SOIL SURVEY

Hillsborough County New Hampshire

Series 1940, No. 13

Issued December 1953

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with the
UNIVERSITY OF NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

How to Use THE SOIL SURVEY REPORT

FARMERS who have lived in one locality for a long time come to know about the soil differences on their own farms and on those of their immediate neighbors. What they do not know, unless a soil survey has been made, is how nearly their soils are like those at experiment stations or in other localities from which higher yields are reported. They do not know whether these higher yields are from soils like their own or from soils so different that they could not hope to get equally high returns, even if they adopted the practices followed in those other places. These similarities and differences are known only after a map of the soils has been made. Knowing what kind of soil one has and comparing it with soils on which new developments have proved successful will remove some of the risk in trying new methods and varieties.

SOILS OF A PARTICULAR FARM

The soil map is in the envelope inside the back cover. To find what soils are on any farm or other land, locate the tract on the map. This is easily done by finding roads, streams, villages, and other landmarks the tract is known to be near.

Each kind of soil is marked with a symbol on the map; for example, all soils marked Mc are Marlow loam, sloping phase. The name of the soil may be found by locating in the legend on the margin of the map the symbol that represents it. The section on Soil Types and Phases tells what this soil is like, for what it is mainly used, and some of the uses to which it is suited.

Suppose, for instance, one wishes to know how productive Marlow loam, sloping phase, is. He may obtain this information by finding the soil name in the left-hand column of table 7 and noting the yields of the different crops shown opposite it. This table also gives expectable yields for other soils mapped, so that the different soils can be compared.

Read the section on Soil Types and Phases to learn what are good uses and management practices for this soil. Look also at the sections headed Land Use and Management and Water Control on the Land. What is said in those sections about crops, crop rotations, fertilization, liming, control of water, conservation of soil moisture, and other management practices may apply to Marlow loam, sloping phase.

SOILS OF THE COUNTY AS A WHOLE

If a general idea of the soils of the county is wanted, read the section on Soils and Their Relations. This tells where the principal kinds are found, what they are like, and how they are related to one another. Then study the soil map and note how the different kinds of soils tend to be arranged in different localities. These arrangement patterns are likely to be associated with well-recognized differences in type of farming and land use.

A newcomer who considers purchasing a farm in the county will want to know about the climate as well as the soils; the principal farm products and how they are marketed; the types and sizes of farms; the kinds of farm tenure; kinds of farm buildings, equipment, and machinery; availability of schools, churches, highways, railroads, telephone and electric services, and water supplies; the location of cities and villages; and about the industries and the population in the neighborhood of the farm. This information will be found in the sections on General Nature of the Area and on Agriculture.

Students and others interested in how the soils of the county were formed and how they are related to the great soil groups of the world should read the section on Morphology and Genesis of Soils.

This publication on the soil survey of Hillsborough County, N. H., is a cooperative contribution from the—

SOIL CONSERVATION SERVICE

and the

UNIVERSITY OF NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

Series 1940, No. 18 Issued December, 1953

SOIL SURVEY OF HILLSBOROUGH COUNTY, NEW HAMPSHIRE

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[1] The Division of Soil Survey was transferred to the Soil Conservation Service on November 15, 1952.

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FOREST covers more than 80 percent of Hillsborough County, and agriculture is less important than manufacturing and lumbering. The peak of agricultural development was passed about 1850, and the abandonment of land to forest still continues. Dairying, poultry raising, and the growing of apples are the major agricultural pursuits. Because of the quantities of forage required for the barn feeding of dairy cows through the long winters, a large part of the farm land is used for growing hay. Manchester, Nashua, and smaller towns produce textiles, shoes, machinery, furniture, and a great variety of manufactured articles. To provide a basis for the best agricultural uses of the land, a cooperative soil survey was made by the United States Department of Agriculture and the New Hampshire Agricultural Experiment Station. Field work was completed in 1940, and, unless otherwise specifically indicated, all statements in this report refer to conditions in the county at that time.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

Hillsborough County is located in the extreme southern part of New Hampshire (fig. 1). Nashua, the county seat, is 15 miles south of Manchester, the largest city in the county, and 15 miles from Concord, the State capital. The county covers an area of approximately 560,000 acres, or 875 square miles.

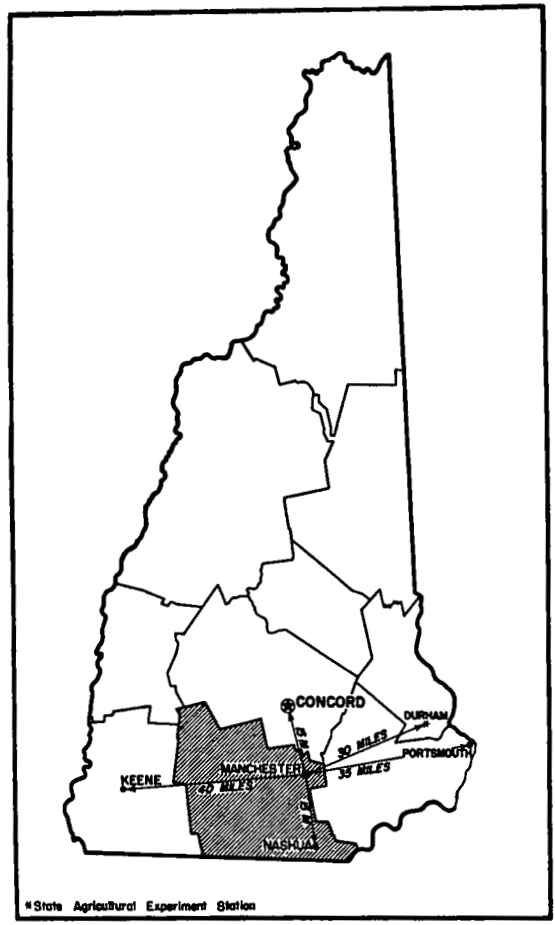


FIGURE 1.—Location of Hillsborough County in New Hampshire.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

Hillsborough County lies within the New England physiographic province [1a] and is for the most part a dissected plateau sloping to the south and east. Although the entire county was covered with ice during the glacial period, the general appearance was probably not

[1a] UNITED STATES GEOLOGICAL SURVEY. PHYSICAL DIVISIONS OF THE UNITED STATES, AN INDEX MAP OF THE UNITED STATES. 1930.

materially changed by glaciation. The mantle of glacial debris averages less than 10 feet deep, and the streams probably occupy approximately the same valleys now as they did in preglacial times. Locally, however, the ice sheet made great changes. Some areas were planed off, others were built up with glacial till or comparatively large deposits of assorted materials, and in places small areas of assorted sand and gravel were deposited on the till plain. Boulders of distant origin occur everywhere except on some of the larger plains of gravel and sand. Glacially striated, or channeled, rocks are plainly visible on Pack Monadnock Mountain.

The plateau section can be divided into upper, middle, and lower divisions, each of which is comparatively uniform in relief and elevation. The upper plateau, which covers the northwestern part, is characterized by steep-sided hills with an average maximum altitude of about 1,800 feet and boggy brooks as high as 1,100 feet above sea level. Locally, elevations often vary as much as 500 feet within half a mile. Dissection is thorough in most places, but strata of hard rock along the margin of the plateau prevent streams from cutting deeper. The boundary of the upper plateau is comparatively easy to determine because streams leaving it flow swiftly over rocky beds through steep-sided narrow valleys.

The middle plateau is characterized by comparatively long sloping hills, the crests of which reach an elevation of about 1,200 feet, and by swift-flowing brooks that cut to a grade level of 600 to 700 feet before reaching the Contoocook River. In most places local relief varies about 300 feet within half a mile. Dissection is thorough, but many brooks flow through high-lying bogs early in their course. The most prominent physiographic features in the county—the area once covered by glacial Lake Contoocook and the Wapack Range—are in the middle plateau. The glacial lake was formed when the ice barrier prevented water from following its preglacial course to the north. As the glacier melted water was impounded in an area comprising the present drainage basin of the Contoocook River.[2] The margins of this former lake can be determined by examining the deltalike gravel deposits occurring in many places at an altitude of about 850 feet. When the ice receded northward as far as Lyndeboro Mountain a temporary outlet was opened by way of Stony Brook and the Souhegan River.

The Wapack Range, a short series of mountains extending northward from northern Massachusetts almost to Hillsboro in this county, consists of several steep-sided and rocky peaks rising 700 to 1,000 feet above the surrounding plateau. Elevations frequently vary as much as 500 feet in one-fourth mile. Another relatively prominent feature in the eastern part of the middle plateau is Joe English Hill, the southern face of which is a cliff 500 feet high.

The division between the lower and middle plateaus is indistinct in most places, but the lower plateau is plainly distinguishable from the hill southeast of Whittemore Hill in the southeastern part of the town[3] of New Ipswich. The lower plateau is characterized by low

[2] GOLDTHWAITE, J. W. THE GEOLOGY OF NEW HAMPSHIRE. 86 pp., illus. Rumford Press, Concord, N. H., 1925.

[3] Towns in New England are comparable to political townships in most other parts of the United States.

hills rising 300 to 400 feet above the grade level of the streams. The tops of the hills average about 800 feet above sea level in the western part, and 400 feet in the eastern. Local variations in relief are gradual—in most places about 200 feet in half a mile, but in some as much as 300 feet.

Outstanding in the lower plateau are relatively extensive nearly level sand and gravel plains in the vicinity of Nashua and Milford. These plains are continuous between the Souhegan, Nashua, and Merrimack Rivers. The assorted deposits forming the plains indicate that the Souhegan River may have once joined the Nashua River about 2 miles west of the present junction of the Nashua with the Merrimack River, and that it later may have followed a course the same as that now taken by Pennichuck Brook. Very likely the deposition of the sand and gravel materials took place when the huge volume of debris-laden water from glacial Lake Contoocook entered the Souhegan Valley from the temporary drainageway near Lyndeboro Mountain. The Uncanoonuc Mountains, composed of two monadnocks in the northern part of the lower plateau, rise about 600 feet above the surrounding plateau, or to an altitude of slightly more than 1,300 feet.

The rivers and tributary streams have deeply dissected the plateau forming this county. Elevations range from 100 feet above sea level, where the Merrimack River leaves the county, to 2,280 feet at the summit of Pack Monadnock Mountain. Locally, elevations vary from 300 to 500 feet.[4] The altitudes of some prominent features are Temple Mountain, 2,081 feet; Crotched Mountain, 2,055; Lyndeboro Mountain, 1,710; and Uncanoonuc Mountains, 1,321. Approximate elevations above sea level for some of the larger towns and villages are Greenville, 800 feet; Peterboro, 750; Hillsboro, 580; Goffstown, 300 feet; Milford, 270; Manchester, 200; and Nashua, 140.

Most of the county lies within the drainage basin of the Merrimack River (pl. 1). The Merrimack River flows through the eastern part of the county but does not drain a large area directly, because a slight rise in the surface routes most drainage water through tributary rivers—the Contoocook, Piscataquog, Souhegan, and Nashau. The Contoocook River drains the western part of the county; the Piscataquog and Souhegan Rivers, the central part; and the Nashua, a small part west of the Merrimack River. A few square miles in the southwestern part of the county in the town of New Ipswich drain through the Miller River into the Connecticut River.

CLIMATE

The climate of Hillsborough County is continental and not greatly modified by any large body of water. The Atlantic Ocean, 50 miles from the eastern boundary, does not appreciably influence temperature, humidity, and precipitation. Summers are warm and winters are cold. Temperatures vary widely in short periods, and variations of 30° F. within 24 hours are not unusual. The periods of extremely

[4] Data on relief and elevation are from topographic surveys of the United States Geologic Survey. Quadrangles including parts of Hillsboro County, N. H., are the Suncook, Concord, Hillsboro, Lovewell Mountain, Monadnock, Peterboro, Milford, and Manchester in New Hampshire; and the Haverhill, Lowell, Groton, and Fitchburg in both New Hampshire and Massachusetts.

Aerial view along the Merrimack River in the vicinity of Litchfield. Most of the cultivated land is near the river; the light-textured droughty soils on the terraces remain in forest.

hot weather in summer are usually tempered by cool nights. Above-freezing temperatures occur in all the winter months.

Normal monthly, seasonal, and annual temperature and precipitation at Nashua are shown in table 1. The data in this table are considered representative of climatic conditions in the large valleys in the eastern part of the county. The eastern valleys are hotter in summer than the uplands, and it is unlikely that the extremes of temperature recorded for Nashua are exceeded anywhere else in the county except on some of the highest mountains. The range between the extreme low and high temperatures is 126° F. This wide variation increases the recreational value of the county, and both winter and summer sports are developed.

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

[Elevation, 125 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total for the driest year	Total for the wettest year	Average snowfall
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	27.3	66	−18	3.34	3.61	5.03	10.4
January	24.2	65	−25	3.43	2.95	2.57	16.2
February	24.4	66	−21	3.32	2.30	4.21	15.9
Winter	25.3	66	−25	10.09	8.86	11.81	42.5
March	33.3	78	−6	3.70	1.39	7.11	12.9
April	43.8	89	11	3.32	.48	1.42	3.3
May	56.3	97	22	3.00	2.26	4.88	[1]
Spring	44.5	97	−6	10.02	4.13	13.41	16.2
June	65.2	100	31	3.13	2.09	3.39	0
July	70.2	101	36	3.38	4.45	3.85	0
August	68.2	100	35	3.53	2.31	5.86	0
Summer	67.9	101	31	10.04	8.85	13.10	0
September	60.8	97	25	3.42	.38	6.01	0
October	49.8	88	14	3.00	2.31	7.39	[1]
November	39.1	79	2	3.25	2.70	1.30	7.8
Fall	49.9	97	2	9.67	5.39	14.70	7.8
Year	46.9	101	−25	39.82	[2] 27.23	[3] 53.02	66.5

[1] Trace. [2] In 1941. [3] In 1890.

The precipitation is relatively evenly distributed throughout the year. The greater part is in the form of slow steady rains lasting 6 to 24 hours. Hailstorms and severe thunderstorms seldom occur. On the average, 66.5 inches of snow falls between the first of Novem-

ber and the last of April. Moisture is usually ample for the rapid growth of crops, but in some years little rain falls during the final part of the growing season. Droughts long enough to affect crop yields seriously seldom occur. Prolonged wet spells are unusual except late in spring or in midautumn.

In most years sandy soils can be tilled from the middle of April to the middle of November and grazed from late in April to early in November, or for 6 to 6½ months. The initial date for grazing heavy, slowly drained soils is in the middle of or late in May, because damage is severe if they are pastured before the ground becomes firm.

Winds are variable and usually gentle to strong. Severe windstorms seldom cross the area, but an exceptionally severe storm, the hurricane of September 21, 1938, did great damage to standing timber in exposed areas. Buildings were damaged mainly on their roofs by falling trees. Storms of hurricane intensity apparently visit New England at intervals of about 100 to 150 years. Records show that a storm like the one of 1938 occurred early in the nineteenth century and another occurred early in the seventeenth century.

The average frost-free season extends from May 14 to September 27, but killing frosts are often recorded as late in spring as June 10 and as early in fall as September 7. Unusual off-season frosts may shorten the season even more in some localities. In 1940, the year with the shortest frost-free season recorded for the Manchester area, many vegetables and much corn near Manchester were killed by frost on June 21, and another frost followed on August 23. Many of the off-season frosts affect only a small area, and the damage is frequently spotty; often only parts of a field are affected. In summer, days are longer in the northern latitude than they are farther south. This longer growing period each day helps to compensate for the shorter growing season.

WATER SUPPLY

Water for farmstead and household use is supplied by wells and springs. Many farmsteads served by springs are at elevations far enough below the source to permit gravity-flow piping of water. Deep wells are not common, but some have been drilled recently when the normal water supply failed or was insufficient. In a few instances sand points have been driven in sandy areas near streams to supply water for farmsteads and livestock. Springs or brooks furnish ample water for livestock in most pastures. Potato growers use sprinkler irrigation systems on some of the lighter soils.

Dug wells 20 to 25 feet deep are the most common and furnish sufficient water for most farms. These shallow wells are dependable except during a prolonged drought. Shallow wells dug in soils having compact substrata withstand drought better than those dug in soils having lighter substrata, but once they become dry, they may remain dry long after the drought is broken—in some instances until the spring thaws.

Streams and lakes are important natural resources of the county. Many of the smaller streams are cold swift-flowing spring-fed brooks that form a natural habitat for trout. Rainbow trout are in the South Branch Piscataquog River and in the upper reaches of the Souhegan River. Most of the lakes contain many species of game and food

fish—smallmouthed black bass, Eastern chain pickerel, yellow perch, white perch, sunfish, horn pout (catfish), and in the cold-water lakes, brook trout.

The recreational value of the lakes is highly developed in many places. Summer camps, family cottages, bathing beaches, and summer hotels are located along the shores of most of the larger lakes. Some ice for domestic and commercial use is cut from the lakes. The larger streams are less desirable for bathing, fishing, boating, and other recreational uses because they are polluted by sewage and industrial waste from the cities.

VEGETATION

When first seen by white men the area now in this county was probably entirely covered with a mixed forest of hardwoods and conifers.[5] Many large mature trees formed a dense canopy, but trees of all ages were included. On the lower plateau the most common broadleaf species were chestnut, Northern red oak, sugar and red maples, beech, yellow birch, elm, and on the heavier soils, shagbark and bitternut hickories and white ash. White pine was the most common conifer. Nearly pure stands of white pine were probably on some sandy plains in the valleys and on dry ridge tops. Pitch and red pines also grew on the dry sand plains, and hemlock was an important component of all mixed stands. The middle and upper plateaus supported the same broadleaf species as the low plateau, but at these higher elevations the stand included more hemlock as well as paper birch and some red spruce.

Much of the original forest was cut and the land cleared for pasture or cultivation before the middle of the nineteenth century, and practically all parts of the county have been cut over for lumber at one time or another. Most of the farms, especially those on rough land, were abandoned, and a uniform cycle of forest growth and reproduction has subsequently taken place. Most of the abandoned fields reseeded naturally to white pine, and many pure even-aged stands resulted. In some places, however, aspen, pin cherry, and gray birch became established and were later replaced by other hardwoods or by mixed stands of hardwoods and white pine.

The pure stands of white pine were clear cut when they reached merchantable size. After the white pine was cut, regeneration was by species in the understory—Northern red oak, red maple, gray birch, and other broadleafed species and some white pine and hemlock. There are few places other than the sand plains and recently abandoned lands where white pine is now the most common species. Many of the forest stands are brushy, and witch-hazel and sweetfern are common in many places. Mountain-laurel is found in many pastures and wooded areas on the lower plateau. Poison ivy commonly occurs at altitudes of less than 1,000 feet.

Continuous pasturing has retarded regeneration in places. Junegrass (Kentucky bluegrass) and poverty oatgrass are common in such pastures at higher elevations, whereas broomsedge frequently grows

[5] CLINE, A. C., and LOCKARD, C. R. MIXED WHITE PINE AND HARDWOOD. Harvard Forest Bul. No. 8, 67 pp., illus. 1925.

in pastures at lower altitudes. Many areas are almost worthless for pasture because they are completely covered by hardhack and low-growing juniper.

Following is a list of scientific and common names for the more important trees, shrubs, and grasses of the county:

TREES AND SHRUBS

Scientific name	*Common name*
Acer rubrum	Red maple.
A. saccharum	Sugar maple.
Betula lutea	Yellow birch.
B. papyrifera	Paper birch.
B. populifolia	Gray birch.
Fagus grandifolia	American beech.
Fraxinus americana	White ash.
Hamamelis virginiana	Witch-hazel.
Carya cordiformis	Bitternut hickory.
C. ovata	Shagbark hickory.
Juniperus communis var. *prostrata*	Dwarf juniper.
Kalmia latifolia	Mountain-laurel.
Comptonia peregrina	Sweetfern.
Picea rubens	Red spruce.
Pinus resinosa	Red pine.
P. rigida	Pitch pine.
P. strobus	Eastern white pine.
Populus tremuloides	Quaking aspen.
Prunus pensylvanica	Pin cherry.
Quercus borealis var. *maxima*	Northern red oak.
Rhus toxicodendron	Poison ivy.
Spiraea tomentosa	Hardhack.
Tsuga canadensis	Eastern hemlock.
Ulmus americana	American elm.

GRASSES

Andropogon virginicus	Broomsedge.
Danthonia spicata	Poverty oatgrass.
Poa pratensis	Kentucky bluegrass.

ORGANIZATION AND POPULATION

The area now comprising Hillsborough County was probably first visited by white men in 1652 when a surveying party from Massachusetts surveyed the Merrimack River as far north as Lake Winnipesaukee.[6] The first settlement was established between 1665 and 1670 on Salmon Brook in what is now Nashua. Other settlements followed slowly—Manchester in 1722, Amherst in 1735, and Bedford in 1737. By 1750 there were isolated settlements in most parts of the area, and, inasmuch as danger from Indian raids ceased at about that time, the population increased rapidly.

The Crown Province of New Hampshire was divided into five counties in 1771. Hillsborough, one of the original five, then had a population of about 15,000 and included most of what is now Merrimack County but not the town of Pelham. Amherst was the county seat and an important trading center. The present boundaries of the county were established in 1823, and the county seat was moved to Nashua in 1862.

[6] HURD, D. H. HISTORY OF HILLSBOROUGH COUNTY, NEW HAMPSHIRE. 748 pp., illus. 1885.

The earliest settlers came from Massachusetts, but many of the later settlements were made by Scotch-Irish and Irish immigrants. As industrial development progressed, Greeks, Italians, and French Canadians came in response to the demand for labor. Later, German, Polish, Belgian, Lithuanian, and other European immigrants established homes.

Before 1850 most of the population lived on farms or in small rural communities, but after the beginning of industrial development, increasing numbers of people moved to Manchester and Nashua, now the two largest cities in New Hampshire. Manchester had a population of 82,732 in 1950 and Nashua, 34,669.

In 1950 the population of the county was 156,987, of which 77.9 percent was classed as urban. In 1950 the rural population was 34,738. Milford, Wilton, Hillsboro, Greenville, and Peterboro are minor industrial centers and have maintained populations fairly well, but many of the rural villages have decreased in size.

INDUSTRIES

Hillsborough County has been an important industrial area for nearly a century.[7] Textiles and shoes are the most important, but a great variety of other manufactured articles are produced, including machinery, furniture, granite and asbestos products, and various wooden articles.

Most of the industrial establishments are in Manchester and Nashua, but many of the smaller towns have one or more factories. Water power is developed at many places throughout the county, particularly along the dividing line between the upper and middle plateaus, and is used in many smaller mills and even some of the larger ones. Some electric current is also generated by water power.

TRANSPORTATION AND MARKETS

Transportation facilities are unusually good and would be adequate even if argiculture and industry were greatly expanded. A main line of the Boston and Maine Railroad follows the valley of the Merrimack River through the county and connects Manchester and Nashua with Boston and Montreal. Branch lines connect the smaller industrial communities and many of the rural towns with the main line through Manchester and Nashua or to a line in Massachusetts. Because local transportation by truck has proved more economical and flexible, a few branch lines have been abandoned in recent years and on the others passenger service has been discontinued and freight service curtailed.

United States highways Nos. 3 and 202 serve the county. All communities are served by well-maintained hard-surfaced or surface-treated roads. In most places surface-treated roads radiate from each larger population center to nearby villages. Most of the rural roads serving only a scattered farm population are graveled. In winter, all roads serving inhabited residences and farmsteads are kept open by snow plows, and icy places on main traffic arteries are sanded to

[7] DODGE, J. R. HILLSBOROUGH COUNTY RECORD, A GLIMPSE OF THE BUSINESS AND RESOURCES OF 31 TOWNS. 156 pp. 1853.

facilitate travel. Nashua and Manchester have modern airports, and scheduled mail and passenger planes stop at Manchester.

Much of the farm produce, including poultry and dairy products, is marketed locally, but large quantities are shipped to Boston by rail and truck. In many communities milk and egg collections are made regularly for Boston markets. Some agricultural products, particularly eggs and live and dressed poultry, are shipped to New York City by truck.

COMMUNITY IMPROVEMENTS

Churches of several denominations are located in the larger rural communities, but many of the smaller centers are served by only one church. Most of the small one-room schools have been closed, and the pupils are now transported to and from centrally located schools. High schools are maintained in the larger towns. Free transportation is furnished grade school pupils, but high school students must furnish their own transportation unless they live in a locality where they can ride the regular school busses.

Each town has a town hall used for the official and social meetings of the community. These are usually large two-story buildings erected when the towns were more densely populated, and many of them are fine examples of New England colonial architecture.

Towns with a municipal water system supply water for domestic use and fire protection to many nearby farms, but most farmers depend on springs and wells. Water for fire protection is obtained from brooks or larger streams in most rural areas, but a few shallow reservoirs have been constructed recently.

AGRICULTURE

Indians were practicing a primitive form of agriculture on the river bottoms when the first surveying party visited the area. They girdled the trees, piles the brush, and burned over the ground in the fall. Fish, principally shad, were numerous in the Merrimack River and were used as fertilizer. Beans, squash, pumpkins, and gourds, which were indigenous to the region, were the principal crops. Each Indian family tilled about one-half an acre, but 10 or 12 family plots would be contiguous.

The agriculture of the first white settlers was chiefly on a sustenance basis. They grew about the same crops as the Indians—corn, beans, pumpkins, squash, melons, gourds, and tobacco. Potatoes and flax were introduced later by the Scotch and Irish. The raising of the livestock, especially sheep, was important during the early period of agricultural expansion, and corn and hay were principal crops. Turnpikes were built in many places in the early part of the nineteenth century, and prior to the building of railroads, a canal was constructed along the Merrimack River. Improved methods of transportation made possible the growing of rye, wheat, and oats for shipment to more populated centers.

By 1830 practically all tillable land was under cultivation and the rural population was at its peak. Cellar holes, rock fences, and old roadbeds show that areas now inaccessible were once densely popu-

lated. The exodus from farms can be traced to several causes. Many farms were stony, steeply sloping, hard to cultivate, and increasingly less productive as virgin fertility was exhausted by cropping. A permanent and profitable system of agriculture for most of these steep stony soils had not been discovered at that time, and the factories growing up in many villages and cities offered employment whereby a man could provide for his family more adequately and with less toil. The West, furthermore, was being opened for settlement at about this time and many New England farmers migrated westward because they believed they could obtain nearly level, stone-free, fabulously fertile land at low cost. The most inaccessible land, although not necessarily poorer than some of the land still cultivated, was abandoned first, and today almost the only evidence of the acreage once under cultivation is the almost pure even-age stands of white pine that grew up as the farms were abandoned.

Agriculture is now considerably less important than manufacturing. Dairying, poultry raising, and the growing of orchard fruits are the main agricultural pursuits. The acreage of improved land has continued to decline, and grain crops are no longer grown to any extent. Recently many farms have been sold to residents of Boston and other New England cities as summer homes. Hay is still harvested on many of these farms, but some of the owners maintain only a small area of cleared land around the buildings.

CROPS

Hay and forage are by far the leading crops of the county; the total area in hay was 25,870 acres, or about 44 percent of all cropland, in 1949. Corn is the most important cereal crop and fruits such as apples and peaches are successfully grown. Acreages of principal crops are given in table 2 for stated years.

Much of the acreage listed as wild hay and all other tame hay is in old fields on abandoned farms or on farms that have been purchased for summer residences. Many of the old fields have not been seeded for 20 years or more, and the grass originally seeded has been replaced mainly by Kentucky bluegrass, sweet vernalgrass, redtop, poverty oatgrass, and other wild grasses. The yield is usually low, or about one-half to three-fourths ton an acre, and many fields are cut only when there is a hay shortage.

Most of the corn is now cut for silage. Field corn is not grown to any extent for grain, chiefly because the season is too short to mature the standard dent varieties. Recently developed and adapted varieties of hybrid dent corn, however, would mature satisfactorily. Oats is the only other cereal crop of any importance, and most of the acreage is cut green for hay or pastured.

Apples and peaches are successfully grown in large commercial orchards located at relatively high altitudes where air drainage is sufficient to prevent frost killing. High-quality MacIntosh apples are produced on many farms, but most of the commercial orchards are in the towns of Wilton (pl. 2, *A*), Lyndeboro, and Temple. This area is protected from cold winter and summer storm winds by relatively high mountains to the west, and on the east by the Souhegan Valley, the width of which provides excellent air drainage. The orchards are chiefly on Marlow soils.

TABLE 2.—*Acreage of principal crops and number of bearing fruit trees in Hillsborough County, N. H., for stated years*

Crop	1919	1929	1939	1949
	Acres	*Acres*	*Acres*	*Acres*
Corn for all purposes	1, 260	1, 623	1, 993	1, 583
For silage	(1)	1, 227	1, 333	1, 381
Harvested	(1)	192	290	93
Grazed or cut for fodder	1, 260	204	370	109
Oats, harvested	332	52	60	40
All hay	46, 793	36, 254	33, 866	25, 870
Alfalfa	34	487	758	1, 572
Clover and timothy, alone or mixed	20, 785	21, 607	16, 045	18, 317
Grains cut green	1, 776	352	633	565
All other tame hay	21, 736	13, 343	15, 606	6, 988
Wild hay	2, 462	465	824	(1)
Potatoes, white	1, 333	570	599	530
Vegetables for sale: [2]				
Sweet corn	(3)	428	315	522
Beans, snap, string, or wax	(3)	78	77	128
Cabbage	(3)	103	56	184
Green peas	(3)	65	17	14
Tomatoes	(3)	95	69	65
All other vegetables and melons	(3)	5	392	543
Blueberries, tame or wild	24	538	701	771
Strawberries	84	71	58	20
	Number	*Number*	*Number*	*Number*
Apples, trees	146, 068	136, 498	145, 882	139, 442
Peaches, do	44, 202	25, 821	11, 766	8, 210
Pears, do	4, 509	2, 757	2, 185	2, 087

[1] Not reported.
[2] Excludes potatoes.
[3] Not reported separately; total for all vegetables, excluding potatoes, was 630 acres in 1919.

Potatoes, market vegetables, and strawberries are grown commercially on a relatively large acreage, but most farms have only a few acres of these crops. Some farmers utilizing land on river terraces and flood plains in the vicinity of Nashua and Litchfield specialize in market vegetables and potatoes. Tomatoes apparently give the highest gross return, but many other vegetables are grown profitably. Large quantities of sweet corn are grown for sale locally or for markets in Boston. In many years sweet corn is protected from frost by nightly fogs until the middle of or late in October in the valley of the Merrimack River. The corn earworm and European corn borer cause only slight damage to corn.

Farm pastures covered a total of 53,222 acres in 1949. Of this total, 12,660 acres was cropland pastured, 25,929 acres was woodland pastured, and 14,633 acres was other land pastured. Permanent pastures are in all parts of the county, but in most areas they have exceptionally low carrying capacity, partly because in many places only the rough, rocky, or wet land unsuitable for tilled crops is used (pl. 2, *B*). The common pasture plants are Kentucky bluegrass, sweet vernalgrass, redtop, and various sedges. The carrying capacity of

pastures is further reduced by weed pests such as juniper, various hardhacks, and in places rhododendron.

In recent years most farmers have realized the value of treating their pastureland as they do their cropland. The best pastures are plowed, disked, limed, fertilized, and seeded to improved pasture mixtures which usually include bromegrass and Ladino clover. With such treatment, the amount of forage is increased, its quality improved, and the grazing season extended for two or more additional weeks each year. Surplus pasturage is often cut and made into silage, a practice which is rapidly increasing.

LIVESTOCK AND LIVESTOCK PRODUCTS

Dairy cattle and poultry are the most important livestock in this county. The number of cattle has remained comparatively constant at about 15,000 head since 1919. The total number in 1950 was 13,580, of which 7,793 were cows and heifers being milked. The herds are made up chiefly of grade cattle of dairy breeds. Many of the cattle are high in Guernsey blood, and there are a few purebred Guernsey, Jersey, and Holstein-Freisian cows in some herds. Several herds in the town of Hollis are grade or purebred Ayrshire Most of the dairy farms are in the eastern part of the county, and dairy products are marketed in Manchester, Nashua, and Boston.

The number of chickens on hand increased from 141,108 in 1919 to 606,479 in 1950. The laying flocks are principally of the New Hampshire breed, which was developed in this State. Many poultrymen cross the New Hampshire breed with the Barred Plymouth Rock to produce hatching eggs for the broiler markets in New York, Pennsylvania, and Maryland. The cross between the two breeds produces an exceptionally vigorous, fast-growing, rapid-feathering bird consistently profitable for the broiler market. Poultry farms are chiefly in the eastern part of the county but they are also located in other parts (pl. 3, *A*). Eggs and live poultry are marketed in Manchester, Nashua, and Derry, N. H., or in Boston, Mass., but much of the poultry is reshipped to New York.

Horses are the only work stock on most farms, but on some a few oxen and mules are used. There were 4,313 horses reported in 1919, or an average of 1.7 a farm; whereas in 1950, the total number was only 880, or about 0.4 a farm. Horses are shipped in from neighboring areas or the Western States because few replacements are raised in the county. No particular breed predominates, but most of the horses are large, hardy, and well kept.

TYPE, SIZE, AND TENURE OF FARMS

The 2,175 farms in Hillsborough County in 1950 were classified as follows: 594 poultry farms, 380 dairy farms, 97 fruit and nut farms, 48 general farms, 44 livestock farms, 10 field-crop farms, 13 vegetable farms, and 989 miscellaneous and unclassified farms.

Most of the fruit farms and dairy farms are on Marlow loam or other soils developed on firm to compact fine-textured glacial till. Fruit trees and grass make better growth and return higher yields on these soils. The truck farms are mainly on nearly level terraces

and glacial outwash plains or on the well-drained soils occurring in steam bottoms. The poultry farms are on all types of soils, but loose-textured soils are most desirable because they make the control of poultry diseases easier (pl. 3, *B*).

Land in farms totaled 225,016 acres, or 39.5 percent of the county area, in 1950, and was divided as follows: Cropland, 59,040 acres; woodland, 139,267 acres; pasture, exclusive of cropland and woodland used as pasture, 14,633 acres; and all other land, 12,076 acres.

The average size of all farms was 103.5 acres in 1950, as compared to 84.2 acres in 1940, 117.4 acres in 1930, and 119.8 acres in 1920. The number of farms and the average size have decreased since 1920. In 1950, farms ranged from under 3 acres to 1,000 acres or more in size, but 1,586 farms, or nearly 76 percent of the total number, were 3 to 139 acres in size. There were 519 farms larger than 139 acres in size and only 70 farms under 3 acres.

As reported in 1950, 95.7 percent of the farms of the county were operated by owners, 3.2 percent by tenants, and 1.1 percent by managers. The percentage of owners, tenants, and managers has not varied materially in the past 50 years.

FARM IMPROVEMENTS AND EQUIPMENT

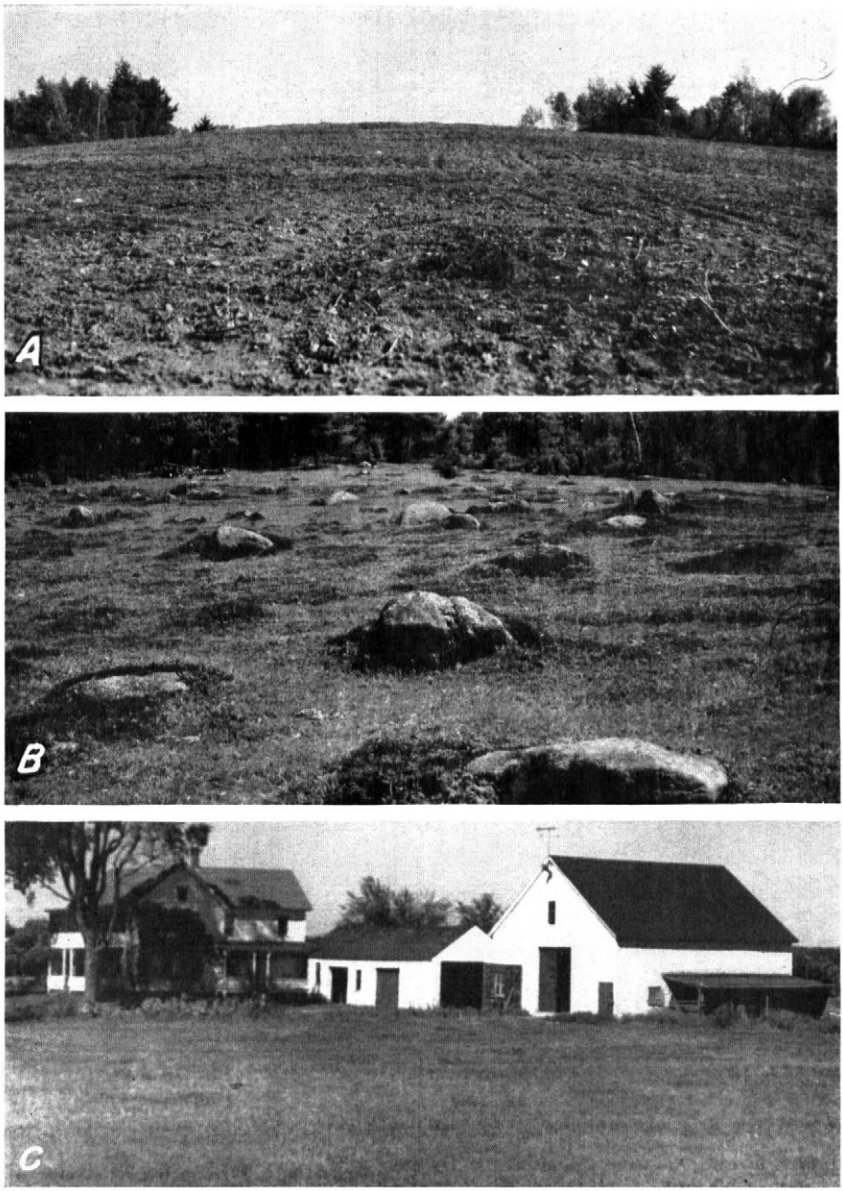
Farm buildings are usually large and substantial and kept in repair. The house and barn are often connected so it is unnecessary to go outside to get from one to the other (pl. 2, *C*). Although convenient during heavy snows, this arrangement increases the danger of fire spreading to all buildings. Telephones were reported in 1,788 farm dwellings in 1950 and electricity in 2,184.

On many farms the fences are of stone and were built when the land was cleared for cultivation. Stones were present in most places when the area was cleared and building fences provided a useful means of disposal. The stone fences are not difficult to keep in repair but furnish refuge for many insects and rodents and are difficult to keep clear of brush, briers, and creeping vines, especially poison ivy. Stone fences are permanent, but in many places this works to the disadvantage of the farmers because it is difficult and expensive to change the size or shape of a field. Barbed wire and temporary electric fences are now commonly used.

