U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE DEPARTMENT OF CONSERVATION AND DEVELOPMENT OF NEW JERSEY, HENRY B. KUMMEL, STATE GEOLOGIST; NEW JERSEY AGRICULTURAL EXPERIMENT STATION, JACOB G. LIPMAN, DIRECTOR.

SOIL SURVEY OF THE BELVIDERE AREA, NEW JERSEY.

BY

AUSTIN L. PATRICK, IN CHARGE, HOWARD C. SMITH, AND J. M. SNYDER, OF THE U. S. DEPARTMENT OF AGRICULTURE, C. C. ENGLE, L. L. LEE, AND H. A. MILLER, OF THE DEPARTMENT OF CONSERVATION AND DEVELOPMENT OF NEW JERSEY.

HUGH H. BENNETT, INSPECTOR, SOUTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1917.]

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Soils,
Washington, D. C., July 1, 1919.

Sir: I have the honor to transmit herewith the manuscript report and map covering the survey of the Belvidere Area, New Jersey, and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils, 1917, as authorized by law. This work was done in cooperation with the Department of Conservation and Development of New Jersey.

Respectfully,

Milton Whitney,
Chief of Bureau.

Hon. D. F. Houston,
Secretary of Agriculture.

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Soil map, Belvidere area sheet, New Jersey.

SOIL SURVEY OF THE BELVIDERE AREA, NEW JERSEY.

By A. L. PATRICK, In Charge, HOWARD C. SMITH, and J. M. SNYDER, of the U. S. Department of Agriculture; C. C. ENGLE, L. L. LEE, and H. A. MILLER, of the Department of Conservation and Development of New Jersey.

DESCRIPTION OF THE AREA.

The Belvidere area, comprising nearly all of Hunterdon County, about three-fourths of Warren County, about one-third of Mercer County, and small parts of Somerset, Morris, and Sussex Counties, is situated in the southwestern part of northern New Jersey. The Delaware River, its western boundary, separates it from the State of Pennsylvania. It has an area of 764 square miles, or 488,960 acres.[1]

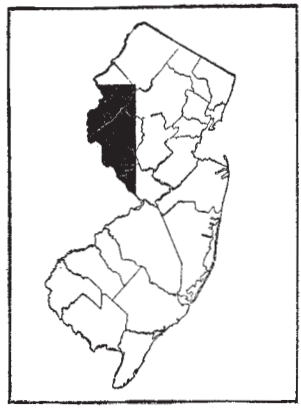


FIG. 1.—Sketch map showing location of the Belvidere area, New Jersey.

Parts of three distinct topographic provinces occur in the Belvidere area, known respectively as the Appalachian Valley, the Appalachian Mountains, and the Piedmont belt. (See Pl. I.)

In the extreme northwest there is a region of flat-topped hills with a somewhat uniform elevation of 600 to 700 feet, whose smooth, and in places steep, slopes descend to narrow valleys cut 100 to 350 feet below the general level. This region is a part of the great Appalachian Valley, the portion in New Jersey being known as Kittatinny Valley. It is crossed at right angles from northwest to southeast by the Delaware River, which flows in a steep-sided, flat-bottomed trench 350 to 400 feet deep and from one-half to three-quarters of a mile wide. A short distance above the town of Belvidere the river turns southwest and flows for 10 miles or more parallel to the southeastern margin of the great valley. In this part of its course the walls of the trench are neither so steep nor so high as in its transverse course, and the river is bordered by somewhat wider bottom lands and terraces.

Southeast of the Appalachian Valley is the Appalachian Mountain province. In New Jersey it is a mountain region 10 to 18 miles

[1] The base map used is that of the Geological Survey of New Jersey and includes all of Atlas sheet No. 24 and the northwest triangle of sheet No. 27.

in width and is known as the Highlands. It consists of several broad, rounded, or flat-topped ridges rising 400 to 600 feet above the lowlands on either side, and separated from one another by deep valleys, some of which are narrow, while others are as wide as or wider than the intervening ridges The larger topographic features of the Highlands, i. e., certain broad lowland belts and the broader and more massive ridges, show a marked northeast-southwest trend, although many of the minor features are irregular. Near the Delaware the ridges are broken and the intervening lowland belts become wider and coalesce, forming near Phillipsburg a broad, level plain with a general elevation of about 400 feet, while the summits of the neighboring ridges rise to elevations of 650 to 1,070 feet. The chief characteristic of the province in New Jersey is the absence of any sharp mountain peaks. The Highland ridges are broad, flat-topped, plateaulike elevations, whose summits over wide areas maintain a closely accordant level which rises northeastward from about 750 or 800 feet near the Delaware to 1,000 or 1,100 feet on Schooleys Mountain and Allamuchy Mountain near Hackettstown in the Belvidere area, and to elevations of 1,400 feet or more farther northeast.

The interhighland lowland belts have rolling surfaces 400 to 700 feet below the bordering upland, and the streams which drain them flow in narrow and for the most part shallow trenches, and are bordered by narrow flood plains. The northern part of Hunterdon, the southern part of Warren and Sussex, and the western part of Morris County are the parts of the Belvidere area belonging to the Appalachian Mountain province.

Southeast of the Highlands is the Piedmont belt, a region of somewhat varied topographic expression. As a whole it lies 500 to 600 feet below the level of the adjoining uplands, but considerable parts of it, particularly in the Belvidere area, rise much above the general level, and indeed have elevations which accord closely with the broad summits of the Highland ridges. In fact, so close is this agreement that it is concluded that the Piedmont and the Highlands were once a part of an extensive plateau of which these higher summits are now the dissected remnants. The level upland west of Flemington known as Hunterdon Plateau (elevation 500 to 700 feet), the horseshoe-shaped ridge known as Cushetunk Mountain south of Lebanon (750 to 834 feet), and Sourland Mountain, northeast of Lambertville (450 to 500 feet), are the more important of these higher areas. The rest of the Piedmont region is a gently rolling plain which rises from about 120 feet near its southern margin at Trenton to 350 or 400 feet along the border of the Highlands, while there are wide areas having a somewhat uniform height of about 200 feet. Many of the streams flow in sharply cut narrow valleys, the slopes of which are

too steep for cultivation, particularly near the Delaware and other master streams.

In all three provinces the larger features of the topography have been determined by the geologic structure, and are the result primarily of stream erosion on rocks of different hardness. Resistant granite and gneiss underlies the Highland ridges, whereas the northeast-southwest interhighland lowland belts have been eroded along belts of softer and more soluble limestone infolded in the crystalline rocks. The rounded hills of the Appalachian Valley are for the most part slate, with a belt of more soluble limestone along the southeastern margin.

The lower portion of the Piedmont is underlain by relatively soft red shale or sandstone, and intrusive masses of extremely resistant diabase (trap) form the central axis of Sourland Mountain, Cushetunk Mountain, and several isolated hills north and west of Pennington. The broad upland west of Flemington, known as the Hunterdon Plateau, owes its elevation to the resistant quality of massive beds of extremely fine-grained claystone (argillite). The high wooded hills south of Pattenburg are formed by conglomerate beds, the quartzite pebbles of which are so large and so insoluble as not to be readily removed by any agents of erosion. All of these factors are of importance in the study and classification of the soils of the area.

The drainage of the area is into the Atlantic Ocean through the Delaware and Raritan Rivers. Nearly three-fourths of the area is drained by the former stream. Its two most important tributaries are the Pequest and Musconetcong Rivers, which flow southwest across the northern part of the area. A large number of streams only a few miles in length empty into the Delaware River between Trenton and Columbia. The South Branch of the Raritan River flows in a southwest direction to High Bridge, where it breaks through the Highlands and flows in a general southeast direction into Raritan Bay.

The area, as a whole, is well drained, and nearly every farm has a drainage outlet. The Hunterdon Plateau, especially in the vicinity of Croton, is the most poorly drained of any of the large tracts in the area. In the Appalachian Valley and on the Piedmont belt the small streams in many places have cut more than 200 or 300 feet below the general surface. The depth of stream dissection is especially marked in the Piedmont region, along the Delaware River, which has cut its channel in places more than 400 feet deep. Prominent bluffs naturally occur in both the Highland and Piedmont regions. The streams are still actively cutting in most places, and water-power can be developed at numerous sites. Many old mills have been operated at various times in the past.

The northern third of the Belvidere area contains a few small lakes or ponds. Greens Pond or Mountain Lake north of Butzville is a summer resort of some renown.

Swedes, English, Quakers, and Holland Dutch all played an important part in the early settlement of this area. The land was purchased from the Indians in 1703, at which time settlements were made at Lambertville and Ringoes. In 1713 the region now comprising Hunterdon, Warren, Morris, Mercer, and Sussex Counties was set off from Burlington County. At first the territory separated was called Hunterdon County, and the other counties were organized and separated at a later date.

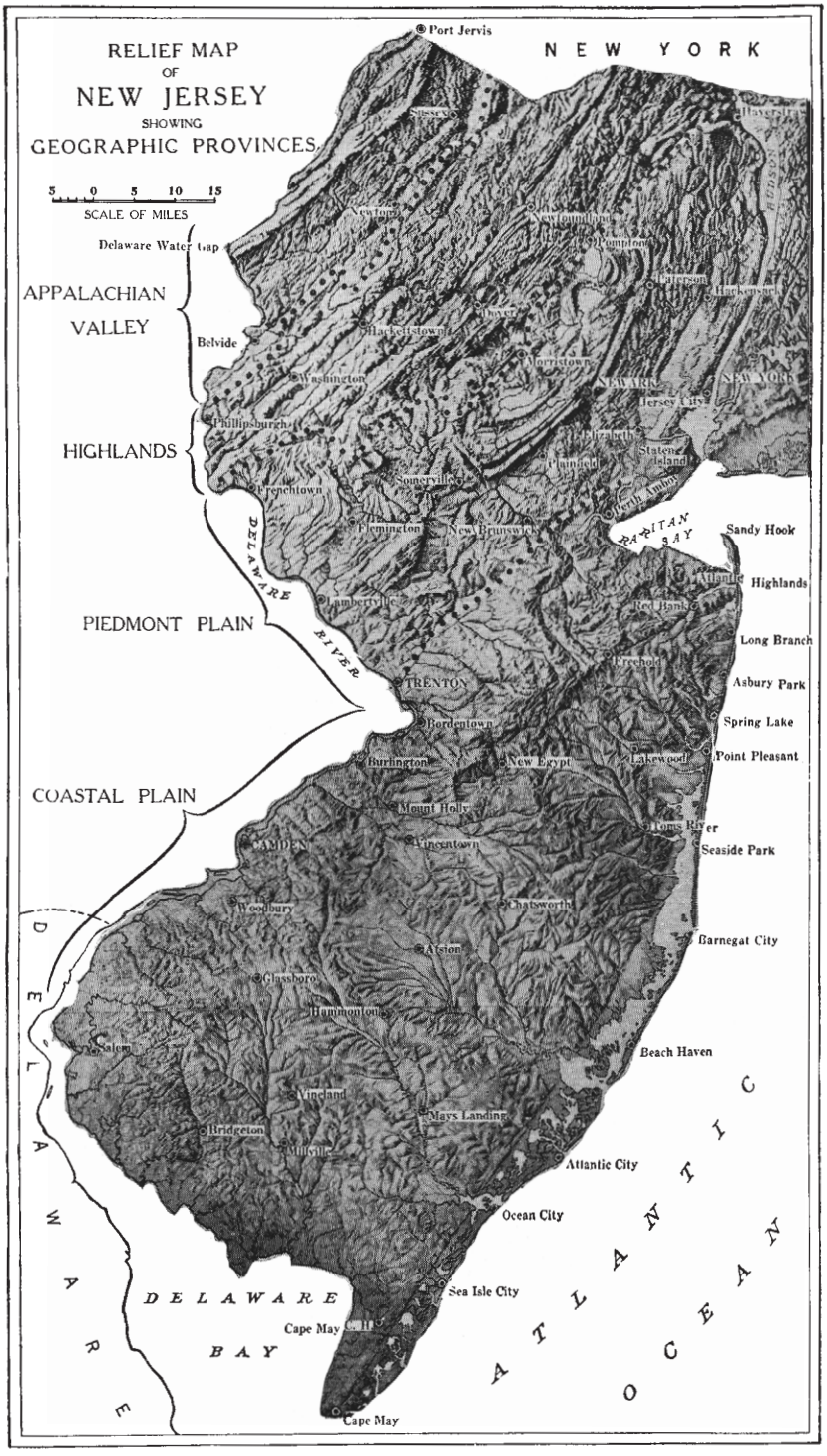
Many of the descendants of the original settlers live in this region to-day. There are, however, a large number of aliens and foreign-born white persons, who are engaged largely in working in the mines at Oxford or in the numerous factories. They are mostly Poles, Italians, Hungarians, and Germans. Near Great Meadows the muck-land farmers are for the most part Poles. The number of foreign-born whites has been increasing for many years.

The population of Hunterdon County in 1910 totaled 33,569, of whom 7,350 lived in towns of over 2,500 inhabitants. In Warren County the total population was 43,187, of whom 20,185 lived in towns.

The average rural population per square mile in Warren County is given as 63.5 persons by the 1910 census, as compared with an average of 60 persons in Hunterdon County. The population of both counties is well distributed, except that the mountain regions are somewhat less thickly settled than the valleys. There has been a slow but constant decrease in the population of Hunterdon County since 1870, while the population of Warren County has increased since 1890.

Among the many towns in the area the only one with a population of over 20,000 in 1914 is the manufacturing city of Trenton, capital of the State, with 103,190 inhabitants. Phillipsburg comes next, with a population of 15,430 in 1914. Lambertville, Washington, Flemington, the county seat of Hunterdon County, Hackettstown, Belvidere, the county seat of Warren County, and High Bridge are manufacturing towns of considerable importance.

The area is situated close to many large centers of population. Easton, Pa., is connected with Phillipsburg by a bridge across the Delaware River. New York, Newark, Jersey City, Hoboken, Philadelphia, and the coal fields of Scranton and Wilkes-Barre are all within 100 miles, and many of these places are within 30 to 60 miles of parts of the area. Philadelphia is only 33 miles to the southwest.



GEOGRAPHIC PROVINCES OF NEW JERSEY.

Main lines and branches of the Pennsylvania, the Delaware, Lackawanna & Western, Central Railroad of New Jersey, Lehigh Valley, Philadelphia & Reading, and Lehigh & Hudson River Railroads traverse nearly all parts of the area. A trolley line connects the southern part of the area with Trenton, and another extends from Phillipsburg up the Pohatcong Valley for nearly 15 miles. Bridges across the Delaware River are found every few miles, connecting the farming sections closely with Pennsylvania. In addition, the old Morris Canal and the Pennsylvania Canal connect Phillipsburg, Trenton, and smaller towns with New York and Philadelphia.

There are many improved State and county roads, and more are being built each year. The rural roads are systematically worked, and except during wet seasons are nearly equal to the improved roads. Good telephone service is available to all the farming sections. Adequate school facilities are found all over the area.

CLIMATE.

The climate of the Belvidere area is characterized by cold winters and moderately warm summers. Recorded extremes in temperature range between —19° F. in the winter and 102° F. in the summer, but temperatures even approximating these are very seldom reached. Temperatures of over 100° or below zero never last longer than a few days at a time.

A study of the records of the various Weather Bureau stations shows a considerable variation in temperature and rainfall within the limits of the area. In the northern half the temperature is from 1 to 2 degrees cooler than in the southern half, and the annual precipitation is from 3 to 5 inches greater. Perhaps the most striking difference in climatic conditions is in the length of the growing season as measured by the average date of last and first killing frosts. At Belvidere there is an average growing season of 163 days, from May 3 to October 13, while at Lambertville the season averages 187 days, from April 23 to October 27. As a consequence, quicker maturing varieties of flint corn are grown for grain in the northern portions of the area, while the dent varieties are favored in the southern parts. There is also considerable difference in climatic conditions between the mountain and valley areas. Thus, in the fall of 1917 early frosts in September killed all the corn in the valleys, while that on the ridges lived for a week or ten days longer.

In winter the ground freezes to a considerable depth, and some damage is often done by alternate thaws and freezes. Clover, wheat, and rye sometimes "heave" and winterkill. Buds of fruit trees, especially peaches, often are injured by late spring frosts, particularly on southern slopes in the northern part of the area.

The precipitation is adequate and well distributed through the growing season, being heaviest during the summer months. The annual precipitation has ranged from a maximum of 67.23 inches in 1889 to a minimum of 30.08 inches in 1914.

The following tables give the more important climatic data as recorded at the Weather Bureau stations at Trenton and Belvidere:

Normal monthly, seasonal, and annual temperature and precipitation at Trenton.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1914).	Total amount for the wettest year (1889).	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	34.4	70	1	3.16	4.64	2.03	3.4
January	30.5	72	−8	3.17	2.72	4.40	7.2
February	30.7	72	−10	3.19	3.00	3.36	10.2
Winter	31.9	72	−10	9.52	10.36	9.79	20.8
March	39.1	86	6	4.04	3.28	5.67	3.8
April	49.8	93	21	3.29	2.57	5.00	.2
May	61.1	99	33	3.52	1.98	4.47	.0
Spring	50.0	99	6	10.85	7.83	15.14	4.0
June	69.5	98	41	3.49	1.74	2.67	.0
July	74.5	100	50	4.77	4.75	9.86	.0
August	73.0	99	46	5.37	1.63	7.23	.0
Summer	72.3	100	41	13.63	8.12	19.76	.0
September	66.9	97	35	3.59	.41	10.13	.0
October	55.6	89	28	3.41	1.74	4.66	.0
November	44.4	78	10	3.43	1.62	7.75	1.1
Fall	55.6	97	10	10.43	3.77	22.54	1.1
Year	52.5	100	−10	44.43	30.08	67.23	25.9

Normal monthly, seasonal, and annual temperature and precipitation at Belvidere.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1900).	Total amount for the wettest year (1902).
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	30.8	67	−4	4.14	2.91	8.99
January	27.5	68	−15	3.75	3.32	3.13
February	27.4	64	−11	4.32	5.09	7.05
Winter	28.6	68	−15	12.21	11.32	19.17

Normal monthly, seasonal, and annual temperature and precipitation at Belvidere—Continued.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1900).	Total amount for the wettest year (1902).
March	36.8	87	−5	4.04	3.66	4.45
April	49.6	96	15	3.27	2.12	3.57
May	60.7	100	29	3.89	2.31	1.48
Spring	49.0	100	−5	11.20	8.09	9.50
June	69.0	99	39	4.40	3.70	6.65
July	72.7	102	42	5.60	5.37	6.21
August	70.8	99	43	4.96	1.92	4.11
Summer	70.8	102	39	14.96	10.99	16.97
September	65.1	98	31	3.92	2.06	8.83
October	52.5	93	18	3.84	1.54	5.62
November	41.2	75	5	3.49	2.37	1.65
Fall	52.9	98	5	11.25	5.97	16.10
Year	50.3	102	−15	49.62	36.37	61.74

AGRICULTURE.

The pioneer farmers in the Belvidere area had to clear much of the land of a dense growth of hardwoods, and in many places stones had to be removed. The early crops grown were corn, barley, oats, rye, wheat, and some flax. Herds of cattle and hogs were branded and allowed to range in the woods. Nearly every farmer's income was supplemented by the sale of logs, which were rafted down the Delaware River to Philadelphia. Transportation for the first hundred years was by wagon. The principal market for farm products was Philadelphia, followed in importance by New York. Boating up the Delaware was possible only in small boats during high-water periods, usually in the spring, but early in the nineteenth century the Delaware & Raritan, Pennsylvania, and Morris Canals were constructed and aided greatly in developing the country. Until recent years they were important factors in the transportation of bulky commodities. With the building of the railroads about the middle of the nineteenth century the real development of this territory began.

Owing to the good natural growth of grass, cattle raising has always been an important branch of agriculture, though there have been many changes in the form of the industry. The beef cattle raised at first were slowly displaced by dairy cows, and butter and

cheese products were made, but with the growth of the large cities the demand for whole milk gradually increased until to-day nearly all the surplus available is shipped directly to the cities. The original Jersey and Guernsey cattle have been largely displaced by Holsteins. The number of sheep and hogs has steadily decreased, and to-day the products from these animals are of minor importance in the agricultural economy.

Peach growing was of primary importance at one time, especially in Hunterdon County. In 1890 a total of 2,073,322 trees was reported in Hunterdon County, but in 1900 there were only 1,046,391, and the number dropped to 309,476 by 1910.

