Soil Survey

Series 1935, No. 6. Issued April 1939

Grafton County New Hampshire

By

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and

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COUNTY SURVEYED

Grafton County is in the west-central part of New Hampshire (fig. 1). Its western boundary, formed by Connecticut River, coincides with the New Hampshire-Vermont State line. Bristol, in the extreme southeastern part, is 100 miles from Boston. The total area of the county is 1,716 square miles, or 1,098,240 acres.

This county lies within the mountain-and-valley section of New England. Physiographically, more than two-thirds of its land area forms a fan-shaped plateau which extends from the northwestern part around to the southeastern part.

The plateau slopes in all directions from the north-central part, adjoining the base of the White Mountains, where the average elevation is about 1,900 feet above sea level, to the outer edges, where the average elevation is about 1,200 feet. The remaining one-third, or northeastern part, of the county, is mountainous. Elevations reach 3,000 feet in many places, and 12 peaks rise above a height of 4,000 feet. Mount Lincoln is 5,108 feet high, and Mount Lafayette, 5,249 feet.

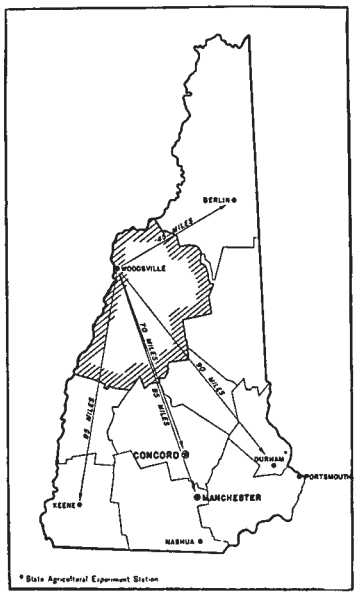

FIGURE 1.—Sketch map showing location of Grafton County, N. H.

A number of lower mountain ranges, extending mainly north and south, such as Moose Mountain, Mount Cube, and Black Mountain in the western part, Gardner Mountain in the northwestern part, and Mount Cardigan in the south-central part, cross the plateau. These mountains range from 2,000 to 3,000 feet above sea level. Scattered over the plateau are numerous small monadnocks which stand well above its general level. Only small remnants of the plateau remain at the original level, as it is severely dissected throughout. Most of the streams, especially the lateral streams which flow west to Connecticut River, have cut rather narrow deep valleys with steep sides. A few streams, however, flow through hanging valleys, or basins,

characterized by a somewhat subdued topography. One example of the latter is the Mascoma Basin. In this section the streams are sluggish, numerous swamps are developed along stream courses, and the hills, in general, are smoother than elsewhere. Wild Ammonoosuc River Valley is a good example of a deeply entrenched valley. The narrow strip along its western edge has what may be called hilly relief. This also might apply to the Mascoma Basin and to the section adjacent to Squam Lake.

The central belt comprises fragmentary plateau tops and more or less steep sides with, in places, lower hills or benches at the base, along the streams. Notwithstanding the severe dissection, there are many gently sloping areas between the plateau tops and the steeper breaks to the bottoms.

The outer edges of the plateau are closely serrated by the entrenched valley of Connecticut River. In the extreme northern part, the valley is narrow, but, throughout most of its extent, it is 1 mile wide. Wide bottoms and smooth broad terraces are developed in places, particularly at Haverhill, Piermont, Orford, and Hanover. At the point where Connecticut River touches the northwestern corner of the county, the elevation is 780 feet, and, at the point where the river touches the southwestern corner, it is 320 feet. Ammonoosuc River, the principal tributary to Connecticut River, flows across the northern part of the county in a rather deeply entrenched valley containing some bottom land and terraces. On the upper reaches of Pemigewasset River, which heads in the White Mountains, the valley is steep sided, but, in the southern part of the county, this valley attains a width of 1 mile in places and includes broad bottoms and terraces. Baker River, the principal tributary of Pemigewasset River, flows in a deeply entrenched valley between the mountain section and the northeastern edge of the plateau. The elevation at the point of confluence of these two rivers at Plymouth is about 500 feet.

A number of lakes are scattered over the county. The largest are Squam Lake, touching the southeastern part; Newfound Lake, in the south-central part; and the system of lakes associated with Mascoma Lake, in the southwestern part. The poorly drained areas or swamps are comparatively small meadows, filled-in lakes, and hollows within the mountains.

The county is drained by two river systems: Connecticut River drains the western one-third, through Ammonoosuc and Mascoma Rivers, and numerous smaller lateral streams; and Pemigewasset River and its main tributary, Baker River, drain the central and eastern two-thirds.

Practically all of the virgin timber has been cut, and most of the present forest vegetation is second growth. The forest cover varies widely with differences in relief. Below a general elevation of 1,000 feet, over the southern part as far north as Woodsville in Connecticut River Valley and as far north as Plymouth in Pemigewasset River Valley, the dominant forest tree is white pine which, in some places, grows in pure stands, and in others is mixed with white oak, red oak, hickory, ash, maple, elm, gray birch, aspen (locally called popple), and hemlock. Between elevations of 1,000 and 2,500 feet

the forest consists mainly of yellow birch, beech, maple, and some spruce, white pine, hemlock, aspen, paper birch, basswood, and oak. Above this, the paper birch, spruce, and yellow birch gradually become dominant. Above 2,500 feet and up to 3,500 feet, red spruce, balsam fir, and paper birch are common, although little merchantable timber grows above a height of 3,000 feet. Between 3,800 and 4,600 feet, the vegetation is mainly stunted spruce. Above the tree line, rock outcrops, although some areas are covered with grass and low shrubs, such as cowberry. At the lower altitudes, in wet or swampy positions, red maple (locally called soft maple), tamarack, elder, and American hornbeam (locally called blue beech) grow, especially in the lowlands, together with an underbrush of *Vaccinium* sp. and leatherleaf. In higher places, the principal trees in swampy areas are black spruce and hemlock.

The underbrush in the open forest consists chiefly of shadblow (locally called shadbush), striped maple, mountain maple, hornbeam, barberry, highbush and lowbush blueberry, ferns, and bracken. This underbrush thins, and it disappears entirely in the coniferous forest at higher elevations. In places, especially where hardwoods and conifers are intermingled, the forest floor is covered with groundpine (*Lycopodium* sp.), moss, wintergreen, and creeping snowberry.

Pastures in all parts of the county contain much spirea, sumac, and aspen sprouts. At lower elevations, in addition, sweetfern, gray birch, dwarf, or ground, juniper, and white pine grow. At higher elevations, spruce and aspen are the common invading trees. Along the fence rows around cleared areas, pin cherry, chokecherry, chokeberry, panicled dogwood, and alternate-leaved dogwood abound. Raspberries, blackberries, and dewberries are common in old clearings along hedgerows and in old trails. The common pasture grasses are Kentucky bluegrass, bentgrass, and poverty grass, with some Canada bluegrass, sweet vernalgrass, and fescue. Some white, or Dutch, clover grows in scattered areas. Creeping bent, meadow fescue, reeds, rushes, and sedges cover the low wet areas. The more common weeds in pastures are devil's-paintbrush (orange hawkweed), wild carrot, oxeye daisy, lady's-tobacco (*Antennaria* sp.), buttercup, sorrel, wild mustard, wild strawberry, goldenrod, moss, and quackgrass.

Following closely the granting of the charter for the southern towns[1] that are now embraced in Grafton County, the first settlement was made at Lebanon, in 1761, by pioneers from Connecticut. The adjacent towns were settled in rapid succession, by people coming mainly from the same source. Grafton County was formed in 1771 and remains today with little change from its original boundaries. Part of Grafton County was annexed to Merrimack County in 1871 (*1*, *10*).[2]

There are 39 towns in the county. The total population in 1930 was 42,816, of which 72.8 percent was classed as rural. A slight shift to industrial towns elsewhere in New England, since 1880,

[1] As in other New England States, a town in New Hampshire is comparable to a township elsewhere in the United States.

[2] Italic numbers in parentheses refer to Literature Cited, p. 79.

when large mills were opened, and a shift to the industrial centers within the county during the World War constitute the most significant movements of the population. The natural increase has offset outward movement, so that the total population has remained practically stationary for the last 50 years. The present inhabitants are largely descendants of the original settlers, together with a few French Canadians and immigrants from central and southern Europe.

The population is fairly well distributed over the southern and western parts of the county but is somewhat more dense in the Connecticut River Valley and adjacent smaller stream valleys. The central belt and the White Mountain section are sparsely settled. The summer population is estimated to be from two to three times the normal population.

Lebanon, the largest town, which had a population of 7,073 in 1930, is situated in the southwestern corner. It is a manufacturing town and the leading center for that part of the county. Littleton, a town in the northern part, had a population of 4,558 in 1930. In addition to some manufacturing, it is the trading center for the White Mountain summer-resort section. Hanover, in the southwestern part, is the seat of Dartmouth College. Woodsville, the county seat, is situated in the northwestern part in the town of Haverhill. Plymouth and Lisbon are small manufacturing towns and local trading centers. Most of the farm produce is marketed in the form of fluid milk in Boston. The manufacturing towns and summer resorts furnish excellent local markets for farm products.

The county is well supplied with rail transportation. Lines of the Boston & Maine Railroad reach nearly all sections. This railroad gives direct service for milk trains to Boston. A system of surfaced highways maintained by the State reaches nearly every town, and each town, except a few in the mountain section, has a number of graveled roads. Secondary roads are in fairly good condition during the summer but are not particularly good during spring and late fall. Many roads and trails lead to points of interest in the White Mountain National Forest. It is planned that this forest shall cover an area of 397,593 acres in the northeastern part of the county. Thus far (1937), 323,807 acres have been acquired.

School and church facilities of each town are adequate for the population. Telephone service was reported in 1930 on 1,221 of the 2,077 farms, water piped to dwellings on 1,645 farms, and dwellings lighted by electricity on 753 farms. In 1930, 26 farms were located on concrete roads, 20 on asphalt roads, 414 on macadam roads, 287 on gravel roads, 3 on sand-clay roads, 150 on improved dirt roads, 1,086 on unimproved dirt roads, and 91 (including those not reported) on all other roads. Since that time a much larger number of farms are on improved roads. Rural free delivery of mail reaches most sections. There are several large and a number of small hydroelectric power plants.

Forest products form the basis of the leading industry of the county—the manufacture of lumber, wooden products, paper, and pulp. Woolen and worsted clothing are other important products

of manufacture. Many gravel pits furnish gravel for ballast, road work, and building material.

CLIMATE

The climate is a modified continental type, in that the presence of the White Mountains makes it more humid than it otherwise would be. It is marked by long cold winters, accompanied by heavy snowfalls, and short comparatively cool summers. Owing to the great differences in elevation, there is a wide range in climatic conditions.

The records of the United States Weather Bureau station at Hanover, 603 feet above sea level, may be taken as fairly representative of the valley section, and the records of the station at Bethlehem, 1,440 feet above sea level, as representative of the plateau section.

The mountain section rises much higher and in places reaches well above the tree line, and the differences in climate in this section are even greater than those between Hanover and Bethlehem, although records showing this are not available.

The mean annual temperature at Hanover of 43.4° F. is about 2° higher than at Bethlehem. The absolute minimum temperature of −37° at Hanover is 2° lower than that at Bethlehem, whereas the absolute maximum of 101° is 5° higher, which indicates the wider range in temperature at the Hanover station. The average annual snowfall is 81.1 inches at Bethlehem and 71.8 inches at Hanover.

An average of 34.89 inches of rain falls annually at the Hanover station and is well distributed throughout the year, the heaviest rainfall occurring in the summer months—June, July, and August. The records at the Bethlehem station follow this very closely, and the average annual rainfall is only 0.37 inch heavier. The Plymouth station, in the Pemigewasset River Valley, reports a mean annual precipitation of 38.26 inches, which is in excess of that of the other stations. This is due to the influence of the mountain section, although the station is located in the valley at an elevation of 500 feet.

The time elapsing between the average dates of the last killing frost—May 22—and the average date of the first—September 22—is 123 days as recorded at the Bethlehem station, whereas the average frost-free season at Hanover is 11 days longer. Frost has been recorded at Bethlehem as late as June 30 and as early as August 22, and at Hanover as late as June 20 and as early as September 7. The records of the station at Plymouth plainly show that the frost hazard in a valley contiguous to very high country is greater than in Connecticut River Valley which is broad and farther removed from the White Mountains. At Plymouth, the average frost-free season extends from May 27 to September 22, a period 16 days shorter than that at Hanover in the Connecticut River Valley, although the latter station is at a higher elevation.

The normal monthly, seasonal, and annual temperature and precipitation at Hanover and Bethlehem are given in tables 1 and 2.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Hanover, Grafton County, N. H.*

[Elevation, 603 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1871)	Total amount for the wettest year (1843)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	21.6	62	−37	2.34	1.49	2.65	12.8
January	17.4	58	−34	2.35	.45	3.50	17.0
February	18.3	57	−32	2.24	2.14	4.50	19.1
Winter	19.1	62	−37	6.93	4.08	10.65	48.9
March	28.9	75	−21	2.72	2.64	4.24	12.5
April	42.4	88	4	2.87	1.63	5.24	4.1
May	54.7	95	20	3.09	2.86	3.90	(1)
Spring	42.0	95	−21	8.68	7.13	13.38	16.6
June	63.3	98	29	3.30	2.16	5 92	.0
July	68.5	101	38	3.60	1.81	2.76	.0
August	65.6	98	36	3.31	3.64	9 00	.0
Summer	65.8	101	29	10.21	7.61	17.68	.0
September	58.6	93	22	3.56	1.32	2.05	.0
October	47.3	87	15	2.83	1.89	7.59	(1)
November	34.2	69	−5	2.68	2.27	4.50	6.3
Fall	46.7	93	−5	9.07	5.48	14.14	6.3
Year	43.4	101	−37	34.89	24.30	55.85	71.8

[1] Trace.

TABLE 2.—*Normal monthly, seasonal, and annual temperature and precipitation at Bethlehem, Grafton County, N. H.*

[Elevation, 1,440 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1930)	Total amount for the wettest year (1898)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	20.0	58	−33	2.30	1.01	2.23	13.2
January	15.4	56	−35	2.20	.85	2.85	16.5
February	16.2	57	−30	2.24	.87	5.36	18.8
Winter	17.2	58	−35	6.74	2.73	10.44	48.5
March	27.5	70	−15	2.67	1.35	1.44	12.4
April	40.0	82	5	2.62	.97	3.09	7.4
May	52.5	91	20	2.91	3.16	2.83	.6
Spring	40.0	91	−15	8.20	5.48	7.36	20.4
June	61.3	94	28	3.56	3.84	5.10	.0
July	66.4	96	38	4.02	3.95	2.55	.0
August	63.7	92	33	3.51	1.98	7.13	.0
Summer	63.8	96	28	11.09	9.77	14.78	.0
September	56.6	88	22	3.66	.83	5.12	.0
October	45.6	80	16	2.96	2.09	4.32	1.3
November	32.5	66	−7	2.61	1.41	4.07	10.9
Fall	44.9	88	−7	9.23	4.33	13.51	12.2
Year	41.5	96	−35	35.26	22.31	46.09	81.1

AGRICULTURAL HISTORY AND STATISTICS

The early agriculture consisted of the growing of wheat, oats, corn, and flax and some vegetables and the keeping of some livestock, a system which was largely subsistence farming. As agriculture gradually expanded, still on a subsistence basis, cattle and sheep became the leading farm interest and source of cash income. This system reached its peak about 1880. After the grainlands and grasslands of the Middle West were opened up, the raising of cattle and sheep gave way to dairying. At first, dairy products were marketed in the form of butter and cheese; later, they were marketed in the form of fluid milk.

The present-day agriculture is based on dairying. A cash income is derived also from the sale of potatoes and poultry products. Some vegetables and fruits, mainly apples, are grown for consumption in the home and for local sale. Many of the small farms are operated mainly on a subsistence basis, and on some of them potatoes are produced as a cash crop. The owners depend on work in the forest to furnish a large part of their income.

The area of land farmed has decreased markedly since the high peak of agricultural development. According to the United States census, in 1880, 64.5 percent of the total area of the county was included in farms, of which 59.6 percent was improved, and, in 1935, only 35.3 percent of the county was included in farms, of which 25.9 percent was improved.

The average farm, as given by the 1935 census, includes 155.9 acres, of which 40.5 acres are improved. This represents a small increase over the average size of farms in 1880, which was 149 acres. The number of farms, however, has decreased from 4,794 in 1880 to 2,504 in 1935.

The 390,404 acres included in farms in 1935 were utilized as follows: Land available for crops, 101,370 acres, which includes land from which crops were harvested, land on which they were a failure, idle or fallow land, and plowable pasture; woodland pasture, 141,777 acres; other pasture, 39,995 acres; woodland not in pasture, 94,996 acres; and all other land in farms, 12,266 acres.

The trend of agriculture is indicated by the acreages devoted to the principal crops, as given in table 3.

TABLE 3.—*Acreage of the principal crops in Grafton County, N. H., in stated years*

Crop	1879	1889	1899	1909	1919	1929	1934
Corn:	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
For grain	5,438	3,799	4,927	2,880	1,345	299	837
For silage and fodder or hogged off						2,085	2,688
Potatoes	5,193	3,763	2,944	2,802	2,064	1,060	1,516
Oats, threshed	9,719	8,616	3,917	3,851	4,353	995	938
Oats, cut and fed unthreshed						769	863
Wheat	2,749	549	93	20	357	6	4
All hay	123,245	118,459	108,503	89,781	81,068	61,525	70,698
Alfalfa			4	13	48	311	340
Timothy and clover (alone or mixed)			[1] 484	52,750	53,764	38,278	36,150
Other tame grasses			102,822	31,907	24,285	20,767	[2] 32,262
Small grains for hay			3,050	2,477	1,637	852	1,764
Legumes for hay					266	78	182
Wild hay			2,143	2,634	1,068	1,239	
	Trees	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*	*Trees*
Apples	[3]	281,000	273,545	189,123	102,074	31,672	29,746

[1] Clover only. [2] Includes wild grasses. [3] Not reported.

From table 3 it may be seen that the acreage in corn, including silage and fodder, reported in 1934, was about 65 percent of that reported in 1879; hay about 57 percent; oats, including that cut and fed unthreshed, about 20 percent; and potatoes, about 20 percent; and that wheat practically has ceased to be grown. These changes can be accounted for, in large measure, by the complete abandonment of some farms and by curtailment of acreages on others, following the shift from cattle and sheep raising to dairying and the purchase of concentrated feeds. Subsistence crops were grown to less extent after the introduction of cheaper grains from the West, the hay market declined after transportation become motorized, and the acreage in potatoes was reduced because of competition from potatoes grown in Aroostook County, Maine.

Most farms have small orchards, in which apple trees predominate, but there are no commercial orchards. The number of fruit trees has been reduced markedly since 1900. Many thousands of quarts of strawberries, raspberries, blackberries, and blueberries are gathered each season from wild or volunteer vines and bushes that grow in profusion in nearly all sections. Many sugar maple groves are worked as sugar orchards and they yielded 17,573 gallons of maple sirup and 20,023 pounds of maple sugar in 1929. The present production, however, is far less than that in former years.

The number and value of livestock on the farms in census years since 1880 are given in table 4.

TABLE 4.—*Number and value of livestock on farms in Grafton County, N. H., in stated years*

Livestock	1880		1890		1900	
	Number	*Value*	*Number*	*Value*	*Number*	*Value*
Cattle	38,000		39,390		44,388	
Horses	8,337		9,168		8,975	
Mules	14	$1,790,600	18	$1,800,360	19	$1,772,178
Sheep	74,054		40,513		25,149	
Swine	8,577		10,172		10,289	
Poultry	[2] 67,095	[1]	[2] 109,017	[1]	106,740	56,237

Livestock	1910		1920		1930		[1]1935
	Number	*Value*	*Number*	*Value*	*Number*	*Value*	*Number*
Cattle	32,475	$937,948	33,205	$2,125,735	29,405	$2,074,522	27,714
Horses	8,083	902,277	6,786	946,486	3,743	385,904	3,376
Mules	33	4,591	36	6,125	41	4,458	9
Sheep	10,489	43,727	5,392	55,412	3,943	31,342	2,471
Swine	8,983	100,518	6,233	123,043	2,398	38,799	2,436
Poultry	103,927	66,991	85,636	133,638	[2] 75,109	93,886	[2] 81,085

[1] Value not reported.
[2] Chickens only.

A sharp decline may be noted in the number of horses, cattle, sheep, and swine since 1920. The decrease in the number of farms accounts for much of this decline.

Dairy cattle are largely Jersey and Holstein-Friesian grades. Farm horses are a semidraft type which is well suited to farm conditions in this section. In recent years the tendency has been toward the purchase of heavier horses. Most of the sheep, which are kept in small scattered flocks, are of dual-purpose breeds, although there

are some of mutton and wool breeds. The breeds include Shropshire and a few Dorset, Southdown, and Hampshire. Chester White is the most common breed of swine, and there are a few Poland China, Berkshire, Duroc-Jersey, or grades of these breeds. The chickens are mainly White Leghorn, Rhode Island Red, and Barred Plymouth Rock.

Table 5 gives the value of agricultural and livestock products in 1929.

TABLE 5.—*Value of agricultural and livestock products by classes in Grafton County, N. H., in 1929*

Crop	Value	Livestock products	Value
Cereals	$46,843	Dairy products sold	$1,838,169
Other grains and seeds	8,736	Poultry and eggs	550,059
Hay and forage	970,217	Honey	3,359
Vegetables (including potatoes)	381,938	Wool	7,021
Fruits	81,176		
All other field crops	46,625	Total	2,398,608
Forest products cut on farms	460,549		
Total	1,996,084		

Farm buildings in general are good. The dwellings are well built and are planned to withstand the rigorous northers of this section. Many residences are connected with the barns. The barns are large and adequate for the type of farming. Many modern dairy barns have been built in recent years in the valley section, and most of the dairy farms are equipped with silos.

Nearly all farms are equipped with mowing machinery, hay rakes, and manure spreaders. The other equipment varies more widely on farms in the valley section than in the hill and plateau sections. Tractors are used on many of the valley farms. The standard equipment on many farms includes machinery drawn by two or more horses, such as sulky plows and cultivators, grain and fertilizer drills, potato planters and diggers, side-delivery rakes, gang plows, disks, spike harrows, spring-toothed harrows, smoothing harrows, and cylindrical soil packers. On most farms there are turn plows, an assortment of cradles, scythes, hoes, and other hand implements.

In 1929, 1,310 farms, or 63.1 percent of all farms, reported the hire of labor at an expenditure of $544,042, or $415.30 per farm reporting. Much of the farm labor is performed by the farmer and members of his family, and most laborers are hired only during rush seasons, such as the mowing season. The larger dairy farms employ help continuously. The average wage paid for farm labor is $2 per day with meals, or $2.50 without, and $30 per month with board, or $50 without. Laborers find employment in lumbering during the slack agricultural seasons. Fertilizers are not used extensively. An expenditure of $50,609, or $53.39 per farm, for fertilizers was made in 1929 on 948, or 45.6 percent of the farms. A statement of the types and quantities of fertilizer used is given in the section entitled "Agricultural Methods and Management." In 1929, 1,777 farms, or 85.6 percent of all farms, purchased feed at a total expenditure of $974,862, or $548.60 per farm. The feed consisted mainly of con-

centrated feeds used by dairy farmers and to less extent by poultry raisers.

According to the 1935 census, owners operate 90.8 percent of all farms, tenants, 8.3 percent, and managers, 0.9 percent. The proportion of tenancy has been fairly constant during the last 50 years. Most tenants rent for cash. The annual rental is approximately 5 percent of the value of the farm.

The average value of farms (including land and buildings), according to the census of 1935, is $3,783, or $24.26 an acre. The value of land alone is highest in the productive bottoms and terraces, especially in the Connecticut River Valley, and lowest in the wood lots in the rougher sections.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [3] and its content of lime and salts are determined by simple tests.[4] Drainage, both internal and external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, especial emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase. Areas of land, such as coastal beach or bare rocky mountain sides that have no true soil, are called (4) miscellaneous land types.

The most important group is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first recognized. Hadley, Ondawa, Agawam, and Merrimac are names of important soil series in this county.

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[3] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

[4] The total content of readily soluble salts is determined by the use of the electrolytic bridge. Phenolphthalein solution is used to detect a strong alkaline reaction.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Ondawa sandy loam and Ondawa fine sandy loam are soil types within the Ondawa series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, which differs from the type in some minor soil characteristic that may have practical significance. Differences in relief, stoniness, and the degree of accelerated erosion frequently are shown as phases. For example, within the normal range of relief for a soil type, there may be areas that are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important difference in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such an instance, the more sloping parts of the soil may be segregated on the map as a sloping or hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

Because of the general physiography of the valley, hill and plateau, and mountain sections, and of the differences in agricultural development in each section, this county was divided into three parts for the purpose of surveying in sufficient detail to bring out the characteristics of each section. This division is shown by diagram on the margin of the accompanying soil maps. The valley section, in which agriculture is best developed, was mapped in detail; the hill and plateau section, in which agricultural development is irregular, was mapped in semidetail; and the mountain section was mapped by the reconnaissance method.

SOILS AND CROPS

For convenience in discussing the soils of Grafton County and the agriculture developed on them, they may be divided into five main groups: (1) Soils of the valleys, (2) soils of the hill section, (3) soils of the plateau section, (4) soils and land types of the mountain section, and (5) soils of the swamps.

Although each section may not have developed a distinct type of agriculture, at least a correlation exists between this classification and the degree of agricultural development, and certain variations in agricultural use are characteristic of each group of soils.

The farms in the valley section are mainly self-sustaining units. Although there are many self-supporting farms in the hill section, some of the land may be considered marginal. The agriculture of the plateau section has been declining for the last 30 years, due either to the high proportion of stone in the soil or to inaccessibility. A survey by the New Hampshire Agricultural Experiment Station disclosed that about 45 percent of the farmers in this section are largely dependent on outside work for a livelihood. The determination of marginal and submarginal lands of this section is one of the problems which this soil survey may help to solve. A large part of the mountain section is included in the White Mountain National Forest, and the acquisition of more land is contemplated.[5] Some of this land is in the plateau section. Areas of swamp are too poorly drained and too isolated to have much agricultural value.

All the soils of this county, except those of the Hadley series, are acid throughout the entire profile.[6]

In the following pages, the soils are described in detail, and their agricultural adaptabilities are discussed. Their distribution is shown on the accompanying soil map, and their acreage and proportionate extent are given in table 6.

TABLE 6.—*Acreage and proportionate extent of the soils mapped in Grafton County, N. H.*

Soil type	Acres	Percent	Soil type	Acres	Percent
Hadley very fine sandy loam	1,664	0.2	Danby gravelly sandy loam	11,200	1.0
Hadley very fine sandy loam, low-bottom phase	960	.1	Merrimac gravelly sandy loam, broken phase	1,344	.1
Hadley silt loam	384	(1)	Colton gravelly sandy loam, broken phase	384	(1)
Ondawa fine sandy loam	11,968	1.1	Hinckley loamy sand	1,920	.2
Ondawa fine sandy loam, high-bottom phase	2,496	.2	Danby loamy sand	960	.1
Ondawa sandy loam	12,160	1.1	Colton loamy sand, broken phase	256	(1)
Ondawa loamy fine sand	2,496	.2	Merrimac loamy sand, broken phase	1,920	.2
Podunk fine sandy loam	6,528	.6	Adams loamy fine sand, broken phase	192	(1)
Podunk silt loam	640	.1	Agawam loamy fine sand, broken phase	256	(1)
Alluvial soils, undifferentiated	704	.1	Windsor sand	512	(1)
Saco silt loam	512	(1)	Colton sandy loam, broken phase	1,280	.1
Agawam very fine sandy loam	1,280	.1	Hartland very fine sandy loam	1,920	.2
Agawam fine sandy loam	5,760	.5	Hartland very fine sandy loam, broken phase	1,600	.2
Groveton fine sandy loam	640	.1	Suffield silt loam, broken phase	960	.1
Merrimac fine sandy loam	5,888	.5	Charlton loam	21,184	1.9
Merrimac sandy loam	5,184	.5	Hollis loam	10,432	.9
Colton fine sandy loam	5,952	.5	Woodbridge loam	5,248	.5
Colton sandy loam	4,736	.4	Sutton silt loam	11,200	1.0
Suffield silt loam	3,328	.3	Charlton stony loam	8,064	.7
Suffield silt loam, mottled-subsoil phase	576	.1	Hollis stony loam	14,144	1.3
Melrose fine sandy loam	1,600	.2	Woodbridge stony loam	2,752	.3
Sudbury fine sandy loam	832	.1	Charlton loam, steep phase	1,984	.2
Merrimac loamy sand	2,880	.3	Hollis loam, steep phase	1,600	.2
Colton loamy sand	4,096	.4	Woodbridge loam, steep phase	384	(1)
Agawam loamy fine sand	1,536	.2	Charlton stony loam, steep phase	7,296	.6
Colton loamy fine sand	704	.1	Hollis stony loam, steep phase	12,416	1.1
Adams loamy fine sand	1,664	.2	Woodbridge stony loam, steep phase	320	(1)
Adams loamy sand	704	.1	Gloucester fine sandy loam	4,928	.5
Merrimac gravelly sandy loam	4,480	.4			
Colton gravelly sandy loam	7,040	.6			
Hinckley gravelly fine sandy loam	6,272	.6			

[1] Less than 0.1 per cent.

