Series 1932, No. 37 Issued September 1939

Soil Survey

Schoolcraft County Michigan

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UNITED STATES DEPARTMENT OF AGRICULTURE
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Michigan Agricultural Experiment Station
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CONTENTS

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COUNTY SURVEYED

Schoolcraft County is in the east-central part of the Upper Peninsula of Michigan (fig. 1). Lake Michigan forms the southern boundary of the county. Manistique, the county seat, is about 350 miles northeast of Chicago and about 100 miles west of the Straits of Mackinac. The area of the county is 1,207 square miles, or 772,480 acres.

FIGURE 1.—Sketch map showing location of Schoolcraft County, Mich.

Physiographically, the county is in the eastern lake section of the great central lowland, a plains area, in which the details of relief were constructed during the glacial period. It is underlain by Paleozoic sedimentary rocks. Although there are no great differences in altitude, local inequalities and diversity of natural features give variety to the surface. There are several distinct topographic divisions resulting from glacial action and postglacial erosion.

Figure 2 shows the land divisions of the county, based on natural features, such as relief, soils, drainage, relative natural fertility, and virgin forest growth.

Bordering the shore of Lake Michigan is a low plain consisting of a series of low sandy or gravelly ridges alternating with swales and swamps. This plain ranges from a narrow band, where the upland extends nearly to the water's edge and is marked by an escarpment, or rise, ranging from 10 to 50 or more feet in height, to 3 or more miles in width. The general elevation is from 8 to 40

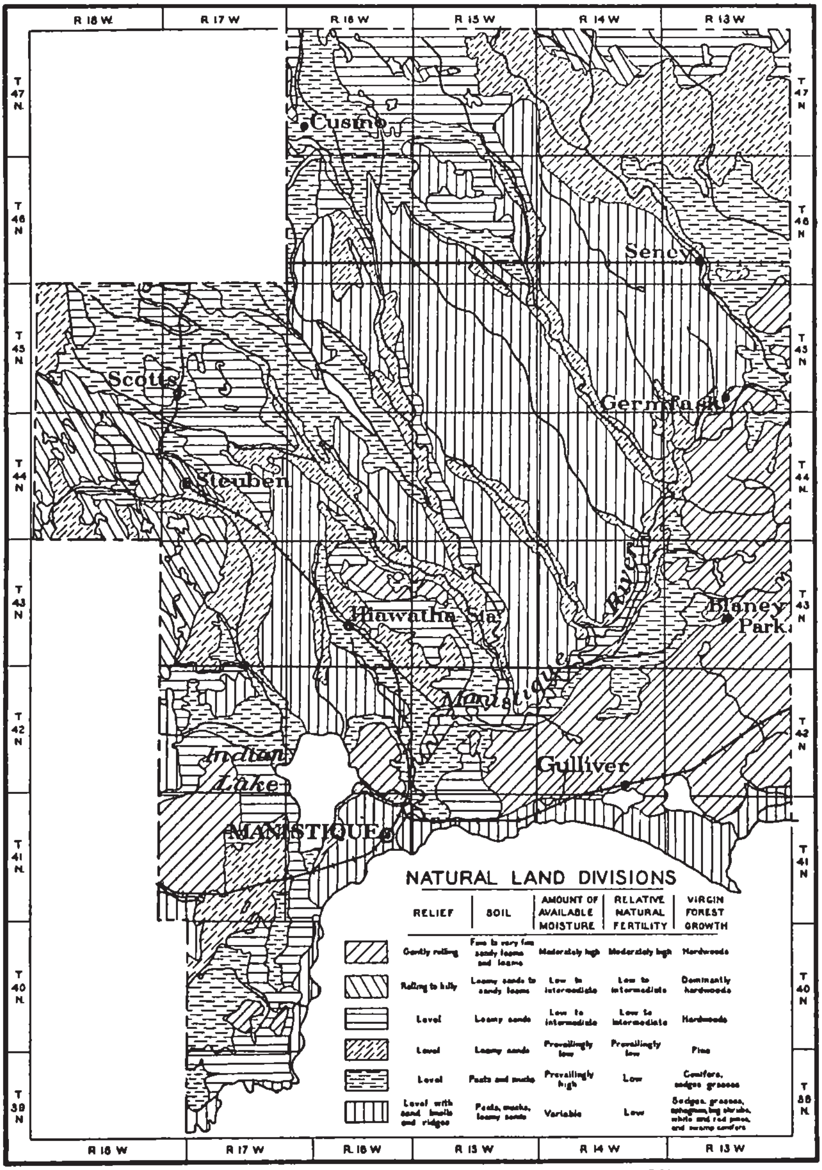

FIGURE 2.—Natural land divisions, Schoolcraft County, Mich.

feet above the level of Lake Michigan except where wind-blown sand knolls and ridges with elevations of 50 or more feet interrupt the characteristically level relief of the swales and swamps.

Lying mostly south of Manistique River, and extending from T. 45 N., R. 13 W. in a southerly and westerly direction to T. 41 N.,

R. 17 W. is an area of undulating and rolling upland interspersed with swamps and lakes. The hills are rounded and slope gently to small streams, depressions, and swamp areas, that drain the upland. This upland is interrupted by Manistique River and its accompanying swamp, where they cut through to Lake Michigan, and by a plain bordering Indian Lake. Elevations in this section range from 800 to 900 feet above sea level.

In the western part of the county, in T. 43 N., R. 17 W., and Ts. 44 and 45 N., R. 18 W., locally known as the Steuben country, is an area of comparatively striking and bold relief. Sharp knobs and ridges rise from 50 to 75 feet above the surrounding country, and depressions occupied by lakes and swamps are numerous. The highest elevation in this section is 950 feet above sea level, or 370 feet above the level of Lake Michigan.

The rest, or approximately 82 percent, of the county consists of a level or undulating plain or old lake bed, more than one-half of which is occupied by swamp and poorly drained land. An old lake plain, extending north and northwest from Indian Lake, is largely occupied by open marsh dotted with sand knolls and ridges. Streams having a southeast-northwest direction traverse this area and are part of the Manistique River drainage system. As a result of a geologically recent uplift near Lake Superior, the land tilts toward the south. The streams have a fall of about 4 feet a mile and near their mouths have entrenched themselves to a depth of about 20 feet. Narrow strips of land bordering many of the streams are fairly well drained, presumably owing to increased drainage caused by this tilting. Elevations[1] in this section range from 613 to 750 feet above sea level. To the north a sandy plain rises abruptly from 40 to 60 feet above the old lake bed. In T. 45 N., R. 17 W., and T. 43 N., Rs. 15 and 16 W., are plateaulike plains which rise sharply to elevations ranging from 50 to 60 feet. West and southwest of Indian Lake are sandy plains having more or less undulating relief, and they are but slightly higher than the lake.

Water for drinking purposes is plentiful and of good quality. Most of the wells are less than 100 feet deep, and the deepest is 214 feet. The water in the northern part of the county is soft, whereas that in the southern part is hard. There are several flowing wells of mineral water in Manistique.

The land originally was covered with a dense forest growth. Except for a few small tracts, the timber has been cut and a large proportion of the land burned over.

Several types or associations of trees represent the original cover: (1) The hardwood forest of sugar maple, yellow birch, and beech, with a few hemlock and white pine; (2) the hardwood-conifer forest consisting of sugar maple, yellow birch, elm, basswood, and ash, mixed with white pine, balsam fir, hemlock, and white spruce; (3) the pine forest consisting of jack pine and red pine on the driest sand plains, red pine and white pine on the slightly moister sandy soils, and white pine mixed with swamp conifers on the poorly drained soils; (4) the swamp conifer-hardwood forest consisting of cedar, spruce, tamarack, ash, elm, balsam, fir, large-toothed aspen, small-toothed aspen, and a few balm-of-Gilead poplars; and (5) a coniferous swamp growth

[1] LEVERETT, F. MORAINES AND SHORE LINES OF THE LAKE SUPERIOR BASIN. U. S. Geol. Survey Prof. Paper 154–A, 72 pp., illus. 1930.

consisting mainly of arborvitae, black spruce, and tamarack. The bogs and marshes support a growth of black birch, alder, stunted black spruce, leatherleaf, sphagnum, wire grass, bluejoint, and sedges.

Cut-over areas tend to reforest with the original species, but in places where the trees are cut and the land burned over, various combinations of growth result. A variety of aspen, locally called "popple," predominates in the second growth following fires. On the more fertile burned-over upland areas the large-toothed aspen predominates and is interspersed with balm-of-Gilead poplar, small-toothed aspen, and species of the original growth. The second growth on wetter soils consists of large-toothed aspen, balm-of-Gilead poplar, and popple, mixed with conifers, but in places there is a dense growth of balsam fir, spruce, and white pine. The drier pine plains are characterized by jack pine and a variety of small-toothed aspen, locally called "trembling" aspen, and the open places are covered with blueberries, sweetfern, bracken, grasses, and sedges.

Manistique, the county seat, is situated at the mouth of Manistique River. It is the principal trading center and shipping point and, in 1930, had a population of 5,198. Gulliver, Seney, Driggs, Walsh, Creighton, and Steuben are shipping points for forest products. Germfask and Thompson are small trading centers in agricultural communities.

The county is served by the Minneapolis, St. Paul & Sault Ste. Marie Railway; the Duluth, South Shore & Atlantic Railway, and the Manistique & Lake Superior Railroad. A harbor is maintained at Manistique, principally for Ann Arbor car ferries which ply between Manistique and Frankfort. United States Highway No. 2 and paved or graveled State highways traverse the county, and considerable produce is trucked over them to Chicago. There are well-graded and graveled county roads in the thickly settled communities. In the more thinly settled and remote parts, the plains and sand-ridge roads, although not graveled, are passable throughout the year.

Rural mail routes reach all the settled parts, and rural telephone lines are in the more thickly settled areas. School facilities are provided by the high school at Manistique, tenth-grade schools at Germfask, Seney, and Cooks Consolidated School; and 21 graded schools distributed over the settled parts of the county.

Schoolcraft County was organized in 1871 and included a part of what is now Alger County. The present boundaries were established in 1885. The population, according to the 1930 United States census report, was 8,451, of which number 3,253, or 38.5 percent, were classed as rural. The population in 1890 totaled 5,818, of which 2,940, or 50.5 percent, were rural. The composition of the population in 1930 was 81.8 percent native-born whites and 17.2 percent foreign-born whites. A large proportion of the inhabitants are of Swedish, German, Norwegian, and Czechoslovakian descent.

Agriculture and lumbering are the principal industries. Lumbering, once the ranking industry, has declined greatly, owing to depletion of the forests. It now consists chiefly of the production of ties, posts, and pulpwood. A paper mill is located at Manistique. Providing accommodations for hunters, fishermen, and tourists is proving to be a profitable occupation. Limestone is shipped from Seul Choix Point. Commercial fishing in Lake Michigan and the picking of wild blueberries and cranberries are additional sources of income.

CLIMATE

Schoolcraft County lies approximately between parallels 45°45′ and 46°30′ north latitude. The climate is cool and temperate, with long cold winters and short pleasant summers. High relative humidity, low wind movement, and low evaporation characterize the climate.

The temperature range and earliest and latest dates of killing frosts are modified by Lake Michigan and vary considerably in different sections. The average length of the frost-free season near Seney, in the interior, is only 73 days, the average latest frost occurring on June 15 and the average first on August 27. Seney lies in a flat poorly drained area which is much more subject to frost than the adjoining higher country. Throughout the agricultural areas, the period free from killing frosts ranges from 100 to 130 days in length, and the mean annual temperature is about 61° F. Light frosts, which damage the more tender vegetation, have been known to occur during June, July, and August.

Rainfall is fairly evenly distributed throughout the year, except that it is heavier during the summer. The average rainfall, at the Seney station, during the growing season (May, June, July, and August) is 9.38 inches. Rainfall is slow and steady, and destructive downpours are rare. Variations in the annual fall are recorded, and short periods of drought sometimes occur. The effect of Lake Michigan on the climate is reflected in the differences in the amounts of annual precipitation as well as in the length of the frost-free season.

