land on which it lies, it is more droughty and therefore less productive.

KEYPORT LOAM

Keyport loam is the dominant soil in the vicinity of Cheesequake. The surface soil consists of grayish-brown loam to a depth of about 12 inches. It is underlain by pale-yellow or yellow moderately friable clay loam, which, at a depth ranging from 15 to 24 inches, grades into somewhat plastic clay containing gray and yellow spots indicative of incomplete oxidation. Quartz gravel may be present in some places on the surface.

This is a lighter-colored soil than the members of the Collington or Colts Neck series, the light color indicating the stage of leaching to which the soils have been subjected. Both the subsoil and sub-

stratum are comparatively heavy and in wet weather are subject to excessive ground water, but this is soon disposed of because of the comparatively good surface drainage.

The largest area of this soil lies just east of Cheesequake. It occurs on smooth or gently rolling relief. In the few small flat spots, the soil is somewhat imperfectly drained because of the heavy subsoil.

This is considered an important general farming soil, and practically all of it has been under cultivation and is still cultivated except where recent development of residential sections has taken place. Grasses and corn are the principal crops, and some truck crops, mainly peppers and tomatoes, are grown for market. This is one of the good corn soils of the area because of its comparatively heavy texture and good moisture supply. The soil is too heavy for successful potato growing.

KEYPORT CLAY LOAM

The surface soil of Keyport clay loam is grayish-brown heavy loam or silty clay loam to a depth of about 6 inches. It is underlain by pale-yellow moderately friable silty clay which, in turn, is underlain at a depth of 20 inches by mottled yellowish-drab plastic clay. The surface soil is rather thin, and deep plowing brings some of the clay to the surface giving the surface soil in cultivated fields a heavier texture than in the unplowed areas. In many places small iron concretions are scattered throughout the surface soil and subsoil.

Keyport clay loam is of small extent, but it is an important soil in the northwestern part of the area. Northwest of Matawan it covers an irregularly shaped but comparatively compact tract of level or gently undulating country. Because of the smooth relief and the heavy character of the surface soil and subsoil, some areas are in need of drainage. Practically all the land is cleared and utilized for general farm crops, tomatoes, and peppers. Because of the heavy character of the surface soil and the liability of a large part of the rainfall to run off rather than to penetrate the soil, crops are likely to suffer from drought in midsummer unless care is taken to keep the land in good tilth. During periods of dry weather the soil cracks, but the cracks close after the rains begin. Because they are saturated with moisture during the winter, these soils are considered somewhat late and can not be used for the growth of early truck crops. The land may be used, however, with fair success for corn, late tomatoes, peppers, and other truck crops intended for the late market. Very little attention is given to the production of fruit. Apple trees, however, will do fairly well in the better-drained places, but because of the much larger areas of better apple soil within the Freehold area, the land is not used for that purpose.

Table 10 shows the results of mechanical analyses of samples of the surface soil and subsoil of Keyport clay loam.

TABLE 10.—*Mechanical analyses of Keyport clay loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
170471	Surface soil, 1 to 6 inches	0.6	1.0	1.6	11.4	29.4	42.4	13.6
170472	Subsoil, 7 to 36 inches	.6	1.4	1.9	11.1	18.3	38.7	27.7

KEYPORT SANDY LOAM

Keyport sandy loam occurs in many small areas in the vicinity of Matawan, Freneau, Keyport, Henningers Mills, and west of Cliffwood. All the areas in the vicinity of Matawan occur where the clay beds, which are responsible for the development of the Keyport soils, lie near the surface. Small areas of Keyport sandy loam occur in patches extending south and southwest from the main area, but none are farther south than Gordons Corner.

The surface soil of Keyport sandy loam is gray loamy fine sand or light sandy loam to a depth of about 8 inches. It is underlain by yellow sandy loam to a depth of about 18 inches, and this in turn by greenish-yellow fine sandy clay. At a depth greater than 26 inches, mottled yellow and grayish-yellow plastic clay is reached, and in the lower part of this layer the color is uniformly drab.

Surface drainage is good.

Keyport sandy loam is an easily cultivated soil and fairly productive. It is an excellent soil for the production of early truck crops, and a large acreage is usually planted to peppers. Early varieties of tomatoes also give good yields. Melons are grown extensively, and this is perhaps one of the most satisfactory soils in the area for the production of asparagus. Grapes and strawberries are successfully grown, but the latter do not yield so well as on the lower-lying Keansburg soils.

This soil has a low content of organic matter, and it requires large applications of stable manure and fertilizers containing nitrogen for the production of good yields of truck crops.

Farms which contain a large proportion of this soil bring comparatively high prices in those parts of the area where the production of truck crops is feasible.

KEYPORT FINE SANDY LOAM

The surface soil of Keyport fine sandy loam is gray fine sandy loam to a depth of 10 inches. It is underlain by yellow or pale-yellow friable fine sandy clay loam which, in turn, grades into yellow moderately friable fine sandy clay loam. This material grades into yellow moderately friable fine sandy clay. At a depth of 20 inches gray spots occur in the material, and at a slightly greater depth plastic drab clay with faint yellow mottlings is reached. Minute flakes of mica and some small quartz gravel are present in this material. Small areas of Keyport loamy fine sand are included in mapping.

Keyport fine sandy loam occurs mainly in a belt of areas extending southward from Browntown for a distance of 3 or 4 miles. The relief of the land is such as to afford ample surface drainage, but in some places the impervious substratum retards the percolation of ground water, especially in areas where the surface is comparatively flat. In such places the surface soil remains saturated for a long time, and this feature reduces the value of the soil for the production of truck crops. General farm crops are grown in most of the areas, together with a certain amount of truck crops. Potatoes, because of the sandiness of the soil, especially where surface drainage is good, do fairly well. The crops most commonly grown are tomatoes, cucumbers, peppers, melons, and strawberries.

Heavy applications of fertilizers and manures are necessary in order to insure good yields.

The results of mechanical analyses of samples of the surface soil and subsoil of Keyport fine sandy loam are shown in Table 11.

TABLE 11.—*Mechanical analyses of Keyport fine sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
170463	Surface soil, 1 to 6 inches	0.0	2.6	21.3	56.0	8.5	7.8	3.7
170464	Subsoil, 7 to 27 inches	.2	2.6	19.9	52.2	6.8	9.9	8.2
170465	Subsoil, 27 to 36 inches	0.0	.6	5.6	16.4	5.2	33.9	38.1

SASSAFRAS LOAM

The surface soil of Sassafras loam consists of mellow brown loam extending to a depth of about 12 inches. The subsoil is friable yellowish-brown or faint reddish-brown heavy loam or silty clay loam. Typically, at a depth ranging to about 35 inches, a coarser or more sandy layer, consisting of reddish-yellow or yellowish-red sandy loam, is present. Locally, where this lighter-textured material is not present at the depth mentioned, the color is yellow rather than reddish yellow.

Important areas of Sassafras loam occur in the vicinity of Freehold, but none of them are within a mile or so of that city. The most important area is about 2 miles to the southeast of Freehold. Other important areas are about 3 miles southeast of Keyport, and a few less important areas occur between Keyport and Freehold. A few small bodies lie in the extreme northwestern part of the area, associated with Sassafras sand.

Sassafras loam is one of the important agricultural soils of the Freehold area. It occurs in association with Collington loam and does not differ essentially from that soil. It is so like Collington loam, especially those bodies lying in the vicinity of Freehold, that it might have been mapped as Collington loam rather than Sassafras loam. It was identified as Sassafras loam because no perceptible amount of greensand was found in the material above a depth of 3 or 4 feet. If greensand had been present in noticeable quantities the soil would have been mapped as Collington loam. Although the presence of so small an amount of greensand as to be barely noticeable in the soil may have important significance from the point of view of soil type definition, it has practically no significance in regard to the producing capacity of the soil.

It was mentioned in the discussion of Collington loam that some of that soil has developed from material accumulated by deposition at a date much later than the date of the accumulation of the greensand. This material, in many places at least, has been derived by local wash from the greensand beds. It is apparent and probable that many, if not most, of the important areas of Sassafras loam have been developed from redeposited material of the character just mentioned. It is probable, because of this fact, that it contains very little greensand.