[5] NOLEN, JOHN; HARTZOG, JUSTIN R.; PLATT, GEOFFREY; and LA FLEUR, ALBERT. STATE PLANNING IN NEW HAMPSHIRE; REPORT SUBMITTED TO STATE PLANNING AND DEVELOPMENT COMMISSION OF NEW HAMPSHIRE AND NATIONAL RESOURCES BOARD, WASHINGTON, D. C. 125 pp., illus. 1935. [Multigraphed.]

[6] pH determinations for the important soils are given in the section entitled "Morphology and Genesis of Soils."

TABLE 6.—*Acreage and proportionate extent of the soils mapped in Grafton County, N. H.*—Continued

Soil type	Acres	Per-cent	Soil type	Acres	Per-cent
Gloucester sandy loam	2,112	.2	Hermon sandy loam, steep phase	128	(1)
Gloucester stony fine sandy loam	22,144	2.0	Hermon stony sandy loam, steep phase	28,992	2.6
Gloucester stony sandy loam	2,944	.3	Becket stony loam, steep phase	7,104	.6
Gloucester very stony fine sandy loam	1,856	.2	Peru loam	3,840	.4
Gloucester fine sandy loam, steep phase	1,408	.1	Peru stony loam	22,656	2.0
Gloucester stony fine sandy loam, steep phase	11,456	1.0	Rough stony land (Gloucester soil material)	13,248	1.2
Blandford loam	4,416	.4	Rough stony land (Berkshire soil material)	34,432	3.1
Berkshire loam	14,400	1.3	Rough stony land (Becket soil material)	6,976	.6
Lyman loam	14,592	1.3	Rough stony land (Hollis soil material)	4,800	.5
Berkshire stony loam	10,304	.9	Rough stony land (Hermon soil material)	128,832	11.7
Lyman stony loam	23,040	2.1	Rough stony land (Canaan soil material)	11,776	1.1
Berkshire loam, steep phase	2,560	.2	Rough stony land (Lyman soil material)	9,088	.8
Lyman loam, steep phase	2,816	.3	Rough mountainous land	301,696	27.4
Berkshire stony loam, steep phase	12,800	1.2	Rock outcrop	7,552	.7
Lyman stony loam, steep phase	5,888	.5	Peat	7,808	.7
Becket loam	15,936	1.4	Muck	1,856	.2
Hermon sandy loam	8,832	.8	Muck, shallow phase	896	.1
Canaan fine sandy loam	576	.1	Whitman loam	8,448	.8
Canaan sandy loam	704	.1	Whitman stony loam	6,144	.6
Canaan loam	6,656	.6	Whitman very stony loam	192	(1)
Becket stony loam	22,080	2.0			
Hermon stony sandy loam	54,464	4.9	Total	1,098,240	
Hermon stony sandy loam, hardpan phase	768	.1			
Canaan stony fine sandy loam	3,520	.4			
Canaan stony sandy loam	11,584	1.0			
Becket loam, steep phase	1,600	.2			

[1] Less than 0.1 percent.

SOILS OF THE VALLEYS

The soils of the valleys are further grouped as follows: (1) Soils of the bottom lands, which are alluvial soils occupying the present flood plain; (2) soils developed on terraces, which are of old alluvial origin; and (3) soils developed on kames and broken edges of terraces. In general, with the exception of the kames, this land is smooth, fairly level, free from stone, friable, and well drained. The bottom-land soils are young, unleached, and inherently more productive than the other soils of the county. The soils developed on terraces, for the most part, consist of light-textured material that, in some places, is excessively drained, but their structure enables them to respond readily to good management. The steep broken soils on the serrated edges of terraces have little agricultural value.

SOILS OF THE BOTTOM LANDS

This subgroup of soils comprises the Hadley soils on the overflow land of Connecticut River and the Ondawa soils, Podunk soils, Saco silt loam, and alluvial soils, undifferentiated, on other stream bottoms. The Hadley soils are the most productive, and they represent the only neutral to slightly alkaline soils in the county. They are well drained and, although sometimes inundated, are well suited to the production of hay, corn, alfalfa, and vegetables, also to pasture. Because of the tendency to lodge, small grains are seldom grown. The Ondawa soils are well drained and, although acid, are suited to the same crops as are the Hadley soils, with the exception of alfalfa. Yields are lower, however, than those obtained on the Hadley soils. The Podunk soils

are imperfectly drained and are utilized mainly for hay and pasture, to which purposes they are highly suited. Alluvial soils, undifferentiated, are poorly drained and, in their native condition, are suited only to pasture. When drained, they are comparable to the Podunk soils. Saco silt loam also is poorly drained and consists of a mucky surface layer over clay. When drained, it is used for pasture.

Hadley very fine sandy loam.—Hadley very fine sandy loam, one of the most important soils in the county, has supported a stable agriculture over a long period of years. Its high inherent productivity is due to the deposition of its parent materials in fairly recent times and the absence of appreciable leaching. The parent materials are derived largely from dark-colored schist containing sufficient lime to make the soil neutral to alkaline. This soil occupies the lowest complete terrace of Connecticut River. It lies well above normal overflow, but it is inundated during extremely high water. The 1927 flood left a deposit rather high in calcium.[7] Most of the lime material may be traced to the formation outcropping in the Connecticut River watershed in Vermont.

Hadley very fine sandy loam is characterized by a 7- to 10-inch dark-brown surface soil, the color of which changes to greenish yellow or olive and becomes paler with depth. The very fine sandy loam texture extends to a depth ranging from 3 to 4 feet where the material becomes a loamy sand. The surface soil is mellow and tends toward a soft-crumb structure when cultivated. The underlying material is rather mealy in consistence, which condition continues to the sandy substratum. This imparts an excellent moisture-holding capacity to the soil and affords an excellent medium for the development of plant roots.

The surface is, in general, smooth, but in places there are low swells extending in the same direction as the current of the main stream which deposited the materials composing the swells. Drainage is well established. The soil lies from 20 to 40 feet above stream level, at an elevation ranging from 320 feet above sea level, in the southern part, to 400 feet in the vicinity of Woodsville.

Hadley very fine sandy loam occupies the meadows of Connecticut River in the towns of Lebanon, Hanover, Lyme, Orford, Piermont, and Haverhill as far north as Woodsville. The best farms in these towns are on this soil. The largest areas lie south of the villages of West Lebanon, Orford, and Woodsville and west of the villages of North Haverhill and Haverhill. All the land is cleared, and practically all is cultivated, mainly to crops which support dairying, such as timothy, clover, and alfalfa for hay, corn for grain and silage, and oats. A small proportion of the land is used for pasture, which furnishes excellent grazing, and for growing such vegetables as potatoes, beans, peas, squash, beets, carrots, and onions for the local market and home use.

Few amendments are used on this soil. In places, however, manure is used once in the rotation. Small quantities of phosphatic fertilizer are applied for small grains or corn, especially if some time has elapsed since an overflow has occurred. Under normal conditions, corn yields from 12 to 15 tons of silage an acre, yields as high as 25

[7] According to determinations made in the laboratory of the New Hampshire Agricultural Experiment Station.

tons having been reported; corn for grain, 40 to 65 bushels; oats, 45 to 65 bushels; potatoes, 150 to 300 bushels, depending on the quantity of fertilizer used. Alfalfa is grown with better success on this soil than on any other soil in the county. Its production is rarely attempted without the addition of lime, of which only small quantities are necessary. This soil, when heavily fertilized, is used extensively and successfully in other parts of the Connecticut River Valley for tobacco, onions, and asparagus. Because of its structure, the soil utilizes the fertilizer applied to the best advantage.

The influence of this soil on the agriculture of the county is greater than its small total area would indicate.

Hadley very fine sandy loam, low-bottom phase.—The low-bottom phase of Hadley very fine sandy loam is associated with the typical soil, but it occurs on lower levels of the Connecticut River bottoms and is subject to overflow in the spring and following freshets. It closely resembles the typical soil except for its darker colored surface soil. Inclusions of small areas of loamy fine sand, especially along the outer edges of streams, have been made in mapping.

This soil, although not extensive, is fairly important, and nearly all of it is farmed. Pasture covers a larger acreage than does any crop. Timothy hay ranks next, with a small acreage. Some corn is grown for grain. The production of few other crops is attempted, owing to the likelihood of hazards from flood. The land is very productive, and, although yields, except of pasture grasses, fall somewhat below those obtained on the typical soil, they are made without the use of amendments, either manure or commercial fertilizer.

Hadley silt loam.—Hadley silt loam occupies a much smaller total area than Hadley very fine sandy loam. Most of this soil is in Lebanon, Lyme, Orford, and Haverhill Towns. Where it occurs as back bottoms it lies slightly lower than Hadley very fine sandy loam but not so low as the low-bottom phase of that soil. The surface is slightly smoother, and although the land is well drained it is not quite so well aerated as is Hadley very fine sandy loam. The surface soil is darker and the subsoil and substratum are a more pronounced olive color than are the corresponding layers of that soil.

This soil is used mainly for hay, pasture, corn, and oats. Crop yields are good, considering the small use of amendments.

Ondawa fine sandy loam.—Ondawa fine sandy loam has a brown mellow surface soil to plow depth, a yellowish-brown mellow subsoil, and a grayish-yellow light-textured substratum below a depth of 2 feet, which in places approaches sand. Some areas of very fine sandy loam are included in mapping. This soil is widely developed throughout the county on stream bottoms subject to overflow and, to some extent, along Connecticut River. The bodies along Connecticut River are situated near the mouths of streams which deposit material derived from granite and gneiss. Small areas, especially along the streams in the rougher sections, contain considerable sand, gravel, and even stone in places. They have a lower agricultural value than the typical soil.

Like the low-bottom phase of Hadley very fine sandy loam, this is a young soil. Recurrent floods tend to maintain fertility. This soil is not quite so productive, however, as the Hadley soils, owing to the character of the parent materials which are dominantly granitic.

The Ondawa soil is also more acid than the Hadley soil. Essentially the same crops are grown on the two soils, except that the production of alfalfa is seldom attempted on Ondawa fine sandy loam.

Ondawa fine sandy loam, high-bottom phase.—The high-bottom phase of Ondawa fine sandy loam occupies a position comparable with that of typical Hadley very fine sandy loam, above the level of normal overflow but it is subject to inundation during extremely high water. Its profile characteristics resemble those of typical Ondawa fine sandy loam, except that the subsoil is somewhat more brown. It is used for a wider range of crops and to a greater extent for cultivated crops than is the typical soil. Plate 1, *A*, shows silage corn growing on this soil. In general, it is handled in the same manner as are the adjacent terrace soils. Small areas are scattered along the larger streams. The largest are near Warren and Lincoln.

Ondawa sandy loam.—Ondawa sandy loam has a soil profile similar to that of Ondawa fine sandy loam, but it differs from that soil mainly in texture. Areas of this soil are scattered along Pemigewasset River and its tributary streams, the currents of which were more rapid than those of streams bordered by Ondawa fine sandy loam. Some areas contain much gravel, especially those along the smaller streams with steep gradients.

This soil is not so desirable for farming as is Ondawa fine sandy loam, and a smaller proportion of the land is utilized for crops. The same crops are grown as on that soil, but yields are lower.

Ondawa loamy fine sand.—Ondawa loamy fine sand is developed mainly on the bottom land of Pemigewasset River and, to less extent, along other streams. Its profile resembles that of Ondawa fine sandy loam except for the lighter texture. Along the Connecticut River bottoms the soil is slightly darker than elsewhere, owing to the influence of darker materials from the watershed of that river. The relief is apt to be slightly more uneven than that of Ondawa fine sandy loam, as swells are numerous. On these swells drainage is excessive compared with that of the other bottom-land soils. The water table, in most places, is high enough, however, even in dry seasons, for crops to gain some moisture by capillary movement. This soil is used for the same crops as those grown on Ondawa fine sandy loam, but yields are lower.

Some areas, particularly along Pemigewasset River south of Plymouth, occupy a high bottom which is above the level of normal overflow but not beyond the reach of high water. The soil in these areas is not productive, and, although nearly all of the land is cleared and used for crops, it is often left fallow, and some of it supports a very poor cover of vegetation. It is handled in the same manner as are the light-textured terrace soils, such as Adams loamy fine sand. Even when manure is used, yields are low.

Podunk fine sandy loam.—Podunk fine sandy loam has a dark-brown or brown mellow surface soil which grades, at an average depth of 8 inches, into a yellowish-brown or pale yellowish-brown subsoil mottled with gray and rusty brown at a depth of 18 or 20 inches. Below a depth ranging from 24 to 30 inches, depending on drainage conditions, is the substratum of gray fine sand or loamy fine sand, streaked with rusty brown. The structure is single grain throughout.

This soil occupies low bottoms which are fairly well drained in the upper part but are poorly drained in the lower part. The largest areas are on the back bottoms of the principal rivers and in the hanging valleys of streams tributary to Connecticut River. Typical of the latter position are the areas along Mascoma River, in the vicinity of West Canaan, and along Oliverian Brook above East Haverhill.

Podunk fine sandy loam is used extensively for hay, and it is very productive for both timothy and redtop. Yields of hay average about 1¾ tons per acre. Very little of the land is used for other crops. A fair acreage, however, is in pasture, in which bentgrass predominates, and good grazing is afforded, even in dry seasons. Practically all of this land has been farmed at some time. At present, the small nonutilized area is covered with alder, willow, and other moisture-loving plants. The soil is highly acid throughout. Like the other bottom-land soils, it is young, unleached, and subject to fresh deposition from stream overflow. Imperfect drainage is the dominant factor limiting its use for agriculture.

Podunk silt loam.—Podunk silt loam is developed in a fairly large area traversed by several streams flowing into the southwestern end of Newfound Lake where the stream gradient is extremely low. Its surface soil consists of dark-brown mellow silt loam having a crumb structure. This passes, with little change in texture or structure, at a depth of 8 or 10 inches, into brown silt loam which is mottled with gray and rusty brown below a depth of 20 inches. At a depth ranging from 24 to 30 inches the subsoil is abruptly underlain by the substratum of gray fine sandy loam streaked with rusty brown. In this soil, as in Podunk fine sandy loam, drainage is fairly good in the upper part but poor in the lower part. The silt loam, also, is highly acid.

Podunk silt loam is used almost exclusively for mowing and pasture. Yields of hay are slightly higher than those obtained on Podunk fine sandy loam, and the pasture grasses are nutritious.

Alluvial soils, undifferentiated.—Soils designated as alluvial soils, undifferentiated, have a surface layer of dark-brown fine sandy loam or sandy loam, containing some organic matter. This is underlain, at a depth ranging from 8 to 12 inches, by brown or yellowish-brown, highly mottled with gray and rusty brown, fine sandy loam or sandy loam. Below a depth of 18 or 20 inches, the material is gray fine sand, sand, or, in some places, fine sandy loam. In a few areas gravel is present, and in others cobblestones or boulders are strewn on the surface, especially near the base of the mountains where the streams lose their steep gradients and assume the lower gradients of the valley floor. Many small spots of a better drained soil, which resembles the Podunk and Ondawa soils, are included.

Alluvial soils, undifferentiated, are distributed widely over the county along most of the smaller streams. Where artificially drained, these soils are comparable to Podunk fine sandy loam and produce good yields of hay and other crops, such as corn and oats, common to the bottom land. Only a small proportion of the land is drained, however, and most of the undrained part is in pasture, in which creeping bent is the principal grass, and rushes and sedges are common. Most of the pastures contain alder, willow, and hardhack.

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Saco silt loam.—The 10- to 12-inch surface soil of Saco silt loam is dark-brown or almost black silt loam or loam, which is high in organic matter. This rests on drab-gray, mottled with brown and rusty brown, heavy silt loam or silty clay loam, which is very sticky when wet and hard when dry. This is the only bottom-land soil having a heavy subsoil.

Saco silt loam occupies low positions on first bottoms that are subject to poor drainage. The total area is small. Several bodies are north of Lebanon, and one is northwest of Plymouth.

In its native condition, the land is covered with reeds and sedges. The pastures support some creeping bent but also contain much bulrush and sedge. All the areas are treeless. This land is best suited to pasture, as its position makes it difficult to drain thoroughly.

SOILS DEVELOPED ON TERRACES

The soils developed on terraces comprise: (1) Medium-textured soils—Agawam very fine sandy loam, Agawam fine sandy loam, Groveton fine sandy loam, Merrimac fine sandy loam, Merrimac sandy loam, Colton fine sandy loam, and Colton sandy loam; (2) heavy-textured soils—Suffield silt loam, Suffield silt loam, mottled-subsoil phase, Melrose fine sandy loam, and Sudbury fine sandy loam; and (3) light-textured soils—Adams loamy fine sand, Adams loamy sand, Agawam loamy fine sand, Colton loamy fine sand, Colton loamy sand, Colton gravelly sandy loam, Merrimac gravelly sandy loam, and Merrimac loamy sand. The Agawam and Suffield soils and Melrose fine sandy loam, together with the Hadley soils of the bottom lands, are among the best agricultural soils in the county.

The Agawam soils are mellow and friable throughout, possess good moisture-holding qualities, and make an excellent medium for the development of plant roots. The Melrose soil is a mantle of sandy material, about 3 feet thick, over clay. It also holds moisture well, and crops rarely suffer in dry seasons, but they may be injured by excessive moisture in wet seasons. Owing to the difficulty of handling the heavy Suffield soils, they are better suited to the growing of grasses than to the production of cultivated crops, even though their fertility is high.

The Merrimac soils occur mainly in the southern and southwestern parts of the county. They are underlain by deposits of coarse sand and gravel, derived, for the most part, from granite, gneiss, or schist materials, and drainage is excessive, owing to the character of the substratum. The Colton soils differ from the Merrimac principally in having a well-defined gray layer beneath the forest duff. They are developed farther north and at higher elevations than the Merrimac soils. Both the Adams and Colton soils are sandy and are subject to leaching.

Agawam very fine sandy loam.—Agawam very fine sandy loam ranks next to the Hadley soils in desirability for farming. It is developed on the stream terraces of Connecticut River. The largest and most representative areas are in Lyme, Piermont, Lebanon, Orford, and Haverhill Towns. This is a comparatively young soil, in that it has not developed a well-defined profile. Its profile is, however, more definite than that of the Hadley soils. Leaching has not progressed so far as in soils developed on the older or postglacial terraces.

In cultivated fields Agawam very fine sandy loam has a brown mellow surface soil to plow depth, which, in places, is slightly darkened by organic matter, depending on and varying with the cultural methods. Under good management the soil has a soft crumb structure. The surface soil is abruptly underlain by pale yellowish-brown firm but friable very fine sandy loam which has a weak crumb structure, and below a depth of 10 or 12 inches the color is somewhat paler yellowish brown. At an average depth of about 23 inches, the subsoil grades into gray very fine sandy loam which is slightly firm in place but is mealy. Below a depth ranging from 36 to 40 inches, the substratum becomes greenish-gray bedded fine sand and very fine sand, containing some strata of silt. The material is fairly firm in place but is not very compact. In some places this material reaches a depth of 6 feet or more, in other places it grades into coarse sand material, and elsewhere it becomes heavier and passes into bedded silts and clays.

Like the Hadley soils, Agawam very fine sandy loam is characterized by a very good moisture-holding capacity. This feature, together with the friability and favorable structure of the soil, allows easy penetration and development of roots. The complete absence of stone and gravel adds to its desirability.

This soil is much more important than its small total area would indicate. It occupies stream terraces from 40 to 60 feet above stream level and has smooth almost level relief. Drainage is thorough but not excessive.

Nearly all of the land is farmed, and most of the crops common to this section are grown successfully. The leading crops are hay (timothy, clover, and some alfalfa), oats, and corn for grain and silage. Yields from land on which manure is applied once in the rotation and small quantities of commercial fertilizer are used for small grains are about equal to or slightly higher than those obtained on the Hadley soils where little soil amendment is practiced. The prevailing system of farming on this soil is dairying, and manure, therefore, is depended on to maintain soil fertility. Rye is used as a cover crop.

Agawam fine sandy loam.—Agawam fine sandy loam is one of the most extensive soils developed on the terraces of Connecticut River and is one of the important agricultural soils of the county. It has a profile which is similar to but, owing to the texture, is somewhat better developed than the profile of Agawam very fine sandy loam. In most places the lower substratum consists of slightly coarse materials. This substratum furnishes thorough drainage, but the thickness of the overlying soil layers is sufficient to store moisture for most crops.

This soil occupies terraces that are slightly higher than those on which Agawam very fine sandy loam is developed but are lower than the old glacial terraces that filled the valley during the postglacial period and are now reduced to a remnant along the outer edge of the valley.

In cleared areas, the 7- or 8-inch surface soil is brown mellow fine sandy loam with a soft crumb structure. It is underlain by yellowish-brown fine sandy loam with similar structure, which gradually passes, at a depth ranging from 20 to 24 inches, into gray fine

sandy loam that rests, at a depth ranging from 32 to 40 inches, on gray fine sand or sand.

The relief is smooth or almost flat, like that of Agawam very fine sandy loam. Fairly large areas, about one-half mile wide and several miles long, extend in the same direction as the stream they border. Agawam fine sandy loam is developed in Connecticut River Valley, on the terraces of the tributary streams, such as Ammonoosuc and Mascoma Rivers, and along Baker and Pemigewasset Rivers in the vicinity of Plymouth. In this valley, Agawam fine sandy loam appears to be less productive than the same type of soil in Connecticut, possibly because of differences in origin of parent materials. The differences, however, are slight, and the soil probably would produce satisfactory yields if handled in the same manner as the soil in Connecticut.

The same crops, in about the same proportion, are grown on this soil as on Agawam very fine sandy loam. Yields are slightly lower than those obtained on that soil but generally exceed those obtained on Merrimac fine sandy loam. In the southern part of the Connecticut River Valley, this soil is used extensively for the production of tobacco, onions, and asparagus.

Groveton fine sandy loam.—Groveton fine sandy loam is developed on level terraces consisting of the same kinds of materials as those from which the Agawam soils have developed.

In cultivated fields, the surface soil consists of brown mellow fine sandy loam to plow depth, that is, 6 or 8 inches. Beneath this, the material changes abruptly to yellowish-brown or rusty-brown firm but friable fine sandy loam which grades rather rapidly, at a depth of 14 or 16 inches, into greenish-yellow or olive-drab firm but friable fine sandy loam. The upper part of the parent material, beginning at a depth of 22 or 24 inches, is olive-yellow or grayish-yellow firm but friable sandy loam which grades into sandier and looser material of slightly lighter color at a depth of about 3 feet. In the virgin condition, Groveton fine sandy loam is covered by a thin mat of partly decayed organic material, has an ash-gray surface soil, 2 to 4 inches thick, and has a coffee-brown firm but friable sandy loam subsoil. Plowing mixes the coffee-brown layer with the ash-gray layer.

This soil occurs mainly on the terraces of Connecticut River northeast of Monroe, on the terraces of Pemigewasset River north of Campton, and on the terraces of Ammonoosuc River near Littleton. It is not an important soil because of its small extent. It is used for the production of hay (timothy), small grains, and potatoes, and yields compare favorably with those obtained on Agawam fine sandy loam. Potatoes are of better quality and return somewhat higher yields than on the Agawam soil.

Merrimac fine sandy loam.—In cultivated fields the 6- or 8-inch surface soil of Merrimac fine sandy loam is brown mellow fine sandy loam, with a weak crumb structure. It grades into yellowish-brown firm but friable fine sandy loam, the color of which gradually fades, with depth, to pale yellow. The subsoil has the same texture and structure as the layer above, and it contains gravel below a depth ranging from 10 to 18 inches. The quantity of gravel present in the subsoil increases with depth until this layer merges, at a depth ranging from 30 to 36 inches, into the underlying bedded gravel and sand

which is loose and open in structure and little altered by soil-forming processes. The soil material throughout the profile has a single-grain structure. In places, indicated on the map by gravel symbols, gravel are present in the upper part of the soil, composing as much as 30 percent of the soil mass.

Merrimac fine sandy loam is developed in scattered areas on the terraces along tributary streams of Connecticut River, along Connecticut River principally below Woodsville in Piermont and Haverhill Towns, and along Ammonoosuc River as far north as Littleton.

Although not extensive, this soil is important to the agriculture of the section in which it occurs. About 90 percent of the land is cleared, most of which is included in dairy farms and is devoted to hay (timothy and, to less extent, clover), oats, corn for silage, potatoes, and garden vegetables. Ordinarily, this land is not pastured but is used for cultivated crops because it is stone free and rougher land is available for pasture. The small area remaining in forest is covered with second-growth white pine, gray birch, aspen, and some oak.

Yields on this soil are fairly good. Inasmuch as it is not an inherently fertile soil, the system of farming followed, the turning under of sod, and the use of manure, lime, and some commercial fertilizer are responsible for the yields obtained. Without the addition of soil amendments, however, yields are only moderate. Hay yields from 1 to 1½ tons per acre; corn, 30 to 50 bushels of grain and 10 to 12 or more tons of silage, depending on the season and improvement of the soil; potatoes, 125 to 250 bushels, with yields of 300 bushels reported frequently, depending on the season and quantity of high-grade fertilizer used.

Merrimac fine sandy loam is one of the easiest soils in the county to cultivate, as it is mellow and free from stones in the upper part. Its relief allows the use of improved farm machinery. Intertilling is possible soon after rains, owing to the openness of the surface soil, subsoil, and substratum. Except under best cultural conditions, it is low in organic matter.

In other sections of New England, especially where markets are available, this land is used for truck gardening. In such places, as much as 1,500 pounds of high-grade commercial fertilizer is used per acre, in addition to lime and manure. The results seem to warrant its use.

Most of this land is in small holdings. Its value is determined largely by the scarcity of comparatively smooth stone-free land in the section where this soil occurs, rather than by its inherent productivity.

Merrimac sandy loam.—The 6- to 8-inch surface layer of Merrimac sandy loam consists of dark-brown mellow sandy loam having a single-grain structure. The upper part of the subsoil, to a depth ranging from 12 to 18 inches, is yellowish-brown fairly firm but friable sandy loam of single-grain structure, and the lower part, to a depth ranging from 20 to 34 inches, is pale-yellow light sandy loam material of similar but looser structure, containing some rounded quartz gravel. Below the subsoil is gray loose gravelly sand. The substratum, below a depth of 36 inches, is composed of alternate strata or beds of assorted sand and gravel. These materials are rather loose and open and continue to a depth of 20 feet

or more. The parent material is derived from granite, gneiss, and schist, laid down as terraces and glacial outwash under rather shallow moving water emerging from the melting glacier. This soil is acid throughout.

This soil occupies fairly level terraces along streams throughout the southern and southwestern parts of the county. The largest areas are along Pemigewasset River south of Campton. It also is developed on the terraces along Ammonoosuc River as far north as Lisbon and along Baker River south of Warren. In general, the upper part of the profile is fairly free from gravel. There are areas, however, included with this soil in mapping, in which the surface layers and upper part of the subsoil contain rounded gravel, but, in most of these areas, the gravel content is not sufficient to interfere with cultivation, nor do the gravel act as a mulch on the surface. These included gravelly areas are, in general, more droughty than the typical soil.

The areas of Merrimac sandy loam are, for the most part, level. The abrupt breaks along the outer edges have been mapped as a broken phase of Merrimac gravelly sandy loam. In places slight swells extend in the same direction as the main current which laid down these deposits. Drainage is thorough because of the porous character of the substratum, and the soil is inclined to be droughty in dry seasons.