The machinery on an average farm consists of a walking plow, spring-tooth and spike-tooth harrows, a dump hay rake, a dump cart, and various wagons and carts. Disk plows and wheel plows are used on many farms, and most farmers who grow a large quantity of hay have mowing machines, side-delivery rakes, and hay loaders. Tractors and heavy farm equipment are used chiefly on farms specializing in the growing of apples or market vegetables. An increasing number of tractors, however, are being used on dairy farms.

FARM EXPENDITURES

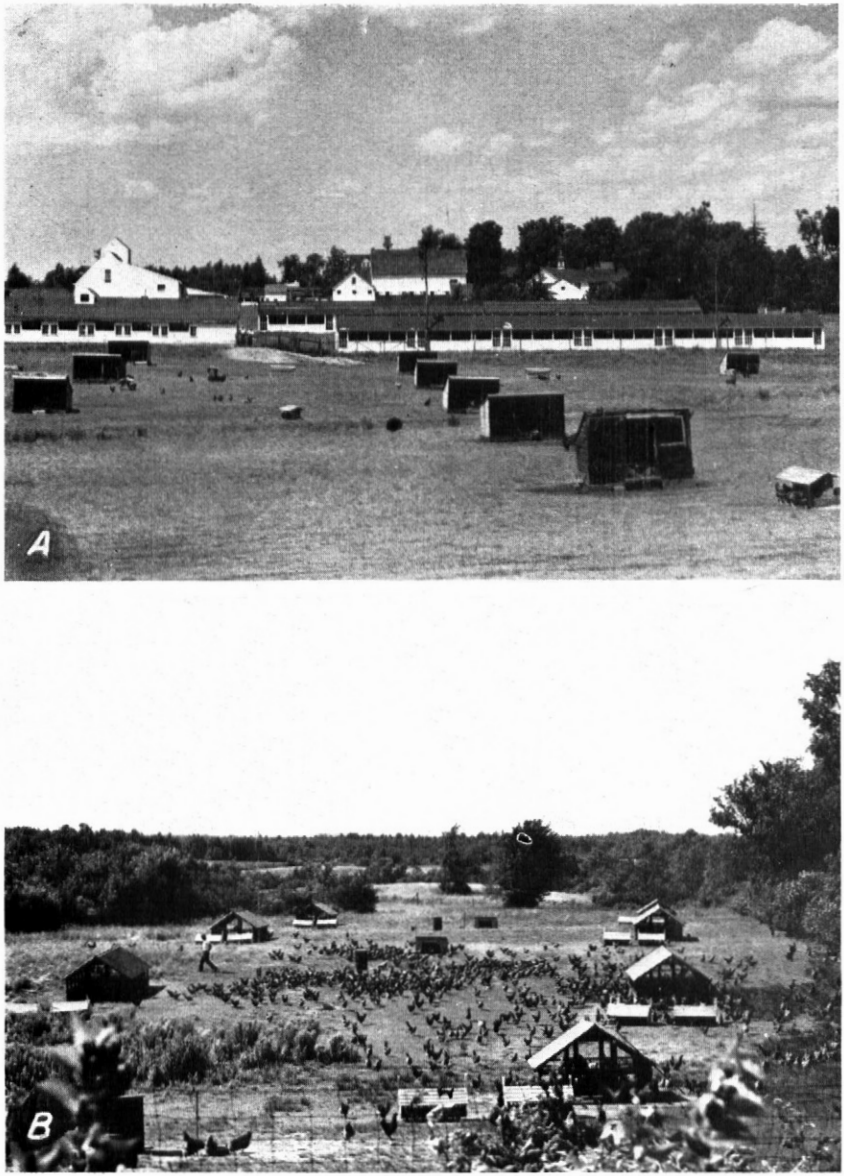
Farmers of this county have been purchasing relatively large quantities of livestock and poultry feed for the past 30 years. Normally, feed grains can be purchased more economically than they can be grown on the farms. Poultrymen in particular have neither the time



A, Recently cleared Marlow soil, on a drumlin in the town of Wilton, to be used for an apple orchard.

B, Bouldery pastures are common on the Gloucester soils. This area was once a hayfield; the smaller stones were removed but the larger partly buried boulders were left.

C, House and barn joined by a shed is common in northern New England.



A, Buildings typical of many of the poultry farms in Hillsborough County
B, Pullets on range on the well-suited droughty light-textured Merrimac soils

nor the equipment necessary to grow and mix feeds. Practically all the feeds are purchased from feed supply companies or consumer cooperatives. In 1950, 85.7 percent of the farms of the county reported expenditure for feeds. The total spent was $5,083,906, or an average of $2,727 for the farms reporting.

The cash expenditure for hired labor was $1,751,410 in 1950, or an average of $1,846 for the 949 farms reporting. About half the farms of the county use hired labor. Dairy and poultry farmers employ much of the hired labor, and on a year-round basis. In most instances single men are employed. The hired man lives with the farm family and often works on the same farm for many years. Some seasonal labor is needed on truck farms but satisfactory help of this kind is difficult to obtain. The farmers employing on a permanent basis usually have efficient help.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field. The soil scientist walks over the area at intervals not more than one-quarter mile apart and bores into the soil with an auger or digs holes with a spade. Each boring or hole shows the soil to consist of several distinctly different layers, or horizons, termed collectively the soil profile. At selected sites these layers are studied carefully for the physical characteristics that affect plant growth and samples may be taken for laboratory studies.

The color of each layer is noted. The darkness of the topmost layer is usually related to its content of organic matter; streaks and spots of gray, yellow, and brown in lower layers generally indicate poor drainage and poor aeration. Texture, or the content of sand, silt, and clay in each layer, is determined by the way the material feels and is checked by mechanical analysis in the laboratory. Texture has much to do with the quantity of moisture the soil makes available to plants, whether plant nutrients or fertilizers will be held by the soil in forms available to plants or will be leached out, and how difficult the soil may be to cultivate.

Structure, or the way the soil granulates, and the amount of pore or open space between particles indicate how easily plant roots can penetrate and how easily water enters the soil. Consistence, or the tendency of the soil to crumble or to stick together, indicates how difficult it is to keep the soil open and porous under cultivation. The kind of rocks and the resulting parent material from which a soil has been developed affect the quantity and kind of plant nutrients the soil may contain. Simple chemical tests show how acid the soil may be. The depth to bedrock or to compact layers is determined. The quantity of gravel or rocks that may interfere with cultivation, the steepness and kind of slope, the quantity of soil lost by erosion, and other external features are observed.

On the basis of all these characteristics, the soils much alike in kind, thickness, and arrangement of layers are mapped as a soil type. Some soil types are separated into two or more phases. For example, if a soil type has slopes ranging from 2 to 15 percent, it may be mapped in two phases, an undulating phase (2- to 7-percent slopes) and a

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rolling phase (7- to 15-percent slopes). A soil type is broken into phases primarily because of differences in the soil other than those of kind, thickness, and arrangement of layers. The slope of a soil, the frequency of outcropping bedrock, the extent of erosion, or need for artificial drainage are representative characteristics that might cause a soil type to be divided into phases.

Two or more soil types may have similar profiles; that is, the soil layers may be nearly the same, except that the texture, especially of the surface layer, will differ. If the other characteristics of the soil layers are similar, these soils are considered to belong in the same soil series. A soil series therefore consists of all the soil types having about the same kind, thickness, and arrangement of layers, except for texture, particularly of the surface layer, whether the number of such soil types be one or several.

The name of a place near where a soil series was first studied is chosen as the name of the series. Thus, Nashua is the name of a deep porous well-drained acid soil occurring on deposits of water-laid sand in Hillsborough County. There are four types of the Nashua soil—Nashua loamy sand, Nashua loamy fine sand, Nashua very fine sandy loam, and Nashua loam. These differ in texture of the surface soil as their names show. The four types of Nashua soil are further divided into phases according to relief.

When two or more soils are mapped as a unit but are not intricately associated, the individual soils are designated by series, type, and phase names to indicate that the soils actually occur individually in separate areas. Such is the case for the Waumbek, Peru, and Acton loams, undulating phases.

When very small areas of two or more kinds of soil are so intricately mixed that they cannot be shown separately on a map of the scale used, they are mapped together and the areas of the mixture are called a soil complex. In areas where the textures are extremely variable, as on small narrow stream bottoms, the individual textures are not named. An example is the complex of Rumney and Saco soils.

Areas having little true soil, and areas where some feature other than the soil itself controls the use of land, are not designated by series and type names but are classified as miscellaneous land types and are given descriptive names. Made land and Stony hilly and steep land, Brookfield soils, are miscellaneous land types in this county.

The soil type, or where the soil type is subdivided, the soil phase, is the principal unit of mapping because it designates the kind of soil most nearly uniform and having the narrowest range of characteristics. For this reason, land use and soil management practices can be more definitely specified for a type or phase than for broader groups of soils that permit more variation. One can say, for example, that soils of the Marlow series need lime for alfalfa; but more specifically it can be said that Marlow loam, gently sloping phase, has mild slopes, needs lime, and is suited to row crops in a rotation with hay, whereas Marlow loam, moderately steep phase, has slopes of 15 to 25 percent, is hard to work with heavy machinery, erodes readily, and should be used principally for long-term hay or pasture.

On the accompanying map of Hillsborough County the location of each of the soil types, phases, and miscellaneous land types is shown in

relation to roads, houses, streams, lakes, town (township) lines, and other cultural and natural features of the landscape. Topographic maps made by the United States Geological Survey were used as a base for plotting the soil information. A detailed-reconnaissance soil map was made in the county. In this type of survey the cultivated areas are mapped in detail, whereas in the more remote wooded areas only a reconnaissance map is made. All roads and trails were traversed in the wooded areas and the soils along them were studied in detail but only a few side trips were made into areas where the land was not farmed.

SOILS

SOILS AND THEIR RELATIONS

The soils of Hillsborough County closely resemble those in other parts of central New England. They have developed from materials ground up, transported, and in some places assorted by glaciers, by water flowing from melting glaciers, by postglacial streams, or by wind. The texture of the surface soil and subsoil is in most places a fine sandy loam or loam. The soils are usually strongly to very strongly acid. The native vegetation was forest in all except a few small areas.

About 30 percent of the county area is occupied by bouldery soils, 25 percent by stony well-drained loams and fine sandy loams, 20 percent by well-drained soils developed on wind-blown deposits and stream and outwash terraces, 5 percent by nonstony well-drained soils developed on till suitable for agriculture, 5 percent by imperfectly and poorly drained upland soils, 5 percent by well-drained stream-bottom soils, 5 percent by poorly drained stream-bottom soils, and 5 percent by organic soils.

The bouldery soils and the stony well-drained loams and fine sandy loams, which together make up about 55 percent of the county, are not suitable for cultivation and are in forest or pasture. About half of the soils on wind-blown deposits and stream outwash terraces are too steeply rolling or droughty for agriculture. The imperfectly and poorly drained soils of uplands are well suited to permanent pasture, but few areas have been cleared for cultivation. In large part the well-drained soils of stream bottoms occur in areas too small to be suited to general agriculture but are well suited to pasture or home gardens. The soils of poorly drained stream bottoms are best suited to pasture or forest, and the organic soils are mostly in forest.

Areas occupied mainly by the rough bouldery and stony soils, as the soils of the Hermon and Gloucester series, are thinly settled and the towns provide few community activities, whereas the areas supporting well-developed prosperous agricultural communities are largely on soils developed from fine-textured glacial till, as the Marlow, Paxton, Hollis, Charlton, and the finer textured Nashua and Merrimac developed on glacial terraces.

The soils on nearly level outwash plains, river terraces, and stream bottoms are most extensive along the Merrimack, Souhegan, and Contoocook Rivers and were important in the early agricultural and industrial development of the county because they were nearly level,

naturally stone-free and near rivers, which were then the principal means of transportation. Nashua, Manchester, and most of the population centers are on these soils, but many of the sandier soils once cleared have been abandoned because they are not easily maintained in a high state of productivity.

The soils are placed in groups on the basis of physiographic position as follows: (1) Soils of glaciated uplands, (2) soils on kames, terraces, and wind-blown deposits, (3) soils of flood plains, and (4) organic soils. These groups are subdivided according to characteristics of the subsoil and parent material. Most of the soils are readily differentiated according to the texture of the parent material, and the texture of the soils can be broadly related to their suitability for agricultural use. In general, the soils most desirable for agriculture are the well-drained soils developed from fine-textured parent material, and those less desirable as general cropland are the soils from coarse-textured parent material. Some phases of the fine-textured soils are suitable only for pasture, whereas in places profitable farms are maintained on the coarse-textured soils, as they are sometimes utilized for special crops. Usually, however, the coarse-textured soils are in forest or used as pasture.

The soils of the county are classified and mapped principally on the basis of their differences in relief, drainage, texture, degree of stoniness and compactness of substratum; and the composition of their parent material. The parent material, drainage, and great soil groups are given for each soil series in table 3.

In addition, 14 land types, which occupy about 28 percent of the county, are mapped. These include Made land; six kinds of Rockland, hilly and steep; six kinds of Stony hilly and steep land; and Stony undulating land, Waumbeck, Peru, and Acton soils.

SOILS OF GLACIATED UPLANDS

The glaciated upland of Hillsborough County is a rolling to mountainous tract, much of it covered by mixed and some nearly pure stands of pines or hardwoods. Where the glacial deposits are fine-textured and more or less compact, much of the land is gently rolling and suitable for agriculture, but where they are coarse, the greater part of the land is rough, stony, and suitable only for forest or pasture. The soils of the glaciated uplands are therefore divided as (1) soils developed on firm to hard fine-textured glacial till and (2) soils on relatively loose coarse-textured glacial till.

SOILS DEVELOPED ON FIRM TO HARD FINE-TEXTURED GLACIAL TILL

The soils developed on firm to hard fine-textured glacial till are the Marlow, Paxton, Becket, Essex, Charlton, Hollis, Sutton, Waumbek, Peru, Acton, and Whitman. These soils occupy the smoother areas of glacial till and for the most part are gently rolling or undulating and less stony than other soils of the glaciated upland. The imperfectly drained Sutton, Waumbek, Peru, and Acton soils and the poorly drained Whitman soils are included in this group because they usually occur in small individual areas and are so closely associated with well-drained soils that they are farmed with them.

TABLE 3.—*Parent material, drainage, and great soil group of the soil series of Hillsborough County, N. H.*

[Letters following series names in parentheses are abbreviations for the great soil groups: A=Alluvial soils; B=Bog soils; BP=Brown Podzolic soils; DS=Sands (dry); HB=Half Bog soils; and PO=Podzol soils]

Parent material	Well or excessively drained		Imperfectly drained	Poorly drained
	Shallow to bedrock	Deep to bedrock		
Glacial till:				
Olive firm loam, mainly from gray mica schist.	Hollis (BP)	Charlton (BP)	Sutton (BP)	Whitman (HB).
Olive hard platy loam, mainly from gray mica schist.		Marlow (PO) Paxton (BP)	Peru (PO) Sutton (BP)	Whitman (HB).
Gray hard platy gritty sandy loam, mainly from granite and granitic gneiss.		Becket (PO) Essex (BP)	Waumbek (PO) Acton (BP)	Whitman (HB).
Yellowish-brown loose loam, mainly from pyritiferous mica schist.	Lempster (PO) Brimfield (BP)	Acworth (PO) Brookfield (BP)	Peru (PO) Sutton (BP)	Whitman (HB).
Gray loose coarse loamy sand, mainly from granite or granitic gneiss.	Canaan (PO) Shapleigh (BP)	Hermon (PO) Gloucester (BP)	Waumbek (PO) Acton (BP)	Whitman (HB).
Glaciofluvial materials in kames, eskers, and terrace edges:				
Pale-yellow or gray stratified sand and gravel, mainly from gray mica schist and granite.		Danby (PO) Hinckley (BP)		
Yellowish-brown stratified sand and gravel, mainly from granite and pyritiferous mica schist.		Peterboro (PO)		
Glaciofluvial and river terrace material:				
Pale-yellow or gray stratified sand and gravel, mainly from gray mica schist and granite.		Colton (PO) Merrimac (BP)	Sudbury (BP)	Scarboro (HB).
Pale-yellow or gray stratified sand and fine sand, mainly from granite.		Nashua (BP)	Sudbury (BP)	Scarboro (HB).

TABLE 3.—*Patent material, drainage, and great soil group of the soil series of Hillsborough County, N. H.*—Continued

[Letters following series names in parentheses are abbreviations for the great soil groups: A=Alluvial soils; B=Bog soils; BP=Brown Podzolic soils; DS=Sands (dry); HB=Half Bog soils; and PO=Podzol soils]

Parent material	Well or excessively drained		Imperfectly drained	Poorly drained
	Shallow to bedrock	Deep to bedrock		
Glaciolacustrine materials: Gray thinly stratified silt and clay.			Buxton (BP)	
Wind-blown deposits: Pale-yellow or gray sand, mainly from granite or schist.		Windsor (DS)		
Flood plain deposits: Pale-yellow or gray sand, mainly from granite and schist.		Ondawa (A)		Rumney (A). Saco (HB).
Organic matter:				
Nearly black well-decomposed acid organic matter.				Waterboro muck (B).
Dark-brown poorly decomposed acid organic matter.				Balch peat (B). Littlefield peat (B).

The Marlow, Paxton, Becket, Essex, Charlton, and Hollis soils are well drained and have a light-brown or grayish-brown loam surface soil and a yellowish-brown loam to silt loam subsoil. The Sutton, Waumbek, Peru, and Acton are imperfectly drained and have a dark-gray or grayish-brown loam surface soil and a grayish-yellow or mottled yellowish-brown and gray subsoil. The Sutton soil is usually a little better drained than the Waumbek, Peru, or Acton soils and is associated with Charlton and Hollis soils. The Waumbek, Peru, and Acton soils are associated with the Marlow, Paxton, Essex, and the coarser textured upland soils. Whitman soils are poorly drained and have a very dark-gray to black loam surface soil and a gray or mottled gray, grayish-brown, or grayish-yellow subsoil.

Collectively, the soils developed on firm to hard fine-textured till cover about 19 percent of the area of the county, but probably more than 50 percent of the crops are grown on them. Farming communities have been maintained wherever soils of this group are extensive, and on many isolated farms most of the tilled land is on one of these well-drained soils. The soils are well suited to hay, corn, small grains, potatoes, fruit, and vegetables. They are relatively cold and late to warm in spring but withstand the short periods of drought that sometimes occur in New England during July and August. Relatively few areas of Waumbek, Peru, Acton, or Whitman soils are included in cultivated fields because they cannot be tilled until very late in spring and may be wet at harvesttime.

The Marlow soils are among the most productive in the county and support many excellent apple orchards and pastures. The Marlow soils are widely distributed, but most of the areas are in the towns of Francestown, Deering, New Boston, Wilton, Greenville, New Ipswich, the eastern part of Temple, and the western part of Mason. The Hollis and Charlton soils, which occur only near the village of Hollis, are well adapted to the production of apples, peaches, and small fruits. Not all of the soils in this group are suitable for cultivation, however, as in places many have stones on the surface and some are steep. The stony, steep, and imperfectly and poorly drained areas are generally well suited to pasture.

SOILS ON RELATIVELY COARSE-TEXTURED GLACIAL TILL

The soils on relatively coarse-textured glacial till are members of the Canaan, Hermon, Shapleigh, Gloucester, Lempster, Acworth, Brimfield, and Brookfield series. All are well drained but are somewhat more droughty than the well-drained soils on compact fine-textured glacial till. They occupy about 21 percent of the county.

The Gloucester, Hermon, Shapleigh, and Canaan soils are developed on deep loose to firm coarse-textured gritty gray glacial till derived largely from granite. The parent material of the Brookfield, Acworth, Brimfield, and Lempster soils is deep loose micaceous yellowish-brown glacial till, mainly from reddish-brown pyritiferous mica schist. Bedrock lies close to the surface of the Canaan, Shapleigh, Lempster, and Brimfield soils, but the others are developed on deep till.

Most of the soils on relatively loose coarse-textured glacial till were not suited to cultivation until a great number of surface stones were removed. Many cultivated areas were abandoned in the nineteenth century and have since produced a crop of lumber. A few successful

farms, principally poultry or specialty farms, are on soils of this group, but generally acidity and droughtiness make farming unsuitable. Hermon and Gloucester, for example, are the most extensive and widely distributed soils in the county but are so stony, bouldery, and droughty that most farms having these soils exclusively have been abandoned or are now used for summer residences.

SOIL ON KAMES, TERRACES, AND WIND-BLOWN DEPOSITS

The soils on kames, terrace, and wind-blown deposits are divided into three groups: (1) Soils developed on gravelly and sandy kame deposits; (2) soils developed on nearly level glaciolacustrine, glaciofluvial, and river terraces; and (3) soils developed on wind-blown sands.

SOILS DEVELOPED ON GRAVELLY AND SANDY KAME DEPOSITS

The soils developed on gravelly and sandy kame deposits—members of the Hinckley, Danby, and Peterboro series—are closely related and nearly alike in characteristics. All have developed from loose gravelly material left in the form of hillocks, or kames. They are widely distributed over the county, and even though individual areas are usually small, the soils cover about 9 percent of the total area.

Soils of this group are usually nonagricultural, and most areas are forested or in permanent pasture. The most common tree in forested areas is white pine. A small acreage is included in cultivated fields or in tracts mowed for hay. These soils are useful as pasture land in spring because they warm early and furnish grazing when other soils are too soft, but the pasture becomes dry and thin early in summer. Most pastures receive no attention, and hardhack, ferns, mosses, juniper, aspen sprouts, white pine seedlings, and brush are common undesirable growth.

SOILS DEVELOPED ON NEARLY LEVEL GLACIOLACUSTRINE, GLACIOFLUVIAL, AND RIVER TERRACES

The soils of the nearly level glaciolacustrine, glaciofluvial, and river terraces are members of the Merrimac, Nashua, Colton, Buxton, Sudbury, and Scarboro series. As a group these soils make up about 11 percent of the county, and they occur mostly in areas once occupied by glacial Lake Merrimack or glacial Lake Contoocook. They also occupy nearly level terraces and outwash plains formed by materials deposited by the waters of receding glaciers or by rivers.

The Merrimac, Nashua, and Colton soils are well drained and range in texture from loamy sand to loam. The surface soil is light brown; the subsoil light yellowish brown; and the substratum, gray. The Merrimac and Colton soils are characterized by some gravel in the upper 30 inches. Nashua soils have no gravel in their profile and are developed from sandy material.

The finer textured well-drained Nashua, Colton, and Merrimac soils are usually used for crops or improved pasture, but the coarser textured soils are very droughty and much of their area has reverted to brush or forest. The finer textured soils have good to excessive internal and external drainage; are easily tilled at any time except when frozen; are nearly level; are free of stones; and respond well to fertilization. This combination of favorable factors makes them

some of the best utilized soils in the county. They yield as well as the better upland soils in all except the especially dry seasons and are used similarly to the upland soils.

The Buxton, Sudbury, and Scarboro soils of nearly level glaciofluvial and glaciolacustrine terraces are imperfectly or poorly drained. They are associated with the well-drained Merrimac, Nashua, and Colton soils but occur in areas where ground water is within 30 inches of the surface during wet seasons. For the most part they lie in areas between the well-drained Merrimac and Nashua soils and the base, or lower margin, of upland soils. They usually have a dark surface soil, a light yellowish-brown subsoil mottled with gray at various depths, and a pale yellow or gray substratum mottled throughout with gray or brown. They are not of particular agricultural importance because they occur as small patches within well-drained areas of cropland or in larger bodies too wet for anything but pasture or forest.

The imperfectly drained Buxton soils have developed from lacustrine silt and clay. They are characterized by a heavy texture, thinly laminated alternate beds of silt and clay, and a mottled subsoil. They usually occur on slight slopes. . The Sudbury and Scarboro soils have developed in depressions from sandy and gravelly materials. The Sudbury soils are most commonly associated with Nashua soils, whereas the Scarboro are most often associated with the Merrimac. The Sudbury has a grayish-brown surface soil and mottled subsoil. The mottling occurs at any depth below 10 to 12 inches, but most frequently at about 15 inches. Scarboro soils have a dark-gray to black surface soil, and the mottling is closer to the surface than in Sudbury soils.

SOILS DEVELOPED ON WIND-BLOWN SANDS

During the retreat of the glacier that once covered New England, the winds were very strong at the edge of the ice, just as they are today in Greenland and Antarctica. The prevalent westerly winds picked up the pale-yellow fine sand from the newly formed outwash plains along the glacial lakes and streams and drifted it onto the edge of the upland bordering the plains. Windsor fine sandy loam, rolling phase, is the only soil developed on wind-blown sands and occupies less than 1 percent of the county. Its surface soil is now well stabilized against wind by its vegetative cover.

SOILS OF FLOOD PLAINS

Soils of the flood plains—the Ondawa, Rumney, and Saco—occur near streams or rivers and are occasionally inundated. They occupy about 6 percent of the county and are most extensive along the Merrimack River and tributary streams in the river valley.

The Ondawa soils are well drained and moderately acid. The finer textured Ondawa soils respond well to fertilizer and produce good crop yields when fertilized; in fact, some of the best yields in the county. The coarser textured soils, however, are not so well adapted to crops because they require more fertilizer and consequently are used more often as pasture or remain in forest.

The Rumney soils occur on poorly drained areas and are used for hay or pasture. They are too wet to be used successfully for cultivated crops. Saco soils occur with the Rumney throughout the county in

areas so small and intimately intermingled that it was impractical to show them separately on a map of the scale used. The complex of Rumney and Saco soils occupies long narrow strips along streams and has various degrees of drainage but is predominantly poorly and very poorly drained. Some of the small areas remain in forest, but a large part of Rumney and Saco soils has been cleared and is used for pasture or hay.

ORGANIC SOILS

The organic soils—Balch and Littlefield peats and Waterboro muck—have been classed as peat or as muck, depending on their color and state of decomposition. The peat soils are brown and the original plant structure can be identified, whereas the muck soil is black or nearly black and all plant structure has disappeared because of decomposition. The organic soils occupy about 4 percent of the county and are not important agriculturally because they are not and have not been used for crops.

SOIL TYPES AND PHASES

In the following pages the soils, identified by the same symbols as those on the soil map, are described in detail and their agricultural relations discussed. Their location and distribution are shown on the map in the envelope on page 3 of the cover, and their acreage and proportionate extent are given in table 4.

TABLE 4.—*Approximate acreage and proportionate extent of the soils mapped in Hillsborough County, N. H.*

Soil	Acres	Percent
Acworth loam, rolling phase	580	0.1
Acworth stony loam:		
Hilly phase	4,184	.7
Rolling phase	238	(1)
Balch and Littlefield peats	21,418	3.8
Shallow phases	876	.2
Becket loam:		
Gently sloping phase	224	(1)
Sloping phase	1,155	.2
Becket stony loam:		
Gently sloping phase	214	(1)
Sloping phase	2,390	.4
Brimfield stony loam, hilly ledgy phase	208	(1)
Brookfield stony loam, hilly phase	821	.1
Buxton silt loam:		
Gently sloping phase	296	.1
Nearly level phase	268	(1)
Canaan stony fine sandy loam:		
Hilly phase	1,095	.2
Rolling phase	372	.1
Charlton loam:		
Rolling phase	684	.1
Undulating phase	572	.1
Charlton stony loam, rolling phase	279	(1)
Colton fine sandy loam:		
Level phase	2,889	.5
Undulating phase	1,003	.2

[1] Footnote at end of table.

TABLE 4.—*Approximate acreage and proportionate extent of the soils mapped in Hillsborough County, N. H.*—Continued

Soil	Acres	Percent
Colton gravelly fine sandy loam:		
Level phase	145	(1)
Undulating phase	1,014	0.2
Colton loamy fine sand:		
Level phase	466	.1
Undulating phase	707	.1
Colton loamy sand:		
Level phase	592	.1
Undulating phase	164	(1)
Colton sandy loam:		
Level phase	674	.1
Undulating phase	200	(1)
Colton stony gravelly fine sandy loam, undulating phase	68	(1)
Danby gravelly fine sandy loam:		
Hilly phase	10,674	1.9
Rolling phase	3,938	.7
Danby gravelly loamy sand, hilly phase	170	(1)
Danby gravelly sandy loam, rolling phase	285	.1
Danby loamy fine sand:		
Hilly phase	6,091	1.1
Rolling phase	2,195	.4
Steep phase	19	(1)
Danby stony gravelly fine sandy loam:		
Hilly phase	3,278	.6
Rolling phase	148	(1)
Danby stony loamy fine sandy, hilly phase	460	.1
Essex loam:		
Gently sloping phase	679	.1
Sloping phase	879	.2
Essex stony loam:		
Gently sloping phase	696	.1
Sloping phase	2,754	.4
Gloucester fine sandy loam:		
Rolling phase	9,422	1.7
Undulating phase	1,447	.3
Gloucester loam:		
Rolling phase	2,954	.5
Undulating phase	1,077	.2
Gloucester stony fine sandy loam:		
Hilly phase	25,628	4.7
Rolling phase	3,922	.7
Undulating phase	986	.2
Gloucester stony loam:		
Hilly phase	10,546	1.9
Rolling phase	318	.1
Undulating phase	367	.1
Hermon fine sandy loam:		
Rolling phase	7,738	1.4
Undulating phase	496	.1
Hermon stony fine sandy loam:		
Hilly phase	30,796	5.6
Rolling phase	3,930	.7
Undulating phase	1,488	.3
Hinckley fine sandy loam:		
Hilly phase	326	.1
Rolling phase	1,767	.3
Hinckley gravelly fine sandy loam:		
Hilly phase	5,102	.9
Rolling phase	1,745	.3

[1] Footnote at end of table.

TABLE 4.—*Approximate acreage and proportionate extent of the soils mapped in Hillsborough County, N. H.*—Continued

Soil	Acres	Percent
Hinckley gravelly loamy sand:		
Hilly phase	1,688	0.3
Rolling phase	1,679	.3
Hinckley gravelly sandy loam:		
Hilly phase	471	.1
Rolling phase	342	.1
Hinckley loamy fine sand:		
Hilly phase	5,494	1.0
Rolling phase	2,829	.5
Hinckley loamy sand:		
Hilly phase	357	.1
Rolling phase	368	.1
Hinckley stony gravelly fine sandy loam, hilly phase	1,124	.2
Hollis loam:		
Rolling phase	2,457	.4
Undulating phase	236	(1)
Hollis stony loam:		
Rolling ledgy phase	2,045	.4
Undulating ledgy phase	69	(1)
Lempster stony loam, hilly ledgy phase	3,722	.7
Made land	91	(1)
Marlow loam:		
Gently sloping phase	1,127	.2
Moderately steep phase	63	(1)
Sloping phase	13,730	2.5
Marlow stony loam:		
Gently sloping phase	682	.1
Moderately steep phase	2,881	.5
Sloping phase	35,551	6.4
Merrimac fine sandy loam:		
Level phase	3,134	.6
Undulating phase	6,998	1.2
Merrimac gravelly fine sandy loam:		
Level phase	267	(1)
Undulating phase	1,578	.3
Merrimac gravelly loamy sand:		
Level phase	1,951	.3
Undulating phase	5,248	.9
Merrimac gravelly sandy loam, undulating phase	506	.1
Merrimac loamy fine sand:		
Level phase	3,321	.6
Undulating phase	7,477	1.3
Merrimac loamy sand:		
Level phase	6,015	1.1
Undulating phase	2,969	.5
Nashua loam:		
Gently sloping phase	170	(1)
Level phase	442	.1
Nashua loamy fine sand:		
Hilly phase	206	(1)
Level phase	981	.2
Rolling phase	781	.1
Undulating phase	2,975	.5
Nashua loamy sand:		
Level phase	206	(1)
Undulating phase	36	(1)
Nashua very fine sandy loam:		
Nearly level phase	1,215	.2
Rolling phase	525	.1
Undulating phase	945	.2

[1] Footnote at end of table.

from the loessal uplands are uniformly silty in texture. More variable in texture are those laid down by the more deeply entrenched streams that have cut through the loess and into the underlying drift and bedrock formations. The mixing and reassorting of the fine and coarse materials also produces a diverse assortment of sediments, and many of the soils vary considerably in texture within comparatively short distances. These more extreme variations occur especially on the bottom lands along the Missouri River, as the materials there originate not only in the adjacent loessal, glacial, and residual uplands but also in areas outside the county, chiefly those to the north and west.

The group includes the Wabash, Lamoure, and Cass series. The Wabash and Lamoure soils are developing in deep deposits of fine-textured alluvium, chiefly silt and clay; the Cass soils, which occur principally near the Missouri River, have both sandy and fine-textured material underlain by sand and gravel. The Lamoure soils are calcareous at or near the surface, but the Wabash and Cass do not react noticeably with dilute hydrochloric acid. All three contain enough lime to meet the demand of any crop, including alfalfa and sweetclover. The Wabash and Cass are well drained, whereas the Lamoure are imperfectly and poorly drained.

These soils are naturally better supplied with moisture than those on uplands and terraces. The precipitation they receive is supplemented to a considerable extent by runoff from higher levels and by moisture brought up from the underlying water table through capillary action. They are easily managed and are used chiefly for growing corn and alfalfa. Except for soils on colluvial slopes they produce better yields of these crops than any of the other soils in the county. Small grains grow well, but owing to the abundant supply of organic matter and moisture, they generally make excessive vegetative growth at the expense of the grain, and they mature rather late. Alfalfa and sweetclover can be grown many consecutive years without danger of depleting the supply of deep-seated soil moisture. The sandy soils are excellent for truck and vegetable crops and are used for such purposes in many places.

Uncultivated areas are confined mainly to poorly drained places and to narrow strips so severely dissected by stream meanders as to be undesirable for cultivation. They support luxuriant grass and a wide variety of trees and are used advantageously for the production of pasture grasses, hay, and timber.

LIGHT-COLORED SOILS OF BOTTOM LANDS

The light-colored soils of bottom lands differ from those of dark color mainly in having a shallower, lighter colored, and, in most places, coarser textured surface layer and in being closer to the Missouri River than most other bottom-land soils. Their external features, including relief, drainage, and topographic position, are comparable with those of other bottom-land soils. In most places the water table is within 3 or 4 feet of the surface.

The soils represent the earlier stages of soil development in light-colored alluvium. None has accumulated enough organic matter to darken the surface layers. They consist largely of alluvium that has been deposited rather recently by the Missouri River and hence com-

Acworth loam, rolling phase (AA).—This well-drained soil occurs in the higher parts of the county on 7- to 18-percent slopes. The 5- to 10-foot thick glacial till deposit on which the soil developed is derived principally from micaceous schist containing some iron pyrites. When exposed to weather, the schist becomes yellowish brown, a color that is imparted to the whole profile. The soil is very strongly acid; porous and easily penetrated by roots, air, and moisture; and moderately low in water-holding capacity. Although originally stony, most of the stone was removed and used for fences or to fill in low places when the land was cleared and cropped.

In the virgin condition the surface soil was a gray layer an inch or two thick covered by forest litter and underlain by a dark-brown layer 3 to 4 inches thick. The Brookfield soil does not have these gray and brown layers. Under cultivation, however, the gray and brown layers of Acworth soils are mixed and the resulting surface soil is similar in color to that of the cultivated Brookfield.

Profile description in a wooded area:

1. Mat of decomposed or partly decomposed leaves and twigs, 1 to 3 inches thick.
2. Surface mineral soil, gray fine sandy loam to a depth of ½ to 1½ inches.
3. Subsoil, dark-brown friable loam to a depth of 12 to 15 inches; in many places the upper part has mixed with organic matter and the original surface soil to form a dark-brown plow soil 5 to 6 inches thick.
4. Deeper subsoil, yellowish-brown friable loam to a depth of 20 to 30 inches.
5. Substratum, loose yellowish-brown loam or fine sandy loam glacial till high in black mica (biotite); in most places sufficient mica to impart a greasy feel when material is pressed between the fingers; thickness of till layer variable but usually less than 2 feet; in many places subsoil rests on bedrock.
6. Bedrock, usually a reddish-brown rusty rock containing much black mica, but where unweathered, rock is a dark-gray coarse crystalline mica schist or thinly banded gneiss.

Use and management.—Acworth loam, rolling phase, was originally forested with Northern red oak, yellow and white birches, sugar maple, beech, hemlock, and some white pine, but the greater part of the land is now cleared and used for hay or pasture. Hay yields 1 ton an acre under ordinary management. Corn for grain, silage corn, and potatoes are grown, usually in small areas of 2 to 5 acres, and yields are about the same as on the rolling phase of Hermon fine sandy loam. The use and management are also much the same. Because of the unevenness of the slopes strip cropping is a problem.

Acworth stony loam, rolling phase (Ac).—Except for its many surface stones 12 to 20 inches in diameter and occasional boulders and rock outcrops, this soil is similar to the associated rolling phase of Acworth loam. It is also closely associated with the Hermon and Peterboro soils. Slopes range from 7 to 15 percent.

Areas that have never been plowed or used extensively for pasture have a 1- to 3-inch mat of organic matter underlain by 1 or 2 inches of gray or nearly white fine sandy loam, and the upper 3 or 4 inches of the subsoil is dark-brown loam. Where disturbed by pasturing or logging operations, the layers may be mixed and the resulting soil is dark brown to the surface.

Use and management.—Almost all of Acworth stony loam, rolling phase, is forested, but 5 to 10 percent of the total area may be used for pasture. The pastures usually have considerable brush and small trees. Red and sugar maples, beech, white and yellow birches, hemlock, and white pine are now the principal trees in forested areas. Practically all the forested land has been cut over once or twice so that there are no stands of virgin timber. Trees grow on this soil at about the same rate as on the Hermon soils.

Acworth stony loam, hilly phase (AB).—This phase is similar in development and degree of stoniness to the rolling phase of Acworth stony loam, but it differs in relief. It occurs on 15- to 25-percent slopes, but a few small included areas have steeper slopes. Practically all of the soil is forested.

Balch and Littlefield peats (BA).—Since these peat soils are not now used for agricultural purposes, they are mapped together. Both occur where organic matter has accumulated in depressional areas wet enough to preserve some cell structure and plant form. In most places the organic accumulation is more than 3 feet deep and in some it may be 50 feet deep. These peats are associated either with soils of uplands or with soils of glaciofluvial terraces.

Balch peat, which dominates this complex, is dark brown, poorly decomposed, and acid. It consists principally of woody fibrous organic material accumulated mainly through the decay of red maple, spruce, alder, hemlock, and other woody plants. The same species now occupy areas of Balch peat. Littlefield peat has accumulated largely from sedges, rushes, and herbaceous plants and is acid. Areas of Littlefield peat support little timber, and in many places there is a shallow pond in the center of the deposit.

Use and management.—Balch and Littlefield peats are not suitable for cropping because they are subject to frost almost any time during the growing season. The areas having a low ash content, however, could be used as a source of material for bedding or as a soil amendment. The biggest obstacle in usage is the difficulty of constructing drainageways that would permit successful mining of the peat. Most areas occupy pot-hole depressions that have no natural outlet, and in only a few places could adequate drainage be obtained at a reasonable cost.