The present dominant type of agriculture is general farming combined with dairying. Poultry raising is of considerable importance, though there are few exclusively poultry farms. The chief money crop is wheat, but in places rye and buckwheat are important sources of income. Hay, corn, and oats are the principal subsistence crops, of which the surplus only is sold, though this often forms a large part of the farm income. According to the census, the total area in cultivated grasses in Hunterdon and Warren Counties in 1909 was 62,818 acres, producing 71,064 tons of hay.[1] Of the cultivated grasses the most popular are timothy and clover, which are usually grown together. In 1910 there were 36,377 acres of mixed timothy and clover, producing 40,964 tons of hay, or slightly more than 1 ton per acre. The hay is either put in the barns or stacked for feed. Large quantities are fed to work horses and dairy cows, and the surplus is baled and sold in the near-by markets.

In 1909 the two counties produced 1,747,042 bushels of corn, 697,043 bushels of oats, 504,456 bushels of wheat, 158,071 bushels of rye, and 121,245 bushels of buckwheat. The total value of the crop production by classes was as follows: Cereals, $2,216,370; hay and forage crops, $1,036,276; vegetables, $385,943; and fruit and nuts, $255,954.

Peaches are of importance locally, especially in parts of Hunterdon County. Lebanon is the center of the peach-growing industry. Onions, celery, and lettuce are important crops in places, as at Great Meadows. Some watermelons and cantaloupes are grown along the Delaware River. Near Trenton and in a few other places the growing of flowers is a well-developed industry. Numerous nurseries, which specialize in fruit and ornamental trees, are located in

[1] In giving crop statistics, no consideration is given to the small portions of Mercer, Somerset, Morris, or Sussex Counties included in the area, as the figures concerning the included portions of those counties, if ascertainable, would not change the deductions otherwise drawn. The total extent of Hunterdon and Warren Counties is about equal to that of the whole area surveyed, and the portions of these two counties not included in the area surveyed are similar to the included portions of the other four counties in topography, soil, and agricultural development.

the southern part of the area. Apples are produced in large quantities in places. Irish potatoes and other vegetables, including sweet corn, beans, peas, squashes, pumpkins, and cucumbers, are grown on nearly every farm to supply the home table, and the surplus is sold. Near some of the local markets a few farmers specialize in market gardening.

Dairying is the leading industry on a majority of the farms. In the two counties there are 28,423 milch cows, or an average of over 6 per farm. The milk is sold in neighboring cities, New York and Philadelphia taking all the surplus. The total value of the dairy products in 1909 amounted to $1,415,575.

In 1909 the value of the animals sold or slaughtered in Hunterdon and Warren Counties totaled $1,008,771, while the poultry and eggs produced amounted to $983,927. Of the animals sold or slaughtered, hogs and calves made up nearly 90 per cent of the total value, there being 40,304 hogs and 23,074 calves sold or slaughtered. Most of the hogs are consumed on the farm where raised, only the surplus being sold. There were 31,904 hogs in the two counties in 1909, or an average of over 7 per farm. Hunterdon County stood first among the counties of the State in 1909 in the number of stands of bees and number of poultry.

The topography and type of soil exercise a considerable influence upon the type of agriculture from place to place. In the Highlands rye is grown in larger quantities than wheat, and flint corn is usually grown on the mountains and dent corn in the valleys. The Muck in the northern part of the area is the only soil upon which onions, celery, and lettuce are grown in large quantities, while only on the sandy soils are melons grown extensively.

The farmers report that wheat and corn do better on the Hagerstown and Dover soils than on many of the others, and that the Chester and Montalto soils are naturally better adapted to peach and apple production than many of the other soils. Oats, rye, timothy, and alsike clover are known to do much better on the Croton soils than wheat, corn, and red clover. To some extent these ideas of soil adaptation govern the farm practices.

The farms as a whole are well equipped, and the buildings are well built and usually kept in good repair. They constitute about 40 per cent of the entire farm value. The barns are large, constructed with the idea of storing large quantities of unbaled hay and straw. The cow stables are usually on the ground floor. The large milk companies insist upon cleanliness, and there is always plenty of window space. The farms usually include a number of smaller buildings such as corn cribs, wagon and machinery sheds, milk and root cellars, hog and chicken houses, and of late years garages. In the barnyards many farmers have built feeding sheds, which have at least

two sides open. A peculiar form of shed is often used for storing hay or straw, called a "barracks." This consists of four posts and a roof which can be moved up or down as the stack increases or decreases. Silos are becoming more numerous each year.

The equipment of farms in machinery is rather complete, and constitutes approximately 6 to 8 per cent of the whole farm value. Thrashers, shellers, feed grinders, gasoline engines, drills, manure spreaders, 2-row corn planters, 2-row cultivators, corn harvesters, and reapers and binders are found on the majority of the farms. A few tractors are in use. The work horses as a rule are large animals, and are found in sufficient numbers on nearly all farms.

The number of dairy cows ranges from 4 to 20 per farm. They are usually good grade animals, of predominately Holstein blood, and often the herds are headed by pure-bred bulls. Some pure-bred herds are kept in various parts of the area. Next to Holstein, Guernsey and Jersey blood predominates. The hogs are usually Chester Whites, and 6 or 7 are found on the average farm. In 1910, 17.1 per cent of the total value of the average farm in Hunterdon County was represented by domestic animals, and 14.7 per cent in Warren County.

In preparing the land for planting, breaking is usually done with two or three horse turning plows. The land is broken to an average depth of about 6 inches and is subsequently run over with disk or spring-tooth harrows, which is followed by a smoothing harrow; drags and rollers are used to break up the clods where necessary. When land is plowed in the fall for spring planting the disk harrow is usually the first implement used in the spring. The two-horse drill is generally used in seeding wheat, rye, oats, and buckwheat, but a few farmers on rough or steep fields still sow these grains by hand.

Corn is planted 12 to 20 inches apart, in rows spaced at intervals of 3 to 4 feet. When hand planters are employed three or more grains are put in a hill. When the crop is to be used for silage dent varieties are grown and the seed is planted closer together. When the crop is grown for grain flint corn is planted on the uplands and in the northern part of the area. Corn is planted late in May or early in June. It receives frequent shallow cultivations until about the last of July or early in August. The crop is cut about October 1 and shocked, after which it is husked and put in cribs.

Wheat and rye are drilled about the middle of September, except following seasons when the ravages of the Hessian fly have been particularly severe, in which case the seed is not put in until after the second killing frost. Timothy is usually sown with the wheat or rye and clover is broadcasted in the grain fields with a wheelbarrow seeder early the next spring. The grains are harvested in July, and after drying in shocks are stacked before thrashing. Oats are seeded

early in the spring, and harvested in July or August. Buckwheat is generally grown on fields in which some other crop has failed to make a stand or, owing to a poor season, could not be planted at the proper time. The crop is put in at any time before the middle of July.

Crops are nearly all grown in rotations. The most common rotation consists of corn, oats, and wheat, each one year, and clover and timothy hay, for two or even three years. Rye is substituted for wheat in places where wheat does not thrive.

The census reports show that in 1909, $152,235 was spent for fertilizer in Hunterdon County, an average of $70.18 for each of the farms reporting its use. In Warren County $66,775 was expended at an average cost per farm of $60. The commercial fertilizers used are of many different formulas, but the most common one is a 2–8–10 preparation.[1] Some farmers use phosphoric acid alone. All the stable manure made on the farm is generally applied to sod during the fall or winter before plowing for corn, and a few farmers apply small quantities of commercial fertilizer in the row at the time of planting the corn. Applications ranging from 150 to 400 pounds of commercial fertilizer are applied at the time of planting oats, wheat, and rye. Wheat usually receives 50 to 100 pounds more per acre than oats. The truckers on the Muck lands near Great Meadows often apply as much as 1 ton of commercial fertilizer per acre. Since the war in Europe began the fertilizer systems have greatly changed. Potash is no longer in common use and the formulas generally read 1–10 or 0.85–10.

Until a few years ago liming of the soils was a general practice. Nearly every farmer had a kiln, in which he converted into quicklime limestone fragments gathered from outcrops or quarried. The lime was air slaked and applied to the land. With the scarcity of labor and the high price of fuel liming has been neglected. Many farmers have the erroneous belief that commercial fertilizers take the place of lime. Numerous cement factories within the Belvidere area and across the Delaware River furnish a source of lime for agricultural purposes.

Most of the farmers buy some prepared cow feed, especially during the winter. The census reports that in Hunterdon County an average of $134.32 for each of 1,703 farms was spent in 1909 for this purpose. In Warren County the average expenditure amounted to $151.

The farm labor is performed for the most part without outside help, but many farmers keep a farm hand the year round and nearly all require some extra help during the summer and early fall months.

[1] Fertilizer formulas are stated in the order nitrogen, phosphoric acid, and potash.

Farm laborers are usually residents of the counties, but in some sections foreigners are hired during the summer. Negroes are employed on a few farms north of Trenton. Owing to the great demand for labor in the many near-by plants and factories, farm help is hard to obtain, and this one drawback has been and is doing more to retard crop production than any other factor. In 1910 the average expenditure for labor on each farm in Hunterdon County was $250.33, as compared with $262 in Warren County. At present laborers hired by the year receive $30 to $40 a month and board. Day laborers receive $2 to $3 a day. In the Great Meadows truck region much of the harvesting is done by women and children, who receive pay according to the work performed.

Farms in the Belvidere area range in size from a few acres up to 200 acres or more. The 1910 census gives the average size of farms in Hunterdon County as 84 acres, of which 70.1 acres consists of improved land. In Warren County the average size was 101.6 acres, of which 78.9 acres are improved.

About 60.8 per cent of the farms in Warren County and about 70.4 per cent in Hunterdon County are operated by the owners. The majority of the rented farms are let on a share basis, the systems of accounting varying considerably, depending on special arrangements. Often the owner furnishes the land, buildings, and permanent fixtures, pays for half the fertilizer and seed, and receives half of the grain. When the owner furnishes the cows, as he often does, he receives a certain proportion of the milk receipts as well. Usually the number of acres to be planted in grain is stipulated in the agreement.

Land values vary greatly, depending on the character of the soil, the topography, the condition of the farm buildings, and the improvements, as well as on the proximity to towns and railroads. The general range is from $20 to $150 an acre. The average assessed value of all farms in Hunterdon County in 1909 was $5,206, of which 34.1 per cent was represented by the land. In Warren County the average farm value was $5,496, of which 40 per cent was for the land.

SOILS.

The Belvidere area lies mainly in the Glacial, Appalachian, and Piedmont soil provinces. Its soils as a whole owe their origin directly to, or are at least largely influenced by, the underlying rocks. These can be broadly classed as crystalline—igneous and metamorphic—and sedimentary. The crystalline rocks include gneiss, diabase, and relatively unimportant bodies of marble. These rocks because of their extreme hardness have not eroded as rapidly as have the softer sedimentary formations, and they form the base of all the high ridges or mountains. In the northern half of the area the ridges consist of gray and white granitoid gneiss of Pre-Cambrian

Age,[1] while in the southern or Piedmont regions the coarse-grained trap or diabase ridges stand high above the general level.

Of the sedimentary rocks the Cambro-Ordovician limestone and shales form the valleys separating the gneiss ridges in the northern part of the area. In the southern part the Triassic shales, sandstones, and conglomerates form probably the greater part of the Piedmont. The extreme southern part of this plain has been thinly covered by unconsolidated gravel and sand of much later origin.

At least two distinct glacial deposits laid down by two ice sheets widely separated in time occur in the northern part of the Belvidere area. The first, known as the Jerseyan, deposited a mantle of drift, but no terminal moraine. It came as far south as the northern border of the Piedmont region and locally encroached upon it. In many places the material accumulated by it has been entirely removed by erosion, and its deposits are of importance only in the wider valleys and on the flat tops of the mountains. Even here erosion has effaced nearly all evidences of glacial topography. So old is this drift sheet that its soluble constituents, notably limestone, have been leached out, leaving only the relatively insoluble flinty sandstone, quartzite, and other siliceous rocks. Rusty-looking quartzite cobbles and gneiss bowlders in all stages of decay are characteristic of this drift sheet.

The later ice invasion was during the Wisconsin glacial epoch. It was characterized by the formation of a strong terminal moraine, with well-marked hummocky topography. It crosses the Belvidere area in a narrow, irregular belt from Belvidere to Hackettstown, and marks the southern limit of the ice sheet during this invasion. The moraine consists of material picked up, transported, partly pulverized, and later deposited by the moving ice sheet along its margin. Where thickest, it attains a depth of 200 or 300 feet. The moraine material reflects in a general way the rocks underlying the region over which the ice had passed. Where it had traversed wide areas floored by limestone, slate, or hard sandstone, as was the case in the Belvidere area, these rocks are conspicuous elements in the moraine, even though the rock on which it rests is gneiss. With the melting of the ice and the gradual withdrawing northward of its margin, a sheet of drift much like that in the terminal moraine was strewn over the uncovered surface. Some of it, chiefly in the valleys, was reworked and redeposited by the streams which flowed from the melting ice. The thinner the drift the more the material it contains has been derived from the rock immediately beneath, and locally it may closely resemble disintegrated residual rock. On

[1] The treatment of geology in this report is based on the work of the Geological Survey of New Jersey.

the whole the drift deposited by the glacial waters, chiefly in the valleys, contains a much higher percentage of foreign material than does the drift deposited directly by the ice.

Scattered throughout the region of the Wisconsin drift are the beds of former lakes which have been filled or drained. These beds usually consist of organic material or Muck resulting from the accumulations of dead vegetation. The largest and most important is situated at Great Meadows.

The soils of the area are derived either from glacial till, directly from the underlying rocks, or from water-laid deposits. They can be broadly classed, according to geologic origin, mode of formation, and topographic position into seven soil provinces, which are shown in the table below. These seven groups are further subdivided into soil series, on the basis of structure, color, and drainage characteristics. The types, the units of soil classification, are separated within the series on the basis of texture and the content of stone and gravel. The relation of the various series to the parent material and the various soil provinces is shown in the following table:

Classification of soils.

Soil province.	Soil material.	Character of bedrock.	Soil series.
Glacial	Glacial till	Limestone	Dover.
			Washington.
		Shale	Dutchess.
		Gneiss	Gloucester.
Glacial Lake and River Terrace.	Old lakebed material	Organic in part	Clyde.
		Wholly organic	Muck.
	Stratified glacial drift.	Limestone	Fox.
		Shales and sandstones	Chenango.
Appalachian	Residual material, shale and sandstone and gneiss	Shale	Berks.
		Gneiss	Chester.
Limestone valleys	Residual material from limestone	Limestone	Hagerstown.
	Residual material from diabase rocks.	Trap (diabase)	Montalto.
Piedmont plateau	Residual material, shale, slate and sandstone.	Shales, slates, sandstones, conglomerates, and argillites.	Penn, red.
			Lansdale, brown.
			Croton, blue or mottled red and yellow.
		The same, partially metamorphosed.	Lehigh, gray.
Coastal plain	Sedimentary transported material.	Unconsolidated clays, sands, and gravels.	Sassafras.
River flood plains	Alluvium	Glacial material	Papakating.
			Genesee.
		Crystalline residual material	Codorus.
			Roanoke.
		Sedimentary residual material.	Bermudian.
			Birdsboro.

Glacial soils.—The glacial soils include all the types north of the late Wisconsin terminal moraine as well as those derived from the till of the Jersey or early drift, which extend 20 to 25 miles farther south. The glacial soils are grouped into four series: Dover, Washington, Dutchess, and Gloucester.

The soils of the Dover series are brown to light brown, with yellowish or slightly reddish yellow subsoils. Often the extreme lower subsoil is slightly lighter in texture than the upper subsoil. Fragments of limestone are scattered through both soil and subsoil. Where the till is thick, as in the moraine, quartzite, gneiss, and flint bowlders and gravel are of common occurrence. Outcrops of limestone occur in many places.

The Washington series is characterized by brown surface soils and reddish-yellow or light-red, moderately friable subsoils. Particles of rock are present through the soil and subsoil, giving a more gritty feel and somewhat more friable structure than is possessed by the subsoil of the Hagerstown series, which the Washington soils closely resemble. Angular fragments and rounded gravel or cobblestones of gneiss, quartzite, flint, and occasionally limestone are present. The parent material consists of old glacial drift remaining here and there south of the terminal moraine, most of it occurring in the valleys over limestone or shale, though some of it is found on the flat mountain tops, over gneiss and over the Triassic shales and sandstones of the Piedmont. Probably limestone was originally present in the material, but if so, it has decayed and disappeared.

The soils of the Dutchess series are light brown to grayish brown, with yellow subsoils. Residual material from the underlying shale is encountered within the 3-foot section in places. The subsoil is friable, although somewhat heavier than the soil. Varying amounts of shale particles are found throughout the 3-foot section. Some of the types contain sandstone and quartzite bowlders and gravel. A rolling topography is characteristic of these soils. The parent glacial material is derived mainly from the Martinsburg (Hudson River) shales and slates.

The Gloucester soils are light brown or grayish brown and overlie yellow subsoils. They are derived from the glaciation of local white and gray granitoid gneiss. Huge bowlders and smaller fragments of the gneiss are nearly always present, except where they have been removed by man. Only on the flatter mountain tops and near the foot of the slopes are there noticeable quantities of foreign rocks, usually quartzite, chert, and limestone. The topography ranges from undulating to rolling and even steep.

Glacial Lake and River Terrace Soils.—The Glacial Lake and River Terrace province, as recognized by the Bureau of Soils, embraces two series of deposits. The first included deposits in the

basins of lakes formed by the advance and retreat of ice during the Glacial Period. These were either temporary lakes, which took form during the Glacial Period and ceased to exist when the ice had passed from that locality, or permanent lakes caused by the reforming of the land surface during the Glacial Period, which persisted for a long time after the retreat of the ice and which ceased to exist only through the operations of the natural drainage forces. The second series of deposits consists of those left by the streams which flowed from the ice. These streams were much larger when fed by the melting ice than at present. The Clyde soils and Muck owe their origin to the first group of deposits, while the Chenango and Fox soils were formed from the second group.

The Clyde series is characterized by dark-brown or black surface soils, and gray, drab, or mottled gray and yellow subsoils. The decay of plant remains under swampy conditions has caused the dark color of the surface soils. The lower subsoil is usually high in calcium carbonate or marllike particles. The topography is flat and drainage is poor.

Muck owes its origin to the accumulation of thoroughly decomposed vegetation, with which is mixed a small percentage of mineral matter. It has been formed under swampy conditions in old lake beds.

The Chenango soils are brown, with brown, yellow, or reddish-yellow subsoils. The subsoil at a depth of about 3 feet in nearly all cases consists of fine sand. These soils occupy terraces along the Delaware River and its tributaries, and consist of reworked glacial material of limestone, shale, and fine-grained sandstone origin, together with some material whose origin can be traced to crystalline rocks.

The Fox series has brown surface soils and yellow or yellowish-brown subsoils. The lower part of the 3-foot section is usually sandy. Like the members of the Chenango series, the Fox soils occur on terraces formed of glacial deposits along streams which flowed from the ice sheets. They differ essentially from the Chenango in containing more limestone material. Limestone gravel, cobbles, and bowlders are plentiful.

Appalachian Mountain soils.—The Appalachian soils of the Belvidere area are residual from the underlying shale and gneiss rocks. The shales have worn down to a much lower level than the gneiss. The Berks and Chester series include the soils of this province.

The types included in the Berks series are characterized by grayish-brown surface soils and yellow subsoils. They have been derived from the underlying thin, platy shales known as the Hudson River or Martinsburg shales. Particles of shale are found in vary-

ing proportions throughout the 3-foot section. The topography is rolling, and the drainage is good to excessive.

The Chester series has grayish-brown surface soils and yellow subsoils. It has been derived from the underlying coarse-grained gneiss, of pre-Cambrian age. Fragments of the parent rock ranging in size from huge masses to small gravel particles are encountered in the soil. The Chester soils occur on the flat tops and sides of the mountains, and differ from the Gloucester soils in mode of formation only.[1]

Soils of the Limestone Valleys.—The soils of the Limestone Valleys province have been derived from limestone, and represent the residual material left upon the removal in solution of the calcium and magnesium carbonates. The soil is thus composed of the impurities in the original rock. The Hagerstown is the only series representing this province in the Belvidere area.