Merrimac sandy loam is a fairly important soil, owing to its comparatively widespread occurrence on the terraces. It is intermediate in productivity between Merrimac fine sandy loam and Merrimac gravelly sandy loam. Most of this land is cleared and farmed; the rest is covered with white pine, aspen, gray birch, and some oak. Cleared areas are used for mowing, for cultivated crops, and, to a limited extent, for pasture. Abandoned fields, of which there are a number, contain broomsedge, poverty grass, running cinquefoil, and briers. If left uncultivated for very long, they grow up in aspen and birch sprouts. Hay consists mainly of timothy and redtop, with much quackgrass and very little clover. The cultivated crops are corn for silage, oats, some rye, and some potatoes. Vegetables are grown mainly for home use. Yields of hay average about 1 ton per acre, and in many dry seasons fall below that quantity. Corn produces from 8 to 10 tons of silage. This crop rarely is grown without the addition of manure. Oats produce 30 to 45 bushels, and they generally receive commercial fertilizer in the form of phosphate or complete fertilizer. Pasture grasses do not do very well. Potato yields range from 100 to 150 bushels an acre.

This land is plowed easily and forms a mellow seedbed suitable for most crops, except wheat and small grains, which require a rather compact seedbed. The land can be plowed, without risk of clodding, at almost any time, owing to the rapidity with which the soil dries after rains. Little commercial fertilizer or lime is used; ordinarily manure is depended on to keep up the fertility.

This soil is valued mainly for its favorable location and the ease with which it can be handled with improved farm machinery rather than for its productivity which is low unless soil amendments are used.

Colton fine sandy loam.—Colton fine sandy loam, together with the other Colton soils, is developed on the old glacial terraces which

partly fill the stream valleys in the northeastern part of the county. It occurs mainly on the terraces in the Pemigewasset River Valley north of Campton, in the upper Connecticut River Valley from the vicinity of Pattenville to the Coos County line, along Ammonoosuc River in the vicinity of Littleton, and along Wild Ammonoosuc and Gale Rivers.

Under the original forest cover a distinct gray layer was developed under the forest duff. Practically all of this land at present, however, is either cleared or in second-growth forest, and only remnants of the original gray layer remain below plow depth. With the exception of these remnants of a gray horizon, the profile resembles that of Merrimac fine sandy loam. In cleared fields the surface soil is brown mellow fine sandy loam to plow depth. It is underlain by brown or rusty-brown mellow firm but friable fine sandy loam with a weak crumb structure. This material becomes paler with depth but changes little in texture or structure. Below a depth of 15 inches, the proportion of gravel and sand increases and the structure becomes loose and less coherent, so that, at a depth ranging from 20 to 24 inches, the material is grayish-yellow decidedly loose and incoherent sand and gravel. Bedded gravel and sand, consisting of quartz, granitic material, and some fragments of schist underlie the soil below a depth of 3 feet. In a number of areas, considerable gravel are strewn on the surface and are present throughout the entire profile.

The land is smooth or level and, in a few places, gently sloping. Drainage is excessive.

The cleared areas are used mainly for hay (timothy and redtop), oats, some corn for silage, rye, and potatoes. It is used to some extent for pasture, although it furnishes but poor grazing. A number of abandoned fields grown up to poverty grass and aspen are used for pasture. Yields of most crops are slightly less than those obtained on Merrimac fine sandy loam. Potatoes, however, when properly fertilized, do as well on this soil as on the Merrimac soil, and yields range from 150 to 250 bushels per acre, and, in some especially good seasons, 300 bushels are obtained. Although some silage corn is grown, most of this soil lies too high or too far north for best success with this crop. Vegetables are grown for use in the home and for the summer-resort trade.

Colton sandy loam.—In cleared fields the 6- or 7-inch surface soil of Colton sandy loam is dark-brown or brown light sandy loam with a single-grain structure. In places remnants of the gray layer developed under the original forest duff occur in pockets below plow depth. In forested areas a 4- or 5-inch layer of leafmold or forest duff overlies a 1- or 2-inch gray layer of loamy sand or sandy loam, which is darker in the upper part and brown in the lower part, or is streaked with these colors. Immediately below is a layer of dark-brown or coffee-colored sandy loam, about 1 inch thick, which contains a high percentage of finely divided organic matter. This is underlain by deep yellowish-brown fairly firm but friable sandy loam which passes gradually, at a depth of 14 or 16 inches, into pale yellowish-brown or yellow fairly loose loamy sand, light sandy loam, or coarse sandy loam. This material, in turn, passes into grayish-yellow or gray loose gravelly sandy loam at a depth of 24 inches. It becomes bedded below a depth of about 36 inches.

In some areas included on the map with Colton sandy loam there is an indurated layer lying 5 or 6 inches below the surface of the mineral soil. It may be as much as 12 inches thick. This hardened layer is not continuous but, where present, prevents the downward movement of roots. The development of roots is confined to the gray layer and the raw organic matter on the surface, which combined are about 1 foot thick. These included areas, which are not extensive, occur mainly in the east-central part of the county. One is 3 miles northeast of Canaan, and one is 2 miles west of North Woodstock. Some of this included soil is used for pasture, but very little of it is farmed. Most of it is covered with spruce, hemlock, yellow birch, and a few maple, paper birch, and aspen trees.

This soil is developed on old glacial outwash terraces derived mainly from granitic and gneiss geologic materials. The relief is smooth or almost flat. Internal drainage is thorough, owing to the looseness of the soil, and run-off is slight. Areas of this soil are scattered throughout the valleys in the northeastern part of the county, particularly in Pemigewasset River Valley north of Woodstock and in Ammonoosuc River Valley east of Littleton. It is also developed along some streams near Newfound Lake.

Most of the land is cleared and is utilized for mowing (timothy and redtop) and for the production of oats, rye, potatoes, and, to a very limited extent, corn for silage. Vegetables are not grown, except in a few home gardens. A few fields, mainly abandoned mowings, are pastured. Poverty grass is common in these pastures which furnish rather poor grazing. Crop yields in general are mediocre, except of potatoes when heavily fertilized. Hay yields from three-fourths to 1¼ tons per acre; oats, 25 to 40 bushels; and potatoes, 100 to 200 bushels. Rye is used as a cover crop. Spruce, hemlock, and white pine, and, in some places, paper birch, yellow birch, aspen, maple, and oak grow in the forested areas. Birch and aspen sprouts are invading the abandoned fields.

Suffield silt loam.—Suffield silt loam is developed from fine lake-laid materials that were deposited, in the various lake stages of Connecticut River, in small local lakes along some of its tributaries and also along Baker River near Plymouth. In cleared areas, the 7- or 8-inch surface soil is dark-brown or dark grayish-brown silt loam with a fine-granular to hard-crumb structure, depending on the organic content and state of cultivation. This material passes into gray or olive-gray silt loam which, when dry, breaks into irregular angular small blocky pieces and, when wet, tends to be sticky. Below a depth ranging from 15 to 20 inches is dark-gray silty clay which, when dry, breaks into irregular angular fragments somewhat larger than those of the horizon above and, when wet, is plastic. The upper soil layers are acid, but the lower part of the subsoil is neutral or slightly alkaline. Bedded gray silts and clays, which are more or less alkaline but not calcareous, lie at a depth ranging from 24 to 36 inches below the surface. Stone is scattered over a few small areas, but in most places the soil is entirely free from gravel or stone.

This soil occupies smooth or level terraces. Drainage is fairly good but is slightly retarded by the heavy character of the subsoil. The largest areas are near Hanover, in the vicinity of Lyme, south

of Orford, in Piermont and Haverhill Towns, and west of Plymouth. Smaller areas are near the village of Lebanon.

All this land is cleared and is used for farming. The few remaining trees indicate a rather vigorous growth of hardwoods—maple, oak, hickory, ash, and beech—and some white pine. Some of the best mowings in the county are on this land (pl. 1, *B*), yields of timothy, redtop, and clover hay ranging from 2 to 3 tons an acre. The land is used also for the production of oats, buckwheat, and, to very limited extent, corn for silage. Yields ranging from 35 to 60 bushels of oats and from 12 to 15 tons of silage are obtained. This soil is seldom used for potatoes, but vegetables are grown successfully in home gardens. Most of the few pastures are clear of brush, and they contain much bentgrass, creeping bent, and some Kentucky bluegrass, Canada bluegrass, and white clover. Most of the farms are dairy farms and have an ample supply of manure for use in improving the physical condition of the land. Some farmers use lime, especially when clover is desired in the mowing, but very few use commercial fertilizer. This soil is not easily cultivated and should be kept in grass as much as possible.

Suffield silt loam, mottled-subsoil phase.—The imperfectly drained interior flats within areas of typical Suffield silt loam are mapped as a mottled-subsoil phase. In such areas, the surface soil is darker than that of the typical soil, and drab-gray and rusty-brown mottlings are present within 6 or 7 inches of the surface. In spots where the ground water is very close to the surface, the surface soil is gray. Soil of this phase is developed principally in Lyme and Orford Towns. The land is cleared and is used for pasture, in which bulrush, hardhack, some creeping bent, and other water-tolerant grasses grow. Artificial drainage is necessary before cultivated crops can be grown successfully. When drained, this soil is comparable to the typical soil.

Melrose fine sandy loam.—Melrose fine sandy loam occurs on the terraces of Connecticut River Valley and, to less extent, in other valleys of the county. It consists of a mantle of sandy material, 3 or 4 feet thick, over beds of clay similar to those underlying the Suffield soils. The largest areas are those in the towns of Hanover, Lyme, and Haverhill. A few bodies are scattered throughout Lebanon Town, and one lies 1 mile northwest of Plymouth.

The 6- to 10-inch surface soil is brown mellow fine sandy loam which has a weak-crumb to single-grain structure and may acquire, under good management, a soft-crumb structure. It is underlain by yellowish-brown fine sandy loam or light sandy loam of single-grain structure, which is slightly firm in place but friable and loose when broken. This material grades, at a depth ranging from 15 to 20 inches, into yellow fine sand having a single-grain structure. Considerable quantities of fine mica and black shale flakes are present in this layer. The material is streaked with brown or rusty brown, and, in the lower part, it is faintly mottled with gray. In places the gray mottlings are distinct. At a depth ranging from 2 to 3 feet, this sandy material rests on gray or olive-gray clay loam which breaks into lumps. The reaction of the soil is acid to a depth ranging from 3 to 4 feet below the surface, at which depth the gray alkaline bedded silts and clays are reached.

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Several areas in Hanover Town have a very fine sandy surface soil underlain by fine sandy or very fine sandy material which extends down to the clay. These areas have a higher agricultural value than the typical soil.

Areas of this soil are level. Drainage of the surface soil is good, but drainage of the lower part of the subsoil is retarded to some extent by the clay strata. Crops may be drowned out in wet seasons, although in dry seasons they seem to do better than on most soils of this section.

This soil occurs in the better farming sections, and it is all cleared and used for crops. Hay (timothy and clover), alfalfa, oats, rye, corn for silage, potatoes, and vegetables are grown. Of these, hay is the most important. This soil is naturally good hay land, and yields, although variable, range from 1 to 3 tons per acre, depending on the season and management. Yields of other crops are variable, but in general they are good except in wet seasons. Oats yield from 35 to 50 bushels per acre; alfalfa, 2 tons; corn, 10 to 15 tons of silage; and potatoes, 100 to 250 bushels, depending on the fertilizer and the season. This soil is used successfully for the production of tobacco and onions, in the Connecticut Valley in Massachusetts.

Sudbury fine sandy loam.—Sudbury fine sandy loam occupies the small widely separated flat or low imperfectly drained areas on terraces in association with the Merrimac soils. Under a forest cover, the topmost 1 inch of soil is dark-brown or almost black fine sandy loam containing a high percentage of forest mold. It is underlain by a 4- or 5-inch layer of dark-brown fine sandy loam. In cleared areas, the surface soil is dark-brown mellow fine sandy loam of soft crumb structure. The subsoil, beginning at a depth of 6 or 8 inches and extending to a depth of 12 or 15 inches, is yellowish-brown firm but friable fine sandy loam which has a single-grain structure. This material grades into pale yellowish-brown fine sandy loam, mottled with gray and rusty brown below a depth of about 2 feet. A considerable quantity of gravel is present in the lower part of the soil. Small areas of sandy loam texture are included in mapping.

Drainage is variable, ranging from imperfect to poor. Poor drainage is due entirely to the low position of areas from which the ground water is unable to move. The color or thickness of the organic material in the surface soil and the depth to which mottling occurs in the subsoil vary according to drainage conditions.

Areas of this soil lie north of Lebanon, in the vicinity of Enfield, between Enfield Center and the head of Mascoma Lake, 2½ miles southeast of Plymouth near Lower Intervale School, 2 miles south of Franconia, near Center Haverhill, in Monroe Town, 1 mile north of West Canaan, and near Etna in Hanover Town. The total area is small.

Sudbury fine sandy loam is not an important agricultural soil, although nearly all of it is cleared. It is used almost exclusively for mowing, which consists of timothy and redtop, and yields range from 1 to 2 tons per acre. A small acreage is devoted to oats. Some of the land is pastured and furnishes fairly good grazing even in dry seasons. The soil is highly acid. Manure, in small quantities, is the only fertilizer used.

The present tree growth consists mainly of soft maple and alder on the lower areas and oak, white pine, beech, and birch in the better drained positions. In Massachusetts this soil is used for market-garden crops.

Merrimac loamy sand.—Merrimac loamy sand is associated with the other Merrimac soils. It has a general profile similar to those soils, except that the content of gravel in the underlying bedded material is smaller. In place of gravel at a depth of 15 or 18 inches, as in other Merrimac soils, coarse sand and fine gravel are present at this depth. The material is more open and porous, especially in the substratum, drainage is more excessive, and leaching and oxidation reach a greater depth in this soil than in the Merrimac soils with gravelly substrata.

In forested areas, the surface soil of Merrimac loamy sand ranges from dark-brown loamy sand to coarse sandy loam of single-grain structure, to a depth of 2 or 3 inches, which is underlain by brown loamy sand or loamy coarse sand to a depth of 5 or 6 inches. The subsoil is yellowish-brown fairly loose and incoherent loamy sand or loamy coarse sand which extends to a depth of about 15 or 18 inches where it becomes pale yellow. At a depth ranging from 20 to 24 inches, the subsoil grades into the loose and open substratum consisting of grayish-yellow coarse sand and fine gravel. The lower part of the substratum, below a depth ranging from 36 to 40 inches, is composed of beds of gray coarse sand and fine gravel which are only slightly coherent. The underlying beds or deposits range from 20 to 100 feet in thickness.

This soil occupies broad level to slightly undulating or billowy terraces along Ammonoosuc River, and it occurs to less extent along Baker River and other streams in the southwestern part of the county. Drainage is excessive, and rain water passes rapidly down through the porous substratum, with practically no surface run-off.

This soil is not important agriculturally, although a fairly large proportion is cleared and used for crops. Most of it supports a growth of white pine, together with a scattering of oaks and other deciduous trees and, in places, pitch pine. Aspen and gray birch sprouts, together with broomsedge, running cinquefoil, and briers, invade many abandoned fields. The underbrush consists mainly of blueberries, leatherleaf, and sweetfern. The cleared areas are used for mowing and the production of field crops common to this section. Yields, even from fertilized land, are low, except in wet seasons. The pasture furnishes but meager grazing, as the cover is predominantly poverty grass. Sorrel is common on fallow fields.

Colton loamy sand.—Colton loamy sand is developed mainly on the terraces in the northern and eastern parts of the county. Except for the presence of the gray layer under the forest duff, the profile of this soil resembles that of Merrimac loamy sand. Ordinarily, the gray material soon disappears under cultivation; in many places, however, where the layer was unusually deep, it persists in tongues which extend below plow depth.

Only a small proportion of this land is used for crops. Owing to climatic conditions, the range of crops adapted to this soil is narrower than that adapted to Merrimac loamy sand, and only the hardier varieties of corn mature. Such crops as rye and barley do fairly well, but yields, in general, are lower than those obtained on

the Merrimac soil. Potatoes, however, return larger yields on the Colton soil than on the Merrimac. This soil is not suited to the growing of grasses. Spruce, hemlock, white pine, paper birch, and aspen make up the forest cover, and, under the deciduous trees, blueberries and similar shrubs form the underbrush. This soil is subject to the same use limitations as are the sandier Merrimac, Colton, and Adams soils.

Small areas along the upper part of the valleys of Pemigewasset River and its tributaries contain gravel and stone.

Agawam loamy fine sand.—The surface soil of Agawam loamy fine sand in forested areas is covered with a layer of loose leaf litter, undecomposed and partly decomposed organic matter, and some fine sand particles which are evidently wind-blown and not a part of the soil proper. The 5- or 6-inch surface soil is dark-brown loamy sand of single-grain structure. The color in the upper 1-inch layer is somewhat darkened by the presence of organic matter and humus. In cultivated fields the surface soil is brown to plow depth, and the subsoil is yellowish-brown fairly loose and open loamy fine sand having a single-grain structure. The subsoil becomes paler with depth and grades, at a depth ranging from 20 to 24 inches, into gray or salt-and-pepper colored fine sand containing a quantity of small mica flakes. This material merges with the underlying bedded fine sandy loam, fine sand, and sandy material at a depth ranging from 3 to 4 feet below the surface.

The relief is fairly level to slightly undulating or billowy. Drainage is well established and is inclined to be excessive. The forest cover is mainly white pine, with little underbrush. In places, however, oak, aspen, and gray birch trees are numerous. Ferns and grasses are scarce. Areas of Agawam loamy fine sand are scattered over the terraces of Connecticut River, the largest ones being in Haverhill and Monroe Towns.

Possibly as much as 70 percent of the land is cleared and used for farming. The same crops are grown as on the other soils on the terraces—hay (timothy and some clover), rye, oats, and potatoes. This soil is used to a very limited extent for the production of corn and vegetables, and for pasture, as other nearby soils are better suited to these crops. It does not have so high moisture-holding capacity or fertility as other Agawam soils. Fertilizer is more apt to leach away and be lost, and crops are more uncertain in dry seasons than on those soils. This soil is subject to blowing and should be kept in a cover crop as much as possible.

Colton loamy fine sand.—Under cultivation, the surface soil of Colton loamy fine sand, to plow depth, is brown loamy fine sand having a decidedly single-grain structure. Under a forest cover, the organic material resting on the soil proper consists of a 2-inch layer of loose leaves, partly disintegrated leafmold, and forest debris. Finely divided organic matter is mixed with the upper part of the soil, causing it to be dark gray. The surface soil changes abruptly to gray loose incoherent loamy fine sand or fine sand, 2 or 3 inches thick, which assumes a rusty-brown color in the lower part. This rests on yellow loamy fine sand which is slightly more firm in places but fairly loose and open. The color fades to pale yellowish brown or pale yellow with depth. Below a depth of 12 or 15 inches the material is grayish-yellow fine sand. The substratum, beginning at

a depth of about 20 inches, is loose incoherent sand and, below a depth of 24 inches, it is bedded and contains a noticeable quantity of darker mineral matter mixed with the quartz sand.

The terraces in Pemigewasset River Valley north of Plymouth, on which this soil occurs, are flat or, in some places, slightly billowy. Drainage is inclined to be excessive.

This is not an extensive soil. It is used to a very limited extent for agriculture. Practically the same crops are grown as on Colton loamy sand, and yields are slightly better. This soil, also, is not good grassland, although it is used to some extent for mowing and pasture. The forest cover is mainly white pine, together with some second-growth white oak, birch, and aspen.

Adams loamy fine sand.—In cleared fields, Adams loamy fine sand to plow depth is brown. In forested areas, a 1-inch layer of loose leaf litter and brown organic matter, covers the surface. The surface soil, to a depth of about 12 inches, consists of brown loamy fine sand of single-grain structure, the upper inch of which is slightly darkened with humus and, in places, contains some undecomposed organic matter. The subsoil is yellowish-brown loamy fine sand of single-grain structure. It is slightly paler below a depth of 20 inches, although it retains the same structure to a depth ranging from 36 to 40 inches, where it gradually gives way to grayish-yellow or gray fine sand or, in some places, sand. The underlying material is more or less bedded below a depth of 4 feet. The soil is acid throughout.

This soil is developed on stream terraces, from materials derived mainly from granite and gneiss. The surface is level, and drainage is entirely internal. Owing to the looseness of the soil, drainage is excessive, and leaching has taken place to a greater depth than in most of the sandy soils of this county. The tendency of the soil to blow is another undesirable feature.

This soil is used to some extent for farming, although many farms have been abandoned. Average crop yields are low. Its freedom from stone and gravel and its location in the Pemigewasset and Baker River Valleys adjacent to extensive stony noncultivable uplands render this land desirable for home sites, and most of the crops produced in this section are grown on this soil. It is used for the production of hay (timothy and redtop), corn, and oats, yields of which range from one-half to three-fourths ton, 6 to 8 tons of silage, and 20 to 30 bushels, respectively, per acre. Rye is used as a cover crop. Some vegetables are grown, mainly in home gardens where the soil in small areas can be improved by the addition of large quantities of manure and organic matter. Crops are short in dry seasons but fairly good in wet seasons.

Abandoned fields are covered with broomsedge and, if left very long, grow up to gray birch and aspen sprouts. In some of the unused areas white pine grows, but in many only scrub oak and some pitch pine grow.

Adams loamy sand.—The profile, relief, and distribution of Adams loamy sand are similar to those features of Adams loamy fine sand. This soil consists of medium-grained loamy sand which, in places, passes into coarse sand below a depth ranging from 36 to 40 inches. Stone and gravel are absent.

Owing to its coarser texture and greater extent of leaching, this soil is even less desirable than Adams loamy fine sand for the production of crops, and only a small proportion of the land is used for that purpose. It would not be utilized for farming at all were it not for its distribution with respect to nonarable land. Soil blowing is a problem on the clean-cultivated land, and rye should be used extensively as a cover crop. This soil makes fairly good home sites, and vegetable gardens are fair if large quantities of manure are applied. In other parts of New England, asparagus is grown successfully on this soil. Many fields are abandoned and covered with broomsedge. If they are left idle for a long time, gray birch and aspen sprouts grow. The grazing value of this land is low. White pine trees are common in the forested areas, and the land might well be utilized exclusively for forestry.

Merrimac gravelly sandy loam.—Merrimac gravelly sandy loam has a soil profile similar in all respects to that of Merrimac sandy loam, with the exception of a larger quantity of gravel on the surface and in the upper part of the soil. It is associated with Merrimac sandy loam on the terraces along Pemigewasset and Baker Rivers and, to less extent, on the terraces along the smaller streams. The farmers consider this soil less valuable than the less gravelly soil, and more of it is idle. The idle areas commonly have grown up in birch and aspen sprouts, together with an underbrush of blueberries and sweetfern. When farmed, the land is used for the same crops as is the less gravelly soil, but yields are slightly lower, owing probably to slightly greater droughtiness of the land. Gravel pits are more common on this soil than on other soils of the Merrimac series, and the land is valued more highly for the gravel it affords than for farming.

Colton gravelly sandy loam.—Colton gravelly sandy loam differs from Colton sandy loam, mainly in its larger content of gravel, especially in the upper part of the soil. The gravel are mainly rounded or water-worn quartz gravel, together with some granitic gravel, ranging from one-half inch to several inches in diameter. They constitute from 20 to 40 percent of the soil mass. This soil is developed on valley terraces along the upper reaches of Pemigewasset River and its tributaries, along Ammonoosuc River above Littleton, and, to less extent, along Wild Ammonoosuc and Gale Rivers. Stones, mainly rounded granitic cobblestones, are present in places.

A smaller proportion of this soil is cleared and used for farming than of Colton sandy loam, due partly to its less favorable position and partly to its lower productivity. The abandoned acreage also is larger than of the less gravelly soil. Essentially the same forest trees grow on the two soils, except, possibly, that spruce is more common on this soil, owing to its position at higher elevations or nearer stream beds. The same crops are grown and the same methods of farming followed as on the less gravelly soil, but slightly lower yields are obtained.

In two areas in the vicinity of Warren, where the soil is influenced by rusty-brown mica schist, the entire solum is colored by this material, giving rise to a much more brown surface soil and to an ocher-yellow subsoil and substratum. This material, owing to the presence of iron pyrites, is very acid, and the soils developed in these areas, although well drained and oxidized, probably are the most acid soils

in the section. Their total extent, however, is not large. They contain a considerable quantity of gravel. At the time of this survey one area was abandoned and a large gravel pit was in operation; the other area was used for general farming.

SOILS DEVELOPED ON KAMES AND BROKEN EDGES OF TERRACES

The soils developed on kames and broken edges of terraces are, for the most part, sandy and gravelly. Their open structure, together with a hummocky and broken relief, allow excessive drainage. All these soils have a low agricultural value. This subgroup includes: (1) Gravelly soils, including Hinckley gravelly fine sandy loam, Danby gravelly sandy loam, Merrimac gravelly sandy loam, broken phase, and Colton gravelly sandy loam, broken phase; (2) sandy soils, including Hinckley loamy sand, Danby loamy sand, Windsor sand, Colton loamy sand, broken phase, Merrimac loamy sand, broken phase, Adams loamy fine sand, broken phase, Agawam loamy fine sand, broken phase, and Colton sandy loam, broken phase; and (3) medium- to heavy-textured soils, including Hartland very fine sandy loam, Hartland very fine sandy loam, broken phase, and Suffield silt loam, broken phase.

The Hinckley soils are developed from glacial drift and outwash materials in valleys in the southern and southwestern parts of the county, whereas the Danby soils, which are similar in origin to the Hinckley, occur in the northern part or at elevations higher than the Hinckley. A gray layer is present below the forest duff in the Danby soils, but this soon disappears under cultivation. Windsor sand is composed of wind-blown sands. The Hartland soils consist of eroded remnants of a silty deposit which formerly filled Connecticut River Valley.

Hinckley gravelly fine sandy loam.—In wooded areas Hinckley gravelly fine sandy loam has a covering of dark-brown leafmold, about 1 inch thick, over dark-brown fine sandy loam having a single-grain structure, which passes, at a depth of 3 or 4 inches, into brown material of the same texture and structure. In cleared areas, the surface soil is brown gravelly fine sandy loam to a depth of 6 to 8 inches. It is underlain by yellowish-brown fairly firm but friable gravelly fine sandy loam which grades, at a depth ranging from 12 to 15 inches, into pale yellowish-brown or pale-yellow gravelly fine sandy loam. This material becomes more loose and open in structure with depth. Below a depth ranging from 20 to 24 inches, the subsoil consists of gray coarse sand, sand and gravel, and a little fine material. This material continues as more or less stratified beds of loosely assorted materials. This soil is derived largely from glacial drift or outwash material occurring in the form of kames and is composed mostly of granitic, gneiss, and other crystalline rock material. Most of this material is more or less rounded or water-worn and contains some boulders in places near the base of the formation. A number of rounded stones, ranging from a few inches to a foot in diameter, are strewn on the surface in places.

The relief is hummocky. Drainage is almost entirely internal and is so excessive that crops generally suffer in dry seasons.

Hinckley gravelly fine sandy loam occurs mostly in the valley, near the bases of hills, or, in some places, along the outer edge, or stream edge, of terraces. The areas are comparatively small and are widely

scattered over the southern and western parts of the county. Their total extent is small.

Although a comparatively large proportion of the land is cleared, it is utilized mainly for pasture. The grass cover is dominantly poverty grass and furnishes poor grazing. The pastures contain much birch, aspen, sweetfern, blueberries, and running cinquefoil. The forest is second-growth white pine, oak, maple, and birch. Elsewhere in New England, where this soil is used for crops, yields are low.

Danby gravelly sandy loam.—Danby gravelly sandy loam, like the Hinckley soils, is developed on kames having a hummocky topography, but it occurs more commonly in valleys in the northern part of the county, where the climatic conditions are similar to those giving rise to the Colton soils on the associated terraces.

In forested areas—and much of this soil is forested—a well-developed gray layer underlies the forest duff and is, in turn, underlain by dark-brown or rusty-brown material, a few inches thick. Under cultivation the surface soil is dark-brown mellow fine sandy loam containing, in many places, considerable gravel. The subsoil, beginning at a depth of 6 or 8 inches, is yellowish-brown firm but friable sandy loam having a single-grain structure. This grades, at a depth ranging from 15 to 20 inches, into pale-yellow gravelly sandy loam which grades about 2 feet below the surface, into gray loose and incoherent sand and gravel. Below a depth of 3 feet, in most places, this material becomes bedded and, in some places, it is composed of roughly assorted sand and water-worn or rounded gravel. The sand grains are mainly quartz, whereas the larger fragments are mainly schist or granite.

Included with this soil on the map are small areas of gravelly fine sandy loam, mainly in the northwestern part of the county. More of the gravel are schist than are those in the typical soil.

Danby gravelly sandy loam is widely distributed in comparatively small areas, the largest of which are in Pemigewasset River Valley and in Alexandria Town.