The rainfall is sufficient, but the short growing season, together with a low mean annual temperature, limits the diversity and the maturing of crops as compared with sections of the State farther south. The climate, however, is favorable to the production of hay, small grains, and root crops.

Table 1, compiled from records of the Weather Bureau station near Seney, gives the important climatic data for that station. The records for this station are so incomplete that it is not possible to give figures for the wettest and driest years.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation near Seney, Schoolcraft County, Mich.*

[Elevation, 743 feet]

Month	Temperature			Precipitation		Month	Temperature			Precipitation	
	Mean	Absolute maximum	Absolute minimum	Mean	Snow average depth		Mean	Absolute maximum	Absolute minimum	Mean	Snow, average depth
	°F	°F.	°F	Inches	Inches		°F.	°F.	°F	Inches	Inches
December	20.2	55	−28	1.26	19.8	June	59.0	98	25	2.68	0
January	13.5	50	−43	1.41	15.1	July	64.6	98	22	2.31	0
February	10.0	51	−47	.78	8.3	August	61.8	100	23	1.92	0
Winter	14.0	55	−47	3.45	43.2	Summer	61.8	100	22	6.91	0
March	21.6	55	−39	1.32	9.3	September	54.5	95	19	2.61	0
April	38.3	96	−2	1.83	2.2	October	44.6	81	8	2.04	1.3
May	49.4	98	19	2.47	1.2	November	34.2	68	−11	1.86	12.1
Spring	36.4	98	−39	5.62	12.7	Fall	44.4	95	−11	6.51	13.4
						Year	39.4	100	−47	22.49	69.3

AGRICULTURE

The history of agriculture in Schoolcraft County is similar to the agricultural history of most of the cut-over areas of the Great Lakes region. White men first visited the country in search of furs; then lumbering was begun in the forests of pines and hardwoods. Lumbering operations opened a market for local farm products, and small clearings were made. Clearing the land for farms was slow and laborious. Prospective settlers started farms with a small outlay of capital, worked in the woods or lumber mills during the winter, and increased the size of their clearings in the summer until sufficient land was cleared to support them. Depletion of the timber has limited outside work to the cutting of cedar poles, posts, railway ties, and pulpwood. Under present conditions considerable capital is necessary for the successful development of a farm from stump and second-growth land.

Between 1870 and 1880 extensive lumbering of pine began, and the first clearings were started. The census of 1880 reported 27 farms. The number increased to 441 in 1910 and was only 451 in 1935. The total area of improved land increased from 1,183 acres in 1880 to 15,431 acres in 1910 and to 20,979 acres in 1935. Only 5.6 percent of the county, however, was included in farms in 1935, and less than one-half of the farm land was improved.

The variety of crops grown is limited by the climate, and no great change has taken place over a period of years. The 1890 Federal census reported the principal crops in 1889 as hay, oats, wheat, rye, barley, and potatoes, and the 1935 census reported hay, oats, potatoes, wheat, rye, barley, buckwheat, and peas as the principal ones grown in 1934. Hay was the principal crop during the early period of settlement and, although it still occupies the largest acreage, its importance as a cash crop has decreased because of the diminishing local demand and increased cost of transportation. Potatoes have taken the place of hay as the main cash crop. The more recent trend in agriculture is toward greater diversity of crops and an increase in dairying and poultry raising. The acreages in barley and peas have increased in recent years. The present-day agriculture is based on the raising of dairy cattle and the production of potatoes, hay, and oats.[2]

In 1929, 23 percent of the farmers reported the use of fertilizers, with a total expenditure of $5,411, or an average of $65.99 a farm reporting. Most of the fertilizer is applied to potatoes. A fertilizer having a moderate quantity of nitrogen, a high percentage of phosphoric acid, and a medium to high percentage of potash, as a 4–16–8,[3] 4–16–12, or 4–16–16, has proved, by experiment, to be best adapted for use on the average soil for potatoes. The rate of application ranges from 500 to 1,000 pounds an acre, depending on the quality of the soil. Farmers are beginning to use lime, especially on the clover and alfalfa fields.

The average size of farms in 1935 was 96.1 acres, of which 46.5 acres were improved. Farming operations are limited by the cost of

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[2] HILL, F. B., RIDDELL, F. T., and ELLIOTT, F. F. TYPES OF FARMING IN MICHIGAN. Mich. Agr. Expt. Sta. Spec. Bull. 206, 83 pp., illus. 1930.

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

clearing and draining the land. In 1935, owners operated 92.2 percent of the farms, tenants 7.3 percent, and managers 0.5 percent. Some tenants rent on a cash basis, but most rent on shares. The buildings range from the small log and frame structures associated with new clearings to modern frame houses, bungalows, and barns on the longer established and more prosperous farms. Modern labor-saving machinery is in general use. A fair grade of work horse is kept. The census of 1935 reported 595 horses on the farms. This number shows a decrease from the number reported in 1920, due, no doubt, to the increased use of tractors and trucks.

Dairying has steadily increased in importance, and it now ranks first among the agricultural enterprises. Butter, cream, and whole milk sold in 1929 amounted to $127,649. Of the 2,414 head of cattle in 1929, about 80 percent were of dairy breeds, mostly purebred and grade Holstein-Friesians and Guernseys. The number of cattle increased to 3,274 in 1935. Milk supplies the local demand, and cream, butter, and cheese are transported to outside markets, chiefly Milwaukee and Chicago. Most of the necessary feed, aside from cottonseed and other oil meals, is produced locally. Most farmers follow a diversified type of farming and keep only a few cows, but a few are primarily dairymen and raise poultry as a side line.

Potatoes, of which 129,299 bushels were harvested from 1,219 acres in 1934, rank next to dairy products in value and are the most valuable cash crop. They are grown for certified seed and for sale on the market. The Late Petoskey (Rural Russet) and White Rural varieties, because of their resistance to heat and drought, are recommended for the production of certified seed. For table use, a potato that withstands shipment, remains firm in storage, and cooks well is required. The Green Mountain variety is favored slightly over the Rurals for this purpose. The average acre yield of potatoes over a period of 10 years is 138 bushels.

Hay, the leading crop in acreage, yielded 7,018 tons from 8,475 acres in 1934. Most of it was obtained from timothy and clover, alone or mixed, which produced 5,358 tons. Red clover, alsike clover, and timothy generally are sown together. Clover, either red or a mixture of red and alsike, yields slightly higher than mixed timothy and clover. Alfalfa can be grown successfully on well-drained soils, and in 1934 the yield was 118 tons of hay from 79 acres. Some wild hay is cut from the marshes, and a few acres are planted to millet. Some mixed oats and peas, or oats and vetch, are cut green for hay.

Oats rank third in acreage. They occupied 1,193 acres and yielded 31,295 bushels in 1934. The average yield over a period of 10 years is about 32 bushels an acre, with occasional yields as high as 60 or 70 bushels. At one time the Wolverine and Swedish Select were the varieties most widely grown, but as they are susceptible to rust, they are being replaced by Iogold and Richland, which are rust-resistant.

Among the small grains, barley ranks next to oats in importance. A mixture of oats and barley is the chief grain feed. Barley was grown on 535 acres and produced 9 872 bushels in 1934. The average yield is about 25 bushels an acre. Spartan, a smooth-awned variety, is replacing Wisconsin Pedigree No. 9, a rough-awned type which has been the leading variety.

The raising of poultry, especially for the production of eggs, is a rapidly growing enterprise. Nearly every farm has a few chickens, and a few specialized poultry farms are scattered throughout the county. The census reported 21,758 poultry, with a total value of $23,602, raised in 1929. The amount realized from the sale of poultry and eggs in 1929 was $33,825. White Leghorn is the dominant breed. In 1935, 10,638 chickens were reported.

Forest products consist mostly of pulpwood, railroad ties, and posts. A few tracts of virgin hardwood timber remain, but in all probability these will be depleted soon. Since much of the better drained undeveloped farm land occurs in small areas surrounded by poorly drained areas and swamps, a farm-forest combination, in which small tracts of timber kept on a sustained-yield basis, in connection with farming, seems practical over much of the undeveloped areas where the soil is fertile enough for farming.

Small fruit orchards are on nearly every farm. Apple trees are the most numerous, and 9, 836 bearing trees were reported by the 1935 census. Apples are not grown for outside markets, and most of the orchards do not receive sufficient care to produce fruit of high quality. A few cherry, plum, and pear trees are grown in association with the apple trees. Strawberries are grown on a commercial scale for consumption within the county. They are of good quality and yield well. Raspberries and blackberries are grown in the gardens. Blueberries grow voluntarily on the sandy pine plains. They are picked for shipment to outside markets. Common garden vegetables, such as onions, lettuce, cabbage, and squash, can be successfully grown throughout the farming area, especially near the lake.

An agricultural classification of the soils, on the bases of their natural fertility, relief, drainage, and tillage, is presented in table 2.

TABLE 2.—*Classification of land in Schoolcraft County, Mich.*

Soil type	Approximate area	Group No and description	Present condition
	Acres		
Trenary fine sandy loam; Trenary loam, Longrie very fine sandy loam, Longrie loam; Blue Lake very fine sandy loam, Ruse fine sandy loam, and parts of Bruce silt loam, Ogemaw fine sandy loam, and Blue Lake fine sandy loam.	60, 000	1. Soils of high or medium natural productivity, gently undulating to nearly level, generally well drained, but some require artificial drainage in order to produce crops.	About 50 percent in farms; 18 percent cultivated or in plowable pasture, of the remainder, part is in stump pasture, greater part occupied by second-growth trees (largely a reproduction of the original growth) together with poplar; a few small tracts of virgin hardwood forest
Bohemian very fine sandy loam, Kalkaska fine sandy loam; Thomastown loamy fine sand, Rubicon loamy fine sand, and parts of the Moye, Ewen, Munuscong, Brimley, Ogemaw, and Bruce soils.	50, 000	2 Soils of medium natural productivity, part well drained and part need artificial drainage, marginal soils, not recommended for profitable farming, can be utilized to some extent for part-time farming	About 7.5 percent in farms, 2 percent cultivated, remainder in stump pasture, second-growth forest with more aspen, pine, and hemlock than on the soils of group 1; some virgin timber, some farms abandoned
Hiawatha loamy fine sand, Blue Lake, Strongs, Au Train, and Kalkaska loamy sands, Bridgman fine sand, Wallace fine sand, Rodman stony loam, Rubicon, Roselawn, Grayling, Eastport, Newton, Saugatuck, and Granby sands, peats and mucks, Wallace-Houghton complex; and Wallace-Rifle complex	650, 000	3. Soils of low natural productivity, either excessively dry or wet	Less than 1 percent cleared and cultivated, a few tracts of virgin hardwood and hardwood-conifer forests, but mostly cut-over and is recent slash or occupied by a poor or only fair growth of the original species and a variable cover of aspen, cherry, white birch, pines, and oaks, forested swamps with a dense growth, but mostly culled over.
Total	760, 000		

Much of the remaining wild land in group 1 consists of small areas surrounded by or adjacent to swamps and poorly drained areas. Some of this land could be utilized in a farm-forest type of agriculture by cultivating the uplands and putting the forested swamps and poorly drained areas on a sustained-yield basis. More of the land in group 2 could be brought under cultivation when economic conditions and the demand for agricultural products justify it, but the soils of group 1 should be utilized first. Forestry, recreation, and game preserves are the only uses for the soils in group 3 at present.

SOIL-SURVEY METHODS AND DEFINITIONS

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

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

The soils are classified according to their characteristics, both internal and external, with special emphasis given to those features influencing the adaptation of the land for the growing of crops, grasses, and trees. On the basis of these characteristics, soils are grouped into classification units. The three principal ones are: (1) Series, (2) type, and (3) phase. In places two or more of these principal units may be in such intimate or mixed pattern that they cannot be clearly shown separately on a map, but must be mapped as (4) a complex. Areas of land, such as coastal beach or bare rocky mountainsides, that have no true soil, are called (5) miscellaneous land types.

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

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the

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

soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Blue Lake fine sandy loam and Blue Lake very fine sandy loam are soil types within the Blue Lake series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and, because of its specific character, it is usually the soil unit to which agronomic data are definitely related.