Sassafras loam areas are characterized by nearly level or very gently rolling relief, and because of this fact can be used for intensive agriculture. Drainage is excellent, though in a very few small areas, artificial drainage has been installed. Such areas, however, are not typical Sassafras loam but are areas having entirely different characteristics, occurring in depressions, and, had the scale of the map allowed, would have been mapped as other soils.

Practically all the Sassafras loam areas are cleared and are under intensive cultivation. The original forest consisted of white, red, and black oak, beech, and chestnut, with a scattered growth of a few other species.

The heaviest yields of potatoes in the Freehold area and in the State are obtained on Sassafras loam, and a large acreage is devoted to this crop. Potatoes are sometimes grown in rotation with other crops in the Freehold area, but even where grown continuously excellent yields are obtained on Sassafras loam. Minimum yields are rarely less than 80 sacks to the acre and maximum yields may be as high as 120 sacks. Corn, grass, and alfalfa are the crops commonly grown in rotation with potatoes. Small acreages of wheat and oats are occasionally grown. Many farmers sow cover crops after the potatoes are harvested, and these crops are turned under the following spring for soil improvement. Large acreages of Sassafras loam were formerly planted to Lima beans in the vicinity of Freehold.

Farm improvements on Sassafras loam are of very high grade and are fully equal to those on Collington loam, in some places even better. Large houses and barns are more universal than on the lighter soils of either the Collington or Colts Neck series. This may be partly due to the fact that these soils have been valued more highly from the time of the first settlement than have the lighter-textured soils. Many farms have remained in possession of the same families almost from the beginning. Farms containing a large proportion of Sassafras loam range in value from $200 an acre upward, depending on location and improvements. Near Freehold, the higher prices are obtained.

Sassafras loam is a soil with productivity and crop adaptability as high as those of any of the maturely developed soils within the humid region of the United States. Soils with heavier texture than the loam become increasingly difficult and expensive to manage and have a narrower range of crop adaptation. Soils with higher percentages of sand return lower yields and have a somewhat narrower range of adaptability to crops. The sandy soils, especially, are less well adapted to the important grain and forage crops, which constitute the fundamental basis of agriculture throughout the United States.

SASSAFRAS SANDY LOAM

The surface soil of Sassafras sandy loam is light-brown or brown light sandy loam to a depth of 10 inches. The material of the surface soil is lighter in color than that of the surface soil of Collington sandy loam or of Sassafras loam, and in some places in the virgin soil, where the land has not been plowed, it may be gray to a depth of 3 or 4 inches. It is underlain by yellow or reddish-yellow friable sandy loam to a depth of 30 inches, at which depth the underlying

material is reddish-yellow loamy sand which, because of its lighter texture, furnishes excellent underdrainage to the surface soil and subsoil, thus facilitating the oxidation of the iron compounds contained, and it is responsible therefore for the red color of the subsoil. The surface soil is not red because of the low percentage of iron oxide present. This lack is due to the process of leaching to which all the soils of the region are subjected, but only the more sandy soils have been leached enough to give them a well-defined light color.

Gravel may be present in the lower part of the subsoil and in some places in the substratum, especially in the southern part of the area. The presence of gravel indicates that the material has been subjected to shifting since the time when the original geological beds of the region were laid down. In general the Sassafras soils, especially the sandy members, have been derived from more sandy beds than the soils of the Collington series, but the materials from these sandy beds have been locally shifted in many places and in some places the materials may consist of deposits much younger than the underlying cretaceous deposits of the region to which reference was made in the discussion of the physiography of the Freehold area.

Sassafras sandy loam, like the sandy loam member of any soil series, ranges in texture from loam to sand, containing various proportions of sand, silt, and clay. In the southeastern part of the area some of the Sassafras sandy loam is finer in texture than elsewhere and resembles fine sandy loam. In areas lying in close association with Sassafras loam or Collington loam, the sandy loam approaches a loam in texture.

Sassafras sandy loam is mapped in small areas widely scattered throughout the region in which the Sassafras soils occur and in other areas in the northwestern part of the Freehold area. One of the most important bodies includes about 1½ square miles in the northwestern part of the area and several others are closely associated with Sassafras loam and Collington loam in the region surrounding Freehold. A number of small bodies occur in the vicinity of Robertsville and northwest of Marlboro.

This soil is adapted to a wide range of crops, probably somewhat wider than the other soils of the area, though the yield of the grain and forage crops is not so good as on the loams. The soil is adapted to a wider range of truck crops than the heavier soils, and it produces a very high grade of potatoes. In the vicinity of Freehold it is not considered so productive a soil as Sassafras loam, but, on account of its loaminess and the comparative ease of cultivation, a large acreage is devoted to potatoes, especially of the earliest and better varieties. Potatoes yield from 40 to 85 sacks an acre. Other crops grown are general farm crops, apples (especially early fall varieties), and peaches.

In former years heavy applications of greensand marl were made to practically all soils of the Freehold area. This practice seems to have resulted in materially increasing the productiveness of the soil, possibly because of the high percentage of potash in the greensand marl as well as because of the increased percentage of clay in the marl giving the sandy soils somewhat better physical characteristics.

The maintenance of a good supply of organic matter in the sandy loam is accomplished by fall seeding of crimson clover, rye, or rye with vetch to be plowed under in the spring. With proper treatment good crops of crimson clover may be obtained with very little difficulty. Crimson clover is sown in the fall after the potatoes are harvested or in late summer after the last cultivation.

Land prices of farms of which Sassafras sandy loam constitutes an important part are lower than of those on Sassafras loam, but prices are good, ranging up to about $200 an acre. However, during recent years very little land has changed hands.

Sassafras sandy loam, deep phase.—Sassafras sandy loam, deep phase, in general surface appearance is identical with the typical soil. It differs from the latter only in that the sandy clay subsoil lies at a greater depth than in the typical soil, the depth ranging from 24 to 30 inches. Underneath the thick layer of light-textured and relatively light-colored sandy material, the subsoil is essentially identical with that underlying the typical soil. The deep phase is less productive than the typical soil because of a lower percentage of plant food in both surface soil and subsoil but mainly because of its lower water-holding capacity. This soil occurs in a number of areas, most of them closely associated with areas of Sassafras sandy loam.

SASSAFRAS GRAVELLY SANDY LOAM

The surface soil of Sassafras gravelly sandy loam is brown or light-brown gravelly sandy loam to a depth of 11 inches. It is underlain by reddish-brown friable gravelly heavy sandy loam or sandy clay. Well-rounded quartz gravel, some of which are more than 2 inches in diameter, occurs in abundance both in the surface soil and in the subsoil.

This soil occupies high areas on hilltops which have resisted erosion. On account of its small extent, it is of very slight importance. Two medium-sized bodies lie in the eastern part of the area, one at Wayside and the other a few miles south of that place. A number of bodies in the northwestern part of the area occupy elevated positions, capping the tops of hills, the main body of which consists mainly of sandy Sassafras soils, principally Sassafras sandy loam, and these areas contain more or less gravel. It is only on the hilltops that the gravel is of sufficient quantity and size to justify separation into a different soil. These gravelly bodies are remmants of an old deposit of sandy clay which covered an important part of this area at one time, but which, with the exception of these few remnants, has been eroded.

Because of good drainage, due to the position in which the soil lies, the material of the whole soil profile has been thoroughly oxidized and somewhat dehydrated, and this has given rise to the reddish-brown color.

This soil receives about the same cultural treatment as other Sassafras soils. However, very little of the land is cultivated. Owing to the high content of gravel, the soil is not so well suited to potatoes or other root crops as Sassafras sandy loam.

From the point of view of both area and soil characteristics, this is an unimportant soil.

SASSAFRAS FINE SANDY LOAM

The surface soil of Sassafras fine sandy loam is light-brown or brown loamy fine sand about 7 or 8 inches thick. It is underlain by yellowish-brown fine sand or fine sandy loam which gradually becomes somewhat heavier with depth and finally grades into reddish-yellow friable fine sandy clay. At a depth ranging from 28 to 40 inches the material becomes somewhat coarser in texture and looser. In some bodies, especially in the southeastern part of the area, the surface soil of virgin areas is gray sand and the subsoil is yellowish gray. In areas having a somewhat heavier surface soil, ranging toward fine sandy loam, the gray color of the surface soil is less distinct. This characteristic of a gray surface soil is also noticeable in Sassafras sand and Sassafras loamy sand.