About 50 percent of the land is cleared and is used mainly for pasture. It furnishes meager pasturage, owing to the dominance of poverty grass and the invasion of running cinquefoil, hardhack, and birch sprouts. Yields on the small cultivated areas are low. White pine, paper birch, and some spruce trees compose the forest on the rest of the land.

Merrimac gravelly sandy loam, broken phase.—The broken phase of Merrimac gravelly sandy loam is developed in small widely scattered areas on the narrow steep outer or stream-side edges of terraces occupied by the Merrimac soils that have gravelly substrata. In general, its profile resembles that of other Merrimac soils. It ranges, however, from shallow to deep, depending on the quantity of soil removed by erosion or added by slipping from higher lying land.

This soil is very gravelly, but it is not so droughty as might be expected on that account, as seepage water is received from higher land. Most of this land is in forest consisting mainly of birch, aspen, and oak, among which are some white pine and hemlock. Where cleared, the land supports a growth of fairly nutritious pasture grasses, but it is rather steep for grazing.

Colton gravelly sandy loam, broken phase.—The broken phase of Colton gravelly sandy loam has a profile similar to that of the typical soil, but it differs from that soil mainly in its occurrence along the steep broken edges of terraces and on short slopes. Soil of this phase bears the same relation to the Colton soils, with which it is associated throughout the northeastern part of the county, that Merrimac gravelly sandy loam, broken phase, just described, bears to the Merrimac soils with gravelly substrata.

Hinckley loamy sand.—Hinckley loamy sand is closely associated with Hinckley gravelly fine sandy loam on hummocky areas, or kames, which are scattered along the bases of hills at the outer edges of valleys or which extend across the valley as barriers or moraines. The profiles of the two soils are essentially the same, except that the loamy sand contains very little gravel and consists almost entirely of more or less bedded coarse sandy material. In places, a number of granite boulders are strewn over the surface and embedded in the soil. In many places on the fronts of the kames are very small wind-blown spots which tend to enlarge if left exposed.

Most of this land has been cleared in the past, and some has been used for crops. At present, most of it is either grown up to birch and aspen sprouts or is used for pasture which generally includes other soils. In a few places small areas, included in fields with other soils, remain in cultivation, but yields are low. The grasses, in which broomsedge and poverty grass dominate, furnish poor grazing.

Danby loamy sand.—In cleared fields, Danby loamy sand has a dark-brown or brown surface soil of a noticeably single-grain structure. In places, remnants of the gray layer are present below plow depth. In forested areas, a 4- or 5-inch layer of brown leafmold or forest duff covers the gray layer of sand which is about 2 inches thick. The material is dark in the upper part and lighter in the lower part. Immediately below the gray zone is a rich-brown or coffee-brown layer, about 1 inch thick, which is loamy on account of the presence of organic matter. This passes into yellowish-brown firm but friable loamy sand which changes, at a depth ranging from 15 to 18 inches, to pale yellowish-brown loamy sand containing some gravel. Below a depth of about 24 inches the substratum is gray or yellowish-gray bedded sand and gravel, in which there is considerable dark mineral matter.

The relief is hummocky, and drainage is excessive. The agricultural value of this soil is low.

Included with Danby loamy sand on the map are forested areas, in which the gray loamy sand layer rests on a dark-brown indurated or hardened layer. The material in the indurated layer is sandy when broken down. It extends to a depth of about 12 inches, where it passes into pale yellowish-brown fairly loose and open loamy sand which grades, below a depth of 2 feet, into gray bedded sand and coarse sand. The indurated subsoil, although more or less impervious to tree roots, does not prevent the downward movement of water, and the soil, owing to the loose open character of the substratum, is well drained. In cultivated fields the surface soil is brown loamy sand and rests directly on the indurated layer. The only vegetation

is grass, the roots of which develop above the indurated layer. Cleared areas are used only for pasture which, like that furnished by the typical soil, is poor. These included areas lie in the valleys between Canaan and Plymouth.

Colton loamy sand, broken phase.—Colton loamy sand, broken phase, occurs in positions similar to those occupied by the broken phase of Colton gravelly sandy loam as hummocky kames along the edges of the valley on the eastern side of Pemigewasset River above Campton and near Easton. It is developed from deposits consisting almost entirely of medium and coarse sand, and it contains little gravel. It has, however, the same color profile as the gravelly soil. The underlying sandy material is mainly quartz and granite. Owing to the topography and the coarse sandy character of the substratum, drainage is excessive, and crops suffer in dry seasons even more than they do on the gravelly soil.

Much of this land has grown up in forest consisting of white pine, spruce, and white birch. Cleared areas are included in pastures, but they furnish poor grazing, as poverty grass, running cinquefoil, and briers constitute most of the cover. This is one of the least extensive soils in the county.

Merrimac loamy sand, broken phase.—The broken phase of Merrimac loamy sand bears the same relation to Merrimac loamy sand as the broken phase of Merrimac gravelly sandy loam does to the gravelly Merrimac soils. This soil is no more valuable for agriculture and is less valuable for its gravelly deposits than the typical soil. It consists of coarse sand and fine gravel.

Land of this kind is used for pasture to a greater extent than is the gravelly soil, owing to its location mainly along Ammonoosuc River, where it lies between the farmed bottom land and terraces and the pastured hilly land with which it generally is included on farms. Its grazing value, however, is little different from that of the gravelly soil and may even be less. Cattle have worn distinct paths on the steep hillsides in places where they pass up and down to pasture.

Adams loamy fine sand, broken phase.—The broken phase of Adams loamy fine sand occupies a few narrow strips along the broken edge of the terraces on which Adams loamy fine sand is developed. Most of the areas are steep and have little agricultural value. They are, therefore, left in forest.

Agawam loamy fine sand, broken phase.—The broken phase of Agawam loamy fine sand is associated with typical Agawam loamy fine sand, principally along Ammonoosuc River where it occupies narrow strips along the steep broken edges of the terraces on which the typical soil occurs. It has little agricultural value, and most of it is in forest.

Windsor sand.—Windsor sand occurs only in a few small widely scattered areas of wind-blown sandy material, generally banked against the low hills on the eastern sides of valleys having a western exposure. In most places, the sands have been accumulated long enough to develop a profile, and in only a few places has the soil recently been subjected to blowing.

The surface soil is brown sand, about 6 inches thick, underlain by yellowish-brown sand or loamy sand, which grades into pale-green or gray sand at a depth ranging from 24 to 30 inches. In some

places, the texture is decidedly fine sand, although, in most places, it is medium sand. In general, this soil contains no gravel or stone. In places, however, especially between Lebanon and West Lebanon, there are granitic boulders which apparently once were buried by the wind-blown sands lodging against them, but most of them now are exposed because the sand has been removed for building purposes.

The relief ranges from decidedly hummocky to dunelike. Drainage is excessive, owing to the sandy character of the surface soil, subsoil, and substratum. This soil is developed in Lebanon Town and, to less extent, in Monroe, Canaan, and the southeastern part of Enfield Towns; south of Grafton Center; and northwest of Ashland. The total area of these bodies, however, is very small.

This soil has little agricultural value. Although it is included in pastures, it furnishes poor grazing. Most of the scanty grass cover is either broomsedge or poverty grass. The few trees are scrub oak or pitch pine.

Colton sandy loam, broken phase.—The broken phase of Colton sandy loam, as the name implies, comprises the broken edges of the terraces on which Colton sandy loam occurs. Owing to its steep slope, the profile of this broken soil is not quite so well developed as is that of the typical soil. Drainage is excessive, and, for this reason, the use of this land, even for pasture, is very limited. It is mainly in forest, to which purpose it is best suited.

Hartland very fine sandy loam.—Hartland very fine sandy loam is developed mainly in Connecticut River Valley and up the Ammonoosuc River Valley to Lisbon. It represents severely eroded remnants of a silty deposit that at one time filled the valley. These remnants, due to the character of the material, consist of smoothly rounded domes or small hills, resembling kames. The deposit is entirely free from stone and gravel.

In forested areas, the surface is covered by a 1-inch layer of loose leaves and forest duff, which contains some wind-blown fine sand. The surface soil, to a depth of 4 or 5 inches, is grayish-brown mellow very fine sandy loam of single-grain or mealy structure. It is underlain by a yellowish-brown subsoil of similar texture and structure. The material becomes pale yellow at a depth of 10 or 12 inches and continues with little change to a depth ranging from 30 to 36 inches. Below this the substratum consists of a 6- or 8-inch layer of greenish-gray slightly heavier very fine sandy loam which is firm in place. It merges into bedded gray and dark-gray silts, fine sands, and clays. The reaction of the bedded material is alkaline in many places, but the soil above these beds is acid. These beds are decidedly laminated. In the central part they are intact, but, along the outer edges, they are crumpled, due to slumping of the formations. In many places, at a depth ranging from 10 to 12 feet, white streaks of calcium carbonate are present, and, in some places, small buttonlike clay stones of calcareous material are present.

Drainage is excellent, and, owing to the fine texture of the material, the soil is fairly retentive of moisture.

Nearly all of this land is cleared and is used for farming. Most of it is included in pastures, as it furnishes fairly good grazing. The grass cover consists of Kentucky bluegrass, bentgrass, and a small proportion of poverty grass. Sweetfern is one of the principal pests in the pastures. Timothy and clover hay is cut from small

areas, and alfalfa is grown in a few fields. In general, the land is too steep for the free use of improved machinery in the harvesting of hay. The trees are second growth, mainly paper birch, gray birch, white pine, red maple, white oak, red oak, aspen, wild cherry, and sumac.

Hartland very fine sandy loam, broken phase.—Areas of the broken phase of Hartland very fine sandy loam are severely dissected and very steep. Rock outcrops in a few places. Most of this soil consists of banks of the parent material which have undergone comparatively little development, and the brown surface soil is thin. Owing to the friable character of the parent material, the youthfulness of this soil is not a serious drawback. The steepness of the land, however, precludes its use for anything except forestry, or, in places, pasture. Red oak, beech, paper birch, and maple trees form the forest cover, together with a few white ash, white pine, yellow birch, basswood, and hophornbeam trees.

This broken soil is closely associated with the typical soil in the Connecticut River Valley as far north as Monroe and up the Ammonoosuc River Valley to Lisbon.

Suffield silt loam, broken phase.—Suffield silt loam, broken phase, occurs on the broken edges of terraces occupied by the typical soil. Its steep relief is the result of geologic erosion. The surface soil is very shallow or, in some places, is entirely lacking. In some places there is a shallow dark surface soil underlain by grayish-brown heavy silt loam which is mellow or has a crumb structure. The material changes quickly to greenish-gray or gray silt loam which breaks into irregular angular fragments. This passes below a depth ranging from 20 to 24 inches, into dark-gray or bluish-gray silty clay similar to Suffield silt loam. This land is not fit for cultivation, but it makes good pasture, in which the grasses are bentgrass, creeping bent, Kentucky bluegrass, and Canada bluegrass, together with some white clover. As the soil is comparatively young, in that it is close to the parent material and receives moisture as seepage, it produces good grass even in dry seasons.

SOILS OF THE HILL SECTION

This group of soils lies between the valley terraces and the plateau top and covers about one-fourth of the total area of the county. According to the sources of their parent materials, the soils may be placed in two subgroups: (1) Soils developed on till derived from schist material; and (2) soils developed on till derived from granite and gneiss materials.

The land is hilly, but it embraces many smoothly rolling to gently sloping areas which are well suited to farming. The elevation of most of this land is less than 1,200 feet above sea level, and a wider range of crops may be grown on it than on land in the plateau section. In general, the soils of this group are friable and well drained. They range from comparatively stone free to very stony and, depending on the degree of stoniness and steepness, are used in farm units as cropland, pasture, wood lots, maple groves or sugar orchards, and timberland. About 20 percent of the farm income in this section is derived from the sale of forest products.

Because of the unsuitability of a considerable proportion of the land to the use of modern farm machinery, less of the land is cultivated now than formerly. All the crops common to the county are grown, but yields are somewhat lower than those obtained on soils in the valley.

SOILS DEVELOPED ON TILL DERIVED FROM SCHIST

The soils developed on till derived from schist material are members of the Charlton, Hollis, Woodbridge, and Sutton series. As typically developed, these soils are smoothly rolling, and the steeply rolling areas are mapped as steep phases.

The Charlton soils are developed from schist accumulated under glacial action and in fairly deep deposits of till. They are comparatively stone free and have mellow friable subsoils, in which plant roots have ample room for development. Charlton loam is well suited to the use of improved farm machinery. Charlton stony loam is used less for cultivated crops than the nonstony type.

The till on which the Hollis soils are developed is similar in origin, but much shallower, than the parent material of the Charlton soils. Bedrock, in most places, lies within 3 feet of the surface. Although farm machinery can be used on these soils, they are less desirable than the Charlton soils of similar texture, owing to their smaller moisture-holding capacity.

The Woodbridge soils are developed from deep glacial till, largely of schist material, laid down in a rather tightly compact mass. Ground water moves along the top of the hard till substratum, and roots rarely penetrate below a depth of about 24 inches. Surface drainage is well established. The relief ranges from smooth to strongly rolling. Woodbridge loam is a fairly good farm soil, especially for grasses and grains. Woodbridge stony loam and the steep phases of these two soils are not so well suited to farming as is Woodbridge loam, but they furnish excellent pasture.

Owing to the heavy texture of Sutton silt loam, underdrainage is retarded. The soil is comparatively stone free, but it warms slowly in the spring and is difficult to handle. It is best suited to grains and grasses.

Charlton loam.—The 1- or 2-inch surface layer of Charlton loam, under a forest cover, is dark-brown loam. It is underlain by brown mellow loam to a depth of 5 or 6 inches. The cultivated soil is mellow rich-brown loam to a depth of 7 or 8 inches. In both the virgin and cultivated soil, the structure is crumblike, although under good cultural methods the soil approaches a granular structure. The upper part of the subsoil is rusty yellowish-brown or yellowish-brown firm but friable loam having a crumb structure, and the lower part, beginning at a depth ranging from 15 to 18 inches, is slightly olive yellow material of somewhat the same texture or structure. Below an average depth of 24 inches, the substratum consists of fairly compact olive-colored or greenish-gray fairly heavy platy till.

This soil occurs on smoothly rounded hills and gentle slopes. It is developed from fairly deep accumulations of till derived from schist. Drainage is well established, and the moisture-holding capacity of the soil is good. The soil is comparatively stone free, although there is some stone which can be picked up easily and put into fences.

Areas of this soil occur in the towns bordering Connecticut River, west of Moose Mountain, Mount Cube, and Mount Moosilauke, and on the low hills bordering Ammonoosuc River as far north as Littleton. The maximum elevation of the areas in the southern part of the county is about 1,200 feet above sea level, in the northwestern part about 1,000 feet.

Charlton loam is one of the most important agricultural soils in the county, and at least 75 percent of the land is cleared and used for farming. The rest is in woodlots, composed of oak, beech, maple, birch, and white pine trees. Most of the cleared area is mowed. A comparatively small proportion of it is in pasture, owing to the proximity of large areas of rough land used for this purpose. The cultivated crops include corn for silage, clover, oats, rye, and potatoes. There are a few small home orchards, and vegetables are grown mainly in home gardens. Dairying is the leading farm activity, and most of the crops are grown to support this. Hay yields from 1 to 2 tons per acre; oats, 30 to 50 bushels; corn, 10 to 15 tons of silage; and potatoes, 150 to 250 bushels, according to fertilization. Clover does well if limed. Productivity is maintained principally through the use of manure. Few farmers use lime or commercial fertilizer, except for special crops, such as clover or potatoes.

Under the prevailing system of soil management and the application of manure, this land is not particularly deficient in organic matter as it has the tendency to conserve the improvements put upon it. Most of it is covered with sod, as mowings run for comparatively long periods, and the beneficial effect of the grass cover is marked. Fewer mowings "run out" on this land than on any other upland soil, and, even where they are depleted, they contain much Kentucky bluegrass.

Hollis loam.—Hollis loam, as developed in this county, is essentially a shallow soil over schist material (pl, 2, *A*). It is derived from the same geologic material as is Charlton loam, but it differs from that soil in that it is much shallower, contains many more fragments of the parent rock, and has a much less compact substratum. It has a dark-brown surface layer, about 1 inch thick, containing some organic matter, which is underlain by brown or light-brown fluffy loam of crumblike structure. At a depth of about 5 inches, the color grades into yellowish brown or pale yellowish brown and, at a depth of 10 or 12 inches, into olive yellow. At this depth the material is firm but friable, but it differs little in structure from the surface soil. At a depth ranging from 20 to 24 inches, the olive-yellow or olive-gray slightly compact finely gritty till is reached, and this material rests on bedrock at an average depth of 30 inches. The depth to bedrock is extremely variable. In many places, bedrock lies very close to the surface, and only in a few places is it deeper than 3 feet below. The bedrock is smooth in some places, and in others it is frayed and partly weathered, so that the lower part of the solum is filled with small platy pieces of schist. Where the bedrock in this condition lies near the surface, shale knolls or shale spots result, in which the soil is filled with chips of this material. The soil, in general, is fairly free from loose stone. Small fragments of schist, however, are common, and in places the rib rock protrudes. Roots easily penetrate the soil down to bedrock.

The relief is smooth, gently rolling, or sloping, but is not precipitous. Drainage is well established. Due to shallowness of this soil, the moisture-holding capacity is not great, and crops sometimes are injured through lack of moisture during continued drought which, however, is not often experienced in this climate. The entire solum is acid in reaction.

Hollis loam is widely distributed in small areas in a narrow belt along the western edge of the county where the schist formations outcrop. This belt has an average width of about 10 miles, narrowing at Haverhill and widening again above Woodsville to normal width.

This soil is used extensively for farming. Possibly as much as three-fourths of it is cleared and is used for mowing, cultivated crops, and pasture. The crops are timothy and redtop, with some clover and alfalfa. Only a small area is devoted to oats, rye, buckwheat, potatoes, or other cultivated crops. Alfalfa is not considered well suited to this soil, although there are some fields near Bath and Lisbon. Yields in general fall below those obtained on Charlton loam, although about the same system of farming is followed on the two soils. Mowings in many fields contain quantities of Kentucky bluegrass, quackgrass, and even poverty grass, together with a complement of weeds which are rarely found in hay from the Charlton soils where mowings are reseeded more often. Pastures contain some bentgrass but also much poverty grass, together with birch and aspen sprouts and hardhack. This soil is used successfully for orchards in Vermont, in the counties southwest of this county. The orchards in Grafton County on this soil are limited to small home orchards containing mainly apple trees, which seem to be in fairly good condition.

Woodbridge loam.—The 6-inch surface soil of Woodbridge loam consists of dark-brown mellow heavy loam having a soft-crumb structure. It is underlain by grayish-brown loam of similar structure as the surface soil, except that the crumbs are slightly harder. This material passes, at a depth of 14 or 15 inches, into grayish-brown fairly compact loam that is decidedly lumpy, and this, in turn, passes into gray or brownish-gray compact heavy loam that breaks into fragments smaller than those in the layer above. Below a depth ranging from 24 to 30 inches is the substratum of gray tightly compact gritty till which has a platy breakage and contains brown or rusty-brown streaks along the planes. In areas near granite outcrops or in places where the parent material is influenced by granite, the subsoil is more brown and the texture is somewhat lighter than in the typical soil. Stones are present but not in sufficient numbers to interfere with cultivation. This soil is not quite so acid as are many soils in the county. It becomes less acid with depth and between depths of 36 and 40 inches is almost neutral.

This soil occurs mainly on hills or on northern and western slopes, principally in the southwestern or west-central parts of the county, where fairly thick deposits of the parent schist material were piled or pressed against the valley walls by the weight of the glacier. The relief in most places ranges from gently sloping to moderately sloping. Drainage of the surface soil is fairly good, but the drainage waters pass along the top of the hard till substratum. Occurring as it does on slopes, the soil generally is able to supply enough moisture for growing plants. The hard till substratum is impervious to both water and roots.

About 50 percent of the land is in forest consisting of beech, oak, maple, white pine, birch, ash, and basswood. There are a number of sugar orchards, the growth of which is favored by the large quantity of water available for tree roots in the spring. The other 50 percent of the land is farmed, of which about one-half is in pasture and most of the rest in mowing. Only a comparatively small proportion is devoted to cultivated crops, mostly corn and oats. This land is excellent for grass, but it is not particularly suited to other crops, although yields under good management are satisfactory. Small patches are used for the production of garden vegetables and potatoes. Hay yields from 1 to 1½ tons per acre, oats 35 to 40 bushels, corn 10 to 12 tons of silage, and potatoes 100 to 250 bushels, depending on the fertilization.

Sutton silt loam.—Sutton silt loam in cleared areas—and practically all of it is cleared—has a very dark brown granular loam or silt loam surface soil about 7 or 8 inches thick, which rests on yellowish-brown heavy loam that breaks into firm angular pieces or fragments when disturbed. This material grades, at a depth ranging from 15 to 18 inches, into grayish-brown, mottled or streaked with gray or rusty brown, loam or silt loam, which has about the same breakage but is slightly more compact. At a depth of about 24 inches this, in turn, passes into greenish-gray or olive-gray fairly heavy slightly compact till which is streaked with grayish brown or rusty brown and extends downward to a depth ranging from 8 to 10 feet. The soil throughout contains small chips of dark slaty schist of the parent rock material. As typically developed, the soil is free from rock, with the exception of a few pieces of schist and a very few erratic boulders.

The areas in which the texture is silt loam are in the northwestern part of the county. Here, the surface soil is somewhat darker and the substratum is heavier than elsewhere, as the soil is derived from material containing a higher percentage of black slaty schist. These areas are used almost exclusively for pasture.

Some areas are included with Sutton silt loam on the map, in which the slabs of schist and erratic granitic boulders are sufficiently numerous to interfere with the use of mowing machines, although they do not prevent cultivation. In some places, the included areas represent soil which differs from the typical soil only in that the original stones have never been removed. In other places, these areas are near granitic outcrops, and the stone is derived from this source. Such areas lie south of the Lebanon-Hanover granitic outcrop. The included areas are utilized almost exclusively for mowing and pasture. The land furnishes excellent pasture and is only slightly inferior to the typical soil for mowing. The pastures contain much hardhack and some alder in spots. The few remaining trees are maple, elm, ash, oak, white pine, and birch.

The relief is almost flat or gently sloping. Drainage is imperfect, but crops can be grown without artificial drainage.

Small areas of this soil are scattered over the belt along the western side of the county where the bedrock is schist and has furnished the glacial parent material.

This is a fairly important soil. Although used mainly for hay, some of the land is utilized for the production of corn and oats. Its imperfect drainage limits the range of crops which may be grown.

Few vegetables are produced outside of home gardens, although the soil seems well suited to vegetables. Hay yields from 1½ to 2½ tons per acre. The hay is mainly timothy, and little clover is grown. Corn yields from 10 to 12 tons of silage an acre; and oats, from 40 to 60 bushels. The pastures are good and contain much bentgrass and Kentucky bluegrass. This soil is used mainly in connection with dairying.

Charlton stony loam.—In forested areas, the 2- or 3-inch surface layer of Charlton stony loam consists of dark-brown mellow loam having a soft-crumb structure. It grades into rusty-brown or brown fluffy loam which continues to a depth of 5 or 6 inches. In cultivated fields, the surface soil is brown mellow loam to a depth of 6 or 7 inches. Below this is brown or rusty-brown fairly firm but friable loam having a crumb structure. At a depth ranging from 15 to 18 inches, this material grades into pale yellowish-brown or olive-tinted yellowish-brown material of similar texture and structure. Below a depth of 24 inches, lies the more or less unchanged till of olive-gray or gray finely gritty, fairly heavy, slightly compact material with a decidedly platy structure. Strewn on the surface and scattered throughout the entire soil mass is a quantity of platy schist, sufficient to interfere with cultivation, although not so great as that in the Gloucester soils. Granite boulders and outcrops of bedrock in ledges occur in only a few places.

This soil is characterized by gently rolling to strongly rolling relief, and it is well drained.

A much smaller proportion of this soil is cleared than of the associated Charlton loam. The cleared areas are utilized mainly for pasture, and a relatively small acreage is in mowing. Bentgrass dominates the pastures which also contain some bluegrass, sweet vernalgrass, and poverty grass. This is considered one of the best pasture soils in the county (pl. 2, *B*). The principal pest in the pastures is hardhack which grows in profusion in nearly all pastures. Some pastures are invaded by brush consisting of ground juniper, sumac, gray birch, and aspen. Cultivated crops, mostly corn for silage, oats, potatoes, and garden vegetables, are grown only in small patches. The yields would be the same as on Charlton loam if the soil were managed as well as that soil. The forested areas support a growth of oak, beech, maple, hemlock, and white pine.

Hollis stony loam.—Hollis stony loam is closely associated with Hollis loam over the belt along the western side of the county, where the bedrock is schist. It is more extensive than the less stony soil. The interstitial material in the surface layer is dark-brown loam in the topmost inch and brown or light-brown fluffy loam having a soft-crumb structure below. The surface layer rests, at a depth of about 5 inches, on yellowish-brown firm but friable loam which changes gradually, at a depth of about 12 inches, to olive-yellow material of the same structure. At a depth of about 20 inches below the surface, the soil grades into olive-yellow or olive-gray finely gritty only slightly compact till containing, in most places, a quantity of small platy fragments of schist. This material rests on bedrock of schist at an average depth of 24 inches. In some places, bedrock lies within a few inches of the surface, and, in other places, it is 3 feet below.

For the most part, the stone content consists of flaggy pieces or slabs of schist, ranging from a few inches to a foot or more in diameter, and of outcrops of rib rock which, in places, occupy as much as 30 or 40 percent of the surface. In places, close to the outcrops of granite and gneiss, numerous boulders of these materials are strewn on the surface.

The relief is smooth, gently undulating, or strongly rolling. Drainage is well established. Although the soil is shallow and its water-holding capacity is limited, moisture seems adequate in most seasons for the growth of grass. Roots penetrate this soil easily, and tree roots reach to bedrock. The reaction is acid throughout.

Owing to its stoniness, only a very small proportion of this land is used for cultivated crops, or even for mowing. In some cultivated fields, the loose stones have been removed, and plows and cultivators pass around the outcrops of rock. These areas are used for the production of corn, oats, potatoes, and garden vegetables, yields of which are about the same as on Hollis loam, when allowance is made for the area covered by the rock protrusions. Difficulty of cultivation, however, is a limiting factor in the use of this soil and is responsible for the large area devoted to pasture. Pastures contain much bentgrass and poverty grass, and hardhack and birch and aspen sprouts are plentiful.

Woodbridge stony loam.—Woodbridge stony loam is developed in the same general section as is Woodbridge loam, but it lies nearer the outcrops of granite or gneiss materials, which are the source, in most areas, of the stone in this soil. In forested areas, the surface is covered with a 1-inch layer of duff. The surface soil consists of dark-brown or grayish-brown loam having a soft-crumb or crumb structure, depending on the amount of organic matter present. It is underlain, at a depth of 4 or 5 inches, by brown or grayish-brown firm but friable loam of similar structure. This grades, at a depth ranging from 12 to 15 inches, into grayish-brown material of similar structure, which is faintly mottled with gray in the lower part, and this, in turn, rests, at a depth of 24 inches, on very compact till which is platy but gritty when broken down. The faces of the plates are coated with brown. This soil contains more stone than does Woodbridge loam but not enough to render cultivation entirely impossible.

Much of the land is forested, although some is in pasture. The pasturage provided is almost equal to that on the less stony soil. Bentgrass, sweet vernalgrass, and poverty grass are dominant in pastures, together with some bluegrass and white clover. Oak, birch, maple, and some gray birch, aspen, hemlock, and white pine make up the forest.

Charlton loam, steep phase.—The steep phase of Charlton loam is associated with the typical soil. It occurs on slopes with a grade ranging from 20 to 30 percent. In general, the profile is similar to that of the typical soil. The brown surface soil is slightly darkened in the upper part by humus and is underlain, at a depth of 5 or 6 inches, by yellowish-brown mellow loam. The subsoil consists of pale-yellow or pale olive-yellow firm but friable material having a single-grain structure, which rests, at a depth of 24 inches, on greenish-gray or olive-gray finely gritty rather compact till.

Drainage is good, although water seeps out on the hillsides in many places.

In spite of its steepness, some of this land is used for mowing, but it rarely is used for crops. Most of it is in pasture, in which bentgrass and Kentucky bluegrass furnish excellent grazing.