Balch and Littlefield peats, shallow phases (BB).—This complex is composed of areas of Balch and Littlefield peats that have a deposit of organic matter less than 3 feet deep. In places the accumulation of organic matter rests on gray sand or on till. The areas are usually small and occur either along or at the edge of the larger bodies of deep peat. Even if drained and cultivated, these shallow phases would probably not prove satisfactory. They would subside, or sink, when drained, and satisfactory moisture relations would be difficult to maintain. The deposit is not deep enough, moreover, to permit the mining of peat on a commercial basis.

Becket loam, gently sloping phase (BC).—This well-drained soil has developed from hard compact gritty glacial till derived principally from granite and gneiss. The parent material is similar to that from which Essex soils developed. Slopes range from 2 to 7

percent, but the gradient of most areas is about 5 percent. Runoff is moderately rapid. Water percolates into the substratum slowly, and in many places the surface and subsoil are saturated early in spring.

In virgin areas the thin gray layer just below the forest litter is underlain by a brown layer 3 to 5 inches thick. These layers are not common in the Essex soils, which occur mostly at altitudes under 700 feet. When cultivated, the gray and brown layers of the Becket soil are mixed, and the resulting plow soil is relatively similar to that of the cultivated Essex soils. Becket soils are associated with Hermon soils but differ from them in that they are heavier textured and rest on compact and platy rather than loose glacial till.

Use and management.—Becket loam, gently sloping phase, is used and managed much as the gently sloping phase of Essex loam. It occurs at higher altitudes than the Essex, and the growing season is a week or 10 days shorter. Corn grown for grain may not mature completely, but yields for other crops are generally about the same as on the gently sloping phase of Essex loam. Because potatoes do well at the higher altitudes, a few of the larger areas are used for commercial production of this crop.

Becket loam, sloping phase (BD).—In most characteristics and in use and management this soil is similar to the gently sloping phase of Becket loam. Slopes, however, are steeper (7 to 15 percent), runoff is more rapid, and more areas have been subject to some erosion. A few areas have lost a large part of the surface soil and some of the subsoil, but most have been eroded only slightly and not to a degree sufficient to lower yields appreciably. The slopes are smooth and can be strip cropped.

Becket stony loam, gently sloping phase (BE).—Except for the greater number of stones on its surface, this soil is similar to the gently sloping phase of Becket loam. Stones are numerous enough to interfere with cultivation, particularly if power-driven equipment is used. The slope range is 2 to 7 percent. The greater part of this phase was probably cleared of forest and smaller stones at one time, but the land is now used largely for permanent pasture or forest. A few areas are still in hay, although most are now forested.

Becket stony loam, sloping phase (BF).—Except for the number of stones on the surface, which interfere appreciably with cultivation, the soil is similar to Becket loam, sloping phase. Many areas were once cleared and used for cultivated crops, but since the advent of modern power machinery they have been used mostly for permanent pasture or have been left to revert to forest. A few areas are still in hay but stones interfere with harvesting.

Brimfield stony loam, hilly ledgy phase (BG).—This well-drained very strongly acid soil has developed on glacial till derived from mica schist, which is the same formation as that from which Brookfield soil developed. The mica schist weathers to a rusty yellowish brown. The principal difference from the Brookfield soil is the shallowness to underlying bedrock, which makes this soil slightly browner throughout its profile. On the average, bedrock lies 20 to 30 inches beneath the surface, but the depth is variable. Exposures of bedrock are common, and many mica-schist stones are on the sur-

face. Slopes range from 15 to 25 percent. Brimfield soil occurs for the most part at altitudes lower than 600 to 700 feet and in this respect differs from the Lempster soil, which developed from similar materials at higher altitudes and is more strongly leached.

Use and management.—Slope, stoniness, and ledginess make Brimfield stony loam, hilly ledgy phase, of little value except for forestry. In the past some stones have been removed from a few areas and the land used for cultivated crops, but most of these areas are now abandoned and have reverted to forest. The forest stand and rate of growth on this soil are about the same as on the Brookfield soil, but trees on it have a greater tendency to blow down during high winds.

Brookfield stony loam, hilly phase (BH).—This well-drained soil developed on loose to firm glacial till derived principally from mica schist that weathers to a yellowish brown. In places the schist contains iron pyrites, which when weathered apparently affect its color. On the surface soil are many angular and subangular stones 8 to 20 inches in diameter, and in a few places stones or boulders are 24 to 30 inches in diameter. For the most part, slopes range from 15 to 25 percent, but a few small areas have slopes of less than 15 percent or more than 25. The soil is very strongly acid.

The Brookfield and Acworth soils have developed on similar materials. The Brookfield soil, however, occurs principally at altitudes under 700 feet and is therefore lower than Acworth soils. It also differs from them in being less strongly leached. It is associated closely with the Gloucester soils. The 1- to 2-inch gray mineral soil of the Acworth soils does not occur in the Brookfield soil. Where cultivated, Brookfield soil is similar to Acworth soils because the gray and brown surface layers of the Acworth have been mixed and incorporated in the plow soil.

Description of a representative virgin profile:

1. Surface soil, dark grayish-brown or dark yellowish-brown friable loam to a depth of 3 or 4 inches; material separates into crumblike aggregates less than ⅛ inch in diameter and contains many small black mica (biotite) flakes.
2. Upper subsoil, strong yellowish-brown micaceous friable loam to a depth of 12 or 15 inches.
3. Deeper subsoil, yellowish-brown loose to friable loam to a depth of 20 or 30 inches; material so high in mica that it may have a greasy feel when pressed between the fingers.
4. Substratum, loose yellowish-brown loam or fine sandy loam glacial till composed largely of debris from reddish-brown micaceous schist or dark thinly banded gneiss that is reddish brown on weathered surfaces; layer variable in thickness because of the microrelief of the bedrock, which is not parallel to the surface; in most places depth to bedrock is more than 30 inches.
5. Bedrock, reddish-brown micaceous schist or a dark thinly banded gneiss, the weathered surfaces of which are reddish brown.

Use and management.—The use of Brookfield stony loam, hilly phase, for cultivated crops is not feasible because stones are too numerous. A few small areas have been cleared of many of the stones and used for crops, but this was done mostly before the day of motor-driven farm implements. If the soil were now cleared of stone and used for agricultural purposes its use and management would be similar to that for the Gloucester, but productivity would be lower.

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Almost all of this soil is forested, principally with Northern red and white oaks, red and sugar maples, beech, yellow and white birches, hemlock, and white pine. Most areas have been cut over at least once and many have been cut over twice. Virgin areas of forest are practically nonexistent.

Buxton silt loam, nearly level phase (BL).—This is an imperfectly drained moderately acid soil developed from silt and clay laid down in quiet water during the glacial period. It usually occurs at the base of slopes on level or nearly level terraces where the water table is near the surface most of the year. The height of the permanent water table prevents aeration and causes differential reduction of certain soil particles. As a result the soil has a mottled appearance. The largest tract of Buxton soil is 3 miles due south of Bedford; small isolated areas are in the vicinity of Peterboro.

Representative profile:

1. Surface soil, grayish-brown silt loam of fine granular structure; about 6 inches thick.
2. Subsoil, light yellowish-brown silty clay loam faintly mottled with gray and moderate brown; fine blocky structure; 13 inches deep; in some places considerable mottling.
3. Substratum, from 13 inches downward, gray ground color modified by yellowish-brown and moderate-brown mottling; upper part of layer fine and blocky, and lower part, very fine and platy; in many places the deeper substratum is composed of alternate layers of silt and clay.

The soil varies mainly in drainage and texture. In some small areas where the water table is closer to the surface than normal, the surface soil is darker and the upper 7 inches may be mottled. Actually, areas with this exceptionally high water table are inclusions of Biddeford soil that are too small to be mapped separately. Also included are well-drained places where the surface soil is browner, the subsoil and substratum more yellowish brown, and mottling, if present, is only below a depth of 30 inches. These better drained areas would be mapped as Suffield soil if they were more extensive. Biddeford and Suffield soils are mapped in Strafford and Rockingham Counties but not in Hillsborough. A few stones may be on the surface of those areas adjoining stony slopes, and the texture varies from place to place. Some small areas have a very fine sandy loam surface soil that grades to loam or silt loam lower in the profile. The texture of the surface soil in a few other areas is heavier than silt loam.

Use and management.—A large part of Buxton silt loam, nearly level phase, remains in hay or pasture because the permanently high water table interferes to some extent with its cultivation. The hazards of weather have also been instrumental in determining its use. The yields of corn and other cultivated crops are high in dry seasons but low when the weather is wet. The good water supply is favorable to hay and pasture, and if hay and pasture land is top-dressed occasionally with lime and is given manure or a complete fertilizer each year or every other year it produces good yields. It is not necessary to plow this soil so often as the coarser textured soils to restore yields. Alfalfa will not grow successfully because the water table is high, but clovers do fairly well if this moderately acid soil is limed.

Clay for brick making was once obtained from this soil, particularly in a relatively large area south of Bedford. The brickyards are

no longer active but there are many brick fragments in areas now grassed over, and old clay pits are prominent features of the landscape near the old brickyards.

Natural vegetation consists mostly of deciduous trees. Red maple and alder make up a large part of the stand in the few forested areas, but elm and hickory are common. White pine occurs but does not grow so well as on well-drained soils.

Buxton silt loam, gently sloping phase (BK).—In profile characteristics this phase is similar to the nearly level phase, but it has smoother slopes (2 to 7 percent) and is more susceptible to erosion when in row crops. Most of it occurs south of Bedford, where it is associated with areas of the level phase. Drainage is imperfect.

Use and management.—Because Buxton silt loam, gently sloping phase does not produce cultivated crops so well as the coarser textured better drained adjacent soils, most of it has been kept in grass. The soil erodes fairly easily, but it is protected from sheet erosion by the grass cover. The areas south of Bedford have a considerable number of erratic glacial stones. When the county was first settled, some clay was dug from this soil for brick.

Canaan stony fine sandy loam, rolling phase (CB).—This well-drained soil developed on loose glacial till derived principally from coarse-grained granite and gneiss. It occurs at altitudes of more than 600 or 700 feet and is 20 to 30 inches deep to underlying granitic bedrock. The bedrock outcrops in a few places, but in most places the soil is deep enough to be not especially droughty in any except very dry seasons. Stones are on the surface in numbers sufficient to interfere with cultivation. Slopes range from 7 to 15 percent and are relatively short.

This soil is similar to the rolling phase of Hermon stony fine sandy loam in profile development and use, but the till is not so deep to bedrock. Canaan soil is more strongly leached than Shapleigh soils, which developed from similar parent material at lower altitudes, and has a thin gray surface layer that Shapleigh soils lack.

Use and management.—When the county was first settled, some areas of Canaan stony fine sandy loam, rolling phase, were cleared of forest and smaller loose stones and used for hay and pasture. Most of the land is now in forest, but a few areas are covered by brushy pasture. Forest growth is about as good as on the Hermon soils, but trees growing close to bedrock are somewhat more likely to be blown down.

Canaan stony fine sandy loam, hilly phase (CA).—This soil is similar to the rolling phase, but it occurs on steeper slopes (15 to 25 percent). Practically all of it is now in forest, which is its best use because the combination of stoniness, droughtiness, and steepness make the soil unsuitable even for pasture. Forest growth is good. The most common trees are white and yellow birches, red and sugar maples, beech, spruce, fir, and white pine.

Charlton loam, undulating phase (CD).—This soil developed on the gently undulating plain in the southeastern part of the county. The most typical areas are in the town of Hollis, where they are associated with Hollis soils. The Charlton soil developed on deep and

moderately firm olive glacial till derived principally from a gray mica schist or phyllite and occurs on 2- to 7-percent slopes. In most places these slopes are less than 300 feet long. Runoff, internal drainage, and moisture relations are good. Water never stands on the soil, and plants wilt only if the rainless period is very long.

Profile description in a cultivated area:

1. Surface soil, dark-brown or dark grayish-brown loam to a depth of 5 or 7 inches, the color indicating moderate organic-matter content; when slightly moist and shaken gently, soil falls into small crumblike aggregates about 1/16 to 1/8 inch in diameter; a few rounded stones larger than 2 inches in diameter are on the surface or in the soil, and in some areas many small fragments of phyllite or schist; medium to slightly acid, depending on whether or not lime has been added; readily penetrated by roots and moisture; easy to cultivate and prepare for seed.
2. Subsoil, yellowish-brown friable loam to a depth of about 15 inches; in places has an olive cast and in others, especially in the upper part, is brown or dark brown; deeper subsoil, yellowish-brown or olive-brown friable loam to a depth of 20 or 24 inches; very strongly acid; moderately firm in place; little or no organic matter; easily separated into small soft subangular aggregates about 1/8 inch on a side; contains a few stones and gravel larger than 3 inches in diameter and in some places has many small fragments of schist or phyllite; holds considerable moisture without injury to crop plants; readily penetrated by roots, air, and moisture.
3. Substratum, or parent material, grayish-yellow to olive fine sandy loam or loam glacial till derived largely from phyllite and schist but including some fragments and debris from gneiss and granite; large boulders not so common as in Gloucester and other soils developed from till derived principally from hard rock; less than 15 percent of the mass consists of stones larger than 6 inches in diameter; till moderately hard but not so hard or compact as that of the Marlow and Essex soils and separates easily into firm angular aggregates about 1/4 or 1/2 inch long; many aggregates coated with dark-brown stain that may contain organic matter leached from the surface soil; till 12 inches to several feet thick over bedrock but in most places less than 10 feet; neutral to slightly alkaline where a few lime lenses in the phyllite have been mixed into the parent material, but in most places slightly acid; stores a large quantity of water but roots, moisture, and air penetrate slowly.

In some places the texture of the surface and subsoil is a light loam and in others a heavy loam or silt loam. The content of large stones varies from practically none to enough to hinder cultivation. The substratum varies slightly in consistence and structure; in places it is friable with soft aggregates, and in a few others it has hard aggregates and resembles that of the Paxton soils.

Use and management.—The entire area of Charlton loam, undulating phase, is cleared, and probably 60 percent of the land is in hay. A few areas are used for potatoes, truck crops, strawberries, raspberries, and asparagus, and there are several apple and peach orchards and a few rotated pastures. A 4-year rotation of corn for grain or silage, oats, hay, and hay is commonly followed, and good yields of all crops are obtained. Under ordinary management acre yields are about 40 bushels of corn for grain or 12 tons for silage, 40 bushels of oats for grain or 1½ to 2 tons of cut hay, and 1½ tons of timothy and clover hay. Corn commonly receives 300 to 500 pounds an acre of superphosphate and heavy applications of manure, but if no manure is available, 1,000–1,200 pounds of 5–10–10[8] is recommended. Where

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

mowings are allowed to stand for more than 2 years, manure sometimes is applied after the second crop is cut.

Charlton loam, rolling phase (Cc).—Except for its steeper slopes (7 to 15 percent, with an average of about 10 percent), this soil is similar to the undulating phase of Charlton loam. The possibility of sheet erosion is greater than on the undulating phase, and a few inches of surface soil have been lost from parts of some areas as a result of sheet erosion. Strip cropping may be necessary to prevent extensive sheet and rill erosion where row crops are grown more than 1 or 2 years in succession.

Use and management.—All of Charlton loam, rolling phase, is cleared and farmed. About 75 to 80 percent of the acreage is in hay most of the time. Many hay fields are allowed to stand several years. A few acres are used as rotated pastures. The yields and management are about the same as for the undulating phase.

Charlton stony loam, rolling phase (Ce).—The till from which Charlton soils developed does not contain so many stones and boulders as that from which the Gloucester soils developed, and in their virgin condition, many areas of Charlton soils were much less stony. Charlton stony loam, rolling phase, nonetheless, has a sufficient number of surface stones to interfere with cultivation by two-horse or motor-driven machinery. It is similar to the rolling phase of Charlton loam in profile characteristics. Slopes range from 7 to 15 percent but in most areas are greater than 10 percent. In wooded areas about 2 inches of partly decayed leaves and twigs are on the surface, and in pastured areas the upper surface soil is darker than in cultivated fields.

Use and management.—Many areas of Charlton stony loam, rolling phase, were probably cropped when cultivation was carried on by one-horse implements supplemented by much hand labor. Now most areas are left in pasture or woodland. Bluegrass is common in pastures, and in wooded areas the principal trees are shagbark hickory, red maple, and Northern red oak. Some of the pastures contain clumps of juniper, hardhack, and sweetfern. Where pastures are top-dressed with mineral fertilizer and ground limestone their grazing capacity is increased.

Colton fine sandy loam, level phase (Cf).—This well-drained soil developed on nearly level glacial stream terraces or in more elevated parts of the county. In general the Colton soils occur at altitudes greater than 600 or 700 feet, and they consequently differ from the Merrimac soils, which developed on similar parent materials at the lower altitudes. In places they are so closely intermingled with the Merrimac soils, however, that an arbitrary line of separation must be made.

Colton soils are a little more strongly leached than the Merrimac, and in their virgin condition have a thin gray layer 1 to 2 inches thick just under the forest litter. The gray layer is underlain by a brown layer 3 to 5 inches thick. The Merrimac soils lack both of these layers, and the surface layer is grayish brown and relatively high in organic matter. When Colton soils are plowed, the gray and brown surface layers are mixed and the resulting plow soil resembles that of cultivated Merrimac soils. Where not eroded, the

cultivated Colton soils, unlike the Merrimac, retain a remnant of the brown layer just under the plow layer.

This phase is strongly acid, and the upper layers in the virgin condition may be extremely acid. It has the best water-holding capacity of any of the Colton soils because of its fine texture and because the gravel layer is so deep that rain entering the soil is stored in the upper finer textured layers. Despite a good water-holding capacity, the soil tends to become droughty more quickly than those on nearby uplands. Little water runs off the surface, and the soil is very porous.

Profile description:

1. Organic mat, in forested areas a layer of partly decomposed litter about 2 inches thick rests upon the mineral soil.
2. Surface mineral soil, grayish-white or gray single-grained fine sand mixed with a few black particles from the organic matter directly above; gray layer about 1 to 2 inches thick but tending to be thinner at lower altitudes where Colton soils grade into the Merrimac.
3. Subsoil, upper 3 to 5 inches moderate-brown fine sandy loam with a weak very fine crumb structure; becomes yellowish brown with depth and may contain some gravel in lower part; about 24 inches deep.
4. Substratum, pale-yellow loose stratified water-laid sand and gravel; the alternating horizontally laid bands of sand and gravel usually 6 to 12 inches thick; gravel ordinarily up to 2 inches in diameter but in some places larger; water-holding capacity of the substratum very low.

Use and management.—Most of Colton fine sandy loam, level phase, is cultivated, but a few areas are used as pasture and some are forested. The principal crops are corn for silage, oats, and hay. The growing season is 7 to 10 days shorter than where Merrimac soils are located, and for this reason, corn for grain does not mature so well. The management requirements and crop yields are very similar to those of Merrimac fine sandy loam, level phase.

Colton fine sandy loam, undulating phase (Cg).—This soil is closely associated with the level phase of Colton fine sandy loam and has practically the same profile characteristics, but it occurs on undulating relief (2- to 7-percent slopes). All types of agricultural machinery can be used on the slopes without difficulty, and erosion is not a problem unless row crops are grown two or more years in succession. If row crops are grown continuously, strip cropping or other special management practices may be necessary to prevent sheet and rill erosion. This soil is used and managed much as the level phase, and crop yields are similar.

Colton gravelly fine sandy loam, level phase (Ch).—By volume, 20 to 25 percent of the surface soil of this phase is gravel. The individual pebbles are usually ½ to 1½ inches in diameter, but some may be smaller and others larger. The soil occurs on nearly level terraces and differs from the level phase of Colton fine sandy loam mainly in having more gravel in its surface soil. The gravel does not make much difference in the use. However, this gravelly soil is a little more droughty than the fine sandy loam, and in dry seasons yields are liable to be lower.

Colton gravelly fine sandy loam, undulating phase (Ck).—This soil differs from the level phase of Colton gravelly fine sandy loam

principally in its greater slope (2- to 7-percent gradient). In use, management, and yields produced, this phase is much like the undulating Merrimac gravelly fine sandy loam.

Colton loamy fine sand, level phase (CL).—This soil is similar to Colton loamy fine sand, undulating phase, in profile characteristics and differs principally in occurring on nearly level areas. Much of the land is forested, and gray birch and pitch pine are common. Areas near villages are used for house sites, a well-suited use because the underlying sand and gravel make the soil excessively drained and open. The soil is productive where it is irrigated, otherwise it is so droughty that crop growth is retarded during the dry periods that occasionally occur in the growing season.

Colton loamy fine sand, undulating phase (CM).—Though this well-drained soil is similar to Colton fine sandy loam, undulating phase, in most profile characteristics, it has a lighter textured surface soil and subsoil. It has complex 2- to 7-percent slopes and developed on glaciofluvial terraces formed principally of material from granitic rock. A large part is in forest because its lighter texture makes it droughty. Some of the soil is used for home gardens, but yields are low unless water for irrigation is available during drier parts of the growing season.

Colton loamy sand, level phase (CN).—The profile relations of this soil are much the same as those of the level phase of Colton loamy fine sand. The principal difference is in texture; this phase is coarser throughout and therefore more droughty. Because of droughtiness, most of it is in forest. The few cleared areas are not farmed intensively and are mainly in hay. Use, management, and yields are similar to those for the level phase of Merrimac loamy sand.

Colton loamy sand, undulating phase (Co).—This soil differs from the level phase of Colton loamy sand in having steeper slopes (2 to 7 percent). Use and management are similar to that for Merrimac loamy sand, undulating phase.

Colton sandy loam, level phase (CP).—This phase occurs on nearly level terraces and, except for the coarser texture of its surface soil, is very similar to Colton fine sandy loam, level phase. Most of it is cleared and farmed. The yields are about 10 percent lower than those obtained on the fine sandy loam.

Colton sandy loam, undulating phase (CR).—This phase differs from the level phase of Colton sandy loam in having steeper slopes (2 to 7 percent). Runoff is somewhat greater than on the level phase. Where this soil is cropped intensively, some erosion occurs, and in a few places it is moderately eroded.

Colton stony gravelly fine sandy loam, undulating phase (Cs).—This phase is commonly closely associated with nonstony Colton or Danby soils and occurs mainly on 2- to 7-percent slopes at the base of uplands. In profile characteristics it is similar in all respects to Colton gravelly fine sandy loam, level phase, but it differs in stoniness. Angular to subangular granite surface stones up to 3 feet in diameter occur in numbers sufficient to interfere with cultivation by two-horse or motor-driven equipment.

Danby gravelly fine sandy loam, hilly phase (DA).—This soil developed from gravelly material, mainly of granitic and schistose origin, that was deposited in kames and eskers. It occurs on small rounded hillocks or hummocks, usually not larger than a quarter of an acre in extent, that rise 50 to 75 feet above the surrounding land. Ordinarily these kames are along the base of hills and adjoin the glacial flood plains, but occasionally they are relatively isolated and associated with areas of Hermon soils. Areas are chiefly at altitudes greater than 600 to 700 feet and are most common along the major drainageways. Slopes are often as great as 40 percent, but the general range is 15 to 25 percent. Surface relief may be gently undulating where several kames are fused together. External drainage is good and internal drainage is excessive. Little reserve moisture is held for plant growth.

Profile description:

1. Organic mat, 1- to 3-inch layer of partly decayed leaves and twigs in forested areas.
2. Surface mineral soil, nearly white fine sandy loam varying from very thin to 2 inches and in some small areas 3 inches or more thick, such range in thickness occurring in places within a radius of less than 3 feet; layer single-grained and individual particles have little tendency to stick together; extremely low organic-matter content; acid; roots penetrate to reach layers lower down but layer itself contains few small fibrous feeding roots.
3. Upper subsoil, 5 inches deep; in forested areas upper part dark-brown gravelly fine sandy loam averaging about 3 inches thick; in small areas where the surface gray layer is uniformly deep this 3-inch dark-brown layer may have scattered cemented granules about ⅛ to ¼ inch in diameter that are easily broken by pressing between the thumb and finger; dark-brown part relatively high organic-matter content; by volume, about one-fourth or more of the upper subsoil commonly consists of gravel less than ⅛ inch in diameter; gravel predominantly granitic but partly granite and partly phyllite where this phase is associated with soils derived from these materials; roots occur throughout.
4. Middle subsoil, in forested areas a light yellowish-brown gravelly fine sandy loam 5 to 12 inches deep; soil particles single grained but may show aggregation into soft granules; by volume, layer about one fourth gravel varying from ¼ to 2 inches but dominantly ¼ to ¾ inch in diameter; easily penetrated by roots, which occur throughout; relatively low water-holding capacity caused by the low quantity of very fine material in the soil mass.
5. Lower subsoil, light yellowish-brown to grayish-yellow gravelly fine sandy loam extending to a depth of 24 or 30 inches; single grained and contains little organic matter; loosely held in place; very low moisture-holding capacity; about the same quantity of gravel as in the overlying layers; rounded stones in places.
6. Substratum, yellowish-gray sand and gravel in most places imperfectly assorted into layers of nearly equal-sized materials loosely held in place; some rounded stones but usually not many; where granite materials predominate, the pebbles are derived principally from granite; in areas where schist rock predominates, gravel consists largely of gray or bluish-gray flat schist fragments; very low water-holding capacity caused by coarse soil material.

In cultivated areas the first three layers and the top part of the middle subsoil have been thoroughly mixed to a depth of 7 inches by plowing, and the resulting soil is a brown gravelly fine sandy loam, essentially single grained. A tendency toward a very fine crumb structure may be noted in some areas that have been cropped in such a manner as to maintain or increase the organic-matter content. Also mapped are

areas of some terrace-escarpment soils that have 15- to 25-percent slopes and are closely associated with the Colton soils. These soils developed where terraces break off suddenly from one to another or down to the flood plain.

In addition, there are a number of variations that are typical of soils developed on kames. Swiftly running melt water deposited the parent material for kame soils along the edges of the glacier, and the varying speed of the water caused considerable variation in the size of the particles deposited. The variations most commonly observed are those in which (1) the surface texture is a sandy loam, (2) the profile includes a very fine sandy or very coarse gravelly layer in either subsoil or substratum, or (3) the number of large surface stones is unusually great and makes the soil difficult to cultivate. Areas of Danby gravelly fine sandy loam, hilly phase, showing these variations are too small to map separately.

Use and management.—Only about 10 percent of Danby gravelly fine sandy loam, hilly phase, is cultivated. The soil occurs in relatively small areas, and accurate data concerning yields and agronomic practices are therefore lacking. In general, yields are low on cultivated areas, but where the kames are associated with an upland soil, this phase is utilized for gardens because it warms earlier in spring than the heavier upland soils and can be plowed any time after frost. Peas, lettuce, and other early vegetables that mature before the dry season in midsummer do very well if well fertilized, and field beans or other longer growing crops requiring less moisture give fair yields. The soil responds well in unusually wet seasons.

Once established, alfalfa grows 3 to 4 years in cultivated fields. Usually about 2 tons of lime an acre must be applied to the soil before planting. The yield is 1½ to 2 tons an acre for 2 or 3 years and then becomes gradually less. Other hay crops yield well for 1 or 2 years after seeding, providing they are fertilized as on associated soils, but yields decline fairly rapidly.

Possibly 25 percent of the soil is in pasture. Although pasture is available earlier in spring than on associated heavier soils, this advantage is offset by the droughtiness of the soil during summer. Pasture improvement is not common, and most areas are becoming brushy with juniper, cinquefoil, lowbush-blueberry, mosses, and sprouts of gray birch and pine. Many areas are reverting to forest. The natural vegetation is largely pitch and white pines and gray birch or a combination of the three.

Sand and gravel for road building are excavated from many areas, but the gravel is usually less desirable than that from Danby gravelly sandy loam, rolling phase.

Danby gravelly fine sandy loam, rolling phase (DB).—This phase differs from the hilly phase mainly in its lesser slope (7 to 15 percent). As a result cultivation is somewhat easier, and more of this soil is in row crops. Hay is the main crop and it yields about the same as on the hilly phase. At least 75 percent of this land is in forest.

Danby gravelly loamy sand, hilly phase (DC).—This phase is similar to the hilly phase of Danby gravelly fine sandy loam in color and profile structure but has a lighter texture. The soil is therefore

more droughty. Slopes range from 15 to 25 percent, but included are a few somewhat steeper areas that have no gravel in the surface soil. In most of these included areas, however, the gravel strata occur somewhere in the upper profile. Practically all the land is forested.

Danby gravelly sandy loam, rolling phase (DD).—This soil differs from the rolling phase of Danby gravelly fine sandy loam mainly in being coarser textured. Slopes range from 7 to 15 percent. The soil is used and managed similarly to the rolling phase of the gravelly fine sandy loam but is somewhat less productive because it is a little more droughty. About 75 to 80 percent of this phase is in forest, and the rest is used principally for hay or pasture.

Danby loamy fine sand, hilly phase (DE).—Bodies of this soil are widely distributed over the entire county in both highland and lowland areas. The soil developed chiefly from sandy material deposited as kames, and it occurs on hills or hummocks in the same general position as Danby gravelly fine sandy loam, hilly phase. The conformity of the hills is almost identical, and slopes for both range from 15 to 25 percent. Gravel is not so prominent in this soil, however, and the texture of the surface soil is lighter. Internal and external drainage are excessive and this soil is even more droughty than the gravelly fine sandy loam. Mineral nutrients are not retained because this soil has a lower organic-matter content and is coarser textured. It is therefore not so valuable as the hilly phase of Danby gravelly fine sandy loam.

Profile description:

1. Organic layer, mat of partly decayed leaves on surface soil in forested areas.
2. Surface mineral soil, light-gray to very pale-brown single-grained very loose loamy fine sand varying from very thin to as much as 3 inches thick.
3. Upper subsoil, in forested areas a brown loamy fine sand to a maximum depth of about 6 inches; averages about 4 inches thick; material single-grained but particles are in places grouped as small friable granules or crumbs; layer a little more coherent than others of the profile but still loose; scattered gravel in places.
4. Lower subsoil, layer of fine sand or sand from a depth of 6 to 24 inches; in first 4 or 5 inches layer is light yellowish brown, but it grades almost imperceptibly into weak yellow or light yellowish brown; the single-grained fine sand or sand is so loose a freshly cut bank will barely hold its shape; gravelstones isolated, not in strata; in some places gravel almost absent.
5. Substratum, pale-yellow to weak-yellow sand that may be alternately stratified with gravel at a depth of 4 to 5 feet; gravelstones and sand particles derived largely from granite but some may be from schist where nearby glacial till is derived from schist; sand grains predominantly quartz; rain water soon drains from the loose incoherent sand and the soil is droughty.

Variations in the soil are not great, but when it is cultivated the profile differs somewhat. The first three layers and the very top part of the lower subsoil are mixed to a depth of 7 inches by plowing. The plow layer is then pale-brown to weak-brown single-grained loamy fine sand that rests immediately on the light yellowish-brown to pale-yellow part of the fourth layer.

Included with this soil are a few areas of soils having the same slope range. These included soils have developed on terrace escarp-

ments and are closely associated with Colton soils developed on terraces but have a profile similar to that of this soil and other soils developed on kames.

Use and management.—Most of Danby loamy fine sand, hilly phase, is in pasture or forest, and little land is cultivated. The same management practices as those used on Danby gravelly fine sandy loam, hilly phase, are appropriate for cultivated or pastured areas. The material in the kames can be used for deep fills but is generally not satisfactory for road building. Forested areas of this soil have a mixed cover of pitch and white pines, gray birch, and, at higher altitudes, some hemlock. As growth proceeds, the pitch pine and gray birch die out, leaving the white pine and hemlock to reach maturity.

Danby loamy fine sand, rolling phase (DF).—The slopes on this soil are 7 to 15 percent, as compared to 15 to 25 percent for the hilly phase; otherwise, the two soils are similar. Most of this soil is forested.

Danby loamy fine sand, steep phase (DG).—This phase is similar to the hilly phase, but it occurs on steeper slopes (25 to 50 percent). Practically all of the land is forested.

Danby stony gravelly fine sandy loam, hilly phase (DH).—Except for many rounded surface stones large enough to interfere with or prevent cultivation and stones and boulders within the profile, this soil is much like the hilly phase of Danby gravelly fine sandy loam. This phase, however, is distributed widely at higher altitudes and occurs most frequently where associated soils are of granitic origin. Slopes range from 15 to 25 percent. Because none of this soil has been cultivated, most areas have a gray surface mineral layer 2 to 3 inches thick immediately below the organic litter.

Only about 10 percent of this soil is pastured intensively, and the rest is forested. If it were cleared of stone and cultivated, this soil would respond in the same way as the hilly phase of Danby gravelly fine sandy loam.

Danby stony gravelly fine sandy loam, rolling phase (DK).—Except for the many stones on the surface and throughout, this phase is similar to the rolling phase of Danby gravelly fine sandy loam. The stones are usually of granite, rounded or subangular, and from pebble size to 2 feet or more in diameter. Slopes range from 7 to 15 percent. Practically all this soil is in forest.

Danby stony loamy fine sand, hilly phase (DL).—Slopes for this soil range from 15 to 25 percent, and the position is similar to that of the hilly phase of Danby loamy fine sand. Rounded surface stones are numerous and would have to be removed before the soil could be cultivated. The stones have been removed from many areas and have been used for walls. At present all of the soil is in pasture and forest. Its response to treatment is similar to that of Danby loamy fine sand, hilly phase, or Danby gravelly fine sandy loam, hilly phase.

Essex loam, gently sloping phase (EA).—This well-drained soil developed from hard platy gritty glacial till derived largely from gneiss and granite. Because most of the areas face north or northwest, or in the direction from which the glacier advanced, the till was probably pressed against a hill or rock obstruction and overridden by the glacier. Probably 10 percent of the till is composed of rock frag-

ments larger than 2 inches in diameter, but most stones measure less than 18 inches. A few fragments of stone, mostly of gneiss or granite, are on the surface. Relief is gently sloping, and runoff is moderately rapid. Water percolates through the substratum slowly, and in many areas both the surface and the subsoil are saturated early in spring.

This soil is widely distributed in the eastern part of the county and occurs in close association with Gloucester soils. The Gloucester soil differs, however, in being developed on loose granitic till. In general the Essex soil occurs at lower altitudes than Becket soils, and it does not have the leached layer just below the forest litter characteristic of those soils. Its parent material differs from that of the Paxton soils, which are developed on hard platy olive till derived in large part from mica schist rather than granite or gneiss. In a few places the surface and subsoil layers are faintly mottled, and in some others the substratum consists of hard lenslike fragments of compact glacial till embedded in compact light-gray sandy till. Included with this soil are very small areas of imperfectly drained Peru loam.

Profile description in a cultivated area:

1. Surface soil, dark-brown or dark-grayish-brown friable loam to a depth of about 6 inches; separates into small soft crumblike aggregates when shaken gently; dark color indicates a small quantity of organic matter; extremely acid.
2. Subsoil, yellowish-brown friable loam to a depth of about 15 inches; breaks into small irregular angular soft aggregates about ⅛ inch in diameter; very strongly acid.
3. Deeper subsoil, grayish-yellow friable loam extending to a depth of about 22 inches; faintly mottled with gray and rust brown in some places, particularly in the lower part; separates into soft plates or oblong fragments about ⅛ inch thick and ¼ to ½ inch across; very hard in places and difficult to penetrate with sampling tools, very strongly acid; this layer as well as those above readily penetrated by roots and water.
4. Substratum, hard compact gray or olive-gray gritty sandy loam or fine sandy loam glacial till extending to a depth of 10 feet or more; very hard in place and difficult to penetrate with sampling tools, but easily separated into hard lenslike fragments about ⅛ to ¼ inch thick and ½ inch across when removed from the side of a cut; in some places faintly mottled with light gray, grayish yellow, and brown, but most discoloration is on the faces of the aggregates; strongly acid; not readily penetrated by roots and moisture but not so impervious as the substratum of Paxton soils.

Use and management.—Owing to the small size of most individual areas, few farms are located entirely on Essex loam, gently sloping phase. The soil is used chiefly for hay, but some areas are in cultivated crops and a few are in pasture or forest. The original forest growth included red and sugar maples, Northern red oak, American elm, ash, yellow, gray, and white birches, hemlock, and some white pine.

Corn, oats, and timothy hay are the most common crops, although the soil is well suited to potatoes. Most of the corn is cut for silage, and the oats are usually cut green and cured for hay. The rotation most used is corn, oats, and then hay for 3 to 10 years. Manure is applied to the hay sod before plowing for corn, and the general recommendation is to add 300 to 500 pounds an acre of 5–10–10 when the corn is planted. With such treatment corn yields 9 to 12 tons an acre of silage, or if allowed to mature, 35 to 50 bushels of grain. Some farmers do not fertilize oats, but others use 200 pounds an acre of 5–10–10 or fertilizer of comparable analysis. Depending on the season and the

type of fertilization, the oat yield varies from 30 to 50 bushels of grain or from 1½ to 2 tons of hay. New hay seedings produce 2 to 3 tons an acre, but if fields are not top-dressed with manure the yield drops to 1 ton or less in 5 or 6 years.

Accelerated erosion is not serious because relief is slight and most fields are in hay or close-growing crops about 90 percent of the time. If a more intensive system of cultivation were practiced, the danger of serious washing would be increased, and diversion ditches, strip cropping, or such control measures would be advisable.

Essex loam, sloping phase (EB).—Except for its steeper slopes, this soil is similar to the associated gently sloping phase of Essex loam. The slope range is 7 to 15 percent, but most of the phase is on 10-percent slopes. Runoff is more rapid than on the gently sloping phase, and danger of erosion is greater in areas planted to clean-cultivated crops.

Use and management.—Most of Essex loam, sloping phase, is in grass for hay, but a small acreage is used for corn or potatoes, and a few areas are used for pasture. The land is farmed in the same manner as the gently sloping phase, and yields are comparable where equal quantities of fertilizer and manure are used.

Essex stony loam, gently sloping phase (EC).—Although this soil is similar to the sloping phase of Essex loam in most features, it has enough stones on the surface to impede or actually prohibit cultivation with machinery. Subangular to nearly round gneiss boulders 18 to 24 inches across and 10 inches thick are most numerous, but a few large granite boulders occur in places. The slope range is 2 to 7 percent. Areas are associated with the other Essex soils.

Use and management.—Some areas of Essex stony loam, gently sloping phase, were cleared of forest and smaller stones by the original settlers and at one time were used fairly intensively for crops. The areas that are relatively stone-free are now used principally for pasture, but the remaining stones could be removed without much difficulty with modern power equipment and the land used for cultivated crops.

Most of this soil is in forest, but a few areas are in pasture. Red maple, gray birch, American elm, white ash, Northern red oak, and white pine are the most common trees in many of the young forests, but some of the older stands include hemlock and sugar maple. Kentucky bluegrass and sweet vernalgrass will seed naturally, but hardhack, sweetfern, other shrubs, and various saplings soon materially reduce the grazing area if they are not removed.