Sassafras fine sandy loam occupies gently rolling or nearly level areas, and the land is well drained. It occurs in practically all parts of the Freehold area but mainly in the northeastern and northwestern parts. Important bodies are on Rumson Neck and in the southern part of the Navesink peninsula. In the vicinity of Freehold, some important areas are associated with Sassafras sandy loam. The areas occurring on Rumson Neck and the Navesink peninsula are associated with the Collington soils.

Although the exact geological origin of most soil types can not be determined with accuracy, it is probable that on Rumson Neck and the Navesink peninsula the soils have been derived from comparatively sandy greensand marl beds. Because of their sandy texture and porosity they weather rapidly and leach easily so that the glauconite minerals are readily decomposed and the excess of iron and potash are soon leached out. These areas belong to the less sandy phase of Sassafras fine sandy loam, and they are browner than the more sandy soils, approaching Collington sandy loam very closely in color characteristics. The large number of bodies scattered over the rest of the area seem to be somewhat more typical members of the Sassafras series.

This soil is easily cultivated, and practically all of it is farmed. This, however, does not apply strictly to the areas on Rumson Neck and the Navesink peninsula since most of this part of the Freehold area is occupied by country estates, parks, and residences. A small area is still in forest, mainly of oak, chestnut, and hickory, with an undergrowth of dogwood. The land is used extensively for general farming and truck growing. Good crop yields are obtained where the land is properly handled. Under exceptional management the yield of corn ranges up to 75 bushels an acre. Potatoes return a yield of 65 sacks of Irish Cobblers and other important varieties where 1,500 pounds of fertilizer is applied. Clover and timothy yield from 1 to 1¾ tons an acre, depending on the seasonal rainfall. Wheat yields about 23 bushels to the acre although much larger yields may be obtained. Tomatoes occupy the largest truck-crop acreage in the northern part of the area. The tomatoes are either shipped fresh to New York City for consumption or are sold to local canning factories. In the vicinity of Hamilton a large part of this soil is used for truck crops, especially peas, beets, snap beans, and tomatoes.

Land values range up to more than $300 an acre, depending on location and improvements.

The results of mechanical analyses of samples of the surface soil and subsoil of Sassafras fine sandy loam are shown in Table 12.

TABLE 12.—*Mechanical analyses of Sassafras fine sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
170445	Surface soil, 1 to 6 inches	0.6	8.0	14.6	27.0	24.1	19.8	5.9
170446	Subsoil, 7 to 30 inches	1.0	8.3	14.6	23.2	19.4	22.8	10.7
170447	Subsoil, 30 to 36 inches	1.4	12.0	24.6	30.4	17.6	9.5	4.7

SASSAFRAS SAND

The surface soil of Sassafras sand is predominantly gray loose sand about 10 inches thick. In places the sand is yellow, and in a few places grayish brown or brownish yellow. The subsoil is loose porous orange-yellow or dark-orange sand which is in general slightly more loamy than the surface soil. The sand consists almost entirely of quartz and contains a small percentage of gravel in places.

Sassafras sand occurs predominantly in the northern and northwestern parts of the area, and a few bodies are in the eastern part. One or two small bodies are associated with the Collington soils in the Collington belt, and in such localities this soil does not differ in any fundamental respect from Collington sand.

The difference in characteristics between Collington sand and Sassafras sand is much less than between the heavier members of the series. The main difference is in the parent material which, beneath Collington sand, still retains a varying amount of glauconite, whereas the parent material of Sassafras sand contains none.

The relief of most areas of Sassafras sand is smooth, and the land is predominantly only slightly elevated above sea level. The wooded areas support a growth of oak and pine, with an undergrowth of blueberry bushes. On the more hilly areas the growth is somewhat more vigorous and consists almost entirely of oak, with a mixture of pine.

This soil is well drained, warm, and early, and it is well adapted to truck crops, especially the early market-garden crops, and sweet corn may be grown on it successfully. Early tomatoes, peppers, sweetpotatoes, garden peas, melons, and cucumbers are the most important market-garden crops. This is not a general farming soil, although large parts of the areas in which it occurs have been cleared, and previous to the period when truck crops were grown, it was used for general farming, but most of the areas used for this purpose have been abandoned. The application of large quantities of stable manure and fertilizer is essential for good crops. Unless the seasonal rainfall is high, general farm crops are practically certain to suffer from drought. Where cultivated and not carefully protected, the soil has a tendency to drift, especially if the cleared areas are large. Winter cover crops are therefore very important.

Land values are low except where market conditions are especially favorable to truck crops, and since this condition controls the price, no figures can be safely given.

SASSAFRAS LOAMY SAND

Sassafras loamy sand is essentially identical in surface characteristics with Sassafras sand, but the subsoil contains a low percentage of fine material consisting of silt and clay, giving it a loamy feel. The color of the subsoil in the loamy sand is a little deeper, having a faint red shade. In places where bodies of Sassafras sand join bodies of Sassafras sandy loam an intermediate belt along the border between the two soils, in most places too narrow to show on the map, consists of Sassafras loamy sand.

Sassafras loamy sand occurs in the northwestern, northern, and eastern parts of the area, but some fairly large bodies lie along the coast in the southeastern part. The most important bodies are in the northern and northwestern parts and are closely associated with Sassafras sand and Collington loamy sand, low greensand-content phase. From the point of view of utilization of the land it is doubtful whether there is any difference whatever between Collington loamy sand, low greensand-content phase, and Sassafras loamy sand. All the bodies in the eastern part of the area are rather closely associated with the Collington soils.

The relief of most bodies of Sassafras loamy sand is gently undulating, though some important areas south of Keansburg are nearly level. On account of its light texture, the soil drifts to some extent. Where drifting has taken place and the material has accumulated to a depth of more than a few inches, the surface soil and subsoil are less loamy than elsewhere.

The virgin areas of Sassafras loamy sand are covered by oak woods. Formerly the forest growth included more or less chestnut, but practically all the chestnut trees have been killed by the blight.

Because of its sandiness, this soil is easily cultivated and responds readily to the application of manure and fertilizers. Like Sassafras sand it is used to a large extent for the production of early truck, such as tomatoes, asparagus, peppers, eggplant, strawberries, watermelons, cantaloupes, sweetpotatoes, and sweet corn. The largest acreages of truck crops on this soil, as well as on the sand, are in the northern part of the Freehold area. In a few areas apples and peaches, especially peaches, are grown on this land, and a few areas are devoted to berries. Kieffer pears do rather well on this and other light-textured soils of the area, the fruit being, according to local opinion, of higher quality than that grown on the heavier soils. This is not a general farming soil, and the areas formerly devoted to general farming have for the most part been abandoned or are now utilized for truck crops.

The organic-matter content, like that of the sand, is very low. The maintenance of a large percentage of organic matter in the soil is very difficult, and the land requires constant care in the use of farm manures and in the plowing under of cover crops.

Market values of farms in which the loamy sand is an important soil, varies very greatly depending on the use to which the land is or could be put.

SASSAFRAS FINE SAND

The surface soil of Sassafras fine sand is gray or nearly white to a depth of about 6 inches. Beneath the surface soil is the subsoil consisting of orange-yellow fine sand. Locally the subsoil may be slightly red or the upper part may have a tendency toward a strong deep-brown color. Both surface soil and subsoil are friable, loose, porous, and leachy, though somewhat less leachy than the sand. Where bodies of this soil border Sassafras fine sandy loam, a gradational soil which is essentially a loamy fine sand is present.

This soil occurs predominantly in undulating or rolling areas, and because of its looseness and porosity the greater part of the rainfall is absorbed. However, the water readily percolates to depths too great for the crops grown, and consequently the soil is droughty.

Sassafras fine sand occurs almost entirely in the northern and northwestern parts of the area. A few small isolated bodies occur in the southern and southeastern parts. The larger number of areas extend from the eastern end of the Highlands of Navesink westward to the northwestern corner of the area.

The forest cover of virgin areas is identical with that on Sassafras sand and Sassafras loamy sand.