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

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

SOILS AND CROPS

The materials from which the soils of Schoolcraft County are derived were deposited during the glacial age, and were either carried in by ice or by running glacial water and glacial lakes. Much of the material was reworked by glacial waters. The action of soil-forming agencies on this unconsolidated mass of loose open sands, sandy clays, and clays produced a large number of soil types which differ in both physical and chemical composition. Climatic variations, although considerable, are not sufficient to influence the soil greatly, and the diversity of soils is mainly due to the character of the underlying soil material and the moisture conditions under which the soils were formed. Local topographic conditions have an important effect on soil moisture.

As a result of these factors, the soils range from those with a loamy sand surface layer over a loose open sand subsoil to soils with a very fine sandy loam surface layer over a sandy clay subsoil; and from very wet soils, such as muck and peat, to the excessively dry sandy pine-plain soils. Excessively wet and poorly drained soils occupy about 54 percent of the area of the county, dry level sandy plain soils about 31 percent, rolling to hilly sandy soils about 4.5 percent, and soils with a sandy loam or loam surface layer over a medium-heavy or heavy subsoil about 10.5 percent.

The variety of crops grown is largely controlled by climate, whereas the soil, and to some extent the climate, limits the area on which these crops are grown.

Land in farms comprises about 5 percent of the area of the county, and this is about one-half of the estimated area suitable for agriculture. The rest of the land is too wet, too dry, or too low in natural productivity. These soils should be utilized primarily for forestry and related projects, such as game refuges, hunting preserves, parks, and recreational centers. From the point of view of utilization, the soils are discussed in three groups: (1) Agricultural soils, (2) forest soils, and (3) miscellaneous soils and land types. In the following pages the soils are described in detail, and their agricultural importance is discussed; their distribution is shown on the accompanying map; and their acreage and proportionate extent is given in table 3.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in Schoolcraft County, Mich.*

Type of soil	Acres	Percent	Type of soil	Acres	Percent
Longrie very fine sandy loam	8,128	1 1	Rubicon loamy fine sand	1,792	0 2
Blue Lake very fine sandy loam	7,552	1 0	Wallace fine sand	16,960	2 2
Blue Lake fine sandy loam	14,528	1.9	Bridgman fine sand	2,368	3
Longrie loam	14,464	1.9	Newton sand	43,136	5 6
Ruse fine sandy loam	5,824	.8	Granby sand	7,360	1 0
Trenary fine sandy loam	6,208	.8	Saugatuck sand	55,552	7 2
Trenary loam	2,496	.3	Ewen loam	6,976	.9
Ogemaw fine sandy loam	8,768	1 1	Moye fine sandy loam	9,856	1 3
Munuscong fine sandy loam	6,080	.8	Carbondale muck	61,312	7 9
Bohemian very fine sandy loam	2,496	.3	Rifle peat	33,024	4 3
Brimley very fine sandy loam	4,032	5	Spalding peat	25,344	3 3
Bruce silt loam	1,280	2	Greenwood peat	19,008	2 5
Kalkaska fine sandy loam	5,056	7	Houghton muck	21,248	2 7
Hiawatha loamy fine sand	22,016	2 8	Kerston muck	10,240	1 3
Strongs loamy sand	2,944	4	Wallace-Houghton complex	121,920	15 8
Blue Lake loamy sand	14,912	1 9	Wallace-Rifle complex	38,784	5.0
Kalkaska loamy sand	23,360	3 0	Eastport sand	2,944	.4
Au Train loamy sand	40,768	5 3	Coastal beach	1,024	1
Rodman stony loam	256	(1)	Made land	384	(1)
Roselawn sand	5,568	7	Quarries	64	(1)
Rubicon sand	84,416	10 9			
Grayling sand	4,352	6	Total	772,480	------
Thomastown loamy fine sand	7,680	1 0			

[1] Less than 0.1 percent.

AGRICULTURAL SOILS

The agricultural soils occur in the southern and eastern parts of the county. From Germfask to Manistique they lie south of Manistique River. North and west of Manistique they are known as the Hiawatha, Maple Grove School, Cooks, and Thompson areas. These areas comprise largely the first group of soils shown in figure 2.

Swamps, poorly drained soils, soils of low productivity, and stony soils, are interspersed with the better soils of this section, and there are few large unbroken areas of tillable soil. The largest unit of fairly productive soil is near Cooks School. Throughout the south-central, eastern, and southeastern parts of the county many small areas of upland are entirely surrounded by swamps and poorly drained soils.

Limestone bedrock underlies most of these soils at various depths. In places bedrock is exposed at the surface and in other places, as at Blaney Park, the drift is 100 or more feet thick. From Blaney

Park southward and westward, the drift generally is shallower and ranges from a thickness of about 40 feet to a few inches, and small areas have bedrock exposed at the surface. Slabs of limestone rock are scattered over the surface, and, in places where the soil is very shallow, they are numerous and a hindrance to cultivation. Limestone fragments are common throughout the soils. Light-colored granitic rocks and boulders are mixed with the limestone fragments on the surface and throughout most of the soils.

The agricultural soils are characterized by fine sandy loam or loam surface layers over sandy loam or sandy clay subsoils. In most places the surface soil is acid, whereas the subsoil is mildly acid or alkaline. Some poorly drained soils are included which, for the most part, under natural conditions, are too wet for the production of crops but are sufficiently fertile to produce crops if properly drained. The relief ranges from nearly level to gently rolling, and the natural cover was a hardwood or mixed hardwood and coniferous forest.

The agriculture is based on the raising of cattle and the production of potatoes. The variety of crops grown is limited by the climate to those which tolerate an abundance of rainfall and have rather long days and comparatively cool nights, throughout a short growing season. Hay, oats, barley, potatoes, and root crops are the main products and are grown on most of the soil types throughout the area occupied by these soils. The yields of the various crops and the distribution of the soils will be discussed under the description of each soil type.

The following soils are included in this group: Longrie very fine sandy loam, Blue Lake very fine sandy loam, Blue Lake fine sandy loam, Longrie loam, Ruse fine sandy loam, Trenary fine sandy loam, Trenary loam, Ogemaw fine sandy loam, Munuscong fine sandy loam, Bohemian very fine sandy loam, Brimley very fine sandy loam, Bruce silt loam, and Kalkaska fine sandy loam.

Longrie very fine sandy loam.—Longrie very fine sandy loam occupies undulating or gently rolling uplands and overlies limestone bedrock which lies at a depth ranging from 3 to 6 feet. Typical areas of this soil are near Maple Grove School north of Manistique and in the vicinity of Wood School.

A profile of the virgin soil comprises the following layers: (1) Forest mold and humous soil, 2 or 3 inches thick; (2) lavender-gray silty loam or very fine sandy loam, 6 or 8 inches thick; (3) cinnamon-brown silty loam or very fine sandy loam, 4 or 6 inches thick; (4) buff-colored very fine sandy loam, from 12 to 18 inches thick; (5) interstratified reddish-brown sandy clay, pink very fine sand and silt, and coarse yellow sand, from 20 to 30 inches thick; and (6) limestone bedrock. In places a 2- or 3-inch layer of whitish-gray clayey material rests directly on the bedrock and appears to be recently decomposed limestone. There is considerable variation in the relative amounts of clay, sand, fine sand, and silt in layer 5. In places clay is dominant, whereas in other places coarse yellow sand and fine sand comprise most of the layer. The material in the first four layers is acid, and that in layer 5 ranges from mildly acid to neutral. A few small areas, in which limestone bedrock lies within 3 feet of the surface, are included on the map with this soil.

The cultivated surface soil is brownish-gray very fine sandy loam. The rolling character of the land provides good natural surface drainage, and the fine texture of the soil and the underlying bedrock favor retention of sufficient moisture for the tillage and growth of crops.

A few limestone slabs and granitic boulders are scattered over the surface and throughout the soil but are not numerous enough to be a serious hindrance to cultivation or to clearing new land.

The original forest was composed of hardwoods and conifers, such as hard maple, yellow birch, beech, elm, basswood, hemlock, balsam fir, spruce, and cedar. Most of the timberland has been cut over, and the present tree growth is a reproduction of the original species mixed with more or less popple.

Longrie very fine sandy loam, because of its natural good surface drainage and moisture-retaining capacity ranks first among the agricultural soils of this county. The average yields of most crops are higher on this soil, and it is especially suited to the production of potatoes on a commercial scale.

Yields of timothy and clover range from 1 to 1½ tons an acre; clover, 1½ to 2 tons; oats, 30 to 35 bushels, with occasional yields of 60 to 70 bushels reported; barley, 25 to 30 bushels; potatoes, 150 to 250 bushels, with yields of 500 or more bushels not uncommon. Carrots, rutabagas, and cabbage are grown to some extent and return satisfactory yields.

Nearly all farms have small orchards which supply fruit for home consumption. Gardens supply the homes with vegetables and small fruits.

Blue Lake very fine sandy loam.—Blue Lake very fine sandy loam is the predominating soil north and west of Cooks School, and it occurs in small bodies associated with the Trenary soils between Germfask and Blaney Park. It occupies broadly rolling hardwood uplands.

The virgin soil profile has the following layers: (1) Forest litter, mold, and humous soil, 2 or 3 inches thick; (2) lavender-gray very fine sandy loam, 6 or 8 inches thick; (3) chocolate- or cinnamon-brown very fine sandy loam or silty loam, 3 or 4 inches thick, overlying a 10- or 12-inch layer of cinnamon-brown or buff very fine sandy loam; and (4) salmon or yellow loose coarse sand with lenses and pockets of silty and very fine sandy material, from 12 to 16 inches thick, overlying material consisting of a mixture of reddish-brown sandy clay, pockets of sand, and silt in which gravel and boulders occur more or less in pockets. Limestone gravel and fragments are not uncommon in the soil, but they are not so common as in Longrie very fine sandy loam.

The upper part of layer 4 is not everywhere consistent. In some places it appears as a faintly bleached layer, especially where sandy clay material is near the surface, and the proportions of sand, clay, and silt vary. Layers 1, 2, and 3 nearly everywhere are acid in reaction, and the subsoil is variable but generally neutral or alkaline.

Limestone bedrock lies at a greater depth beneath this soil than under Longrie very fine sandy loam. The deeper till provides freer drainage, and in consequence the Blue Lake soil is slightly more droughty. Boulders of granite origin and limestone slabs are common but not numerous over the surface and throughout the soil.

The original forest cover was largely hard maple, yellow birch, beech, elm, and basswood, with various quantities of large white pine, spruce, and cedar. The present cover consists of a second growth of the original species, interspersed with poplar.

During seasons of plentiful rainfall, crop yields on Blue Lake very fine sandy loam compare favorably with those on Longrie very fine sandy loam, but, owing to the more pervious subsoil, the Blue Lake soil is more susceptible to drought, and the average yields, over a period of years, are less than on the Longrie soil.

Grain and hay are the main crops. Oats yield from 25 to 30 bushels an acre; barley, 20 to 25 bushels; timothy and clover, ¾ to 1½ tons; clover, 1½ to 2 tons; and potatoes 90 to 150 bushels. A few small fields are in alfalfa.

Blue Lake fine sandy loam.—Blue Lake fine sandy loam is closely associated with Blue Lake very fine sandy loam, and the boundary lines drawn on the map between these two soils are arbitrary in many places. The profile of the virgin soil consists of the following layers: (1) Forest litter and mold, 1 or 2 inches thick; (2) lavender-gray loamy sand, 4 or 6 inches thick; (3) chocolate-brown very fine sandy loam in the upper 2 or 3 inches, grading into lighter brown fine sandy loam which, in turn, at a depth ranging from 16 to 20 inches below the surface, grades into (4) pale-yellow or salmon-colored fine sand with lenses and pockets of silty and clayey material. The brown layer of this soil is shallower and apparently contains less organic matter than the corresponding layer in Blue Lake very fine sandy loam. The subsoil of the latter is more sandy and pervious.

This soil is farmed to some extent, and the same crops are grown as on the other agricultural soils. The average yields are slightly less than on Blue Lake very fine sandy loam and are similar to those obtained on Kalkaska fine sandy loam.