Essex stony loam, sloping phase (ED).—This soil occurs on steeper slopes but is otherwise similar to the gently sloping phase of Essex stony loam. Slopes range from 7 to 15 percent but in most places are about 10 percent; a few areas have 15- to 25-percent slopes. Most of this soil is forested, but a few areas are in pasture. Many tracts could be cleared with comparatively little labor and would be well adapted to potatoes and general farm crops.

Gloucester fine sandy loam, rolling phase (GA).—Areas of this well-drained soil occur on 7- to 15-percent slopes in the eastern and middle parts of the county, mainly at altitudes lower than 700 feet.

The phase developed from sandy glacial till composed principally of granite debris. In depth to bedrock the till mantle varies from a few to 100 feet or more, but the average is about 10 feet. For the most part the till has not been transported a great distance. It varies in composition from place to place according to the nature of the country rock, and small stones other than those from granite and gneiss are included. Many of the areas are less than 20 acres and are surrounded by stone walls 2 to 4 feet thick and 3 to 5 feet high.

The Gloucester soil differs from the Hermon soils developed on similar materials at higher altitudes. It does not have the thin gray layer that occurs just under the forest litter in the virgin Hermon soils, nor does it have the dark-brown layer that occurs beneath the gray.

The Gloucester surface soil and subsoil are extremely acid, and the substratum is medium acid in most places. The soil is open and porous, and roots, air, and moisture penetrate easily. Water from moderately intense rains soak in, but there is some runoff during very hard rains. During prolonged droughts, plants wilt and some die because a relatively small quantity of moisture is held. The water table is usually more than 8 feet from the surface, and in many places there is no free water above bedrock.

Profile description in a cultivated area:

1. Surface soil, grayish-brown friable fine sandy loam to a depth of about 6 inches; color of the material indicates low organic-matter content; soft crumblike aggregates ⅛ inch in diameter visible when the soil is shaken gently; in most places 5 to 20 percent of layer composed of stones less than 4 inches in diameter; larger stones have been removed.
2. Upper subsoil, yellowish-brown fine sandy loam to a depth of about 10 inches; moderately firm in place; becomes yellower with increased depth; contains a few boulders and about the same quantity of small stones as the surface soil.
3. Deeper subsoil, brownish-yellow or grayish-yellow fine sandy loam extending to a depth of 20 to 30 inches; material moderately firm in place but without definite structure; contains about the same number of stones as layers above but more large boulders.
4. Substratum, pale-yellow moderately loose to firm gritty loamy sand to fine sandy loam granitic glacial till; some large granite fragments and stones and boulders larger than 2 inches in diameter make up 20 to 50 percent of the total mass; no definite structure is apparent in most places, but in some the material is slightly platy.

Variations are common but do not materially influence the use of the soil. Both black and white mica flakes occur throughout the soil, the quantity varying according to the content in the parent material. Usually there is more black mica than white. The intensity of brown in the various layers differs according to the content of iron-bearing minerals. In a few places the texture of the surface and subsoil layers is sandy loam. A few small areas of loam were included. The consistency of the till varies from moderately firm to loose, and in some places it resembles water-deposited sand and gravel. In a few places a 3- to 4-foot deposit of typical Gloucester till lies on compact platy till similar to that underlying Essex soils.

Use and management.—Although 70 percent of Gloucester fine sandy loam, rolling phase, is occupied by farms, it is used mostly for pasture or old meadow. Redtop, bentgrass, poverty oatgrass, brooms-

edge, devils paintbrush, and plantain grow in old abandoned fields, but timothy, clovers, and Kentucky bluegrass grow where the land is fertilized. Many old fields are several miles from any farm now occupied and mark the location of abandoned farms. Some of the old fields are mowed annually, but most of them are used as pasture and are growing up in briers, juniper, hardhack, and other undesirable vegetation.

Less than half of this soil is in rotated crops. Corn, potatoes, oats, and redtop and timothy mixed are the crops most commonly grown. Yields are about 1½ tons of hay an acre in newly seeded meadows but less than 1 ton of poor quality hay in old unfertilized mowings. Some farmers maintain the yield and quality of hay by top dressing the meadows with 4 to 6 loads of manure an acre every 1 or 2 years.

If manure is available, 6 to 10 loads an acre are spread on sod before it is plowed for corn. When the corn is planted, superphosphate or 5–10–10 may be added at the rate of 400–600 pounds an acre. Under ordinary management the average corn yield is 6 tons of silage. Oats are planted with no addition of fertilizer or with an application of 200 to 300 pounds of 5–10–10 or fertilizer of comparable analysis. The yield is about 20 bushels of grain or one-half ton of hay if the oats are cut green.

Several commercial orchards are on this soil, and some fields are planted to truck crops. The soil is not considered so suitable for orchards as the Paxton soils. The trees do not appear to be so thrifty, and though the apples are more highly colored, they are of poorer quality. MacIntosh apples are the variety most commonly grown. In many places no fertilizer is used, but an application of about 5 pounds of nitrate of soda or of a complete fertilizer once or twice during the season will improve yields. Under good management the apple yield is about 200 bushels an acre or 8 to 10 bushels from a 25-year-old tree.

All areas of this soil were originally forested with mixed hardwoods and white pine, but every area has been cleared and cultivated at some time. Maple, Northern red oak, beech, and gray birch were the most common broadleafed species in the virgin forest.

Gloucester fine sandy loam, undulating phase (GB).—This soil is widely distributed but occurs most frequently in the southeastern part of the county. It has gentle slopes (2 to 7 percent). It is much like the rolling phase of Gloucester fine sandy loam but is more easily tilled, is slightly less droughty, and is used to larger extent for corn, potatoes, and other row crops. Crop suitability, management practices, and yields are similar to those for the rolling phase.

Gloucester loam, undulating phase (GD).—This soil resembles Gloucester fine sandy loam, undulating phase, in color but it developed from finer textured glacial till composed largely of gneiss or mica-schist debris. It is associated with the sandier Gloucester soils and the Hollis and Charlton. In characteristics and suitability for use it is intermediate between Gloucester fine sandy loam, undulating phase, and Charlton loam, undulating phase. All parts are extremely to very strongly acid. Stones and boulders, mostly from granite and gneiss, are not so numerous as in the more sandy Gloucester soils. The slope range is 2 to 7 percent.

Profile description in a cultivated area:

1. Surface soil, dark-brown or dark grayish-brown loam; moderate content of very fine sand; weak very fine crumb structure; 5 to 6 inches deep.
2. Upper subsoil, yellowish-brown loam; weak crumb structure to a depth of 8 to 10 inches; 10 to 20 percent of the soil mass is small granitic rock fragments.
3. Deeper subsoil, yellowish-brown to grayish-yellow fine sandy loam, friable in place and practically without structure; small rock fragments and a few boulders in this layer and throughout the profile.
4. Substratum, gray moderately compact but single-grained fine sandy loam glacial till derived mainly from granitic gneiss but partly from admixed material derived from phyllitic schist similar to that underlying Hollis soils.

Included with this soil are some soils in the southern part of the county that developed on till containing some fine-grained sandstone. These included soils are more yellowish brown but are similar to this phase in other respects.

Use and management.—About 50 percent of Gloucester loam, undulating phase, is in rotated farm land, 40 percent in pasture, and 10 percent in forest or brushland. It is slightly more productive and drought resistant than the undulating phase of Gloucester fine sandy loam but not so productive or drought resistant as the undulating phase of Charlton loam. The soil is cropped and fertilized similarly to the undulating phase of Gloucester fine sandy loam but gives slightly higher yields.

Sod is commonly top-dressed with 6 to 8 loads of superphosphated manure an acre before being plowed for corn. Corn yields 30 to 45 bushels of grain or 7 to 10 tons of silage an acre, the lower limits being for ordinary management and the upper for good management. Oats are not always fertilized, but some farmers use 200 to 300 pounds or more an acre of 5–10–10. The oat yield is 25 to 40 bushels of grain an acre or 1½ to 2 tons of hay.

Many of the hayfields are mowed 5 or 6 years, or until the yield drops below 1 ton, but some farmers maintain a good yield by top dressing their fields with manure every 1 or 2 years. Many of the pastures are infested with juniper, hardhack, sweetfern, and various sprouts and annual weeds. On such pastures 3 or 4 acres is necessary to support one cow throughout the grazing season, whereas on the improved and fertilized pasture, 1 to 2 acres is sufficient for one cow.

Gloucester loam, rolling phase (Gc).—Except for its rolling relief this soil is similar to the undulating phase of Gloucester loam. The slope range is 7 to 15 percent, but the average is about 10 percent. A greater area of this soil, about 55 percent, is in pasture, but it is farmed in much the same way as Gloucester loam, undulating phase, and equal yields are obtained. The danger of damage from accelerated erosion is slightly higher than on the undulating phase.

Gloucester stony fine sandy loam, hilly phase (GE).—In most characteristics other than slope and stoniness this soil is similar to the rolling phase of Gloucester fine sandy loam. Stones are on the surface in numbers sufficient to make cultivation with two-horse or motor-driven machinery impracticable. The relief is strongly rolling to steep, and long irregular slopes are common. The dominant slope is less than 20 percent, but the slope range is 15 to 25.

Use and management.—Almost all of Gloucester stony fine sandy loam, hilly phase, is forested with mixed hardwoods and white pine or with practically pure stands of even-aged white pine. White pine and gray birch are self-seeded in abandoned grasslands, but sugar and red maples, Northern red oak, and yellow, gray, and white birches have encroached on cut-over lands.

Many areas of this soil were once completely cleared of stones or cleared enough to permit the simpler methods of cultivation then in use. These tracts, however, have not been cropped for 75 years. Stones near the surface have been exposed by frost heaving, falling trees, and in a few places, by erosion. Evidence of former farm sites is abundant. Countless stone walls occur in forested areas, and in places trees 12 inches in diameter are growing from holes that were once cellars.

The common pasture plants are bentgrass, redtop, witchgrass, broomsedge, and poverty oatgrass. Most pastured areas are growing up to juniper, hardhack, sweetfern, and various sprouts and annual weeds. In such pasture, 5 or 6 acres are required to supply grazing for one cow through the season. In weed-free pastures 3 or 4 acres will carry one cow through the grazing season, and this capacity could be increased 50 to 100 percent if manure and 100 to 200 pounds an acre of superphosphate or 200 to 300 pounds of complete fertilizer were applied. Because this phase is steeply sloping, care must be exercised in pasturing. Some damage may result if cattle are turned on this land early in spring or if areas are grazed beyond their carrying capacity.

Gloucester stony fine sandy loam, rolling phase (GF).—This soil occurs on less rugged relief but is otherwise similar to the hilly phase of Gloucester stony fine sandy loam. Slopes are shorter and less steep. The average slope is about 12 percent, but the range is 7 to 15. About half of this soil is in permanent pasture and the rest is forested. The pastures and forests are similar to those on the hilly phase.

Gloucester stony fine sandy loam, undulating phase (GG).—This phase is similar to the hilly phase of Gloucester stony fine sandy loam except that it occurs on undulating relief. The range is 2 to 7 percent and the dominant slope is about 5 percent. About half of this soil is in pasture and the rest is forested. Many of the areas are on smooth hilltops well suited to grazing, but the carrying capacity is no greater than that of the hilly phase of Gloucester stony fine sandy loam. Danger of erosion is slight on this soil because water percolates rapidly and the sod cover remains good if not seriously overgrazed.

Gloucester stony loam, rolling phase (GK).—Surface stones are on this soil in numbers sufficient to hinder cultivation with two-horse or power machinery, but in most other characteristics the phase is similar to the rolling phase of Gloucester loam. Most of the slopes are short; they range from 7 to 15 percent but average about 12 percent. A few areas are included in the southeastern part of the county that occur on similar relief but are derived in part from coarse gray sandstone or crystalline schist. The included soils are slightly more yellowish brown than typical Gloucester soils.

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Use and management.—A few areas of Gloucester stony loam, rolling phase, are pastured, but most of the land is forested. The pasture plants include bentgrass, poverty oatgrass, witchgrass, broomsedge, and in better areas, Kentucky bluegrass. The carrying capacity of the pastures is low because they are in large part covered by hardhack, sweetfern, and various sprouts and annual weeds. The common trees in forested areas are Northern red oak, sugar maple, gray birch, aspen, and white pine.

Gloucester stony loam, undulating phase (GL).—Aside from having relief in which slopes do not exceed 7 percent, this phase is similar to the rolling phase. It is much used for pasture because its moisture relations are good and there is little likelihood of accelerated erosion. The pastures are not likely to become parched during summer, but most of them are so weedy and brushy that 5 to 6 acres are required to carry one cow through the grazing season.

Gloucester stony loam, hilly phase (GH).—This soil is similar to Gloucester stony loam, rolling phase, but it has steeper slopes. The slope range is 15 to 25 percent, but most areas are on slopes of less than 20 percent. Many areas are pastured, but most of the land is forested. Forest growth and grazing capacity are similar to those for Gloucester loam, rolling phase.

Hermon fine sandy loam, rolling phase (HA).—This well-drained soil developed on loose glacial till derived principally from relatively coarse-grained gneiss and granite. It occurs on fairly short irregular slopes of 7 to 15 percent. Originally the soil was stony, but the stones have been cleared off and piled in nearby fences or used to fill in low places. A few larger stones still remain in some areas, but they are not numerous enough to interfere with ordinary cultivation.

This soil is open and porous and easily penetrated by air, roots, and moisture. Water from ordinary rains soaks in readily, but there is some runoff during very hard rains. During prolonged drought, plants on this soil wilt and yields are liable to be low. The water table is at 8 feet in most places, but in many there may be no free water above bedrock, which may be 20 to 30 feet from the surface.

Hermon soil is similar to Gloucester soils in drainage, relief, and kind of parent material, but it occurs at higher altitudes and is more strongly leached. In virgin areas the upper soil just below the forest litter is a thin gray mineral layer 1 or 2 inches thick, under which is a 3- to 4-inch dark-brown layer. Both of these layers are absent or discontinuous in Gloucester soils.

When Hermon soil is cultivated, the gray and brown layers are mixed and the resulting grayish-brown plow layer resembles that of the Gloucester soils. If the cultivated Hermon soil is not eroded, however, a remnant of the dark-brown layer remains under the plow layer, and this helps to differentiate the two. In forested areas, the separation of Hermon and Gloucester soils is usually fairly sharp in all areas except those at intermediate altitudes, where the two are intermingled. In such areas it is often necessary to make an arbitrary line of demarcation.

Profile description:

1. Organic layer, 1 to 3 inches of decayed and partly decayed leaves and twigs in forested areas.

2. Surface soil, gray single-grained fine sandy loam to a depth of not more than 3 inches.
3. Upper subsoil, dark-brown material slightly more loamy than that of overlying layer to a depth of 8 to 10 inches (in areas comparatively recently cultivated or in grass, this material is mixed with upper layers to form a grayish-brown layer); granitic stones and boulders, which may be in any layer, occur at relatively frequent intervals; about 10 to 20 percent of the soil mass made up of rock fragments up to 3 or 4 inches in diameter.
4. Deeper subsoil, yellowish-brown gritty sandy loam with a very weak fine crumb structure; extends to a depth of 24 to 30 inches.
5. Substratum, gray or light grayish-yellow loose gritty loamy sand glacial till derived mainly from granite and gneiss; large and small boulders and stones of granite and gneiss common; till varies from loose to firm and sometimes contains thin strata of material that appears water-washed.

In places the texture of the surface and subsoil layers is sandy loam, and in others loam. The principal textural variations occur in the northwestern part of the county, especially in the towns of Hillsboro, Windsor, Antrim, and Hancock, where much of the country rock is porphyritic granite high in content of feldspar. This granite makes a fine-grained till, and where such till occurs the surface soil and subsoil layers have a high content of very fine sand and the substratum is fine-grained and moderately compact. The soil developed from the fine-grained till has a slightly higher moisture-holding capacity than the normal soil and occurs on gently rolling to hilly areas where slopes range from 7 to 15 percent and average about 10 percent. Many slopes of this included soil are long, but some areas are characterized by low hills and valleys.

Use and management.—In present use, management, and yields, Hermon fine sandy loam, rolling phase, is similar to the rolling phase of Gloucester fine sandy loam. The growing season is somewhat shorter, however, and corn may not develop enough to be harvested for grain in some seasons. The forest growth is much the same as on the Gloucester soils occurring at lower altitudes but includes less white pine and more beech, yellow and white birch, and such northern hardwoods.

Hermon fine sandy loam, undulating phase (HB).—This soil is similar to Hermon fine sandy loam, rolling phase, in all respects except slope. The slope range is 2 to 7 percent, as compared to 7 to 15 percent in the rolling phase; consequently, runoff is not so high and tillage is somewhat easier. Most of the slopes are short and uneven and do not lend themselves readily to strip cropping. In use, management, and yields this soil is similar to Gloucester fine sandy loam, undulating phase.

Hermon stony fine sandy loam, rolling phase (HD).—The profile of this soil is similar to that of Hermon fine sandy loam, rolling phase, except that it is stony. Stones 12 to 24 inches in diameter and sometimes larger are on this soil in sufficient numbers to interfere appreciably with tillage operations, especially where this soil is cultivated with two-horse or motor-driven equipment. The smaller stones were removed at some time in the past, but at least 50 to 60 larger stones an acre remain.

Use and management.—A large part of Hermon stony fine sandy loam, rolling phase, was once cleared and in pasture or cultivated

crops. Cultivation was done by hand or with one-horse equipment, and the stones were not much of a problem. Now, about one-half of the land is forested and the rest is almost entirely in pasture. Only a few areas are still used for hay.

Hermon stony fine sandy loam, hilly phase (Hc).—This soil is similar to the rolling phase of Hermon stony fine sandy loam and differs principally in that it occurs on 15- to 25-percent slopes. Its use is much the same as that of Gloucester stony fine sandy loam, hilly phase.

Hermon stony fine sandy loam, undulating phase (He).—This phase is similar to Hermon stony fine sandy loam, rolling phase, but occurs on gentler slopes (2 to 7 percent). About half of the area is in pasture and the rest is forested. Many areas are on hilltops and suited to pasture, but they have a carrying capacity not much greater than that of the rolling and hilly phases of Hermon stony fine sandy loam.

Hinckley fine sandy loam, rolling phase (Hg).—This well-drained soil has developed on 7- to 15-percent slopes on terraces or kames composed principally of granitic or schistose materials. In the vicinity of Hollis the parent material contains more slaty schist or phyllite than elsewhere. Gravelly strata commonly occur at a depth of 18 to 24 inches. Most of the soil is associated with Merrimac soils. This soil is not so droughty, but in most characteristics other than texture it is much like the rolling phase of Hinckley gravelly fine sandy loam. Present use and management of the two soils are similar. This soil appears to have developed principally on terrace breaks, whereas the gravelly fine sandy loam has developed on kames.

Hinckley fine sandy loam, hilly phase (Hf).—In most respects other than relief this soil is similar to the rolling phase of Hinckley fine sandy loam. The slope range is 15 to 25 percent. Most of the soil is forested but a few areas are pastured.

Hinckley gravelly fine sandy loam, hilly phase (Hh).—This well-drained soil on 15- to 25-percent slopes has developed from gravelly material deposited as kames. It is much like the hilly phase of Danby gravelly fine sandy loam and is developed on similar material. It occurs at altitudes below 700 feet, however, or lower than Danby soils, and differs from them principally in that it lacks the continuous thin gray layer just under the forest litter and the dark-brown layer underneath the gray.

In virgin areas a thin dark grayish-brown layer fairly high in organic matter is just below the surface mineral soil. This layer grades into a yellowish-brown material within a depth of 2 to 3 inches. In the upper layers the Hickley and Danby soils differ, but they are similar in the lower part of the profile. When Danby soils are cultivated the gray and the brown layers are mixed and the resulting soil is similar to that of the cultivated Hinckley.

Use and management are similar to those for the hilly phase of Danby gravelly fine sandy loam. The growing season of the Danby soil is shorter.

Hinckley gravelly fine sandy loam, rolling phase (Hk).—Except for its greater slopes (7 to 15 percent), this soil is similar to the

hilly phase of Hinckley gravelly fine sandy loam. A slightly larger acreage of this soil is cleared, however, and tillage is easier than on the hilly phase. Only a few cleared areas are entirely on this soil; most fields contain some of this soil and either Gloucester or Merrimac soils in addition.

Hinckley gravelly loamy sand, hilly phase (HL).—For the most part this soil occurs on 15- to 25-percent slopes along major glacial waterways. It resembles the hilly phase of Hinckley gravelly fine sandy loam in every respect except texture. The surface soil is gravelly loamy sand that is coarser and lower in organic matter than the surface soil of the gravelly fine sandy loam. The subsoil is coarser textured but has about the same color as the corresponding part of the gravelly fine sandy loam. Gravel up to 2 inches in diameter is in all layers, and large stones occur at intervals on the surface but not in numbers sufficient to interfere with tillage.

The soil is very droughty and therefore not cultivated to any great extent. Most of the land is in pasture or forest. The parent material is widely used for road surfacing because it contains a minimum of fine material.

Hinckley gravelly loamy sand, rolling phase (HM).—This soil resembles the hilly phase of Hinckley gravelly loamy sand in profile and use but occurs on 7- to 15-percent slopes rather than 15- to 25-percent slopes.

Hinckley gravelly sandy loam, hilly phase (HN).—In mode of formation, relief, and agricultural use, this soil is essentially the same as the hilly phase of Hinckley gravelly fine sandy loam. It differs from the hilly phase mainly in the texture of its surface soil, but the upper subsoil may be slightly more sandy. Included with this soil are a few areas of soil developed on terrace escarpments in close association with Merrimac soils. Though these included areas have not developed on kames, they are similar to Hinckley soil in profile characteristics.

The parent material of this soil is valuable for road building because it does not contain much very fine material.

Hinckley gravelly sandy loam, rolling phase (HO).—This soil has a milder relief than Hinckley gravelly sandy loam, hilly phase. The slope range is 7 to 15 percent rather than 15 to 25 percent, and tillage operations are easier. The acreage of this soil cleared and cropped, chiefly to hay, is greater than that of the hilly phase.

Hinckley loamy fine sand, hilly phase (HP).—This well to excessively drained soil developed on kames formed principally of material of granitic origin. Relief is hilly and slopes are 15 to 25 percent. This soil occurs at lower altitudes than the hilly phase of Danby loamy fine sand and lacks the gray mineral surface layer and underlying brown layer of the Danby soil. It has, instead, a grayish-brown loamy fine sand surface soil underlain by light yellowish-brown loamy fine sand subsoil. When plowed, this soil and Danby loamy fine sand, hilly phase, look much alike because of the mixing of surface layers. Most of the area of both soils is in forest.

Included with this phase are a few areas where surface stones and cobbles occur in numbers sufficient to hinder tillage operations or pas-

ture improvement. These areas are indicated on the map by stone symbols. Also included are some areas of soil developed on terraces in association with Merrimac soils, but these are very similar to Hinckley soil in profile characteristics.

Hinckley loamy fine sand, rolling phase (HR).—Except for its gentler slopes (7 to 15 percent), this soil is similar to the hilly phase of Hinckley loamy fine sand. A few stony areas are included and are indicated on the map by stone symbols.

Hinckley loamy sand, hilly phase (Hs).—Areas of this soil are on terrace edges or where one terrace breaks to another lower down. The escarpments have a dominant slope range of 15 to 25 percent, but some slopes may be as much as 35 percent. The soil is associated with Merrimac soils.

Usually there is a 3- or 4-inch surface layer of grayish-brown loamy sand, but in some places there is no true profile and the yellowish-gray gravelly substratum is exposed. Except where it has been disturbed by slippage or trees overturning, the profile is essentially the same as that of the rolling phase of Hinckley loamy sand. The steepness of slope has caused no particular difference in depth of layers.

Use and management.—Most of Hinckley loamy sand, hilly phase, is forested, but some areas are in pasture. White pine and scrub oak are the common trees in forested areas. The common plants in pastures are poverty oatgrass and broomsedge. Sweetfern, hardhack, and briers are pests in most pastures. South-facing slopes provide some early pasture, but grazing is very poor in summer. There are many pits in this soil from which sand and gravel are excavated for road building and commercial purposes.

Hinckley loamy sand, rolling phase (HT).—From the standpoint of origin, parent material, and use, this soil is similar to the hilly phase of Hinckley loamy sand. The principal difference is in slope—7 to 15 percent for this soil, as compared to 15 to 25 percent for the hilly phase.

Hinckley stony gravelly fine sandy loam, hilly phase (HU).—This soil occurs on 15- to 25-percent slopes and on its surface has many rounded boulders and stones large enough to interfere with or prevent cultivation. The number of boulders and stones within the profile is greater than in the hilly phase of Hinckley gravelly fine sandy loam, a soil which is similar to this in other characteristics. Included in mapping are some areas with a similar profile but milder slopes. Some of these included areas may be nearly level, but they make up a very small proportion of the soil mapped.

Use and management.—The stones on Hinckley stony gravelly fine sandy loam, hilly phase, are usually not too large to be removed by a pair of horses or a small tractor, and if the soil were cleared of stone and cultivated, it would respond in exactly the same way as the hilly phase of Hinckley gravelly fine sandy loam. The soil is not cultivated. About 10 percent is pastured intensively, and the rest is forested.

Hollis loam, undulating phase (Hw).—This well-drained soil occurs on undulating relief (2- to 7-percent slopes) in the vicinity of Hollis in the southeastern part of the county. The parent material

is glacial till derived principally from mica schist or phyllite, and the underlying bedrock is about 20 to 30 inches from the surface. The Hollis soil is closely associated with the Charlton, developed on similar material, and differs mainly in being somewhat browner and shallower to bedrock.

The bedrock under the Hollis soil is mainly soft thinly bedded schist which over moderately large areas is covered by a uniformly thick soil mantle. The bedrock has been broken by ice pressure and movement and this gives the Hollis soils a greater moisture-holding capacity than soils that are shallow to hard unbroken bedrock. In Cheshire and Sullivan Counties, however, the bedrock under Hollis soil is hard somewhat massive crystalline schist in many places and is so jagged that the soil mantle may be totally lacking in one spot and 3 feet or more deep within a short distance.

Profile description in a cultivated area:

1. Surface soil, brown to dark-brown friable loam to a depth of 6 to 8 inches; grayish brown when dry; medium to slightly acid; falls into soft crumblike aggregates less than ⅛ inch in diameter when shaken gently; judging from color, relatively low in organic matter; readily penetrated by roots, air, and moisture; high water-holding capacity; many small fragments of phyllite or schist mixed with the soil in most places; a few subangular boulders of granite or other hard rock.
2. Upper subsoil, brownish-yellow or yellowish-brown friable loam to a depth of 12 to 15 inches; very strongly acid; only a trace of organic matter; many small fragments of phyllite or schist in most places; when shaken gently, falls into soft partly rounded aggregates about ⅛ inch in diameter; easily penetrated by roots, air, and moisture; high moisture-holding capacity.
3. Deeper subsoil, layer grades from yellowish-brown to olive-gray friable loam glacial till and extends to bedrock, usually at a depth of 20 to 30 inches; medium to strongly acid; no evidence of organic matter; breaks into either soft angular particles ⅛ inch in diameter or soft plates 1/16 to ⅛ inch thick and ¼ to ¾ inch across; small fragments of phyllite or schist make up 50 percent or more of the material and in places constitute the whole soil mass; readily penetrated by roots, air, and water; high moisture-holding capacity.
4. Bedrock, soft phyllite in most places but in some areas a hard micaceous fine-grained rock with obvious cleavage planes an inch or more apart; usually no free lime but in a few places near the village of Hollis a low lime content.

Variation is principally in thickness of the soil over bedrock. Outcrops occur in most areas, but within a few feet, the bedrock may be at a depth of 30 inches. The sand content of the surface soil and subsoil also varies. In some areas the texture is fine sandy loam, and in others, heavy loam or silt loam. Mapped with this soil are small areas of Charlton loam, undulating phase, where bedrock is at depth greater than 3 feet.

Use and management.—Practically all of Hollis loam, undulating phase, is cleared and in farms. Hay, corn, oats, and fruit or truck crops are grown on almost the entire acreage, but a few areas are pastured. About 40 percent of the land is in hay, 25 percent in corn, and 15 percent in small grains and fruits. Fertilization practices for this soil are similar to those followed on Charlton loam, undulating phase, and approximately equal yields are obtained. This soil, however, with its shallow depth to bedrock, can absorb only a limited quantity of moisture, and in especially dry periods, crops may wilt.

The crop rotation commonly followed is corn the first year, small grains (usually oats) the second year, and hay for 2 years. If farmers have enough manure, they spread 6 to 10 loads an acre on the hay sod before plowing for corn and add 300 to 500 pounds of superphosphate in the row when the corn is planted. If manure is not available, 1,000–1,200 pounds an acre of 5–10–10 fertilizer on one of nearly similar analysis is applied when the corn is seeded. The yield of corn is 30 to 40 bushels of grain or 6 to 9 tons of silage. The oats are not always fertilized, but many farmers drill 200 or 300 pounds of 5–10–10 when seeding. The yield is about 35 bushels of grain or 1½ to 2 tons of hay if the oats are cut green. Land in hay is top-dressed with manure if the stand is left more than 2 years. The yield varies from 1½ to 2 tons. Some farmers keep their fields in grass as long as the yield is above 1 ton.

The forest vegetation on this soil consists of mixed hardwood and scattered white pine. The most common broadleafed species are shagbark hickory, white and Northern red oaks, hard maple, beech, and white ash.

Hollis loam, rolling phase (Hv).—This phase is similar to Hollis loam, undulating phase, except it is on 7- to 15-percent slopes. The average slope is about 10 percent and relief in most places is choppy. Many slopes are less than 50 yards long. Water runs off steeper slopes more rapidly, and therefore this soil is subject to more severe damage through accelerated erosion when cultivated to clean-tilled crops for successive years. Because runoff is more rapid, less water is absorbed by the soil and crops are injured by drought more frequently than on the undulating phase.

Included with this phase are 100 acres of Hollis soil that have slopes steeper than 15 percent. These areas are on small knolls or steep slopes and are cultivated to improve the shape of the fields. In most places most or all of the surface soil has been removed through erosion, and the areas are relatively unproductive and droughty. The soil mantle is less than 18 inches in most places, and the present surface soil contains many fragments of phyllite and schist.

Use and management.—Hollis loam, rolling phase, has crop adaptations and fertilizer requirements similar to those of Hollis loam, undulating phase, and under similar treatment, equal yields may be expected. It is somewhat better suited to the production of fruit, and some of the areas are used for apple and peach orchards.

Hollis stony loam, rolling ledgy phase (Hx).—In soil characteristics this phase is similar to the undulating ledgy phase of Hollis stony loam, but it is on relief much like that of Hollis loam, rolling phase. The dominant slope range is 7 to 15 percent, but several areas having about 20- to 25-percent slopes are included. Much of this soil is in timber, but there are also many areas in permanent pasture, a use to which the soil is well suited.

Hollis stony loam, undulating ledgy phase (Hy).—Although this soil resembles the undulating phase of Hollis loam in soil characteristics, it occurs in areas where surface stones and outcropping ledges of bedrock hinder or prevent cultivation with two-horse implements. Most of the land is in pasture but a few areas are in timber.

Lempster stony loam, hilly ledgy phase (LA).—This well-drained soil developed on glacial till derived principally from mica schist high in iron pyrites. It occurs on 15- to 25-percent slopes in more elevated parts of the county, mainly at altitudes greater than 600 feet. Many fragments of mica schist rock 12 to 20 inches wide are on the surface. Bedrock is within 20 to 30 inches of the surface. Although outcrops of underlying bedrock are common and fairly well distributed over each area, they do not occupy a very large total acreage.

In depth and origin of parent material Lempster soil resembles Brimfield stony loam, hilly ledgy phase, but it differs in being more strongly leached. Under the forest litter in the Lempster soil is 1 or 2 inches of gray leached mineral soil underlain by a 3- or 4-inch dark-brown layer. These layers ordinarily do not occur in Brimfield soil. Aside from depth to underlying bedrock, the relation between the Lempster soil and the Brimfield is the same as that between the Acwortn soils and the Brookfield. The Lempster soil also resembles the Acworth but is shallower to bedrock. Between the outcrops Lempster soil is 3 to 4 feet deep and much like the Acworth.

Use and management.—If it were cleared of stone, Lempster stony loam, hilly ledgy phase, could be planted to cultivated crops, but the ledges would hinder tillage to some extent. A few areas were once cleared and cropped, but most of them are now abandoned and have reverted to forest. The soil seems about as productive of forest trees as the Acworth soils, but trees on it are more likely to be blown down, particularly where they are near ridges.

Made land (M).—Two large areas of this land near Nashua have been filled in with sand or gravel and used as mill sites. These two areas are nearly level, and the material has no definite soil profile.

Marlow loam, sloping phase (Mc).—This well-drained soil developed on hard compact platy olive glacial till derived principally from schist but in part from granite and gneiss. It occurs on smoothly rounded drumlins or drumloid hills in almost every town in the western part of the county and is closely associated with the Hermon and Acworth soils. The slopes vary between 7 and 15 percent but in most places are about 12 percent.

In many places this soil is on northern or northwestern slopes of hills where the material presumably was pressed against a hard rock formation by the glacier that advanced from the northwest. Consequently, many areas have hard rock cores, and in places outcrops occur at the crest of the hills. The Marlow soil differs from the Becket soils in having developed on till largely from schist rather than from granite. It occurs at higher altitudes than the Paxton soils and is more strongly leached.

Moisture conditions favorable to plant growth are maintained on this soil throughout the summer if rainfall is normal, crops being injured only in long periods of drought. When this soil becomes dry, a large quantity of precipitation is required to restore the normal moisture content. If wells dug in Marlow soil become dry they are likely to remain dry until the following spring. Surface drainage, or runoff, is rapid, and water and air penetrate the surface and subsoil readily except in spring. The substratum is practically impervious, and excess subsoil water moves slowly downhill parallel

to the surface. The surface and subsoil layers are usually saturated with water in spring and are wet and soft after other soils are tillable. Unless they are well-built and heavily gravelled, roads on this soil are muddy in spring and fall and almost impassible until May.

Profile description in a cultivated area:

1. Surface soil, dark-brown friable loam containing a small quantity of organic matter to a depth of about 6 inches; very strongly acid; few stones; soft crumblike aggregates developed in most places.
2. Subsoil, brown or yellowish-brown firm but friable loam to a depth of about 20 inches; very strongly acid; weakly developed crumb structure; few boulders larger than 6 inches in diameter.
3. Substratum, hard compact platy grayish-yellow or olive glacial till containing many black mica flakes; very strongly acid; difficult to penetrate with sampling tools but easily separated into angular aggregates when removed from an excavation; these aggregates about ¼ inch on the vertical axis and ¼ to ½ inch on the horizontal, are hard and difficult to break; when broken, aggregates are grayish-yellow inside, and the crushed mass is yellow or brownish-yellow gritty loam containing many black mica flakes; many aggregates coated with a lustrous dark-gray stain; less than 10 percent of the soil mass composed of stones and boulders larger than 6 inches in diameter; all the layers except this one are easily penetrated, and some roots force their way through the aggregates for short distance in this layer.

In some places the subsoil varies from brown to olive brown; in a few others the total thickness of the soil over bedrock ranges from 18 to 24 inches and may reach 30 inches. The hardness and degree of compaction usually vary slightly, but some areas in the town of Weare have a relatively friable substratum and closely resemble the Berkshire soils.[9]

The variations in this soil are caused mainly by the differing quantities and kinds of schist, granite, and gneiss included in the glacial till. Where a large quantity of reddish-brown fine-grained schist is ground into the mixture, the till is yellower and more micaceous than normal. This has occurred in the vicinity of Lithia Spring, in Temple, and generally along the Wapack Range. In some places in those areas the substratum is not so hard and compact as usual. Similarly, where a relatively large quantity of coarse-grained schist is included in the petrological complex, the till and soil developed on the till are sandier than typical. In fact, some areas in the vicinity of Gibson Four Corners, in New Ipswich, and near the village of Greenfield have a fine sandy loam or very fine sandy loam surface soil. Near Danas Corner in New Ipswich, the glacial till substratum is loam or silt loam and the surface and subsoil are silt loam.

Use and management.—Practically all of Marlow loam, sloping phase, is cleared and cultivated. Only a small acreage is in pasture, and a few areas are timbered. It is one of the most productive soils in the county and supports many dairy farms and commercial orchards. Hay, silage, corn, oats, and potatoes are the crops most commonly grown. Probably more than half of the land is in hay, and some of the fields have been in hay for 15 or 20 years. Corn for silage and oats for hay are planted extensively, but on most farms

[9] LATIMER, W. J., and LAYTON, M. H. SOIL SURVEY OF GRAFTON COUNTY, NEW HAMPSHIRE. U. S. Dept. Agr., Div. Soil Survey, Ser. 1935, No. 6, 79 pp., illus. 1939.

potatoes are grown only for home use. The crop rotation most frequently followed is corn or potatoes, clover and timothy mixed, and timothy alone for 2 to 10 years.

Although most of the alfalfa grown in the county is grown on this soil and the gently sloping phase of Marlow loam, timothy is the most common hay crop. In recent years smooth bromegrass has been replacing timothy to some extent. Mixed timothy and medium-red clover are sown in a nurse crop of oats, but the medium-red clover disappears after 1 or 2 years and a pure stand of timothy remains. Hayfields are top-dressed with manure. Mixed clover and timothy or timothy alone yield about 2 tons an acre. Records show that the yield of timothy has been maintained at 2 tons an acre for 20 years by top dressing fields with manure each year. The average alfalfa stand lives about 3 years, but the crop is regarded profitable because it gives large yields of high-quality forage. Alfalfa yields as much as 4 tons an acre, but the average is about 3 tons for two cuttings.

Hay sod is plowed when the yield drops to less than 1 ton an acre, or when the field is needed for corn. Manure is applied to the sod before plowing for corn, and 300 to 400 pounds of superphosphate or mixed fertilizer is added when the corn is planted. Under this treatment corn yields 30 to 50 bushels of grain or 10 to 14 tons of silage an acre.

Oats are not always fertilized, but some farmers apply about 200 pounds of 5–10–10 with the seed. The yield is 35 to 50 bushels an acre, depending on the season and the fertilization. Most of the oats are cut green for hay, with a yield of about 2 tons an acre. Some oats are pastured.

Many farmers apply 1,000 to 1,500 pounds an acre of 8–16–16 or equivalent fertilizer when planting potatoes. Potatoes yield 200 to 350 bushels an acre.

Apples are extensively grown on this soil in the vicinity of Wilton and Greenville. Growers state that yields and quality of MacIntosh apples are higher than on the looser sandier soils such as Hermon fine sandy loam, but the color of the fruit is not so good. Fertilization practices vary and are determined in many orchards by the appearance of the trees. Mulching is highly recommended. The yield of MacIntosh apples—the main variety grown—is 15 to 25 bushels for a 25-year-old tree.

The present system of cropping controls erosion satisfactorily, and no practices designed primarily for control of runoff are employed. Erosion is not especially active in any locality, but control methods would be necessary if this soil were planted to clean-cultivated crops several years in succession. The soil should not be plowed in fall, because sheet erosion may occur in spring on uncovered areas.