Important areas of Sassafras fine sand and its rolling phase occur in the Highlands of Navesink, in close association with Colts Neck gravelly sand. The two soils have undoubtedly been developed from exactly the same rocks. Most of the areas of Sassafras fine sand lie on the tops of the hills, except where the material has been washed down onto the lower slopes, and Colts Neck gravelly sand occupies the steeper slopes. On the higher parts of the Highlands of Navesink, where the surface is comparatively smooth, the soil material has lain in place for a long time, during which the iron oxide has been leached from the surface soil giving it the characteristic gray color of the sandy Sassafras soils of the Freehold area, whereas the soils on the slopes, although sandy, have not been leached to such an extent because surface erosion has removed the leached surface material practically as rapidly as it has formed. The soil, therefore, remains young or unleached and has the characteristic color of the Colts Neck soils.

The rather large area of Sassafras fine sand lying along Clay Pit Creek and west of Stone Church joins a large area lying around the head of a small stream which flows into Clay Pit Creek. The lower-lying part of this area consists of material washed from the upper part and has not been formed in place from material immediately underlying it.

This soil is generally used for the same crops as those grown on the other light-textured Sassafras soils. None of the sandy Sassafras soils are general farming soils, but because of the fortunate occurrence of a large city population only a few miles away from the Sassafras belt, a large part of these sandy soils may be profitably used for the production of truck crops. Were it not for the large population easily within reach, most of these sandy soils would be of practically no use for agricultural purposes. Among the important truck crops are asparagus, peppers, carrots, turnips, cucumbers, watermelons, and cantaloupes, all of which return good yields when the soil is carefully cultivated and fertilized. Peaches and Kieffer pears are successfully

grown in some places, and a few small apple orchards are located on the soil, but it is too light in texture for successful apple growing. Other fruit crops are grapes and berries, with strawberries in most of the low-lying moist depressions. This land must be handled in essentially the same way as other sandy Sassafras soils.

The price of farm land ranges up to nearly $200 an acre, depending on the location with respect to cheap marketing for the truck crops.

Sassafras fine sand, rolling phase.—Sassafras fine sand, rolling phase, is in all respects identical with Sassafras fine sand except in its occurrence on uneven rolling areas. It is less important as an agricultural soil because of the greater liability to drift. In other respects it is identical and needs no further discussion. Bodies of this phase are shown on the soil map by shading.

SASSAFRAS COARSE SAND

Sassafras coarse sand is gray to a depth ranging from 6 to 10 inches. This layer is underlain by yellow coarse sand, and this in turn passes into reddish-yellow coarse sand at a depth ranging from 3 to 4 feet. The lower part of the last-mentioned layer in most places contains a higher percentage of fine material than the upper part. This soil occurs both on slopes and in smooth areas, mainly in the eastern part of the Freehold area.

Because of its coarse texture this soil is too droughty to be used in agriculture, especially where such large areas of the finer-textured sand, equally or better adapted to the truck crops of the area, are available. Only a few small areas were identified and mapped.

LAKEWOOD SAND

The surface soil of Lakewood sand is light-gray or white loose sand, ranging from 6 to 24 inches in thickness. In the virgin soil there is in most places a thin layer an inch or two thick beneath the forest mold, which contains enough organic matter to give the sand a darker color. The subsoil is yellow, coffee-brown, or golden-yellow sand, and in most places it is uniform in character to a great depth. In places a rather compact yellowish-brown hardpanlike layer lies immediately beneath the gray surface layer. A stratum of gravelly sand is present in places, continuing to a depth of 24 inches.

Lakewood sand occurs mainly in the southeastern part of the area. An isolated area including between 3 and 4 square miles lies a few miles south of Keansburg in the northern part of the area. This area is associated with Sassafras sand and the differentiation from that soil was based mainly on the thickness of the gray surface layer. Both soils are gray in the surface layer and a casual examination of them shows practically no difference. It is only the greater thickness of the surface soil in Lakewood sand which serves as a basis for separating the two soils.

Like all sands, Lakewood sand is easily cultivated, but it is droughty. Only a few small areas, however, are now in cultivation. Most of the cultivated areas lie along the northern part of the Lakewood belt, where they join areas of Sassafras, Collington, or Colts Neck soils, which probably comprise most of the more productive land on the farms in this region.

The natural vegetation consists of scrub oak and pine, with an undergrowth of fern, smilax, and blueberry bushes. The cultivated land is used mainly for truck crops. Like the sandy Sassafras soils, this soil responds readily to applications of manure and fertilizer and produces good yields of truck in seasons of normal or a little higher than normal rainfall.

Because of the proximity of the area of Lakewood sand to the summer colonies along the coast, such as Bradley Beach, Asbury Park, Allenhurst, and West Grove, the truck crops are grown largely for sale in these towns. Snap beans, Lima beans, tomatoes, asparagus, eggplant, spinach, peppers, and a great many other truck crops, berries, and melons are grown. A comparatively smaller acreage of asparagus is grown on Lakewood sand than on the Sassafras sandy soils as the Sassafras soils lie nearer New York City, and asparagus, being a very early spring crop, is harvested before the summer colonists have arrived.

Like the sandy Sassafras soils, this is not a general farming soil. In this region, to a certain extent, and southward in New Jersey, to a greater extent, it is used for poultry farms.

Land prices range from a very few dollars to $100 an acre, depending mainly on the location.

LAKEWOOD FINE SAND

Lakewood fine sand is essentially identical in its characteristics with Lakewood sand except that the grains of sand of which it is composed are smaller. The gray surface layer in the sand is in most places somewhat thicker than in the fine sand. Lakewood fine sand occurs only in the southern part of the Freehold area.

The larger bodies are in the eastern part of the Lakewood soils region which is in the southeastern part of the Freehold area. They are nearer the region occupied by summer colonists than the sand areas and for this reason are somewhat more important than the sand for growing truck crops to supply the local demand. The fine sand is used for exactly the same purposes as the sand and practically the same results are obtained by cultivating it. In favorable localities, because of its somewhat finer texture, the fine sand will give slightly higher yields, but in most places the difference in yields between the two soils is not perceptible.

LAKEWOOD GRAVELLY SANDY LOAM

Lakewood gravelly sandy loam is gray loamy fine sand or very fine sandy loam to a depth of 6 inches. This layer is underlain by golden-yellow or dark yellowish-brown sandy loam or fine sandy clay loam. In most places quartz gravel is present on the surface and throughout the soil. The quantity of gravel is variable but is sufficiently large to interfere with cultivation, in some places forming a large part of the soil mass.

It is apparent that these are areas of comparatively recent deposits which once covered a larger part of the New Jersey coastal plain. Most of them were eroded at an early date. They consist of heavier material than the soils from which Lakewood sand and Lakewood fine sand have developed. Because of its heavier texture, the surface

soil has not been leached of its coloring matter to such great depth as in other soils of the Lakewood series.

The main bodies of Lakewood gravelly sandy loam occur as a fringe around the southern and southeastern parts of the main area of Lakewood sand known as the Hominy Hills. A few bodies are in other localities, all in the south-central and southeastern parts of the area. This soil, after having been saturated with water, runs together and bakes unless it is cultivated soon after a rain. The gravel content practically unfits it for crops which require very careful cultivation, especially asparagus, and it also adds to the difficulty of tillage of truck crops. Because of the higher percentage of clay in this soil, the asparagus grown on it is not of such high quality as that grown on the purer sand. The less gravelly areas produce moderately good truck crops and, with liberal fertilization, are capable of producing sweet corn, tomatoes, peppers, and a number of other crops. Such areas are somewhat better adapted for general farm crops than Lakewood sand.

SHREWSBURY FINE SANDY LOAM

The surface soil of Shrewsbury fine sandy loam is grayish-brown loamy fine sand or heavy fine sandy loam to a depth of 10 inches. It is underlain by yellow or pale-yellow fine sandy clay loam, and this in turn, at a depth ranging from 15 to 20 inches, by greenish-yellow heavy fine sandy loam which becomes lighter in texture with depth, or in some places is mottled drab and yellow fine sandy clay. Quartz pebbles are present locally. The subsoil contains rather large quantities of mica flakes.

Some small areas of this soil are poorly drained, but the larger bodies are as well drained as the bodies of Sassafras sandy loam and Sassafras fine sandy loam. The better-drained areas are in the vicinity of Lafayette Mills, Gordons Corner, Wickatunk, and Robertsville.