The original forest cover included hard maple, yellow birch, and beech, with some elm, basswood, and white pine. The second growth is largely hard maple, but the second growth on burned-over areas consists largely of poplar.

Longrie loam.—Longrie loam consists of a shallow layer of soil over limestone bedrock. It occurs in fair-sized areas in the vicinity of Calaspar and between Calaspar and Manistique. The soil ranges from only a few inches to 3 feet in thickness, and small areas of exposed bedrock are included on the map. Limestone slabs on the surface and throughout the soil are characteristic and generally are numerous enough to be an obstacle in clearing land.

A virgin profile shows the following layers: (1) Forest litter and humus, from 1 to 3 inches thick; (2) lavender-gray very fine sandy loam, from 3 to 5 inches thick; (3) umber or cinnamon-brown loam grading, with depth, into lighter brown or buff very fine sandy loam, from 8 to 24 inches thick; and (4) limestone bedrock. As the depth of the soil over bedrock increases, this soil merges with Longrie very fine sandy loam, and separation of areas on the map is arbitrary in places. Although limestone bedrock lies at a slight depth, the soil is prevailingly acid in reaction.

Longrie loam occurs in small bodies on tablelands and rock benches. The relief conforms to the underlying rock and, although it is in places nearly level, in others it is characterized by short abrupt slopes. Surface drainage is generally good, but in some small areas water is held near the surface by the flat rock. Areas of this wetter soil, which are large enough to warrant separation, are shown on the map as Ruse fine sandy loam.

Areas of Longrie loam associated with areas of Longrie very fine sandy loam have been cleared. The loam soil is comparatively fertile but is more subject to short droughty spells, and the yields over a period of years are not so high as on the very fine sandy loam. The crops grown are those common to the county. Extremely stony areas, when cleared of trees, afford good pasture.

The original forest consisted of hard maple, yellow birch, beech, elm, and basswood, with cedar, spruce, and balsam fir as an undercover where the soil was shallow. Areas with only an inch or two of dark mucky material over bedrock support an almost pure stand of cedar.

Ruse fine sandy loam.—Ruse fine sandy loam is a poorly drained shallow soil occupying slight depressions within areas of Longrie loam. Limestone bedrock lies at a depth of 30 inches or less below the surface.

The virgin profile shows the following layers: (1) Dark-colored or black organic matter or mucky material, from 2 to 8 inches thick; (2) dark-gray very fine sandy or silty loam, 4 or 6 inches thick; (3) grayish-brown, mottled with brown and yellow, sandy loam or fine sandy loam, grading into mottled grayish-brown and yellow fine sandy loam or sandy clay, from 6 to 14 inches thick; (4) yellow sticky gritty sand, gravel, and clay, 2 or 3 inches thick; and (5) limestone bedrock.

Ruse fine sandy loam is well supplied with humus, is fairly fertile, and the subsoil has a neutral or alkaline reaction. Excessive stoniness and poor drainage are depreciating factors affecting the value of the land. Where artificially drained the soil produces good yields of hay and grain. Alsike clover grows naturally on this soil, and good pasture is provided in areas which have been cleared or on which the forest growth has been thinned sufficiently.

The original forest was a swamp conifer-hardwood type including cedar, black spruce, ash, elm, white birch, and a few yellow birch. The second growth on cut-over areas includes much popple and alder in addition to the original species.

Trenary fine sandy loam.—Trenary fine sandy loam occurs on broadly rolling hardwood uplands in the eastern and southeastern parts of the county in the vicinities of Germfask and Blaney Park in small areas surrounded by swamps and poorly drained soils.

Under virgin conditions the soil has the following profile: (1) Forest litter, mold, and humus, 2 or 3 inches thick; (2) lavender-gray very fine sandy loam, 6 or 8 inches thick; (3) cinnamon-brown very fine sandy loam, from 12 to 16 inches thick; (4) gray mottled coarse slightly cemented sand, 8 or 10 inches thick; and (5) reddish-brown compact sandy clay material containing gravel and stones dominantly of limestone origin. The plowed surface soil is gray-brown fine sandy loam. The upper 35 or 40 inches of the soil is acid in reaction. The subsoil is neutral or slightly alkaline, owing to the presence of limestone fragments.

Surface drainage is good, but the compact nature of the subsoil and of the fourth layer retards internal drainage. Although the soil is comparatively fertile, only a small percentage is farmed, owing to its occurrence in small areas and its slow internal drainage. Hay and grain are the principal crops. Alfalfa is grown with some success. Average crop yields compare favorably with those obtained on other soils of the county. This is a good soil for pasture.

The original forest consisted of hard maple, yellow birch, elm, basswood, hemlock, and beech, with some cedar and spruce. Most of the original timber has been removed, and the second growth is a reproduction of the original species, with a large proportion of hard maple.

Trenary loam.—Trenary loam has a calcareous rather heavy clay subsoil at a slight depth. Limestone bedrock underlies it, in places, at a depth ranging from 3 to 4 feet, but generally is much deeper. The forested soil has a thin covering of forest litter and humous soil 2 or 3 inches thick over a layer of lavender-gray silty loam or very fine sandy loam, 5 or 6 inches thick. This overlies a 10- or 12-inch layer of brown loam or very fine sandy loam. The subsoil is a comparatively heavy reddish-brown clay containing gritty and gravelly material.

Granitic and limestone boulders and slabs are common over the surface and embedded in the subsoil. Surface drainage ranges from fair to good, but internal drainage is somewhat slow. The surface soil is slightly acid. Hay and small grains do well. The value of this soil is depreciated to some extent by its occurrence in small bodies surrounded or penetrated by wet land and swamps. The soil is not extensive.

The original forest consisted of mixed hardwoods and conifers and included hard maple, yellow birch, elm, basswood, hemlock, balsam fir, cedar, and spruce. The proportion of conifers was larger than on most of the other upland soils in this group.

Ogemaw fine sandy loam.—Ogemaw fine sandy loam is a poorly drained upland soil which is moderately productive and, when cleared, is utilized for hay and pasture. When adequate drainage is provided small grains do well. The plowed land has a patchy appearance of dark gray and gray brown. In most virgin areas the layer of forest litter is deeper than on the better drained soils. The gray layer is sandy or fine sandy loam 8 or 10 inches thick, and the brown layer is rust-brown or yellowish-brown very fine sandy loam slightly cemented in places. The subsoil is strongly mottled reddish-brown sandy limy clay which in most places is wet at a depth ranging from 24 to 30 inches. Limestone bedrock lies at a depth of 30 inches below the surface in places, but generally at a much greater depth.

The original forest was a hardwood-conifer type, with a larger proportion of conifers than on the better-drained soils. Cut-over and burned-over areas reproduce largely to popple, with some spruce, cedar, balsam fir, and alder.

The aggregate acreage of Ogemaw fine sandy loam is not very large, and the soil occurs in small areas which are of but slight importance as farm land.

Munuscong fine sandy loam.—Munuscong fine sandy loam resembles Ruse fine sandy loam, but it is underlain by fine sandy loam or sandy clay instead of limestone at a depth ranging from 12 to 30 inches.

The soil occupies depressions and borders between swamp and upland and occurs mostly in small bodies or narrow bands. It is fairly fertile and not excessively acid in reaction. The land is not utilized to any extent for agriculture because of the cost of clearing and draining. Small cleared areas are used for hay and pasture land.

Most of the forest has been cut over, and, where the land is not cleared, aspen, alder, and willow have combined with the original species of balsam fir, cedar, spruce, tamarack, and a few swamp hardwoods to form a dense second growth.

Bohemian very fine sandy loam.—The natural cover of Bohemian very fine sandy loam is a hardwood forest. The relief is level or undulating. Typical areas border Indian Lake on the west and southwest, and also occur in the vicinity of Germfask.

The following layers are seen in a profile of the virgin soil: (1) Forest litter and humus, 2 or 3 inches thick; (2) lavender-gray loamy very fine sand, 6 or 8 inches thick; (3) cinnamon-brown very fine sandy or silty loam, 4 or 6 inches thick; (4) buff very fine sandy or silty loam, 8 or 12 inches thick; and (5) pink stratified material consisting of layers of very fine sand, fine sand, silt, and silty clay. In places a layer of coarse sand or gravel is reached at a depth ranging from 5 to 6 feet. The soil mass generally is free from stones or gravel, but a few granitic boulders are scattered over the surface.

This soil is subject to extremes in moisture content, but in normal seasons the moisture is sufficient for good growth of plants without extremes of wetness or dryness. The soil is acid, but the parent material in many places shows an alkaline reaction in the clay and silt layers at a depth between 4 and 5 feet.

Some of the land is cultivated with fairly good success. Small grains, potatoes, and hay are grown, but the average yields indicate that this soil is not quite so fertile as is Blue Lake very fine sandy loam, and productivity is harder to maintain.

Hard maple, yellow birch, white birch, and hemlock, with some cedar and spruce, comprised the original forest growth. Cut-over areas reproduce the original species, with some large-toothed and small-toothed aspen in addition. The cleared areas have a good grass cover and provide fair pasture.

Brimley very fine sandy loam.—The soil material of Brimley very fine sandy loam is very similar to that of Bohemian very fine sandy loam, but the soil profiles differ because the Brimley soils have developed under wetter conditions.

A profile of the virgin Brimley soil consists of the following layers: (1) Forest mold and humus, 2 or 3 inches thick; (2) light-gray or pale-lavender leached very fine sand, 4 to 10 inches thick; (3) rust-brown or dark-brown loamy very fine sand, 4 to 10 inches thick; and (4) gray or yellow, splotched with reddish brown, wet stratified fine sand, pale-red silt, and clay. The soil is acid to a depth ranging from 3 to 4 feet, or where the layers of silt and clay generally are neutral or alkaline.

The land has a wavy appearance, owing to small swales and depressions and slight knolls and ridges. The soil occurs in small areas

49948—39——3

in the eastern and southern parts of the county and in the vicinity of Indian Lake. Although fairly fertile, only small bodies are cultivated.

A thick forest of hemlock, white pine, red maple, yellow birch, and beech, mixed with ash, elm, cedar, spruce, and balsam fir formed the original cover. The present forest consists largely of popple, with a scattered growth of the original species.

Poor drainage, cost of clearing, and low fertility tend to make this a marginal soil for agriculture.

Bruce silt loam.—Bruce silt loam, in surface features, is very similar to Ruse fine sandy loam and Munuscong fine sandy loam. It occupies flat poorly drained areas and supports a mixed growth of conifers and swamp hardwoods.

The surface soil is dark-gray or black muck—in places consists of peat. It is underlain at a depth ranging from 4 to 10 inches by pale-lavender or very light gray very fine sand and silt. Below a depth ranging from 10 to 20 inches the soil consists of wet gray silt and very fine sand mottled with yellow and brown.

A fairly large area of this soil is northwest of Indian Lake, and smaller bodies are in the vicinity of Germfask. Bruce silt loam requires artificial drainage before it can be farmed, and practically none of the land is under cultivation. Judging from the thick forest growth, the soil is fertile and would produce good crops if the need for more land and economic conditions justified proper drainage.

The original forest consisted of a mixed dense stand of conifers and swamp hardwoods, mainly cedar, spruce, balsam fir, balm-of-Gilead poplar, ash, and elm, with some hemlock and large white pine.

Kalkaska fine sandy loam.—A profile of virgin areas of Kalkaska fine sandy loam shows the following layers: (1) Forest mold and humus, 1 or 2 inches thick; (2) lavender-gray sandy loam, 5 or 6 inches thick; (3) a brown layer, from 20 to 30 inches thick, of chocolate- or dark-brown fine sandy loam or loam in the upper part and lighter brown fine sandy loam below; (4) brownish-yellow loose sand, from 10 to 20 inches thick; and (5) pale-yellow loose sand. The lower part of the soil mass contains numerous limestone fragments, especially along the eastern boundary of the county. The upper part of the soil is acid, and the subsoil in general is neutral or slightly acid.

Kalkaska fine sandy loam is farmed to some extent. Fair yields of potatoes and small grains can be obtained, but constant care is needed to maintain fertility, and most of the farms on this soil are not self-sustaining. Natural wild grasses and clover furnish only fair pasture on the cleared areas.