Natural vegetation was largely hardwoods with some white pine. Hardwood stands were composed mostly of Northern red oak, sugar maple, American elm, yellow birch, hickory, and beech. In the northern part of the county white birch and hemlock were an important part of the stand in many areas. Many old-growth stands now include all the species of the native stands except chestnut.

Marlow loam, gently sloping phase (MA).—This phase is similar to the sloping phase of Marlow loam in profile characteristics but is less sloping. It occurs on smooth crests of broad hills where slopes

range from 2 to 7 percent but are dominantly about 5 percent. It developed in the same part of the county as the sloping phase and in many places adjoins areas of that soil. Most of the bodies are oval-shaped and contain 10 acres or more. The areas were originally stony for the most part, but the stones were removed and piled in fences when the land was cleared for cultivation. Outcrops of underlying bedrock occur in a few places and are indicated on the map by symbols.

Use and management.—Marlow loam, gently sloping phase, is somewhat more desirable than the sloping phase because it is not so subject to accelerated erosion and because heavy machinery can be used on it to better advantage. Its use is about the same as that of the sloping phase, and under similar management, yields are the same.

Marlow loam, moderately steep phase (MB).—This soil is similar to the sloping phase of Marlow loam in profile characteristics, but it has a steeper relief. Slopes are greater than 15 percent and are usually 20 percent. Most areas are small and are parts or corners of fields located mainly on the sloping phase of Marlow loam. Heavy machinery cannot be used to advantage, and the land is mostly in hay or pasture. The soil erodes rapidly when cultivated to clean-tilled crops, and in some eroded areas the compact substratum is reached at a depth of less than 18 inches.

Marlow stony loam, sloping phase (MF).—Stones and boulders are on the surface of this phase in numbers sufficient to prevent cultivation with two-horse or motor-driven equipment, but in other characteristics this soil is similar to Marlow loam, sloping phase. It occurs in the same general areas as the sloping phase and is on similar relief. In pastured areas it has a dark grayish-brown loam surface soil to a depth of about 5 inches, although the subsoil and substratum are similar to those of the sloping phase of Marlow loam. In places underlying bedrock is relatively close to the surface, and it may outcrop as long narrow ledges near the tops of hills. Areas of rock outcrop are indicated on the map by symbols.

Use and management.—About 80 percent of Marlow stony loam, sloping phase, is forested; only a few areas are used for pasture. Many areas no longer cultivated were tilled in the early part of the last century, and some of these, which have few surface stones, could easily be cleared for cultivation. Most of the areas now in pasture were once cultivated and have few stones on the surface. Bentgrass, Kentucky bluegrass, and wild white clover grow naturally in most pastures, but weed growth, as juniper, hardhack, and sweetfern, greatly decrease the grazing areas. Pastures furnish some grazing throughout the summer unless the season is abnormally dry. Many areas of this phase that are well suited for use as farm sites are left in forest because they are isolated from good roads or are a considerable distance from markets.

The most common trees in forested areas are Northern red oak, sugar and red maples, hickory, beech, white pine, and, in old-growth stands, yellow birch and hemlock. Hemlock is more common in cool ravines or on north-facing slopes, and in such places the gray layer may be thicker.

Marlow stony loam, gently sloping phase (MD).—This phase is similar to the sloping phase of Marlow stony loam in profile char-

acteristics but less sloping in relief. It occurs on smooth crests of broad hills where the slope range is 2 to 7 percent and the dominant slope is about 5 percent. The proportion of this soil used for pasture is probably greater than for the sloping phase.

Marlow stony loam, moderately steep phase (ME).—Except for its more steeply sloping relief, this soil is similar to the sloping phase of Marlow stony loam. The slope range is 15 to 25 percent, but a few areas are included that have slopes greater than 25 percent. This soil is associated with other Marlow soils, and for the most part, it is forested.

Merrimac fine sandy loam, level phase (MG).—This soil is on level or nearly level terraces along the larger streams and on the higher terraces in the area once occupied by glacial Lake Merrimack. The parent material was derived chiefly from granite, and the soil material is sandy. Little water runs off because the soil is very porous. It is the least droughty of the Merrimac soils because it is fine textured and its gravel layer is down so deep that more of the rain entering the soil is stored in the upper levels. The gravel layer, moreover, breaks the tiny channels that take away water, and therefore a little more moisture accumulates. In spite of these factors, the soil still becomes droughty more quickly than heavier upland soils. Plants wilt during prolonged dry periods, and crop yields are reduced.

Profile description:

1. Organic layer, mat of partly decomposed litter about 2 inches thick in forested areas.
2. Surface soil, dark grayish-brown or brown fine sandy loam, moderately high in organic-matter content, of weak fine crumb structure, and about 2 to 3 inches thick; a light-gray leached layer of fine sand, seldom over 1 inch thick and not continuous, may occur at higher altitudes or under old stands of conifers at lower elevations.
3. Subsoil, yellowish-brown loose fine sandy loam to a depth of about 24 inches; some gravel in lower part, where the color grades to light yellowish brown.
4. Substratum, below depth of 24 inches, gray or pale-yellow loose stratified water-assorted alternate horizontal beds of sand and gravel 6 to 12 inches thick; gravelstones usually up to 2 inches in diameter but some strata are composed of larger rounded cobblestones; medium to strongly acid; very low in water-holding capacity.

In cultivated areas the upper 7 inches of the soil has been thoroughly mixed to form a brown fine sandy loam of weak very fine crumb structure. This mixed layer is very friable and shows a tendency to form stable crumbs only when the organic-matter content is carefully maintained by frequent manuring. The subsoil under the cultivated surface soil is light yellowish-brown fine sandy loam because its browner upper part has been incorporated in the plow layer.

Included with Merrimac fine sandy loam, level phase, in the vicinity of Hollis are areas of other soils that were too small to map alone. These soils are derived from phyllite or weak slaty schist and are influenced greatly by those rocks. The gravel layers in these inclusions are derived mostly from schist, only a small percentage being from granite. In Rhode Island, soils that are somewhat similar to these but have darker parent material are classified as members of the Warwick series. Agricultural methods and crops are almost identical to those for typical Merrimac soil, and yields are approximately the same.

The only other variation in Merrimac fine sandy loam, level phase, is in the deepness at which the gravel strata occur. Included are small areas where the gravel is as much as 48 inches deep instead of the usual 12 to 30 inches. These areas with deeper gravel strata have a higher water-holding capacity but otherwise are not appreciably different from the typical soil.

Use and management.—Some areas of Merrimac fine sandy loam, level phase, are pastured, and a few are forested, but most of the land is cultivated. Corn, oats, and hay are the principal crops, but some vegetables are grown for sale in nearby markets.

About 20 tons of manure an acre is applied to sod before plowing for corn, and approximately 300 pounds of superphosphate or 4–12–4 mixed fertilizer is applied when the corn is planted. The yield of corn is 25 to 40 bushels of grain or 6 to 9 tons of silage. From 200 to 300 pounds of 4–12–4 mixed fertilizer may be sown with oats; the yield is 20 to 30 bushels an acre.

Clover, timothy, and redtop grown for hay yield 1 to 1½ tons an acre. Mowings more than 2 years old are top-dressed with mixed fertilizer or manure. Most hayfields are plowed after 1 or 2 years because yields become low and wild grasses appear. If water is available, irrigation can increase crop yields materially, especially in dry seasons.

The areas pastured are inaccessible or too narrow to be cultivated profitably. Bentgrass, bluegrass, poverty oatgrass, witchgrass, and broomsedge, together with hardhack, sweetfern, blueberries, and mosses, are in most pastures. From 3 to 5 acres of unimproved pasture is needed to carry one cow, whereas in the pastures that are frequently top-dressed, the yield of grass may be increased until 2 or 3 acres will carry one cow in normal seasons.

White pine, scrub oak, and gray birch are common in the few areas of this soil forested. In some places there are pits in this soil from which sand and gravel are excavated for road building.

Merrimac fine sandy loam, undulating phase (MH).—This soil is on 2- to 7-percent slopes, and all ordinary agricultural machinery can be used without difficulty. External drainage is good but not excessive. Erosion is not a problem unless row crops are grown several years in succession. This phase occurs in association with the level phase of Merrimac fine sandy loam, is practically the same in profile characteristics, and is similar in use and crop yields.

Merrimac gravelly fine sandy loam, level phase (MK).—This soil occurs on level or nearly level terraces and differs from the level phase of Merrimac fine sandy loam only in containing pebbles ½ to 1½ inches in diameter. In dry seasons yields are a little lower than on the fine sandy loam, but otherwise the gravel does not affect agriculture particularly.

Merrimac gravelly fine sandy loam, undulating phase (ML).—The essential difference between this soil and the level phase of Merrimac gravelly fine sandy loam is in its relief (2- to 7-percent slopes). Such a slope for heavy-textured soils might be sufficient to cause some erosion, but the good to excessive drainage precludes erosion unless unusual cropping conditions exist.

Use and management.—Except for a few areas where more than 40 percent of the surface soil is gravel, Merrimac gravelly fine sandy loam, undulating phase, has nearly the same crop-producing capability as the undulating phase of the fine sandy loam and is managed in the same way. Most of the very gravelly areas are forested because they are less drought resistant than the others. White pine commonly grows on the gravelly areas. Many pits are in this soil, from which sand and gravel are excavated for commercial purposes.

Merrimac gravelly loamy sand, level phase (MM).—Although this soil occurs in association with the level phase of Merrimac loamy sand and has the same color profile, it differs in having gravel in both the surface soil and subsoil. Small gravel up to one-half inch in diameter makes up 10 to 25 percent of the soil layers. Both soils are utilized in the same manner, agricultural practices are similar, and about the same proportion (90 percent) is forested. Gravel and sand are excavated from pits on this soil for highway construction.

Merrimac gravelly loamy sand, undulating phase (MN).—Practically all of this soil is in the valley of the Merrimack River between Nashua and Milford. It occurs in association with the level phase of Merrimac gravelly loamy sand and has an identical profile. Its only difference is its billowy or undulating relief; the slope range is 2 to 7 percent, but some short slopes are as steep as 10 percent. The soil is not too uneven for the type of agriculture practiced on the level phase of Merrimac gravelly loamy sand. Water erosion is not a serious factor, because of the great porosity of the sandy material. Wind erosion is modified because the surface gravel makes an effective windbreak for the smaller particles.

Merrimac gravelly sandy loam, undulating phase (Mo).—This well-drained soil occurs on 2- to 7-percent slopes but included are a few small areas that have nearly level relief. Except for its lighter textured surface soil and subsoil, it is similar to Merrimac gravelly fine sandy loam, undulating phase, in practically all profile characteristics. It tends to be relatively droughty but is not nearly so droughty as the other lighter textured Merrimac soils. About half of the land is forested and the rest is used for hay and row crops. The yields are slightly less than on the undulating gravelly fine sandy loam.

Merrimac loamy fine sand, level phase (MP).—This level or nearly level soil occurs chiefly in the valley of the Merrimack River. The plow layer, extending to a depth of 7 inches, is brown loamy fine sand. The underlying subsoil is light yellowish-brown to weak-yellow loamy fine sand to a depth of 20 inches. The substratum is stratified grayish-yellow gravel and sand, the small gravel ranging up to one-half inch in diameter. Some gravel is also in the subsoil. The soil contains more silica sand than the level phase of Merrimac fine sandy loam, and the large quantity of sand partly explains its low productivity.

Use and management.—More than 90 percent of Merrimac loamy fine sand, level phase, is forested. Most of it has been cultivated at some time but has reverted to forest or scrubland, partly because of droughtiness. The vegetative cover is largely pitch pine, gray birch, scrub oak, and an undergrowth of low blueberry bushes.

A few areas are now used for small farms and gardens, but yields comparable to those obtained on the level phase of Merrimac fine sandy loam can be obtained only if large quantities of manure and commercial fertilizer are added and the land is irrigated. Some of this soil is a part of poultry farms, as it is ideal for purposes requiring extreme drainage.

Merrimac loamy fine sand, undulating phase (MR).—Areas of this phase are located for the most part in the valley of the Merrimack River between Manchester and Nashua. It is similar to the level phase of Merrimac loamy fine sand in profile characteristics and in forest vegetation but differs in relief. The land is undulating or billowy, slopes ranging for the most part between 2 and 7 percent. A few slopes are steeper than 10 percent and are always short. The soil is not cultivated to any appreciable extent.

Merrimac loamy sand, level phase (Ms).—This phase occurs principally in the valley of the Merrimack River between Manchester and Nashua. In forested areas the surface soil is dark-brown or grayish-brown loamy sand 2 to 3 inches deep. The upper subsoil, which extends to a depth of 6 to 7 inches, is strong yellowish-brown loamy sand. The lower subsoil is loose or very slightly coherent yellowish-brown loamy sand to a depth of 15 to 18 inches and from that depth down to 20 to 24 inches is brownish-yellow or grayish-yellow single-grained loamy sand. The substratum is composed of loose sand and small gravel, in most places stratified. In many areas the substratum is chiefly small gravel, and small quantities of gravel are in all layers. The profile is strongly acid. In cleared areas the surface soil and upper subsoil are mixed by cultivation or pasturing, and the resulting surface soil is loose brown loamy sand.

Included with this soil are a few areas, indicated on the map by symbols, that have surface stones; some areas are loamy coarse sand and a few are loamy fine sand. Areas of Hollis and Nashua soils not large enough or of sufficient importance to show separately on the map are also included; they occur where there are several distinct terraces with narrow escarpments between them.

Use of management.—Practically all of Merrimac loamy sand, level phase, was cultivated in colonial times, but more than 90 percent is now forested. Pitch pine and scrub oak are common species in forested areas, but there are many nearly pure stands of white pine.

Usually a farm located entirely on this soil is not long successful. Where this soil forms only part of the farm area and the other areas are less droughty, the phase may be used, and the occasional dry seasons will not be so severely felt. Some of this soil is used for gardens, and if large quantities of manure and fertilizer are applied, good yields are obtained. In general, however, yields are low and vary directly with the rainfall during the growing season. Crop failures are common, and consistent failure is the greatest reason for the return of this soil to forest.

Part of the land is used for grazing, and poverty oatgrass and broomsedge are the common grasses. Hardhack, sweetfern, blueberries, cinquefoil, sorrel, and pine seedlings have invaded most pastures. Little grazing is furnished during summer, but the pastures can be used early in summer.

Corn will yield as much as 20 to 30 bushels an acre or 6 to 8 tons of silage if 20 tons of manure and 300 to 500 pounds an acre of superphosphate or 5–10–10 are added at planting time. About 200 to 400 pounds of mixed fertilizer is applied when oats are sown, and the yield is 20 to 30 bushels an acre. Timothy and red top, the grasses most frequently grown, yield ¾ to 1 ton an acre when first sown. Some alfalfa is grown where lime is used before seeding.

Wind erosion is severe on some areas, but this soil can be plowed in fall with little danger of water erosion. In some places sand and gravel are excavated for highway construction.

Merrimac loamy sand, undulating phase (MT).—Practically all of this soil is forested. In profile characteristics and extent of cultivation, this phase and the level phase of Merrimac loamy sand are essentially the same. Slopes for this phase, however, range mainly from 2 to 7 percent. Some short slopes may be as steep as 10 percent. The slopes are not long enough to permit serious water erosion, unless the organic-matter content is very low. Wind erosion may be appreciable, however, just as on the level phase.

Nashua loam, level phase (NB).—This soil occurs in the valley of the Merrimack River in association with other Nashua soils, particularly with the nearly level phase of Nashua very fine sandy loam. For the most part, it is near the Nashua River, and its heavier texture may be caused by the mixing in of schist particles from the schist area near Hollis, which is a part of the Nashua River drainage basin. Because of the admixture of schist material, this soil is similar to the Agawam soils of the Connecticut River valley, which are not mapped in this county. Included with this soil are a few small areas of imperfectly drained soils.

Except for texture, the soil profile is much like that of Nashua very fine sandy loam, nearly level phase. The plow layer is brownish-gray to grayish-brown mellow loam or silt loam and about 7 inches deep. Underlying this layer and extending to a depth of 20 inches is the yellowish-brown very fine sandy loam to silt loam upper subsoil, firm in place but mellow when removed from a cut. The yellowish-brown lower subsoil, which extends to a depth of 20 to 30 inches, has about the same structure and consistence as the upper subsoil but has slightly less color. The substratum consists of stratified light yellowish-brown to brownish-gray fine sand or sand, principally of granitic origin.

Use and management.—Some 70 to 75 percent of Nashua loam, level phase, is cropped; the rest is in forest. Cropping practices are the same as for Nashua very fine sandy loam, nearly level phase, and vegetation is also similar.

Nashua loam, gently sloping phase (NA).—Most of this phase occurs just west of the city of Nashua along the Nashua River. The soil profile and crop yields are similar to those of the level phase, but relief is billowy or undulating. The slopes are mainly 2 to 7 percent, but a few short ones up to 10-percent gradient occur irregularly over the terrace.

Nashua loamy fine sand, level phase (ND).—Areas of this soil are adjacent to or in close association with much larger tracts of the un-

dulating phase of Nashua loamy fine sand, particularly near the city of Manchester. The soil occurs on level terraces and in general profile is about the same as other Nashua soils. The parent material was derived mostly from granite and gneiss, and the gray color of the substratum and the presence of particles of quartz and feldspar are caused by the parent rock.

The lack of organic matter and the uniform coarseness of particles are major causes for the lack of good water relations. The moisture-holding capacity is low in all layers, and therefore crops do not obtain optimum moisture in ordinary seasons.

Profile description:

1. Surface soil, grayish-brown or brown loose single-grained loamy fine sand to plow depth (5 to 7 inches).
2. Upper subsoil, yellowish-brown moderately firm loamy fine sand to a depth of about 15 inches.
3. Lower subsoil, light yellowish-brown loose loamy fine sand to a depth of about 21 inches.
4. Substratum, grayish-yellow loose fine sand stratified by alternate layers of fine sand and sand at depths of 21 to 24 inches; extends to the parent material, which in places is as much as 50 feet down.

The soil is acid throughout, but the surface soil is often slightly more acid than other layers in the profile. Some areas have a loamy very fine sand to loamy sand texture, but these are small and intimately associated with larger areas of the loamy fine sand. The surface soil may be influenced by wind erosion in a few places, and, in such instances, the plow soil is usually single-grained.

Use and management.—Nearly all of Nashua loamy fine sand, level phase, was cleared and plowed during colonial times, but about 90 percent is now forested or is scrubland. The remaining 10 percent is used for home sites and gardens. All the common garden vegetables are grown, and yields are usually fair because manure or commercially mixed fertilizer is used liberally. Droughtiness and low inherent fertility are the major causes for the reversion of much of this soil to forest.

Nashua loamy fine sand, undulating phase (NF).—This phase occurs on both sides of the Merrimack River. One particularly large area over a square mile in size is in the southern part of the city of Manchester and is occupied by parts of the business and residential districts. The other areas are small—not over a half square mile in size. The billowy or undulating relief (2 to 7 percent) characterizing this phase is caused partly by wind erosion and partly by the wanderings of flood water when the terraces were low enough to be flooded. Slopes are not abrupt, do not interfere with use of agricultural machinery, and are not long or steep enough to be a factor in sheet erosion. The soil is so porous that nearly all precipitation penetrates the soil.

Nashua loamy fine sand, rolling phase (NE).—This phase occurs in long relatively smooth areas where the terraces break to overflow land below. It is essentially the same as the level phase of Nashua loamy fine sand in profile. Slopes range from 7 to 15 percent but are about 10 to 12 percent in most places. Small nearly level areas may be included with this soil. One fairly large area of this soil in the city of Manchester closely parallels the Merrimack River and is oc-

cupied by tenements, residences, and business properties. At other places along the Merrimack River the soil is commonly forested or idle and is reverting to forest.

Nashua loamy fine sand, hilly phase (Nc).—Areas of this soil occur on steep breaks of terraces where slopes range mainly from 15 to 25 percent but reach 35 percent in several places. In profile the soil is similar to the level phase of Nashua loamy fine sand but is developed to less depth. Nearly all of these terrace breaks have been pastured at various times or cut over for lumber, and the soil profile is therefore variable. This land is not cropped, because it is steep, but is forested with white and pitch pines and gray birch.

Nashua loamy sand, level phase (Ng).—This phase differs from the level phase of Nashua loamy fine sand only in texture. The texture of the surface soil is loamy sand, and the various subsoil layers are also slightly coarser textured than those of the loamy fine sand. Parent material for the two soils is almost identical. A large area of this soil is just south of Reeds Ferry; other smaller areas of 10 to 20 acres occur between Manchester and Nashua. The soil is used in the same way as the level phase of Nashua loamy fine sand.

Nashua loamy sand, undulating phase (Nh).—Unlike the level phase this soil has a billowy relief. The short slopes range from 2 to 7 percent. The use is the same as for Nashua loamy sand, level phase.

Nashua very fine sandy loam, nearly level phase (Nk).—This phase occurs principally in the valley of the Merrimack River. Only a few small isolated areas are in the Contoocook River valley near Peterboro. The individual areas are never large and most of them are or have been cultivated. The areas occupy smooth terraces lying above ordinary overflow. Probably these terraces were bottom land at the end of the glacial period, but subsequent cutting by the river has left them in positions too high to be affected by overflow. Drainage is very good. Water does not remain on the surface for any length of time after a rain but penetrates rapidly. The moisture-holding capacity is good, and crops are less injured by droughts than when planted on coarser textured soils, as the Merrimac.

This soil is closely associated with the Merrimac soils occupying slightly higher terraces and with the Ondawa soils occurring in lower bottom lands along the Merrimack River. Nearly every farm in the valley is therefore on soils of at least two of these series, and it is not unusual for a farm to be on all three. Nashua soil is similar in most respects to the Merrimac soils, but although it contains no gravel it has a somewhat firmer subsoil and is more droughty. The parent rock was chiefly granite or gneiss, and therefore Nashua soil has lighter colored subsoil and substratum and is somewhat less productive than Agawam soils, which are derived partly from schist and occur in the Connecticut River valley.

Profile description:

1. Surface soil, grayish-brown friable strongly acid very fine sandy loam; weak very fine crumb structure to a depth of 7 inches.
2. Upper subsoil, yellowish-brown friable very fine sandy loam; weak very fine crumb structure; extends from 7 to about 13 inches; roots occur throughout; good water-holding capacity.

3. Lower subsoil, light yellowish-brown loamy fine sand of friable to loose consistence; extends to a depth of 24 to 26 inches; less organic matter than in layer above and a little less retentive of moisture.
4. Substratum, gray to yellowish-gray loose very fine sand or fine sand with scattered black mica particles; composed of particles fine enough to hold together in place when a roadside bank is cut down but is easily separated into single grains; grains in large part quartz and feldspar derived from granite or gneiss; isolated layers of gravel in places but not in great enough quantities to throw the soil into the Merrimac series; water-holding capacity low in comparison with overlying layers; easily penetrated by tree roots.

All layers of the profile are strongly acid. Scattered gravel occurs in one or two of the layers in some places. The substratum may contain isolated clay lenses. Slight differences in texture may occur where the parent material is influenced by a small contribution of material from rocks other than granite, and in such places darker colors may predominate.

Use and management.—Some 70 to 75 percent of Nashua very fine sandy loam, nearly level phase, is used for cultivated crops or is in urban districts. About half of the cropland is in permanent sod, and the rest is planted to corn, oats, and other common dairy-farm crops, or to vegetables. About 300 to 400 acres of the residential area of Nashua is on this phase and is used in part for vegetable gardens. The remaining 30 percent of this phase is in areas too narrow or too closely associated with larger areas of imperfectly or poorly drained soils for farming. These small isolated areas are pastured or in forest, depending on the use of the associated soils.

Yields of the common crops are essentially the same as those obtained on the better upland soils, and use and management do not differ appreciably from that practiced on comparable soils of the upland in the county. Water erosion is not a problem. The organic-matter content is sufficient to keep the soil well aggregated, and the content in the surface soil can be maintained by keeping the soil in sod 2 or 3 years at a time. Wind erosion is not important if this is done. The acidity of the soil is about the same as that of other soils of the county, and lime is used in comparable quantities.

Hay land and pastures are top-dressed with 1 ton of lime every 5 to 10 years. If alfalfa is to be grown, up to 2 tons of lime may be spread on the plowed soil. Because the soil is well drained, it can be worked in any season or at practically any moisture content insofar as structure and workability of the plow layer are concerned. Judging by the few isolated areas still forested, the original vegetation consisted largely of white pine, white oak, and red maple.

Nashua very fine sandy loam, undulating phase (NM).—This phase is similar to the associated nearly level phase of Nashua very fine sandy loam in profile characteristics and use but has a different slope. Relief is billowy or gently rolling (2 to 7 percent) but does not interfere with the use of agricultural machinery. Erosion is not serious, because the slopes are short, but if the soil has been row cropped for 3 years or more, heavier rains may cause some soil loss. Some 10 to 15 percent is forested with white pine, scrub oak, and a few red maples; the rest is cleared and used for cultivated crops.

Nashua very fine sandy loam, rolling phase (NL).—The relief of this soil is made up of a series of short steep slopes (7- to 15-percent

gradient) between which are less sloping areas. In most areas this phase has a profile similar to that of the level phase of Nashua very fine sandy loam. Some soils in the Contoocook River valley that have developed on terraces laid down in glacial lakes are included. The included soils have interbedded fine sand and silt rather than fine sand as parent material, but they are used practically the same as the typical soil. Also included are one or two forested areas having slopes that range up to 35 percent.

Ondawa fine sandy loam (OA).—This soil, which occupies the flood plains, developed predominantly from granitic material. Although it is in nearly level river bottoms, it is well drained, and its open porous nature allows rapid percolation of rainfall. Some danger exists from overflow, mainly in spring before crops are planted or late in fall after crops have been harvested. Many of the areas are overflowed only occasionally, and therefore the danger of crop destruction is not great. Wind erosion may be appreciable on large plowed areas but not serious enough to require special protective measures.

Profile description:

1. Surface soil, grayish-brown or dark yellowish-brown very friable fine sandy loam without definite structure; 6 to 10 inches deep.
2. Subsoil, very friable single-grained fine sandy loam to loamy fine sand of much the same color as the surface soil; 15 to 25 inches deep; contains a few mica flakes.
3. Substratum, pale-yellow loose sand and gravel noticeably flecked with mica; extends downward from a depth of 25 inches.

The soil is medium to strongly acid. Some variation in texture may occur in the various layers. In a few places the subsoil is faintly mottled in the lower part because of a local high water table. Mapped with this soil are one or two small areas with a sandy loam texture.

Use and management.—Many areas of Ondawa fine sandy loam are cultivated, and almost all the others are in pasture. Only areas in very narrow bottoms or isolated places are forested. Corn and hay are the common crops. Manure is applied to sod before plowing for corn and is sometimes the only fertilizer used. Usually, however, farmers add 300 to 500 pounds an acre of superphosphate when the corn is planted. Most of the corn is cut for silage, and the yield is 10 to 15 tons an acre.

Land is ordinarily left in hay several seasons, and many fields are top-dressed with manure after the second crop is cut. Timothy and redtop are the common grasses, but many hayfields contain much witchgrass. In pastures, bentgrass, Kentucky bluegrass, and witchgrass are the main forage plants. Most of the pastures contain many small and some large trees but are comparatively free from weedy or brushy growth. The pastures furnish good grazing, and 2 acres will usually support one cow. Red maple, hemlock, aspen, and gray birch are the dominant species in forested areas.

Ondawa fine sandy loam, high-bottom phase (OB).—This soil closely resembles Ondawa fine sandy loam in many respects but occurs at higher levels; hence it is subject to overflow only during periods of very high water. It has a more yellowish brown subsoil. The soil is usually nearly level and occurs almost exclusively in the valley of the Merrimack River. A few areas are along smaller swiftly flowing

streams, however, and have a slope of about 5 percent. The soil is porous and well drained. Water penetrates quickly, and in most seasons the water table is near enough to the surface to maintain optimum moisture for plant growth.

Use and management.—Small areas of Ondawa fine sandy loam, high-bottom phase, are used as homesites and gardens; larger tracts are farmed in the same manner as Ondawa fine sandy loam. Oats are grown successfully, yielding 40 to 50 bushels an acre without additional fertilizer. All the cultivated crops of the area can be grown and will give satisfactory yields if manure and commercial fertilizer are applied.

Ondawa loamy fine sand (Oc).—Areas of this soil occur throughout the county, but the largest bodies are adjacent to the Merrimack River or its tributaries. These areas have received the relatively coarse-textured sand that is carried along the bottoms of streams during normal seasons but deposited along the stream courses in periods of overflow. The coarse-textured materials are not carried far and are deposited near the main channels where water is moving swiftly, whereas the fine-textured materials are deposited some distance from the stream or in relatively slow water. The soil is usually subject to overflow, but some areas lie slightly above the level of normal overflow.

This soil resembles Ondawa fine sandy loam but is much looser and lighter textured. The 8- to 9-inch surface soil is grayish-brown loose loamy fine sand without definite texture, and the subsoil, extending to a depth of 24 to 30 inches, is of much the same color as the surface soil and also without definite structure. Sometimes the upper subsoil is yellowish brown. The substratum is pale-yellow or gray loose fine sand or sand. All layers of the profile are medium to strongly acid. In a few places some gravel is in the subtratum and in the overlying layers.

Included with this soil are several areas in the vicinity of Litchfield that have a loamy fine sand texture and somewhat better moisture relations. The included areas are used in much the same way as this soil, but their lack of organic matter limits crop production.

Use and management.—Ondawa loamy fine sand is not so productive as Ondawa fine sandy loam and is therefore used chiefly for pasture. Bentgrass, Kentucky bluegrass, and witchgrass are the forage plants common in pastures, and 3 to 5 acres of pasture will usually provide grazing for one cow. Many of the pastured areas are brushy or have trees along the stream banks. Willow, white pine, red maple, white oak, and elm are most common. The cultivated areas usually make up only part of a field; the rest of the field is on one of the heavier textured Ondawa soils.

Ondawa loamy fine sand, high-bottom phase (Od).—This phase occurs only adjacent to the Merrimack River. It is similar to Ondawa loamy fine sand except that it occurs higher above stream level, is not so subject to overflow, and has a more yellowish-brown subsoil. Included with this soil are a few areas near Litchfield that have a very fine sand surface texture. This phase is used similarly to Ondawa loamy fine sand, most of it being in pasture. The woody growth is limited to oaks and blueberries because the water table is too far

from the surface for the successful growth of moisture-loving willows and red maple.

Ondawa loamy sand (OE).—This soil is located in stream bottoms that have received recent increments of loamy sand material during floods. The soil is similar to Ondawa loamy fine sand, but the surface layer is composed of loose loamy sand underlain by sand or by sand and gravel. Pasture is the only use; 3 to 5 acres are required for each cow because the soil is so droughty. There are scattered growths of gray birch and white pine.

Ondawa silt loam (OF).—This soil is good for pasture and hay because it does not dry out quickly. It occurs in close association with Ondawa very fine sandy loam, but the texture of its upper profile layers differs. The surface soil is of silt loam or loam texture, and the subsoil texture ranges from very fine sandy loam to silt loam. Sandier materials occur in the substratum, just as they do in Ondawa fine sandy loam. The soil is used in about the same way as the fine sandy loam. It is somewhat more desirable for crops because it has better moisture-holding capacity, but is a little less useful because it cannot be worked so soon after rains.

Ondawa silt loam, high-bottom phase (OG).—Except for the texture of the surface soil and subsoil, this phase is much like Ondawa very fine sandy loam, high-bottom phase. It has a similar origin, and the use and management are much the same.

Ondawa very fine sandy loam (OH).—Areas of this soil occur on both sides of the Merrimack River between Manchester and Nashua. The floods of 1936 and 1938 deposited 6 inches to 3 feet of sand over large areas of this soil. The sand came mostly from stream banks farther up the river and was therefore devoid of organic matter. Special farming practices were subsequently necessary to restore the productivity that existed before the floods.

The soil profile is similar to that of Ondawa fine sandy loam, except that all of the layers are finer textured. A typical profile consists of (1) a dark grayish-brown to grayish-brown very fine sandy loam; (2) an underlying grayish-yellow or grayish-brown very fine sandy loam, friable in place, that extends to a depth of about 40 inches; and (3) interbedded sand and silt. Gravel layers sometimes occur in the lower part of the profile.

Use and management.—Ondawa very fine sandy loam is more desirable than Ondawa fine sandy loam because it is more retentive of moisture, and therefore gives higher crop yields. Several areas in the vicinity of Litchfield and Merrimac are planted to vegetables. Potatoes and squash are grown to the greatest extent and give good yields in all except the dry seasons. The potential productivity of the soil and its nearness to the river indicate that irrigation would be profitable. Overhead irrigation of potatoes has been tried to a limited extent, and results seem to warrant greater use.

Ondawa very fine sandy loam, high-bottom phase (OK).—This soil occupies higher bottom land, and it is separated from the closely associated areas of Ondawa very fine sandy loam by definite breaks in elevation. Because it is seldom flooded, there has been opportunity

for profile development, and consequently the subsoil is more yellowish brown than the subsoil of Ondawa very fine sandy loam.

Use and management.—Level areas of Ondawa very fine sandy loam, high-bottom phase, are in cultivated crops or hay, and the included undulating areas that break from one level to another are pastured. Little of the land is forested. This soil is used similarly to Ondawa very fine sandy loam, but it is more desirable because crops are destroyed by overflow only in unusual seasons, and because sandy sediment is less likely to be deposited when major floods occur. The floods usually come in spring before crops are planted or in fall after harvesting, and the danger of damage from overflow is therefore not great.

Paxton loam, sloping phase (PB).—This well-drained soil developed on olive hard platy glacial till derived mainly from schist but partly from granite and gneiss. It occurs on smoothly rounded drumlins on drumloid hills where slopes range from 7 to 15 percent but are in most places about 12 percent. This soil differs from the Marlow soils by occurring generally at lower altitudes and in being less strongly leached. It differs from the Charlton soils mainly in having developed on hard platy till rather than loose or firm till.

In its virgin condition this soil does not have a leached gray surface mineral layer or underlying brown layer but has 3 or 4 inches of dark grayish-brown surface soil fairly high in organic matter. This layer is underlain by a yellowish-brown layer that gradually becomes olive with depth. Below about 8 or 9 inches the Paxton and the Marlow soil materials are similar. When cultivated, the two soils are similar because the surface layers that serve to differentiate them are mixed into the plow layer.

Use and management.—Paxton loam, sloping phase, is very similar to the sloping phase of Marlow loam in use, management, and productivity. It occurs in areas where the growing season is longer, and for this reason it is more desirable for vegetable crops and corn grown for grain. A somewhat larger part of this soil than the Marlow soil is used for apple orchards, principally because it lies nearer railroads and local markets.

Paxton loam, gently sloping phase (PA).—This phase is similar to the sloping phase of Paxton loam in most respects, but it occurs on gentler relief. The slopes—smooth and easily strip-cropped—range from 2 to 7 percent. A larger part of this soil than of the sloping phase is in row crops, and it is less subject to erosion when row crops are grown almost continuously. In use, management, and productivity it is similar to Marlow loam, gently sloping phase.

Paxton stony loam, gently sloping phase (PC).—The relief of this soil is smoother than that of Paxton stony loam, sloping phase. Slopes range from 2 to 7 percent, and areas are for the most part on brows of hills. Erosion is not a problem; few areas have lost appreciable quantities of surface soil through sheet erosion.

Use and management.—Most of Paxton stony loam, gently sloping phase, is forested, but up to 20 percent may be in hay or permanent pasture. Although stones are so close together they interfere appreciably with cultivation, the soil can be planted to hay crops if needed.

Many areas were once cleared of forest and smaller stones and cultivated, but with the advent of two-horse and power-driven equipment, stony soils such as this one have been used to less extent.

Paxton stony loam, sloping phase (PE).—In profile and slope this soil is similar to Paxton loam, sloping phase. It differs in having many surface stones up to 24 inches in diameter. These stones are so numerous it is not feasible to cultivate the cleared areas intensively, particularly with two-horse or motor-driven equipment. Many areas were cleared and cropped when the area was first settled, but most of these have reverted to forest. About 1 or 2 percent of the soil is still cleared and is in hay, and approximately 10 percent is in pasture.

Paxton stony loam, moderately steep phase (PD).—This soil differs from the sloping phase of Paxton stony loam in having 15- to 25-percent slopes. Most of the soil is forested but a small acreage is in hay. Included with this phase are one or two areas in the vicinity of Hollis that have developed on fairly loose till. These included soils are more nearly like the Charlton soils in profile but have been included with the Paxton because of their small acreage.

Peterboro gravelly fine sandy loam, hilly phase (PF).—This soil developed on kames and has a slope range of 15 to 25 percent. It is usually fairly closely associated with soils of the Acworth and Lempster series and bears about the same relation to the Acworth soils as Danby soils bear to the Hermon. In origin of parent material, relief, drainage, and native vegetation this soil is the same as the hilly phase of Danby gravelly fine sandy loam. It differs only in that its parent material is derived partly from easily weathered mica schist containing some iron pyrites. Scattered mica flakes are present in each layer. The whole profile is deeper yellowish-brown than that of Danby soils, and the individual layers are less distinct.

Profile description:

1. Organic layer, mat of partly decayed litter 1 to 3 inches thick resting on the mineral soil in forested areas.
2. Surface soil, in forested areas a pale-brown to grayish-white fine sand, ½ to 3 inches deep; extremely acid; low organic-matter content; single grained; little coherence between individual soil particles; usually about 1 inch thick and with incipient coloration, but varying in small areas to 2 to 3 inches thick; at higher altitudes may be uniformly 1 to 2 inches thick.

   Upper subsoil, brown or reddish-brown gravelly fine sandy loam to a depth of about 9 inches from the surface; immediately beneath the grayish-white surface soil and continuing downward 1 or 2 inches the color is darker; gradation to the brown or reddish brown of the lower part almost imperceptible; particles definitely aggregated to form a weak very fine crumb structure; where the gray surface layer is about 3 inches deep there occur isolated cemented particles ⅛ inch in size and easily broken by pressing between the thumb finger; scattered gravel, but not in strata; about 10 to 20 percent of the gravel is mica schist weathered to a moderate brown; rest of gravel, from granite, retains its original unweathered gray; many roots.
4. Lower subsoil, moderate yellowish-brown single-grained sand and gravel to a depth of about 26 inches; weakly cemented in a few places but does not hold in place when a bank is dug into; gravel similar to that in the layer immediately overlying; usually no gravel and sand strata; mica flakes scattered throughout sandy parts of layer; water-holding capacity low because of coarseness of the materials.