Hollis loam, steep phase.—The steep phase of Hollis loam occupies steep slopes with a gradient ranging from 20 to 30 percent and bears the same relation to the typical soil as does the steep phase of Charlton loam. The profiles differ very little, except that the depth to bedrock within short distances is more variable in the steeper soil. The brown mellow loam surface soil becomes yellowish brown in the lower part, and the olive-yellow subsoil begins at a depth of about 12 inches and grades, at a depth ranging from 20 to 24 inches, into olive-yellow or olive-gray finely gritty till. This material rests on the schist bedrock within 3 feet of the surface. The soil has a loam texture and a crumb structure throughout.

The small platy stone fragments present are not large enough or sufficiently numerous to interfere with cultivation. On the whole, the land is well drained, although there are seepy spots in places. It is used, to a limited extent, for cultivated crops, and, to a slightly larger extent, for mowing. Most of the cleared area, however, is in pasture which furnishes fair grazing. The grasses are bentgrass, some Kentucky bluegrass, and much poverty grass. As in the pastures on most of the Hollis soils, hardhack, birch and aspen sprouts, and ferns are common. The forest, which covers about one-half of the land, is composed of oak, birch, beech, maple, white pine, and hemlock.

Woodbridge loam, steep phase.—The steep phase of Woodbridge loam is closely associated with the typical soil, but it occurs on steep slopes which have a grade ranging from 20 to 30 percent. The profiles of the two soils are similar, with the exception that in the steep phase the material in the upper part of the subsoil is more brown, due to slightly better drainage conditions in the upper horizons, and the substratum is, in most places, more compact, as copious quantities of water from higher ground pass continuously over the hard layer, even in dry seasons. Most of this soil occurs in a small body east of Enfield.

Owing to the steep relief, only a small proportion of this land is devoted to crops. Some areas are mowed, but most of the cleared land is pastured. The pasture is comparable to that on the typical soil. The forests on the two soils are essentially the same, except, possibly, more hemlocks are mixed with the forest on the steeper land. The soil is valued more for pasture than for any other farming purpose.

Charlton stony loam, steep phase.—The steep soil is closely associated with typical Charlton stony loam, but it occupies slopes with a grade ranging from 20 to 30 percent. It has essentially the same profile, contains about the same quantity of stone, and has the same moisture-holding capacity as the typical soil. Its total area is much larger than that of the steep phase of Charlton loam.

This soil is used to less extent than typical Charlton stony loam for cultivated crops and mowing. Nearly all of the cleared land, which probably constitutes as much as 50 percent of the total area, is in pasture. The pasture grasses, consisting of bentgrass, some

bluegrass, sweet vernalgrass, and poverty grass, are nutritious. Ferns and brush, including sumac, birch and aspen sprouts, ground juniper, and hardhack, are common invaders in the pastures. Nevertheless, the pastures are in general better than those on the Hollis and Gloucester soils. Although steep and stony, this land is not so steep or so stony as is rough stony land.

Hollis stony loam, steep phase.—The steep phase of Hollis stony loam is closely associated with the typical soil, but it occurs on slopes with a grade ranging from 20 to 30 percent. It has a profile development similar to that of the other Hollis soils. Drainage is well developed in most places, although there are some seepy spots. The stone content is similar to that in Hollis stony loam, but ledge outcrops are more common. This soil is almost as extensive as the typical soil.

This steep land is utilized extensively for pasture, and it furnishes fair grazing. In addition to bentgrass, the pastures contain much poverty grass and some bluegrass. About 50 percent of the land is forested to oak, beech, birch, aspen, maple, white pine, and hemlock.

Were it not for the proximity of this soil to better land, so that it can be utilized solely for pasture, it would have a much lower agricultural value.

Woodbridge stony loam, steep phase.—The steep phase of Woodbridge stony loam is similar to the steep phase of Woodbridge loam in all respects except its stone content, in which it resembles Woodbridge stony loam. The steep relief favors good surface drainage, but seepage from higher ground passes along the top of the hard substratum. Even in dry seasons, plants generally receive enough moisture. Roots do not penetrate this hard substratum, but the 2- to 3-foot layer of material above it is ample for good development of roots. Practically all of this soil occupies two small areas southeast of Lebanon.

This land is almost entirely in forest. Only a few areas are cleared and used for pasture. Most of the soil is so situated that it could be used for pasture, if needed. Although the land is steep, it furnishes good grazing.

SOILS DEVELOPED ON TILL DERIVED FROM GRANITE AND GNEISS

All the soils developed on till derived from granite and gneiss materials are members of the Gloucester series. They all contain an appreciable quantity of stone which, in the less stony soils, is in the form of boulders. In many places, these have been removed from the fields and piled into fences. Even the less stony soils are used for farming with only fair success because of the difficulty of using improved farm machinery. The stony soils contain too much stone for profitable removal and are therefore best suited to pasture, and the steep phases and very stony soil are best utilized for pasture or forest.

Gloucester fine sandy loam.—Gloucester fine sandy loam is the most important Gloucester soil in relation to agriculture, although it is not the most extensive. It occurs chiefly in the south-central and southeastern parts of the county as low smooth hills, few of which rise above an elevation of 1,200 feet above sea level, or more than 600 feet above the valley floor.

The surface soil, in cultivated fields, is brown mellow fine sandy loam, having a weak-crumb structure. It grades at a depth of 5 or 6

inches into yellowish-brown firm but friable fine sandy loam having a crumb structure, and this material, in turn, grades at a depth of 12 or 15 inches, into pale-yellow fine sandy loam of single-grain structure. At an average depth of 20 inches this merges with gray gritty till of sandy loam texture. This material is rather firm in place but is not highly compact. The parent material has been accumulated by glacial action from granitic sources, and numerous fragments of the parent material occur as boulders of various sizes on the surface and throughout the soil. The smaller stones have been removed from the surface in most places and have been piled into fences that surround the fields.

The relief is undulating or rolling to gently sloping. Drainage is well established.

Nearly all of this land is cleared and is used for farming. Hay, mainly timothy and redtop, and oats, some corn for silage, potatoes, and garden vegetables are grown. Yields vary according to fertilization. Hay yields 1 to 1½ tons per acre; corn, 8 to 10 tons of silage; oats, 30 to 45 bushels; and potatoes, 100 to 175 bushels. This land is not particularly productive, but it compares favorably with the average productivity for the county.

Gloucester sandy loam.—In cleared areas, Gloucester sandy loam has a 7- or 8-inch brown surface soil. In forested areas, the surface soil is covered with a duff, from ½ to 1 inch thick. The mineral soil consists of dark-brown sandy loam which changes within a few inches to light brown. The material is mellow and friable and has a distinct soft-crumb structure. At a depth of 5 or 6 inches below the surface, this material passes into yellowish-brown slightly firm but friable sandy loam having a single-grain structure. The color fades with depth to pale yellowish brown. The soil material grades, at an average depth of 24 inches, into grayish-yellow till of the same structure, which changes to gray gritty slightly firm in place, but friable, till below a depth of about 36 inches. Gravel and granitic boulders, ranging from a few inches to several feet in diameter, are scattered on the surface and throughout the soil mass but are not so numerous as in the parent till material.

This soil is developed from fairly deep glacial till derived from granites and gneiss. It occurs in scattered areas on smoothly rounded hills and gentle slopes chiefly in the south-central part of the county, particularly in Enfield, Canaan, Grafton, Alexandria, and Ashland Towns, and on the lower hills in Dorchester Town.

Drainage is almost entirely internal, and, owing to the rather coarse porous nature of the material, it is well established.

Gloucester sandy loam is not important agriculturally, but, in places, it comprises most of the farmed land. Possibly as much as 50 percent is cleared and used for farming. A number of fields have been abandoned. Most of this soil occurs below an elevation of 1,200 feet and supports the vegetation characteristic of land at that elevation. White pine dominates the forest which also includes white oak, red oak, aspen, birch, maple, and beech. Most of this soil is used for mowing, and a small area is devoted to cultivated crops consisting mainly of oats, corn for silage, and potatoes. A comparatively small area is in pasture. The agriculture is typical of that of the interior part of the State. There are a few small orchards and vegetable gardens. Hay, the most important crop, yields from ¾ to 1 ton per

acre. Yields of other crops are slightly lower than those obtained on Gloucester fine sandy loam, and the same agricultural methods are used on the two soils.

Little effort is made to remedy the deficiency in organic matter. Few farmers use fertilizer, as they depend on manure for maintaining the fertility of the soil. This soil is not so good for farming as is Gloucester fine sandy loam.

Gloucester stony fine sandy loam.—The profile of Gloucester stony fine sandy loam is similar to that of Gloucester fine sandy loam except that the stone content is greater. In forested areas—and a large part of this soil is forested—the surface soil consists of a thin layer of loose leaf litter, a 1-inch layer of partly decomposed organic matter and leafmold, a 2- or 3-inch layer of dark-brown fine sandy loam containing some organic matter, in places a thin or incipient gray layer less than one-fourth inch thick, and, to a depth of 5 or 6 inches, yellowish-brown fine sandy loam having a soft-crumb structure. The surface soil is underlain by somewhat firm but friable fine sandy loam which grades, below a depth ranging from 15 to 20 inches, into a pale-yellow material of the same texture and single-grain structure. This material merges, about 2 feet below the surface, with gray or grayish-yellow gritty till. Fragments and boulders of granitic material are numerous throughout the soil mass.

This soil is rather extensively developed over the southeastern and south-central parts of the county. The cleared areas are used mainly for pasture which furnishes fair grazing. The grasses are dominantly bentgrass, with some Kentucky bluegrass and some poverty grass. These pastures, in common with most pastures in this section, contain gray birch and aspen sprouts, sweetfern, and hazel, together with bracken and other ferns. Very little of the stone has been removed, and the area devoted to cultivated crops is small. Mowings (timothy and redtop) occupy most of the farmed land. As little attention is given to farming, mowings are allowed to stand without reseeding for indefinite periods and, in the course of time, are run out by weeds and brush.

Gloucester stony sandy loam.—Gloucester stony sandy loam is similar in all respects to Gloucester stony fine sandy loam, except in texture. It is developed in the south-central part of the county where much of the glacial material is derived from coarse crystalline rocks. The interstitial soil material ranges from sandy loam to coarse sandy loam, and the parent material, below a depth ranging from 20 to 24 inches, is much coarser and more open in structure than the substratum of Gloucester stony fine sandy loam.

The cleared area, comprising about one-third of the total area, is used mainly for pasture. The rest of the land is covered with forest, consisting of oak, white pine, birch, beech, and hemlock. The pastures, although containing much bentgrass, are inferior to those on Gloucester stony fine sandy loam, because the loose substratum makes this soil somewhat less resistant to drought.

Gloucester very stony fine sandy loam.—Gloucester very stony fine sandy loam resembles Gloucester stony fine sandy loam, except that, in general, the stones are larger, more difficult to remove, and so numerous that they prohibit the use of the land for crops. This soil occupies smoothly sloping hillsides and can be used for pasture, even though the stones are not removed. The same pasture grasses grow

as on Gloucester stony fine sandy loam. Most of this soil, however, is in forest. If it is contiguous to other and better farm lands in the valley, it can be used profitably for pasture; otherwise it is best left in woods. It occurs mainly in the southwestern and south-central parts of the county.

Gloucester fine sandy loam, steep phase.—The steep phase of Gloucester fine sandy loam occurs on the hillsides and steeper slopes associated with typical Gloucester fine sandy loam. The profiles of the two soils are essentially the same. In places, however, the steeper soil is slightly shallower than the typical soil; and, in other places, due to slumping, it is thicker. This land was at one time cleared and used for crops. At present, however, with the exception of a few isolated mowings, it is used for pasture or has reverted to woods. Its value for pasture is about the same as that of Gloucester fine sandy loam, but, under present conditions, its value for crops is very low, owing to the steep relief which practically prohibits the use of improved machinery.

Small areas, in which the texture is sandy loam, are included with this soil in mapping. The included soil probably is slightly less valuable for pasture, because of the prevalence of plants, such as lady's-tobacco and poverty grass, which afford poor grazing. The forested areas contain white pine trees, in addition to a few oak, birch, maple, and aspen trees.

Gloucester stony fine sandy loam, steep phase.—The steep phase of Gloucester stony fine sandy loam differs from the typical soil, with which it is associated, only in that it is steeper. Stones are sufficiently numerous to preclude its use for tilled crops, but it can be, and is, used for pasture. Much of it, however, is covered with forest consisting of oak, white pine, birch, aspen, maple, and some hemlock.

SOILS OF THE PLATEAU SECTION

The soils of the plateau section lie at elevations ranging from 1,200 feet above sea level, in the southern part of the county, and 1,000 feet, in the northern part, to 2,400 feet. According to the source of their parent materials, these soils, like those of the hill section, may be placed in two subgroups, as follows: (1) Soils developed on till derived from schist; and (2) soils developed on till derived from granite and gneiss.

The relief of the plateau section, for the most part, is smooth, but many fairly steep hillsides are included. The soils range from somewhat stony to moderately stony, and some soils are comparatively free from stone.

The elevation slightly restricts the range of crops which may be grown. Corn is matured with difficulty, and only the hardiest flint varieties are used. On the other hand, the land is better adapted, in places, to the growing of potatoes than are soils at lower elevations. The isolation of certain areas places more restriction on their possibilities for farming than does low productivity, for these soils return as good yields of adapted crops, such as grasses, small grains, and potatoes, as do the soils of the hill section. Farm units have somewhat the same subdivisions as in the hill section, that is, cropland, pasture, and forest. Steep and stony land constitutes a much larger proportion of the plateau section, however, than it does of the hill section.

SOILS DEVELOPED ON TILL DERIVED FROM SCHIST

The group of soils developed on till derived from schist material includes members of the Blandford, Berkshire, and Lyman series, which, as typically developed, are smoothly rolling, and steep phases of the Berkshire and Lyman soils, which are steeply sloping. All these soils are well drained.

Blandford loam, the only type of the Blandford series mapped, is the most smooth, least stony, and most productive soil in the plateau section. It is developed from dark slaty schist. Isolated spots containing stone are indicated on the map by symbol.

The Berkshire soils are developed on fairly deep till derived from brown micaceous schist. The substratum is fairly compact. Berkshire loam is comparatively free from stone and may be used largely for cultivated crops. The stony type and steep phases of these soils are suited to pasture or forestry.

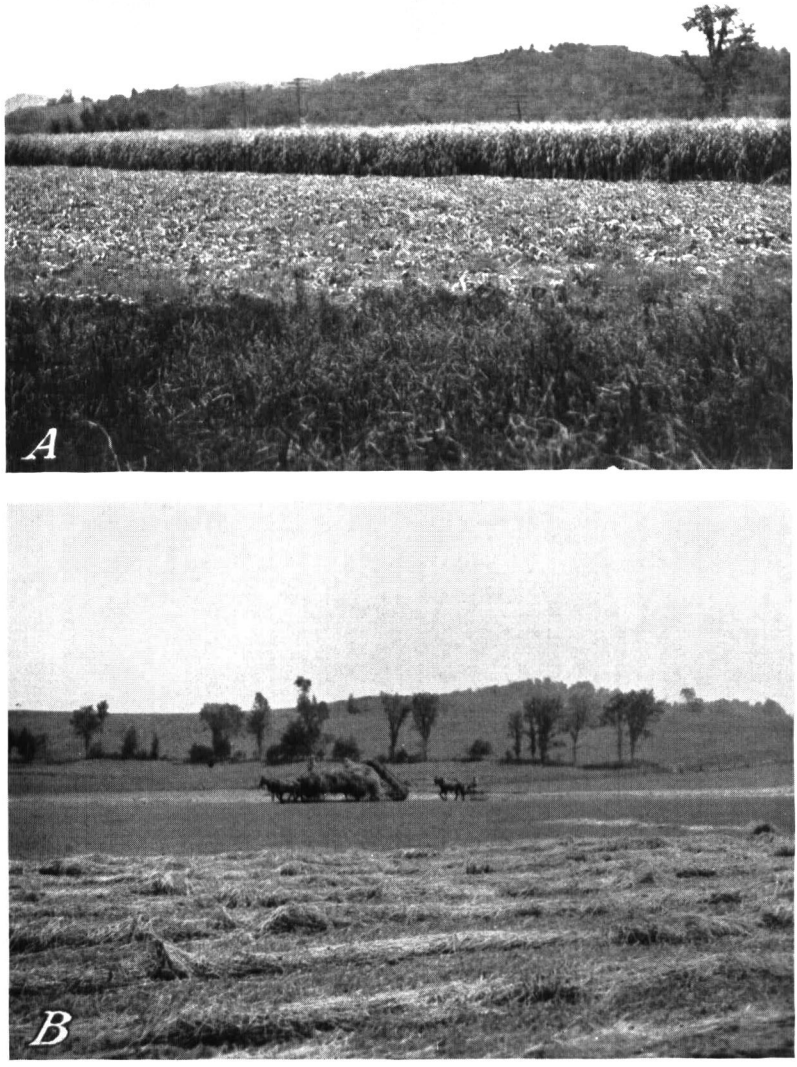
The Lyman soils are shallow and are similar to the Hollis soils of the hill section except that they occur at higher elevations and have a Podzol soil development. They are used mainly for pasture, and a rather large proportion of them is in woods.

Blandford loam.—Blandford loam is developed on the almost flat ridge tops over the western part of the county, in the section where schist rocks outcrop and where the parent material was accumulated by glacial action from these materials. Drainage is well established, owing mainly to the position and narrowness of the ridge tops.

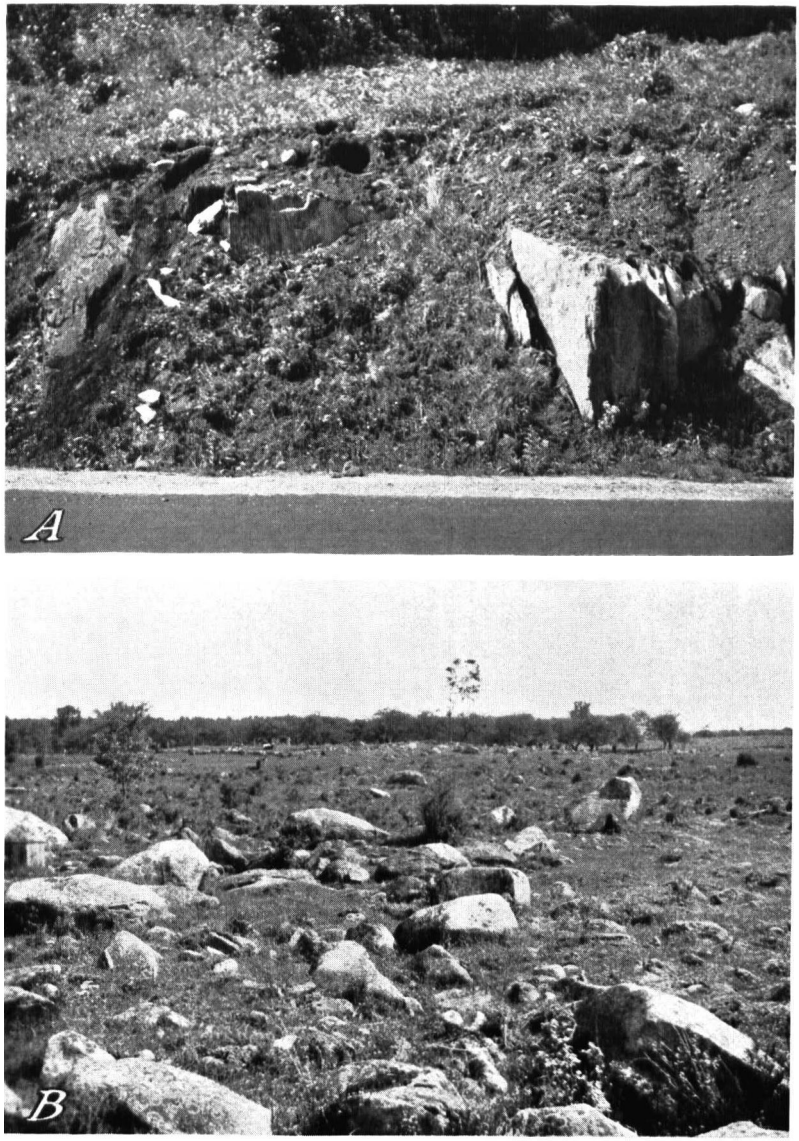
The surface layer, in most places, is dark-brown loam having a crumb structure. It is underlain, at a depth of 5 or 7 inches, by brown or slightly lighter colored material of the same texture and structure. The subsoil, beginning at a depth of 10 or 12 inches, is grayish-brown or olive-brown fairly heavy loam or silt loam, having a small irregular angular breakage. At a depth ranging from 15 to 18 inches, this material grades into greenish-gray or olive-gray firm silt loam—slightly platy till. Below a depth of 24 inches the material is dark greenish-gray somewhat compact till. This soil contains little stone but does contain a quantity of small angular slaty chips of schist.

In a few areas, included with Blandford loam on the map, the content of stone, consisting of fragments and slabs of the parent material and some erratic granite boulders, is sufficient to interfere with cultivation and the use of mowing machines. The removal of this stone, although possible, is not attempted because the adjacent readily tillable land is ample to make up farm units. This land, therefore, is used for pasture, in which grazing is as good and the vegetation is the same as in pastures on the typical soil. In a few places in these areas, bedrock is exposed on the surface or protrudes as ledges.

Nearly all of Blandford loam is cleared and farmed. Its occurrence at an elevation ranging from 1,200 to 1,500 feet limits the crops grown mainly to grasses, small grains, potatoes, and vegetables. Corn can be matured, but danger of frost is great. Hay, consisting of timothy and redtop, is the leading crop. A fairly large area is in pasture which furnishes excellent grazing of Kentucky bluegrass and bentgrass, with a minimum of poverty grass. The pasture contains much hardhack—the principal pasture pest. Many of the mowings contain a quantity of orange hawkweed. This soil is young,



A, Silage corn on Ondawa fine sandy loam, high-bottom phase, near Lisbon; *B*, hay on Suffield silt loam, near Piermont.



A, Hollis loam, 2 miles east of Lebanon, showing shallowness over bedrock; *B*, pasture on Whitman stony loam in foreground, Charlton stony loam in background.

has suffered little from eluviation, and has a somewhat higher base content than any other upland soil of the section. These facts account for its high productivity. Its heaviness makes it more difficult to handle than most of the associated lighter upland soils, but, where properly managed, it returns good yields. Hay yields from 1 to 2 tons per acre, depending on the condition of the mowings; oats, 35 to 60 bushels; buckwheat, 18 to 20 bushels; and potatoes 100 to 200 bushels. Very little fertilizer or lime is applied. The farmers depend on the application of manure and the turning under of a sod cover to maintain fertility. The few remaining trees are maple, beech, and birch. Spruce trees grow up in pastures and abandoned fields.

Berkshire loam.—In cleared areas, the surface soil of Berkshire loam is dark-brown or brown mellow loam of soft-crumb structure to a depth of 7 or 8 inches. In virgin areas, the surface is covered with a thick mat of partly disintegrated organic matter and raw humus, which is underlain by a 1-inch layer of gray material which rests on a 1- or 2-inch layer of dark rusty-brown or coffee-brown material that grades into deep yellowish-brown or reddish-brown firm but friable loam having a crumb structure. This material, in turn, passes, at a depth of 15 inches, into pale yellowish-brown loam of similar structure. Below a depth of 24 inches, the substratum consists of pale yellowish-gray or greenish-gray fairly heavy till which is slightly influenced by soil-forming processes and which passes, below a depth of 36 inches, into gray or greenish-gray compact till having a small platy breakage. The soil in several areas in the northwestern part of the county, north of Wild Ammonoosuc River, is fine sandy loam. These included areas are used for the same purposes as is the typical soil.

The parent material of this soil is derived mainly from schist, ranging from dark slaty schist to brown micaceous schist. Fragments and boulders of this material are scattered over the surface and throughout the entire soil, but not in sufficient quantities to interfere with cultivation. The glacial accumulations which give rise to this soil occur, for the most part, on the plateau top or ridge tops in the western part of the county, mainly in intermittent areas on ridges above a height of 1,200 feet above sea level, near and parallel to the bases of Moose Mountain, Mount Cube, and Black Mountain. The areas north and west of Black Mountain and Littleton lie at a lower elevation (from 700 to 800 feet above sea level) than do those elsewhere in the county. Drainage is well established, and the underlying till in few places is hard enough to resist the downward movement of water or to prevent the penetration of roots.

About 60 percent of this soil is cleared and is used for general farm crops and pasture. Mowing occupies the largest acreage, followed in order by oats and potatoes. Little corn is grown. Vegetables are grown in home gardens. Hay, mainly timothy and redtop, produces from 1 to 1½ tons per acre; oats, 35 to 50 bushels; and potatoes, 100 to 250 bushels. Yields of 300 bushels are reported in good seasons and with extra fertilization. Pastures, predominantly of bentgrass, together with some Kentucky bluegrass and poverty grass, furnish fairly good grazing, provided the invasion of hardhack and birch and aspen sprouts is controlled. The forested area supports a growth of oak, beech, maple, and yellow birch.

Lyman loam.—Lyman loam has a profile similar to that of Berkshire loam, but the Lyman soil is shallower over bedrock which is present at a depth ranging from a few inches to 3 feet or deeper and which, in places, is exposed as rib rock. The elevation above sea level is more than 1,200 feet in most places in the southwestern part of the county, and more than 800 feet in the northwestern part. The land is smoothly rolling and is well drained. The total area of this soil is not large, but the bodies are widely scattered over the section where schist rocks prevail.

Most of the land is cleared and is used for mowing or pasture. Its value for farming is less than that of Berkshire loam and is somewhat the same as that of Hollis loam, except that the Lyman soil is more isolated and, due to its position, produces a more limited range of crops.

Berkshire stony loam.—In cultivated areas Berkshire stony loam has a dark-brown or brown surface soil, of single-grain structure, about 7 or 8 inches thick. In undisturbed wooded areas, a gray layer, about 1 inch thick, underlies the forest duff and rests on rusty-brown loose fluffy loam, about 1 to 1½ inches thick, which grades into yellowish-brown firm but friable loam. Below a depth of 15 inches is pale yellowish-brown loam of the same consistence as the layer above. At a depth ranging from 20 to 24 inches, is pale-yellow or grayish-yellow firm till which is slightly influenced by the soil-forming agencies and passes almost imperceptibly, at a depth of 36 inches, into gray, greenish-gray, or olive-gray till having a platy breakage and vesicular structure. The entire soil mass contains considerable stone consisting of fragments and boulders of the parent schist material, which, in places, are flaggy. These occur in such quantities that they interfere with cultivation, but, in most places, they may be removed. The substratum in few places prevents the penetration of roots or water, although it holds moisture well. The parent glacial till is not quite so deep as that of Berkshire loam, but bedrock lies from 4 to 10 feet below the surface in most places. In a few places, however, the bedrock protrudes in ledges.

Berkshire stony loam is widely distributed over the western part of the county where schist rock forms the basal rock outcrop. It occurs on the ridge tops of the plateau above an elevation of 1,200 feet, in most places in the southern part of the county, and as low as 800 or 900 feet in the northern part. In places where the plateau is very high, it also extends down the hillsides.

About 20 percent of this soil is cleared and used for pasture. Very little is used for hay or other crops. The pasture consists mainly of bentgrass, with some Kentucky bluegrass and poverty grass, especially in pastures which have run out. Hardhack and birch and aspen sprouts commonly invade the pastures. The principal forest trees are birch, aspen, beech, and hemlock, together with some oak. In addition, spruce grows at the higher elevations and hophornbeam at the lower elevations.

Lyman stony loam.—Lyman stony loam is closely associated with Lyman loam and is similar to that soil except for its stone content, which is sufficient to interfere with cultivation. The stone consists of fragments and slabs of schist and protrusions of bedrock. The relief, in most places, is somewhat more rolling than that of Lyman loam.

Much of this land is in forest, and the few cleared areas are in

pasture which furnishes fairly good grazing in normal seasons, but there is a tendency to shortage in dry seasons. Poverty grass predominates in the pastures. Hardhack and other brush are common, and they reduce the value of this land for grazing.

Berkshire loam, steep phase.—The steep phase of Berkshire loam occurs on hillsides and sides of ridges, whereas the typical soil occupies the smoother ridge tops. The 6- or 7-inch surface soil in cleared areas is dark-brown or brown mellow loam, single grain in structure. Under a forest cover, a one-half- to 1-inch gray layer is developed under the forest litter and duff and rests on a layer of rusty-brown or dark-brown fluffy loam, about 1½ or 2 inches thick, which, in turn, passes into yellowish-brown firm but friable loam having a weak-crumb structure. This material grades into pale yellowish-brown light loam of the same structure. Below a depth of about 24 inches, the substratum consists of greenish-yellow firm loam which grades, at a depth of about 30 inches, into greenish-gray somewhat compact platy till. This soil is not extensive.