Shrewsbury fine sandy loam was differentiated from Sassafras sandy loam by the presence of mottling in the subsoil. In some places mottling consists merely of rust-brown spots in the sandy material. In other places the deep subsoil material consists of sandy clay or clay and has not yet become uniformly oxidized. In such localities the subsoil partakes of the character of the deep subsoil of the greater part of the Keyport soils described on a previous page.

The more important areas extend in a belt northeastward from Tennent through Gordons Corner and Robertsville. The surface ranges from slightly depressed to level or very gently rolling. On the lower, more nearly level areas, artificial drainage is necessary, but elsewhere drainage is good.

When properly drained, the soil is usually cultivated and when good tilth has been obtained early in the season little difficulty is experienced in maintaining it throughout the season, especially in the areas of the heavier soils.

The greater part of this soil is under cultivation, and the virgin areas are covered with the same type of forest as the Sassafras soils, mainly oak. The land is used partly for general farming and partly for growing potatoes and truck crops. It is intermediate in char-

acteristics between the sandy soils used mainly for truck crops and the heavier soils used largely for general-farming crops and potatoes. Fair success is attained with both types of utilization. Peaches and apples may be grown in the better-drained areas.

In Table 13 are given the results of mechanical analyses of samples of the surface soil and subsoil of Shrewsbury fine sandy loam.

TABLE 13.—*Mechanical analyses of Shrewsbury fine sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
170485	Surface soil, 1 to 7 inches	0.1	1.2	4.6	66.6	11.0	10.4	6.0
170486	Subsoil, 7 to 36 inches	.0	.4	2.0	57.4	11.2	17.9	11.2

SHREWSBURY SANDY LOAM

The surface soil of Shrewsbury sandy loam is light-brown or brown loamy sand or sandy loam about 12 inches thick. It is underlain by mottled red sandy loam grading with depth into mottled yellowish-drab plastic clay. The lower part of the subsoil may have a definite green shade, and it may also be lighter in texture than the upper part. The mottling in the subsoil indicates imperfect drainage and oxidation.

A short distance east of Keyport two or three areas, which differ from the typical soil, are shown on the map as Shrewsbury sandy loam. These range in texture from sandy loam to sandy clay and the surface soil is predominately dark brown or nearly black. The subsoil also varies in its characteristics, but it consists mainly of gray sandy loam mottled with yellow and red spots. The subsoil is moist and in places is saturated in the lower part.

Shrewsbury sandy loam is unimportant because of the small total area it occupies. It is not a normal soil of the region, but its characteristics are caused largely by imperfect drainage. Most of the areas have been cleared and are used for cultivated crops. The poorly drained areas are utilized mainly for hay and pasture. Where the land is better drained, good yields of corn may be produced. Unless the land is well drained corn grows slowly in the first part of the season, but after the soil has dried the growth is satisfactory. Other crops may be grown in dry seasons, but this is not a soil that is adapted to general farm or truck crops except where it has been drained.

The results of mechanical analyses of samples of Shrewsbury sandy loam are shown in Table 14.

TABLE 14.—*Mechanical analyses of Shrewsbury sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
170424	Surface soil, 0 to 8 inches	0.3	5.4	26.9	41.7	4.4	12.3	8.9
170425	Subsoil, 8 to 36 inches	.6	5.2	30.5	42.6	2.6	10.5	7.9

SHREWSBURY LOAM

When moist the surface soil of Shrewsbury loam is light brown, but on drying it has a decided gray shade. Underlying the surface soil, at a depth of about 10 inches, is mottled gray and drab or yellow, red, and gray clay loam. This layer, in turn, is underlain by mottled yellow and drab plastic clay. The lower part of the subsoil may be lighter in texture than the upper part, and in such places it contains a larger proportion of red and yellow colors than where it is heavy.

This soil occurs in small bodies in various parts of the Freehold area but mainly in the neighborhood of Shrewsbury River. It differs from the fine sandy loam of the Shrewsbury series in the dominant imperfect or poor drainage to which it has been subjected.

Practically all the land is cleared and under cultivation. At present it is used almost entirely for hay and pasture, though corn may be grown. With good artificial drainage and the application of lime and fertilizers, the soil is greatly improved and may be used for the production of most of the crops commonly grown in the area.

Land prices are comparatively high, as this soil occurs largely in areas where it is in demand for residential sites.

The results of mechanical analyses of samples of the surface soil and subsoil of Shrewsbury loam are given in Table 15.

TABLE 15.—*Mechanical analyses of Shrewsbury loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
170433	Surface soil, 1 to 6 inches	0.4	4.4	10.6	12.8	11.2	50.8	9.7
170434	Subsoil, 7 to 36 inches	1.2	6.5	16.2	18.7	8.9	34.9	13.7

SHREWSBURY SILT LOAM

The surface soil of Shrewsbury silt loam is grayish-brown, gray, or drab silty loam or silty clay loam to a depth of about 10 inches. It is underlain by a thin layer of yellow silty clay and this, in turn, by plastic silty clay mottled with yellow, green, or drab spots.

Practically all the areas of Shrewsbury silt loam lie close to the coast and in low-lying situations. The larger bodies are around Shrewsbury River in the northeastern part of the area. Together with the loam, this soil occurs in close association with tidal marsh and is only slightly higher. This soil is similar in its characteristics to the Elkton soils in the Chesapeake Bay region.

Practically all the land has been cleared. Forested areas support a growth of various deciduous trees, mainly white oak which gives rise to the local name "white oak land." Although a large part of the land is cleared, very little is used for the growth of crops. Most of it is in residential sites or is used for hay and pasture. Poor drainage and the fact that the soil is inclined to bake in dry weather and is difficult to work in wet weather are responsible for the fact that it is not used for cultivated crops. Timothy is the principal crop. Some corn and wheat are produced, and late tomatoes may be grown.

The results of mechanical analyses of samples of Shrewsbury silt loam are shown in Table 16.

TABLE 16.—*Mechanical analyses of Shrewsbury silt loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
170439	Surface soil, 1 to 6 inches	0.4	1.6	3.3	4.1	14.4	62.9	12.2
170440	Subsoil, 7 to 36 inches	.4	1.0	1.7	2.2	10.2	61.5	23.0

KEANSBURG SANDY LOAM

The surface soil of Keansburg sandy loam is black or very dark brown sandy loam 8 or 10 inches thick. The subsoil, although varying considerably in both color and texture, is predominantly dark-gray loamy sand or sandy clay grading downward, at a depth ranging from somewhat more than a foot to more than 2 feet, into mottled drab and yellow sandy clay. In some places the lower part of the subsoil is lighter in texture than the upper part and shows the presence of much green, yellow, and blue material. Since the Keansburg soils are not immediately associated in most places with the Collington soils, it is probable that the green material does not consist of greensand, though some of the soils within the area of Keansburg soils contain small amounts of this constituent.

Bodies of Keansburg sandy loam are widely scattered over the entire Freehold area. They occupy low, poorly drained situations. Some of the areas are covered with birch, alder, and other water-loving plants, including grasses. Where artificially drained the soil is used for the production of corn, tomatoes, grass, late truck crops, and occasionally potatoes. As this is not a good potato soil, it is not used for commercial potato growing. Tomatoes and corn constitute the main crops other than grass. Grass makes an excellent growth, and at the present time most of the land is utilized for pasture.

KEANSBURG FINE SANDY LOAM

The surface soil of Keansburg fine sandy loam consists of dark-gray or black fine sandy loam or fine sand about 10 inches thick. It is underlain by gray fine sandy loam mottled in most places with spots of yellow sand. The lower part of the subsoil is orange-yellow or greenish-yellow fine sand or loamy fine sand. In places, at a depth ranging from 15 to 24 inches, a compact and somewhat impervious hardpan layer is present. Ordinarily at lower depths, this layer grades into yellow or golden-yellow sand or loamy sand. The lower part of the subsoil is everywhere saturated with water.

Both the sandy loam and fine sandy loam members of the Keansburg series are poorly drained soils, and the two soils are similar in texture throughout. The difference between the texture of the surface soil and that of the subsoil is not so great as it is in well-developed, well-drained soils derived from the same materials and developed under the same climatic conditions. Such differences in texture as occur in the Keansburg soils in the various parts of the soil section are mainly differences in texture of the geological material from

which the soil has developed rather than differences brought about by soil development.