The soils of the Hagerstown series are brown in color, with brownish-yellow or reddish-yellow subsoils. Fragments and small outcrops of limestone are of common occurrence. The topography is gently rolling, and the drainage is excellent.

Soils of the Piedmont Plateau.—The soils of the Piedmont Plateau owe their origin to the weathering of the underlying Triassic formations, which consist of sandstone, shale, argillite, conglomerate, and diabase. The soils resulting therefrom are classed with five series, the Montalto, Penn, Lansdale, Croton, and Lehigh.

The Montalto soils occur in the northern part of the Piedmont region and are derived from the weathering of the underlying dikes and intrusive sheets of trap rock. The surface soil is reddish brown or brown, and the subsoil reddish yellow. The soils occupy high ridges, and this location, together with the fact that they contain large quantities of fine rock particles, have led to the local name of "mountain grit sand." They are also known as "ironstone land."

The Penn series includes the chocolate-red soils derived from the red shales, conglomerates, and sandstones of Triassic age.

The Lansdale series includes brown or grayish-brown soils with yellow subsoils. It is derived from the underlying dark argillite, gray shales, and sandstones.

The Croton series has grayish-brown to brownish-gray or ashy-gray soils, with a yellowish, mottled yellowish and grayish, or light-gray subsurface layer, overlying a very compact, hardpan-like stratum of clay which is brownish red or mottled pinkish and yellowish in color and often contains limonite-yellow and dark friable concretionary material. The soil is residual mainly from

[1] The Chester soils rightly belong in the Piedmont, while the corresponding soils in the Appalachian Mountains are called Ashe. It was not deemed necessary to separate the two in the Belvidere area.

brownish-red and dark-colored argillite of Triassic age. The bedrock often is reached within the 3-foot section or at depths not much over 3 feet. In this area the Croton soils occur on a flat plateau into which few streams reach, and as these have very shallow channels and valleys the drainage is imperfect.

The Lehigh series is characterized by brownish-gray or chocolate-gray surface soils and mottled gray and yellow subsoils. It owes its origin to the breaking down of the underlying shale and argillite, which differ from the rock that has given rise to the Lansdale, Penn, and Croton soils in having been subjected to great heat and pressure by the intrusion of molten material. These rocks have been more or less metamorphosed and have a grayish color. The Lehigh soils in places receive seepage water from the adjacent higher slopes underlain by trap rock and so are locally poorly drained.

Soils of the Coastal Plain.—Although no part of the Belvidere area lies in the Coastal Plain, certain soils occurring along the southern border of the Piedmont, near Trenton, are associated with clayey sand and gravel deposits which are very widespread farther south, but which occur here only as thin, more or less discontinuous patches. The deposit was much thicker and more extensive at one time than it is at present, as its isolated remnants occur widely scattered in the region adjoining the Belvidere area on the east. Within the area surveyed the remnants vary in thickness from 30 inches or less to several feet, and have given rise to one soil series, the Sassafras.

The Sassafras series includes types with brown or grayish-brown surface soils and yellowish subsoils, typically coarser in texture and less compact in structure in the lower part of the 3-foot section. Quartz gravel is found in many places.

Soils of the River Flood Plains.—The River Flood Plains province, as recognized by the Bureau of Soils, includes areas of soils that have been transported and deposited by rivers and streams. These are of two classes, depending upon their situation. Types occupying flood plains subject to periodical overflow and still in process of formation and change are called first-bottom soils. The second-bottom or terrace soils occupy benches which in former years were subject to floods, but which are no longer overflowed, except in part and then only by very high waters. This change has been brought about by the deepening or changing of the natural drainage channels. The first-bottom soils mapped in the area are classed in the Genesee, Papakating, Codorus, and Bermudian series, and the second-bottom soils in the Roanoke and Birdsboro series.

The types included in the Papakating series have blackish surface soils and grayish, drab, blue, or mottled yellow and gray subsoils.

These soils occur along streams which flow through or from glaciated areas, and the component sediments are derived from wash from glacial uplands. The Papakating soils differ from the Genesee in being much more poorly drained and in having a darker color.

The Genesee soils consist of dark-brown or grayish-brown alluvial sediments deposited along streams of the Glacial province, and the sediments are derived from glacial upland soils in which some limestone material is present. The Genesee soils are fairly well drained, considering their position in stream bottoms.

The Codorus series is distinguished by brown or bark-brown surface soils and yellowish-brown or brown subsoils. Grit is present throughout the 3-foot section, as well as some flakes of mica. This series represents material washed from upland soils of crystalline origin.

The Bermudian series includes soils which are brown or reddish brown in the surface section and brownish Indian red in the subsoil, with yellowish mottling in many places. They consist of sediments washed from the Penn and Lansdale soils of the upland.

The Roanoke series includes second-bottom soils washed largely from upland types derived from crystalline rocks. The surface soils are gray or brownish gray, and the subsoils are mottled gray and yellow. The latter are usually very compact.

The Birdsboro series has brown or reddish-brown surface soils and yellow or Indian-red subsoil. The members of this series are second-bottom soils occurring along streams of the Piedmont region. They consist of material washed from upland soils derived from the Triassic rocks.

Rough stony land includes nonagricultural areas correlated without reference to color or origin.

In the following pages of this report the various soils of the Belvidere area are described in detail and their relation to agriculture discussed. The distribution of the soils is shown on the accompanying map, and the following table gives the name and the actual and relative extent of each:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent
Chester gravelly loam	69,888	14.3	Croton silt loam	14,976	4.2
Penn shale loam	43,584	8.9	Poorly drained phase	5,632	
Penn silt loam	40,064	8.2	Lansdale gravelly loam	17,024	3.5
Chester stony loam	34,880	7.1	Penn gravelly loam	15,680	3.2
Washington loam	32,064	6.6	Rough stony land	15,296	3.1
Lansdale silt loam	29,184	6.0	Dutchess shale loam	8,320	2.0
Hagerstown silt loam	21,952	4.5	Steep phase	1,472	
Bermudian silt loam	20,736	4.2	Montalto silt loam	9,280	1.9

Areas of different soils—Continued.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dover loam	7,552	1.8	Muck	1,600	0.8
Sandy phase	1,344		Intermediate phase	1,792	
Chenango fine sandy loam	8,896	1.8	Shallow phase	576	
Chester loam	8,704	1.8	Papakating silt loam	3,584	0.7
Montalto stony loam	8,128	1.7	Sassafras loam	3,008	0.6
Dover gravelly loam	7,552	1.5	Fox gravelly loam	3,008	0.6
Genesee silt loam	6,464	1.3	Fox sandy loam	2,496	0.5
Berks shale loam	6,336	1.3	Chenango fine sand	2,176	0.5
Gloucester stony loam	6,144	1.3	Birdsboro silt loam	1,792	0.4
Gloucester gravelly loam	5,440	1.1	Dutchess silt loam	1,728	0.4
Clyde stony loam	5,376	1.1	Fox loam	1,152	0.2
Codorus loam	4,864	1.0	Roanoke silt loam	448	0.1
Lehigh shale loam	4,800	1.0			
Clyde silt loam	3,968	0.8	Total	488,960	.....

DOVER GRAVELLY LOAM.

The Dover gravelly loam is a brown or light-brown loam, quite silty in places, underlain at 8 to 15 inches by yellowish-brown, friable clay loam to gritty, friable clay. In depressions and on some flats and lower slopes receiving wash from adjacent slopes the soil is more silty, deeper, and often slightly darker. Small angular and rounded fragments and bowlders of sandstone, quartzite, flint, quartz, limestone, and in places of gneiss and shale are plentiful on the surface and throughout the 3-foot section. In places the material is very gritty and contains a relatively large proporton of sand. The soil in general is derived from till containing much limestone, but in some places, as in the vicinity of Hackettstown, the original limestone content was considerably less than typical. Many of the limestone cobblestones and bowlders have been collected and burned for lime or used in road building.

The largest areas of Dover gravelly loam occur between Belvidere and Hackettstown. Some of the most important areas are situated near Hackettstown, Vienna, Townsbury, Oxford Church, and Bridgeville. The type has been mapped both on (1) the terminal moraine, where it occupies sloping mountain sides, rounded hills and knobs, and valleys, where there is some stratification of the material[1]; and on (2) smoother, gently rolling country where the till is not so deep, and mainly over limestone, with the edges of some areas reaching out over gneiss or shale.

The Dover gravelly loam is a well-drained, productive soil, largely cleared and under cultivation. The principal growth on the un-

[1] Though there is some stratification, it is not possible to tell just where the stratified material occurs. Dr. H. B. Kummel, State Geologist, says one hill or even part of a hill may be stratified, while another or a part of another may be pure till.

cleared areas is red cedar, oak, hickory, ash, maple, and some chestnut. Most of the chestnut trees are dead or dying. The type is used for growing corn, oats, rye, wheat, buckwheat, and timothy and clover, in conjunction with dairying, the cattle being pastured on the adjacent low or stony soils. As a whole the type is handled similarly to the Dover loam, and the returns are nearly as large. This soil is harder to cultivate, because of its irregular and gravelly surface, and in places the slopes are so steep that improved machinery can not be used.

The type is well suited to the present system of agriculture. The steeper slopes are well adapted to orcharding, all the common fruits succeeding. On some of the steeper slopes the soil would be especially benefited by the growing of winter cover crops. The former practice of liming every four or five years was a good one and should be revived.

DOVER LOAM.

The Dover loam consists of a brown to light-brown, gritty loam or silt loam, 8 to 15 inches deep, overlying yellowish-brown, gritty clay or gritty clay loam which passes quickly into yellow or reddish-yellow, friable sandy clay. In places the lower subsoil is somewhat more sandy than the upper subsoil. Gravel and occasional bowlders of limestone, gneiss, quartzite, and chert are present in some areas.

The type is derived from glacial till containing varying amounts of limestone. It occurs in the northern third of the area, principally in the vicinity of Allamuchy, Mount Hermon, Shiloh, Townsbury, Petersburg, and Hope. The topography is slightly undulating, as at Townsbury and Vienna; gently rolling, as near Mount Hermon; or sloping, as west of Allamuchy and south of Hope. In all cases the slope is sufficient to give both the surface soil and subsoil good natural drainage.

This is not an extensive type, but it has a high agricultural value. It is nearly all cleared and cultivated, though there are a few patches of second growth cedar and oak. Corn, timothy, and red clover, rye, oats, wheat, and buckwheat are the leading crops. Nearly every farm has a herd of dairy cows, numbering from half a dozen to 30 or more. The average herd consists of about 12 cows and a bull. Very few of the herds are pure bred, but nearly all consist of good grade animals of predominant Holstein blood. Fully 80 per cent of the milk is shipped to New York or local markets, but a few farmers make butter for sale and nearly all make sufficient for home use. Hogs are kept on nearly every farm in sufficient numbers to supply the household with pork and lard, and some farmers each year raise a few for sale. Chester White is the most popular breed. Poultry is raised by all farmers, and is the source of considerable

income. Only a few horses are raised on the farms, most of the work stock being purchased outside the State.

Corn yields range from 40 to 75 bushels per acre, with an average of about 50 bushels; oats yield 30 to 45 bushels, wheat 15 to 30 bushels, and clover and timothy hay 1 to 2 tons. Alfalfa does well where it has been properly handled, and gives three or four cuttings a year. Vegetables, berries, and apples are grown in sufficient quantities for home use.

Crops are grown in rotations, of which the most common embraces corn, oats, and wheat or rye for 1 year each, followed by timothy and clover for 2 or 3 years. In many cases the hay land is pastured after the hay has been harvested, and some farmers keep the land in pasture the third or fourth year. The soil is plowed fairly deep, with 2 or 3 horse turning plows, and the seed bed is well prepared with harrows, rollers, and drags. Improved farm machinery is in common use.

Corn is planted in May or June and harvested in September. It usually escapes frost, though occasionally late-planted corn is damaged by an exceptionally early frost, as was the case in 1917. The dent varieties are planted for silage, while flint corn is generally planted for grain.

Oats are seeded very early in the spring and are harvested during August, in time to plow and prepare the ground for wheat, which is sown about September 10 to 20. Timothy is sown with the wheat, and red clover is sown broadcast with a wheelbarrow seeder in the spring.

Rye when grown takes the place of wheat in the rotation and is seeded and handled in about the same way. Buckwheat is used as a catch crop, and is planted much later than any of the other staples. Hay is usually put in the barn mow unbaled for use on the farm, and any surplus is baled and shipped to the market.

Most of the stable manure produced is applied to sod during the fall and winter, and plowed under in the spring for corn. At the time of seeding oats receive about 200 and wheat about 250 pounds of commercial fertilizers per acre. Since the present war began the fertilizer commonly used contains .85 to 1 per cent of nitrogen and 8 to 10 per cent of phosphoric acid. In normal times the fertilizers in ordinary use analyze 2–8–10, 2–9–5, or 2–9–8.

Land of the Dover loam ranges in value from $50 to $100 an acre.

The Dover loam is a rich productive soil, and on the whole it is handled well. The fine limestone material originally in the soil has been largely dissolved and the lime more or less completely leached out, and as a consequence the type is benefited by the addition of lime. In former years, when wood was cheap and easily available, the farmers used to gather the limestone on their farms,

burn it, and return it to the land. This practice is no longer common and the land is showing the effect of lack of lime.

Some stony areas of Dover loam (Dover stony loam) are shown on the map with stone symbols. This soil consists of a brown, gritty loam which passes at 3 to 8 inches into yellowish-brown or yellow, gritty, friable clay. In wooded areas the brown soil is in places only 2 or 3 inches deep, over a subsurface layer of yellow loam. There is an abundance of limestone, and in places quartzite and gneiss, cobbles, bowlders, and gravel. On the shoulders of most of the slopes in the vicinity of Hope the underlying bedrock is very close to the surface and here and there is exposed. The Dover stony loam occurs in large bodies near Hope and Shiloh, where it is largely residual from the underlying limestone. The areas north of Hackettstown consist entirely of till composed largely of limestone material. The topography varies from gently rolling to sloping, with occasional hillocks of very steep, broken land. Much of the surface has a knobby appearance, due to the outcropping of limestone. Drainage is good. Practically none of this soil is cultivated, owing to its stoniness, but most of it is cleared and used as pasture. The characteristic forest growth is red cedar, with a sparse growth of hickory, maple, ash, and oak. Blackberry bushes grow thickly where the land is abandoned. The Dover stony loam is an excellent soil, and it would probably pay to remove the stones where they are not too numerous and where the soil is comparatively deep.

Dover loam, sandy phase.—The sandy phase of the Dover loam consists of brown or light-brown sandy loam or fine sandy loam, 10 to 24 inches deep, over yellowish-brown sandy loam or sandy clay loam. In many places there is considerable fine gravel or coarse grit, consisting mainly of limestone and gneiss, through the 3-foot section, and some large gravel and bowlders are present in places.

The most important areas of the phase are mapped near Vienna, Pequest Furnace, and Warrington, and in other places in the glaciated area. The topography is gently rolling to rolling. Most of the phase occurs on slopes south of the Pequest River, at elevations ranging between 420 and 500 feet above sea level, and it is well drained.

This phase is of small extent, but it is nearly all under cultivation and one of the most productive soils of the area. The same crops are grown as on the typical Dover loam, Irish potatoes being probably a more important crop. Somewhat larger dairy herds are maintained, owing doubtless to the nearness to larger pasture areas, as much of the phase is adjacent to the Genesee and Papakating soils occurring in the rather wide bottoms of the Pequest River. Crop yields differ little from those on the typical Dover loam, and the soil is handled in a like manner. Farmers do not consider the phase to be

as strong as the typical soil, and somewhat heavier applications of fertilizer are necessary on the phase in order to produce equal yields. The selling value of the land ranges from $35 to $90 an acre.

The Dover loam, sandy phase, would be benefited by the addition of lime and the incorporation of organic matter, as by turning under vetch and rye. These or a similar crop could be planted in the corn fields at the last cultivation. If allowed to lie on the land these would prevent erosion during the winter months and in this way prevent loss of fertility through leaching.

WASHINGTON LOAM.

The Washington loam is a brown, mellow loam, 10 to 15 inches deep, overlying reddish-yellow, moderately friable silty clay, which is usually quite gritty, especially in the lower part, and which contains small fragments of partly decomposed rock, giving greater friability than exists in the Hagerstown subsoil. There is always more gritty material or small fragments of rock through the entire 3-foot section than in the Hagerstown. In places the surface soil is distinctly reddish-brown when moist and the subsoil is dull red. Large cobblestones or angular fragments of gneiss, quartzite, and bluish-black flint are nearly everywhere present. The more gravelly areas are shown on the map by gravel symbol. In some places the quartzite is almost sufficient to make the soil a gravelly loam. Near Apgars Corner and Potterstown the type as mapped contains sufficient sand to be a sandy loam, but owing to the very small acreage of this character it is not separated. Some areas of Washington silt loam and some Hagerstown silt loam are included with the type.

The Washington loam occurs in the north-central part of the area, mainly in the valleys, where it is associated with the Hagerstown silt loam. Other important areas lie on the mountains near Hazen, Schooleys Mountain, and Drakestown. The areas mapped near Apgars Corner, White House, and Pattenburg are associated with the Penn soils. In the valleys the old drift from which this soil is derived overlies limestone, while on the mountains it overlies gneiss, and in places near the southern limits of the old drift, it is found over the Triassic rocks. The topography is gently rolling, and the drainage is adequate. Some of the flatter areas are those overlying the gneiss rock on the mountain tops.

The Washington loam is an extensive and very important agricultural soil. The principal tree growth in the uncleared areas consists of chestnut oak, white oak, elm, chestnut, walnut, hickory, sassafras, and maple. Corn, oats, wheat, and hay are the principal crops, followed by rye and buckwheat. On the mountains rye is often grown instead of wheat, wheat being less satisfactory, according to the statements of the farmers. Dairying is a very important industry.

In general yields and methods of handling and fertilization the type differs little from the Hagerstown silt loam. Because of the numerous stones it is often somewhat more difficult to till. In the past century most of the larger stones have been removed and piled along the fence rows. Land values are slightly lower than in the case of similarly situated areas of the Hagerstown soil, but considerably higher than in the case of similarly located Chester and Penn soils.

The Washington loam is productive and generally well managed, and the farmers seem thrifty and prosperous. Better returns would be obtained if more lime were used. On the mountains and on the higher slopes or hills apple and peach orchards, if properly cared for, would probably be profitable.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Washington loam:

Mechanical analyses of Washington loam.

Number.	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 ct.*	*Per ct.*
170721, 170737, 170741..	Soil.....	4.0	7.6	3.5	10.7	13.0	49.0	12.1
170722, 170738, 170742..	Subsoil.....	6.0	8.6	3.5	10.9	8.1	41.4	18.3

DUTCHESS SHALE LOAM.

The surface soil of the Dutchess shale loam is a light-brown to grayish-brown silt loam, 6 to 10 inches deep. The subsoil is a yellowish-brown silt loam to silty clay loam. The entire 3-foot section contains a very high percentage of shale fragments. The depth to bedrock probably does not average over 2 feet, and the shale outcrops in places on the tops of hillocks and the crests of ridges. The rock fragments in the soil vary from small chips to platy pieces 4 or 5 inches across. The unweathered shale is dark colored, black, or bluish black. Foreign bowlders and gravel of quartzite and gneiss and occasionally of limestone occur, and in some places so abundantly that it is necessary to clear the land before cultivating. Gravel and stone symbols are shown on the map in these places.

Large areas of Dutchess shale loam occur in the northwestern end of the area between Jenny Jump Mountain and the Delaware River. Here the type occupies even more rolling areas than the silt loam, and it is very well drained. Crops in fact often suffer from lack of moisture during dry periods, especially where the bedrock is close to the surface.

The shale loam is the most extensive member of the Dutchess series. It is practically all under cultivation, and is used for the same crops

as the silt loam. Wheat is not as extensively grown as rye. On some of the steep slopes more hand work is necessary than on the silt loam, but improved machinery is used on most of the type. Owing to the more droughty nature of much of the Dutchess shale loam, the yields do not equal those obtained on the silt loam. Grass is often killed during July and August in the shallower areas.

The Dutchess shale loam needs organic matter and lime. The addition of organic matter will help to retain moisture, and also add to the plant food supply, and large quantities of stable manure or green vegetation should be plowed under. Because of the sloping topography fields should not be left fallow during the winter. Crops such as vetch and rye combined and crimson clover should be sown early in the fall or late in the summer, to be plowed under early the next spring. Apples and peaches would do well on this soil with proper care.