5. Substratum, yellowish-brown sand and gravel with occasional mica flakes downward from a depth of about 26 inches; weakly assorted layers of gravel and sand in the deeper part; gravel from granite and mica schist in about the same proportion as in the upper subsoil; gravelstones from both the mica schist and the granite partly rounded; where granitic material predominates, the gravel and sand are derived to greater extent from granite than in areas where mica schist is the common rock; quantity of mica schist gravel seldom more than 50 percent of the soil mass; materials so coarse that water precolates very rapidly, and little moisture is retained for plants.

When cultivated, the three upper layers are mixed to a depth of 7 inches and the resulting surface soil is grayish-brown single-grained fine sandy loam low in organic matter and water-holding capacity. In places where mica schist bedrock contributed to the mineral composition, the soil may contain a large quantity of mica; the increase in mica will be evident in kames near such bedrock. In other places the proportion of mica schist to granite may be small, and in these the yellowish brown of the substratum may be less intense. Surface stones are relatively numerous in some places and are indicated on the map by stone symbols.

Use and management.—Use and management of Peterboro gravelly fine sandy loam, hilly phase, is practically the same as for the hilly phase of Danby gravelly fine sandy loam. Yields may be a little lower than on the Danby soil because the solum is slightly more acid. If this soil is limed, however, yields are essentially the same as on the Danby.

Rockland, hilly and steep, Brimfield soils (RA).—The soils between the rocks of this land type are similar to the hilly ledgy phase of Brimfield stony loam in profile but have a greater slope range (15 to 30 percent). The outcrops are so numerous and close together that cultivation would be impracticable, but tree roots can reach the small areas of deep soil. Trees grow about as well as on the hilly ledgy Brimfield soil. Where trees grow very near the outcrops they tend to be more easily blown down in high winds. This land might be used for unimproved pastures, but it would be droughty in dry weather.

Rockland, hilly and steep, Canaan soils (RB).—The soils that lie between the ledges and stones of this land type are similar to the Canaan in profile characteristics but have a wider slope range (15 to 30 percent). Many loose stones are on the surface, and exposed bedrock occurs at close intervals over the whole area. The stones and outcrops make clearing of the land for cultivation impracticable. A few areas were cleared and in pasture and crops when the land was first settled, but these have reverted to forest because the soils tend to be droughty in dry weather. This land is essentially nonarable.

Rockland, hilly and steep, Hollis soils (RC).—The soils between the rock outcrops of this land type are similar to stony Hollis soils in profile. Slopes range from 15 to 30 percent. Outcrops are so numerous that tillage would not be feasible if the land were cleared. Small parts of some areas have been cleared and used for pasture, but generally the land is so uneven and ledgy that fertilizing can be done only by hand. This land type is essentially nonarable and suitable only for forestry.

Rockland, hilly and steep, Lempster soils (RD).—This land type occurs mostly on high ridge tops on 15- to 30-percent slopes. Bedrock outcrops in many places. The soils between the outcrops are much like Lempster stony loam, hilly ledgy phase. Even if cleared of surface stone, this soil could not feasibly be used for cultivated crops. The outcrops are so numerous they would interfere appreciably with cultivation, and the soils between the outcrops would tend to be droughty. Tree growth is usually comparable to that on Acworth soils. The tree roots spread out to the deeper soil lying between the outcrops, as that soil retains enough moisture to keep growth going even during the drier periods.

Rockland, hilly and steep, Marlow soils (RE).—Large boulders occur in many places on this land type. The underlying bedrock—relatively smooth and probably leveled off by glacial action—lies parallel to the surface in most areas and outcrops only in places. The bedrock lies at about 10 to 20 inches, and the overlying soil has a profile much like that of Marlow loam soils, except it is shallower. Shallowness makes this land more droughty, and trees are more likely to blow down. Slopes range from 15 to 30 percent. Much of the land is on or near the tops of high hills or mountains, has been cleared, and is used for commercial production of lowbush blueberries. The land in blueberries is burned over every third year to keep the bushes productive. The blueberry roots mat and make a cover that is practically proof against erosion.

Rockland, hilly and steep, Shapleigh soils (RF).—Areas of this essentially nonarable land type have a wide slope range (15 to 30 percent) and many exposed outcrops or ledges. The profile of the soil occurring between the rocks is similar to that of Shapleigh soils. Loose stones and rock outcrops are so numerous that clearing for cultivation would not be practicable. A few bodies of this land were cleared of forest and used for pasture and crops when the area was first settled, but the soils tend to be droughty in dry weather, and the cleared places have reverted to forest.

Rumney and Saco soils (RG).—The soils of this complex occur on nearly level first bottoms of small streams in such small areas that it was not feasible to delineate them separately on the map. They are so variable in surface layers that texture is not designated in the complex name. For the most part, surface texture ranges from sandy loam to loam, but there are areas with a sand surface texture. The Rumney soils are imperfectly drained, whereas the Saco are very poorly drained. In the virgin condition, the Saco soils often have a 6- to 8-inch mucky layer on the surface, but when they are cleared and pastured, this layer usually disappears and they are then slightly darker than the Rumney. In wider areas the Rumney and Saco soils of this complex may occur together in close association, but in the narrow bodies, one or the other tends to predominate.

Included with this complex are a few small bodies of well-drained Ondawa soils; a few small areas of imperfectly drained Podunk soils, which are not mapped separately in this county; and some areas covered by recently deposited sand and gravel that supports no vegetation. A few of these barren areas are along some smaller streams,

a large tract is near the village of North Weare, and several areas are farther down the Piscataquog River. If these included bodies of sand and gravel were mapped separately, they would be designated as Riverwash.

Use and management.—Adequate drainage is the greatest need of Rumney and Saco soils. Where the land is properly drained and adequately fertilized, it produces fair to good crops of hay, corn, oats, and vegetables. Most of the land, however, is in hay, pasture, or forest. Sedge is common in pastures and, together with grasses, furnishes grazing during dry weather. Alder, briers, red maple, hemlock, and some willow are the chief plants in forested areas.

Rumney fine sandy loam (RH).—This poorly drained soil occurs along streams on level bottom land just above stream level. It is developed chiefly from granitic material and is fairly widely distributed over the whole county. The areas are usually in places where the gradient is such that streams make many meanders. The soil is not so important agriculturally as the Ondawa soils, which are mapped on well-drained parts of the bottom lands where the water table is lower.

Profile description:

1. Surface soil, dark grayish-brown very friable fine sandy loam mottled with gray and dark brown almost to the surface; 8 to 10 inches deep.
2. Subsoil, grayish-brown friable fine sandy loam mottled with gray and moderate brown; 16 to 18 inches thick.
3. Substratum, gray fine sand to fine sandy loam in places mottled or splotched with moderate brown.

All layers of the profile are medium to strongly acid, and variations consist principally of a darker surface soil in included areas. Also included are small imperfectly drained areas that would have been mapped separately as Podunk fine sandy loam if they had been large enough. Podunk fine sandy loam, a soil not mapped separately in this county, differs from this Rumney soil mainly in having a browner surface and in being mottled at a lower depth, or below 15 inches. The included Podunk areas may be as large as 5 acres and may be cropped to some extent.

Use and management.—Rumney fine sandy loam is used chiefly for pasture or hay. Many pastures are grown up to alder, willow, and various kinds of underbrush, but even these shrubby tracts afford reasonably good grazing. They are especially useful in dry seasons when pastures on well-drained soils are poor. The growth on the hay land, mainly sedge and redtop, is cut twice a year and produces 2 to 3 tons an acre.

Rumney silt loam (RK).—This soil is composed of somewhat finer textured materials but occurs in positions similar to those occupied by Rumney fine sandy loam. The surface soil is dark grayish-brown silt loam mottled with light yellowish brown. The subsoil is gray relatively plastic silt loam, also mottled. The substratum is variable but in most places is a fine sandy loam exactly like that of Rumney fine sandy loam. The texture and color of the surface soil varies within a narrow range. In use and management this soil is similar to the fine sandy loam.

Scarboro fine sandy loam, level phase (SA).—This poorly drained soil usually occurs in small narrow areas along drainageways or in depressional areas on terraces. It is closely associated with the Merrimac, Nashua, and Sudbury soils and has developed on similar parent material. In a few places localized layers of clay or rock within the profile cause a high water table, but in most places the water table is high because the soil occurs in a low place between a slope and a bordering terrace or within larger areas of Merrimac or Nashua soils.

Profile description:

1. Surface soil, dark-gray to black mucky fine sandy loam; 6 to 7 inches deep.
2. Subsoil, mottled gray to brownish-gray fine sandy loam or loamy fine sand to sand; 7 to 12 inches deep; variable texture but sandy in most places.
3. Parent material, below 12 inches and downward, yellowish-gray sand; gravel strata in some places compose as much as 25 percent of the soil mass.

There is some variation, mainly in the surface soil color and in the subsoil texture. The surface soil may range from brownish gray to dark gray; the subsoil, from sand to silt. Alternate thin beds of sand and clay occur within the substratum in a few places.

Use and management.—Scarboro fine sandy loam, level phase, is almost entirely in pasture or forest. Red maple is the dominant tree in forested areas, and alder and hardhack form the undergrowth. Various rushes and sedges make up the larger part of the cover in pastured areas, with the result that the carrying capacity of pastures is not so great as on areas of less poorly drained Sudbury soil. A few small areas that have been artificially drained give excellent yields of garden crops and corn. Drainage is usually resorted to only where a small narrow area of this soil occurs between two larger tracts of a well-drained soil.

Scarboro loam, level phase (SB).—This strongly acid soil is localized in an area on the east side of the Merrimack River extending from 3 or 4 miles above the village of Litchfield to about the same distance below. It and the associated nearly level phase of Scarboro silt loam occupy a narrow area between the terraces and the wide bottom land, and though the individual bodies are narrow, they parallel the river in continuous strips a mile or more long. The Scarboro soils in this vicinity occupy old river channels where the water table is high. The fine texture of the soils is due to the deposit of fine sediments during floods.

Profile description:

1. Surface soil, dark-gray loam to a depth of about 4 inches; high organic-matter content causes soil to be somewhat mucky in many places.
2. Subsoil, dark-gray loam mottled with brown and having dark streaks of surface material in the old root channels; 4 to 13 inches deep.
3. Substratum, below 13 inches material is gray or pale-yellow coarse sand and fine gravel cemented loosely in some places; during most seasons layer is below the top of the water table and therefore waterlogged.

Use and management.—If undrained, Scarboro loam, level phase, is almost exclusively in pasture and forest. The pastures are brushy, consisting of hardhack, highbush-blueberry, and alders. Where drained, the soil is used for row crops and provides very good yields

if fertilization is adequate. The forested areas contain considerable red maple and a few hemlocks and scrub oaks.

Scarboro silt loam, nearly level phase (Sc).—This soil is associated with the level phase of Scarboro loam but when drained is more productive because its fine material is deeper (36 to 48 inches as compared to 12 to 15 inches for the level phase). Undrained areas are in pasture or forest. Part of one long narrow area in the vicinity of the village of Litchfield is drained and planted to vegetable crops. Exceptionally good yields are obtained on this tract.

Shapleigh fine sandy loam, rolling phase (SD).—This well-drained soil developed in the southeastern part of the county where shallow deposits of relatively fine grained glacial till rest on hard coarse crystalline gneiss or granite. The relief is gently rolling to hilly (7- to 15-percent slopes). Most slopes are short and uneven, but a few smooth ones are included. Runoff is rapid during torrential downpours, but most of the water is absorbed during an average rain. Shallow soils like this erode readily when they become saturated with water. Shapleigh soil is similar to the Canaan soils in depth and origin of parent material but occurs at lower altitudes and, in virgin condition, is less strongly leached. It is medium to strongly acid.

The content of stones and boulders is variable, but in most places many small fragments of crystalline gneiss and a few large granite boulders are on the surface. In some areas on ridge tops the depth to bedrock is uniform over wide areas; in most places, however, the microrelief of the bedrock is not parallel to the surface and outcrops are numerous. The depth of the soil material may be 5 to 6 feet a short distance from an outcrop, but these exposures of bedrock occur in so many places that the average depth of soil material for the total area is probably less than 30 inches.

Profile description:

1. Surface soil, brown light loam or fine sandy loam to a depth of 5 to 8 inches.
2. Upper subsoil, brown very friable fine sandy loam to a depth of 10 to 12 inches.
3. Deeper subsoil, yellowish-brown fine sandy loam to a depth of 20 to 24 inches.
4. Substratum, gray or olive-gray friable to firm sandy loam glacial till in many places containing a great number of fragments of hard crystalline schist and of granite and gneiss; in places layer absent and bedrock is at 24 inches.
5. Bedrock, in most places a hard crystalline gneiss, usually seamed with layers of quartz 2 inches or more thick.

Use and management.—Shapleigh fine sandy loam rolling phase, was originally forested with mixed hardwoods, white pine, and hemlock, but most areas are now in grass. More than half of the land is pastured, and the rest is in hay or cultivated crops. Broomsedge, poverty oatgrass, witchgrass, and bentgrass are common in old pastures. Many pastures are infested with juniper, hardhack, sweetfern, various sprouts, and annual weeds. Up to 5 acres of such weedy pasture is necessary to graze one cow through the season. Definite data on yields of hay and cultivated crops are not available, but yields are generally low.

Shapleigh stony fine sandy loam, hilly phase (SE).—Although this soil is similar to the Shapleigh fine sandy loam, rolling phase, in

most characteristics, it has more rugged relief and stones and boulders on the surface in numbers sufficient to hinder or prevent cultivation with two-horse or motor-driven machinery. The slope range is 15 to 25 percent, but the dominant gradient is about 18 percent. Included with this soil are some areas steeper than 25 percent and others having slopes under 15 percent.

Use and management.—Shapleigh stony fine sandy loam, hilly phase, is chiefly in timber or brush; about 10 percent is in pasture. Northern red oak, sugar maple, aspen, gray birch, and white pine are common in forested areas, but a dense growth of scrub oak is in some places.

Most of the pastures are poor and weedy and have a carrying capacity of about 30 cow-acre-days. The steep slopes should not be overgrazed, because water runs off rapidly when the absorption capacity is reached. A good grass cover is necessary to bind the soil and prevent erosion or slipping.

Stony hilly and steep land, Acworth soils (SF).—The slope range of this land type is 15 to 30 percent, but a few areas with a slope greater than 30 percent or less than 15 percent are included. On the surface are large stones and boulders 3 to 5 feet in diameter and usually 100 feet or less apart. Between the boulders are many stones up to 2 feet in diameter. In some places, however, the boulders and stones are as close as 2 or 3 feet apart. The soil between the stones is similar to Acworth soils in profile characteristics. Few areas have been cultivated, and the thin gray surface layer of mineral soil and the underlying brown layer are present almost everywhere. Exceptions are the places where trees have been uprooted in the past or where lumbering operations have mixed the layers. In such places the mixed layer resembles Brookfield surface soil.

Use and management.—Stony hilly and steep land, Acworth soils, is almost entirely forested, and boulders are so numerous that clearing for cultivation probably would not be feasible. The land will likely remain in forest, just as it has in the past.

Stony hilly and steep land, Becket soils (SG).—Very large stones or boulders are scattered on the surface of this land type. The soil profile between the stones is similar to that of the Becket soils, but stones and boulders are so numerous that preparation of the land for cultivation would be impractical. The slope range is 15 to 30 percent, but a few included areas have relief steeper than 30 percent and a few other very stony or bouldery areas have relief less than 15-percent gradient. This land type was not mapped in detail; therefore, a few small areas are included that may be entirely free of stone, as well as a few small bodies of poorly and imperfectly drained soils.

Use and management.—Little of Stony hilly and steep land, Becket soils, has ever been cultivated, but some areas were cleared of forest and smaller stones when the county was first settled. Most of these cleared areas have returned to forest. About 95 percent of the land is forested; the rest is in brushy pasture. The pastured areas furnish poor grazing because 30 to 40 percent of the pasture may be covered by large stones or boulders, and a large part of the rest by brush and small trees. Much of the land is isolated from settled districts, and few roads pass through the area.

Stony hilly and steep land, Brookfield soils (SH).—This stony land type occurs principally on 15- to 30-percent slopes. The surface boulders are chiefly 30 inches or more in diameter, but in some places there are numerous stones not large enough to be classed as boulders. On some of this land stones or boulders are as close as 1 or 2 feet apart. A few outcrops also occur. The profile of the soil between the stones is similar to that of Brookfield stony loam, hilly phase. Stones and boulders are too large and numerous for this land to be used for any thing except forestry or unimproved permanent pasture.

Stony hilly and steep land, Gloucester soils (SK).—A great number of extremely large boulders are on the surface of this soil. The boulders are 100 to 150 feet apart in most places, and many stones up to 2 feet in diameter are between them. Frequently stones and boulders are as close together as 1 or 2 feet. The slope range is 15 to 30 percent, but a few areas with slopes of more than 30 percent or less than 15 percent are included. This land type is not mapped in detail and includes a few small areas that may be entirely free of stone or that may be poorly or imperfectly drained.

Use and management.—Although some of Stony hilly and steep land, Gloucester soils, was cleared of forest and smaller stones when the county was first settled, little of it has ever been cultivated. Most of the areas once cleared have reverted to forest or are in brushy pasture. Much of the land is isolated from settled places, and few roads pass through the areas. Approximately 95 percent of this land is forested, and the rest is in brushy pasture. Pastured areas furnish only very poor grazing because 10 to 20 percent of the surface is covered by large stones and boulders and because a good deal of the rest is grown up to brush and small trees.

Stony hilly and steep land, Hermon soils (SL).—Essentially the same features characterize this land type as characterize Stony hilly and steep land, Gloucester soils. These areas, however, are at higher altitude, and the soil is more leached; they are therefore classified as Hermon rather than Gloucester soils. Relief ranges from 15 to 30 percent, but a few areas that have slopes of less than 15 percent and some having more than 30 percent are included. In some areas large boulders and stones are very numerous and almost entirely cover the ground. Some small areas of nonstony soils and other small bodies of imperfectly drained soils were included in mapping.

Use and management.—About 95 percent of the land is in forest; the rest is in brushy pasture that is about 10 to 20 percent covered by stones. Some of the land was cleared in early days, but these cleared tracts have reverted to forest or brushy pasture. The land often occurs in isolated areas where there are no roads.

Stony hilly and steep land, Marlow soils (SM).—In stoniness, relief, included areas, and most other respects this land type is the same as Stony hilly and steep land, Gloucester soils. The only difference is in profile characteristics of the soils between the rocks. About 95 percent of the land is forested, and 5 percent in brushy pasture of very low grazing value.

Stony undulating land, Waumbek, Peru, and Acton soils (SN) — The imperfectly drained soils occurring among the rocks of this land type have the same profile characteristics and slope as undulating

phases of the Waumbek, Peru, and Acton stony loams, but they have more large stones and boulders on the surface. Stones are so numerous one can easily cross many areas by jumping from one stone to another.

Use and management.—Most of stony undulating land, Waumbek, Peru, and Acton soils, is forested, but a few areas have been cleared of trees and used for pasture. The pastured areas are so boulder they can be fertilized only by hand and are commonly unimproved and useful only as supplemental grazing land. The pastures provide grazing in summer when well-drained adjacent soils are unproductive.

Sudbury fine sandy loam, level phase (Sp).—This imperfectly drained soil occurs on outwash or stream terraces and is developed from material similar to that of the Merrimac soils. Nearly level areas occur throughout the county in close association with the Merrimac and Colton soils. In hilly areas where it is associated with upland soils, it occupies nearly level gravelly terraces at the foot of long slopes where the water table is near the surface. On the larger broad terraces of the valley of the Merrimack River it is closely associated with the Merrimac soils. The soil is moderately acid.

Profile description:

1. Surface soil, dark grayish-brown very friable single-grained fine sandy loam; relatively high organic-matter content; 6 inches deep.
2. Subsoil, faintly mottled yellowish-brown and brown gravelly single-grained loamy fine sand to loamy sand continues from 6 inches to a depth of 14 inches; variable texture (may be fine sandy loam in places); quantity of gravel varies from almost none to so much that it makes up almost all the soil mass.
3. Lower subsoil, mottled yellow, brown, and yellowish-gray gravelly loamy sand to a depth of 27 to 30 inches.
4. Substratum, yellowish-gray gravelly sand; gravel derived chiefly from granite, but in places near Merrimac and Colton soils schist pebbles are part of the parent material and the quantity of schist in this layer and those above may be greater.

Included with this soil are a few areas of soils that would have been mapped as members of the Saugatuck series if they had been large enough. Because of their relatively small extent, the Saugatuck soils are not mapped separately in this county. The included areas do not have the mottled subsoil described for this one but instead have a grayish-white single-grained fine sandy loam subsoil. Underlying this grayish-white layer is a 6- to 12-inch layer of brown cemented fine sandy loam. The cementation is general where the gray subsoil occurs and can be penetrated only by a bar or pick. Underlying the brown cemented layer is yellowish-gray gravelly sand the same as that described for the Sudbury soils. Also included with the Sudbury soil are small isolated areas of Merrimac fine sandy loam, level phase, and small bodies of peat and muck.

Since the survey was made the Sudbury soils have been subdivided into two series—the Sudbury and Walpole. The separation is made principally on the basis of depth to mottling. The Sudbury soils are limited to soils that are not mottled above a depth of 14 to 18 inches, and the Walpole soils, to those that are mottled to plow depth. The Walpole are so much wetter than the Sudbury that they are seldom used for row crops. In this county the Sudbury soils include the Walpole.

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Use and management.—Only a small part of Sudbury fine sandy loam, level phase, is cultivated. Little of the soil has been artifically drained, and relatively large areas are used mainly for pasture. Areas recently plowed produce good stands of grass and excellent forage during the dry season of the year, but wild swale grasses soon crowd out the Kentucky bluegrass and redtop, and the pasture becomes less valuable. Red maple and some gray birch, elm, and white pine are the principal trees in forested areas. Alder forms a dense growth in many of the pastures. A few soil areas can be cultivated when they dry out in dry seasons. Some silage corn, oats, and hay are grown on the better drained areas, but the acreage is very small and definite yields cannot be given.

Sudbury fine sandy loam, gently sloping phase (So).—This soil is associated with Buxton silt loam soils and occurs on 2- to 5-percent slopes. The upper profile is the same as that of Sudbury fine sandy loam, level phase, to a depth of 30 to 40 inches, but at that level, clay occurs. The layer of clay evidently keeps the ground water high. Even though surface relief is undulating, the water table remains at a relatively constant height. In other areas these imperfectly drained soils with clay substrata have been classified as members of the Elinwood series.

Use and management.—The gently sloping phase of Sudbury fine sandy loam is used to a limited extent, and in about the same way as the level phase. Sheet erosion might be a problem in a cultivated area, but if the soil is in forest or pasture, it can be treated the same as the level phase.

Sudbury loam, level phase (Sʀ).—This soil is very similar to the level phase of Sudbury fine sandy loam except in texture. The surface layer ranges from loam to silty clay loam, and underlying layers, though similar to corresponding layers of Sudbury fine sandy loam, level phase, may be heavier textured. This soil occurs almost entirely in old river channels in the Merrimack River valley where the ground water level is high. Use and management practices are like those for the level phase of Sudbury fine sandy loam, and yields are similar.

Sudbury loamy sand, level phase (Ss).—This soil occurs in the Merrimack River valley. The surface soil is coarser textured than that of Sudbury fine sandy loam, level phase, but in other characteristics the two soils are similar.

Profile description in a cultivated area:

1. Surface soil, mottled brownish-gray and dark grayish-brown single-grained loamy sand to a depth of 7 inches; dark color indicates a moderate organic-matter content.
2. Subsoil, mottled yellowish-brown and brown loose gravelly loamy sand 7 to 19 inches deep; gravel varies from almost none to 50 percent of the soil mass.
3. Parent material, from 19 inches downward the material is grayish-yellow single-grained sand and gravel streaked with yellowish-brown sand.

Variations in this soil are the same as those described for the level phase of Sudbury fine sandy loam. In some places the subsoil is gray and underlain by a cemented brown layer; in other areas the texture and the depth of the layers vary somewhat.

Use and management.—Agriculturally, Sudbury loamy sand, level phase, is similar to the level phase of Sudbury fine sandy loam. Little

of the land is used for cultivated crops. Because it is imperfectly drained, most of the land remains in pasture or forest.

Sutton silt loam, gently sloping phase (St).—This imperfectly drained soil occurs in the southern part of the county with Charlton and Hollis soils. It has developed on glacial till derived from schist or phyllite and is on nearly level or slightly concave relief where slopes are less than 7 percent. Runoff is slow, and for much of the year underdrainage is restricted by a relatively high permanent water table. A few large granitic boulders are still scattered on the surface and in the soil, but in most places stones were removed and placed in walls or piles when the land was cleared.

Profile description in a cultivated area:

1. Surface soil, brown or dark grayish-brown friable silt loam to a depth of 6 to 8 inches; breaks into soft thin plates when slight pressure is applied, but in many places structure is obscured by the action of earthworms or by grass roots; brown color indicates a relatively high organic-matter content; small pieces of schist mixed with the soil in places; soil readily penetrated by roots, air, and moisture in summer but sometimes waterlogged in spring or during periods of excessive rainfall.
2. Upper subsoil, yellowish-brown friable silt loam in most places faintly mottled with gray and grayish yellow; extends to a depth of 12 or 15 inches; breaks into small soft granules about ⅛ inch in diameter; small phyllite and schist fragments common in most places; layer readily penetrated by roots, air, and moisture in summer but sometimes waterlogged in spring or during periods of excessive rainfall.
3. Deeper subsoil, mottled grayish-yellow, gray, and brown friable silt loam to a depth of 20 or 24 inches; structure not well developed but soil can be separated into small angular aggregates about ⅛ inch in diameter; some areas nearly stone-free but many small fragments of phyllite or schist and a few larger stones of granitic origin occur in most places; freely penetrated by roots, air, and moisture during the summer but sometimes waterlogged in spring or during excessive rainfall.
4. Substratum, moderately firm somewhat platy olive-gray fine- to medium-textured glacial till similar to that underlying the Charlton soils; faintly mottled with gray and brown in most places; derived largely from local phyllite and schist but includes varying quantities of granitic debris; layer contacts water table and is moist during most seasons; furnishes sufficient water for plant growth during most seasons, but sometimes waterlogged in spring or during excessive rainfall; penetrated by roots and air with difficulty; slow downward movement of water.

The soil is strongly to medium acid throughout. Variations from the profile described are of local importance and in most places include minor differences in drainage—as reflected in the degree of mottling—and in texture. In some places faint grayish mottlings are in the surface soil, and in others both the surface soil and upper part of the subsoil are unmottled. In places more sand is mixed with the soil material, and the surface and subsoil layers are of a loam or, in a very few places, fine sandy loam texture. A few stony areas, shown on the map by stone symbols, are included.

Use and management.—Sutton silt loam, gently sloping phase, was originally forested with mixed hardwoods. Red maple was the dominant species, but a few hemlock and white pine occurred. Practically the entire area is now cleared and cultivated or used as permanent pasture. Kentucky Bluegrass, redtop, and broomsedge are common in most pastures. This soil is well suited to grass, and many

areas are kept in hay for 4 years or more. About 20 percent of the area is in pasture, 50 percent in hay, and the rest in corn or oats, which do well in dry seasons but not in moist ones.

No definite rotation is followed. Many meadows are allowed to stand as long as the hay yields more than 1 ton an acre. Meadows are top-dressed every 2 or 3 years. Most permanent pastures are not fertilized, but only 2 or 3 acres is required to graze a cow through the season.

Artificial drainage is not provided on most areas, because natural drainage is sufficient to permit good hay crops. Open ditches have been dug in a few areas. Some areas of this soil may be under water for a few days, usually in spring before tillage begins. This soil cannot be worked so early as adjoining areas of Charlton and Hollis soils, but artificial drainage is still profitable.

Waterboro muck (WA).—This soil occurs in depressions and along nearly level stream channels and is widely distributed throughout the county. It consists of mixed very dark brown to black well-decomposed organic matter and mineral material. The mineral material may make up as much as 50 percent of the soil mass. The plant remains have disintegrated to the point where individual fibers and cell structure cannot be seen. Usually the mixed organic-mineral material extends to a depth of 3 feet or more. In some places the lower part of the profile is brown organic matter and the substratum is gray or light-gray glacial till or sand and gravel. All layers are very acid.

Use and management.—A few areas of Waterboro muck are in pasture and some are used as wild hay meadows, but over 90 percent of the land is forested. Little of this soil is in vegetable crops, and it probably should not be used for them, because it lies in low areas always susceptible to frost and flood. In some years frost may occur in almost any month. Sedges predominate in pastures and meadows; forested areas support a dense growth of alder, briers, red maple, willow, and some hemlock.

Waterboro muck, shallow phase (WB).—This phase is similar to Waterboro muck in other characteristics but its organic-matter deposit is less than 3 feet thick. If the use of muck soil should become agriculturally profitable in the county, the shallow phase would likely be less desirable than Waterboro muck. Because the level of the muck sinks when it is drained, the organic deposit in the shallow phase would be of less satisfactory depth. The height of the water table, moreover, would be harder to control after drainage than in the drained deep muck.

Waumbek, Peru, and Acton stony loams, undulating phases (WD).—These imperfectly drained soils occur in association with all soils of the upland except the Charlton and Hollis. In most places they are closely associated with or are immediately adjacent to the poorly drained Whitman soils that occur in depressional areas. They are on undulating relief (2- to 7-percent slopes).

Although three kinds of soils are mapped together in this separation, the kind of soil occurring in any area under consideration can be determined by observing the associated well-drained soils. The Waumbek soils of this separation are associated with the Hermon soils in the western part of the county and have developed on similar parent materials. The Waumbek differs from the Hermon soils

principally in having varicolored or mottled areas in the lower subsoil at a depth of about 15 to 18 inches. This mottling indicates that the soil has a high water table in wetter parts of the year. In addition to mottling, the forest litter on the Waumbek surface soil may be a little thicker, and the leached gray layer, though present, may not be so thick. When cultivated, the imperfectly drained Waumbek soils may have a slightly darker plow layer than that of associated well-drained soil.

The Acton soils of this separation occur in association with the Gloucester soils in the eastern part of the county and are similar to them, although their lower subsoil is mottled.

The Peru soils occur in association with the Marlow and Acworth soils and differ from them chiefly in being mottled.

The soils vary in color, texture, or stoniness, but are used similarly. In some nearly level areas where the water table is close to the top of the ground, the surface soil is mucky loam to a depth of 3 to 4 inches; the subsurface soil is light-gray sandy loam mottled with rust brown to a depth of 6 or 8 inches; and the upper subsoil is dark-brown loam that is in a few places moderately cemented. In a few places drainage is somewhat poorer than is typical for these soils, and the soil may be mottled to within 10 or 12 inches of the surface.

The quantity of stone on the surface and in the soils varies from about 15 percent to almost 90 percent of the total mass, but in most places it is 30 or 40 percent. The surface soils and subsoils vary in texture from a sandy loam to silt loam. Areas having a silt loam texture are usually associated with Marlow soils. Fine material washed from surrounding areas of other soils have produced a heavy texture in places. In many smaller areas of this separation the center of the depression contains Whitman stony loam, nearly level phase.

Use and management.—Most of Waumbek, Peru, and Acton stony loams, undulating phases, is forested with red maple, aspen, gray birch, Northern red oak, hemlock, willows, black ash, and a few yellow and white birches, sugar maple, white ash, red spruce, and white pine. The original forest cover probably included the same species but a larger proportion of red maple, white ash, and hemlock. Several species of moisture-loving shrubs grow on these soils or in zones transitional between these soils and adjoining well-drained soils. Winterberry, speckled alder, and withe-rod are the more common shrubs.

Waumbek, Peru, and Acton loams, undulating phases (Wo).—These soils occur where stones have been removed from stony areas. Profile characteristics are the same as those described for Waumbek, Peru, and Acton stony loams, undulating phases. The slope range is 2 to 7 percent. Natural outlets carry off standing water in a short time in most places, but shallow open ditches are used in some places and could be used in many others.

Use and management.—About 75 percent of Waumbek, Peru, and Acton loams, undulating phases, is forested, and the rest is used for pasture. Some timbered areas are used as woodland pasture, and many tracts now timbered were once a part of pastures or fields. Most cultivated areas are small and included in fields composed principally of Marlow, Hermon, Gloucester, Acworth, and Brookfield soils. In many instances drainage is only slightly restricted

in these small areas, and therefore they do not seriously interfere with cultivation.

These soils are well suited to pasture because they have an ample supply of moisture for grass during most summers. Cattle should not be pastured early in spring, however, as the ground is soft and the turf would be cut. No care is taken of most pastures; hardhack and moisture-loving shrubs occupy much of the space. The carrying capacity of these brushy pastures through the grazing season is one cow for 2 or 3 acres, but if weeds were controlled and fertilizer were applied, 1 acre would be adequate.

Whitman loam, nearly level phase (WE).—In profile characteristics this poorly drained soil is similar to Whitman stony loam, nearly level phase. It is most common in the southeastern part of the county. Practically all the areas are small and were once stony, but the stones have been cleared away and placed in stone walls or dumped in low spots. In many places practically no stone is on the surface, but in others a few of the larger stones or boulders still remain, though not in numbers sufficient to interfere appreciably with tillage.

Use and management.—Whitman loam, nearly level phase, is principally in hay or pasture. It often occurs in cultivated areas where its inclusion will improve the shape of a field. In such instances, the greater part of the field is made up of well-drained soils, and the small areas of this included Whitman soil are artificially drained by open ditches. Where the areas of Whitman soil are not drained they are used only for hay. Horse-drawn equipment can be used for harvesting hay on the nonstony undrained areas in the drier part of the summer, but use of heavy power-driven equipment may be hindered by the soft wet condition of the soil. Where adequately drained, yields of corn and oats on this soil are comparable to those obtained on associated well-drained soils.

Whitman stony loam, nearly level phase (WF).—This poorly drained soil is widely distributed over the county in association with all the upland soils. It is developed on glacial till derived principally from granite, gneiss, or schist and occurs on nearly level land in the bottoms of depressions or at heads of drainageways. Most areas are less than 50 acres. Surface stones are so numerous that tillage by two-horse or motor-driven equipment is not feasible.

Profile description:

1. Surface soil, very dark-gray to black loam (in the virgin condition is mucky) to a depth of 6 or 8 inches; easily penetrated by roots but waterlogged during much of each year; numerous large stones and boulders in most areas and in places practically cover the surface.
2. Subsoil, gray or mottled gray, grayish-yellow, and brown loam to silty clay loam to a depth of 15 or 20 inches; material has very weak structure and is somewhat plastic and sticky where the clay content is high; content of large and small stones varies from practically none to 80 or 90 percent; in most places 20 to 40 percent of soil mass made up of stones; plants chiefly shallow-rooted with most of their roots in the surface soil, but some roots penetrate this layer even though it is waterlogged much of each year.
3. Substratum, loose gray sandy loam glacial till in places stained with yellowish-brown or brown; till usually composed mainly of granitic fragments, but where associated with Marlow, Paxton, Charlton, and Hollis soils, relatively smooth and containing some fragments of schist or phyllite.

The profile described is representative, but this soil is variable, particularly in organic-matter content of the surface soil. In places as much as 8 inches of muck are on the surface, whereas in others the dark surface soil is thin. The mucky areas are somewhat more poorly drained than those with only a thin organic surface layer. If they were large enough, areas with the thin organic layer could be considered Leicester soils, which are not mapped in this county. Textural variations are common, for in places there is a large sand content, and in others the soil is a silt loam or silty clay loam. In spite of these variations, at least 60 percent of the total area has a loam surface texture. Although most of the soil is in depressions or on nearly level relief, a few areas north of Manchester on slopes grading up to 5 percent have been included in mapping. Also included are several small very stony or bouldery areas.

Use and management.—Most areas of Whitman stony loam, nearly level phase, are in brush or timber, but some are in pasture. The pasture carrying capacity is low because most areas are brushy, weedy, and very wet during much of each season. If a few of the not especially stony areas were cleared, drained, limed, and fertilized, they would have a carrying capacity of one cow an acre through the season. Such improvement would be profitable in only a few places. In addition to various small moisture-loving shrubs such as winterberry, speckled alder, and withe-rod, the natural vegetation includes red maple, black ash, hemlock, gray birch, willows, and some red spruce.

Windsor fine sand, rolling phase (Wo).—This excessively drained soil has developed on wind-blown deposits located mostly on the eastern side of the Merrimack River. Apparently before fresh alluvial material in the bed of the old glacial Lake Merrimac was stabilized by vegetation, the wind carried it away and deposited it on the older higher terraces or glacial till to the east. In a few places wind erosion is still active and the soil material is being blown out, but most areas are forested. The areas being actively eroded do not cover more than an acre.

The soil occurs on rolling relief where slopes are 7 to 15 percent. Dune formations are not common. In many places the surface is so smooth that the soil may be confused with that developed on an eroded terrace until it is more closely examined. This acid soil has a very poor water-holding capacity. It is associated with the soils of the Merrimac and Nashua series and occupies isolated areas at the edge of the glacial terraces. It differs from the associated soils not only in the origin of its parent materials but also in the weaker development in depth and in color of its profile.

Profile description:

1. Organic layer, mat of partly decomposed pine needles about 2 inches thick on the mineral soil in forested areas but absent or nearly absent where the trees are scattered.
2. Surface soil, light grayish-brown fine sand of single-grained structure to a depth of about 4 inches; organic matter, the supply of which is not great, occurs as small individual particles intermingled with the sand grains rather than as a colloidal coating over mineral particles; a newly deposited thin layer of light gray wind-blown sand on the surface in places.

3. Subsoil, pale-yellow loose single-grained fine sand to a depth of about 18 inches; sand particles uniform in size and consist of angular grains of quartz, feldspar, and some mica; colorless mica flakes make up only about 2 percent of the sand.
4. Substratum, below a depth of 18 inches material similar to subsoil but paler yellow or gray.

Use and management.—Practically all of Windsor fine sand, rolling phase, is forested with a poor growth of white and pitch pines, scrub oak, and gray birch. The small areas in pasture are associated with much larger areas of better soils. Crops are not grown. The soil is particularly susceptible to wind erosion and should be kept in forest.

LAND USE AND MANAGEMENT[10]

Hillsborough County is located where climate and soil are favorable for the production of a wide variety of crops and for a diversity in farming. Dairying or poultry raising is the chief pursuit on most farms, followed by orcharding and market gardening.

The soils vary widely in external and internal characteristics and therefore differ in their capability for producing crops, grasses, and trees. At the peak of the agricultural development, about 80 percent of the land in the county was cleared. Through a gradual selective process the better soils have remained under cultivation and much of the less desirable land, at one time cleared, has been allowed to revert to forest or brush pasture. This was caused largely by the economic changes brought about in the late 1850's by the opening of the West and the industrial development in the East.

Extensive areas of the light-textured soils of the terraces were once cleared, but owing to low inherent fertility and droughtiness, they are now largely in forest, lying idle, or used for pasture. Clearing the land on the glaciated uplands was a slow process even during the expansion period because stones severely hindered tillage and use of improved farm machinery. Much of the land on the steeper slopes and in poorly drained areas has always been in forest. Extensive areas that have been cleared of trees and partly cleared of stone are now in young forest or brushy pasture. Areas of cultivated land on the glaciated uplands are now comparatively stone-free and occur mostly as scattered bodies.