Keansburg fine sandy loam is the most extensive member of the Keansburg series in the Freehold area. It occurs in depressions mainly along drainage ways and in areas subject to seepage. This soil is mapped in the northern and eastern parts of the area, but the largest acreage lies in the southeastern part where the soil is associated with the light-gray soils of the Lakewood series. In the Freehold area very little of the Keansburg fine sandy loam is used for farming, the greater part being covered with deciduous trees and a more or less dense undergrowth of shrubs and herbaceous plants, gall berry being an important shrub.

On account of poor drainage and the large amount of available well-drained land in the area, little attention has been given to this soil. Like the sandy loam, when artificially drained it can be used for corn or many of the truck crops. In its undeveloped condition the value of the land is very low.

The results of mechanical analyses of samples of the surface soil and subsoil of Keansburg fine sandy loam are shown in Table 17.

TABLE 17.—*Mechanical analyses of Keansburg fine sandy loam*

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
170461	Surface soil, 1 to 10 inches	1.7	8.5	12.6	32.4	26.4	12.4	5.8
170462	Subsoil, 11 to 36 inches	1.9	12.0	16.4	35.0	25.4	5.3	4.0

KEANSBURG LOAM

The surface soil of Keansburg loam is black loam about 10 inches thick. It is underlain by a mottled yellowish-gray loamy sand subsoil which, in turn, is underlain by yellow loamy sand or sand. Under natural conditions drainage has been deficient and organic matter has accumulated. In some parts of the areas the surface is covered with a peaty layer.

Keansburg loam occurs in only a few bodies, most of which are in the southeastern part of the area. One of the largest bodies lies on the southern boundary of the area, and another is due north of this one just north of the Hominy Hills. A few bodies are in the southeastern part of the area, and two small bodies lie about a mile southeast of Keyport in the northern part.

Practically all the land is cleared and is utilized for farming. Artificial drainage is necessary to bring the soil under cultivation. Corn, grass, potatoes, and late truck crops are grown to a small extent. Good celery, cabbage, and onions could be grown on this land.

KEANSBURG SAND

The surface soil of Keansburg sand is black or dark-gray loamy sand to a depth of about 15 inches. The dark color, like that of other Keansburg soils, is due to the presence of a high percentage of organic matter. The subsoil is porous white or gray sand containing in places green materials. In some localities, at a depth

ranging between 24 and 30 inches, a compact almost black hardpan is present. The thickness of this layer varies, but in most places it is between 3 and 4 inches. Below this lies yellow and golden-yellow sand.

Keansburg sand occurs in small bodies in various parts of the Freehold area, but the few important bodies are in the southeastern part, the largest body including the Hockhockson Swamp, which is immediately north of the Hominy Hills. Practically all of this part of the soil has been cleared and drained and is used for the production of truck crops. Because of the high moisture content, crops mature later than on the sand and loamy sand members of the Sassafras series with which this soil is associated. Corn, tomatoes, and strawberries are produced.

About a mile northwest of Green Grove is a small body in which the surface soil is fine black sand, from 8 to 12 inches thick, which overlies gray sand. This, in turn, is underlain by mottled gray, yellow, and light yellowish-brown sand. This area has been included with Keansburg sand in mapping.

FRENEAU LOAM

Freneau loam is an alluvial soil. The surface soil consists of dark reddish-brown loam to a depth of about 10 inches. It is underlain by material which ranges in color from mottled reddish brown, rust brown, and greenish brown to limonite yellow, and in texture from clay to sandy clay. No attempt was made to differentiate this material into soil types according to drainage, texture of the surface soils, or layers of different textures. All the alluvial deposits with fair drainage and consisting mainly of mineral material were mapped, without further differentiation, as Freneau loam.

The soil is subject to flooding by high water. Because of the shallow channels in which the small streams of the region flow, flooding takes place very readily and frequently. Protection from flooding must be provided for this soil before it can be used for crop production. Very little of it is under cultivation, but a great part of it is used for hay and pasture. Because of its high moisture content and its fertility as compared with the upland soils, this is a good soil for hay and pasture. In some areas an acre yield of 2½ tons of hay is obtained.

MEADOW

An important part of the alluvial strips of the area is mapped as meadow. This name does not mean that these soils are used for pasture or hay to any greater extent than the other soils of the area, but it merely means that the strips consist of material washed into the stream valleys in such a heterogeneous way that there is no uniformity of character from place to place.

The material ranges from coarse to fine and through the whole gamut of local soil colors. Most of the land is very poorly drained. The natural vegetation is principally maples, shrubs of various kinds, and coarse grasses.

Very few of these bodies can be used for agriculture until they have been artificially drained, and at the present time there is no demand for this outlay as the cost would be greater than would be

justified under existing conditions. Some of the areas afford a little summer pasture, but most of them are still in brush.

MUCK

A large number of areas of muck were mapped, all of them lying in low areas, mainly in the small stream valleys. The muck areas are closely associated with the Keansburg soils. The material consists of a decomposed layer of black organic matter to a depth of about 12 inches, underlain by dark-brown less decomposed organic matter ranging up to a few feet in depth. The material lying below the organic layer is different in different places, both in color and texture, but most of it consists of mottled gray and yellow sand or sandy material. Most of the bodies are covered with a dense growth of white cedar, birch, and maple trees, together with a heavy undergrowth of coarse grasses.

For successful utilization these bodies must be artificially drained, fertilized, and limed. None of them is in use at the present time.

Muck, shallow phase.—Bodies of this soil consist of muck overlying, at slight depths, mineral material consisting predominantly of sand or sandy loam.

TIDAL MARSH

Tidal marsh comprises areas of land subject to inundation by tidewater at periods usually of the highest tides. Some of the bodies may be flooded at each high tide.

Tidal marsh grades into meadow in the upper parts of the tidewater streams, but sharp boundaries between meadow and tidal marsh do not exist. Much of this land is covered with cattails, numerous other reeds, and coarse grasses. In such places the material is soft, wet, and consists of blue or dark-drab silty clay loam or silty clay matted with grass roots in the upper part. A strong odor of hydrogen sulphide is noticeable over the freshly exposed subsoil material. Some areas, especially the more sandy ones, are covered by short marsh grass. In the better-drained areas, the percentage of mineral material is larger than in the poorly drained ones.

Tidal marsh occurs in the vicinity of the mouths of most of the larger streams within the area.

COASTAL BEACH

Along the northern and eastern shores of the area lies a narrow sandy strip consisting of coastal beach. It lies between the ocean and the more or less inclosed bay, and areas of tidal marsh. The material of these beaches consists almost entirely of rather fine quartz sand which, because of its continuous washing by the sea, is more or less rounded. On close examination some dark-colored specks may be seen in the mass of this material, such specks consisting of dark-colored minerals. Very little gravel or stones are present in the beach sand.

From Highlands to Monmouth Beach, much of the land has been graded and is now used as summer residential sites. Sandy Hook occupies the most extensive strip of coastal beach within the area.

Here a large development of sand dunes has taken place. Much of the coastal beach is covered with red cedar, scrub oak, poison ivy, beach plum, bayberry, beach grass, wild lupine, and weeds of various kinds. The growth of this vegetation is very dense in places where the water table lies near the surface.

MADE LAND

Made land comprises small areas located for the most part along the coast where sand beaches and tidal meadows have been built up or covered with earth. In those parts of the area lying some distance from the coast, where this material is shown on the map, it represents land whose surface has been changed so that no soil characteristics are present either in the surface soil or subsoil. Many of these areas represent extensive clay pits or pits from which clay sand has been removed. Made land has, at the present time, no agricultural value.

SOILS AND THEIR INTERPRETATION

The climate, relief, physiography, and general geology of the Freehold area have been given in the introductory chapter of this report. The materials from which the soils of the area have developed consist of greensand marls, clays, and sands.

The natural vegetation on the well-drained soils is of three kinds, as follows: (1) Hardwoods, consisting almost entirely of oak, (2) pine, and (3) mixtures of pine and oak.

The oak forests contain, in places where the soil is unusually fertile, a few trees of yellow poplar, beech, maple, linden, and a few other scattered species. All the open-forest areas and areas along the roadsides where the sun can reach the surface are covered with a rather dense growth of huckleberry bushes. Where the forest is rather dense so that practically all the surface of the land is well shaded, there is very little undergrowth.