Most of this land is cleared and pastured. In general, its steepness precludes the profitable production of cultivated crops under present economic conditions, although it has been used for that purpose in the past. It furnishes fairly good pasture of bentgrass, together with some Kentucky bluegrass and poverty grass. Hardhack is the principal pest in the pastures and, together with birch and aspen sprouts, occupies a considerable proportion of the pasture land.

Lyman loam, steep phase.—The steep phase of Lyman loam is developed on fairly steep slopes in the northwestern part of the county, becomes less extensive southward, and does not occur south of Lyme Town. It consists of a thin layer of soil over schist and is somewhat similar to the Hollis soils, but it occurs at higher elevations and farther north than those soils, in places where a gray layer is developed under the forest duff. Where cleared—and a considerable area is cleared and used for pasture, notwithstanding its steepness—the surface soil is deep-brown or rich-brown mellow loam to a depth of 5 or 6 inches. It is underlain by rich-brown or yellowish-brown firm but friable loam which gradually changes to pale yellowish-brown loam of similar consistence. This material, in turn grades, at a depth of about 24 inches, into greenish-gray fairly compact till which has a small platy breakage. Bedrock of schist is reached at an average depth of 3 feet. Some stones, mainly schist fragments and small boulders, are on the surface and embedded in the soil. In a few places, bedrock lies near the surface or outcrops.

Drainage, owing to the steep slope, is good in most places, but there are some seepy spots.

This soil is widely used for pasture, and it furnishes fair grazing. Bentgrass and poverty grass abound, together with some Kentucky bluegrass. Hardhack is the leading pest in the pastures. Birch and aspen sprouts and sumac also are common.

Berkshire stony loam, steep phase.—The steep phase of Berkshire stony loam is much more extensive than the steep phase of Berkshire loam. It is developed on the steeper hillsides in association with Berkshire stony loam. Its profile is similar to that of the steep phase of Berkshire loam, except for its greater stone content. It is not so stony, however, as rough stony land.

The stoniness and steepness of this soil preclude its use for anything except pasture and forest, to which purposes it is well suited. The grass cover is essentially the same as that on the steep phase of Berkshire loam. The forest consists of yellow birch, paper birch, beech, maple, and hemlock.

Lyman stony loam, steep phase.—The steep phase of Lyman stony loam is similar to the steep phase of Lyman loam, except for its stone content. It is developed in association with the less stony phase throughout the northwestern part of the county. The stones are mainly schist, ranging from small fragments to large stones several feet in diameter. Bedrock is near the surface or outcrops in many places. Drainage in most places is well established, owing to the steep slope, but seepage creates some wet spots on the hillsides. Most of the land is forested, although some small areas are pastured. The pasture is only fair. It contains, in addition to bentgrass, much poverty grass, hardhack, and other brush.

SOILS DEVELOPED ON TILL DERIVED FROM GNEISS AND GRANITE

This subgroup of soils developed on till derived from gneiss and granite includes the typically developed soils of the Becket, Hermon, Canaan, and Peru series, which are smoothly rolling, and the steep phases of the Becket and Hermon soils, which are steeply sloping. All except the Peru soils are well drained.

The Becket soils are similar in position and relief to the Berkshire soils, but they are derived from gneiss and granite and, in general, have a more compact substratum of hard somewhat platy till. Becket loam is suited to tilled crops and pasture grasses. The stony type and steep phases are essentially pasture land or timberland, as they are unsuited to cultivation.

The Hermon soils are developed from granitic till and are, in general, the stoniest and roughest soils of the subgroup. Removal of the stone, in many places, has made cultivation possible. The Hermon soils occur at high elevations, in most places above 1,200 feet, where, under a native forest cover, a well-defined gray layer is developed under a thick forest duff. Beneath this gray layer, in places, is a discontinuous indurated layer. The stony type and steep phases are best suited to pasture or forest, and the very stony areas, although used in places for pasture, are mainly in forest.

The Canaan soils are shallow and are developed mainly from granitic till. The nonstony areas may be used for mowing and, to a limited extent, for crops. Like that of most shallow soils, their moisture-holding capacity is small, and, in very dry seasons grass and other crops suffer from lack of moisture. The stony areas are pastured, in places, but for the most part are forested. These soils occur mainly on the top of the plateau.

The imperfectly drained areas throughout the plateau section are occupied by the Peru soils. The relief ranges from almost flat to gently sloping. Imperfect drainage limits the use of these soils to forestry and pasture, for which purposes they are well suited.

Becket loam.—The 7- or 8-inch surface soil of Becket loam is dark-brown loam with a weak-crumb structure. It is underlain by rich-brown rather loose and fluffy loam of the same structure. This changes gradually, at a depth ranging from 15 to 18 inches, into pale yellowish-brown loam of similar consistence. At an average

depth of 24 inches, the material is greenish-gray rather compact till which has a fine platy or shell breakage and a vesicular structure. Bedrock lies from 4 to 10 feet below the surface. The compact till does not, however, retard the downward movement of water, but it does serve to retain moisture in the soil. It is not in any sense a hardpan, although it hinders the penetration of roots to some extent. This soil contains some stone, mainly granitic boulders, scattered on the surface and throughout the solum. In most places, the stones have been picked off the surface and piled into fences.

Some areas of fine sandy loam texture, in the northwestern part of the county around the village of Benton, are included with Becket loam on the map. The substratum in these areas, however, is essentially the same as that in the typical soil.

Becket loam is developed from glacial material accumulated from granite, gneiss, and some schist materials. It occurs on the tops of the plateaus throughout the central part of the county, in most places above an elevation of 1,200 feet. In a few places, it extends down the slopes on both sides of the ridges. In the southeastern part, around the northern border of Squam Lake, it assumes the form of low hills or drumlins. The relief is smoothly rolling, gently sloping, or almost level. Drainage is well established.

Becket loam, at one time, was used extensively for farming, but within the last 30 years much of the farm land has been abandoned, owing to its inaccessibility. The comparatively small timbered area supports second-growth maple, birch, beech, white pine, hemlock, and spruce trees. Many of the abandoned areas are growing up to birch and aspen sprouts, and in places, spruce. Many areas, formerly mowed, now furnish good grazing, owing to the comparatively large proportion of bentgrass. Hardhack is the chief pest in the pastures. On areas still used for farming, timothy and redtop hay is the chief crop, followed in order by oats and potatoes. Mowings yield from ½ to 1½ tons of hay. Quackgrass is a common constituent of the hay. Run-out mowings produce low yields of a poor-quality hay, and orange hawkweed is common. Oats yield from 25 to 45 bushels an acre; and potatoes, 100 to 300 bushels, depending on fertilization. Recently, some abandoned farms have been bought for the sole purpose of growing potatoes. The owners reside elsewhere. Where a sod cover has been maintained for a long period, this abandoned land has good possibilities for farming. The occurrence of this soil on inaccessible high ridge tops is the greatest drawback to its cultivation.

Hermon sandy loam.—The surface soil of Hermon sandy loam, to plow depth—7 or 8 inches—is brown sandy loam. Under forest cover, particularly in a virgin forest, there is a thick mat of organic material or forest duff over a thin surface layer of dark sandy loam which contains finely divided organic matter and is underlain by a 1- to 3-inch gray or leached layer which, in turn, gives way to dark-brown fine sandy loam. This material rests on a 3- to 5-inch layer of rusty-brown firm but friable fine sandy loam which passes into yellowish-brown slightly firm but friable sandy loam. At a depth of 18 or 20 inches, this material, in turn, grades into pale-yellow only slightly firm sandy till which, at a depth ranging from 24 to 30 inches, gives way to gray sandy till that is only slightly compact in place and breaks readily into loose single-grain sandy

material. The entire soil from the surface downward has a well-defined single-grain structure. Stones, ranging in size from a few inches in diameter to large boulders, occur throughout the soil but not in sufficient quantities to prohibit cultivation. Unless the stones are removed, however, they interfere, to some extent, with the use of improved implements.

This soil is not extensive. Small areas are scattered over the southern and south-central parts of the county, where the material accumulated by glacial action is derived from granites and gneiss. The elevation, in most places, ranges from 1,000 to 2,400 feet above sea level. The soil occurs on ridge tops and in undulating areas. Owing to the light character of the soil mass and the substratum, drainage is thorough.

In the northern part of the county, in the vicinity of Bethlehem, areas of fine sandy loam texture are included with this soil on the map. They are utilized in much the same way as the typical soil.

A considerable area of this land was cleared and farmed at one time, but little is used at present except for an occasional mowing and for pasture. The pasturage is only fair, as some bentgrass and much poverty grass grow in places. Aspen sprouts and ground hemlock are common in the pastures, in addition to bracken and ferns. About 1 ton of hay an acre is cut. The land is used, to a limited extent, for the production of potatoes and vegetables. Potatoes yield from 100 to 200 bushels when they are heavily fertilized and the season is not too dry. Oats in small fields do fairly well. Red spruce, balsam, gray birch, yellow birch, some white pine, hemlock, aspen, and maple trees comprise the forest growth.

Canaan fine sandy loam.—The surface soil of Canaan fine sandy loam, where cleared, is brown fine sandy loam having a single-grain structure. Under forest conditions, a gray or leached layer underlies the forest duff in places, and a layer of rich-brown material several inches thick is everywhere present below either the duff or the gray layer. The subsoil is yellowish-brown firm but friable fine sandy loam of single-grain structure, which grades, at a depth ranging from 15 to 18 inches, into pale yellowish-brown material of slightly lighter texture and less firm structure. A yellowish-gray slightly firm till is reached, in places, at a depth ranging from 20 to 24 inches, and, below a depth of 30 inches, is the gray gritty sandy till which is fairly firm in place but not noticeably compact. Bedrock of granite, gneiss, or, in a few places, schist, lies at an average depth of 36 inches. The parent material in most places was accumulated by glacial action on ridge tops and was derived mainly from the bedrock material, although, in some places, other crystalline materials contributed to it.

This soil occurs on tops of the plateaus, mainly in the south-central and southeastern parts of the county, at an elevation ranging from 1,000 to 1,500 feet.

A considerable proportion of the land has been cleared and used for farming in the past, but at present it is abandoned or, where accessible, is used either for pasture or, to a limited extent, for mowing. These pastures, like so many in this section, contain birch and aspen sprouts and hardhack. The cover consists of poverty grass, with some bentgrass, Kentucky bluegrass, and ferns. The stones, which originally were comparatively few, have been removed in

most places so that mowing machines and tillage implements can be used easily. Hay (timothy and redtop) yields from ½ to 1 ton per acre, depending on the condition of the meadows. The chief disadvantage of this soil is its shallowness and consequent low moisture-holding capacity, and, in extremely dry seasons, the yield of hay is greatly reduced. During most seasons, the rain is sufficient for the growth of grass. The forest trees are oak, white pine, hemlock, birch, beech, and maple.

Canaan sandy loam.—Canaan sandy loam has a 6- or 7-inch surface layer of brown mellow sandy loam of single-grain structure. It is underlain by yellowish-brown slightly firm but friable sandy loam which changes gradually, at a depth ranging 12 to 15 inches, to pale yellowish-brown or pale-yellow slightly lighter textured sandy loam. This material grades, at a depth ranging from 20 to 24 inches, into firm but not compact gray sandy till which crumbles readily when taken out. The stones, which are mainly granite, can be removed easily.

This soil is developed in small widely scattered areas in a belt extending north and south through the center of the county. The relief ranges from smoothly rolling to gently sloping. Drainage, owing to the friability of the surface soil and comparative porosity of the subsoil, is well established. The elevation ranges from 1,200 to 2,500 feet above sea level.

A considerable area of this soil has been cleared and used for farming in the past, and some of it still is farmed. Hay is the leading crop, and very small acreages are in oats and potatoes. Some vegetables are grown for home use. A fairly large acreage, representing abandoned mowings, is used for pasture. Bentgrass and poverty grass are the chief pasture grasses. The pastures are invaded by brush. Most of this soil, at present, is covered with a forest of white pine, spruce, hemlock, yellow birch, and some paper birch and aspen trees.

Canaan loam.—In forested areas of Canaan loam, a well-defined gray layer, about 1 inch thick, is developed underneath the forest duff. It is underlain by rusty-brown loam. In cleared fields, the surface soil is brown mellow loam to a depth of 7 or 8 inches. This grades into yellowish-brown firm friable loam of crumblike structure, which, at a depth ranging from 12 to 15 inches, is pale yellowish brown. This material passes, at a depth of about 24 inches, into fairly compact greenish-gray or gray till. Bedrock is reached at an average depth of 3 feet below the surface. It consists of granite, gneiss, or, in places, schist, which has been worn smooth by glacial action. Some rock fragments of granite, gneiss, or schist are present in the soil but in the typically developed areas are not sufficiently numerous to interfere with cultivation. Some of the loose fragments can be and have been picked from the fields and piled into fences.

Included with Canaan loam on the map are areas which differ from the typical soil in having a larger content of stone and in which bedrock comes to the surface in places. The included soil is used either for pasture or forestry although much of the land was cultivated at one time.

This soil is developed from shallow glacial till over bedrock in almost flat areas on the plateau tops, in the southwestern and western

parts of the county. A few areas are scattered over the north-central part.

Most of the land has been cleared and used for crops at one time. At present, however, much of it has reverted to a second-growth forest of maple, birch, spruce, and hemlock. The cleared areas are used for mowing and pasture. Fair grazing is provided, but the grass tends to be short in extremely dry seasons, owing to the shallowness and consequent limited moisture-holding capacity of the soil. Hay consists of timothy and redtop, but many mowings are run out and invaded by orange hawkweed and other weeds. The pastures contain bentgrass, some poverty grass, and much hardhack. Mowing machinery and other improved implements can be used on this land.

Becket stony loam.—Becket stony loam, in virgin areas, has a gray layer, from 1 to 1½ inches thick, under the forest duff. This rests on a thin layer of rusty-brown mellow loam which has a crumblike structure and passes into yellowish-brown firm but friable loam of the same structure. This material changes gradually, at a depth of 15 inches, to pale yellowish-brown light loam. At a depth ranging from 20 to 24 inches is greenish-gray somewhat compact platy till derived from granites and gneisses. Stones and boulders of the parent material are strewn on the surface and embedded in the soil in such quantities that clearing of the land from stone is not feasible, and cultivating it with modern improved farm implements is extremely difficult. Unquestionably, at one time some of this land was utilized for crops, but, under present economic conditions, it is serviceable only for pasture or forest. At present, more than one-half of this land is in forest, mainly yellow birch and spruce, together with some paper birch, maple, beech, ash, and basswood. The pasture cover contains much poverty grass, bentgrass, and hardhack. A few areas of fine sandy loam are included in mapping. In general, this included soil is less valuable for grasses, but it supports about the same forest growth.

Hermon stony sandy loam.—Hermon stony sandy loam is covered mainly with forest, under which conditions the surface is covered with a mat of organic matter and forest debris, several inches thick. The very thin surface layer of sandy loam is underlain by a well-defined gray layer, from 2 to 4 inches thick, which is dark brown near the bottom. The structure throughout this entire layer is single grain. This material rests on a layer of rusty-brown mellow or fluffy sandy loam, about 5 inches thick, that passes into yellowish-brown fairly firm but friable sandy loam which becomes pale yellowish brown at a depth ranging from 15 to 18 inches. Below a depth of about 20 inches is grayish-yellow sandy till, the color of which changes to gray below a depth of about 24 inches. Rock fragments, ranging from gravel to boulders, are present throughout the soil in such quantities that they not only interfere with cultivation but cannot be removed readily.

Most of this soil is developed on ridges and hills, on the sides and tops of plateaus, and around the bases of the mountains above an elevation of 1,000 feet. It is one of the most extensive soils in the county.

The small cleared areas are used for pasture, but they furnish only fair grazing. The grasses are mainly bentgrass and poverty grass.

Brush, consisting of aspen and birch sprouts, bracken, and ferns, is common in the pastures. The forest growth is spruce, hemlock, yellow birch, paper birch, aspen, and maple.

Hermon stony sandy loam, hardpan phase.—The hardpan phase of Hermon stony sandy loam, under forest conditions, has a thick covering of raw humus and debris from a coniferous forest, in most places 4 or 5 inches thick, over a 3- or 4-inch layer of dark-brown partly decomposed organic matter. The thin surface layer of dark-gray loam contains much finely divided organic matter and is underlain by a layer of gray fine sandy loam, about 3 or 4 inches thick. Below is a layer of highly organic dark-brown loam, about 1 inch thick, which contains small lumps of indurated material but is otherwise friable. This rests on a 6-inch highly indurated or hardened layer of yellowish-brown loam. Below this, the material is also indurated but not so much so. At a depth of about 20 inches is yellowish-gray sandy till which is only slightly compact in place and which grades, below a depth ranging from 24 to 30 inches, into gray rather coarse sandy till derived from granitic materials. Stones, ranging from small fragments to boulders, are present throughout the soil mass.

The relief is gently sloping, and drainage is well established. Several areas of this soil are in the south-central part of the county—one near the northern end and another southwest of Newfound Lake. Although the area mapped as Hermon stony sandy loam, hardpan phase, is not extensive, much of the land designated as rough mountainous land is of this character.

A forest of hemlock, spruce, white pine, yellow birch, and aspen covers the land. Roots are matted in the soil above the indurated layer, but they do not penetrate the hardened layer, except in a few thin cracks. If the forest duff is burned, it is difficult to get trees started.

Canaan stony fine sandy loam.—The 6- or 7-inch surface soil of Canaan stony fine sandy loam is brown mellow fine sandy loam of single-grain structure, and the subsoil is yellowish-brown firm but friable fine sandy loam which becomes pale yellowish brown at a depth ranging from 12 to 15 inches, but it retains the same texture and structure. This material rests, at a depth ranging from 24 to 36 inches, on bedrock which has, in most places, a smooth surface and is composed of granite and gneiss. The entire soil contains rock fragments and boulders of the parent granitic or gneiss materials.

This soil occurs in fairly smooth areas on the plateau throughout the south-central and southeastern parts of the county, in most places lying above an elevation of 1,000 feet.

At one time, some of this soil was used for farm crops, but, at present, where not covered with forest, it is used for pasture. The pasture furnishes only fair grazing, owing to the large amount of poverty grass in proportion to bentgrass and to the invasion of brush which consists of birch and aspen sprouts and hardhack. The forest trees are oak, white pine, hemlock, birch, beech, and maple.

Canaan stony sandy loam.—Canaan stony sandy loam, where forested—and most of this land is forested—consists of a thick covering of raw humus over a gray layer, from ½ to 1½ inches thick, of sandy material that is underlain by a rusty-brown layer of about the same thickness. The subsoil is yellowish-brown sandy loam. In

cleared areas, the surface soil is brown mellow sandy loam, having a single-grain structure, which rests on a subsoil of yellowish-brown firm but friable sandy loam, also having a single-grain structure. Below a depth ranging from 12 to 15 inches the material is pale-yellow sandy loam of about the same consistence and structure as that above. This changes, at a depth ranging from 20 to 24 inches, into gray gritty till which is only slightly compact in place and which rests on bedrock of granite or gneiss at a depth ranging from 30 to 36 inches. In places, bedrock is close to the surface, or even outcrops, and, in few places, it lies more than 4 feet below the surface. On the surface and throughout the soil are quantities of stones ranging in size from small fragments to boulders several feet in diameter.

The land, in general, is smooth and ranges from almost level to gently sloping or, in a very few places, strongly sloping. Drainage is well established. This soil occupies the tops of plateaus throughout the central and southern parts of the county at an elevation ranging from 1,200 to 2,500 feet.

The forest consists of spruce, yellow birch, and paper birch, with some hemlock and white pine at lower elevations. Small areas are used for pasture, but they furnish poor grazing.

Becket loam, steep phase.—The steep phase of Becket loam is associated with the typical soil, but it occurs on hillsides and on the sides of the plateau ridges which, in most places, are too steep for the general use of improved machinery. Only two small bodies are mapped. The profile, in general, resembles that of the other Becket soils. Beneath the forest duff, in places, is a gray layer, ½ to 1 inch thick. The 5- or 6-inch surface soil is brown mellow loam, and the subsoil is brown mellow firm loam having a soft-crumb structure. This material grades, at a depth of 15 or 16 inches, into pale yellowish-brown loam of the same consistence. The compact substratum of greenish-gray till is reached at a depth ranging from 24 to 30 inches. In places, this compact zone retards the downward movement of water, causing it to move along over the surface of the till on the slopes. The soil is stony throughout but not sufficiently so to interfere with cultivation.

Some of this steep soil has been used for crops in the past, but at present the cleared areas are used mainly for pasture, and they furnish fair grazing. Bentgrass predominates in the pastures, which also contain some poverty grass and a considerable proportion of birch and aspen sprouts and hardhack.

Hermon sandy loam, steep phase.—The steep phase of Hermon sandy loam is similar to Hermon sandy loam, but it occupies rather steep hillsides. In its natural state it contains less stone than the steep phase of Hermon stony sandy loam, and much of the stone was removed and put into fences when the land was farmed. At present, this land is used to only a small extent, even for pasture. It furnishes fair but not better grazing than does typical Hermon sandy loam.

Hermon stony sandy loam, steep phase.—The steep phase of Hermon stony sandy loam has a profile and a stony condition similar to those features of Hermon stony sandy loam, but it occurs on steep hillsides and on the sloping sides of valley walls, where the degree of slope ranges from 15 to 20 percent. It can be utilized for

pasture and forest. The grazing, consisting of bentgrass and poverty grass, is only fair, and brush grows in profusion. The forest growth is essentially the same as that on the typical soil, with the exception that the forest on the steeper soil contains more paper birch, yellow birch, and hemlock. The soil is well suited to forestry and should be used for that purpose.

Becket stony loam, steep phase.—The steep phase of Becket stony loam is closely associated with the typical soil and has a profile similar to that of the other Becket soils.

Only a comparatively small area of this steep land is cleared. It is used almost exclusively for pasture which furnishes fair grazing. The grasses are mainly bentgrass and poverty grass. Hardhack, birch and aspen sprouts, bracken, and ferns grow in considerable quantities in most of these pastures which are not well kept. The forest trees are paper birch, yellow birch, maple, beech, hemlock, and spruce.

Peru loam.—Peru loam occupies imperfectly drained areas scattered over the plateau section in the southern part of the county. In places the areas extend to the valley section. Areas of this soil are flat or occupy long gentle slopes and benches which receive considerable water from higher positions.

Where typically developed the soil has a 2- or 3-inch surface layer of dark-brown or almost black highly organic loam underlain by light-brown mellow loam having a soft-crumb structure. This material grades, at a depth of 7 or 8 inches, into yellowish-brown loam which is mottled with gray and rusty brown below a depth ranging from 15 to 18 inches. The substratum, beginning at a depth ranging from 20 to 24 inches, is gray or greenish-gray compact more or less platy till mottled or streaked with rusty brown, and, below a depth of 3 feet, it gives way to gray less compact till. The compact layer retards the downward movement of water and the penetration of roots. Stone fragments and boulders are present throughout the soil. Most of the land has never been cleared of stones, as the soil has always been used as pasture or left in forest. The stones, however, could be removed if necessary.

The pastures on this land furnish good grazing. The grasses are mainly bentgrass and creeping bent, with some Kentucky bluegrass and very little poverty grass. Spruce, hardhack, meadowsweet, blueberries, bracken and other ferns, and alder grow in the pastures, and little effort has been made to remove them or control their growth. This is naturally good grassland, but, because of imperfect drainage, it has little value for other crops. The small acreage in hay produces about 1 ton per acre. Spruce, hemlock, gray birch, yellow birch, red maple, and beech trees are the principal forest trees. Some white pine grows at lower elevations.

Peru stony loam.—Peru stony loam is similar to Peru loam, except that a larger quantity of stones is on the surface and embedded in the soil. The stones are largely granitic in origin and occur in such quantities that their removal was impractical under past economic conditions and certainly is inadvisable under present conditions. Even if the stones were removed, the soil would have to be drained before it could be used for the production of crops.

Much of this soil is in forest consisting of spruce, birch, beech, hemlock, and soft maple. The cleared areas are used for pastures

which provide fair grazing. Spruce, hardhack, blueberries, and alder, in places, are serious invaders of the pastures. The grasses are mainly bentgrass and creeping bent, and rushes and sedges grow in wet spots.

Fairly large areas of this soil occur in both the northern and southern parts of the plateau section.

SOILS AND LAND TYPES OF THE MOUNTAIN SECTION

This group of soils and land types includes widely scattered areas of rough stony land, small areas of rock outcrop, and a large area of rough mountainous land, which together comprise about one-half of the total area of the county. The interstitial and parent materials of the areas of rough stony land represent nearly all of the major upland soils. These areas are mainly in the central part of the county. They have little value except for forest and, in small spots, for pasture. Oaks, maple, beech, gray birch, and white pine grow at lower elevations, giving way to spruce, balsam fir, and yellow birch at higher elevations. Rock outcrop has little value, even for forest. Rough mountainous land is mapped in the northeastern part of the county. Most of it is included in the White Mountain National Forest.

Rough stony land (Gloucester soil material).—This type of rough stony land has a 5- or 6-inch brown mellow fine sandy loam or sandy loam surface soil, under a thin layer of forest duff, and a yellowish-brown firm friable subsoil of slightly heavier texture than the surface soil. The soil material grades, below a depth ranging from 15 to 20 inches, into pale yellowish-brown or pale-yellow material of the same structure but slightly lighter texture. The substratum, beginning at a depth of 24 inches, is gray slightly compact till. Granitic stones and boulders, of various sizes, many several feet in diameter, are present throughout the soil in such numbers as to interfere with cultivation.

The relief is fairly steep and more or less broken. Owing both to the relief and to the friable or loose consistence of the soil material, drainage is well established. This land occurs mainly in the southern part of the county, in most places below an elevation of 1,200 feet, and it extends down to the level of streams. Practically all of it is forested. The principal trees are oak, white pine, gray birch, and aspen, together with some beech, maple, and hemlock.

Rough stony land (Berkshire soil material).—The soil material between the rocks in land designated as rough stony land (Berkshire soil material) has a well-developed gray layer, from ½ to 1 inch thick, of mealy fine sandy loam or loam, with a single-grain structure, under a layer of forest duff that ranges from 1 to 2 inches in thickness. Beneath the gray layer is a 1-inch layer of rich-brown decidedly fluffy loam resting on yellowish-brown firm but friable loam, the color of which changes gradually, at a depth ranging from 15 to 18 inches, to pale yellowish brown. Below a depth of about 24 inches is the substratum of greenish-gray somewhat compact and platy raw till. Numerous stone fragments and boulders are strewn over the surface, and ledges outcrop in many places. In places, the soil material is thin, and bedrock is exposed on the surface.

The relief is fairly steep and more or less broken. Drainage is well established. This land is developed over the western part of the county, following the schist belt, above an elevation of 1,200 feet in the southern part of the belt, dropping to 800 feet in the northern part. In few places does it lie above an elevation of 2,500 feet.

This land is forested with yellow birch, paper birch, hemlock, maple, beech, and spruce trees.

Rough stony land (Becket soil material).—This type of rough stony land occurs on the steeper and stonier sides of the plateau section, where the Becket soils are developed, at an elevation ranging from 1,200 to 2,400 feet. The fine material has a dark-brown surface soil under a thick mat of raw organic matter and, in most places, under a gray layer ranging from a thin streak to about 1 inch in thickness. This passes below into yellowish-brown firm but friable loam, of soft-crumb structure, which changes gradually, at a depth ranging from 15 to 18 inches, into pale yellowish-brown or pale-yellow loam. This material, in turn, rests on the substratum of greenish-gray rather compact platy till.

Seep water passes along the top of this layer in places, but this does not affect the surface drainage. In most places drainage is well established. This soil is too steep and stony for agricultural use, except possibly for pasture in the more favorably situated areas. It is covered with a forest of spruce, hemlock, yellow birch, gray birch, some beech, and maple.

Rough stony land (Hollis soil material).—Rough stony land (Hollis soil material) occurs in steep and stony areas, associated with the Hollis soils, scattered over a belt extending from the southern to the northern county line, mainly west of Moose Mountain and Mount Cube. The interstitial soil material is dark-brown loam containing some organic matter in the upper part. This grades, below a depth of 5 or 6 inches, into yellowish-brown firm but friable fine sandy loam which passes, below a depth of 15 inches, into pale-yellow material of the same texture and consistence. To this depth, the entire soil has a single-grain structure. Below a depth of 20 inches is greenish-gray friable till which rests on bedrock of schist at an average depth of 36 inches below the surface. The depth to bedrock is variable, ranging from almost nothing to 4 feet.