In 1950, less than 26 percent of the farm area of the county was in improved land, including plowable pasture. With a few exceptions the improved land is the best agricultural land, and in general its texture and structure are favorable to good aeration and deep root penetration. Drainage is adequate, and the water-holding capacity is fair to good. The soils now farmed respond to fertilization and care and are capable of being built up to and maintained in a fairly productive

[10] This section includes the 1950 fertilizer and seeding recommendations of the New Hampshire Agricultural Experiment Station. The discussion of the land use and management emphasizes these recommendations and the currently used farm practices. The tendency is toward more intensive use of better land; use of a greater quantity of fertilizer, that is, more than in 1940 when the soil survey was made; and particularly, better management of hay and pasture crops. Yields are likewise somewhat greater because of the better management now practiced, use of improved varieties, and application of fungicides and insecticides. More efficient fertilizers and new varieties are constantly being made available. The Agricultural Experiment Station or county agricultural agent should be consulted for the latest recommendations.

state. In large part the soils now in forest are probably best adapted to that use or for pasture because of their stoniness, hilly or steep relief, poor drainage, and low inherent fertility, which limit their use for hay or cultivated crops. The trend has been and still is toward the use of the soils for purposes to which they are best adapted.

On most dairy farms, large acreages are used for hay and pasture, and increasing attention is given to improving these lands, especially those suitable for both hay and rotational pasture. The use of high yielding tall-growing grasses and legumes—Ladino clover, timothy, and bromegrass rather than low-growing wild white clover and Kentucky bluegrass—has been emphasized for rotational pastures. Until recently hay and pasture were on separate areas on the same farm, the pasture areas often being unplowable. The present tendency is to use a combination hay-pasture seeding on plowable land and to use the areas thus seeded for both hay and pasture. Recommended hay-pasture mixtures and seeding rates are given in table 5.

TABLE 5.—*Recommended seeding rates of hay-pasture mixtures for New Hampshire soils*

Use and seed mixtures	Quantity	Soil condition [1]
	Pounds per acre	
Hay-pasture:		
Ladino clover [2]	1	Well drained, well limed.
Alfalfa	8	
Timothy [3]	4	
Red clover [4]	3	
Hay:		
Alfalfa	12	Do.
Timothy [3]	5	
Red clover	3	
Hay-pasture:		
Ladino clover [2]	1	Imperfectly and poorly drained.
Red clover [4]	4	
Alsike clover [5]	2	
Timothy [3]	6	
Redtop	2	
Hay-pasture:		
Ladino clover	1	Imperfectly drained.
Red clover	3	
Timothy	8	
Hay-pasture:		
Ladino clover	1	Do.
Red clover	3	
Smooth bromegrass [6]	14	
Hay-pasture:		
Ladino clover	1	Very wet, poorly drained soil.
Alsike clover	2	
Reed canarygrass	10	

[1] Seedings should be made on recently limed and well-prepared seedbeds.
[2] Ladino clover may be omitted if mixture is used for hay only.
[3] 10 pounds of smooth bromegrass seed may be substituted.
[4] 2 pounds of alsike seed may be substituted.
[5] If this mixture is used on wet soil, omit red clover and use 4 pounds of alsike clover.
[6] Smooth bromegrass should be mixed with oats or rye for more even distribution, and on a very heavy soil mixed with 5 to 7 pounds of birdsfoot trefoil.

The hay-pasture seedings produce high yields if adequately fertilized, but careful management is required for best results. Usually, the first cutting from such a seeding is harvested for grass silage or hay, depending mainly on the weather. Some of the better dairymen graze the new seedings for 1 or 2 years or until the ratio of clover to grass decreases and the newly cut hay is easier to dry. After the first cutting, the fields may be used for rotational pasture, or on part of the fields a second hay crop may be harvested. The handling of such fields depends on the quantity of forage that is needed and on weather conditions. On the more progressive dairy farms the areas that are pastured are usually subdivided into three or more small units, and each is grazed for a period of about a week or 10 days, thus allowing time for the recovery of the grazed areas and resulting in a higher yield per acre.

On the better dairy farms, permanent pastures are utilized for spring and early summer grazing and as pasture for young stock. The better parts of the permanent pastures are often improved by top dressing with lime and commercial fertilizer. Rotational and supplementary pastures furnish grazing during the summer and early fall. Supplementary crops, such as Sudangrass, Japanese millet, Hungarian millet, and soybeans, are grown to furnish pasture late in summer and early in fall. These crops may also be used for silage, providing the pasture is not needed. Rye and winter wheat are grown for grazing late in fall and early in spring, and oats and barley are recommended for grazing late in fall.

Relatively long rotations are the general rule on dairy farms. On the better farms a 4- to 6-year rotation of silage corn for 1 year and hay-pasture for 3 to 5 years is the most common practice. The time that elapses before the rotation cycle is completed varies widely, depending on the needs of the individual farm and on the soil type. The rotations are shorter on the more droughty Merrimac, Gloucester, and Nashua soils than on the Paxton, Marlow, or Essex because the droughtier soils do not remain productive as long. On the smaller and less intensively managed dairy farms, the rotation may run 9 or 10 years or until hay has dropped to a yield of about half a ton an acre.

Fertilizer, lime, and manure are used on dairy farms. The manure on the dairy farms is used under silage corn, for establishing new seedings, and for top dressing fields used for hay. In addition to cow manure, many farmers use manure from nearby poultry farms. Where poultry manure is used, it should be applied at half the rate of cow manure.

Manure is commonly supplemented with superphosphate in the gutter at the rate of about 1 to 2 pounds per cow per day. This is equivalent to about 30 to 50 pounds of 20-percent superphosphate per ton of manure. Recommended rates for the use of cow manure are 15 tons an acre for corn, millets, and Sudangrass; 10 tons on new seedings; and 8 tons for top dressing. When manure is used for silage corn, 400 to 600 pounds an acre of 4–12–4 fertilizer is recommended. This is drilled with the planter. Without manure, 1,000 to 1,200 pounds of 5–10–10, or its equivalent, should be used.

For establishing new seedings with manure, 400 to 500 pounds an acre of 4–12–16 is recommended. For top dressing fields with a stand of 75 percent or more of legumes, 8 tons of manure fortified with 20-percent superphosphate an acre should be applied; or, if manure is not used, 500 pounds of 0–20–20. For top dressing stands of mixed legumes and grasses not receiving manure, 700 to 800 pounds of 5–10–10 is recommended; for stands primarily of grasses without manure application, 600 to 800 pounds 7–7–7 should be used.

Lime is usually used at the rate of 1 to 2 tons an acre. The exact rate to be used is dependent largely on the reaction and texture of the soil. Seedings in which alfalfa is used generally receive heavier applications of lime than the regular hay pastures. Because alfalfa is especially sensitive to lack of boron, the addition of 30 to 35 pounds of borax per acre when seeding this crop is recommended. Most fields on which alfalfa is to be grown are sampled, and reaction and quick chemical tests are run by the station to provide a basis for fertilizer and lime recommendations.

Some farmers have found it profitable to use additional top dressing after the first crop is removed. Fertilizer recommendations on dairy farms are essentially the same for all soils. It is recognized, however, that the productivity of the droughtier soils, like the Merrimac, Gloucester, and Nashua, is generally less than that of the heavier textured Paxton, Marlow, and Essex. The yields on the droughtier soils are dependent to a greater extent on the frequency and quantity of rainfall, inasmuch as less rainfall can be stored in these soils than in heavier textured ones. Recommended fertilizers and rates of fertilization are given in table 6.

Poultry raising has expanded rapidly in the last few years and exceeds the dairy industry in income. Some of the larger poultry farms are located on droughty soils of the terraces that are not well suited to dairying, and others are located on the upland. Poultry raising has become specialized and is not so often connected with dairying as it was at one time. Poultry growers in general do not grow their own grain but purchase it already mixed from commercial feed companies. The fields of the poultry farm are used principally as summer range for the growing pullets.

The areas with the best soils for growing grass are chosen for poultry range. Ranges generally are not rotated but are used for several years. The shelters remain in the same spot, and the area in the immediate vicinity remains bare, but the shelters and the number of ranging birds are regulated so that the area in between the shelters has a good sod. Clovers have difficulty in withstanding the constant grazing, and as a result the sod is composed principally of grass. Clipping the tall grass, applying lime, and top dressing with fertilizer are recommended practices for encouraging and preserving a good growth of grass. Poultry manure commonly is not used on the farm itself but is either given to nearby dairy or vegetable farmers or sold for a low price. Although it might seem desirable for poultry farmers to grow oats and corn for grain and thereby use some of the manure, they generally do not have enough land or special equipment for grain farming. They feel that the time and money spent for growing these crops can be spent more profitably raising more poultry.

Apples are grown entirely in sod, most of the young trees being set out in sod and mulched with hay. About 100 pounds of hay is applied to the newly set tree, and later more is added at intervals so that enough mulch is present to prevent the growth of grass. In general, not less than 200 to 300 pounds of hay per tree is applied at any one time. The quantity is about 2 or 3 tons an acre per year. The mulch covers an area slightly greater than the spread of the branches; none is applied closer than 2 or 3 feet to the trunk so as to minimize damage from mice. The grass between the trees is mowed and supplies part of the mulch. Recommended fertilizer application under the sod-mulch system is one-fourth pound of nitrate of soda, or its equivalent, for each year the tree is old, up to a maximum of 10 pounds per tree per year. Recent studies indicate that if the mulch is used for 5 to 10 years, less nitrogen can be applied without reduction in yields.

TABLE 6.—*Suggested fertilizers and rates of fertilization for certain crops of New Hampshire*

Crop	Medium analysis		High analysis	
	Mixture	Quantity	Mixture	Quantity
		Pounds per acre		*Pounds per acre*
Grass seedings [1]	5–10–10	600–800	8–16–16	400–500
	[2] 4–12–16	400–500		
Top dressing legumes	0–14–14	600–800	0–20–20	400–600
Top dressing legumes and grasses	5–10–10	700–800	8–16–16	400–500
Top dressing grasses	7– 7–7	600–800	10–10–10	400–600
Corn for grain or silage	5–10–10	1, 000–1, 200	10–10–10	1,000–1,200
	7– 7–7	1, 200–1, 400	8–16–16	600–800
Millet or Sudangrass	7– 7–7	600–800	10–10–10	400–500
Permanent pasture	[3] 0–14–14	500–700	0–20–20	300–500
	[4] 5–10–10	500–600	8–16–16	300–500
Potatoes	5–10–10	2, 000	8–16–16	1, 250
			8–12–12	1, 500
Vegetables and home gardens	5–10–10	2, 000	8–16–16	1, 250
	5–10– 5	2, 000	10–10–10	1, 300
Fruit trees [5]				

[1] 30 to 35 pounds of borax an acre before seeding alfalfa is advised.
[2] In addition to manure.
[3] Safe application on soil suited to clover.
[4] To be used where pasture can be controlled.
[5] For each year tree is old use either ¼ pound of common nitrogen carrier up to 10 pounds per tree or ⅛ pound ammonium nitrate up to 5 pounds per tree; apply ½ pound borax per tree every 3 years.

Poultry manure is excellent for apple trees on all soils, especially for the phases of Gloucester fine sandy loam, on which many of the

smaller orchards are located. A combination of poultry raising and apple orcharding is an efficient farming system because the labor demands of these two do not overlap.

The hay mulch apparently provides sufficient potassium and phosphorous so that these need not be applied. The mulch also supplies some of the needed magnesium. As indicated by leaf scorch, magnesium deficiency is widespread, being particularly noticeable where acidity is high. It can be temporarily corrected by use of sprays containing magnesium sulfate or permanently corrected by using magnesium limestone, which does not give beneficial results until several years after application. Boron deficiency also occurs and is especially evident in dry years. Experimental results show that boron deficiency can be corrected by applying borax at the rate of one-half pound per tree every 3 years.[11]

Market gardening is carried on principally in the Merrimack River valley, mainly on the Ondawa and Nashua soils. The principal crops are sweet corn, snap beans, carrots, tomatoes, cucumbers, potatoes, cabbage, and summer, fall, and winter squash. Late cabbage is grown to some extent on the finer textured Podunk and Sudbury soils associated with the Ondawa and Nashua soils. These vegetables are grown on level or nearly level areas. The soils are cropped yearly but usually have a winter cover crop of rye which prevents winter erosion, reduces leaching, and provides organic matter. The rye is plowed under early in spring, and about a ton or more an acre of 5–10–10 is applied to soil that is to be used for vegetable crops. Many of the market gardeners make good use of the poultry manure produced on the nearby large poultry farms. If such manure is used, about one-half ton an acre of 4–12–4 fertilizer is recommended in addition.

ESTIMATED YIELDS

Estimated average acre yields of principal crops to be expected under two levels of management over a period of years on soils of this county are given in table 7. These estimates are based primarily on interviews with farmers, the county agricultural agent, and staff members of the University of New Hampshire Agricultural Experiment Station. They express reasonably well the productivity of the soils in 1940, but the yields estimated will not be obtained every year or on every tract. Individual soils vary somewhat from place to place; management practices vary from farm to farm; and climatic conditions fluctuate from year to year. The trend toward use of adapted varieties of crops indicates that yields will soon be higher than those given in table 7.

Ordinary management, as specified in columns A, generally includes use of long rotations—corn or potatoes the first year, small grain the second, and hay for 2 to 4 years. Hay usually receives 1 to 1¼ tons of lime when reseeded; corn, an application of manure and superphosphate; and potatoes, about 500 pounds of complete fertilizer.

[11] For further information see THE APPLE ORCHARD IN NEW HAMPSHIRE, by RAWLINGS, C. O., and others, N. H. Agr. Ext. Bul. 59, 39 pp., illus. 1941.

TABLE 7.—*Average expectable acre yields of principal crops on soils of Hillsborough County, N. H., and their relative suitability for forestry*

[Figures in columns A—yields under ordinary management; those in columns B—yields under good management. Dashes indicate soil is mostly in forest, yield data is not available, or that soil is unsuitable because of steep relief, stoniness, droughtiness, poor drainage, or other unfavorable conditions]

Soil	Corn for grain		Corn for silage		Oats		Mixed hay		Potatoes		Apples		Permanent pasture		Relative suitability for forestry
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
	Bushels	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Acres per cow per season*	*Acres per cow per season*	
Acworth stony loam:															
Hilly phase													5	3	Good.
Rolling phase													5	3	Do.
Acworth loam, rolling phase	25	40	5	9	20	25	1.0	1.5	100	200			5	3	Do.
Balch and Littlefield peats															Poor.
Shallow phases															Do.
Becket stony loam															
Gently sloping phase							1.5						3	2	Good.
Sloping phase							1.5						3	2	Do.
Becket loam:															
Gently sloping phase	35	50	9	12	30	50	1.5	3.0	175	300	100	250	3	2	Do.
Sloping phase	35	50	9	12	30	50	1.5	3.0	175	300	100	250	3	2	Do.
Brimfield stony loam, hilly ledgy phase															Poor.
Brookfield stony loam, hilly phase															Moderate.
Buxton silt loam:															
Gently sloping phase	30	40	9	12	25	35	2.0	3.0					2	1	Good.
Nearly level phase	30	40	9	12	25	35	2.0	3.0					2	1	Do.
Canaan stony fine sandy loam:															
Hilly phase															Poor.
Rolling phase															Do.
Charlton stony loam, rolling phase															Good.
Charlton loam:															
Rolling phase	40	60	12	16	40	60	1.5	3.0	200	350	150	300	3	2	Do.
Undulating phase	40	60	12	16	40	60	1.5	3.0	200	350	150	300	3	2	Do.
Colton fine sandy loam:															
Level phase	25	40	6	9	20	30	1.0	1.5	100	175			5	3	Do.
Undulating phase	25	40	6	9	20	30	1.0	1.5	100	175			5	3	Do.
Colton gravelly fine sandy loam:															
Level phase	20	35	5	8	20	30	1.0	1.5	100	175			5	3	Moderate.
Undulating phase	20	35	5	8	20	30	1.0	1.5	100	175			5	3	Do.
Colton loamy fine sand:															
Level phase															Poor.
Undulating phase															Do.

Colton loamy sand:															
Level phase															Do.
Undulating phase															Do.
Colton sandy loam:															
Level phase	20	30	5	8	15	25	.7	1.5					6	3	Moderate.
Undulating phase	25	40	5	8	20	30	1.0	1.5					5	3	Do.
Colton stony gravelly fine sandy loam, undulating phase.															Do.
Danby gravelly fine sandy loam:															
Hilly phase	15	25	3	5	20	25	.5	1.5					6	4	Do.
Rolling phase	5	25	3	5	20	25	.5	1.5					6	4	Do.
Danby gravelly loamy sand, hilly phase															Poor.
Danby gravelly sandy loam, rolling phase.							.5	1.5					6	4	Moderate.
Danby loamy fine sand:															
Hilly phase															Poor.
Rolling phase															Do.
Steep phase															Do.
Danby stony gravelly fine sandy loam:															
Hilly phase															Moderate.
Rolling phase															Do.
Danby stony loamy fine sand, hilly phase.															Poor.
Essex stony loam:															
Gently sloping phase							1.5						3	2	Good.
Sloping phase							1.5						3	2	Do.
Essex loam:															
Gently sloping phase	35	50	9	12	30	50	1.5	3.0	175	300	100	250	3	2	Do.
Sloping phase	35	50	9	12	30	50	1.5	3.0	175	300	100	250	3	2	Do.
Gloucester fine sandy loam:															
Rolling phase	25	40	6	9	20	35	1.0	1.5	100	200	100	200	5	3	Moderate.
Undulating phase	25	40	6	9	20	35	1.0	1.5	100	200	100	200	5	3	Do.
Gloucester loam:															
Rolling phase	30	45	7	10	25	40	1.0	2.0	100	250	100	200	4	2	Do.
Undulating phase	30	45	7	10	25	40	1.0	2.5	100	250	100	200	4	2	Do.
Gloucester stony fine sandy loam:															
Hilly phase													5	3	Do.
Rolling phase													5	3	Do.
Undulating phase							1.0						5	3	Do.
Gloucester stony loam:															
Hilly phase													5	3	Do.
Rolling phase													5	3	Do.
Undulating phase							1.0						5	3	Do.
Hermon stony fine sandy loam:															
Hilly phase															Do.
Rolling phase															Do.
Undulating phase							1.0						5	3	Do.
Hermon fine sandy loam:															
Rolling phase	25	40	6	9	20	35	1.0	1.5	100	200	100	200	5	3	Do.
Undulating phase	25	40	6	9	20	35	1.0	1.5	100	200	100	200	5	3	Do.
Hinckley fine sandy loam:															
Hilly phase	15	25	3	5	20	25	.5	1.5					6	4	Do.
Rolling phase	15	25	3	5	20	25	.5	1.5					6	4	Do.

TABLE 7.—*Average expectable acre yields of principal crops on soils of Hillsborough County, N. H., and their relative suitability for forestry*—Continued

Soil	Corn for grain		Corn for silage		Oats		Mixed hay		Potatoes		Apples		Permanent pasture		Relative suitability for forestry
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
	Bushels	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Acres per cow per season*	*Acres per cow per season*	
Hinckley gravelly fine sandy loam:															
Hilly phase	15	25	3	5	20	25	0 5	1.5					6	4	Moderate.
Rolling phase	15	25	3	5	20	25	.5	1.5					6	4	Do.
Hinckley gravelly loamy sand:															
Hilly phase															Poor.
Rolling phase															Do.
Hinckley gravelly sandy loam:															
Hilly phase													6	4	Moderate.
Rolling phase							.5	1.5					6	4	Do.
Hinckley loamy fine sand:															
Hilly phase															Poor.
Rolling phase															Do.
Hinckley loamy sand:															
Hilly phase															Moderate.
Rolling phase															Do.
Hinckley stony gravelly fine sandy loam, hilly phase.															Do.
Hollis stony loam:															
Rolling ledgy phase													4	2	Do.
Undulating ledgy phase													4	2	Do.
Hollis loam:															
Rolling phase	30	40	6	9	30	50	1.0	2.0					3	2	Do.
Undulating phase	30	40	6	9	30	50	1.0	2.0					3	2	Do.
Lempster stony loam, hilly ledgy phase															Poor.
Made land															Do.
Marlow stony loam:															
Gently sloping phase							1.0						3	1	Good.
Moderately steep phase															Do.
Sloping phase													3	1	Do.
Marlow loam:															
Gently sloping phase	30	50	10	14	35	50	1.5	3.0	200	350	100	300	3	1	Do.
Sloping phase	30	50	10	14	35	50	1.5	3.0	200	350	100	300	3	1	Do.
Moderately steep phase							1.5						3	1	Do.
Merrimac fine sandy loam:															
Level phase	25	40	6	9	20	30	1.0	1.5	100	175			5	3	Do.
Undulating phase	25	40	6	9	20	30	1.0	1.5	100	175			5	3	Do.
Merrimac gravelly fine sandy loam:															
Level phase	25	35	5	8	20	30	1.0	1.5	100	175			5	3	Moderate.
Undulating phase	25	35	5	8	20	30	1.0	1.5	100	175					Do.

Merrimac gravelly loamy sand:															
Level phase															Poor.
Undulating phase															Do.
Merrimac gravelly sandy loam, undulating phase.	25	35	5	8	20	30	1.0	1.5	100	175			5	3	Moderate.
Merrimac loamy fine sand:															
Level phase															Poor.
Undulating phase															Do.
Merrimac loamy sand:															
Level phase															Do.
Undulating phase															Do.
Nashua loam:															
Gently sloping phase	30	50	10	14	35	50	1.5	3.0	150	250			3	1	Good.
Level phase	30	50	10	14	35	50	1.5	3.0	150	250			3	1	Do.
Nashua loamy fine sand:															
Hilly phase															Poor.
Level phase															Do.
Rolling phase															Do.
Undulating phase															Do.
Nashua loamy sand:															
Level phase															Do.
Undulating phase															Do.
Nashua very fine sandy loam:															
Nearly level phase	30	50	10	14	35	50	1.5	3.0	150	250			3	1	Good.
Rolling phase	30	50	10	14	35	50	1.5	3.0	150	250			3	1	Do.
Undulating phase	30	50	10	14	35	50	1.5	3.0	150	250			3	1	Do.
Ondawa fine sandy loam	40	60	10	15	40	60	1.5	2.5	150	250			3	1	Do.
High-bottom phase	40	60	10	15	40	60	1.5	2.5	150	250			3	1	Do.
Ondawa loamy fine sand	20	30	5	7	20	30	.75	1.5					5	2	Moderate.
High-bottom phase	20	30	5	7	20	30	.7	1.5					5	2	Do.
Ondawa loamy sand													5	3	Poor.
Ondawa silt loam	40	60	10	15	40	60	1.5	3.0					2	1	Good.
High-bottom phase	40	60	10	15	40	60	1.5	3.0					2	1	Do.
Ondawa very fine sandy loam	40	60	10	15	40	60	1.5	3.0					2	1	Do.
High-bottom phase	40	60	10	15	40	60	1.5	3.0					2	1	Do.
Paxton stony loam:															
Gently sloping phase							1.0						3	1	Do.
Moderately steep phase													3	1	Do.
Sloping phase							1.0						3	1	Do.
Paxton loam:															
Gently sloping phase	30	50	10	14	35	50	1.5	3.0	200	350	100	300	3	1	Do.
Sloping phase	30	50	10	14	35	50	1.5	3.0	200	350	100	300	3	1	Do.
Peterboro gravelly fine sandy loam, hilly phase.	15	25	3	5	20	25	.5	1.5					8	6	Moderate.
Rockland, hilly and steep:															
Brimfield soils															Poor.
Canaan soils															Do.
Hollis soils															Moderate.
Lempster soils															Poor.
Marlow soils															Moderate.
Shapleigh soils															Poor.
Rumney fine sandy loam							1.0	2.0					4	1	Good.

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TABLE 7.—*Average expectable acre yields of principal crops on soils of Hillsborough County, N. H., and their relative suitability for forestry*—Continued

Soil	Corn for grain		Corn for silage		Oats		Mixed hay		Potatoes		Apples		Permanent pasture		Relative suitability for forestry
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
	Bushels	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Acres per cow per season*	*Acres per cow per season*	
Rumney silt loam							1.0	2.0					3	1	Good.
Rumney and Saco soils							.7	1.5					3	1	Moderate.
Scarboro fine sandy loam, level phase													3	1	Poor.
Scarboro loam, level phase													3	1	Do.
Scarboro silt loam, nearly level phase													3	1	Do.
Shapleigh fine sandy loam, rolling phase							.5	1.5					5	2	Moderate.
Shapleigh stony fine sandy loam, hilly phase															Do.
Stony hilly and steep land:															
Acworth soils															Good.
Becket soils															Do.
Brookfield soils															Moderate.
Gloucester soils															Do.
Hermon soils															Do.
Marlow soils															Good.
Stony undulating land, Waumbek, Peru, and Acton soils.															Moderate.
Sudbury fine sandy loam:															
Gently sloping phase							1.0	2.0					4	1	Do.
Level phase							1.0	2.0					4	1	Do.
Sudbury loam, level phase							1.0	2.0					4	1	Do.
Sudbury loamy sand, level phase					15	25	.5	1.5					5	2	Do.
Sutton silt loam, gently sloping phase	30	40	9	12	30	50	1.5	3.0					3	1	Good.
Waterboro muck															Poor.
Shallow phase															Do.
Waumbek, Peru, and Acton stony loams, undulating phases.															Moderate.
Waumbek, Peru, and Acton loams, undulating phase.															Do.
Whitman loam, nearly level phase							1.0	2.0					3	1	Poor.
Whitman stony loam, nearly level phase													3	1	Do.
Windsor fine sand, rolling phase															Do.

Under the more intensive management specified for the estimated yields in columns B, larger quantities of lime, phosphate, and complete fertilizer are applied more frequently. Hay land receives 1½ to 2 tons of lime at seeding and is top-dressed annually with 300 to 500 pounds an acre of complete fertilizer of about a 7–7–7 or 0–20–20 mixture, depending on the quantity of legumes grown with the grass. Corn and potatoes receive heavier applications of manure, phosphate, or complete fertilizer. Pasture is improved by removing brush and fertilizing and liming the soil. In addition, more intensive management includes erosion-control measures where necessary and use of green-manure crops to improve the organic-matter content.

WATER CONTROL ON THE LAND

The control of runoff, drainage, irrigation, and overflow or floods in this county is not especially important, as compared to its importance in some other sections of the United States. Erosion is not especially troublesome, there are no large areas to drain, and irrigation is feasible only for certain specialized crops. Flooding is sometimes a serious problem in the valley of the Merrimack River, but the recent establishment of flood-control dams in the headwaters of the larger tributary streams may minimize future flood damage on the productive bottom lands.

RUNOFF

Runoff refers to the movement of water over the surface of the soil. Rain strikes the surface of the soil and soon is absorbed as it runs over the surface in sheets, in small streams, or in a combination of both. The condition of the surface layer of the soil, the slope of the land, the type of vegetative cover, and the intensity with which the rain falls are important factors affecting infiltration and erosion. If the surface soil is packed tightly so that the water cannot infiltrate rapidly or if the soil is already saturated with water from previous rains, runoff is increased, and water moving off a field may remove considerable quantities of surface soil and make gullies where it is concentrated by irregularities in the soil surface. Likewise, as the slope increases, there is less opportunity for infiltration and more rainfall tends to be removed as runoff.

If the surface of the soil has a good sod or is covered with growing grain crops, runoff does not remove appreciable quantities of soil, but if the soil has been cultivated and the surface is exposed, runoff is increased and surface soil may be carried away.

Where runoff causes appreciable soil loss, some control methods are necessary. In one method, clean-cultivated or intertilled crops are grown crosswise of the slope in narrow strips that alternate with strips of grass or of close-growing grain. This method, which is called strip cropping, controls runoff because the strips are narrow (75 to 150 feet in width, depending on the slope) and do not allow the water to gain in velocity and erosive power. The runoff that does come from the narrow intertilled strips is slowed down when it reaches the next lower strip, which is in grass or close-growing crops, and the soil carried by the water is deposited on the upper edge of the lower strip. In strip cropping the soil may move down-

ward somewhat, but it does not leave the field entirely as it might if the entire slope were used for a cultivated crop.

In some places strip cropping is not sufficient and must be supplemented by shallow drainage ditches constructed across the slope of the field to remove runoff slowly. These drainageways are sometimes called diversion ditches and are constructed so that machinery can be used over them. They are relatively expensive to build and maintain but may be necessary where erosion is severe.

Much of the land used for cultivated crops is in river and stream valleys and not subject to erosion, and even in other areas three conditions serve to minimize runoff and resulting soil erosion. First, only a small part of the area is actually plowed and harvested each year. Second, the upland areas, which would be most subject to erosion, are used largely for dairying, and the land is not in cultivated crops more than a year or two before it is put back in grass. The short period of use for cultivated crops does not break down the structure of the surface soil to the point where percolation will not remove almost all the water that falls. Third, in this region almost all the rains are gentle, and in most soils the rate of infiltration is rapid enough that the soil soaks up the rain as fast as it falls.

Several farms in the county have been considerably damaged by sheet erosion, particularly where the slopes are 8 to 10 percent or more, and the soil has been cropped for more than 3 years with the rows running up and down the slope. Erosion is likely to be greatest where the soil is used for crops like potatoes because the soil surface is not protected by trash or by cover crops during fall and spring. Erosion on such unprotected fields occurs because of heavy rains and in some years because of thawing in spring. The surface soil thaws first, and if a rain or snowstorm occurs when only the surface 3 or 4 inches is thawed, that part becomes saturated quickly and the rest of the water must run off. Under these conditions runoff may remove considerable quantities of soil, even though the surface soil is well granulated and able to remove water by percolation when not frozen. Almost all the erosion that takes place is sheet or rill erosion; gullying is almost nonexistent.

In general, soil erosion in this county can be controlled by running the rows of cultivated crops across the slope rather than up and down. Where long slopes are completely cultivated, strip cropping may be necessary. If these simple methods are used, terraces and more costly engineering structures generally should not be necessary, unless economic conditions cause a radical change in the type of farming.

CONTROL OF OVERFLOW

Overflow from rivers and streams during floods causes considerable damage to soils of the flood plains. The damage results from the deposition of sandy material on productive bottom land and from the cutting away of large areas bordering the stream.

The complete prevention of overflow is outside the scope of the individual farmer because it must be accomplished by controlling streams at their headwaters. Recently dams have been built at the headwaters of the Merrimack River, and these will lessen flood damage by controlling the flow of water in the river itself. Serious

damage from deposition will probably be decreased, but bank cutting may still be serious because the river continually washes at the base of the banks during normal flow and prevents the stabilization of the banks by vegetation. The farmer may prevent bank cutting to some degree by encouraging the growth of vegetation along the edge of rivers, and he may prevent it almost entirely by paving the banks above and below the normal water level with rock. Paving is expensive and should be used only where a considerable expanse of bottom land is liable to be affected.

DRAINAGE

Large areas of poorly drained soils are not common in this county. If the few large areas that do occur were drained, they would not be any better for agriculture than adjacent areas of well-drained soils not now farmed. Artificial drainage is therefore limited to small poorly drained patches within larger well-drained areas or to areas adjacent to streams. The fields are drained either by open ditches or by the use of tile, the open-ditch method probably being most common.

IRRIGATION

Irrigation is not widely practiced in the county, but its use for crops on sandy porous soils is worthy of consideration. The sandy porous soils do not store enough water to sustain plant growth over a long period of dry weather. Dry spells lasting several weeks are common during the growing season; therefore the sandy soils are not used so much for cultivated crops as the fine-textured ones. Several farmers have used overhead irrigation near streams or rivers and have obtained consistent increases in yield. This type of irrigation offers considerable promise on Merrimac, Nashua, and Ondawa soils, which usually occur near a good water supply, and it can be used for potatoes, vegetables, and other commercial crops with a good chance of success.

FORESTS [12]

FOREST GROWTH

Before the coming of the white man, forest covered practically all the upland soils. In most places the growth consisted of mixed hardwoods and hemlock; white pine grew here and there but developed pure stands only on the lighter sandy soils around lake shores and on eskers and kames. Virtually all the virgin timber has been cut; the last remnants were destroyed by the hurricane of 1938. Nonetheless, forest growth still occupies the largest part of the county, and an ever increasing acreage is reverting to forest. From 1740 to 1840, almost 80 percent of the land was cleared for fields or pasture, but in the period that followed the land began to be abandoned, and the pastures and fields grew up in trees. This process is still going on.

The natural course of forest succession on denuded lands, commencing with light-seeded and light-demanding species as gray birch, aspen, and conifers, was modified by the browsing of cattle. Hard-

[12] Prepared by Henry I. Baldwin, research forester, New Hampshire Forestry and Recreation Commission.

woods—white ash, basswood, and hard maple—that were especially preferred by grazing animals, were greatly reduced or eliminated in the new growth, so pure or nearly pure stands of conifers often resulted. Pine therefore came to occupy heavier upland soils where it had never predominated in the original forest. Gradually, however, the hardwoods become established beneath the maturing pines, and following clear-cutting by portable mills and the hurricane of 1938, the hardwood growth is again gaining prominence.

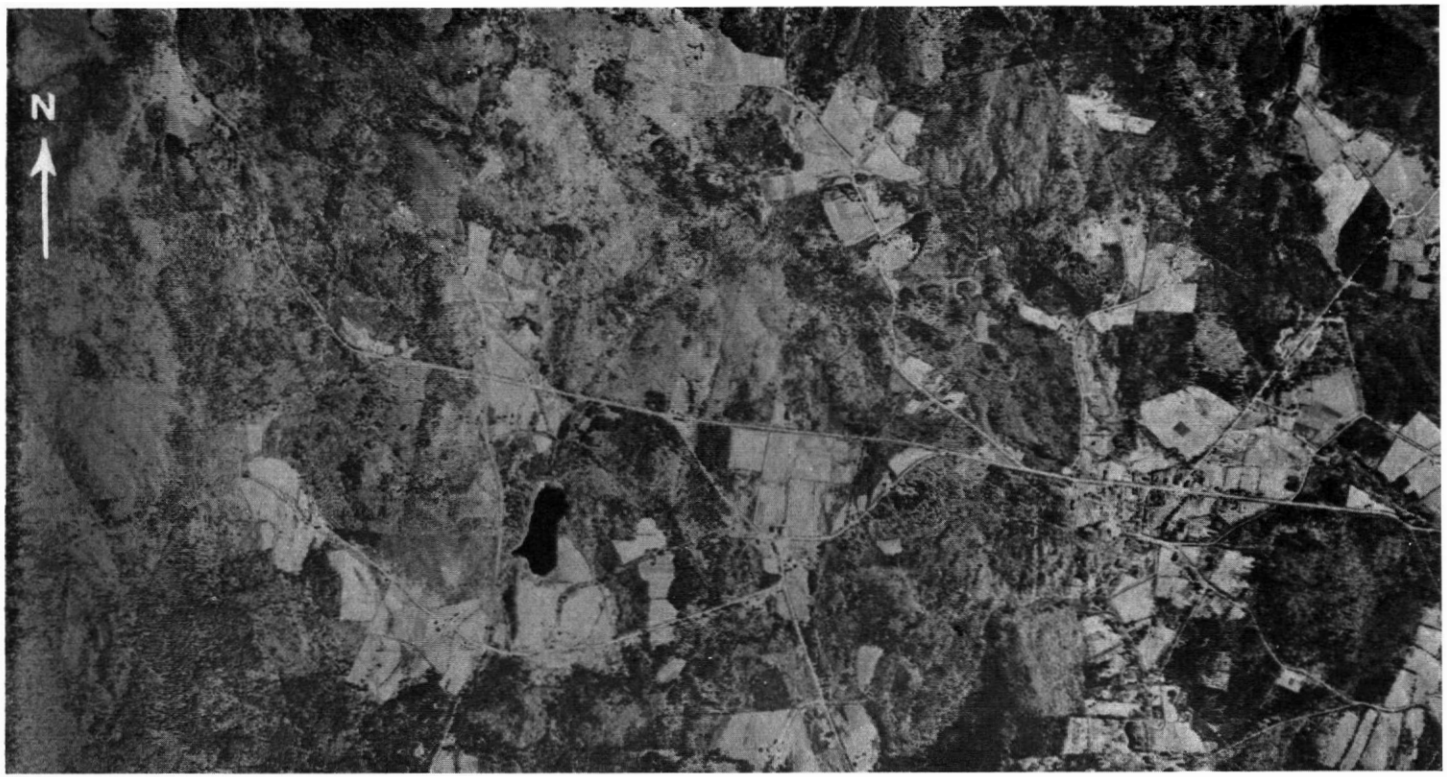
Obviously, the treatment the forest land has received has resulted in progressive deterioration of the forest in composition, density, and in the form and grade of individual trees. Stands that grew up during grazing may be easily distinguished by their branchiness, the predominance of light-demanding species, and prevalence of cankers, natural grafting of branches and trunks, forkedness, and other defects. In contrast, many of the steep ravines and rockier lands, which were never completely cleared of forest and were only lightly grazed, developed excellent stands of young hardwood and softwood. Portable mills during the present century, however, have removed most of the best second-growth stands that have matured.

Forest is not confined to any particular type of soil and topography, but like the small acreage of cleared land, occurs in a wide variety of locations (pl. 4). There is no recognizable pattern of differentiation between cleared land and forest, but in general the stone-free flood plains and the more fertile soils of the upland have remained cleared longest. Curiously, many of the pastures on higher hills never grew up in trees. Grazing pressure is likely no more intense on these pastures than on cleared lowlands, but probably the lack of moisture for seedlings during the early part of summer largely prevents forest from invading the hill areas more rapidly. Soil deterioration, moreover, is worse on the higher hill pastures. Conditions are almost too unfavorable to permit the establishment of tree seedlings, and the seed supply is scanty.

PUBLIC FOREST RESERVATIONS

The forest land in this county includes 14 State forests aggregating 3,510 acres; 4,030 acres of Federally owned forest land; a small area used by the hospital and county farms; other county lands; and 3,969 acres of town forest. If adequate provision could be made for its development and management under sustained yield operation, much additional forest land might well be owned by the State or towns to round out the areas now held by those agencies into economical management units. Lacking the assurance of actual forestry operations, however, it is questionable that a change of ownership would effect any immediate improvement in forestry conditions. Opportunities for marketing low grade forest products available are now so uncertain that public forestry would apparently have to be heavily subsidized if conditions were to be improved over any large area.

Additional reservations are needed to give the public access to bathing sites along the more desirable lakes and ponds. Such areas should be acquired and developed so that there would be at least one in every town. This would involve the acquisition of a considerable forest area in some cases, and the area acquired should be managed together with other town or State forests.



Aerial view in the southern part of the county near New Ipswich, showing the proportion of cultivated and forested land. This is representative of much of the county except for the area along the Merrimack River.