Dutchess shale loam, steep phase.—The steep phase includes very steep slopes of Dutchess shale loam where the soil is shallow and contains frequent outcrops of shale. It is also more droughty than the typical soil.

Part of this rather inextensive phase has been cleared. The chief tree growth on the uncleared areas consists of chestnut and oak. The same crops are grown as on the typical shale loam, but a larger percentage of the fields are kept in grass. The numerous shale fragments help to prevent excessive erosion. Yields are somewhat lower than on the typical Dutchess shale loam.

DUTCHESS SILT LOAM.

The Dutchess silt loam is a brown or light-brown silt loam, 10 to 15 inches deep, overlying yellowish-brown silty clay loam or yellow silt loam, which passes into yellow, friable silty clay loam or silty clay. In wooded areas the yellow color is often reached within 3 or 4 inches of the surface. Fragments of shale are common on the surface and through the soil and subsoil, but they are not nearly as abundant as in the shale loam, and the shale bedrock averages considerably deeper, although it is reached at 18 or 20 inches in some places. There are some ferruginous gravel and cobbles of quartzite, gneiss, flint, and limestone. Where these occur in sufficient numbers gravel symbols are used on the map.

This soil is confined to the northwestern part of the area between the Delaware River and the Jenny Jump Mountain. Important bodies are mapped at Knowlton and Warrington and north of Delaware, the surface is rolling, with smooth slopes, the hills, ridges, and depressions giving a distinctive rounded topography.

Drainage is adequate and most of the type is under cultivation. It is the most highly valued of the Dutchess soils. The timber growth

in the few wooded areas consists largely of oak. The chestnut, which formerly was important, has been killed by blight.

Wheat, corn, oats, rye, buckwheat, timothy and clover hay are the principal crops. Dairying is important on nearly every farm, and an increasing amount of corn each year is put into silos for winter feed. Potato culture is gradually becoming more important. The soil seems highly adapted to this industry. Apples do well but there are no commercial orchards on this soil. Wheat yields average about 20 bushels per acre, ranging from 15 to 25 bushels, rye 15 to 20 bushels, and corn 35 to 40 bushels. Clover without applications of lime and manure does not thrive.

The manure made on the farm is usually applied to grass sod just before plowing for corn. Small grains in the rotation usually receive from 150 to 300 pounds per acre of commercial fertilizer at the time of drilling.

Land values on this soil have increased rapidly during the last 10 years, and now range from $35 to $75 an acre, some of the best farms selling for even higher prices.

The type as a whole needs more lime and organic matter. The production of potatoes on a large scale has proved successful on this type in some parts of Pennsylvania. Baldwin and Greening apples are especially well suited to the soil and would greatly increase the profits of the farm, provided the orchards were given proper care.

GLOUCESTER STONY LOAM.

The Gloucester stony loam is a light-brown, gritty loam, 3 to 6 inches deep, over yellowish-brown, gritty loam which passes at about 8 inches into yellow, very gritty loam or clay loam. The material is more gritty than any of the Dover or Dutchess soils, the grit consisting of particles of quartz and feldspar and small fragments of the underlying gneiss. In the densely wooded areas the yellow subsurface material often underlies the brownish layer at only 1 or 2 inches below the surface, and even in some cleared fields the surface soil is yellowish brown. The subsoil is occasionally reddish yellow. Gravel and bowlders or gneiss are abundant, and there is an occasional bowlder of quartzite, flint, and limestone. Gneiss outcrops occur in many places. Some small bodies of Gloucester gravelly loam are included with the type as mapped, as well as small patches of Rough stony land.

Important areas of Gloucester stony loam occur here and there on the Allamuchy, Mohepinoke, and Jenny Jump Mountains near the villages of Allamuchy, Warrenville, Pequest Furnace, Shiloh, and Bridgeville, where the type occupies mountain slopes, high hills and ridges, and in places gently rolling crests of the mountains. (See Pl. II, fig. 1.) The range in elevation is from 500 to 1,150 feet

above sea level. Owing to the surface slope the drainage is adequate, though the type is not excessively drained.

The Gloucester stony loam is a wooded type and only a few patches have been cleared of the forest growth, which consists principally of hemlock, tulip poplar, elm, maple, hickory, basswood, ash, oak, and birch. The chestnut which formerly was very important on this type is dead or dying on account of the blight, but young chestnut shoots are seen around the base of nearly every dead tree. Ferns are numerous in the densely wooded areas. Often the lower slopes approaching the limestone soils are covered with red cedar, maple, alder, witch-hazel, and hazelnut.

The principal use of this soil at present is for forestry and pasture. Where the timber and stones have been removed so as to permit cultivation the soil is mapped as Gloucester gravelly loam, and much of the present acreage mapped as stony loam will be so cleared within a few years. Some of the steeper, rougher areas should be left in forest or kept in permanent pasture grasses in order to prevent washing. Peaches and apples would do well on much of the type.

GLOUCESTER GRAVELLY LOAM.

The Gloucester gravelly loam might be considered a "cleared phase" of the Gloucester stony loam, for most of it was undoubtedly similar to that soil before the forest growth was cut and cultivation made possible by removing many of the stones and bowlders. Huge piles of these stones are seen along the margins of the fields, and many of the fences are made of the stones picked from the inclosed areas. The surface soil of gritty loam overlying the yellowish subsoil is 5 to 6 inches deep. In many places it is so filled with grit as to resemble a coarse sandy loam.

The most important bodies of the Gloucester gravelly loam are mapped between Mountain Lake and Danville, north of Hackettstown, and north of Bridgeville. It occupies gently rolling tops of plateaus or the less steeply sloping sides of mountains and hills, and the drainage is good except in a few places at the base of slopes where seepage water accumulates.

Corn, oats, rye, buckwheat, clover, and timothy are the more important crops. Little wheat is grown. Much of the type is used for pasturing dairy cows and a few sheep and hogs. Peaches, apples, pears, and cherries do well, though there are only a few commercial orchards.

The steep topography in places and the stoniness make cultivation somewhat difficult, but the soil can be broken to fair depth with a 2-horse turning plow (see Pl. II, fig. 1). Owing to the slope the small grains are often cut with a cradle. The flint varieties of corn

S. 9555

FIG. 1.—CLOVER AND TIMOTHY COMING UP THROUGH WHEAT STUBBLE ON THE FOX SANDY LOAM NEAR MOUNTAIN LAKE.

Note the flat topography of the Fox sandy loam. The more sloping surface of the Gloucester soils beyond is characteristic of much of their area. In the middle distance the Gloucester gravelly loam is being plowed for rye. The soil above the plowed field is the Gloucester sandy loam.

S. 9548

FIG. 2.—TIMBER GROWTH ON CHESTER STONY LOAM ON MOUNTAIN NORTHEAST OF HACKETTSTOWN.

The nearly level topography is characteristic of much of the land on the very top of most of the gneiss mountains. Note the numerous dead chestnut trees. The oat stubble in the foreground is on the Chester gravelly loam.

are grown for grain, and yield 35 to 60 bushels per acre. Dent varieties are used for silage. Hay gives only fair yields, ranging from three-fourths to 1¼ tons per acre.

Commercial fertilizer is used in applications varying from 150 to 250 pounds per acre. It is usually applied at the time of seeding the small grains. Manure is spread on the fields to be planted with corn.

This land is held at much lower prices than land of the Dover soils.

The Gloucester gravelly loam is an excellent fruit soil, well adapted to apple and peach culture with proper care. Formerly peaches were produced extensively, but diseases of different kinds killed many of the trees and discouraged the growers. Some of the rougher, cheaper land could well be seeded to permanent pasture grasses, on which large numbers of cattle and sheep could be grazed for several months each year.

CLYDE STONY LOAM.

The Clyde stony loam consists of a black silt loam, 8 to 12 inches deep, overlying gray or mottled grayish, yellowish, and brownish clay, which often contains much limonite-yellow, friable material. Part of the type consists of a dark-brown or rusty-brown silt loam over mottled yellow and gray clay, and some included areas are grayish brown in the soil. Large gneiss stones are scattered through the greater part of the type, but some areas have only the smaller stones and others are stone free.

This soil occurs in drainage-way depressions, along low slopes near drainage ways, and in flats in the areas of gneiss. It occupies only small patches, but the total acreage is rather large. The soil is poorly drained, much of it on account of seepage.

Only a small percentage of this type is thoroughly cleared, but much of it has been partly cleared. Black alder, rushes, calamus, ferns, and skunk cabbage are common in the more poorly drained places, and ash, oak, hickory, black haw, black gum, elm, birch, alder, and maple are plentiful elsewhere. The wooded tracts are used almost wholly for pasture.

Some areas of the Clyde stony loam, after being drained, cleared, and limed, could be made to grow onions, lettuce, cabbage, corn, and hay. It is well suited for use as pasture, as the grasses flourish during periods of drought, when those on the higher upland die.

Some small areas of silt loam soil are included with the Clyde stony loam. They consist of a black or brown silt loam, 6 or 8 inches deep, over ashy-gray to whitish silty clay which passes into mottled yellowish and grayish clay. In places the gray layer is ab-

sent and the surface soil lies over the mottled gray and yellow clay. Near Broadway there is a small area of nearly black silt loam overlying dark-brown or black, coarse loamy sand to sand. This soil is associated with the Clyde stony loam, differing mainly in containing few or no stones. Some areas are found at the foot of the gneiss mountains or near Hackettstown. The land is poorly drained, and little of it is cleared. The vegetation is similar to that on the stony loam, and the chief use of the land is likewise for pasturing dairy cattle. Some cleared areas have been drained and give fair crops of corn, hay, oats, and cabbage.

CLYDE SILT LOAM.

The Clyde silt loam is a black or dark-brown silt loam, underlain at any depth from 8 to 24 inches by mottled yellowish and grayish or grayish-yellow silty clay mottled with rusty brown or gray in places. Occasionally the black soil overlies a light-gray silty clay, often mottled with yellow. In places the soil is very nearly a Muck, and some small patches of true Muck are included. Along the southeastern and western borders of the Great Meadows, the areas mapped as Clyde silt loam consist of 8 to 10 inches of brown silt loam or loam overlying deep black Muck. They really represent the Wallkill silt loam, but owing to their small extent are not separated. At the northern end of the Great Meadows between the higher Fox terraces there occur areas of gray silt loam or heavy compact sandy loam with mottled gray and yellow clay subsoils. The surface soil here is better drained than typical. In some areas, shown with stone symbols on the map, bowlders of limestone or gneiss are plentiful.

The Clyde silt loam occurs in poorly drained, marshy depressions at the heads of small streams, and adjoining stream bottoms and Muck areas in the glacial regions. It is mapped in small, widely separated bodies over the whole northern third of the area. The most important developments occur north of Allamuchy, bordering Great Meadows, near Hope, and south of Mountain Lake.

This is not an important type agriculturally. In some of the better drained situations oak, elm, and basswood grow, while reeds, sweet flag, or calamus, and other water-loving plants and grasses form the principal growth in the wetter places. Nearly all of the type has been roughly cleared and partly reclaimed by ditching or enlarging and straightening the natural streams. It is used largely as permanent pasture for dairy cattle. At the head of the Great Meadows and in a few other places where the drainage is good timothy hay, corn, and small grains are grown with marked success. Many of the areas could be made very productive by underdrainage and by the liberal use of lime.

FOX GRAVELLY LOAM.

The typical Fox gravelly loam is a brown, mellow loam or silty loam, underlain at 10 or 12 inches by yellowish-brown or yellow friable gritty clay. The lower subsoil is usually lighter in texture and slightly redder in color. Gravel and cobblestones of gneiss, quartzite, and some limestone are plentiful on the surface and through the 3-foot section. The type as mapped at Warrington and near Sarepta differs from the typical soil in containing considerable reworked shale material, some fragments of the rock being present. The soil here might be classed as Hoosic gravelly loam if it were extensive enough to make such a separation practicable. On the terraces 1 miles west of Hampton Junction, and at Van Sickles, and Little York the soil contains much wash, probably from the old drift, in which there is little limestone gravel, but in which there may have been considerable limestone originally. The subsoil here is slightly redder in places than typical.

The largest body of the Fox gravelly loam occurs on the flat terrace of the Musconetcong River at Hackettstown. Here the river flows through the terminal moraine, which contains a large proportion of limestone gravel and bowlders, and undoubtedly the terrace deposits contain much limestone material. Similarly formed terraces are found along the Pequest River at Bridgeville and Belvidere. The type has excellent natural drainage, owing no doubt to the included gravel as well as to the sandy or gravelly nature of the underlying material.

Nearly all the Fox gravelly loam is cleared. It is chiefly devoted to corn, oats, wheat, hay (timothy and clover), rye, and buckwheat. Dairying is an important industry, the cows being pastured on the adjacent bottom lands. Most of the milk is sold to local receiving stations to be shipped to the large city dairies. Alfalfa seems to thrive where it has received proper attention, but it occupies only a very small acreage. Potato growing is increasing in importance, and vegetables, berries of all kinds, and apples are produced in sufficient quantities to supply the farm. A few have a surplus of these crops to sell. Hogs and poultry are raised on every farm to supply the home needs.

This is a productive soil. Wheat ordinarily yields 18 to 20 bushels per acre, rye about 18 bushels, and corn from 40 to 70 bushels, depending on the season and the method of handling. Hay yields 1 to 1½ tons per acre. This soil is well farmed. Crops are usually grown in rotation, and the seed bed is properly prepared by the use of two-horse turning plows, multi-toothed cultivators, drags, and rollers. Crops planted in rows receive several cultivations each season with one or two horse cultivators and hand hoes. Small grain is nearly

always seeded with drills. Corn is either planted in rows with one or two horse planters or by hand planters in check rows. In the northern third of the area varieties of flint corn are planted for grain and dent varieties for silage. In the southern part the dent varieties are planted for grain as well as for silage. Buckwheat is usually sown as a catch crop.

The fertilizer methods on this soil are similar to those practiced on the other upland types. Corn receives nearly all the stable manure, which is applied with a manure spreader or broadcasted on the sod during the fall or winter before plowing. The small grains receive 150 to 300 pounds of commercial fertilizer per acre, usually at the time of seeding. Wheat usually receives about 50 pounds per acre more than oats. Liming was a universal practice on this type up to 10 or 12 years ago, limestone being gathered in the neighborhood and burned in kilns on the farm. Since the wood supply has become scarce and labor expensive very little lime is applied.

The land is highly valued where it lies close to towns and good roads, selling at $150 to $200 an acre. Most of it, however, ranges from $50 to $100 an acre.

Liming is the foremost need of this soil. When it is properly limed and the productiveness increased by the addition of organic matter clover, alfalfa, and other legumes succeed, and if they had a place in the rotation better yields of all crops would be obtained. Potatoes have proved a profitable crop, and the acreage might well be increased on many farms.

FOX SANDY LOAM.

The surface soil of the Fox sandy loam consists of a brown, heavy sandy loam, 12 or 15 inches deep. The subsoil is a yellowish-brown or yellow sandy loam, or in places a sandy clay which becomes lighter below, or occasionally a loamy sand. Gneiss, quartzite, and limestone gravel occurs in places, and in areas where this is abundant gravel symbols are used on the map. As shown in exposures, the material is stratified and includes a large proportion of fine to large gravel and cobblestones of limestone. Some areas above Saxton Falls along the Musconetcong River contain a few limestone, gneiss, and quartzite bowlders and are indicated on the map by stone symbols. Some of the areas mapped at the northern end of the Great Meadows contain patches in which the lower subsoil is a pale yellow or mottled with yellow.

The Fox sandy loam is developed in rather small bodies in the glaciated region, or northern third, of the area. The largest bodies are mapped at the northern end of Great Meadows in the vicinity of Long Bridge and Allamuchy. Other important bodies are found

northeast of Saxton Falls, bordering Mountain Lake (Greens Pond) and the adjoining swamp. The type occupies flat to faintly billowy terraces bordering old lake beds or rivers, and is adequately drained.

This type is practically all cleared and devoted to the same agricultural uses as the Fox loam and gravelly loam. Yields of corn and grass are slightly lower than on the heavier types, but the sandy loam is, nevertheless, an excellent soil. It gives better yields of truck crops and matures them earlier than the Fox loam. Irish potatoes are successfully grown by a few farmers and could be made a much more important crop. The type needs lime and is slightly more deficient in organic matter than the loams. It is somewhat more inclined to leach, and the plowing under of cowpeas, crimson clover, hairy vetch, rye, and similar crops would be very profitable. Alfalfa does well when the organic supply of the soil is increased and the natural acidity overcome by liming. Plate II, figure 1, shows a stand of clover and timothy coming up through wheat stubble on the Fox sandy loam.

FOX LOAM.

The Fox loam consists of a brown, mellow loam, 10 or 12 inches deep, overlying yellowish-brown, friable loam to gritty clay loam or clay. In places there is considerable sand in the lower subsoil, and the material at the base of the 3-foot section in a layer 6 or 8 inches thick is often slightly redder than the overlying material. Gravel and cobblestones of limestone and flint and also some of gneiss and quartzite are present in places.

Some small patches of Fox gravelly loam are included with this soil, being distinguished by gravel symbols on the map. About 2¼ miles south of Hope and in a few other places a silty variation consisting of brown silt loam over yellowish, moderately friable silty clay is included with the type. About one-half mile north of Delaware, Lackawanna and Western Railroad near the northeast corner of the area the type as mapped is very gritty, containing more sand than typical. The area mapped at Febletown represents an imperfectly drained variation, having a grayer surface soil and a subsoil slightly mottled yellow and gray. The small areas mapped at Stephensburgh, south of Harmony, and in a few other places south of the moraine contain much wash from the old drift in which limestone material was originally present.

The Fox loam is mapped south of Waterloo, northeast of Hackettstown, in several places along Beaver Brook just west of the Jenny Jump Mountain, and along the Pequest River at Butzville, Pequest Furnace, Townsbury, Danville, and Vienna. Other small developments are scattered over the northern third of the area. The type is

found on flat or slightly rolling terraces, and is naturally well drained.

Nearly all the Fox loam has been cleared and is used mainly for growing the general farm crops—corn, oats, wheat, and hay. Buckwheat, rye, potatoes, and alfalfa are grown by many of the farmers. Dairying is an important industry, the cattle grazing on the cheaper adjacent soils. Yields are possibly a little larger than those obtained on the Fox gravelly loam. The methods of handling and the fertilization system are about the same as on the gravelly loam.

The selling value of the loam is practically the same as that of the Fox gravelly loam. Some farmers value the loam a little higher, owing to its smaller content of gravel, which makes tillage somewhat easier.

The Fox loam is an excellent soil, well adapted to the present system of farming. Lime should be added every few years. Many fields would undoubtedly maintain good stands of alfalfa. Potatoes could well be worked into the rotation.

CHENANGO FINE SAND.

The Chenango fine sand consists of 10 to 12 inches of brown or light-brown fine sand or slightly loamy fine sand, overlying reddish-yellow or reddish-brown fine sand. Quartz, quartzite, gneiss, and sandstone gravel are found in places. In some places coarse sand, or even fine gravel, is encountered in the lower subsoil, or substratum. There are included with the type, as mapped, some areas which differ from the typical in having a rather loamy surface soil.

On a few islands in the Delaware River and in a few strips along the river there are small low areas which consist of gravel, cobblestones, coarse sand, and other materials. These areas (which really represent the soil usually classed as Riverwash) are overflowed at every slight rise of the river.

The Chenango fine sand occurs associated with the Chenango fine sandy loam along the Delaware River. It normally occurs at slightly lower elevations than the latter type. The largest areas are mapped near Lambertville, Raven Rock, Bulls Island, Frenchtown, Milford, and north of Delaware. A narrow strip borders part of the Great Meadows Muck area, and was evidently the beach of the old lake. The type, as a rule, occupies level or nearly flat second bottoms along the Delaware River, but the areas near Great Meadows differ in being sloping. All the type is rather well drained; once or twice in a generation it is overflowed, and in 1903 nearly all the Chenango soil along the river was under water for many days.

Nearly all the type is cleared and most of it is used for growing the general farm crops common to the region. Part of it is used for

producing melons, cantaloupes, asparagus, and other truck crops. Crops mature 10 days to 2 weeks earlier than on the higher uplands. This soil should be devoted even more extensively to the production of early truck crops for the markets of Trenton, Easton, Philadelphia, Lambertville, Belvidere, and other cities. The soil needs more organic material and lime. Green-manure crops should be grown, and plenty of stable manure added.