This land, in places, is used for pasture, but most of it is in forest consisting of oak, maple, beech, gray birch, paper birch, hophornbeam, white pine, aspen, and hemlock.

Rough stony land (Hermon soil material).—Rough stony land (Hermon soil material) includes steep slopes and mountainsides, associated with Hermon stony sandy loam, which the soil material resembles, except that it has a higher content of stone, in places, and steeper relief than that soil. Under a thick covering of forest duff is a gray layer, from one-half inch to several inches thick, which rests on a rich-brown layer. In most places the texture of these two layers is sandy loam, and the structure is single grain. Below this is the yellowish-brown fairly firm but friable subsoil which extends to a depth ranging from 12 to 15 inches, where it grades into pale yellowish-brown or pale-yellow light sandy loam. The material in both layers has a single-grain structure. The substratum lies at a depth of 18 or 20 inches below the surface and consists of gray sandy till which is

firm or slightly compact in place. Roots can penetrate the substratum readily. Drainage is good.

This land is of little agricultural value, much of it is inaccessible, and all is steep and stony. It is very extensive. A few of the best areas may be used for pastures which furnish but poor grazing. The forest is mainly coniferous, spruce and hemlock trees predominating, with much yellow birch, some paper birch, and a smaller proportion of maple and beech.

Rough stony land (Canaan soil material).—This type of rough stony land represents a stony, steep shallow soil derived from many materials. It is widely scattered in nearly all parts of the county. Most of it lies above an elevation of 1,200 feet in the southern part, but it is as low as 800 feet in the northern part. The surface soil, under forest conditions, generally is podzolic. The depth to bedrock ranges from nothing to 3 feet.

The forest is composed of oaks, hemlock, maple, and beech, at the lower elevations, and spruce, yellow birch, and balsam fir at the higher elevations. This land is best suited for forest, but a few small areas are used for pasture.

Rough stony land (Lyman soil material).—The material mapped as rough stony land (Lyman soil material) is, in most places, shallow over bedrock which consists of schist. It is developed in the steep and stony areas associated with the Lyman soils in the western part of the county. In addition to numerous outcrops of rib rock, quantities of large and small boulders, mainly of schist, but some of granite, are present. The land has little value except for forest.

Rough mountainous land.—The area of rough mountainous land is in the northeastern part of the county and covers almost one-third of the county. It consists of rough mountainous country, cut by deep narrow valleys. Most of it lies above an elevation of 2,000 feet, with numerous peaks rising to a height of 4,800 feet. It includes soil representative of the Podzol soils of the rough stony land group, rock outcrop, other areas and small valleys of less steep and less stony materials, and some low swamps and peat bogs, all of which are more or less inaccessible for farming operations and are of little agricultural value, even were they more favorably situated. Most of this land is within the White Mountain National Forest, but several large tracts are owned privately. It is for the most part cut-over land, although logging operations are still active in some places.

The tree growth between elevations of 2,000 and 3,000 feet is mainly spruce, yellow birch, and paper birch, together with a scattering of hardwoods, maple, and beech. From this elevation to a height of 3,800 feet, spruce and balsam fir predominate, with some birch. Above 3,800 feet and extending up to 4,800 feet is the subalpine region, in which only stunted trees grow—mainly spruce and balsam fir, and a few birch. No trees grow above a height of 4,800 feet in the alpine region, and, in places where there is any soil material it supports a growth of running vines, such as partridgeberry, rushes, and sedges. The rest of the land at this height consists of rock outcrop.

In the alpine meadows, the 4- or 5-inch surface soil is dark brown or almost black. It contains a high proportion of organic matter and a small amount of mineral material. It rests on brown mellow loam, having a single-grain structure, which passes at a depth of 14 or 15

inches into rusty-brown fine sandy loam containing very small particles of schist and mica. This, in turn, rests on bedrock of schist at a depth ranging from 20 to 24 inches below the surface.

Rock outcrop.—Rock outcrop consists of rather steep or vertical cliffs and protrusions of rock, which are widely scattered over the county, mainly in the rougher mountainous section. Small outcrops within areas of other soils are indicated by symbol.

Prominent areas of rock outcrop are those on Black Mountain in Haverhill Town, on Franconia Notch, on Kinsman Notch, on Holts Ledge and on Winslow Ledge in Lyme Town, on Mount Cube, on Cardigan Mountain, on the face of Cottonstone Mountain in Orford Town, and on Rattlesnake Mountain in Rumney Town. Many outcrops are scattered over the section northeast and northwest of Campton.

These steep and stony areas have little value, even for forest.

SOILS OF THE SWAMPS

The soils of the swamps are poorly drained and include organic soils, which are of no agricultural value, and mineral soils, which have very limited agricultural value.

ORGANIC SOILS

Peat, muck, and a shallow phase of muck are included in this group. The character of the material, difficulty in draining the land, isolation, and frost hazard are such that these soils have no agricultural value.

Peat.—Peat occurs in low depressions and filled-in lakes, both in the valleys and at the higher elevations where it is associated with stony and forested areas. It consists of brown fibrous poorly decomposed highly acid peat. Its depth ranges from a few feet to more than 10 feet. The present growth on it is spruce, hemlock, and tamarack.

Several large areas are south of Alexandria, south of Grafton Center, north of Stinson Lake, between Tinkerville and Pattenville, north, northeast, and southeast of Bethlehem, at East Holderness, near Indian Pond, north of Goose Pond, along Crystal Lake Brook, near West Canaan, and south of Enfield Center.

Muck.—Muck consists of dark-brown or almost black partly decomposed organic matter ranging in thickness from 2 to 5 or more feet. It contains some mineral material. In most places the muck is woody, but, in some places, it is developed from reeds and sedges. The reaction is highly acid. In stream bottoms the underlying material is gray sand, but in the uplands it is bluish-gray till. In some places this land is covered with coarse wild grasses, but in most places it supports a growth of soft maple, willow, and alder trees. The small quantity of wild hay cut represents its sole agricultural use. The largest areas are developed near West Canaan, south of Indian Pond, and along Hewes Brook in Lyme Town, south of Franconia, south of Easton, and north of Lisbon.

Muck, shallow phase.—The shallow phase of muck is the same as typical muck, except that it ranges from only 12 to 36 inches in thickness and averages about 24 inches. It rests on gray fine sand or fine sandy loam or on gray till. The reaction is acid throughout.

Muck, shallow phase, occurs in low depressions in stream valleys or filled-in shallow lakes and everywhere is poorly drained. The individual areas are small, and their total extent is not large. The larger areas are north of Plymouth in Campton Bog, south of Indian Pond, east of Franconia, north of Tinkerville, east of North Lisbon, and east of Stinson Lake. Most of the land is covered with soft maple and alder trees, and, in some places, hemlock and spruce trees grow.

MINERAL SOILS

The mineral soils of the swamps are members of the Whitman series. A thin covering of mucky material is on the surface, and stone is abundant in many places. These soils are used for pasture and, where drained, for mowing and small grains to a limited extent.

Whitman loam.—The 10- or 12-inch surface soil of Whitman loam is very dark brown or almost black mellow loam containing much organic matter. The material, when wet, is inclined to have the consistence of muck within the topmost 5 or 6 inches. The subsoil is grayish-brown or pale grayish-brown rather friable loam which, at a depth of 18 or 20 inches, changes to grayish yellow or yellowish brown and is mottled or streaked with rusty brown, yellow, and drab gray. Below a depth ranging from 24 to 30 inches is gray or drab-gray till which is slightly compact in place but has a sandy loam texture. Some stone fragments and small boulders are scattered on the surface and embedded in the soil mass.

Whitman loam occurs in small areas mainly over the western part of the county, where it occupies the low areas between the till ridges or the swalelike depressions. It is a Half-Bog soil developed on till parent material subjected to poor drainage. A forest of soft maple, hemlock, and white pine covers the land in most places.

The cleared area is very small, and most of it is in pasture. When the brush, which consists of alder, is removed, the land furnishes fair pasturage of creeping bent and wild grasses. Very little of the land is artificially drained. Bulrush, sedge, hardhack, and meadowsweet tend to crowd out the grasses in undrained areas. Where cleared of brush, drained, and cleared of stone, this soil is fairly productive of grasses, such as timothy and redtop, and small grains, particularly oats.

Whitman stony loam.—Whitman stony loam has a 10- or 12-inch surface soil of dark-brown or nearly black mellow loam containing a quantity of organic matter in all stages of decomposition. When wet, the material in the upper part resembles muck, but, in most places, it contains more mineral matter than does muck. The subsoil is grayish-brown or pale grayish-brown rather friable loam. It passes, at a depth of 18 or 20 inches, into grayish-yellow or pale yellowish-brown material which is mottled or streaked with rusty brown and dark gray and has the same consistence as the layer above, or is slightly more compact. Below a depth ranging from 24 to 30 inches, this material gives way to gray or drab-gray slightly compact till of sandy loam texture. The stone fragments and boulders on the surface and throughout the soil are numerous and large enough to interfere with cultivation.

This soil occupies low positions or swalelike depressions throughout the county, in association mainly with soils developed from granitic materials but also with soils developed from schist. Drain-

age is poor. Water stands on the surface in wet seasons, although in dry seasons it is lowered considerably below the surface.

Nearly all this land is in forest. A few small areas are cleared and used for pastures (pl. 2, *B*), but they furnish only fair grazing. The grasses consist of sedge, or bulrush, and other aquatic species. Alder, willow, highbush blueberries, spirea, leatherleaf, *Vaccinium* sp., and other varieties of plants are common. When drained and seeded to grass, the land furnishes fair pasture. The tree growth is soft maple, hemlock, and spruce.

Whitman very stony loam.—Whitman very stony loam, as the name implies, contains a large quantity of very large stones on the surface and embedded in the soil. It occurs in low or depressed poorly drained areas, in most places associated with the areas of rough stony land. It has a dark almost mucky surface soil and a mottled gray and drab subsoil which passes, below a depth ranging from 15 to 18 inches, into drab-gray till. The land has never been cleared, except in a few small spots, and it is entirely unsuited to agriculture. The tree growth is mainly spruce and hemlock. Most of the small total area borders Lovejoy Brook in the southwestern part of the county.

MORPHOLOGY AND GENESIS OF SOILS

The soils of Grafton County occur within two of the great soil groups of the United States, the Podzol soils and the Brown Podzolic soils. A more or less arbitrary boundary between the two groups passes through this county, but the soils within the Brown Podzolic soil region are weakly developed Podzols, in places where the parent materials are at all light in texture, and Brown Podzolic soils in places where the parent materials are heavy.

In general, the true Podzols lie above an elevation of about 1,200 feet above sea level in the southern part of the county and 1,000 feet or lower in the northern part. Upon sandy material, the Podzol soils occur in much lower positions. They are developed under climatic conditions of comparatively high rainfall and low evaporation, resulting in a rather high percentage of percolating water in the soil. The ground is frozen for many months during the winter. All these factors favor the growth of forest vegetation which furnishes organic matter from fallen leaves. This not only is abundant and highly acid, but also does not break down readily. It, therefore, accumulates on the forest floor as a mat, commonly known as duff and scientifically referred to as trockentorf, in which fungi are more abundant and active than bacteria. As most of the parent material is rather low in minerals which furnish bases, this duff is more acid than it would be were the parent material higher in content of lime. Under these conditions the bases, or soluble salts, are readily removed by the downward moving water as fast as they become available, and only a small quantity remain in the thin upper, or darkened, layer of the true soil. This is made possible by the large quantity of hydrogen ions that enter into the colloid complex and displace the bases which, being freed, are readily leached by the water. These, together with alumina and iron oxides, and humus go down together and are deposited in the B horizon, concentrated in the upper part

where they first meet the electrolites of the parent material. The silica of the disintegrating feldspars goes into solution and is carried also by the drainage water. The remaining silica in quartz form remains and by default of the other minerals makes up a larger proportion than do the other minerals in the A horizon. This is known as the bleicherde, or leached horizon. The oxides of iron and alumina and the organic compounds deposited in the B horizon tend to form an indurated layer in light-textured soils, known as the ortstein, and a layer which is not indurated in heavier textured soils, known as the orterde.

The podzolic process therefore develops an acid soil, having a well-defined structural soil profile in which all the bases are removed from the eluviated or leached zone formed near the top of the profile and accumulated, together with iron, alumina oxides, and organic matter, in the B horizon. These conditions and the comparatively heavy rainfall favor the dominance of conifers in the forest. Under this process, as already pointed out, in the highly acid saturated soil, much of the original minerals remains, and the mineral plant nutrients become slowly available as decomposition proceeds. This is in a measure responsible for the fact that crops, especially grasses and some legumes, succeed as well as they do on these highly acid soils.

Below the general elevation of the Podzols are soils, most of which are transitional between Podzols and Brown Podzolic soils. Except for the heavier members of this group, the soils actually are weak Podzols, in that, under a forest cover, an incipient gray layer (bleicherde) has developed, especially in soils derived from light-textured parent materials. Pronounced leaching and eluviation in the light-textured soils largely is responsible for this condition. The heavier members more nearly resemble the true Brown Podzolic soils.

The Brown Podzolic soils develop under conditions of slightly greater warmth, slightly more rapid evaporation, and less accumulation of organic matter on the surface than do the true Podzols. These conditions favor the dominance of deciduous trees in the forest. In this process of soil formation, the layer of loose leaves on the surface is thinner than that covering the Podzols because the deciduous leaves disintegrate faster than do the coniferous leaves. Under the duff is a comparatively thin layer of finely decomposed organic matter, one-half inch or more thick, a mull which is, in many places, granular in structure. This rests directly on the soil which, to a depth of 2 or 3 inches, is dark brown, being darkened by the presence of organic matter, and which has a crumb structure. This grades into a 5- or 6-inch layer of light-brown, brown, or tan material, the color depending on the character or coloration of the parent material. The material in this layer has a crumblike structure, which depends largely on the texture of the material. It passes into brown or yellow-brown firm but friable material which is slightly heavier than the surface soil and which is sufficiently coherent to fall into lumps, if developed from heavy materials, or is single grain in structure if developed from light materials. The color fades with depth to a pale yellowish brown or olive yellow, but there is no change in structure and texture, and the material merges gradually with the parent material.

The Hermon soils may be considered typical of the Podzol soils of this section, although they are developed on sandy loam. The sample of Hermon stony sandy loam, a description of a profile of which follows, was collected 4 miles north of Canaan Street, at an elevation of about 1,500 feet.

A_0. A covering, about 3 inches thick, of loose leaves, fine litter, and brown more or less undecomposed organic matter with some dark-brown partly decomposed organic matter near the bottom.

A_2. 0 to 4 inches, gray sand or sandy loam, having a thin darkened layer, one-fourth inch thick, near the top and a brown corresponding layer near the bottom. This material in place may be somewhat platy in structure but readily breaks down to a single-grain structure.

B_2. 4 to 9 inches, rusty-brown slightly firm sandy loam, inclined to form lumps which are not hard but tend toward induration. The lumps are yellow on the inside and reddish brown on the outside. Otherwise the structure is crumblike. The change to the underlying layer is gradual.

B_3. 9 to 17 inches, pale yellowish-brown less coherent sandy loam, with a crumblike structure which gradually gives way to the layer below.

C_1. 17 to 27 inches, yellowish-gray looose and open light sandy loam or sand with a single-grain structure, containing many small angular fragments of the unweathered parent rock.

C_2. 27 to 47 inches, gray sandy gritty till which is uninfluenced by soil-forming processes, slightly compact in place, but breaks down readily under pressure. Fragments of the parent rock are numerous.

This soil is developed from glacial till of granitic origin, and granitic boulders are present on the surface in places. The relief ranges from undulating to rolling. Drainage is well established. The forest consists of spruce, hemlock, white pine, some birch, maple, aspen, and servicetree.

Chemical analyses of Hermon sandy loam are given in table 7. With the exception of the large stone content of Hermon stony sandy loam, these two soils are practically identical.

TABLE 7.—*Chemical analysis of Hermon sandy loam*[1]

Sample No.	Horizon	Depth	SiO_2	Fe_2O_3	Al_2O_3	MgO	CaO	K_2O	Na_2O	TiO_2	MnO
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
C1431	A_1	0- 1	59.75	2.51	8.44	0.65	1.90	0.50	1.64	0.48	0.05
C1432	A_2	1- 5	80.65	1.71	8.79	.46	2.08	.48	2.00	.47	.05
C1433	B_1	5-15	65.72	3.87	13.68	1.00	2.55	.68	2.02	.45	.07
C1434	B_2	15-24	71.31	3.34	14.10	1.11	2.95	1.00	2.32	.37	.09
C1435	B_3	24-32	74.50	3.06	12.84	1.32	3.15	.70	2.34	.35	.09
C1435A	C	32+	74.27	3.14	12.85	1.39	3.54	.80	2.57	.37	.09
C1435B	Rock	--------	66.43	6.57	13.72	3.13	4.00	1.74	2.60	.78	.09

Sample No.	Horizon	Depth	P_2O_5	SO_3	Ignition loss	Total	Organic matter	CO_2[2][3]	N	Soluble salts	pH
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Parts per million*	
C1431	A_1	0- 1	0.09	0.16	23.97	100.14	21.34	0	0.48	360	3.9
C1432	A_2	1- 5	.03	Trace	3.32	100.04	2.94	0	.07	150	4.0
C1433	B_1	5-15	.03	.01	9.98	100.06	6.69	0	.12	200	4.8
C1434	B_2	15-24	.03	.03	3.44	100.09	1.76	0	.04	160	4.9
C1435	B_3	24-32	.04	.06	1.11	99.56	.44	0	.01	150	5.5
C1435A	C	32+	.07	.01	.56	99.66	.16	0	0	20	5.7
C1435B	Rock	--------	.01	.17	.93	100.17	--------	--------	--------	--------	--------

[1] Analyses made in the laboratories of the Soil Chemistry and Physics Division of the Bureau of Chemistry and Soils (*2, p. 16*).

[2] By combustion method ($CO_2 \times 0.471$).

[3] CO_2 of the carbonates.

Due to the fact that the Brown Podzolic soils of this county lie so close to the true Podzols, their profiles resemble in some respects those of true Podzols, but the gray horizon generally is incipient or not developed. Charlton loam is given as an example of a Brown Podzolic soil which has developed from medium-textured parent material. The intensely brown color of the B_2 horizon is due to the fact that the parent material contains schist which weathers into rusty-brown material on exposure. A description of a profile of Charlton loam, samples of which were taken one-fourth mile south of Hanover Center, follows:

A_0. Loose leaf litter, less than one-half inch thick, consisting of leaves and twigs of deciduous trees over a 1½-inch layer of dark-brown partly decomposed organic matter.

A_1. 0 to 2 inches, dark-brown mellow loam having a soft-crumb structure. The material contains some finely divided organic matter. It is abruptly underlain by the material in the horizon below.

A_2. 2 to 8 inches, brown sofewhat fluffy loam, with a crumblike structure, which changes gradually to the material in the underlying layer.

B_2. 8 to 15 inches, rusty yellowish-brown fairly heavy firm but friable loam having a hard-crumb structure. The color fades gradually to that of the layer below.

B_3. 15 to 24 inches, pale yellowish-brown loam having the same structure as the material in the horizon above, but the texture is not quite so heavy.

C. 24 to 48 inches, greenish-gray or olive-gray slightly compact till which breaks into small irregular angular to platy fragments.

On high elevations and in favorable positions, in sandier materials the ortstein tends to become indurated. This development occurs in few places, and the strata of indurated material are discontinuous. In places, however, the indurated material is persistent and is sufficient to prevent the penetration of roots.

The materials from which the soils of this region are developed have a marked effect on the soils, since the formation of the soil has taken place to an average depth of only 24 inches and, in the heavier soils, to a depth of only 18 inches.

The penetrability of the soil to water and roots is directly dependent on the character of the parent material. In soils, such as the Woodbridge and Peru, developed from tightly compact, though not heavy, till, the till stops the downward movement of water and roots. The Becket soils, although formed from a till which is similar but more porous than the parent material of the Woodbridge and Peru soils, occupy positions from which water is more easily removed. This till is vesicular and decidedly platy, breaking out in flat pieces, ranging from one-eighth to one-fourth inch in thickness and several inches long. The till under such soils as the Gloucester and Hermon, although slightly firm in place, breaks down more readily and is decidedly more porous than that underlying the Woodbridge, Peru, and Becket soils; therefore it does not interfere with the downward movement of water or roots. The soils derived from heavier till, such as the Sutton and Blandford, or from lacustrine materials, such as the Suffield, have been affected by soil-forming processes to very slight depths. Notwithstanding this fact, the penetration of water and roots is effected more readily than in the tightly compact till.

The stone content, a very important factor, depends largely on the hardness of the parent rock materials. Soils developed from

granite or from materials influenced by granite generally contain more rock in the form of boulders. The softer rocks, such as schist, on the other hand, are less in evidence as loose surface rock but are likely to outcrop or be close to the surface, giving rise to shallower soils.

The following description of a profile of Agawam fine sandy loam, as observed 2 miles south of West Lebanon, is typical of the Brown Podzolic soils occurring on the terraces of Connecticut River, which are developed from lighter materials:

1. Loose leaves on the surface, underlain by forest leafmold, or partly decayed organic matter, containing near the bottom a very thin layer of finely divided organic matter.
2. 0 to 3 inches, dark-brown fine sandy loam containing some humus. The structure is single grain.
3. 3 to 8 inches, yellowish-brown mellow fine sandy loam of single-grain structure.
4. 8 to 20 inches, yellowish-brown slightly firm but friable fine sandy loam which grades almost imperceptibly into the layer below.
5. 20 to 32 inches, pale yellowish-brown sandy loam similar in texture and structure to that in the horizon above.
6. 32 to 40 inches, yellowish-gray fine sand which is fairly loose and open in structure and is uninfluenced by soil-forming processes.

The Agawam soils are developed on stream terraces of more recent origin than the glacial outwash terraces, nearly all of which are occupied by the Merrimac and Colton soils. The Merrimac soils are similar to the Agawam in profile, but they have more of a single-grain structure and contain gravel at a depth ranging from 15 to 24 inches and bedded gravel below a depth of 36 inches. The Colton soils differ from the Merrimac mainly in having a well-developed Podzol profile with a well-defined gray layer, or bleicherde, and, in general, they contain less gravel. The Adams soils, although sandy throughout, have not developed a gray horizon. The Suffield soils, also developed on terraces but from heavy lacustrine material, have a mildly alkaline, although not calcareous, subsoil. The Melrose soil represents a mantle of sand over lacustrine deposits. The Sudbury soil resembles the Merrimac soils, except that it occurs in slight depressions, from which the subsurface water cannot be removed so fast as from the better drained areas occupied by the Merrimac and associated terrace soils.

The recent alluvial, or bottom-land, soils are young and have suffered little or no leaching. They bear a direct relation to the material from which they were derived. The Hadley soils occur along Connecticut River and are influenced by the numerous large streams which empty into that river from the Vermont side and drain an area containing dark calciferous schist. This accounts for the darker color and also for the neutral to alkaline reaction of these soils. The Ondawa soils are formed mainly from granitic and gneiss material, with some admixture of schist. They are browner and are more acid in reaction than the Hadley soils. Imperfect and poor drainage account for the character of the other bottom-land soils.

The organic soils, peat and muck, differ according to the material from which they are derived. The brown fibrous peat has undergone very little decomposition. Muck, on the other hand, contains much mineral matter and is in a fairly well advanced stage of decomposition.

The Whitman soils are Half-Bog soils, occupy low or depressed areas in the till, and have a cover, ranging from 5 to 12 inches in thickness, of dark organic matter mixed with mineral matter in various proportions. The bluish-gray horizon overlying the parent material may be considered a glei horizon developed under drainage conditions which preclude oxidation of the iron accumulations.

Table 8 gives the pH determinations of several soils in this county.

TABLE 8.—*pH determinations of several soil profiles from Grafton County, N. H.*

Soil type and sample No.	Horizon	Depth	pH
Agawam fine sandy loam:		*Inches*	
1 L	A_0	0–1	4.7
2 L	A_2	1–8	4.7
3 L	B_2	8–20	5.5
4 L	B_3	20–32	5.7
5 L	C	32–40	5.8
Hartland very fine sandy loam:			
6 L	A_0	0–1	5.7
7 L	A_2	1–5	4.9
8 L	B_2	5–10	5.1
9 L	B_{21}	10–20	5.1
10 L	B_3	20–34	5.3
11 L	C_1	34–40	5.2
12 L	C_2	40–60	5.9
Agawam very fine sandy loam:			
13 L	A	0–5	5.7
14 L	B_2	5–10	5.8
15 L	B_{21}	10–24	6.0
16 L	B_3	24–40	6.0
17 L	C	40–50	5.8
Merrimac gravelly sandy loam:			
18 L	A	0–7	5.3
19 L	B_2	7–18	6.1
20 L	B_3	18–24	6.0
21 L	C	24–38	5.8
Melrose fine sandy loam:			
22 L	A	0–6	5.4
23 L	B_2	6–16	5.7
24 L	C	16–26	5.9
25 L	D	26–40	5.9
Hadley very fine sandy loam:			
26 L	A	0–7	5.8
27 L	B	7–20	5.8
28 L	C_1	20–32	6.1
29 L	C_2	32–44	6.1
Suffield silt loam:			
30 L	A	0–7	5.0
31 L	B	7–15	5.6
32 L	C	15–24	6.3
Woodbridge loam:			
33 L	A	0–6	5.6
34 L	B_2	6–15	5.8
35 L	B_{21}	15–20	6.2
36 L	C_1	20–36	6.3
37 L	C_2	36–40	6.7
Becket loam:			
38 L	A	0–7	6.6
39 L	B_2	7–14	5.4
40 L	B_{21}	14–21	5.6
41 L	C	21–36	6.1
Gloucester sandy loam:			
42 L	A	0–6	5.4
43 L	B_2	6–12	5.8
44 L	B_{21}	12–22	5.8
45 L	C	22–36	5.8
Hermon stony sandy loam:		*Inches*	
46 L	A_0	0–3	4.4
47 L	A_2	3–7	4.5
48 L	B_1	7–12	5.5
49 L	B_2	12–20	5.3
50 L	C_1	20–30	5.3
51 L	C_2	30–54	5.6
Charlton loam:			
52 L	A	0–8	5.2
53 L	B_2	8–15	5.5
54 L	B_{21}	15–24	5.6
55 L	C	24–48	5.6
Sutton silt loam:			
87 L	A	0–8	5.6
88 L	B_2	8–16	5.8
89 L	B_{21}	16–24	6.1
90 L	C	24–32	6.3
Ondawa fine sandy loam, high-bottom phase:			
60 L	1	0–10	6.3
61 L	2	10–15	5.9
62 L	3	15–20	5.9
63 L	4	20–36	5.8
Colton sandy loam:			
64 L	A_0	0–4	4.8
65 L	A_2	4–6	4.7
66 L	B_1	6–7	4.7
67 L	B_2	7–10	4.7
68 L	B_{21}	10–18	5.1
69 L	B_3	18–24	5.2
70 L	C_1	24–30	5.2
71 L	C	30–36	5.3
Colton loamy sand:			
72 L	A_0	0–8	3.1
73 L	A_2	8–12	3.3
74 L	B_1	12–16	4.4
75 L	B_2	16–24	4.5
76 L	B_3	24–36	4.6
Blandford loam:			
77 L	A	0–5	5.2
78 L	B_2	5–10	5.6
79 L	B_{21}	10–16	5.5
80 L	C_1	16–24	5.7
81 L	C_2	24–36	5.7
Hollis loam:			
82 L	A_1	0–5	5.5
83 L	A_2	5–10	5.1
84 L	B	10–20	5.0
85 L	C	20–30	5.0
86 L[2]	D	30+	-----
Agawam loamy fine sand:			
91 L	A_0	0–1	4.5
92 L	A_2	1–6	4.7
93 L	B_2	6–13	5.2
94 L	B_{21}	13–20	5.6
95 L	C	20–36	5.7

[1] Determinations made by the quinhydrone electrode method in the laboratories of the New Hampshire Agricultural Experiment Station.

[2] Bedrock of schist.