The Freehold area lies in what has been designated in the United States as the area of gray-brown podzolic soils. It lies in the northern part of this area, but because of the low elevation the heavier-textured soils are somewhat more like the podzolic soils of the central and southern part of the belt than those of the extreme northern part such as those occurring in central New England and central New York. It is a region in which the rainfall is high, amounting to 45 inches, and the annual average temperature is about 52° F. The summers are warm but not excessively hot, because of the nearness to the ocean, and the winters are moderate. The ground does not freeze to great depths, but it is covered with a thin cover of snow during the greater part of the winter.

The outstanding characteristic of the soils of the Freehold area is the advanced stage attained in the development of a podzol profile. All the soils of the great belt in which the Freehold area lies, as well as all the soils of the Freehold area, are podzolic, but the fullness of development of the true podzol profile varies rather widely within the Freehold area. The advanced stage of development is attained only in the sandy soils and occurs in direct proportion to the percentage of sand in the soil material. The podzol profile, however, is

present in all the mature or nearly mature soils, even in the loams and sandy loams, and in the heavier soils to such slight extent that it can be detected on close examination in the virgin soils only.

In general the podzol profile has not attained an advanced stage in the Collington and Colts Neck soils or, in other words, in those soils developed from materials containing a large percentage of greensand or glauconite. This is due, in the first place, to the presence of an important constituent of clay in these soils, and in the second place to the presence of a large proportion of compounds of iron.

The podzol profile manifests itself most strikingly in the gray or white color of the surface soils. This color is due to the removal of iron oxide which was present in the material before soil development began. When this material contains a rather large percentage of fine-grained particles, water does not percolate through it so rapidly as it does through the sandy material where the percentage of fine-grained particles is less.

Other things being equal, therefore, it takes longer for soil developing from material containing an important constituent of clay or silt to become leached to a stage of light color or whiteness than soil from material containing a low percentage of clay or silt. The soil material that contains a high percentage of iron oxide attains the gray color in the surface soil, other things being equal, at a later time than it will be attained in soils where the percentage of iron is lower. The gray color expresses the absence or very low percentage of iron oxide. Practically any iron present in the podzolic soils will be in the oxide form, so that if the soil be gray it can contain practically no iron oxide. If the material contains a high percentage of iron oxide a stage of development represented by the absence of iron oxide will be reached after a much longer time than would be required in material identical in other characteristics. Since the Collington and Keyport soils of the Freehold area contain a higher percentage of clay than the other well-drained soils of the area and also contain a higher percentage of iron, it is evident that they should have attained a stage of podzolic development much less advanced than that of the other soils. If it were found to be equally advanced, some explanation would be demanded at once. The Collington and Colts Neck soils are very slightly podzolic.

The very sandy soils and especially the sands of this region have a highly developed podzol profile. These soils occur in two parts of the Freehold area: One in the northern and northwestern part, north and west of the Freehold-Colts Neck belt; the other in the south-central and extreme southeastern parts. The south-central and extreme southeastern parts of the Freehold area constitute the northern end of a large region in eastern New Jersey in which the soils are made up predominantly of sand and throughout which the podzol profile is highly developed.

The southern part of the Freehold area, therefore, is only part of a large area of true podzols lying in eastern New Jersey. Part of this area is covered by hardwoods consisting almost entirely of scrubby oaks, and part is covered with scrub pine. While young the oaks seem to grow at a fair rate, but they do not attain large size. The podzol profile of the soils, however, is developed under both

kinds of forest, and studies so far carried on indicate that it is as strongly developed under the oak forest as under the pine forest. The region has not been sufficiently studied up to the present time, however, especially from this point of view, to warrant a conclusive statement regarding this matter. The existing facts indicate that the stage of development of the podzol profile is to a greater extent due to the presence of sand than to the presence of oak or pine forest. South of New Jersey, in Maryland and Delaware, there is some indication that even the sands have not attained so advanced a stage of podzol development as in New Jersey. This, however, is a suggestion obtained by preliminary study and will have to be confirmed by further study.

The typical podzol profile of the region consists of four successive layers extending from the surface downward. These are as follows: (1) A mat of organic matter consisting of various kinds of forest débris; (2) a layer of gray mineral material, consisting essentially of sand; (3) a layer of brown, coffee-brown, or yellowish-brown material, mainly coffee-brown; and (4) grayish-yellow, yellow, or gray material which constitutes the parent material.

The mat of organic matter in the deciduous and mixed forests, consists of three layers as follows: The surface layer, consisting of loose, recently fallen leaves; the second layer, about an inch thick, consisting of undecomposed or only slightly decomposed leaves packed into a loose mass in which the leaves seem to have arranged themselves on each other in more or less regular order without very much crumpling; and the third layer consisting of dark fibrous material constituting the real mat. This material is dark brown or almost black and shows practically no leaf structure, as it consists of a finely divided mass of remnants of leaves and other forest débris, fibrous roots, and white fungous material. The fibrous roots run all through the material and seem to come from the larger tree roots which lie in the mineral soil immediately beneath the mat layer. The small roots that enter this mat divide and redivide, permeating the whole mass of dark, partly decomposed material, but apparently they do not extend into the brown layer of packed leaves above. The abundance of root fibers within the whole mass holds it in position causing it to assume the form of a mat. In soil nomenclature this layer is called the A_0 horizon.

In pine woods the mat is not developed as it is in oak woods, but it consists essentially of a thin layer of undecomposed pine needles underlain by a somewhat thicker layer of partly decomposed pine needles but not held together as a well-defined mat. It must be admitted, however, that studies have not been carried on far enough in the exclusively pine woods of the region to warrant the statement that the mat is never formed under a pine forest. It is clear, however, that it does not develop so readily under the pine forest as under the oak or mixed oak and pine woods.

The second layer consists of two parts, the upper one of which is gray or white sand containing enough organic matter to darken it. The transition between the lower part of the mat and this layer, which consists mainly of sand, is, in most places, abrupt. Some sand occurs within the mat, and, as just stated, organic matter is found within the sand layer, but very little sand reaches up into the true forest mat. This thin layer of organically stained dark-

colored sand is in few places more than 2 inches thick. It constitutes in soil nomenclature what is usually called the A_1 horizon. The second part of the gray layer or second fundamental horizon in the podzolic profile consists of structureless gray or white material. In the Freehold area where well developed it is sand. It contains little or no organic matter and where the profile is well developed the color is practically white. This constitutes the A_2 horizon. The A_1 and A_2 horizons constitute what in the United States is designated as the gray layer and what is known in Germany and throughout Europe as the bleicherde.

The brown layer consists also of two parts, the upper part being a coffee-brown or dark-brown layer of sand impregnated with dark-brown material which on chemical analysis is shown to consist of iron oxide and organic matter, with a low percentage of alumina and small percentages of the alkalies and alkaline earths. The organic matter and iron oxide which have been precipitated in this layer, constituting a kind of binding material, together comprise the fine-grained material within the layer. In many places where the percentage of iron oxide and organic matter is high and where the original material consisted of sand, this layer may constitute a stone-like layer, or hardpan, which is designated in German terminology as ortstein. In the United States it is usually called hardpan, where the precipitated organic matter and iron oxide have not cemented the sand it is designated as ortsand, and where it has developed in material containing a large percentage of clay, constituting a loam or sandy loam, it is designated as orterde. This layer in the Freehold area is rarely more than 4 or 5 inches thick. It is usually present throughout the area, even in the loamy soils of the Colts Neck and Collington series. In such places, however, it consists merely of lumps of material which are deeper brown than the other material with which it is associated. This layer is designated as the B_1 horizon.

The lower part of this layer changes gradually into lighter-colored and usually lighter-textured material constituting the B_2 horizon which is a mere gradation from the B_1 horizon, where the greatest change has taken place through the precipitation of organic matter and iron, to the parent material below, where little or no change has taken place.

The fourth layer constitutes the parent material, and in the sandy material of the Freehold area this consists of sand. In the heavier soils of the Freehold area, where the podzol profile is only faintly developed, this consists of the greensand marls or such other material as may be present.