As mapped, the Chenango fine sand includes some narrow scattered strips of soil along the Delaware River from Delaware to Trenton which really represent the Genesee fine sand. They consist of a light-brown fine sand which shows little change throughout the 3-foot section. The subsoil in some places at about 24 inches grades into a slightly darker loamy sand. In places the surface soil is darker and somewhat more loamy than the subsoil. This soil is well drained, except that in some places it may be inundated by backwater from the creeks. It is nearly all cleared except in narrow strips along the river, where elm, ash, sycamore, and some sweet gum is found. Much of the type is used for pasture. Corn, wheat, rye, oats, and hay are grown by many farmers. The yields are only fairly good, averaging lower than those obtained on the heavier lands. Near markets watermelons, cantaloupes, pumpkins, squash, turnips, and other truck crops are grown. Truck farmers state that this soil and the Chenango fine sand are the best in the area for these products. This soil needs lime and organic material. Because of its porous, rather leachy nature, it requires rather large quantities of fertilizer. It is essentially an early truck soil.

CHENANGO FINE SANDY LOAM.

The Chenango fine sandy loam consists of a light-brown to brown fine sandy loam to heavy fine sandy loam, underlain at 8 to 12 inches by yellowish-brown fine sandy loam to loamy fine sand. In places the subsoil is reddish yellow. As mapped, some patches consist of loam and others of sand or loamy sand or fine sand. Considerable quartzite, quartz, and sandstone is found in places, and particles of shale occur in the areas north of Belvidere. Where gravel is found in sufficient quantities gravel symbols are shown on the map. In some places, as in the area just south of Belvidere, it is not easy to determine whether the soil is Fox or Chenango, since there are no exposed sections to show the content of limestone material.

The Chenango fine sandy loam occurs on terraces of the Delaware River. It is found in many places from Columbia to Trenton, some of the largest areas occurring near Belvidere, Delaware, Frenchtown, Milford, and Lambertville. The surface is level or nearly level in most places, although northeast of Belvidere it is somewhat

billowy. In some places between Frenchtown and Trenton back of the flat typical second bottom there are found remnants of older, higher terraces. Here the material seems to be the same as on the lower terraces, though the topography is more sloping. Drainage is good over the entire type.

The Chenango fine sandy loam is nearly all cultivated. The leading crops are corn for grain and silage, oats, wheat, and hay, with rye and buckwheat of secondary importance. Nearer the local markets much of the type is devoted to Irish potatoes, sweet corn, tomatoes, and other truck crops. There is a tomato cannery at Lambertville, and some of the tomatoes used are grown on this type. Alfalfa has done well in the few places where it has been tried and handled properly. Some peaches and apples are grown. This soil in most places is well suited to the use of modern farm machinery.

Dairying is an important industry on nearly all the farms. Holstein blood predominates in most of the herds. There are a few pure-bred herds and many farmers are gradually improving their stock by the use of good blooded bulls. The average sized herd consists of 12 cows.

Wheat yields are somewhat lighter than on the heavier upland types, ranging from 15 to 20 bushels per acre. Oats yield 25 to 35 bushels, and corn 45 to 50 bushels. Crops are grown in rotations, the most common one being the 5-year rotation of corn, oats, wheat, and hay (combinations of timothy and red clover). The hay is cut two seasons before the sod is plowed under for corn. The dent varieties of corn are grown for both grain and silage purposes, except in the more northern parts of the area, where the flint varieties are grown for grain. The common method of harvesting corn for grain is to cut the stalk near the base and allow the crop to dry in the field in shocks. When it is well dried or cured the ears are husked and put in the crib, and the fodder is fed to the stock either whole or shredded. Near Belvidere, however, many farmers on this soil practice the southern system of cutting the stalk off above the ears and allowing the ears to stand on the shortened stalk until dry, when they are pulled and thrown into a wagon. The short stalk is plowed under in the spring.

Wheat is sown in the fall from about September 10 to 20, except when the farmers have reason to believe the Hessian fly is plentiful, in which case it is not drilled in until after killing frosts.

Practically all the stable manure made on the farm is applied to the sod land intended for corn. Some farmers also add 100 to 200 pounds of acid phosphate in the row at the time of planting the corn. Wheat receives 300 to 400 pounds per acre of some commercial fertilizer, usually a complete mixture, and fertilizer is used in some cases on oats and buckwheat.

Land values on this type vary from $30 to $100 or more an acre, depending mainly upon the location with reference to markets. The areas near Trenton often bring very high prices.

The Chenango fine sandy loam under proper management is an excellent soil for general farm crops and for such truck crops as potatoes, late tomatoes, and sweet corn. Alfalfa can be grown successfully, but lime is needed for best results with either alfalfa or clover. The organic supply of the soil could be greatly increased by growing winter crops to be plowed under the following spring.

BERKS SHALE LOAM.

The Berks shale loam consists of brown or chocolate-brown silt loam 6 to 12 inches deep over yellowish-brown or brownish-yellow silty clay, which is slightly reddish in places. There is an abundance of thin to fairly thick or blocky shale fragments on the surface and throughout the soil profile. Typically the shale is thin and the areas of blocky fragments occur in the body of the type southwest of Clinton, which also differs from the typical soil in containing patches of red or reddish shale material. Shale rock in places is frequently reached within less than 3 feet of the surface.

Small areas on the tops of many of the knobs and larger areas north of the Clinton and Perryville Road, as well as two small areas south of Stewartsville, differ from the typical soil in having very little fragmentary shale in the surface 20 inches. Quartz, quartzite, and gneiss fragments are present in places on the slopes, especially in the areas between Port Colden and Hackettstown. The unweathered shale is bluish black.

Important areas of the Berks shale loam are found north of Asbury, between Port Murray and Hackettstown, east of Port Colden, and west of Clinton. The type occurs in the valleys associated with the Hagerstown and Washington soils. It has a rolling to hilly topography, the outlines of the hills and ridges being roundish. The range in elevation is from a little less than 400 to slightly more than 650 feet above sea level, the type averaging 150 to 300 feet higher than the rest of the valley soils. Drainage is good to excessive, and crops occasionally suffer in dry seasons, particularly where the soil is shallow.

This type is nearly all cleared and devoted to the general farm crops. Corn, oats, rye, hay, wheat, and buckwheat are grown extensively. Apples and peaches do well, with proper cultural methods. Potatoes and alfalfa are produced by a few farmers. Dairying is an important industry. Corn yields range from 20 to 65 or 70 bushels per acre. Rye yields 15 to 25 bushels, wheat 15 to 25 bushels, and hay 1 to 1½ tons per acre. Oats do well in places where

the soil is deep. Buckwheat is usually grown when some other crop fails. Rotations are usually followed on this soil, and the tillage is generally thorough. The fertilizer practice is about the same as that on the other valley types. The corn crop receives most of the stable manure and the smaller grains receive applications of commercial fertilizer.

Land of the Berks shale loam ranges in value from $25 to $75 an acre, depending on the location with reference to transportation lines and towns, the surface configuration, and the depth to shale.

This soil is lacking in lime and organic matter. In Lehigh County, Pa., Irish potatoes are grown extensively on this soil, and yields of 200 to 250 bushels per acre are obtained with proper culture and fertilization.

CHESTER STONY LOAM.

The Chester stony loam consists of a brown, gritty loam, 3 or 4 inches deep, grading into yellow, gritty loam, which extends to a depth of 8 to 12 inches, where the subsoil, consisting of yellow, friable, gritty clay loam or clay is encountered. On the surface a layer an inch or so thick consists of dark leaf mold. Large quantities of gneiss fragments of varying sizes occur on the surface and throughout the 3-foot section. The areas which have been sufficiently cleared of stone and timber to permit cultivation are separated and mapped as Chester gravelly loam. In these areas the brown surface material has been mixed through the first 8 inches or more of soil, so that the brownish cast extends much deeper than in the wooded stony loam areas. Small developments of Chester loam and gravelly loam and Rough stony land, which can not well be separated on the map, are included with the type as mapped.

The Chester stony loam, in association with the other Chester soils, occupies a large proportion of the wooded slopes and stony uplands on the gneiss mountains. Much of the topography is steeper than in the case of the gravelly loam, though there are some rather level areas on the tops of the ridges. The soil is naturally well drained.

Nearly all the type is forested. Chestnut was a common tree at one time, but most of it has been killed by blight. (See Pl. II, fig. 2.) Oak, hickory, maple, basswood, and ash make up a large part of the present growth. In cut-over areas blackberries form nearly impenetrable thickets. Poison ivy grows abundantly in places, especially along old stone piles or stone fences. A few areas have been cleared of the trees, but the stones remain. The type is used as pasture and forest land.

Much of this soil can and probably will be cleared of trees and stones within a few years, when it can be used in the same way as the Chester gravelly loam. The steeper areas should be left in

forest, as stock can find subsistence on much of the type, and with an increased demand for veal and lambs it would be profitable to inclose areas for pasturage.

CHESTER GRAVELLY LOAM.

The Chester gravelly loam consists of a light-brown or brown, gritty loam, 8 to 12 inches deep, overlying brownish-yellow or yellow, friable, gritty clay loam or clay. The surface layer when dry has a grayish shade. Angular fragments of gneiss are abundant over the surface and through the soil and subsoil, giving the former a decidedly gravelly character. Varying amounts of mica are found. In some places, as near Harmony and south of Broadway, the soil contains large quantities of mica and is redder than typical. Usually it is impossible to bore more than about 15 inches deep with a soil auger on account of the gravel. In places the soil is shallow, the yellowish subsoil coming near enough to the surface to give plowed fields a spotted brownish and yellowish appearance. In the mountains northeast of Bloomsbury there is included an area which differs from the typical in containing more sand.

The Chester gravelly loam is a very extensive soil on the gneiss mountains or uplands south of the glaciated area, where it comprises 85 or 90 per cent of the cleared land. These mountains are situated in the central part of the Belvidere area, where they occur in parallel ridges running in a southwesterly direction across it. The topography varies from steep on the flanks of ridges to gently rolling or nearly level on the crest. The elevation ranges from 700 to over 1,100 feet above sea level, and the soil is well drained, except in a very few places bordering depressions on the ridges where the underdrainage is sometimes imperfect. The gravel helps to make the soil porous but absorptive of moisture. This tends to check erosion.

This type is nearly all cleared and used for the growing of corn, oats, rye, hay, and buckwheat. Some wheat is grown, but most of the farmers state that rye does much better than wheat. Dairying is important on nearly every farm. Most of the milk is sold to local receiving stations. On farms remote from stations the milk is made into butter. A few hogs are raised on each farm to supply pork products for home use, the surplus being marketed. Sheep are raised by a few farmers, and sheep raising promises to become a more important industry.

Apples and peaches do well on this soil. There were large peach orchards on it at one time, but the trees became infected with disease and died. During the last 10 years a few farmers near Lebanon and Fairmount and in a few other places have proved that with good orchard practice good crops of peaches can still be grown.

The flint varieties of corn are usually grown for grain, and the dent varieties for silage. Corn yields from 25 to 60 or 70 bushels per acre; oats 30 to 60 or even 70 bushels; wheat 15 to 25 bushels; rye 15 to 25 bushels; and hay 1 to 1½ tons. Crops are usually grown in rotation and are handled under the general farming methods prevailing throughout the area.

The selling value of land of the Chester gravelly loam is in most cases considerably lower than that of many of the valley soils. This is due largely to the steep hills and the expense of hauling. The price varies from $25 to $75 an acre, depending on the location with reference to good roads, towns, and railroads, and upon the surface configuration and improvements. Many city people pay high prices for some of these farms, preferring them to the valley areas because of the higher altitude and the scenic value.

The Chester gravelly loam is a productive soil, and it responds well to good farming methods. On most farms the soil needs lime. Alfalfa and sweet clover can be grown where proper attention is given to reducing the acidity and adding to the organic content. The soil is well adapted to fruit production, and large commercial orchards if properly handled would do well. Potatoes can be made a profitable crop, and many farmers near good roads could increase their income by growing them commercially.

CHESTER LOAM.

The typical Chester loam consists of a brown to light-brown gritty loam, 8 to 12 inches deep, underlain by a yellow or brownish-yellow, friable, gritty clay subsoil. In places the subsoil has a reddish cast, but this is not typical. Whitish particles, consisting apparently of partly decomposed feldspar, are usually noticeable in the subsoil, as well as mica flakes in both soil and subsoil. Fragments of gneiss are common on the surface and through the subsoil. In places there is so much grit that the soil has the feel of a coarse sandy loam. In some flat, depressed areas and on the lower slopes, where the drainage is not good, the subsoil is pale yellow and more compact than typical.

Important developments of the Chester loam are mapped near Mount Bethel, Port Murray, Spring Mills, Hamden, High Bridge, Apgars Corner, Asbury, Pleasant Grove, and Farmersville, and in other places on the tops of the gneiss mountains or high ridges and hills. The type also occupies gentle slopes, benchlike situations, and flats. It is associated with the other Chester soils, but its topography is more regular. It is naturally well drained except in the depressions near the Clyde soils, where the drainage is sometimes imperfect in the lower subsoil.

The Chester loam is nearly all cleared and devoted to corn, oats, wheat, rye, buckwheat, and hay. Dairying is an important industry, much of the milk being sold to dairy companies in the near-by city markets. There are some apple and peach orchards, and where proper care is given the trees good yields of first-class fruit are obtained. Potatoes and alfalfa are grown by some farmers. Yields differ little from those obtained on the gravelly loam member of the series, and this type is handled similarly. Much of it is easier to work, owing to the smaller content of stone and the more even topography. As a consequence the value is usually slightly higher than that of the Chester gravelly loam.

HAGERSTOWN SILT LOAM.

The surface soil of the Hagerstown silt loam is a brown, mellow silt loam, 10 to 15 inches deep, overlying slightly reddish-yellow, moderately friable silty clay which shows no important change to a depth of 3 feet or more. There are some eroded slopes occupied by a clay loam which plows up with a conspicuous reddish cast, especially when moist. Frequently the soil is a brown silt loam to about 10 inches, overlying yellow silt loam or silty clay loam which passes at 20 to 24 inches into reddish-yellow, moderately friable silty clay. Small, whitish or cream-colored particles are common in the subsoil, and occasionally a little dark concretionary material is noticed at a depth of about 30 inches. In some depressions or flats where material has washed in from adjacent slopes the soil is deeper, occasionally ranging to 15 or 20 inches. Fragments of limestone and chert occur here and there over the type. On some knobs or on the shoulders of slopes small limestone outcrops are seen, and the most important of these are shown on the map by outcrop symbols. Some patches of loam are included with the Hagerstown silt loam as mapped. Where the type adjoins areas of Washington loam and Berks shale loam it is often impossible to draw sharp boundaries.

The Hagerstown silt loam occurs in large areas in the Musconetcong Valley south of the glacial region, and in the German, Pohatcong, and Lopatcong Valleys. Important areas also are mapped in the valleys near Phillipsburg, Stewartsville, Bloomsbury, Asbury, Middle Valley, German Valley, Clinton, and Annandale, and at other places in the central part of the area between the gneiss uplands. The type has a gently rolling topography. According to the Geological Survey of New Jersey the elevations range from a little less than 200 feet to slightly more than 500 feet above sea level. Drainage is adequate, but the soil is retentive of moisture.

The Hagerstown silt loam is practically all cleared. It is considered by the farmers to be the strongest and most productive up-

land soil in the area for general farming. Corn, oats, wheat, and hay (consisting of combinations of red clover and timothy or either alone) are the principal crops. Some rye and buckwheat are grown, as well as Irish potatoes and alfalfa. Plums, pears, apples, peaches, small fruits, and vegetables are grown in sufficient quantities by most farmers to supply the home needs. Dairying is an important industry on a majority of the farms. The milk is sold to local receiving stations, where it is iced and sent to the city dealers for distribution. Holstein blood predominates in the dairy herds. Many of the farmers are improving their herds by the use of good blooded bulls. There are a few registered herds. The cattle are usually pastured on the adjacent bottom soils or on hay fields after the hay has been cut. Poultry and hogs are raised in sufficient numbers to supply home demands, and the surplus is sold.

Corn yields range from 40 to 90 bushels per acre, averaging about 55 bushels. An increasing acreage of corn is grown each year for silage. The dent varieties are grown usually both for grain and silage. Oats yield from 30 to 60 bushels per acre, averaging between 40 and 50 bushels. Yields of wheat average about 23 bushels per acre, with a range from 18 to 35 bushels. Hay yields from 1 to 2 tons, averaging about 1½ tons per acre.

Crops are grown in rotations, the one most commonly practiced consisting of corn, oats, wheat, and hay for two years. Wheat is drilled in, timothy being seeded at the same time. The clover is sown in the spring with a wheelbarrow broadcaster. Good, thorough tillage methods are practiced. Two and three horse plows, cultivators, harrows, reapers and binders, corn harvesters, etc., are used. A few farmers use tractors, which seem to give good results, though they do not displace many horses. The stable manure made on the farm is applied to the sod before it is turned under for corn, and same farmers use acid phosphate at the time of planting. Small grain is fertilized with a complete commercial preparation at the time of seeding. At the present time, with potash scarce and high in price, most of the fertilizer used contains little or none of this ingredient. Applications of fertilizers range from 150 to 400 pounds per acre. Wheat usually receives larger applications than oats, rye, or buckwheat.

Farms on the Hagerstown silt loam are valued at prices ranging from $60 to $150 an acre, depending upon the improvements and the nearness to towns and lines of transportation. Farms nearer Phillipsburg and the other large towns are somewhat higher priced than those in other parts of the survey.

The type as a whole is well handled. Applications of lime every four or five years has proved beneficial. Ground limestone is pre-

pared in the Delaware Valley close to many of the areas of this soil. Quicklime could be readily obtained from some of the big dealers in the vicinity, or the rock could be burned on the farm as in former years. Many of the kilns are still serviceable. With proper attention to liming, in view of the general productiveness of the soil, alfalfa could be grown in large quantities.

MONTALTO STONY LOAM.

The Montalto stony loam resembles the Montalto gravelly loam except that it contains many larger rock fragments. Where these have been removed the areas are mapped as the gravelly loam. In many places there are outcroppings of the parent bedrock. This rock is used for road making, and places where quarries have been opened up are shown on the map by symbol.

The Montalto stony loam is associated with the other soils of the series. It generally lies on the steeper slopes and is well drained. Most of it is forested, chestnut oak, witch-hazel, basswood, and maple forming the principal growth. About the only agricultural use made of the soil is for pasturing dairy cattle, some sheep, and a few horses.

MONTALTO SILT LOAM.

The Montalto silt loam consists of a light-brown or brown silt loam, which often has a slight reddish cast, especially when moist, and overlies at depths ranging from 12 to 20 inches a yellowish-red or reddish-yellow, gritty clay. In places the soil ranges to a loam, silty clay loam, or clay loam. There are relatively few rock fragments. In some places the subsoil is yellow.

This type is associated with the Montalto gravelly loam. It usually occurs on the gentler lower slopes or the smoother, gently rolling ridge tops. The drainage is good, except in places near the foot of the slopes, where some of the type is imperfectly drained in the lower subsoil.

The type in not extensive, but it is nearly all cleared and used for the general farm crops. Apples and peaches do well where properly handled. It is used in about the same way as the Montalto gravelly loam, the main difference between the two soils being the lower content of stones and the smoother topography occupied by the silt loam. Improved machinery is used on nearly all farms and the wear and tear on implements is not so great as on the gravelly loam. In the region of Round Valley and in other places where the red shales border this type the farm buildings are located on it instead of on the shales, owing to the fact that good water can be obtained more readily in the trap rock formation.

Certain areas shown on the soil map by means of gravel symbols, in areas of the silt loam, represent developments of Montalto gravelly loam. The type consists of a very gravelly, gritty loam of a rusty-brown color, grading at 8 to 10 inches into lighter colored, rusty-brown, gritty gravelly loam, which in turn passes at 15 to 20 inches into reddish-yellow, gritty gravelly clay or clay loam containing whitish particles. The soil is very gravelly from the surface down, the gravel consisting of small angular fragments of the parent trap rock (coarse-grained diabase and locally fine-grained basalt), in some places ranging to the size of cobbles. In some areas apparently 50 to 70 per cent of the soil mass consists of gravel and cobbles. Occasionally the texture of the soil ranges to a clay loam, which is more reddish than the gravelly loam.