This soil is mapped on the hardwood plain east of Manistique, and east of Blaney Park near the county line. The original forest consisted of maple, yellow birch, and beech, with some basswood, elm, helmlock, and large white pine.

Included on the map with Kalkaska fine sandy loam are a few small areas of Kalkaska very fine sandy loam which, under forested conditions, has the following profile: (1) Forest mold and humus, 1 or 2 inches thick; (2) lavender-gray very fine sandy loam, 6 or 8 inches thick; (3) a brown layer, 10 or 12 inches thick, of which the upper 2 or 3 inches are chocolate-brown very fine sandy loam, and the lower part is lighter brown very fine sandy loam or silty loam; and (4) pale-yellow sand and gravel. Silty and clayey layers are present at a depth ranging from 40 to 60 inches. There are limestone gravel and fragments in the subsoil, but the soil is generally acid to a depth ranging from 2 to 3 feet.

The original forest on the included soil consisted of hard maple, yellow birch, beech, and hemlock, with some elm, spruce, balsam fir, and large white pine. The second growth consists of popple and trees of the original species. Like typical Kalkaska fine sandy loam this soil is of fair fertility and is farmed to some extent. Yields of potatoes and small grain compare favorably with those obtained on Blue Lake very fine sandy loam, but it seems more difficult to retain fertility in this soil than in the Blue Lake soil.

FOREST SOILS

The soils of this group are not designated forest soils because they will produce better trees than the other soils—in fact, they will not—but because low natural fertility, unfavorable moisture conditions, or rough topography render them unsuitable for the production of cultivated crops. Under present economic conditions utilization of these soils should be confined to forestry and associated uses.

The forest soils are divided into subgroups as follows: Loamy sands and stony loams of the hardwood uplands and plains, dry sands of the pine uplands and plains, wet and poorly drained sandy mineral soils, stream-bottom or alluvial soils, and organic soils.

LOAMY SANDS AND STONY LOAMS OF THE HARDWOOD UPLANDS AND PLAINS

The soils of this subgroup are characterized by a strong development of the brown layer. They are generally acid in the surface soil and to a depth of several feet, but acidity is modified by the presence of limestone in some of them. Natural fertility is low, but, in general, these soils are better supplied with organic matter than are the dry sands of the pine uplands and plains. Drainage is comparatively free, but moisture conditions are more favorable than in the dry sands. These soils formerly supported a fairly dense hardwood forest consisting of hard maple, yellow birch, beech, hemlock, and some elm, white pine, balsam fir, and spruce. Cut-over and burned-over areas reproduce largely to fire cherry and aspen, accompanied by a heavy growth of bracken and a fair growth of native grasses in the open spaces.

The general profile of these soils is as follows: (1) Forest mold and humus, (2) a gray layer, (3) a brown layer, and (4) parent material. The first three layers are very similar in all soils of the group, but there are slight variations in the brown layer. The parent material is noticeably variable and is the principal basis for separating the different soil series. A number of distinctions are made on the bases of relief, color, and content of limestone. Hiawatha loamy fine sand, Strongs loamy sand, Blue Lake loamy sand, Kalkaska loamy sand, Au Train loamy sand, and Rodman stony loam comprise the subgroup. These soils occur in parts of the county indicated in the second and third divisions of figure 2.

Hiawatha loamy fine sand.—Hiawatha loamy fine sand occurs on the hardwood hills west and south of Steuben. Strong slopes, knobby hills, and kettlelike depressions occupied by swamps or lakes are characteristic of the areas of this soil. Granite boulders are scattered over the surface and in a few places in the soil.

A profile of the virgin soil shows the following layers: (1) 2 or 3 inches of forest mold and humus; (2) 6 or 8 inches of lavender-gray fine sand; (3) a brown layer, from 12 to 20 inches thick, with various degrees of cementation and consisting of a 2- to 4-inch layer of dark-brown loamy sand grading into light-brown loamy fine sand which, in turn, grades into (4) pale-yellow or pink sand containing pockets of sandy clay, silty material, and gravel.

The soil is strongly acid to a depth of several feet. Only a few small areas are cultivated, mostly as summer gardens. The virgin forest growth consisted of hard maple, yellow birch, beech, and hemlock, with a few white pine, elm, balsam fir, and spruce. Cut-over and burned-over areas have a growth of fire cherry and aspen, with bracken and native grasses in the open spaces.

Small areas of fine sandy loam, in which the surface soil is of finer texture and the sandy clay substratum is within 3 feet of the surface, are in sec. 25, T. 44 N., R. 18 W., sec. 7, T. 44 N., R. 17 W., and sec. 30, T. 45 N., R. 18 W. These areas are too small and variable to map separately and are therefore included with Hiawatha loamy fine sand.

Strongs loamy sand.—Strongs loamy sand occupies comparatively high plainlike uplands along and near the northern county line. Locally, pot-hole depressions and valleys make the surface broken and uneven. Small stones and boulders of foreign origin occur over the surface and throughout the soil. This soil is not extensive.

Strongs loamy sand differs from Hiawatha loamy fine sand in that it has more uniform, apparently stratified, layers of fine sand, silt, and clay in the lower part of the soil and also has smoother relief. It is slightly more rolling than Au Train loamy sand, the cementation of the brown layer is not so apparent as in that soil, and the underlying material is different. There is little or no limestone influence throughout the Strongs soil.

The virgin forest consisted of hard maple and beech, with some yellow birch, hemlock, and large white pine. The hemlock and pine have been removed, but most of the hardwoods remain. None of the land is cultivated.

Blue Lake loamy sand.—Blue Lake loamy sand occupies undulating or nearly level hardwood uplands. This soil differs from Strongs loamy sand in that it has more limestone in the underlying drift, and it differs from Kalkaska loamy sand in having more fine sand, sandy clay, and silt in the subsoil and a slightly more strongly developed brown layer.

The soil profile, under forested conditions, shows 2 or 3 inches of forest mold and humus over 6 or 8 inches of gray leached sand. The sand is underlain by a 2- or 3-inch layer of dark-brown loamy sand, grading into a 14- or 16-inch layer of light-brown loamy sand which is strongly cemented in places; and this, in turn, grades into comparatively dry sand containing a few boulders and pockets or thin layers of reddish-brown sandy clay.

The original forest consisted of maple, beech, yellow birch, and a few elm, hemlock, and large white pine. Practically all of the land has been cut over, and the present forest consists of aspen with various proportions of the original species, or of aspen and fire cherry, with a ground cover of bracken and native grasses on the burned-over areas.

Some of the land has been cleared and put under cultivation, but at present most of the land is out of cultivation. The cleared areas support a grass cover which furnishes fair pasture in the spring, but the grasses wither and die during the summer.

Kalkaska loamy sand.—Kalkaska loamy sand occupies level hardwood plains in the western, southern, and northeastern parts of the county. A typical area is on the plateaulike upland around Boot Lake. The surface soil and subsoil are free of boulders, and the underlying material is loose sand. Some gravel, much of which is limestone, is on the surface and throughout the soil. This soil differs from Au Train loamy sand in that there is less intense development of the brown layer.

The virgin profile shows the following layers: (1) Forest mold and humus, 1 or 2 inches thick; (2) gray medium sand, 6 or 8 inches thick; (3) a brown layer, from 10 to 16 inches thick, which is cemented in places, consisting of a 2- or 3-inch layer of dark-brown loamy sand grading into light-brown loamy sand; and (4) pale-yellow coarse sand and gravel. The soil is acid to considerable depth, but the underlying material is influenced by the presence of limestone gravel.

Most of the timber has been removed and the land burned over. The present cover is aspen and fire cherry, with bracken and grass in the open spaces. The original forest consisted of hard maple, beech, and yellow birch, with a few hemlock, large white pine, spruce, and balsam fir.

Some of this land has been farmed, and it produced only fair yields of grain and potatoes during the years when moisture conditions were ideal. Most of the areas formerly cultivated have been abandoned.

Au Train loamy sand.—Au Train loamy sand occupies level hardwood plains and benches in the northern part of the county. Its distinguishing characteristic is the presence of a thick brown or yellow cemented hardpan layer in the subsoil. The cementation and color are not uniform. Fingers of cemented material extend to a depth of 40 or more inches in some places, and cementation is scarcely noticeable in others. Dark-brown and yellowish-brown colors are intermixed with no definite pattern. The soil is strongly acid to a depth of several feet.

The profile in forested areas shows the following layers: (1) Forest mold and humus, 2 or 3 inches thick; (2) pale-gray sand, 8 or 10 inches; (3) coffee-brown velvety loamy fine sand containing an appreciable quantity of organic matter, 1 or 2 inches thick; (4) dark-brown or brownish-yellow loamy sand, cemented in various degrees, from 20 to 30 inches thick, with the brownish-yellow color extending to a depth ranging from 5 to 6 feet in places; and (5) pale-yellow sand and fine sand.

The original forest included a large proportion of hemlock, together with hard maple, yellow birch, beech, and some large white pine, spruce, and balsam fir. Considerable areas of this soil are still forested, but the hemlock and white pine have been removed. Aspen occupies most of the cut-over and burned-over areas, with rank growths of bracken in the more open spaces. None of the land is farmed.

Rodman stony loam.—Rodman stony loam occupies gravelly stony ridges, "hogbacks", and knolls, such as the area in sec. 4, T. 43 N., R. 13 W. It includes a very small total area. The soil has fair natural fertility but is too rough and stony to be of much agricultural value. The soil profile is variable, but in general consists of a 4- to 8-inch layer of gray loamy sand over a brownish-gray cobbly sandy loam or loam. The subsoil is a mass of cobbly, gravelly, and sandy material, generally high in limestone content.

The soil formerly supported a forest of hard maple, yellow birch, hemlock, elm, balsam fir, and spruce. The present forest consists of poplar, white birch, red maple, cherry, and various proportions of the original species.

DRY SANDS OF THE PINE UPLANDS AND PLAINS

The soils of this subgroup are excessively well drained, low in natural fertility, comparatively free from stones on the surface and throughout the soil, strongly acid, and have poorly developed profiles. A forest consisting of white pine, red pine, and a few oaks constituted the original cover. Lumbering and fires have removed or destroyed most of the original timber, and the present growth consists of aspen, jack pine, fire cherry, and some red maple and second-growth red pine and white pine. Open spaces are grown up to bracken, sweetfern, blueberries, and grasses. The average accumulation of forest litter and humus on these soils is comparatively thin. These soils are not cultivated and in general they are too dry to afford pasture during the summer.

Roselawn sand, Rubicon sand, Grayling sand, Thomastown loamy fine sand, Rubicon loamy fine sand, Wallace fine sand, and Bridgman fine sand belong to this subgroup. The greater part of these soils are within the fourth natural land division, shown in figure 2.

Roselawn sand.—Roselawn sand occupies the rolling and hilly deep sandy pine uplands north and west of Thunder Lake. The area as a whole has the appearance of a high plain, but pot-hole depressions and deep valleys give a local impression of rough hilly country.

Under cut-over conditions the soil has the following layers: (1) Loose mold and humous soil, 1 or 2 inches thick; (2) loose gray sand, 4 or 6 inches thick; (3) medium-brown or light-brown slightly loamy sand, 12 or 15 inches thick; and (4) pale-yellow sand which grades into (5) the parent material consisting of a fairly uniform mixture of somewhat pink sand and fine sand.

Drainage conditions are free, and, during dry periods, the soil is excessively dry to a depth of several feet. The original forest consisted of red pine, jack pine, and oak. Most of the land has been burned over, and the present cover consists of jack pine, red pine, oak, aspen, fire cherry, and red maple, with sweetfern, bracken, and some blueberries and grass in the more open spaces.

Rubicon sand.—Rubicon sand comprises the greater part of the level sandy pine plains and occurs in large areas throughout the northern and western parts of the county. Typical areas are northeast, northwest, and southwest of Indian Lake, and on the pine plains north of Seney.

The soil consists of the following layers: (1) Forest mold, or gray sand mixed with charred organic matter and plant roots, 1 or 2 inches thick; (2) gray leached harsh sand, from 4 to 10 inches thick; (3) medium-brown or light-brown sand, 8 to 12 inches thick; and (4) pale-yellow pervious sand or sand and gravel. The soil is fairly uniform throughout the county, although the content of gravel differs from place to place. A stronger development of the brown layer is noticeable as areas of this soil approach the wetter areas of Saugatuck sand.