A considerable number of game refuges, 2,000 to 5,000 acres in one compact block, should also be established and bounded by roads in areas well distributed over the county. These refuges would be on private land for the most part.

FOREST SOILS

Forests occur on practically all the soils, and because of the disturbances attendant on clearing and reinvasion under special influences, some forest types are now on soils not naturally suited to them. Extremely sterile sandy and gravelly soils on outwash plains support pitch pine as an edaphic climax association. Outstanding examples of this cover are in the towns of Milford and Amherst near the Souhegan River and in Nashua.

While Podzols are common everywhere in the western half of the county, the most pronounced Podzol development is under pure or nearly pure stands of conifers on imperfectly drained soils and especially on sandy soils on glaciofluvial materials already deficient in bases. The characteristic leached surface mineral soil horizon can be discerned even in some second-growth old-field stands of pine. A leached layer ½ to 1 inch thick develops during the maturing of such a stand of pine on soils that originally bore rich mixtures of hardwoods and the soils have humus layers that are a mixture of organic matter and mineral soil, somewhat similar to mulls.

White pine stands occur, however, on fertile lower slopes where moisture is so favorable that a true crumb earthworm mull has been maintained despite the deposit of acid litter. An abundance of soft-foliaged hardwood seedlings, shrubs, and herbs almost invariably occurs on such sites and aids in perpetuating a favorable humus condition. Succession tends toward increasing mesophytism, so that soils kept continuously in forest, provided fire and grazing are excluded, may be expected to develop favorable humus conditions, especially on moist but well-drained sites. The hurricane of 1938 and the cutting of pure pine stands have both hastened succession in the direction of hardwood or mixed stands.

FOREST SPECIES AND THEIR DISTRIBUTION

The composition of the forests is discussed most conveniently by describing the forest associations or types into which the forest of this region may be classified. Most of the county lies in what is commonly called the white pine region, as Eastern white pine (*Pinus strobus*) is the most important species. Areas on the higher hills and along the western highland form scattered offshoots of the spruce region characteristic of the northern part of New England. Between these two regions on the better soils is often a poorly defined belt of northern hardwoods. In this belt Northern red oak (*Quercus borealis* var. *maxima*) is commonly mixed with yellow birch (*Betula lutea*), American beech (*Fagus grandiflora*), and sugar maple (*Acer saccharum*), and in this respect the stands are not typical of the northern hardwoods region farther north. In fact, various species of oak grow on the highest summits in the county in mixture with red spruce (*Picea rubens*).

WHITE PINE REGION

Most of the county falls in the white pine region, but white pine is not the dominant tree over the entire area. Probably a high percentage of the area, even in the white pine region, is covered with predominantly hardwood stands. The principal forest types[13] in the region are described in the following paragraphs.

The white pine type consists of pure stands of white pine or of stands predominantly of white pine mixed with other conifers and hardwoods. It is typical of abandoned pastures and other cleared land in the southern part of the area and in the Connecticut River valley. On dry sandy soils the stand may be purely white pine or predominantly that species mixed with red (Norway) pine, pitch pine, gray birch, aspen, or white oak. On heavier soils, the stand of white pine may be pure or may be mixed with paper, black, yellow, and gray birches, black cherry, ash, Northern red oak, sugar maple, hemlock, and red spruce.

Pure stands of Norway pine or of that species mixed with white pine, red spruce, paper birch, and aspen occur for the most part in small patches on dry gravel ridges along lake shores.

Heavier and moister soils, often in cool ravines, are occupied by the white pine-hemlock association, and the two species are about equally mixed. Subordinate species include sugar maple, red maple, yellow, paper, and black birches, white ash, Northern red oak, and red spruce.

Pure stands of hemlock are predominant over any other single species in a mixture that may include beech, sugar and red maples, white ash, balsam fir, red spruce, white pine, various birches, and Northern red oak. This type of cover usually occupies relatively small areas in cool moist ravines.

Dry sandy flats frequently burned over may have pure stands of pitch pine or that species mixed with occasional white and Norway pines. Usually there is an understory of scrub oak.

Gray birch-red maple is perhaps the most common association on cut-over land. There is much less gray birch in the mixture here than in southern New England, and more aspen, yellow and paper birches, white pine, white ash, and sugar maple. This forest type occurs on a variety of soils and often succeeds white pine on cut-over areas of lighter soils. Stands of other species completely destroyed by high winds will often be followed by this kind of cover.

The sugar maple-basswood association differs from the gray birch-red maple association chiefly in having a larger percentage of basswood and hophornbeam with the maple. It occurs most frequently in limited areas on rich (but often hot and dry) hillsides.

The white pine-red oak-white ash association often follows logging of pure stands of white pine and occurs on deep fertile well-drained soils in the southern part of the area. In blow-down pine areas on better soils it will probably become even more important in the future. Red maple is the chief associated species, but basswood, sugar maple, beech, paper birch, hemlock, and black birch also occur in varying proportions.

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[13] Classification follows that of the Society of American Foresters, Committee on Forest Types, 1932. [Revised, 1940.]

NORTHERN HARDWOODS REGION

Many of the associations of the white pine region are also characteristic of the Northern hardwoods region, especially the hemlock, gray birch-red maple, and sugar maple-basswood associations. In addition the following associations occur.

Pure stands of sugar maple may occur naturally or as the result of cutting out other species to form sugar orchards. Best development is attained on rich moist soils.

Pure stands of yellow birch may grow up following cutting in spruce-hardwood stands where the soil is moist and not well enough drained to support the sugar maple-beech type of cover.

The black ash-American elm-red maple mixture is typically found in swamps, gullies, and poorly drained areas along streams and lakes. Black ash is the determining species in recognizing this association; the other component species may vary greatly. Subordinate species are balsam fir, white pine, tamarack, and yellow birch. There is generally a flow of water in the swamps, not an acid bog condition as in black-spruce bogs.

The red spruce-sugar maple-beech type is predominant on the lower slopes and ridges of the White, Green, and Adirondack Mountains. It represents the original forest composition in much of northern New England and is commonly referred to as spruce and hardwoods.

The yellow birch-red spruce association frequently covers lower mountain slopes, ravines, and flats in the north. Included are balsam fir, paper birch, and red maple. On cut-over lands an understory of small red spruce trees persists.

Paper birch-red spruce-balsam fir is a mixture common in the later stages of colonization of burned areas and cut-over land. When the conifers attain dominance in the stand, they may succeed the paper birch or the aspen types. Red maple, yellow birch, and white pine also occur in the association.

A wide variety of sites may be occupied by paper birch in either pure stands or as the predominant species in a mixture of aspen, spruce, fir, white pine, hemlock, other birches, and maples. Usually an understory of conifers or other hardwoods develops.

Aspen (poplar) grows in burns and is often present in pure stands or mixed with paper or gray birches and pin cherry. The cherry soon dies out, and an understory of balsam fir and red spruce develops in the northern part of the county and one of pine in the southern. This understory outlives the aspen and eventually occupies the ground.

After logging or fire, pure stands of pin cherry may arise from seed stored in the ground by birds and rodents. The pin cherry occurs on well-drained soils and is extremely short-lived. The understory of spruce or fir, or occasionally of pine, soon becomes predominant.

The sugar maple-beech-yellow birch mixture is typical of forest types frequently referred to as northern hardwoods and occurs on fertile well-watered soils throughout northern New England. Basswood, red maple, hemlock, red spruce, Northern red oak, white ash, balsam fir, and hardwood species may be admixed. This association is probably typical of the virgin forest in much of this area.

SPRUCE REGION

The spruce region differs from the northern spruce region chiefly in the scarcity of balsam fir in its southern part; it reflects the drier character of the site. Paper birch and other northern hardwoods are frequently intermingled with pure stands of red spruce that originate chiefly in pastures.

Red spruce often occurs in pure stands on old pasture land at elevations greater than 1,000 feet and on the higher slopes and summits of mountains. In these locations it may be the original type of cover or it may have replaced the old forest after logging or fire. Paper birch, aspen, balsam fir, mountain ash, and red maple are associated.

DENSITY AND AGE OF STANDS

The low density of pine stands growing up on abandoned pastures subject to grazing has already been mentioned. The stands of pine, hemlock, and spruce that regenerated naturally after logging are also unsatisfactorily stocked but usually contain enough hardwoods to act as fillers and trainers for the conifers. As a result the crop is of far better quality than that on areas pastured. The hardwoods also render an important service in affording the conifers protection from the white-pine weevil. Hardwood stands that have reproduced without being grazed are generally well stocked.

If the distribution of age classes were known accurately, stands 20 years of age or less would probably be in great preponderance and a very small fraction of the forests would be fully matured timber. The scarcity of mature stands reflects the heavy portable-mill and cordwood cutting. Cordwood cutting has been especially severe in the vicinity of Manchester and Nashua and in the southern tier of towns near the Massachusetts line. The National Forest survey conducted in 1947 showed the following rough distribution:

Area occupied by:	*Acres*
Saw timber	135,600
Pole timber	154,100
Seedlings and saplings	72,100
Poorly stocked stands	80,500
Total commercial forest	442,300

Judging by the trends for the State as a whole, it is probable that the area in merchantable timber and the acreage used for agriculture have been still further reduced. The 1950 census places the total land available for crops, including plowable pasture, at 59,040 acres.

Only very rough approximations of forest growth can be made. Young stands are obviously growing very rapidly now and producing a large volume of wood annually, even though the quality of the understocked stands is low. The National Forest survey of 1947 for the county estimates the total net annual growth at 79,000 cords of softwoods and 87,000 cords of hardwoods, or a combined total of 166,000 cords.

PRESENT FOREST UTILIZATION AND MANAGEMENT PRACTICES

There are no large permanent industries consuming large quantities of saw timber or wood at one place in the county. The few

stationary sawmills get their timber chiefly in an area within a radius of about 10 miles and tend more and more to become resawing and finishing plants that rework lumber from the portable mills. Some logs are exported to mills in Massachusetts. Besides the mills cutting saw timber, a few smaller establishments use oak or ash for baskets, handles, and other novelties. The volume cut for these products is small, and the harvesting creates no unfavorable effect upon the forest. Customarily, the landowner sells his entire stumpage to a portable-mill operator when it is barely of merchantable size. A mill is then moved onto the lot and everything that will saw out a board is cut. The defective forked and branchy trees are left to develop into wolf trees in the sprout stand that ensues. Much of the promising advance reproduction is buried under the heavy slash and deformed or prevented from developing at all. Lots cut over for saw timber are frequently stripped for cordwood, which is shipped to Massachusetts or used in the larger cities and towns.

The general effect of present industrial utilization is to deplete seriously the more accessible stands and to cause a progressive deterioration in composition and quality. As a result the operation of permanent mills is jeopardized, and a steady supply of timber becomes more uncertain each year. The tendency is therefore for wood-using industries to move elsewhere.

One of the major uses of forest land in this areas is for recreation—hunting, fishing, hiking, and picnicking. This county is especially heavily dotted with summer homes and camps and attracts a very large vacation population, especially from nearby Boston and other large cities to the south. Many old farms consisting chiefly of woodland are bought and remodeled for year-round homes. The shores of the numerous lakes furnish sites for thousands of smaller camps. In the Monadnock region especially, many activities—autumn-foliage tours, apple-blossom tours, and maple-sugar festivals—attract tourists. Foot and bridle trails, ski trails and lifts, and camp grounds on public reservations are also popular.

FOREST PROTECTION

An effective service for detecting and extinguishing ordinary fires is provided by a well-organized system of lookout towers, town and district wardens, and a dispatcher in the district office constantly on duty during the fire season. Exceptionally large fires require aid from adjacent counties and sometimes from other States. The current situation is precarious because of the scarcity of manpower for fire fighting. Certain towns in the county—Milford, Amherst, Hollis, Merrimack, and Brookline—have more frequent fires than others. These particular towns have a high percentage of hot dry sandy soils covered with pine, and such soils are especially hazardous early in spring. There appears to be a high degree of correlation between fire hazard and soil series throughout New England.

Fire protection should be strengthened during times of drought and extreme hazard by establishing at least one patrol in each town and by stricter enforcement of all State forest-fire laws. Control of insects and disease should also be improved by enlisting more complete cooperation of landowners with public agencies in charge of

control work and by carrying out cutting operations in such way as to minimize the danger of starting pest epidemics. Where grazing is injurious to forest regeneration, it should be eliminated, especially in hardwood stands.

RECOMMENDED FOREST-MANAGEMENT PRACTICES

A program to develop maximum productivity of the soils in the county should include definite planning for the management of forested soils, which make up more than three-fourths of the area. Present methods of harvesting the timber crop and fire protection will not perpetuate commercially productive forests. Reproduction is easy to secure because of favorable climate, and sprout cover of some kind soon reclothes the most heavily cut area. This cover is sufficient to prevent serious erosion, but the growth promises only cordwood of progressively poorer quality. Timber surpasses most other crops in that so little outlay an acre must be expended to establish it by natural reseeding. Nonetheless, some care is needed, and the length of time required to produce a mature crop dictates caution in expenditures for culture and for the conservation of immature stands.

In the following discussion are presented rules reflecting the opinion of the New England Section, Society of American Foresters, on minimum requirements needed to keep forest lands reasonably productive. Much more intensive work would be necessary for full production, as that is possible only with optimally stocked stands and the frequent thinning of stands.

CUTTING

Clear-cutting should be used only in harvesting stands of mature or over-mature timber, heavily culled stands, burned or insect-infested timber, and areas where reproduction of desirable species is already well established and can be preserved during logging.

Conservation of advance reproduction should be practiced. Except when it is unavoidable in cutting and extracting merchantable trees, immature trees should not be cut for any purpose except to improve the stand in spacing, quality, or composition of species. Young seedlings and saplings of valuable species should be protected during logging and precautions should be taken to avoid covering them with slash.

Partial cutting, not clear-cutting of the entire stand, should be the standard method of harvesting. This may take the form of diameter-limit cutting (the removing only of those trees larger than a certain minimum diameter on the stump or at breast height) or the cutting of some trees of various sizes that may be marked for removal. Diseased and branchy trees should be removed first and the more thrifty trees left for future growth. Only by such methods of partial cutting can the increment be improved. Selective cutting may take the form of groups or strips if the trees that should be cut are concentrated in those ways.

Liberation cuttings and weeding are important because most of the heavily logged forest land is in more or less urgent need of a simple cheap treatment that will release valuable young trees, as pine, spruce,

ash, or hard maple, from competition with worthless or unpromising trees. Large deformed or defective trees left standing at the time of logging are best eliminated by girdling, or ringing the bark with an axe, an operation requiring about 1 minute for a large hardwood. The girdled trees then die slowly and allow the smaller suppressed trees to develop naturally. Obviously, trees should be girdled only if several more promising seedlings will thereby be released. Girdling can be carried out for a few cents an acre. Weeding, a more intensive measure less often justified because of the greater cost, consists of the cutting back of worthless sprouts and inferior trees to procure more growing space for the crop trees.

PLANTING

Planting is not recommended as a general forestry practice, because of the high cost and uncertainty of results. In special cases, however, as in establishment of windbreaks and snowbreaks for farms, buildings, or roads and in reforesting burned land or sand wastes for the protection of reservoirs and the like, planting may be justified. Experience has shown that some discretion is necessary in choosing the species best suited to the soil and to the purpose of the planting.

White pine grows well on all soils except droughty loamy sands on outwash terraces and poorly drained soils. It is good for windbreaks and general protection but susceptible to attack by white-pine weevil if planted in the open without a light overhead cover. Protection from weevil requires a sparse mixture of aspen, gray birch, or other trees, and moderately close spacing, as 5 by 5 feet. On lands occupied by white pine currant and gooseberry bushes should be eradicated within a radius of 900 feet as protection against white-pine blister rust. Planting on logged-over pine land must be delayed 3 years on account of the pales weevil, which is prevalent in this county.

Red (Norway) pine is the most generally satisfactory tree for planting in the area. It grows rapidly on all soils but is best suited to light sandy and gravelly places. Where some other trees are present to act as fillers, red pine may well be planted at somewhat wider spacing (up to 8 by 8 feet) for economy.

Scotch pine is probably superior to red pine in its capacity for providing rapid protective cover on extremely barren sandy and gravelly soils, as areas of Windsor soils, but it cannot be recommended for timber production because its bole is unsatisfactory in this climate.

White spruce is especially good for windbreaks and grows well on all soils except the very dry sands. Red spruce, somewhat slower growing, is slightly attacked by the white-pine weevil; Norway spruce, though best in rate of growth, is very severely attacked by the weevil and should be kept partly shaded.

European larch and balsam fir have a limited field of usefulness, as they are suitable only on relatively fertile well-watered soils. Hardwoods have not proved satisfactory for planting and generally occur naturally in abundance. Sugar maple, though slow growing, stands transplanting and might well be set out on better soils for the establishment of maple sugar orchards.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and soil development acting on soil materials deposited or accumulated by geological agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material. The climate, and its influence on soil and plants, depends not only on temperature, rainfall, and humidity but also on the physical characteristics of the soil or soil material and on the relief, which in turn strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

The soils of Hillsborough County have developed from (1) glacial drift, (2) comparatively recent alluvial deposits, and (3) organic accumulations. The area covered by alluvial deposits and by organic accumulations is much less than that covered by glacial drift, and the soils from those materials have not yet attained the mature profile development of the soils developed on the drift. Consequently, the following discussion concerns mainly the soils developed on glacial drift.

Of the area covered by glacial drift, 75 to 85 percent is overlain by glacial till and the rest by fluvial deposits in the form of kames, eskers, terraces, and lake plains. In about 80 percent of the area covered by glacial till, the till is composed largely of granitic debris; the remaining 20 percent is covered mainly by debris derived from mica schist that has a slight admixture of granite. Near the village of Hollis several square miles of glacial till is derived from phyllite or slaty schist, and this till has a finer texture than that derived from granite or mica schist. In most places the glacial till is dominantly of local origin and lies upon or near a rock formation similar to that from which it was derived. In a few places, however, the glacier caused some overdrag of material as it moved southeastward, and in these places the till is more like the rock strata lying in the direction from which the ice came than it is like the formation, or rock stratum, on which it lies.

In this county the five factors of soil genesis have combined to make the podzolization process of soil development dominant in all the well-drained soils. Podzolization takes place in the following manner. On the surface of mineral soil is an organic layer of fallen leaves furnished by the forest cover. Through this layer percolates much of the precipitation, which is fairly great in an area where rainfall is comparatively high and the evaporation rate is low. The acid organic layer contributes to the acidity of the water, and the acid water in turn causes leaching of bases high in the electromotive series from the soil profile. Iron and aluminum are also largely leached from the surface soil and are in part deposited in the subsoil as sesquioxides and in part removed in the ground water. The leaching causes a relative concentration of silica in the surface, or A horizon, and of iron and aluminum oxides in the subsoil, or B horizon.

Different intensities of the podzolization process within this county have caused the development of two great soil groups—the Podzol soils and the Brown Podzolic soils.

The Podzol soils, developed because of much leaching, occur in the western half of the county (pl. 5, *A*). They are characterized by a 3- to 5-inch layer of organic matter on the surface and by a thin but more or less continuous light-gray mineral surface soil (bleicherde) up to 3 inches thick in places but averaging about 2 inches. They have a dark- to moderate-brown subsoil (orterde) about 4 inches thick that grades through yellowish brown to the parent material at a depth of 16 to 20 inches. In a few places dark-brown concretions the size of peas occur within the orterde layer, and in some areas there is a cemented, or ortstein, layer of much the same color as the cementations in the orterde. This orstein layer is developed in place of or in conjunction with the orterde.

The soils of this county belonging to the Podzol great soil group are those of the Hermon, Lempster, Canaan, Marlow, Acworth, Becket, Danby, Peterboro, Colton, Peru, and Waumbek series.

Hermon fine sandy loam, rolling phase, a soil occurring in the northwestern part of the county and developed on granitic till, has a typical Podzol profile. It is a Podzol counterpart of the Gloucester soils of the Brown Podzolic region in drainage, relief, and parent material but occurs at higher altitudes and is more strongly leached. The following describes a profile of the Hermon soil in a fresh road cut 3 miles north of Peterboro:

A_0. Organic layer, thin deposit of undecomposed leaves underlain by very dark-brown to black partly decomposed organic matter; lower ½ inch of layer is organic matter decomposed to such extent that the original structure of the leaves cannot be seen.

A_2. 0 to 3 inches, mineral surface soil (bleicherde) immediately below the forest litter consists of 2 to 3 inches of light-gray to very pale-brown loose fine sandy loam; pH, 4.0 to 4.5.

B_{21}. 3 to 12 inches, fine sandy loam grading from reddish brown to moderate brown to a light or moderate yellowish brown in the lower part; this layer sometimes called the orterde; generally weak very fine crumb structure; in most places small cemented particles and in a few places the entire layer (ortstein) relatively cemented; separation between the gray A_2 layer and the B_{21} layer sharp and very striking; pH, 4.0 to 4.5.

B_{22}. 12 to 21 inches, grayish-yellow to light yellowish-brown fine sandy loam; weak very fine crumb structure; grades from darker color above to lighter below; pH, 4.5 to 5.0.

C. 21 inches +, gray to grayish-yellow gritty granitic till parent material composed principally of sand-size particles; single grained and moderately firm in place; pH, 5.0.

The thickness of the layers varies within short distances because of minor changes in local relief. In some places where the A_2 horizon has developed in old root channels, a small part of that layer may occupy a position below or within the B_{21} horizon.

Brown Podzolic soils (pl. 6) develop under conditions of slightly greater warmth, a little more rapid evaporation, and a smaller accumulation of surface organic matter than do the true Podzols. In the central part of the Brown Podzolic region the soils are characterized by a 1- to 3-inch layer of dark grayish-brown finely decomposed mineral soil having a high organic-matter content and an

underlying 2- to 3-inch layer of moderate-brown mineral soil of weak crumb structure. The brown layer grades into light to moderate yellowish-brown material, which in turn merges with the parent material at a depth of 24 to 30 inches.

As the altitude increases, however, virgin Brown Podzolic soils take on the nature of the Podzols to a greater extent. A discontinuous thin gray layer develops at intermediate altitudes and becomes more evident as elevation increases. At an altitude of 1,200 feet the gray layer is approximately an inch thick and more or less continuous.

The Brown Podzolic soils of this county are represented by types of the Gloucester, Charlton, Hollis, Brimfield, Shapleigh, Paxton, Brookfield, Essex, Hinckley, Merrimac, Nashua, Sutton, Acton, Buxton, and Sudbury series.

Gloucester fine sandy loam, rolling phase, represents the Brown Podzolic soils. It developed from granitic till, as did Hermon fine sandy loam, rolling phase, but occurs at lower altitudes. It lacks the gray and reddish-brown upper horizons that characterize the Hermon soils. The Gloucester profile is as follows:

A_0. Layer of partly decomposed leaves about 3 inches thick.

A_1. 0 to 2 inches, black or dark grayish-brown fine sandy loam surface soil; weak very fine crumb structure; mineral soil and organic material about equally mixed; in a few places a very pale-brown fine sandy loam just below the overlying A_0 horizon, but this layer only an inch or so thick and not continuous as it is in the Podzols.

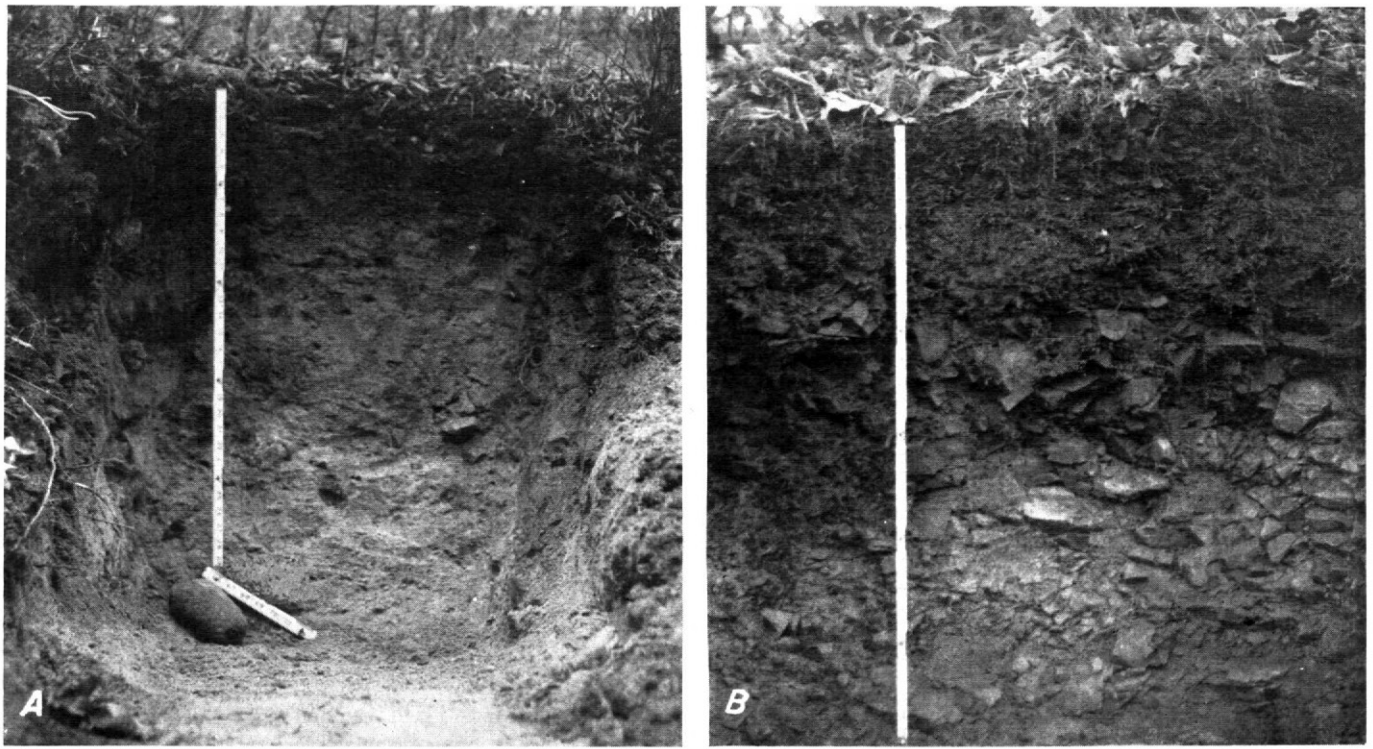
B_{21}. 2 to 10 inches, moderate yellowish-brown moderately firm fine sandy loam; weak very fine crumb structure; some small stones and a few boulders.

B_{22}. 10 to 20 inches, light yellowish-brown to grayish-yellow fine sandy loam moderately firm in place but of single-grained structure; color grading from darker above to lighter below, but very slight change from the B_{21} layer above and to the C layer below; content of small stones about the same as in the B_{21} horizon but large boulders more numerous.

C. 20 inches +, light yellowish-gray moderately firm sandy gritty granitic glacial till containing many small stones and some large granite boulders; till firm in place but breaking out in angular fragments easily reduced under pressure to single grains; texture of till ranges from coarse loamy sand to fine sandy loam.

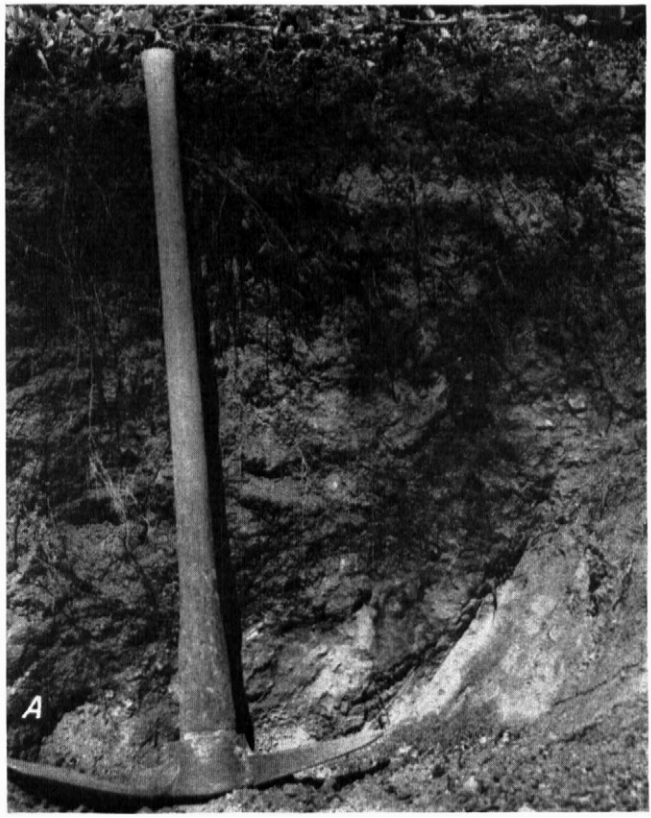
Several important soil series belonging to the Podzol great soil group have the same general profile as that described for the rolling phase of Hermon fine sandy loam. Also, important series of the Brown Podzolic group have the same general profile as that for the rolling phase of Gloucester fine sandy loam. The principal differences among the soils is in the character of the substratum.

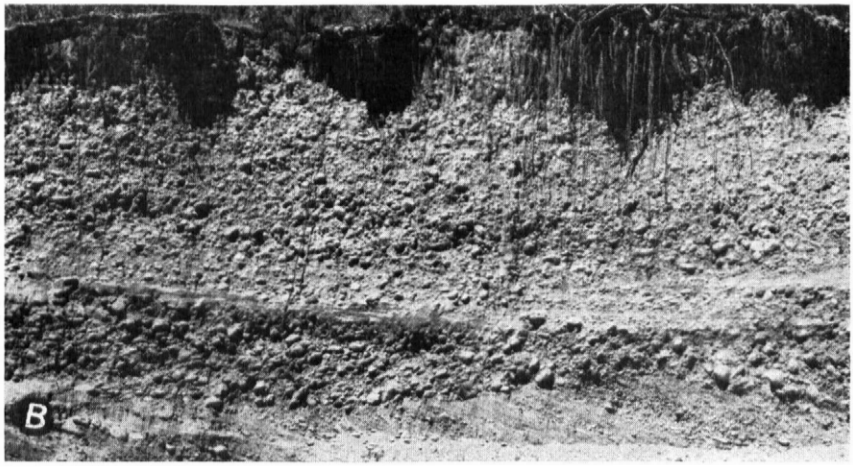
The Canaan—shallow soils developed from granitic till over granite bedrock—are Podzol counterparts of the Shapleigh soils occurring in the Brown Podzolic region; the Acworth, developed from parent material derived from pyritiferous mica schist, are Podzol analogs of the Brown Podzolic Brookfield soil; the Lempster, a shallow soil developed from pyritiferous mica schist till over schist bedrock, is the Podzol counterpart of the Brimfield soil occurring in the Brown Podzolic region. The Podzol Becket soils have developed on compact till derived mainly from granitic rock similar to that on which the Brown Podzolic Essex soils developed.



A, Profile of Colton soil near Wilton, showing the irregular gray horizon above the darker horizon, a characteristic of the Podzol soils developed in the higher and cooler parts of the county.

B, Profile of Merrimac gravelly fine sandy loam soil near Milford, showing strata of gravel and sand from which this soil has developed.





A, Profile of a Gloucester loam soil, a Brown Podzolic soil developed on granitic till.

B, Profile of a Hollis loam soil, a shallow-to-bedrock Brown Podzolic soil developed on phyllite or mica schist.

The Danby soils—Podzols developed on gravelly outwash deposited in kames or very gravelly moraines—are analogs of the Brown Podzolic Hinckley soils, which developed on kames and eskers. The Peterboro soil is a Podzol developed on gravelly kames, and its parent material contains much moderate-brown limonitic micaceous schist.

The Podzol Colton soils and the Brown Podzolic Merrimac soils (pl. 5, *B*) together occupy nearly the whole area of glacial outwash terraces. The Colton soils, developed on loose gravelly outwash deposited in nearly level terraces, are counterparts of the Merrimac; the main difference is the well-developed Podzol profile of the Colton. In general the Colton are Podzols occurring at an altitude lower than that of the Podzols developed on glacial till. They occur as Podzols at a lower altitude because their parent material is sandy and encourages more leaching than would normally occur at a lower altitude and in an attendant slightly warmer climate.

The Nashua are Brown Podzolic soils on stream terraces of more recent origin than the glacial outwash terraces, and their profile is not so well developed in color as that described for Gloucester fine sandy loam. Nashua soils are developed on sandy material derived from granitic sources, and in most places their upper subsoil is not so strongly colored as that of the associated Merrimac soils. Also, the Merrimac soils contain gravel at a depth of 15 to 24 inches and bedded gravel below a depth of 36 inches, whereas the Nashua are sandy throughout.

The Buxton soils are of small extent, have developed on local areas of bedded silts and clays, occur on level to gently sloping terraces, and are imperfectly drained. The Sudbury are imperfectly drained Brown Podzolic soils on outwash or stream terraces and resemble the Merrimac soils except for the fact that they occur in slight depressions from which the subsurface water is not completely removed.

The Waumbek, Peru, and Acton soils are mapped together in this county. Soils of these three series have developed where the parent till material is firm to compact and water penetrates slowly. The slow removal of water gives rise to these imperfectly drained soils, which may occur on sloping land. They are characterized particularly by mottling in the subsoil. The Waumbek and Peru are classified as Podzols; the Acton, as Brown Podzolic.

The relations of other Podzol soils (Marlow) and Brown Podzolic soils (Charlton, Hollis, Paxton, and Sutton) are shown in table 3, where all the soil series of the county are listed and parent material, drainage, and great soil group are given for each. As will be noted in table 3, most soils of the county belong to the Podzol and Brown Podzolic great soil groups, but soils of the Alluvial, Sands (dry), Half Bog, and Bog groups are also represented.

The Rumney and Ondawa are Alluvial soils. The Ondawa soils, which occur on recent alluvium or on bottom land subject to periodic overflow, are formed mainly of granitic material, but on some of the tributary streams they may have a considerable admixture of schist because the streams drain areas with schist bedrock. The Rumney soils occupy poorly drained areas of bottom land and are developed predominantly from granitic material.

The Windsor is the only soil developed on wind-blown sand and belongs to the Sands (dry) group. Windsor soil shows little evidence of soil development and occurs principally on the east side of the Merrimack River in association with Merrimac and Nashua soils.

The Half Bog soils are members of the Whitman, Scarboro, and Saco series. The Whitman are intrazonal soils developed on till occurring in depressions, drainageways, and seepage areas where drainage is poor. The Scarboro occur in narrow areas along drainageways or in depressional areas on terraces and are developed on material similar to that of the Merrimac, Nashua, and Sudbury soils. The Scarboro are more poorly drained than the Brown Podzolic Sudbury soils and have a gray to nearly black rather than a grayish-brown surface soil. The Saco soils, mapped only in complex with the Alluvial Rumney soils, are very poorly drained.

The Bog soils are classified according to the material from which they were derived. The brown fibrous material of Balch and Littlefield peats has undergone little decomposition, whereas that of Waterboro muck contains much mineral matter and is in a fairly well advanced stage of decomposition. Woody peats (Balch peat) were not differentiated from peat derived from sedges, rushes, and reeds (Littlefield peat). All the peat and muck areas are acid.

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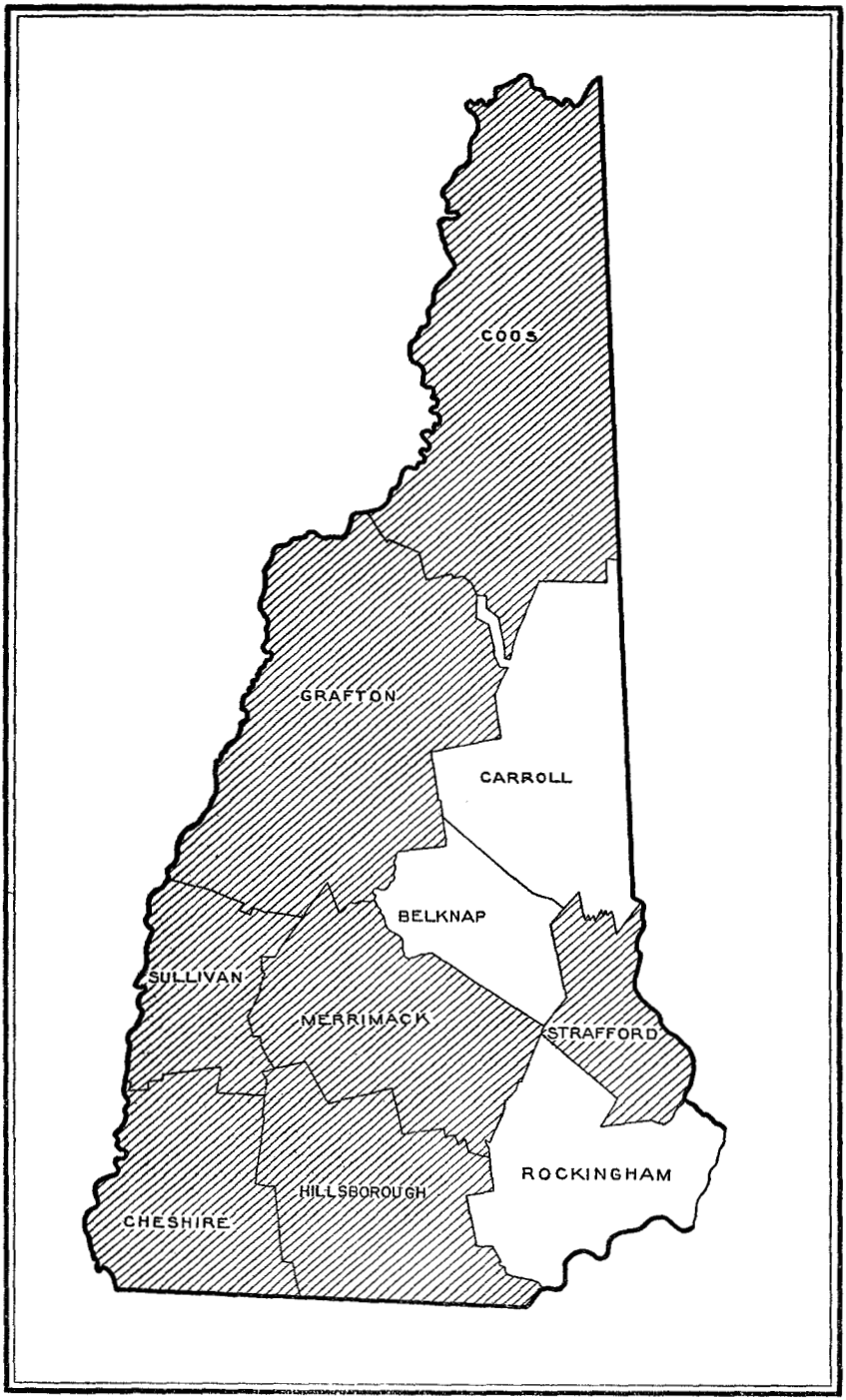

Areas surveyed in New Hampshire shown by shading.

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