The Montalto gravelly loam occurs in association with the other Montalto soils on the trap hills or mountains which rise 200 to 300 feet above the surrounding shale soils. The most important areas are those on the slopes of the Cushetunk Mountain surrounding Round Valley, south of Stanton on Round Mountain, and on the Sourland Mountain and associated ridges which begin just south of Lambertville and extend northeast across the area. Smaller patches are found here and there in Hunterdon and Mercer Counties. The type is found at an elevation ranging from 250 to 450 feet above sea level. It usually occupies moderate to steep slopes and rolling, ridgy, and hilly country. Drainage is thorough. The gravel content helps to keep the soil porous, thus allowing free absorption of moisture, and it also serves as a mulch in places, preventing excessive evaporation as well as washing. As a result even the quite steep slopes are cultivated.

The Montalto gravelly loam is an important soil in the agriculture of the area. Most of it is cultivated. The uncleared areas are forested mainly with maple, chestnut oak, and basswood. The principal crops grown are corn, oats, wheat, hay, buckwheat, and rye. Some potatoes are produced, and tomatoes are grown for canning by a few farmers near Lambertville. Dairying is an important industry, and poultry raising is carried on extensively by a few farmers. Nearly every farmer has a surplus of dairy and poultry products to sell. Orcharding was very important on the type a few years ago and there are still many orchards, but the returns are generally small, owing to the lack of attention. Some of the most popular varieties of peaches grown are the Carman, Mayflower, Hiley, Iron Mountain, Champion, and Elberta. The Starr, Astrakan, Oldenburg (*Duchess of Oldenburg*), Yellow Transparent, Wealthy, and Fall Pippin are among the best-known early varieties of apples. The most favored varieties of winter apples are

the Baldwin, Gravenstein, Stayman Winesap, Rome Beauty, York Imperial, and Delicious.

Corn yields 40 to 60 bushels per acre, oats 40 to 60 bushels, wheat 20 to 30 bushels, and hay 1 to 1½ tons per acre. Crops are usually grown in rotations, and good tillage methods are followed. The steeper slopes require more handwork than do some of the smoother areas, where improved farm machinery is used. Stable manure is applied to sod before plowing it under for corn, and the small grains receive 150 to 400 pounds per acre of commercial fertilizer. The type is valued at $40 to $85 or more an acre, depending upon the location and improvements. It is known as "mountain grit land." When properly handled this is an excellent fruit soil, and there is apparently no reason why large commercial orchards would not pay. Lime may be needed in most areas for best results.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Montalto silt loam:

Mechanical analyses of Montalto silt loam.

Number.	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.*
170733	Soil	3.5	9.7	3.8	10.1	9.9	49.6	13.7
170734	Subsoil	6.7	11.7	3.8	9.9	9.9	44.7	14.0

PENN SHALE LOAM.

The Penn shale loam consists of Indian-red silt loam, 8 to 14 inches deep, over brighter Indian-red, brittle clay. There is an abundance of shale fragments from the surface down, and in most places the parent shale occurs within the 3-foot section. This is a common if not universal occurrence on the steeper slopes and especially those approaching streams. Often the lower subsoil is quite friable, owing to the larger quantity of partly decomposed shale material present. The shale fragments range from less than one-eighth to one-half inch or more in thickness. They have practically the same color as the soil. In places where the fragments are not so abundant and the parent rock lies below the 3-foot section the soil is brown and the subsoil reddish brown and friable.

The Penn shale loam is most extensive in the southern part of the area, in the vicinity of Milford and Frenchtown, east and south of Flemington and northeast of Lambertville. It occupies gently rolling ridges, hillsides, and stream slopes, and is often encountered in more level situations where the parent shale is close to the surface. Drainage is usually excessive, especially on the slopes, and the soil

may be eroded. Crops often suffer from lack of moisture, especially during dry seasons.

All the type is cleared except the rather steep slopes or places where the shale is close to the surface. White oak and hickory predominate in the forested areas. Cedar grows on some slopes where the soil is thin, while on other slopes beech is an important tree. The type is used mainly for growing corn, oats, wheat, and hay. Some rye and buckwheat are grown. Dairying is an important industry.

Yields in very favorable seasons are as high as on the Penn silt loam, but the average for a period of years is considerably lower. The methods of handling and the fertilizer practices are about the same as on the associated soils.

This land is valued at prices ranging from $25 to $75 or more an acre, depending upon the location, the depth to bed shale, and the improvements.

The Penn shale loam needs lime and organic matter. Red clover would do much better if the soil were well limed. The steeper areas, of thinner soil, should be kept in grass or in forest, and should never be allowed to go through the winter without a cover crop to prevent loss through leaching and excessive surface washing.

PENN GRAVELLY LOAM.

The typical Penn gravelly loam consists of Indian-red or brownish Indian red silt loam to loam, underlain at any depth from 10 to 20 inches by Indian-red silty clay, carrying a large quantity of angular fragments and small cobblestones of whitish, grayish, and reddish quartz on the surface and through the soil mass. Usually the soil contains so much gravel that it is impossible to bore to depths greater than 10 or 15 inches. The bedrock, consisting of conglomerate beds with quartzite, quartz, and some limestone pebbles in a red matrix, is encountered within the 3-foot section in places. South of the area of occurrence of the conglomerate beds the Penn gravelly loam as mapped contains angular fragments of red and grayish sandstone and quartzite or argillite.

This type occurs along the northwestern borders of the shale formations. The largest areas are those near Pattenburg, Clinton, Hamden, Everittstown, Cherryville, and Mount Pleasant. The soil typically is ridgy or hilly, occupying hills which stand 200 or 300 feet above the other Penn soils. These ridges are locally called the "Barrens." South of the large developments the type is found on stream slopes at lower elevations than most of the other Penn soils. It is everywhere well drained. The gravel seems to make the soil rather porous, and at the same time prevents erosion on the slopes. Crops are apt to suffer during excessively long dry spells.

Approximately 50 per cent of the type is cleared. The original forest growth was made up largely of chestnut, which has been killed by the blight, and the wooded areas now appear filled with dead timber. Oak and hickory are common trees. The cleared areas are used for the growing of corn, oats, wheat, rye, buckwheat, and hay. Dairying is an important industry. Where there is no near bottom land rye, corn, and similar crops are often sown thickly and cut green for feeding. Some alfalfa is grown and there are a few fields of excellent sweet clover,[1] which is a common plant along the roads. Some peach orchards have been set out on this type.

Yields compare favorably with those obtained on the Penn loam and silt loam. Corn yields 20 to 50 bushels per acre, oats 20 to 40 bushels, wheat 12 to 20 bushels, and timothy and clover hay about 1 ton. Peaches and apples give very good yields when they receive proper care, but most of the orchards receive little or no attention and are in a dying condition. The type is rather difficult to plow and till, owing to the large quantities of stone.

Land of the Penn gravelly loam is valued at prices ranging from $20 to $75 an acre, or even more in some places. The price depends largely upon the location, the topography, and the improvements.

This is a good, productive soil, naturally well suited to peach and apple production. It can be made more productive by growing legumes. Sweet clover seems to thrive naturally, but it is nevertheless best to inoculate the soil before sowing the crop. After sweet clover has been grown in a field it is less difficult to start alfalfa. Steep hillsides should be seeded down each fall with a cover crop.

PENN SILT LOAM.

The Penn silt loam consists of a chocolate colored or brownish Indian red silt loam, 8 to 18 inches in depth, overlying Indian red, brittle clay. Some whitish and reddish quartzite occurs in places along the northern border of the type, and red shale fragments are often present on the surface. The lower subsoil nearly always contains some shale particles. The parent red shale is usually encountered at depths ranging from 20 to 36 inches. Occasionally some fragments of blue or red argillite occur within the 3-foot section.

The Penn silt loam is a very extensive soil throughout the southern part of the Belvidere area, and is one of the most important soils in Hunterdon and Mercer Counties. Large areas are mapped near Pennington, between Lambertville and Flemington, in the vicinity of Stanton, White House, and Clinton, and northeast of Milford. The surface is undulating or gently rolling and traversed by many

[1] Two species are common; one with white blossoms, *Melitotus alba*, and one with yellow blossoms, probably *M. officinalis*.

small streams whose valley slopes are smooth. The type is well drained, but only the areas in which the depth to shale is shallow ordinarily suffer from drought.

This type is nearly all cleared, the existing wooded areas for the most part consisting of 5 or 10 acre tracts used for woodlots. The principal tree growth consists of red, white, chestnut, and other oaks, chestnut (which was an important growth before the blight became destructive), hickory, maple, ash, walnut, and sassafras. The most important crops grown are corn, oats, wheat, hay (timothy and red clover), rye, and buckwheat. Irish potatoes and alfalfa are still minor crops, but their acreage is increasing. Dairying is an important industry. Poultry raising is well developed on farms just northwest of Trenton. In this section also there are many farms devoted to the production of nursery stock, especially fruit and ornamental trees, and strawberry, raspberry, and blackberry plants. Hogs are raised on most farms to supply pork products for home use, and some farmers have a surplus to sell. Large quantities of peaches are produced on this soil. A few years ago peach production was one of the most important industries, and fruit exchanges were maintained at Flemington and other places. The lack of good orcharding practice, together with the development of new orchards in southern New Jersey, caused the industry to decline. Apples, plums, pears, and quinces are grown by some farmers and give good returns. This type is considered by the growers not to equal the Montalto or Chester soils for fruit production.

A considerable proportion of the Penn silt loam has been cultivated for more than 125 or 150 years, and the yields obtained to-day are as a rule as good as, or better than, those obtained on the newer land. Corn yields of 50 or 75 bushels are not uncommon, though the average yield is about 35 bushels per acre. Yields of wheat range from 15 to 25 bushels, averaging about 18 bushels. Oats yield 30 to 40 bushels, rye 15 to 20 bushels, and hay (timothy and clover) 1 to 1½ tons per acre.

Crop rotations are practiced by practically all farmers. Corn is followed by oats, and this crop by wheat or rye. Timothy is seeded with the wheat or rye, and red clover is sown with a wheelbarrow seeder in the spring. Hay is cut for 2 years or more before the sod is turned under for corn. The soil is well tilled, heavy teams being used in connection with improved farm machinery. Large barns are used to store crops and many of the houses are of substantial stone construction. (See Pl. III, fig. 1.)

Dent varieties of corn are generally grown on this soil. Some of the farmers plow corn land in the fall and stir it with disk and other harrows in the spring. They report that better results are obtained than when the land is plowed in the spring. Manure is applied usu-

ally on sod before plowing it under for corn. Commercial fertilizer at the rate of 200 to 400 pounds per acre is applied in the row at the time of drilling the small grains. Wheat usually receives an acreage application of 50 or 100 pounds larger than the other grains. In normal times 2–8–10 was the common fertilizer formula, but since 1914 little or no potash is in the fertilizer, and the formulas analyze 2–10, 1–10, or even 0.85–10.

Land of the Penn silt loam has a wide range in value, from $50 to $100 or more an acre. From $60 to $75 is the ordinary price in most places. Near Trenton the prices are very high.

The Penn silt loam is well adapted to the growing of general farm crops and to dairying. Yields of red clover would be greatly increased if lime were added in some form at least every 5 or 6 years. Deeper plowing would probably be profitable. Larger yields of all crops could be obtained if more care were used in fertilization, seed selection, and tillage.

Some small areas of Penn loam, occurring in Hunterdon and Mercer Counties near Mount Pleasant, Rosemont, Trenton Junction, and in a few other places, are included with the silt loam as mapped, because of their small importance and the close similarity in agricultural value. The Penn loam is a brownish Indian red loam underlain at about 10 inches by a clay loam or silty clay loam of the same color as the soil, resting on a rather brittle clay. Over part of the type the material shows little change to a depth of about 2 feet, below which there is a higher content of partly decomposed shale. Near Mount Pleasant some partly rounded quartzite is present, and in some other places argillite fragments are found. The surface is gently rolling, and the type is well drained. Nearly all of it has been cleared and is used for the production of corn, oats, wheat, and hay. Some rye, buckwheat, alfalfa, and potatoes are grown. Dairying is an important industry. Orcharding is of minor importance, although peaches do well and in former years large peach orchards were set out on this soil. Crop yields average about the same as on the Penn silt loam. The type is handled in the same manner. It is easily tilled and mellow.

LANSDALE GRAVELLY LOAM.

The Lansdale gravelly loam consists of a brown or light-brown silt loam, underlain at 6 to 10 inches by light-brown or yellowish-brown silt loam which passes quickly into brownish-yellow or yellow silty clay or silty clay loam. In some places the subsoil has a reddish cast. There is an abundance of angular, platy fragments of grayish and reddish argillite or sandstone, quartzite, and shale on the surface and through the soil and subsoil. In areas associated with the Penn gravelly loam, north of Everittstown, west of Jutland, and

in a few other places in this same general region (the "Barrens") the stones consist largely of small rounded quartz or quartzite fragments as well as cobblestone of the same material. The stones on the areas mapped southeast of Frenchtown, near Milltown and Rosemont, east of Lambertville, and west of Flemington consist largely of platy fragments of blue or red argillite, while the areas mapped along the slopes of the Raritan contain much platy sandstone.

Included with the type south of Clinton are two small areas of an old, high, river-terrace soil, largely sandy loam, containing large quantities of gneiss, quartzite, flint, and limestone gravel.

The Lansdale gravelly loam occurs in many places in Hunterdon and Mercer Counties. Large areas are mapped south of Croton, near Cherryville, and in many other places. The surface is hilly to sloping. Much of the type is found along stream slopes. Drainage is fair, except in spots where there is seepage from higher slopes.

This is a rather extensive soil. Only a part of it is cleared. The native trees are mainly chestnut oak, red oak, hickory, dogwood, basswood, maple, and chestnut. Near the foot of the slopes in the sections where the gravel is of argillite, beech and elm are numerous. The type is used for general farming and dairying. It gives about the same yields as the Penn gravelly loam except where the gravel consists of argillite; here the yields are somewhat lower. The type is handled under the same methods as the Penn gravelly loam.

Land values on this type range from $20 to $60 an acre, depending upon the location, the kind and amount of stone present (the areas of argillite gravel being of less value than the typical), and the improvements.

The Lansdale gravelly loam needs the addition of lime. This is particularly true of the argillite areas, and here also in places artificial drainage would be beneficial.

LANSDALE SILT LOAM.

The typical Lansdale silt loam consists of a brown silt loam, 8 to 14 inches deep, over yellowish-brown, friable silty clay loam which passes beneath into yellow or yellowish-brown, friable silty clay. There are frequently present some sandstone and shale fragments. Some small patches of Lansdale loam are included in the type as mapped.

In places the brown silt loam is only 4 or 5 inches deep over yellowish-brown silt loam, with yellowish-brown silty clay loam coming in at 6 to 10 inches and passing into yellow silty clay or a mottled gray and yellow silty clay. This latter material has a more compact structure in the lower part of the 3-foot section, and shades into a chocolate-brown or brownish Indian-red color. Soil of this character represents an approach toward the Croton soils. It usually

occupies flatter areas than the typical Lansdale silt loam. The principal areas are situated near Barbartown and Milltown, and south of Quakertown.

The most important areas of the typical Lansdale silt loam are situated near Quakertown, Cherryville, and Pennington, north of Trenton, and in other places in Hunterdon and Mercer Counties. The topography on the whole is gently rolling, though in some places the type is found on slopes. Drainage is well established except on the flatter areas, where the subsoil is sometimes imperfectly drained.

This is an important soil agriculturally. Wheat, timothy and clover, corn, oats, rye, and buckwheat are the main crops. The type is nearly all under cultivation, only small tracts of a few acres each being left in timber, and these are often on the flatter areas. Here chestnut oak, red oak, chestnut, elm, black walnut, maple, hickory, tulip poplar, and dogwood form the principal growth.

Dairying is an important industry, nearly every farmer having from 6 to 18 cows, usually grade Holsteins. The milk is hauled to the nearest milk station, where it is iced and shipped directly to the market. A few farmers who live farther back from the railroads send their milk to the local creameries to be made into butter. The dairy herds are gradually being improved by local breeding, but many cattle are still purchased from New York, Pennsylvania, and Maryland. Hogs and poultry are raised by most farmers in sufficient numbers to supply the home demand for pork and poultry products, and many have a surplus to sell. A few farmers depend almost entirely upon poultry raising for a livelihood. These are generally people who until recently have lived in cities.

Alfalfa does well on this type of soil, and the acreage is being extended. From three to four cuttings are obtained each year. Potatoes are grown by a few farmers north of Trenton and near Pittstown, and very good yields are obtained. The crop matures about the last of August or the first part of September. Dent varieties of corn are grown, the seed usually being selected from the owner's crib. The ordinary yield of corn per acre is 45 or 50 bushels, but there is a range from 40 to 70 bushels.

Wheat yields range from 15 to 25 bushels per acre, averaging about 18 bushels. Rye gives somewhat lower yields than wheat. Hay, which usually consists of a mixture of red clover and timothy, yields about 1¼ tons per acre.

The common practice is to grow crops in a four or five year rotation. Corn, oats, and wheat are each grown for one year, followed by clover and timothy for one or two years. Dairy cows may be pastured in the hay fields the third season. Sometimes rye takes the place of wheat or buckwheat, or it may be sown early to take the place of oats. Usually buckwheat is grown as a catch crop when some

other crop fails. Wheat, buckwheat, oats, and rye are usually seeded with a drill. Moderately deep plowing is done by most farmers, while some plow as much as 8 inches deep. Wheat is drilled from September 10 to 20, except following seasons when the Hessian fly has caused considerable damage, when it is drilled three or four weeks later. Timothy is sown with the wheat, and the clover is sown broadcast on the wheat land in the spring. Good seed beds are prepared by the use of two or three horse plows or tractors; disk, spring-tooth, spike-tooth, and other harrows; and drags and rollers. Cultivated crops such as corn receive many cultivations each season. One and two row multi-toothed cultivators are in common use. Reapers and binders, mowers, hayrakes, manure spreaders, and other improved farm machinery are found on most farms.

The principal commercial fertilizer in former use was a 2–8–10 mixture, but at present, when potash can not be obtained at all, a 1–10 or even a 0.84–10 preparation is commonly used. The stable manure made on the farm is usually applied on sod before it is plowed under for corn. From 150 to 250 pounds of commercial fertilizer per acre is ordinarily applied at the time of seeding the small grains. Burnt lime was used by nearly every farmer until a few years ago, but fuel and labor became so high that the burning of the natural limestone was discontinued in the near-by districts, despite the fact that the soil needs liming.

The selling value of this land ranges from $50 to $150 or even more an acre. This wide range is due almost entirely to differences in location. Near Trenton the price is very high.

The Lansdale silt loam as a whole is handled well, but deeper plowing would improve the condition of the soil, and lime in some form should be added at least every four or five years. Alfalfa does well and should be grown more extensively. Sweet clover probably will succeed. A cover crop such as crimson clover or rye and vetch, sown just before the last cultivation of corn, to be plowed under in the spring, would add to the productiveness of the soil, as well as aid in preventing erosion.

Some small areas of Lansdale shale loam are included on the map with the Lansdale silt loam, on account of their small extent and relatively little importance. The soil consists of light-brown silt loam, 6 to 8 inches deep, underlain by light-brown or yellowish-brown silt loam, which passes into brownish-yellow silty clay or silty clay loam. Fragments of thin, platy, gray shale are scattered over the surface and through the soil and subsoil, in many places being so abundant that it is impossible to bore deeper than 15 inches. Some areas contain small fragments of blue argillite rock. In places the bedrock outcrops or is close to the surface. The most important bodies of Lansdale shale loam are found between Baptistown and Kingwood

Station, near Locktown, about 1½ miles southeast of Lambertville, and just north of Birmingham. The topography is usually rather sloping and drainage is good or even excessive, except in a few places where seepage water collects. A considerable percentage of the type has been cleared of the native growth of beech, ash, hickory, and white, red, and chestnut oak, and is devoted to corn, oats, wheat, rye, buckwheat, and hay. Dairying is an important industry. During wet periods part of the type is used for pasture. Crop yields are about the same as on the Penn shale loam. Crops do well when the rainfall is well distributed through the growing season, but yields are rather poor when there are droughts, especially in fields where the bedrock is close to the surface. Farmers state that much of this type can be plowed earlier in the season than can the heavier, deeper soils. The value of the land ranges from $20 to $50 or $60 an acre.