TABLE 8.—*pH determinations of several soil profiles from Grafton County, N. H.* —Continued

Soil type and sample No.	Horizon	Depth	pH	Soil type and sample No.	Horizon	Depth	pH
Berkshire loam:		*Inches*				*Inches*	
96 L	A_0	0–1	4.4	118 L	3	16–20	5.2
97 L	A_1	1–6	5.1	119 L	4	20–28	5.3
98 L	B_1	6–15	5.0	120 L	5	28–36	5.4
99 L	B_2	15–24	5.3	Adams loamy fine sand:			
100 L	C_1	24–36	5.2	121 L	A_0	0–1	4.6
101 L	C_2	36–48	5.5	122 L	A_1	1–13	5.1
Gloucester fine sandy loam:				123 L	B_2	13–20	5.6
102 L	A	0–5	5.4	124 L	B_2	20–26	5.7
103 L	B	5–12	5.5	125 L	B_2	26–40	5.8
104 L	C_1	12–18	5.5	Merrimac loamy sand:			
105 L	C_2	18–36	5.6	126 L	A	0–7	5.7
Ondawa fine sandy loam:				127 L	B_2	7–11	6.0
106 L	1	0–7	5.1	128 L	B_{21}	11–16	6.0
107 L	2	7–13	5.4	129 L	C	16–21	5.9
108 L	3	13–17	5.4	130 L	C	21–36	6.0
109 L	4	17–26	5.4	Hermon stony sandy loam, hardpan phase:			
110 L	5	26–40	5.4	131 L	A_{00}	0–2	4.2
Peru loam:				132 L	A_{00}	2–8	3.0
111 L	A	0–4	4.6	133 L	A_0	8–13	2.8
112 L	B_2	4–11	5.1	134 L	A_2	13–17	3.4
113 L	B_{21}	11–18	5.1	135 L	B_1	17–19	3.7
114 L	B_3	18–34	5.3	136 L	B_2	19–25	4.5
115 L	C	34–40	5.6	137 L	B_{21}	25–32	4.8
Podunk silt loam:				138 L	B_3	32–39	5.0
116 L	1	0–8	5.7	139 L	C	39–48	5.3
117 L	2	8–16	5.3				

The mechanical analyses of several soils are given in table 9.

TABLE 9.—*Mechanical analyses of samples of several soils from Grafton County, N. H.*

Soil type and sample No.	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Becket loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
110338	0–7	3.4	8.8	9.2	20.9	19.2	31.0	7.5
110339	7–14	3.6	8.7	7.9	16.6	16.5	38.7	8.0
110340	14–21	4.6	10.1	8.5	17.9	16.2	41.4	1.3
110341	21–36	3.1	8.4	9.1	20.5	16.4	40.2	2.3
Hadley very fine sandy loam:								
110326	0–7	.0	.2	.4	15.0	41.6	37.2	5.5
110327	7–20	.0	.5	.5	12.8	45.2	35.4	5.6
110328	20–32	.0	.2	.4	11.9	38.9	42.6	6.0
110329	32–44	.0	.1	.2	7.8	32.0	50.4	9.4
Agawam very fine sandy loam:								
110313	0–5	.0	.2	.2	1.8	37.7	55.5	4.7
110314	5–10	.0	.1	.1	1.4	44.1	52.4	1.8
110315	10–24	.0	.1	.2	2.1	45.0	52.4	.3
110316	24–40	.0	.1	.1	1.5	38.4	57.7	2.2
110317	40–50	.0	.2	.2	1.2	17.9	78.7	1.7
Gloucester fine sandy loam:								
1103107	0–5	6.6	11.7	8.1	15.4	14.9	42.2	1.2
1103108	5–12	6.3	12.4	8.5	15.6	14.0	42.5	.7
1103109	12–18	9.1	15.8	10.9	18.9	13.1	30.9	1.3
1103110	18–36	9.5	19.9	14.5	25.4	13.9	15.7	1.2
1103111	36–48	7.2	15.3	12.6	26.8	17.4	19.0	1.6
Sutton silt loam:								
110386	0–8	4.5	5.3	4.0	13.6	16.7	40.7	15.2
110387	8–16	4.9	5.6	4.6	14.5	17.2	42.8	10.4
110388	16–24	4.2	6.0	4.9	15.3	16.5	40.2	13.0
110389	24–30	4.2	6.5	5.5	16.5	17.0	36.0	14.3
Hartland very fine sandy loam:								
110306	0–1	.5	.7	.5	6.8	40.2	44.6	6.6
110307	1–5	.2	.2	.2	3.3	30.5	58.6	7.1
110308	5–10	.2	.4	.3	3.6	32.5	58.8	4.1
110309	10–20	.0	.3	.3	3.3	32.1	60.9	3.1
110310	20–34	.0	.1	.3	3.5	33.4	56.8	6.0
110311	34–40	.0	.1	.1	1.5	17.7	63.8	16.8
110312	40–60	.0	.1	.2	3.0	29.1	56.9	10.8
Charlton loam:								
110352	0–8	3.5	6.2	5.5	14.2	20 6	47.8	2.3
110353	8–15	5.5	6.4	4.9	12.8	19.9	49.2	1.3
110354	15–24	4.8	7.7	6.1	16.8	22.9	40.6	1.0
110355	24–48	2.6	4.4	3.8	12.9	21.6	51.4	3.4

AGRICULTURAL METHODS AND MANAGEMENT

Grafton County, in common with the New England and other Northeastern States, is situated in a section in which the climate and soil allow the production of a wide range of crops and the pursuit of a variety of farming activities. Types of farming and agricultural methods vary widely. Dairying is an activity on most farms. Some farmers concentrate on dairying, whereas others may keep only a few cows and depend mainly on poultry for an income. Still others may depend on potatoes or vegetables as cash crops, and they give little attention to the raising of livestock. The form of crop rotation followed, if any, varies between wide limits, as also do crops and practices of fertilization.

The most general method of farm management, which results in a form of rotation, is to turn under sod, plant the land to corn, then sow to oats, and seed again to grass. The time that elapses before the rotation cycle is completed varies widely, depending on the needs of the individual farm. Sod may be turned, as under best practices, every 3 or 4 years, but mowings may run indefinitely. On most farms, however, when the yield of hay falls below one-half ton per acre, the sod is turned under and the land reseeded. On some farms, the land is pastured when the hay begins to fail, and on others the sod may be turned under and the land sown to grass, without other crops intervening.

Most of the corn grown is for silage, very little being allowed to mature for grain. Cornfields are generally small, ranging from 3 to 10 acres. Oats are cut green, with mowing machines, and fed as forage or cured as hay, or they are cut later and fed during the colder winter weather. Some oats are threshed for grain. Rye is used mainly as a cover crop. Under a decreasing acreage of farm land, pasture is abandoned when it becomes filled with birch and aspen sprouts or spruce, and land formerly used for mowing is taken for pasture, thus tending to concentrate the land used for mowing and crops into smaller units.

Most farmers, especially dairy farmers, use from 15 to 25 loads of manure an acre on cropland and for top dressing on pastures from 10 to 15 loads, depending on the supply. Fertilizers are used to some extent but not by all farmers. From 200 to 400 pounds per acre of 4–8–4 [8] or 4–12–4 are applied for corn, together with some manure. An application ranging from 20 to 500 pounds per acre of superphosphate is used for corn or oats, and a top dressing ranging from 300 to 500 pounds of sodium nitrate is used occasionally for corn or small grain. The grade of fertilizer generally used for potatoes is 5–8–7, of which from 1,500 to 2,000 pounds per acre are applied. Some growers use 1,000 pounds of 8–16–14. Higher grade, or double-strength, fertilizers are coming into use but slowly. Lime is not in general use; some farmers use it occasionally, but not every time the sod is turned. An application ranging from 2 to 3 tons of ground limestone per acre is made in preparation of the land for alfalfa. Only 45.6 percent of the farmers reported the purchase of fertilizers in 1929. Fertilization is practically the same on all

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

soils, but greater attention is being given to the requirements of particular crops.

According to experiments conducted by the New Hampshire Station near Claremont, on soils similar to the terrace soils of the Connecticut River Valley, the best growth of sweetclover and alfalfa comes from plants treated with potash (*4*). An increase in acre yield, over that of the untreated check plot, of 2,800 pounds of sweetclover was made with applications of lime and potash; 1,880 pounds with lime, phosphorus, and potash; and 2,065 pounds with lime, nitrogen, phosphorus, and potash. With alfalfa, the increase over the untreated check plot was 1,744 pounds of hay per acre for potash alone; 2,418 pounds for lime and potash; 2,877 pounds for lime, potash, and phosphorus; 2,543 pounds for potash and phosphorus; 3,583 pounds for nitrogen, potash, and phosphorus; and 3,877 pounds for lime, potash, phosphorus, and nitrogen.

Experiments in 11 places, on the effect of the top dressing of old pastures, indicate that the best results are obtained from a treatment of 16-percent superphosphate and muriate of potash every 3 years, or a combined treatment, consisting of 1 ton of ground limestone per acre every 3 years, 300 pounds of a 15-percent nitrogen carrier annually, and 600 pounds of 16-percent superphosphate and 200 pounds of muriate of potash every 3 years. At Colebrook, on soils similar to those of the northwestern part of this county, magnesium sulphate used in a 3-year rotation of potatoes, oats, and clover increased yields of potatoes 32 bushels per acre over the check plot with its treatment of 1 ton of 5–8–7 fertilizer which is considered significant. Fertilizer was applied in the rotation for potatoes only, and liming follows this crop. Hay did best on plots receiving lime, and the best oats came from plots receiving 3,000 pounds of 5–8–7.

Experiments with fertilizer for potatoes on clay soils similar to the Suffield soils showed that various grades of potash, on a 9-year average, give the following acre yields: 4–8–0, 214 bushels; 4–8–3, 239 bushels; 4–8–6, 263 bushels; and 4–8–10, 268 bushels. The check plot which received no fertilizer yielded 161 bushels (*3*). Manure applied at the rate of 12 tons per acre gave a 5-year average of 225 bushels, compared with 260 bushels for an application of 24 tons, and 140 bushels for none. Sulphate of ammonia in a 4–8–4 fertilizer, on a 4-year average, does not give so good results as nitrate or a mixture of sulphate and nitrate. Average acre yields were as follows: With nitrate, 280 bushels; mixed, 279 bushels; and sulphate, 264 bushels.

A concentrated grade, 16–32–16, has given almost as good results as four times as much 4–8–4. In a 4-year average the former produces a yield of 264 bushels per acre, whereas the latter produces a yield of 279 bushels. The concentrated fertilizer costs less per unit of plant nutrition.

In the Connecticut River Valley section, especially on the higher lands on the edge of the valley, pastures would yield adequate returns from top dressing (*9*). On the river terraces, near Claremont, experiments show increased yields in a mixed stand of grass and Dutch closer from the use of potash and prosphorus. The results are given in table 10.

TABLE 10.—*Average annual yield (2 years), Livingston pasture*

Fertilizer treatment	Yield per acre		Fertilizer treatment	Yield per acre	
	Dry matter	Protein		Dry matter	Protein
	Pounds	*Pounds*		*Pounds*	*Pounds*
Cal-Nitro, 250 pounds	2,378	463	10–20–20, 500 pounds	3,640	596
Nitrate of soda, 312 pounds	2,110	461	Nitrate of soda, 312 pounds	3,150	575
Sulphate of ammonia, 250 pounds	1,938	390	Superphosphate, 600 pounds		
Calcium nitrate, 333 pounds	1,843	391	Muriate of potash, 200 pounds		
Cyanamid, 250 pounds	1,826	394	Ammo-Phos A, 200 pounds	2,933	551
None (average of 3 untreated check plots)	1,576	264	Nitrate of soda, 220 pounds		
Nitrate of soda, 312 pounds	2,110	357	18–6–6, 280 pounds [1]	2,044	346
Nitrate of soda, 156 pounds	1,919	361	0–20–20, 500 pounds [2]	2,193	520
None (average of 2 nearest untreated check plots)	1,576	264	None (average of 3 untreated check plots)	1,576	264

[1] 417 pounds of 12–4–4 used in 1 year.
[2] Not a complete fertilizer, but used in this table for comparison.

Grasses in the Connecticut River Valley respond to potash and phosphorus; elsewhere they do not respond so readily, although the response of clover is marked. Top dressing of pastures containing Dutch clover gives better response. For most situations, from 250 to 500 pounds of double-strength 8–16–16 fertilizer, or its equivalent, will prove ample for a single application; of nitrogen carriers alone, from 150 to 300 pounds are suggested. The tendency for phosphorus to become fixed in New Hampshire soils would indicate that this element should be added in smaller quantities and more frequently. On pastures which do not carry heavy grazing, 200 pounds of superphosphate and 75 pounds of muriate of potash should be sufficient; double this amount if the pasture is to last 2 years, and triple the amount for a 3-year period. Due to its lime content, basic slag should prove a little better than superphosphate. These elements will stimulate the better grasses and especially clover. Seeding of pasture is recommended for areas where the acreage of good pasture land is limited.

In a 5-year yield (10 cuttings) at Greenland, on land similar to the Merrimac soils, potash was indicated as the most essential element for stimulation of the growth of alfalfa (*6*). Phosphorus ranked second. Because of its tendency to become fixed in the topmost few inches of soil, phosphorus should be worked into the soil before seeding alfalfa. Manure applied at the time of seeding has proved beneficial, and returns have averaged 350 pounds of hay for every ton of manure used. On farms where more manure is produced than is needed for other purposes, its application to land for alfalfa is recommended; an application as heavy as 40 tons per acre at the time of seeding seems to give marked returns. The use of 10 tons per acre a season as a top dressing is beneficial.

Timothy and other grasses in hay mixtures respond differently to fertilizer than do clover or alfalfa, as the results from a 5-year experiment at Greenland indicate. The annual yield of hay on land plowed and reseeded, but untreated, averaged a little less than 1,500 pounds an acre. An initial acre application of 10 tons of manure

resulted in an annual increase in yield of 685 pounds of hay. An annual application of 100 pounds of nitrate of soda, without manure, resulted in an increase in yield of 976 pounds of hay; with manure, 807 pounds; and with 250 pounds of superphosphate and manure, 898 pounds.

On farms where more hay is needed, manure, if available, is probably the best and cheapest top-dressing material to use for alfalfa, grass, or mixed-hay stands. For alfalfa, where manure is not available or where it has not been used in abundance, muriate of potash is the safest fertilizer to use. This is practically certain to increase the yield of alfalfa and pay a good rate of interest on the money invested in it, even under the present adverse economic conditions on dairy farms. Mixed fertilizer carrying both phosphorus and potash may be used if the potash figure in the mixture is as high as or higher than the figure for phosphorus. If such a fertilizer cannot be obtained, an acre application of a mixture of 150 or 200 pounds each of 16-percent superphosphate and muriate of potash is a reasonable annual top dressing.

Hay fields run out because their fertility becomes exhausted through loss of nitrogen (*7*). This retards the work of bacteria and other organisms that are important in plant nutrition, and elements other than nitrogen, needed by growing plants, also become less available. While the process of soil depletion is going on through the years of mowing, the desirable hay plants, such as clover and timothy, gradually die out. Clover lasts about 2 years, unless conditions are very favorable, and the grasses are crowded out by the less valuable but more persistent plants, such as Kentucky bluegrass, sweet vernalgrass, and sedge, and finally poverty grass and moss. Nitrate of soda proved to be most effective in increasing the yield from mowings in a 9-year experiment on the college farm at Durham. For each 100 pounds of nitrate of soda up to 400 pounds, a gain of one-fourth ton of hay an acre was obtained. If a field has been left until the desirable hay plants are gone, however, it is best to reseed. Manure is the best soil amendment for hay. In seeding leguminous crops on all New Hampshire soils, lime must be used. More than 2 tons per acre at seeding time is not justified by experiments.

All the farming lands in New Hampshire, except certain flooded lands along Connecticut River, are so acid as to handicap the successful production of all crops except potatoes (*8*). When the basic materials are removed from the surface soil, through leaching and cropping, the less soluble residues accumulate and make the soil acid. Under this acid condition bacteria are less active. The presence of soluble iron and aluminum directly affects the phosphorus, by changing it to insoluble forms of iron and aluminum phosphates, or by fixing the phosphorus, as the process is commonly called. The addition of lime, making the soil neutral, interrupts this action, and the phosphates used become available.

Tables 11, 12, and 13 give the results of experiments that prove conclusively the value of the use of lime on all upland soils of Grafton County.

TABLE 11.—*Response of fodder crops in rotation to 1- and 2-ton applications of lime made at seeding time on a fine sandy loam in the Merrimac River Valley* [1]

Crop	Increase in yield with—		Crop	Increase in yield with—	
	1 ton	2 tons		1 ton	2 tons
	Pounds	*Pounds*		*Pounds*	*Pounds*
Corn silage	3,147	4,643	Alsike-clover hay	1,851	2,456
Oat hay	966	953	Soybean hay	966	400

[1] pH determination was 5.2 at the outset.

TABLE 12.—*Response of mixed alfalfa and timothy to applications of lime on silt loam in the Connecticut River Valley, 100 feet above overflow* [1]

Treatment [2]	Increase in yield [3] of cured hay per acre	Treatment [2]	Increase in yield [3] of cured hay per acre
	Pounds		*Pounds*
Lime, 1 ton	1,287	Lime, 1 ton, with potash, as compared to potash alone	3,565
Lime, 2 tons	3,096		

[1] pH determination was 5.6 at the outset.
[2] A basic application of 10 tons of manure an acre was made in all places. Where potash was used it was applied as an annual top dressing.
[3] Total of 5 cuttings made in 3 seasons.

TABLE 13.—*Response of timothy to lime on the Whenal farm, Greenland, N. H.*

Treatment [1]	Increase in cured hay per acre	
	Total for 6 years	Average annual increase
	Pounds	*Pounds*
Ground limestone, 2 tons	3,269	545
Ground limestone, 4 tons	4,135	689

[1] pH determination was 5.2 at the outset.
[2] Top dressed annually with nitrate and superphosphate.

A study of land utilization in a selected back-town area of Grafton County, carried on by the New Hampshire Station, discloses some interesting facts about farm incomes (*5*).

A summary of records indicates that most of the farms are operated as self-sufficing units and that, from a commercial point of view, the growing of cultivated crops is not important. Table 14 gives the 577 farms studied, arranged by groups on the basis of gross receipts from the sale of agricultural products.

TABLE 14.—*Selected farms, arranged according to gross receipts from the sale of agricultural products*

Group	Farms		Receipts	Group	Farms		Receipts
	Number	*Percent*	*Dollars*		*Number*	*Percent*	*Dollars*
1	261	45.2	0 to 50.	4	56	9.7	501 to 1,000.
2	59	10.2	51 to 100.	5	65	11.3	1,000+.
3	136	23.6	101 to 500.				

In groups 1 and 2, most of the farmers' income was obtained from outside work, mainly in the forest. Outside work, a part of which was relief work, accounted for 70 percent of the income received in group 1. Even in groups 4 and 5, which include farms on which more farming is done, some income is obtained from outside work.

The average amount of tilled land on the farms of group 1 is 15 acres, and crop yields are low. These farms carry only 1.6 animal units[9] per 10 acres; hay yields therefore are low. The trend is toward still lower yields. Conditions on the farms in groups 2 and 3 are similar. These farms cannot be brought back to profitable production without considerable investment. From the point of view of commercial agriculture, they may, owing to low yields, unfavorable location, small fields, and rocks, be ignored. A few farms in groups 4 and 5 may be considered of some importance, and the most favorably located probably would continue indefinitely as farms.

The best stands of blueberries are on hardwood land, between elevations of 1,000 and 2,000 feet, on soils with a pH determination ranging from 4.5 to 5.0 (*3*). Especially favorable positions for this berry are on shallow soils having a good supply of underground water and overlying granite ledges. Varieties are mostly of the low-bush type (*Vaccinium pennsylvanicum*).

Investigations indicate that of the trees encroaching on pastures—white pine, gray birch, common juniper, and red cedar—the white pine is the most frequent invader of abandoned pastures and ordinarily will survive in competition with the other species (*3*). This applies especially to land below an elevation of 1,200 feet.

SUMMARY

Grafton County, situated in the west-central part of New Hampshire, has an area of 1,098,240 acres, or 1,716 square miles. Physiographically it presents a plateau at an elevation ranging from 1,200 to 1,800 feet above sea level, flanked on the northeast by a high mountain section which in places rise to 5,000 feet. The plateau is severely dissected by streams, and in places the land has reached a subdued level, but most of it has comparatively narrow deeply entrenched stream valleys. The valleys of Connecticut River and its main tributary, Ammonoosuc River, on the western side, and those of Pemigewasset and Baker Rivers, in the central part of the county, are prominent features. These valleys include most of the level bottom land and terraces. Originally, a heavy forest covered the county. This consisted of a mixture of white pine, oak, beech, maple, hemlock, gray birch, and aspen trees below an elevation of 1,000 feet; the oaks and white pine gradually give way, with increase in elevation, to yellow birch, paper birch, spruce, and fir; and spruce becomes the dominant tree up to the timber line at an elevation of 4,800 feet.

The county was settled in the middle of the eighteenth century by pioneers from other New England States. The population in 1930 was 42,816—72.8 percent of which was classed as rural.

The climate is a modified continental type, with long cold winters, accompanied by heavy snowfall, and comparatively short cool summers. There is, as would be expected, a great variation in the climate

[9] An animal unit is a means of measuring the feed requirement of livestock. It is the equivalent of a mature horse, cow, or steer; five hogs; seven sheep or goats; or 100 poultry.

between the valley section, about 500 feet above sea level, and the plateau section at an elevation ranging from 1,200 to 1,800 feet; and also between the plateau section and the mountain section which in many places reaches an elevation of more than 4,000 feet. The rainfall of about 35 inches in the valley and plateau sections is well distributed throughout the year. The average frost-free season of 134 days in the valley section is ample for the maturing of most crops common to the North Temperate Zone. At higher elevations, in the plateau section, the crop range is limited to grasses and quicker maturing crops.

Agriculture and lumbering have been the leading occupations of the inhabitants since the early days of settlement. Agriculture early assumed a subsistence form, then turned to the raising of livestock, because of the adaptability of the section to grass. This activity changed to dairying, as the market for dairy products increased. At present, although the sale of milk is the principal source of farm income, the farmers on a high percentage of the smaller farms, especially in the hill sections, depend largely on outside work. The leading crops are hay (timothy with some redtop and other grasses), corn for silage, oats, and potatoes. Smaller acreages are in alfalfa, clover, rye, barley, buckwheat, and corn for grain. The most intensive agricultural development is in the Connecticut River Valley. About one-half of the county is mountainous, is largely nonagricultural, and, for the most part, is included in the White Mountain National Forest. Agriculture has decreased to a marked degree since 1880. This is reflected in the percentage of land included in farms, which was 64.5 percent of the total area of the county at that time with 59.6 percent of the farm land improved, compared with 35.3 percent in farms in 1935, with 26.9 percent improved.

The sources of the material from which most of the soils are developed are granite, gneiss, and schist, which occur in rather well-defined belts. Schist outcrops in a belt of land along the western side of the county, covering about one-third of the total area; and granite and gneiss underlie the rest of the land. The parent material was accumulated through glacial action, glacial outwash, and lacustrine and recent stream deposits.

The soils developed from these materials differ considerably, according to age, character of deposit, and climatic conditions. The soils of the present flood plains are recent in origin and have not been subjected to leaching. They have not been in position long enough to be influenced by the soil-forming processes which act under the existing climatic conditions. Certain heavy materials also have resisted these processes to some extent. The rest of the soils, except in a few low poorly drained areas and under bog conditions, have developed profiles which reflect the climatic conditions and forest cover. The soils below a general elevation of 1,200 feet in the southern part and 800 feet in the northern part, belong to the Brown Podzolic soils group, in which the accumulation of organic matter on the surface is comparatively small, owing to the dominance of deciduous trees in the forest cover. There is some mixing of the decomposed organic matter with the soil in the topmost few inches. Slight leaching takes place to a depth of 7 or 8 inches, but little finer earth materials accumulate immediately below this depth. The process is not so active, however, as in soils farther south.

Above the general elevation of the plateau soils, such as on the tops of the plateaus, climatic conditions favor the dominance of conifers. A thick mat of organic matter or forest duff is preserved on the surface and is underlain by a gray leached layer ranging from ½ to 2 inches in thickness. This, in turn, is underlain by a dark-brown soil layer. The soil-forming process in most of the upland soils, however, has reached an average depth of 2½ feet, below which is the unaltered parent material.

At least 75 percent of the soils carry enough stone on the surface, in the form of boulders or rock outcrops, to interfere seriously with cultivation. This is due to the character and composition of the accumulated material. The harder rocks, such as granite, are more resistant to glacial action.

The valley soils, including the recent alluvial soils and those developed on the terraces, together represent the best agricultural soils, and a large proportion of the best farms are located on them. The hill section ranks next, with a fair development of agriculture. The plateau section, although much of the land is fairly smooth, is inaccessible and, therefore, is less developed. This section at one time included many farms which are now abandoned. The mountain section supports little or no agriculture, owing to steepness and stoniness, and it is mainly in forest. Soils of the swamps are little used, due to difficulty of drainage and, in some places, stoniness.

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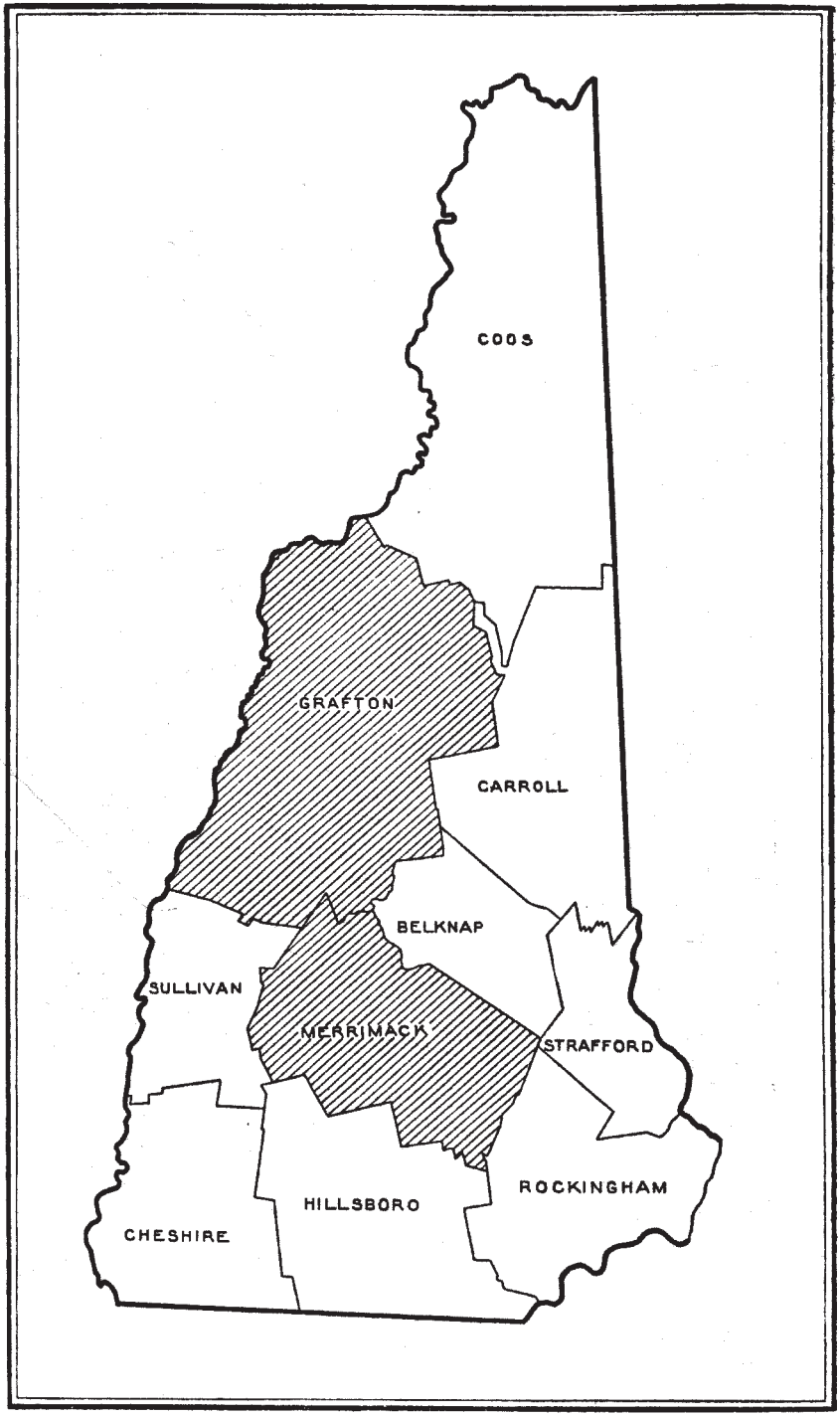

Areas surveyed in New Hampshire shown by shading. Detailed surveys shown by northeast-southwest hatching.

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