The average moisture content is low to a depth ranging from 3 to 5 feet. The original cover was a forest of white pine, red pine, and some jack pine. The present cover is variable, with clumps of jack pine dominant in some places; red maple, oak, and scattered young white and red pine in others; and aspen and various proportions of red maple, oak, jack pine, and young white pine or red pine in others. The ground cover consists of bracken, sweetfern, blueberries, and grass in open spaces or thinly forested areas.

The soil is too acid and too low in natural fertility to have much value for agricultural purposes, but blueberries thrive in the wild state and provide a source of considerable income.

Grayling sand.—Grayling sand is a deep sandy soil on the level pine plains. Red pine and jack pine comprised the original tree growth. Jack pine and various proportions of trembling aspen and a ground cover of sweetfern, blueberries, and grass form the present cover.

The soil has the same general profile as Rubicon sand but has only a shallow gray layer, 2 or 3 inches thick, and a poorly developed brown layer of sand stained yellowish brown by organic matter. The soil is low in fertility, is acid, and is excessively dry. Only a small total area of this soil is mapped.

Thomastown loamy fine sand.—Thomastown loamy fine sand occupies level areas bordering streams, at elevations ranging from 8 to 20 feet above water level. A typical area is along West Branch Manistique River. The land has a wavy appearance caused by small mounds of sand.

The soil in cut-over areas has the following layers: (1) Loose mold and humous soil or a somewhat red material consisting of mineral matter mixed with charred organic matter and plant roots, 1 or 2 inches thick; (2) gray sandy material, 1 or 2 inches thick, which is not everywhere noticeable; (3) dark reddish-brown fine sandy loam, in which the color presumably is due to iron, from 4 to 8 inches thick; and (4) pale-yellow sand or fine sand splotched with gray or brown.

The original forest consisted of red pine and white pine. The present cover is composed of jack pine and trembling aspen, with occasional clumps of young red pine or white pine. Bracken and grass cover the ground.

This soil is not extensive and has not been cultivated. The reddish-brown layer appears to contain considerable organic matter, but the underlying material is largely sand without much natural fertility.

Small areas of Thomastown loam, included on the map with Thomastown loamy fine sand, occur as narrow bands of level benchland bordering West Branch Manistique River. A reddish-brown somewhat silty loam surface soil characterizes such areas. The profile of virgin areas of this included soil shows the following layers: (1) Forest mold and humus, 1 or 2 inches thick; (2) reddish-brown somewhat silty loam, 12 or 14 inches thick; and (3) pale-yellow sand splotched with brown and gray. A few small rounded pebbles are in the parent material. The development of a faint-gray layer is noticeable under the humus in places but generally is absent. The soil is acid throughout.

The original forest on the included soil consisted of hard maple, yellow birch, beech, and some elm, basswood, balsam fir, spruce, hemlock, and large white pine. The hemlock and pine have been removed, and many white birch trees have grown up since. The soil material apparently is of recent origin. The surface soil, to a depth of a foot or more, seems well supplied with organic matter, but the underlying material is low in organic matter.

Rubicon loamy fine sand.—Rubicon loamy fine sand differs from Rubicon sand in the finer texture of the surface soil and in the presence of a few layers of silt in the parent material. The relief and vegetative cover are very similar for the two soils.

Rubicon loamy fine sand consists of the following layers: (1) Forest mold and humus, 1 or 2 inches thick; (2) lavender-gray fine sand, 6 or 8 inches thick; (3) cinnamon-brown or buff loamy fine sand or fine sandy loam, 10 or 12 inches thick; and (4) yellowish-brown fine sand, with a layer of silty material in places The soil is strongly acid in the upper layers and ranges from acid to neutral at a depth ranging from 3 to 4 feet.

The original forest consisted of white pine and red pine, with a few balsam fir, white spruce, beech, and maple. The present cover consists of poplar, with scattered trees of the original species. Bracken and grass form the dominant ground cover. This soil is not extensive, and none of it is under cultivation. Although it is comparatively low in natural fertility, fair yields of grain and potatoes could be produced under intensive cultural methods if economic conditions justified the clearing and cultivation of the land.

Wallace fine sand.—Wallace fine sand comprises the dry fine or medium sands occurring on knolls or ridges, representing old dunes or old beach ridges.

A profile of this soil shows the following layers: (1) 1 or 2 inches of forest mold and humus; (2) from 6 to 16 inches of gray leached fine sand; (3) fine sand or sand stained yellowish brown or dark brown by organic matter, slightly or firmly cemented in lumps of irregular thickness and shape, and extending to a depth ranging from 3 to 4 feet in places; (4) pale-yellow or pink fine sand. The soil is strongly acid throughout, and no stones or gravel are present.

Wallace fine sand comprises a rather large aggregate area, but it occurs as individual knolls and narrow winding ridges and as islands within swamps, which rise to elevations ranging from 8 to 40 feet above the adjacent land. It is distributed over all parts of the county but is especially prominent in the central and southern parts as a component of the Wallace-Houghton and Wallace-Rifle complexes.

The original forest growth consisted mostly of white and red pines. On some low ridges and knolls entirely surrounded by swamps, there was some encroachment of swamp species, such as tamarack and black spruce. Some trees of the original species remain, but, in areas from which they have been removed, the present tree growth is mainly aspen, jack pine, white birch, and some oak. Blueberries, sweetfern, bracken, and wintergreen constitute the ground cover.

This soil is strongly acid. None of it is cultivated, and it is unsuitable for agricultural purposes because of its occurrence in small areas, its uneven relief, and its low natural fertility.

Bridgman fine sand.—Bridgman fine sand occupies the more recent dunes and beach ridges adjacent to Lake Michigan. This soil occurs for the most part in ridgelike areas, but a few larger bodies have a billowy appearance. The soil is excessively dry and subject to displacement by wind, and some areas are bare. Narrow swamps and open grassy marshes occupy some of the valleys between the ridges.

Bridgman fine sand is differentiated from Wallace fine sand by the poor development of its brown layer. The soil consists of the following layers: (1) Forest mold, 1 or 2 inches thick; (2) gray sand, 4 or 6 inches thick; (3) fine sand, 10 or 12 inches thick, stained brownish yellow by organic matter, streaks of which extend to a depth ranging from 30 to 40 inches; and (4) pale-yellow incoherent sand.

The original forest consisted of red pine, white oak, white pine, and some white birch and red maple. The present cover is composed of white birch, aspen, and red, jack, and white pines. A sparse cover of coarse grasses grows in the open spaces.

WET AND POORLY DRAINED SANDY MINERAL SOILS

The soils of this subgroup occupy narrow strips between peat swamps or between lakes and the better drained upland soils, and larger bodies of flat land where drainage is retarded. Some flat areas are poorly drained and permanently wet, and in other areas the water table fluctuates widely and evidence of permanent waterlogging appears only at a depth ranging from 2 to 3 feet.

A dense plant growth was sustained by these soils under natural conditions. The type of growth varies considerably from a hardwood-coniferous forest on the drier areas to sedge and grass on some of the flat permanently wet areas. The low natural fertility, high cost of reclamation due to poor drainage, and dense cover of vegetation depreciate the value of these soils for agricultural purposes.

Newton sand, Granby sand, and Saugatuck sand are included in this subgroup.

Newton sand.—Newton sand occupies low, flat, poorly drained areas of considerable size in the north-central part of the county and small areas throughout the section north of Manistique River. A typical area is in sec. 29, T. 46 N., R. 16 W.

The soil is characterized by a 2- to 12-inch layer of muck over gray water-soaked sand which in most places shows rust-yellow splotches or smoke-colored stains. The sand immediately under the mucky surface layer is dark gray in many places, owing to an admixture of organic matter. Normally the water table lies at a depth ranging from 10 to 20 inches below the surface, but at times it is at or near the surface.

Newton sand is strongly acid and sandy to a considerable depth. The waterlogged sand is low in fertility, and the fertility contained in the organic surface soil is soon exhausted after the soil is drained sufficiently for crop production.

The natural plant growth varies on this type of soil. The original forest growth included some white pine, large-toothed poplar, white birch, and a few elm and ash. Aspen, alder, spruce, tamarack, and cedar now comprise the principal cover in most places, but aspen and alder, or alder alone, grow in some places. Marsh plants, such as sedges, coarse grasses, bluejoint, and wire grass, comprise the present growth over some of the larger areas. Root development is shallow in most places, owing to the high water table.

Attempted production of crops on this soil has not proved successful, with the exception of a few small garden spots where fertilizers have been added. Some wild hay has been cut from areas where bluejoint grass is dominant. The sedges and coarse grasses, which form the bulk of the growth on the moist areas, make poor hay.

Granby sand.—Granby sand differs from Newton sand in that it is associated with limestone bedrock and the more limy drifts, and it presumably contains more lime. Natural drainage of the two soils is similar.

The 2- to 12-inch mucky surface soil overlies wet gray sand which, in most places, extends to a depth ranging from 30 to 40 inches but in a few places is underlain by bedrock at a depth between 16 and 20 inches. Sandy clay is present in a few places at a depth ranging from 30 to 36 inches. Granby sand may be slightly more fertile than Newton sand, but it is not recommended for agricultural purposes. The land is cultivated only in small areas adjacent to areas of better soils.

This soil occupies small areas distributed throughout the southern part of the county, associated with the soils in the first natural land division shown in figure 2. The total acreage is rather small. A thick growth of cedar, spruce, tamarack, balsam fir, and some large-toothed aspen and white pine characterized the original growth. The forests have been cut over, and a mixture of the original species, together with alder, aspen, and white birch, comprises the present cover. Jack, red, and white pines and red maple grow in some of the drier areas where limestone bedrock lies close to the surface.

Saugatuck sand.—Saugatuck sand is a poorly drained sandy soil of low fertility, in which the depth to the water table fluctuates from a few inches to 3 feet below the surface. This soil occurs on flat sandy plains bordering swamps, and it is characterized by a dark coffee-brown or rust-brown cemented sand or hardpan layer.

The profile consists of the following layers: (1) Dark-colored mixed organic matter and sand, from 2 to 8 inches thick; (2) almost white leached medium or fine harsh sand, from 6 to 15 inches thick; (3) a dark-brown or coffee-brown hardpan which varies somewhat in hardness and grades into yellowish-brown sand that, in turn, grades into (4) grayish-brown, rust-brown, or pale-yellow moist sand extending to the water table which lies at a depth ranging from 2 to 3 feet below the surface.

This soil, although it occurs for the most part in comparatively small areas, occupies a large total acreage. The relief in general is level, but small mounds and knolls of sand give much of the land a hummocky appearance.

Saugatuck sand is strongly acid and is low in fertility. The land is not cultivated, but small areas are used for pasture. Practically all of it has been cut over, and most of the cut-over land has been burned over. The original forest consisted of hemlock, red maple, and some hard maple, yellow birch, white pine, balsam fir, cedar, and spruce. The wetter areas also supported some elm and ash. Aspen, jack pine, red maple, and alder, together with bracken, lichens, sweetfern, and blueberries, form the present cover.

Areas of Newton sand and Wallace sand, which are too small to separate on a small-scale map, are included in areas mapped as Saugatuck sand. Also included are small areas of Saugatuck loamy sand, which are poorly drained or semiswampy and are underlain by limestone bedrock at a depth ranging from 3 to 5 feet. Surface features, drainage conditions, and profile development of the included Saugatuck soil are almost identical with those of Saugatuck sand. A pale-yellow thin sandy slightly sticky mass containing limestone fragments is present immediately above the limestone bedrock, and in places a few limestone slabs occur on the surface and through the soil.

STREAM-BOTTOM OR ALLUVIAL SOILS

The total acreage of stream-bottom or alluvial soils in Schoolcraft County is larger than in other counties in the Upper Peninsula. Manistique River and some of its tributaries, for a short distance from their mouths, have built up an appreciable amount of alluvial soil to form narrow bottom lands. The material deposited by the streams is mostly sandy but, as evidenced by vegetation, is fairly fertile. None of these soils are under cultivation. Drainage conditions differ in the different types, and the soils are practically free of stones and gravel.