In addition to the included areas of Lansdale shale loam, a number of small, unimportant areas of Lansdale loam are included on the soil map with the Lansdale silt loam. They are practically confined to the region between Stockton and Sand Brook. The largest bodies occur on Sandy Ridge and north of Sergeantsville. The soil consists of a light-brown, mellow loam, which passes at 8 to 10 inches into a yellowish-brown loam. In some places the subsoil has a slight reddish cast. In places the soil is quite sandy, approximating a sandy loam, especially in Hunterdon County to the northeast of Sergeantsville and about half way between Stockton and Headquarters. Unweathered bedrock occurs at depths of 3 to 6 feet. Fragments of sandstone, shale, and argillite are found in some places throughout the 3-foot section. The topography is undulating or gently rolling, and drainage is adequate even in wet seasons. About 95 per cent of the Lansdale loam has been cleared. The staple crops grown are corn, oats, wheat, and hay (consisting of combinations of timothy and clover, or either alone). A small acreage is planted to rye, buckwheat, and potatoes. Nearly every farm supports from 6 to 15 dairy cows. Part of this type has been under constant cultivation for 100 to 150 years, and the yields are still good. Hay yields from 1 to 1½ tons, corn 40 to 70 bushels, oats 30 to 50 bushels, and wheat 18 to 25 bushels per acre.

Stony areas of Lansdale loam (representing the Lansdale stony loam) are shown on the map with stone symbols. The Lansdale stony loam is much like the Lansdale silt loam. As most of the type is wooded, the surface half inch usually consists of leaf mold, under which is a dark-brown silt loam underlain at 3 or 4 inches by yellow silt loam or gritty loam which passes into a yellow clay loam to clay. Numerous stone fragments, usually of blue or red argillite, varying in size from that of an egg to pieces several feet in diameter, are found in this type, and in some places outcrops of

bedrock occur. Near areas of the Montalto soils the surface material has a grayish cast and the lower subsoil is slightly mottled with yellow and gray. Here some of the rocks look as though they had been subjected to some heat, and many of them seem slightly fused. An important area of Lansdale stony loam occurs 2 miles north of Raven Rock, while another enters the Belvidere area just north of Buttonwood and extends in a narrow belt southwest of Snydertown. The surface is sloping to steep, and drainage is fairly good except in local spots where seepage water from higher slopes accumulates. Very little of this soil is cleared. The forest growth consists largely of red oak, white oak, and chestnut oak, ash, some maple, beech, and elm. Chestnut was once an important tree. The few cleared areas are used almost exclusively for pasture. The steeper slopes occupied by this soil should be kept in forest. Many of the better situated areas are capable of being cleared, and some of them could be made ready for cultivation with little labor.

CROTON SILT LOAM.

The Croton silt loam consists of a grayish-brown to gray silt loam, 5 to 8 inches deep, overlying light-gray silty clay loam which passes abruptly into gray clay and this at any depth from 14 to 24 inches into a very compact, chocolate-brown or reddish-brown silty clay. This hardpanlike layer usually contains considerable brownish or brownish-yellow, more friable material, apparently of a concretionary nature. In many places the upper subsoil is mottled gray and yellow, the yellow mottlings becoming more marked with increase in depth. In places the soil is browner than typical, the upper subsoil is a yellowish silty clay loam passing into yellow silty clay, and the compact lower stratum is mottled with brownish red, yellowish, and grayish colors. In places there is some dark concretionary material in the subsoil. The areas bordering the Penn soils, as, for example, that 1½ miles north of Baptistown, are often browner in the surface layer and slightly reddish in the upper subsoil, though the gray and yellow mottlings are usually encountered just above the characteristic hardpan. Frequently the parent rock—bluish and brownish-red argillite and in places red shale—is reached within the 3-foot section, and platy fragments of this rock are scattered over the surface and disseminated through the soil and subsoil. Where the type grades into the Lansdale silt loam it is not everywhere easy to decide definitely just where to draw the line between the two soils. Some small areas of Lansdale silt loam are included with the Croton as mapped.

The largest areas of Croton silt loam are mapped on the Hunterdon Plateau, locally called "the swamp," between Frenchtown and Flem-

ington. Other areas are found near Pennington and Lambertville. Drainage is poor to imperfect, owing to the flat topography and to the hard, impervious subsoil layer, which prevents the proper circulation of moisture. Many farms are underdrained.

This is an extensive soil, and most of it is cultivated. The principal native trees are turkey or black oak, ash, birch, maple, hickory, ironwood, and post oak. The general farm crops are grown, mainly corn, oats, rye, hay, buckwheat, and some wheat. Dairying is a very important industry, nearly every farm having a number of milch cows. The average herd comprises about 12 cows. Holstein blood predominates in the dairy stock. Chickens and hogs are raised in sufficient numbers to supply the home needs, and a few farmers make a specialty of poultry raising.

The yields of oats, rye, and buckwheat are nearly as good on most of the type as on any of the Lansdale or Penn soils. Wheat does not do well. Some farmers report that the crop drowns during the wet periods in the winter. Corn and other deep-rooted crops do not generally give good results except in very favorable seasons, as during very wet years the roots stand in a water-logged soil and during dry periods the "hardpan" layer prevents sufficient moisture from rising. Hay crops do well as a rule. The common hay crop consists of combinations of timothy and alsike clover. Red clover does not do well, except where the drainage is naturally better than typical and where heavy applications of lime have been made.

Crops are grown in rotations, the most common one consisting of corn, oats, rye, and hay. Buckwheat is sometimes sown in July, usually when some other crop has failed to come up or when, because of the late spring, the crop could not be put in at the proper time. Planting is often delayed by the slowness of the soil in drying out. Plowing is done with two or three horse turning plows. Disk, spring-tooth, and spike-tooth harrows, cultivators, and other improved farm implements are in common use.

Corn land generally receives the stable manure, while the small grains are given acreage applications of 150 to 400 pounds of commercial fertilizer, distributed in the row at the time of planting. This soil retains fertilizer much longer than well-drained types, owing to its flat topography and to the underlying "hardpan," which prevents leaching.

The Croton silt loam is known locally as "white land," "swamp land," and "clay land." It has a wide range in selling value, from $20 to $60 or even more an acre, the price depending upon the location with reference to good roads, towns, and improvements. Near Croton and Flemington many farms have been sold at abnormally high figures to city men, many of whom have become discouraged

with farm life in a year or two, the farm then going back to the dealer to be resold.

The Croton silt loam is badly in need of lime and artificial drainage. Some of it would be greatly improved by underdrainage, though in most cases draining can not be easily accomplished, owing to the hardpan layer. Blasting this layer might improve the drainage.

Croton silt loam, poorly drained phase.—The Croton silt loam, poorly drained phase, has a brownish-gray or ashy-gray silt loam surface soil, 6 or 8 inches deep, overlying light-gray or mottled gray and yellow silty clay loam. This passes quickly into mottled, limonite-yellow, and gray silty clay, which is underlain at 12 to 28 inches by compact silty clay of a limonite-yellow or mottled Indian-red and limonite-yellow color. Rusty-brown and dark-colored concretionary material is usually present in this hardpanlike lower subsoil. This layer is so hard and impervious that even during the periods of excessive rainfall it seems hard and very dry. Slabs of bluish and reddish argillite are present in many places on the surface and through the soil section.

The poorly drained phase is found in association with the typical Croton silt loam, occupying flats or depressions at the head of or adjacent to streams and other places slightly lower than the adjacent typical Croton silt loam and other soils. It is not an extensive soil, and it occurs only in small tracts.

Part of this phase is cleared. The tree growth differs from that on the typical soil in that there is more birch, ironwood, maple, and willow. Black haw, hazel, and jewelwood grow rapidly. Sedges and rushes often crowd out the other pasture grasses. Pasturing is the chief use of this soil.

This phase is harder to drain than the typical soil, but with proper care forage crops can be grown profitably and good pastures can be obtained. Lime is much needed.

In the following table are given the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the typical Croton silt loam:

Mechanical analyses of Croton silt loam.

Number.	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.*
170701, 170703.....	Soil.....	0.9	1.6	0.5	1.4	8.8	66.1	20.6
170702, 170704.....	Subsoil.....	1.7	3.0	1.0	2.6	11.0	58.1	22.4
170702a, 170704a...	Lower subsoil.....	.8	1.7	.6	2.2	11.1	60.6	22.9

LEHIGH SHALE LOAM.

The Lehigh shale loam is a brownish-gray or chocolate-gray silt loam passing at 8 to 10 inches into mottled gray and yellow silt loam or silty clay loam. In places the subsoil is a bluish silty clay. There is an abundance of chocolate-colored and grayish to bluish shale fragments on the surface and through the soil and subsoil. In many places the underlying shale comes within the 3-foot section. Near Stanton some platy sandstone fragments are scattered over the surface. The color of the soil is grayer than that of the Lansdale soils.

The Lehigh shale loam occurs near the Montalto soils. It is probable that the parent rock, the Triassic shale, was metamorphosed by contact with the dikes and intrusive sheets of molten material which give rise to the trap rocks of the area. Some of the most important bodies of the Lehigh shale loam are encountered in the vicinity of Stanton, southeast of Union, south of Ringoes, and east of Lambertville.

The type occupies gentle slopes and is well drained. The mottlings of the subsoil are not due to imperfect drainage, but have been caused partly by the large amounts of shale fragments, which are in all stages of weathering. During long periods of drought crops suffer on this type from lack of moisture. In places seepage water from the higher Montalto soils gives some trouble.

The Lehigh shale loam is not an extensive type, but nearly all of it is cleared and devoted to the general farm crops. The yields are about the same as on the Penn and Lansdale shale loams, or possibly lower.

On account of their small extent some small areas of Lehigh silt loam are included with the Lehigh shale loam. The surface soil is a gray silt loam, underlain at 6 to 10 inches by mottled gray and yellow silty clay loam to silty clay. In some places the mottling is more vivid than in others. A few fragments of hard, blue argillite or grayish shale are encountered in places. Areas of Lehigh silt loam are associated with the Montalto soils. Some of the most important bodies are situated east of Lambertville in patches on both sides of the trap mountain extending northeast across the area. The topography is gently sloping, and drainage is thorough or even slightly excessive, except where seepage water from the higher lands accumulates. The type is nearly all cleared and used for corn, oats, wheat, rye, buckwheat, and hay. Dairying is an important industry. Yields are only fair, though slightly higher than those obtained on the Lehigh shale loam. The methods of handling the soil and the fertilization practices are similar to those prevailing on the other types of the region.

SASSAFRAS LOAM.

The Sassafras loam consists of 8 to 10 inches of brown, mellow loam overlying light-yellow loam which passes quickly through reddish-yellow or orange-colored loam into reddish-yellow silty clay loam. The lower part of the 3-foot section is lighter in texture than the upper subsoil, ranging from sandy clay to coarse sand. Varying amounts of small quartz gravel occur through the 3-foot section, usually increasing in quantity with depth. In places the surface soil seems to consist largely of very fine sandy loam. A few bodies are included in which the material that gives rise to this soil is so thin that the lower subsoil contains some red material from the underlying red shale.

The material which gives rise to the Sassafras loam in the Belvidere area is similar to the soil-forming material of much of the series as mapped in southern New Jersey. It is found overlapping the Triassic shales along the southern border of those formations. In this survey the type is mapped in slightly rolling areas north of Trenton, near Ewingville and Trenton Junction. It is well drained.

The type is largely cleared and cultivated. The principal tree growth consists of white, red, chestnut, and black oak, dogwood, ash, and some chestnut. Most of the chestnut trees are dead. The type is highly prized for the growing of corn, oats, wheat, and hay. Some rye and buckwheat are grown, and small areas are devoted to alfalfa and potatoes. The yields are equal to those obtained on the best parts of the Lansdale silt loam or loam. Much of the type is located so close to Trenton that its value for building sites greatly exceeds its farm value.

PAPAKATING SILT LOAM.

The Papakating silt loam consists of a black, dark-gray, or dark-brown silt loam overlying at variable depths, usually 10 to 15 inches, a bluish-gray silty clay which is mottled with brown or rusty brown and which usually passes into bluish-gray fine sandy loam or fine sand. In places the sand is marllike and contains some small shells. Occasionally the subsoil is a black loam or silt loam. There are some included hummocks of dark-gray fine sandy loam, as along the Pequest River. In many of the bottoms in the northwestern end of the Belvidere area, between the Delaware River and the Jenny Jump Mountain, the soil is a black, mucky silt loam, about 10 inches deep, over black or dark-brown silty clay loam, with a layer of grayish marl, containing small shells, at 26 to 30 inches. Below this there is encountered a blue clay. Some gneiss, quartzite, and limestone bowlders are found in places on this type, such areas being shown on the map by stone symbols.

The Papakating silt loam occupies wet, poorly drained bottoms along many of the streams in the glacial region. The largest bodies are mapped along the Pequest River in the Great Meadows region and along Muddy and Beaver Brooks near Hope. The type is naturally swampy and poorly drained, and in addition it is subject to overflow. Much of the upper Pequest River has been dredged, so that it no longer floods as widely as in former times, and some of the farmers in this region have dug lateral ditches into the river.

This is not an important soil at present. Approximately half of it has received little or no attention. The native forest growth consists largely of elm, dogwood, basswood, willow, sycamore, oak, and beech. In the mucky spots, for example, west of Hope, a marshy growth consisting of sweet flag, reeds, and water-loving grasses is found.

The Papakating silt loam is used mainly for pasture. The cleared and partly reclaimed areas make dependable, permanent pastures, but the wetter areas can only be pastured during droughts, owing to their miry condition at other times. Part of the type, as along the northern end of the Great Meadows, is used for the production of hay, which gives an average yield of over 1 ton per acre.

This soil could be made one of the most valuable types in the area for the production of forage if the drainage were improved and the land limed. Cabbage, lettuce, onions, and many other crops should succeed, as well as the general farm crops.

GENESEE SILT LOAM.

The Genesee silt loam, in its typical development, is a brown to dark-brown silt loam, passing at 15 to 20 inches into yellowish-brown silty clay loam and this into yellow or yellowish-brown, friable, silty clay. The type is exceedingly variable. One boring may show typical material, while a few feet away the soil may be much sandier. Nearer the streams the sand content is usually larger.

There are included with the type some patches of poorly drained soil, too small to separate. In the Great Meadows some of the better drained bottoms have been mapped as Genesee, although the subsoil in places closely resembles that of the Papakating silt loam. There are also some included areas of Genesee sandy loam. In places the soil contains considerable gravel of gneiss, quartzite, flint, and limestone, but little mica.

The Genesee silt loam occurs along the better drained stream bottoms receiving wash from glacial till, a varying percentage of which is limestone material in nearly all cases. The largest areas of the type occur along the Pequest and Musconetcong Rivers and their tributaries, where it is subject to overflow. In some places the channels of the streams have been deepened or cleaned out, and here overflows occur only in seasons of exceptionally high water.

Many of the bottom areas have been cleared of trees and undergrowth. The principal growth in the uncleared areas consists of willow, elm, sycamore, tulip poplar, hickory, maple, and some sweet gum, with an undergrowth of black alder and hazel. The cleared areas are devoted chiefly to pasture grasses. They afford excellent pasturage, even during periods of drought. Dairy cattle are kept by nearly every farmer on the adjacent upland and pastured in the bottoms. (See Pl. III, fig. 2.) Some areas are devoted to the growing of corn, and in favorable seasons very good results are obtained.

CODORUS LOAM.

The Codorus loam typically consists of a brown, gritty loam or silty loam, underlain at 12 or 15 inches by light-brown to yellowish-brown loam or gritty silty loam. In many places the lower subsoil is a sandy clay, sandy loam, or sand, and it varies in color from reddish yellow to yellow or mottled yellowish and rusty brown. Gravel and mica flakes are common in the subsoil, and mica flakes are present throughout the 3-foot section in places. Gneiss gravel and bowlders occur in many places; areas where they are numerous are shown on the map by symbols. Where the drainage is poor the soil and subsoil show more or less mottling with rusty brown or dark drab. There are included some areas of gravelly loam, gravelly sandy loam, and silt loam.

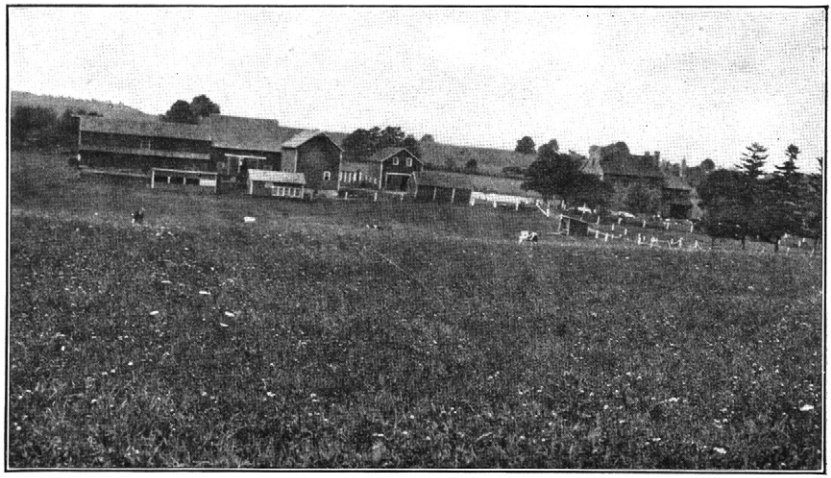
Most of the material giving rise to the Codorus loam is wash from the crystalline-mountain soils (Chester or Montalto), but along some streams it includes wash from the limestone soils, and in fact part of the type really represents the Huntington silt loam. Near the head of some of the drainage ways there is more or less colluvial wash in the shallow depressions.

Some of the largest bodies of the Codorus loam are found along the South Branch of the Raritan River and its tributaries north of Clinton. The drainage is generally fair to good, but in some places the type has poor drainage. Part of it has been cleared, the remainder being forested with sycamore, willow, elm, basswood, and oak. The soil is used largely for pasturing dairy cows. Some well-drained areas are used for growing corn, hay, and vegetables.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Codorus loam:

Mechanical analyses of Codorus loam.

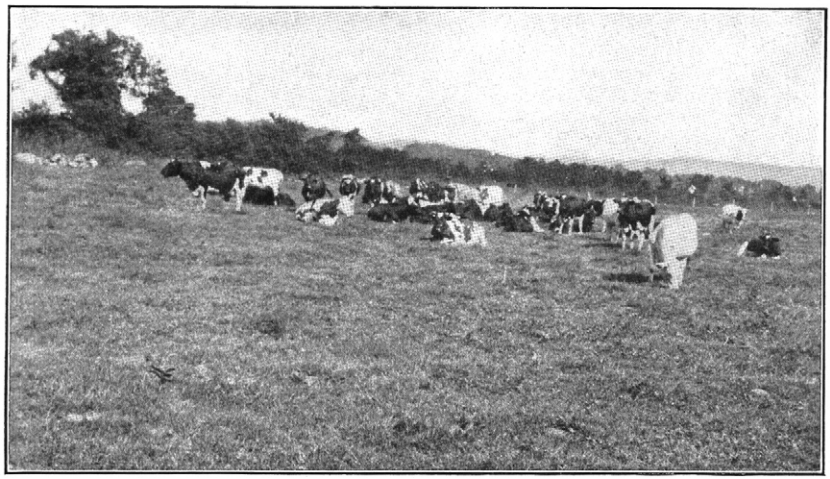
Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
170743	Soil	4.2	7.8	3.7	15.0	15.0	44.4	9.9
170744	Subsoil	7.1	11.5	5.2	14.2	14.1	36.4	11.5



S. 9547

FIG. 1.—CHARACTERISTIC GROUP OF FARM BUILDINGS ON THE PENN SILT LOAM, NEAR RINGOES.