In places where the organic-matter mat has not developed, for example, along roadsides where leaves do not fall or where because of the wind they do not accumulate, the surface layer of virgin areas is covered with a thin growth of moss, but no accumulation of an organic-matter layer takes place and the soil profile is essentially the same as under the organic mat. It is apparent that these areas, where the organic-matter mat is not present, are accidental and only recently has the surface soil been laid bare. The soil profile developed under an organic mat that previously existed in such spots and has not been changed since the organic mat was removed.

The podzol profile as just described is developed in the Lakewood soils and in the Sassafras sands and loamy sands. The difference between the Lakewood and the sandy Sassafras soils lies in the somewhat greater thickness of the surface gray layer, or bleicherde. In the Lakewood sands this layer is thick and white, but in the Sassafras sands it is less thick and, in some places at least, not so white as in the Lakewood sands.

Sand soils, with a well-developed podzol profile, have been described and named, on Nantucket Island, Mass., and on Long Island, N. Y., both of which lie northeast of the Freehold area and in approximately the same latitude, as Dukes sand. The Sassafras sand in the Freehold area is essentially identical with the Dukes sand, the only slight difference being an apparently somewhat more perfectly developed podzol profile.

Sassafras sand and Sassafras loamy sand in New Jersey are different from the corresponding Sassafras soils in Maryland west of the Chesapeake Bay, at least in the presence of the podzol profile in New Jersey and its absence in Maryland and also in the presence in Maryland of a red B horizon and the absence of such a red B horizon in the sands of the Freehold area. In the Freehold area the color of the B horizon is brown rather than red. The color of the subsoil, however, is less important as a distinction between the sandy soils in the two localities than is the absence of a well-developed gray layer in the one and its presence in the other.

In the sandy loams of the Collington series in New Jersey the podzol profile, as already stated, is present though only faintly developed. In the virgin soil the forest mat is typically developed, which, so far as studies carried on up to the present time show, does not differ in any respect from the forest mat on the Sassafras soils. Beneath the forest mat lies a thin gray or yellowish-gray layer, in few places as much as 1 inch thick. Although it has not attained a white color, it is light enough to show definitely that the podzol profile is in the process of development. This layer is underlain by brown material containing lumps of stronger-brown material. This strong-brown material constitutes the orterde of the faintly developed podzol profile. The material below this consists of the brown or reddish-brown material of the Collington profile.

In the sands of the Collington or Colts Neck series a thin sandy bleicherde is definitely developed, ranging up to about 2 inches in thickness. The orterde is also somewhat better developed than in the other members of the Collington and Colts Neck series.

The poorly drained and alluvial soils throughout the Freehold area consist essentially of geological material slightly modified, in the poorly drained soils, by the presence of ground water.

SUMMARY

The Freehold area includes part of the coastal plain of New Jersey, where the soils have developed mainly from the older beds of the coastal plain, consisting of sands, clays, sandy clays, and glauconite deposits, all unconsolidated. The distribution of geological formations, physiographic features, and soils is in east-west belts.

The growing season is long enough to allow the maturing of the important grain, vegetable, and fruit crops of the Temperate Zone. The summers are warm but not excessively hot and the winters mild.

The annual rainfall is well distributed and amounts to about 45 inches.

The agriculture of the area, on the loams and sandy loams which are inherently the most productive soils, consists in the growing of the ordinary general-farm crops of the United States predominating in the latitude in which the area lies. These crops are grain, grass, and legumes, and in addition potatoes, grown on a commercial scale, and fruit, mainly tree fruits. On the sandy soils the crops are mainly truck crops, predominantly asparagus, sweet corn, and tomatoes.

The loams and sandy loams of the region belong mainly to the Collington and Colts Neck soil series, the members of both series having been derived from deposits containing an important glauconite constituent and in which this material is still present in perceptible amounts in the subsoil or substratum.

The sands and very sandy soils have developed from sand deposits and occupy two parts of the area, the southern and the northwestern. Some of the sand deposits contain, where unweathered or only slightly weathered, some glauconite material. In the northwestern part of the area some areas of clay deposits lie near enough to the surface to have allowed the development of soils from them. The soils developed from sands in the southern part of the area are mainly members of the Lakewood series and in the northwestern part are members of the Sassafras series. The soils developed from clays are members of the Keyport series.

Some areas of poorly drained and imperfectly drained soils are members of the Keansburg and Shrewsbury series.

The Freehold area lies in that part of the United States where soil development takes place under the influence of the podzolic process. The loams and heavier sandy loams are slightly developed podzols or are only slightly podzolic, and the very sandy soils are well-developed podzols.

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[PUBLIC RESOLUTION—No. 9.]

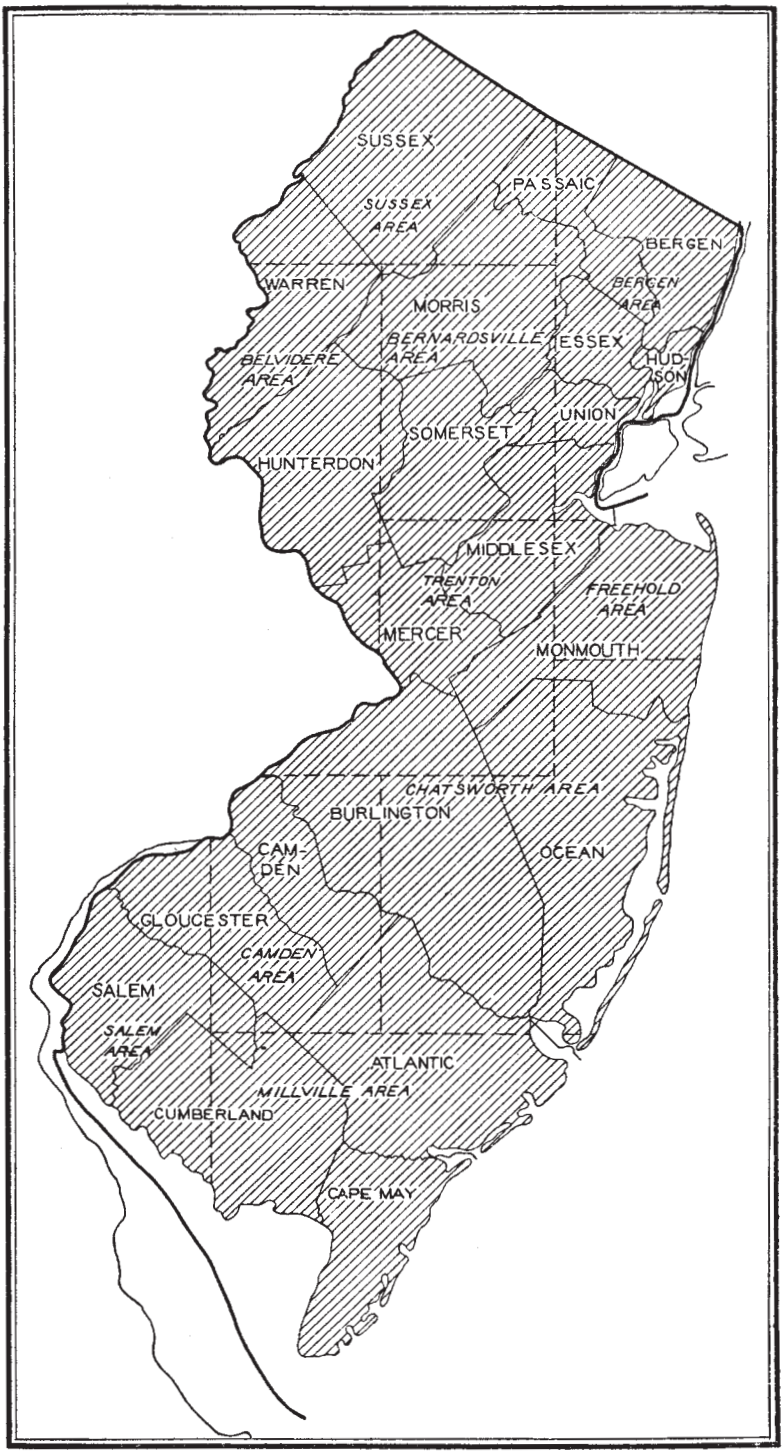
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Areas surveyed in New Jersey, shown by shading

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