Ewen loam.—Ewen loam is characterized by a reddish-brown fine sandy loam or silty surface soil, ranging from 8 to 20 inches in thickness. It is underlain by gray or yellowish-gray sand containing layers of silt and fine sand. It occurs in narrow strips bordering streams and lies from 2 to 5 feet above the stream level. It is subject to overflow several times a year, during periods of high water. The land is fairly well drained between periods of overflow, to a depth ranging from 2 to 5 feet, or to the depth of the normal water table.

The original forest growth was elm, ash, yellow birch, beech, red maple, cedar, spruce, alder, and willow, with white pine on the higher elevations. The present cover consists of a dense growth of alder, cedar, spruce, willow, and some of the other original species.

Ewen loam, as mapped, includes a few areas of loamy fine sand which occupy the same position as Ewen loam and have almost identical drainage conditions and forest growth. The main difference is the color and texture of the surface soil. The included soil has a surface layer of brown, brownish-gray, or gray loamy fine sand, ranging from 12 to 20 inches in thickness. It is underlain by grayish-yellow sand which contains layers of gray silt in a few places. None of this soil is cultivated. There were more hemlock and white pine in the original forest growth than on the typical loam areas.

Moye fine sandy loam.—Moye fine sandy loam occurs in comparatively broad terracelike areas bordering Manistique River and some of its tributaries. The elevation ranges from 8 to 20 feet above stream level; consequently this soil is seldom, if ever, overflowed. The level surface is interrupted by old river channels, ox bows, or sloughs of various depths, most of which are permanently dry, but a few hold water practically the year around.

The virgin soil consists of the following layers: (1) Forest litter and mold, 2 or 3 inches thick; (2) gray sand mixed with organic matter, 1 or 2 inches thick; (3) reddish-brown fine sandy or silty loam, from 12 to 20 inches thick; (4) reddish-yellow medium sand or fine sand, splotched with gray and brown. In places layers of very fine sand, silt, or reddish-brown (iron rust-colored) silty material are present in the subsoil.

Moye fine sandy loam is free from stones. Both surface and internal drainage are good. The soil is not cultivated but is fairly fertile, as is evidenced by the forest cover. The land would be fairly productive of truck crops if economic conditions justified the cost of clearing it. The forest cover consists of elm, hard maple, yellow birch, basswood, hemlock, beech, spruce, cedar, and white birch, and some oak and white pine. Grasses grow well in the open spaces.

ORGANIC SOILS

The organic soils, or deposits of peat and muck, occur in forested swamps, marshes, and open heath bogs. They are composed dominantly of plant matter and in this respect are distinct from the upland soils which are composed dominantly of mineral or inorganic matter. The deposits are composed of the remains of plants which have accumulated in permanently wet or water-covered situations, such as flat plains or valleys underlain at a slight depth by sand, clay, or bedrock; slopes permanently wet from seepage waters; and certain types of lakes, in which the water is comparatively calm and not subject to any great fluctuation in level. Organic soils of the flat plains and valleys predominate in acreage.

As a class the organic soils are characterized by a high moisture-holding capacity, high shrinkage on drying, comparatively high total but low available nitrogen content, low potash content, and variable lime and phosphorus content. The water table is variable but in most places is near or at the surface, and most types of peat require controlled artificial drainage before they can be cultivated successfully. When drained, or very dry, the organic soil is likely to catch fire and burn off. When cultivated the light finely divided plowed soil is subject to blowing by the wind.

Peat deposits differ in composition of plant remains, succession of different layers, texture, and structure, level of water table, movement of water, degree of decomposition, and chemical nature. Several fairly well defined types are recognized and separated on the bases of these variations, but the boundaries drawn on the map are somewhat arbitrary. The peat deposits are rather shallow, generally not more than 5 feet thick, but they range from 1 foot to more than 20 feet in thickness.

Mucks also are composed chiefly of organic matter, but they are more highly decomposed than the peats and in general contain a higher percentage of mineral matter.

Carbondale muck.—Carbondale muck is composed of dark-brown moderately well decomposed woody material, comparatively high in content of ash. The soil, to a depth of 20 or 24 inches—the depth to the normal level of the water table—is dark-brown or black decomposed woody material with granular structure. This material grades into yellowish-brown slightly decomposed woody material containing many identifiable roots and pieces of wood. Yellowish-brown raw fibrous peat occurs in places at a depth ranging from 36 to 50 inches. This soil, as mapped, includes small areas of well-decomposed black material in a more advanced stage of decomposition than is typical.

Carbondale muck occupies seepage slopes, narrow valley floors, and stream borders, and it is associated with the more limy drift soils in the southeastern part of the county. It is more highly decomposed than Rifle peat and Spalding peat, has a darker color, freer movement of water, and a higher lime content. Most of the deposits range from 2 to 10 feet in thickness. They are underlain by clayey till, sand, or limestone bedrock.

Swamp forests occupy most of this land. A dense growth of cedar, black spruce, balsam fir, and tamarack characterizes the tree growth, but there is, or was, a considerable proportion of elm, black ash, white birch, red maple, balm-of-Gilead poplar, and a few white pine and hemlock intermingled. The density and size of the trees is greater than on the Rifle and Spalding peats. Aspen, alder, and willow are included in the second growth in cut-over or burned-over areas.

A few small areas of this land are under cultivation, and some stump land is utilized for pasture. This type of muck is suitable for the production of truck and hay crops, when properly prepared, but present conditions do not warrant extensive development. Its chief value lies in its tree growth and its use as feeding grounds and wintering places for game.

Rifle peat.—Rifle peat consists of dark-brown or brown moderately decomposed woody peat, ranging from 1 to 2 feet in thickness, over raw yellowish-brown fibrous peat. This type of peat is generally acid in reaction, very high in organic matter, and contains very little admixed mineral matter. The more disintegrated, darker colored surface layer, which contains the remains of woody vegetation, ranges from 4 to 8 inches in thickness and is underlain by lighter brown, coarser, and less decomposed woody peat over raw fibrous peat. The depth to the water table varies but in most places is about 1 foot below the surface. The peat deposits occupy flat plains or valleys and range from 2 to 8 feet in thickness, although they are thicker in places where they fill lake beds. The deposits, for the most part, are underlain by sand.

The vegetation is variable on this type of peat, but arborvitae, black spruce, and tamarack are more common, and some balsam fir, yellow birch, black ash, and a few white pine grow in places. Aspen, alder, willow, and red-osier dogwood, together with some black birch grow in dense thickets in the more thinly wooded areas. The value of the land lies in the tree growth it supports and in the cover and feeding ground it affords for game.

Spalding peat.—Spalding peat consists of brown slightly decomposed mixed fibrous and woody material, 8 or 10 inches thick, underlain by yellow raw fibrous peat which, in places, overlies brown smeary aquatic muck, at a depth ranging from 30 to 60 inches below the surface. This type of peat represents a transitional stage from the open heath bog type to the forested or swamp types of organic soils, such as Rifle peat and Carbondale muck. The surface layer is strongly acid. The water table is at a depth ranging from 2 to 18 inches below the surface.

Black spruce and tamarack, with a few cedar, represent the tree growth. Sphagnum moss is common as a surface mat and, together with shrubs, such as leatherleaf, Labrador-tea, and blueberries, comprises the ground cover.

Spalding peat occupies almost 15 percent of the total area of the peat and muck soils. It occupies flat wet sand plains and is associated with Greenwood peat and also occurs in smaller deeper bodies which fill lake beds. It has no agricultural value, and tree growth is comparatively slow.

Greenwood peat.—Greenwood peat is composed of brown or yellow raw spongy coarse-textured fibrous organic material from the surface downward. In places smeary aquatic muck may underlie it at a depth of 2 feet or more. Very little decomposition has taken place in this type of peat. It is strongly acid in the surface layer. The water table is normally within a few inches of the surface, but during very dry spells it may sink to a depth ranging from 2 to 3 feet.

Open heath bogs with a growth of plants, such as leatherleaf, Labrador-tea, wild cotton, blueberries, cranberries, and sphagnum and hypnum mosses, are characteristic of this type of peat. A few stunted black spruce and tamarack grow in the bogs.

Most of the Greenwood peat has accumulated in lakes where the deposits are from 30 to 40 feet thick in places. Open water surrounded by floating bogs occurs in some places. In some areas on wet sandy flats, the accumulations range from 2 to 5 feet in thickness. The land has practically no value at present, except as a refuge for wild animals.

A variation of Greenwood peat is more consistently underlain at a slight depth by brown smeary aquatic muck. It is strongly acid in the topmost layer. For the most part it represents shallow accumulations of organic matter, from 2 to 6 feet thick, on wet sandy flats, but it has also accumulated in lakes where the peat may range in thickness from 30 to 40 feet. A thin stand of stunted black spruce represents the dominant cover, but considerable jack pine has encroached on areas in which the accumulations are shallow and especially where the water table has been lowered by natural or artificial drainage. Leatherleaf, Labrador-tea, black birch, and a mat of sphagnum moss, with some blueberries and cranberries, form the ground cover. Large areas of this variation occur northeast of Seney, south and southeast of Round Lake, and northeast and east of Cedar Lake.

Houghton muck.—Houghton muck has accumulated on wet sandy flats in the central and northern parts of the county in broad continuous areas or in small areas intermingled with the sand knolls and ridges. (The small areas are included on the map with the Wallace-Houghton complex.) In most places the deposits range from about

3 to 4 feet in thickness, and in only a very few places do they exceed 10 feet. The water table is normally high, at or near the surface, but it fluctuates with seasonal and periodical variations of rainfall. Drainage ditches have lowered the water table in some places.

Houghton muck comprises dark-brown or brown spongy feltlike finely fibrous muck. The topmost layer in most places is dark to a depth of a foot or more, but over most of the area very little decomposition has taken place. In most places, an almost black or gray fine pasty material forms the underlying mass. Layers of woody material are present in places in the profile. Houghton muck differs from the other organic soils in the material from which it is derived. It has a finer texture than Greenwood peat and generally is not so strongly acid.

The vegetation is chiefly sedges and grasses, with some alder, black birch, dwarf willow, or stunted black spruce. Judged by the vegetation, this soil constitutes wet prairie rather than heath bog or forest swamp.

Attempts to drain this soil and use it for agricultural purposes have not been very successful for several reasons. No attempt was made to regulate the water table in the drainage system, and the surface soil, where cultivated, has a tendency to blow and crack during dry seasons. The ground water contains considerable iron, as evidenced by iron concretions on burned-over land and precipitation of iron in ditches by drainage waters. The iron might prove harmful to crops if the water table were not excessively lowered. Climatic conditions are not favorable to the production of such crops as would yield a profitable return above the cost of drainage and necessary fertilization. Some wild hay is cut from the marshes. Peppermint was produced profitably during the period of high prices, but very little is grown now. The land has potential value as a refuge or resting place for wild fowl, if the ditches and streams were blocked to afford surface water the year around.

Kerston muck.—Kerston muck lies along stream courses and represents alternate layers of alluvial mineral material and organic matter. Most of the mineral material is sand, and the muck is generally almost black or brown and is not highly acid in reaction. This land is subject to overflow, and generally the water table is high and the land swampy. In places directly adjacent to the streams, the mineral content of the soil predominates over the organic content.

A dense growth of cedar, spruce, and tamarack, together with some alder, willow, aspen, white birch, elm, ash, and a few balm-of-Gilead poplar and white pine covers the land.

Although this soil is comparatively fertile, it has no agricultural value, but it is capable of producing a fairly large volume of swamp timber. Its total extent is small.

Wallace-Houghton complex.—The central part of the county extending westward and southwestward from Seney comprises a flat wet sand plain dotted with numerous mounds and ridges of sand. The soils on the sand knolls and ridges and poorly drained areas form such an intricate pattern, are of such poor quality, and have such small value, either for forestry or agriculture, that a detailed separation is not warranted. Houghton muck and Wallace fine sand in various combinations with Newton sand, Saugatuck sand, and Greenwood peat make up the land type designated as the Wallace-Houghton complex (pl. 1, *A* and *B*).