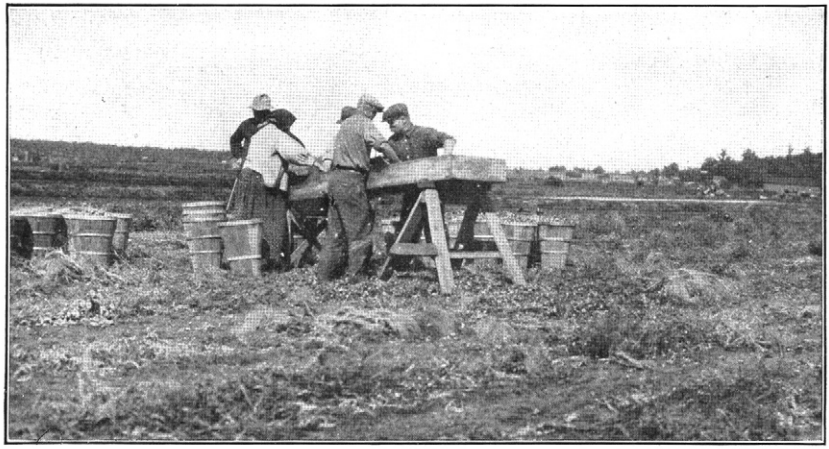
The topography is common to much of the type.



S. 9566

FIG. 2.—GENESEE SILT LOAM, NEAR GREAT MEADOWS.

Grazing is the principal use made of this soil.



S. 9565

FIG. 1.—HARVESTING AND PACKING ONIONS ON MUCK, NEAR GREAT MEADOWS.

S. 9553

FIG. 2.—HARVESTING CELERY ON MUCK, NEAR GREAT MEADOWS.

BERMUDIAN SILT LOAM.

The Bermudian silt loam is a reddish-brown or brownish Indian red silt loam, underlain by reddish-brown or Indian-red silt loam to silty clay loam. The lower few inches of the 3-foot section frequently consist of sandy loam or sand. Pockets or strata of sand and small sandy patches are sometimes found. In places the deep subsoil is a bluish silty clay. Where the material consists largely of reworked wash from the Lansdale or Montalto soils, or from both, the surface soil is light brown to grayish brown, with a yellow subsoil. In places where the drainage is imperfect or poor the subsoil is mottled red and yellow or gray and yellow or bluish.

The Bermudian silt loam is a first-bottom soil consisting largely of wash from the Penn and Lansdale soils. It occurs in Hunterdon, Mercer, and Somerset Counties along streams which flow through the Lansdale and Penn soils. The largest and widest bottoms occupied by the type are those along the South Branch of the Raritan River. The type as a whole is fairly well drained for a bottom soil, but it is subject to overflow during periods of excessive precipitation, especially where it borders the smaller streams.

Nearly all the type has been cleared of the native growth of willow, sycamore, pin oak, elm, shagbark hickory, ash, and alder. Often where the bottoms have been cleared willow and sycamore are allowed to grow along the creek banks. The principal use made of the type is the pasturing of dairy cows. It supports a good growth of native grasses which, owing to the high level of the water table, do not suffer much even during periods of drought. Small areas here and there are cultivated, and when the crops are not killed by overflows excellent yields of corn, oats, and wheat are obtained. In most places, however, the risk of loss is considerable, and unless the stream channels are deepened, dikes built, or floods prevented in some other way, cultivation of the type is more or less hazardous. Some areas, however, are inundated so rarely that they can be farmed profitably.

ROANOKE SILT LOAM.

The Roanoke silt loam consists of brownish-gray or gray silt loam, about 6 inches deep, overlying whitish silt loam which passes at 10 to 15 inches into a mottled gray and yellow silty clay containing considerable grit. In places reddish-yellow mottlings are noted in the deep subsoil. Some gneiss stones are present in places.

This type is found in only a few places, mainly between Van Sickles and High Bridge. It occurs on low, poorly drained second bottoms. The material appears to have been washed from upland gneissic soils.

The Roanoke silt loam has been cleared and is used largely for pasturing dairy cattle. Some areas are devoted to the production of corn, hay, oats, rye, and buckwheat.

BIRDSBORO SILT LOAM.

The typical Birsboro silt loam is a chocolate-brown or brownish Indian red silt loam, 10 or 15 inches deep, overlying Indian-red silty clay. In many places, as in the areas near Flemington Junction, the surface soil is a light-brown or yellow-brown silt loam about 12 inches deep, and the subsoil is a yellow silty clay to gritty clay. Where the drainage is imperfect the subsoil is slightly mottled with yellow and red, or yellow and gray. The texture of the soil as mapped ranges to a loam or gravelly loam in places. Pockets of sand are sometimes encountered, and occasionally the lower substrata is sandy in texture.

The Birdsboro silt loam is developed on flat to slightly undulating stream terraces in Hunterdon and Mercer Counties. It represents reworked alluvium derived from Penn and Lansdale material. The largest areas are mapped along the South Branch of the Raritan River south of Clinton. The type is naturally well drained, though patches occur here and there in which the drainage is imperfect. It is not an extensive soil, but nearly all of it is cleared and cultivated. Good yields of corn, oats, wheat, and hay are obtained. Corn does especially well in most places. Dairying is an important industry.

MUCK.

Muck consists of black, well-decomposed vegetable matter containing some inorganic or mineral material. The organic deposit is 24 inches or more in depth, and is underlain by gray or pale yellowish-gray silty clay, sandy clay, or clay. This passes quickly into a greenish-gray loamy fine sand or fine sand, which in most places contains some shells. A brown mass of partially decomposed organic matter is often encountered in the areas of deep Muck at depths varying from 8 to 20 inches. This layer is usually several inches thick and is underlain either by black Muck or by the above-described clay or sand. In some places along the southern end of the Great Meadows (Pequest Meadows) the organic deposit is said to be 25 or 30 feet deep. Three classes of Muck are recognized—typical Muck, an intermediate phase, and a shallow phase. These are mapped separately, but patches of intermediate and shallow Muck are included with the typical Muck where too small to separate, and patches of deep Muck are included with the two phases for the same reason.

Important areas of typical Muck occur in the Great Meadows region, in the "Tamarack Swamp" south of Mountain Lake (Greens

Pond), between Vienna and Hackettstown, and north of Mount Bethel, and smaller patches here and there within the glacial region. The type occupies flat, swampy depressions marking the site of glacial lakes. Numerous large ditches, with smaller laterals, are necessary in order properly to drain these swamps.

Water maple, elm, willow, and sycamore are the principal trees on this soil, though the growth in some of the swamps consists largely of tamarack or cedar. The undergrowth is abundant, consisting of smilax, ivy, ferns, and other water-loving flora. In places the swamps are more like marshes, and here reeds and marsh grasses are the principal plants.

The type is important agriculturally, all the larger patches being cultivated. Celery, onions, and lettuce are the principal crops, occupying fully 90 per cent of the developed area. Corn does very well and is grown by some farmers who have only a small patch of Muck adjoining fields of upland soil. In some cases where this type has been partly reclaimed it is used for pasturing herds of dairy cows during periods of drought. It is only during such times that it is possible to allow stock to pasture on it, because of its miry nature.

Onions ordinarily yield from 400 to 800 bushels per acre. Growers state that from 600 to 700 bushels is considered a fair crop, but 900 bushels is often obtained. Varieties of white, yellow, and red onions are grown. Celery is the principal crop on most Muck farms. Large yields of excellent celery and lettuce are obtained.

Muck is held for the most part in large tracts and leased to tenant farmers in plots of 8 to 15 acres. The tenants are nearly all foreigners, largely Poles. As a rule the whole family helps with the work. The land is plowed in the fall or early in the spring, with 1 or 2 horse turning plows. The seed is sown in rows usually 12 to 18 inches apart. The crops receive many cultivations during the season, small hand cultivators being used. A few growers plant the seed in rows 3 feet apart, and till with a one-horse cultivator. The common practice is to plant lettuce early in the spring and as soon as this crop is harvested to follow with celery or onions, which are harvested during September, when lettuce is again planted to be harvested the same fall, provided frosts do not come too early. Sometimes onion seed is planted in September for "sets." Another common system is to plant early white onions in April and follow these with celery. Two crops of celery can be obtained, provided the season is favorable, and seed for the second crop is sown between the rows of the first crop before the latter is harvested.

Boards are used to bleach the celery in the field. The crop is washed, bunched, and packed in crates. (See Pl. IV, fig. 2.) Lettuce is packed in boxes, while onions are shipped in baskets or bags and are sold by the bushel or by the hundredweight. Many buyers come

directly to the farms. Each year an increasing percentage of the crop is hauled to the markets over improved roads in automobile trucks.

The fertilizer formerly used was the common 2–8–10 preparation, and 1 ton to the acre was the usual application. Since potash is so hard to get the growers use any kind of fertilizer they can obtain. In 1917 some used 1 ton of a 2–8–3 mixture to the acre, while others used the same amount of a 1–10 or 2–10 preparation. Some growers believe that the shortage of potash was the direct cause of the practical failure of the lettuce crop of 1917. Stable manure is used by some growers, but they report that weeds are nearly impossible to control when this is used, though the effect on the crops is very beneficial.

Muck lands are rented under both the share and cash rent systems. Under the former the owner furnishes everything, including the seed and fertilizer. He also plows and prepares the seed bed, and hauls the crop to the freight station. The operator furnishes the labor only, and each receives half the crops. The owner directs the work and has charge of selling the crop. Under the cash system the renter pays $15 to $20 an acre, besides paying rent for the house and barn. The many smaller details are arranged variously by different persons.

Areas of Muck large enough to sell separately bring from $75 to $500 an acre, depending upon the extent of clearing and reclamation, as well as the condition of the ditches, the nearness to good roads, the depth of the organic material, and the buildings. Under the best conditions it is the highest-priced land in the Belvidere area.

Muck, intermediate phase.—The intermediate phase of Muck consists of black Muck exactly like the typical soil except for the shallower depth to the underlying clay, sandy clay, or loamy sand, which is reached at depths usually ranging from 10 to 24 inches. The intermediate phase occurs associated with the typical Muck and is used for the same crops. It has a somewhat lower value on the market, though there is no marked difference in its productiveness.

Muck, shallow phase.—The shallow phase differs from the typical Muck in that the organic layer is not more than 10 inches deep, usually ranging from 8 to 10 inches. The area south of Mountain Lake (Greens Pond) seems to have more shell material in the sandy layer than does the typical Muck. The large area mapped at Oxford consists of black Muck which grades at 8 to 10 or 12 inches into a brown mucky clay, this passing quickly into a bluish-gray clay. Near Oxford station the black Muck grades into a black mucky clay, which in turn passes down through a bluish-black clay into rusty-brown clay. The subsoil clay of the whole Oxford tract

is more plastic and less sandy than the lower subsoil of the typical Muck and the intermediate phase.

The largest bodies of the Muck, shallow phase, occur near the upland in the Great Meadows region, south of Mountain Lake, and near Oxford. Part of the phase has been reclaimed, though it is the least improved of the Muck soils. Much of it has been cleared and partly reclaimed by ditching, and is used for pasturing dairy cattle during the dry summer months. Part of the Oxford tract, as well as much of the Great Meadows and other tracts, is devoted to the growing of onions, celery, and lettuce. Here the yields compare favorably with those on the deeper Muck.

North of Vienna in the Great Meadows section a so-called "humus" company has been at work for several years, skimming off the organic mantle right down to the clay or sandy layer, leaving a wet, barren area in the place of the once wonderfully fertile material. Such areas are included with the Muck, shallow phase. Some attempt has been made by the company to reclaim these areas, but the effort to this time (1917) has been without success.

ROUGH STONY LAND.

Rough stony land includes areas which on account of roughness of surface, due to stones and bowlders, rock outcrops, or steepness of slope have little or no agricultural value. Limestone, gneiss, sandstone, and shale stones occur through the soil. The type represents extremely stony or rough areas of several of the regular stony or shale loam soil types, and does not differ to any extent in character of the soil material.

The river bluffs and very steep slopes along the Delaware River form important bodies of the Rough stony land. Other important areas occur here and there along the slopes of the gneiss mountains in the northern half of the area. Smaller developments are mapped along the steep sides of small streams, especially in the shale regions.

Rough stony land is valued almost wholly for the timber. Sheep raising might be profitable on some of the less sloping areas.

SUMMARY.

The Belvidere area is situated in the southwestern part of northern New Jersey, its western boundary being formed by the Delaware River. The area embraces parts of six counties and covers 764 square miles, or 488,960 acres. The greater part of it is comprised in three main physiographic divisions, the Appalachian Valley, Appalachian Mountains, and Piedmont Plateau. These include mountainlike ridges, broad and narrow valleys, and plainlike plateaus, ranging in elevation from less than 100 feet to 1,277 feet above sea

level. The area falls within two drainage basins, those of the Delaware and Raritan Rivers, the former draining fully three-fourths of its total extent.

The population is composed largely of descendants of the early settlers and other white persons of native birth. The foreigners as a class are confined to the many manufacturing towns, though locally as near Great Meadows, foreign-born persons, especially Poles, form the main laboring or renting class.

The area is favorably situated with reference to numerous large centers of population, such as New York City, Philadelphia, and the coal and manufacturing regions of the Lackawanna, Wyoming, and Schuylkill Valleys of Pennsylvania. Numerous railroads, canals, and pikes connect all points of the area with these markets.

The climate is characterized by rather cold winters and warm, pleasant summers. The growing season in the northern part of the area is nearly a month shorter than in the southern part.

Agriculture in the Belvidere area consists of the growing of such general farm crops as wheat, oats, corn, rye, buckwheat, and hay (timothy and clover), together with dairying. Fruit and poultry products are important locally. Areas of soil especially adapted to the production of celery, lettuce, and onions make these products of great importance in the Great Meadows region.

The soils of the area lie in seven soil provinces, viz, Glacial, Glacial Lake and River Terrace, Limestone Valleys, Appalachian Mountains, Piedmont Plateau, Coastal Plain, and River Flood Plains. Twenty-two series of soils are recognized, including 35 types, in addition to Muck and Rough stony land.

The Washington and Dover soils are considered to be the types of the Glacial province best adapted to grass and corn. The Dutchess soils are more apt to be droughty, though they are better suited to the growing of Irish potatoes. The Gloucester soils are exceptionally well suited to the production of fruit, especially apples. The loams are the largest and most important types of the Glacial province.

The Chenango and Fox soils of the Glacial Lake and River Terrace province are strong, rich, well-drained types, and because of their productiveness and level topography they are very popular for the growing of the general-farm crops. The Chenango fine sand is the principal soil suited to the growing of melons and early truck crops for local markets. The Fox soils are important agriculturally, though they are not extensive. The Clyde stony loam and silt loam occupy a position in soil classification between Muck and the higher upland soils. They are not well drained and are used chiefly for pasture. The Muck deposits are used almost wholly for the produc-

tion of celery, onions, and lettuce. The largest bodies occur near Great Meadows.

The Berks shale loam and the Chester soils represent the Appalachian Mountain province. The Berks soil occupies rolling areas at an elevation just slightly above the limestone valleys. It is well drained or even excessively drained, but is well suited to general farm crops. Irish potatoes seem to do well, though they are not extensively grown. The Chester gravelly loam and loam are the only two members of the Chester series under cultivation. They are good, well-drained soils, devoted chiefly to the growing of corn, oats, rye, and hay. Peaches were produced in large quantities in former years and a few excellent orchards of peaches and apples exist to-day. The Chester stony loam is for the most part in forest. It occupies more sloping areas than the other types and is used only for forest and pasture land. Some of it can be cleared of stone and timber and converted into tillable land.

The only soil mapped in the Limestone Valleys province is the Hagerstown silt loam, which has a well-established reputation for productiveness. It is well drained, free from large stones, and in every way suited to the growing of general farm crops.

Of the five series of soils found in the Piedmont Plateau the Penn and Lansdale are the most extensive. They are used for the general farm crops common to the region. The chief difference between these series is in color, the Penn being deeper brown or redder than the Lansdale. The silt loam areas of each series are the most productive, crops on the shale loam type being subject to drought unless the season be very favorable. The Penn gravelly loam seems to be better adapted to the production of peaches than are the other soils. The Croton silt loam for the most part is less highly esteemed than the adjacent soils. Farmers report that the drainage is imperfect, and early crops are often drowned out, while the later ones often suffer from drought. Shallow-rooted crops seem to do best. The poorly drained phase is used almost wholly for pasture. The Lehigh shale loam is used for the common general farm crops. It does not give as good returns as the Penn and Lansdale soils. The Montalto stony loam has not been cleared of timber. The silt loam of the series is considered to be well adapted to fruits, especially peaches.

The Sassafras loam is the only type mapped in the Coastal Plain province. It is a strong, well-drained soil, but owing to its location in and near Trenton it is little used for farming.

The River Flood Plains province includes the soils of both the terraces and second bottoms, and the present flood plains, or first bottoms.

The first bottom soils of the area are all used for pasturing dairy cows. They seem to be well suited to this, as they afford good green pasturage when the grass in upland pastures has been killed by the hot summer weather. The Papakating silt loam is probably the swampiest of the bottom soils. The Genesee, Codorus, and Bermudian soils are cultivated in a few of the best-drained situations. The Birdsboro silt loam occupies the second-bottom areas of the Piedmont region. It is a well-drained, productive soil. The Roanoke silt loam is an unimportant soil because of its imperfect drainage. It is used chiefly as pasture land.

Rough stony land includes areas where argiculture is impracticable because of the numerous stones and the steep topography.

○

[PUBLIC RESOLUTION.—No. 9.]

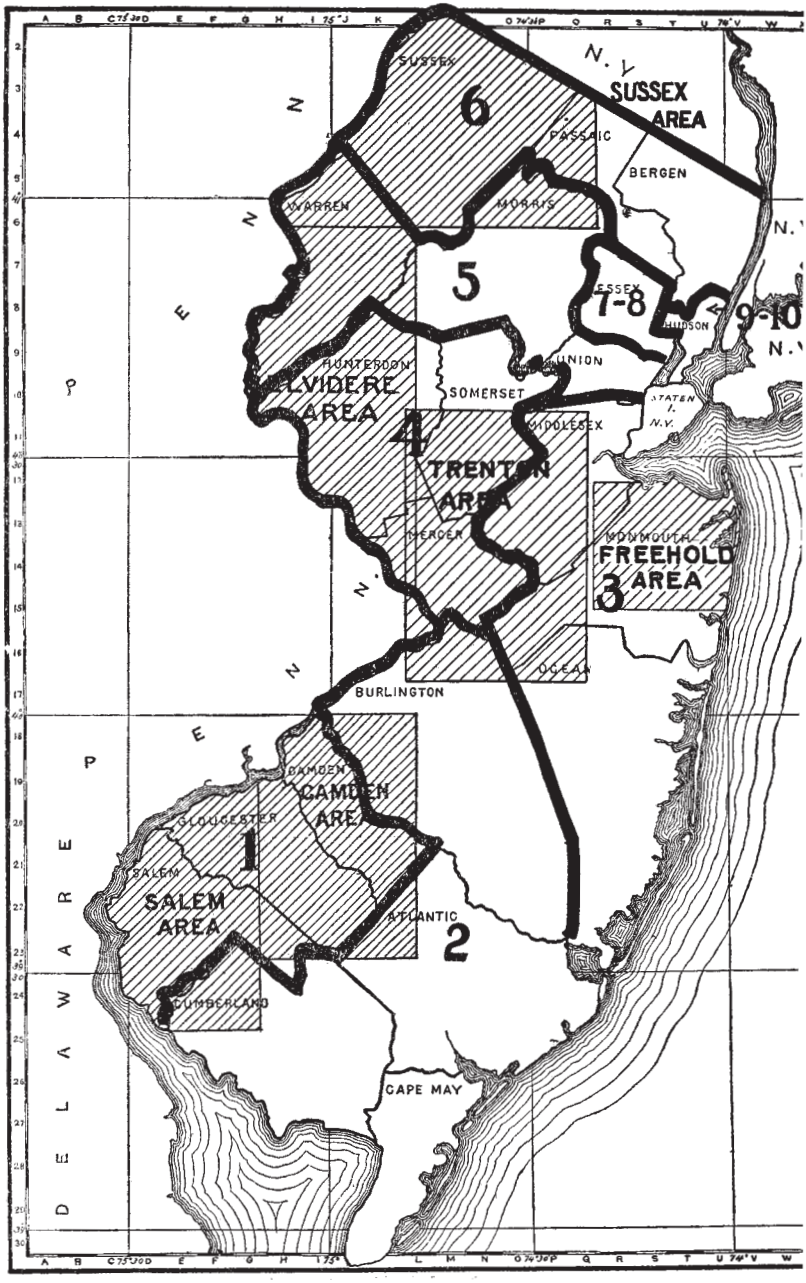
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

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.]



Areas surveyed in New Jersey.

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