The present growth on the sand knolls and ridges consists of red, white, and jack pines, with various proportions of aspen. The growth on the peat and poorly drained soils consists either of grasses and sedges; black birch, alder, and willow; or leatherleaf, Labrador-tea, sphagnum moss, and a few stunted black spruce, tamarack (pl. 1, *C*), and jack pine.

Only the small areas of Houghton muck have agricultural possibilities, and these have been discussed. Drainage ditches have lowered the water table to some extent and lessened the value of the land as a refuge for wild fowls or as a preserve for beavers, muskrats, and minks.

Wallace-Rifle complex.—Bordering the shore of Lake Michigan and extending inland to a distance of 3 miles or more is a series of low sand ridges alternating with swales or swamp and designated as the Wallace-Rifle complex. The sand ridges average about 100 feet across and the width of the swales ranges from 100 to 200 feet. Wind has changed the character of the landscape in places, for example, in the area south of Gulliver Lake, where the complex is composed of rather high sand knolls and intervening pits, the latter containing either swampy or poorly drained soil (pl. 2, *A* and *B*.) The ridges are mostly Wallace sand, and the swales are mostly Rifle peat, with some Carbondale muck or Greenwood peat in places. Eastport sand and Saugatuck sand comprise some of the lower lying ridges; and shallow swamp soils, such as Granby and Newton sands, occur in a few of the swales.

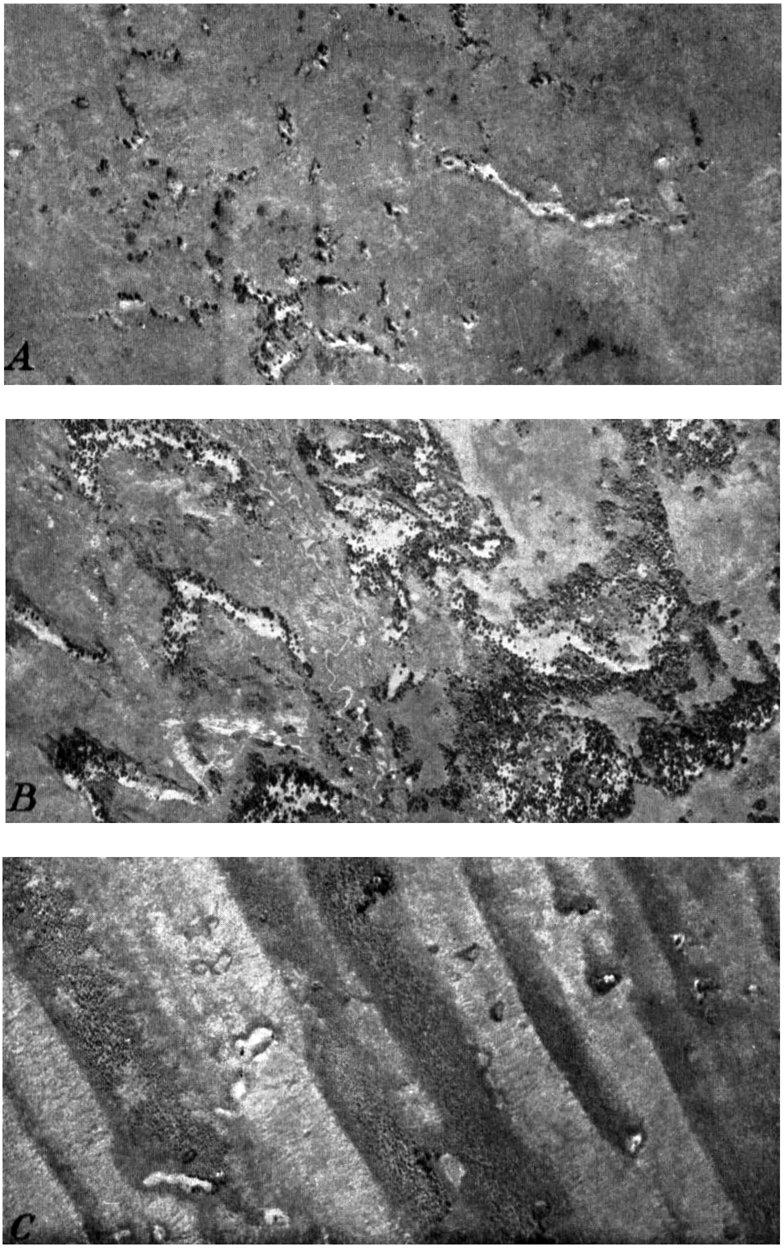
Red, white, and jack pines, with some white birch, red maple, and aspen grow on the ridges. Swamp conifers, such as black spruce, tamarack, and cedar, with alder, willow, and a few ash and elm, grow in the swales. Open places covered by grass or leatherleaf are not uncommon.

The value of this land lies in the forest growth it is capable of supporting and in its usefulness as a refuge and feeding ground for game.

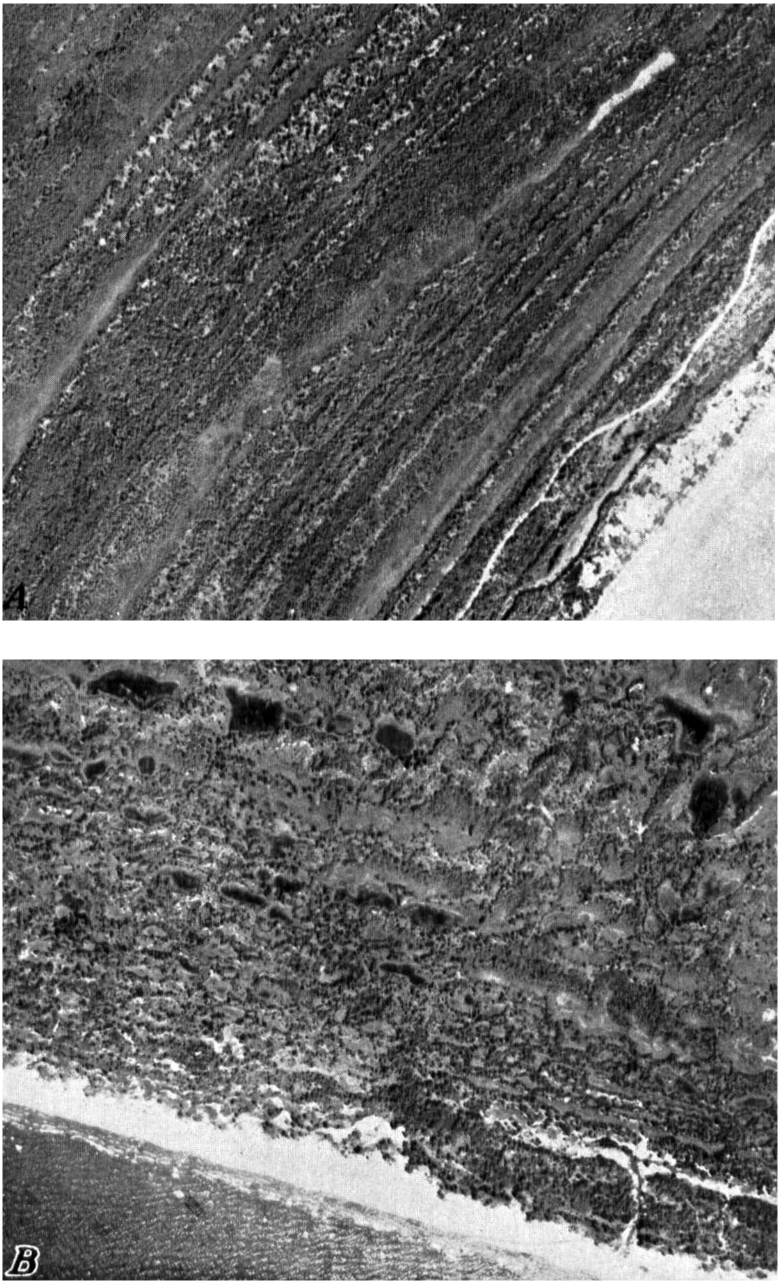
MISCELLANEOUS SOILS AND LAND TYPES

The group of miscellaneous soils and land types includes Eastport sand, coastal beach, and made land, none of which has any value for agriculture, and only Eastport sand is capable of supporting a growth of trees.

Eastport sand.—Eastport sand comprises low ridges and level strips of beach and lake-bed sand lying directly along the shore of Lake Michigan. The sand is gray and for the most part is of medium texture. Scarcely any development of a profile has taken place, other than an accumulation of mold on the surface and a darkening in color, to a depth of 2 or 3 inches, caused by the admixture of organic matter. This sand is typically dry and incoherent to a depth ranging from 2 to 3 feet. It shows some influence from limestone, and



Aerial photographs illustrating the character of the Wallace-Houghton complex *A*, Average proportion between areas of the sand knolls and ridges and the poorly drained soils, *B*, a larger proportion than typical, occupied by sand knolls and ridges, *C*, the smallest proportion occupied by sand knolls The dark areas indicate a growth of black birch and stunted tamarack, which grow on wet soils in places (Scale 4 inches=1 mile)



Aerial photographs illustrating the character of the Wallace-Rifle complex. *A*, A series of sand ridges with bands of peat between; *B*, character of the complex altered by wind-blown sand. (Scale 4 inches = 1 mile.)

much of it is alkaline in reaction. Areas containing slabs and fragments of limestone are indicated on the map by stone symbols.

This soil has practically no value for agricultural purposes, but the moisture content and fertility are sufficient to support a fairly dense cover of natural vegetation. The present tree growth consists of cedar, aspen, balsam fir, spruce, white birch, and a few balm-of-Gilead poplar and red maple.

Coastal beach.—Coastal beach comprises the narrow strip of beach along the shores of the larger lakes. In most places these strips range from 100 to 200 feet in width. The material consists of sand, shingles, or limestone bedrock and mud flats, and it is bare except for a scattered growth of sedges, rushes, and reeds. This land varies in area with the height of the water of the lakes and, should the lakes rise to former levels, much of the land shown on the map would again be covered with water.

Made land.—Artificial fills, refuse dumps, and old lumber-mill refuse are shown on the map as made land. Such land ordinarily is practically useless either for agriculture or forestry.

MORPHOLOGY AND GENESIS OF SOILS

Schoolcraft County is in the east-central part of the Upper Peninsula of Michigan, a part of the Great Lakes plains section which is the glaciated part of the Great Central Lowland. It lies in the eastern, or lowland, plain of the Upper Peninsula, which is underlain by Paleozoic sedimentary rocks and is, therefore, contrasted with the western part, comprising a part of the Superior Highlands which are underlain largely by a complex of igneous rocks and metamorphosed pre-Cambrian sediments.

The area lies within the Podzol soil region of north-central United States. The soils were formed from material deposited by the late Wisconsin glacier. An average rainfall of about 22 inches, short cool summers, long cold winters, an average temperature of 39° F., and frequent freezing and thawing in spring and fall, are climatic features affecting soil-forming processes. All the soils support vegetation, and the inorganic soils and a part of the organic soils at one time were covered with a dense forest of hardwoods and swamp conifers.

Soils which are dominantly inorganic, except for the superficial accumulation of organic matter, and which have a solum distinct from the underlying geological formation are estimated to comprise 44 percent of the area of the county; organic soils, 54 percent; water surface, inland lakes, and streams, between 1 and 2 percent; and unconsolidated geologic materials which have not been appreciably altered by soil-forming processes, less than 1 percent.

The mineral soils are classed in two major divisions, on the basis of the average amount of water in the solum, as follows: (1) Soils which have developed under free drainage and aeration and contain a normal amount of moisture for the region; and (2) soils which are permanently or intermittently saturated with water. The first division is represented by soils of the Blue Lake, Hiawatha, and Trenary series, and similar soils, and the second division by such soils as Newton sand, Granby sand, and Saugatuck sand.

The generalized profile of the well-developed soils of the first division, under virgin conditions, is as follows:

1. Litter and forest mold or duff.
2. A very thin humous soil layer.
3. A highly leached gray layer.
4. A layer having brown or yellowish-brown humic and ferric oxide coloring.
5. A layer of maximum clay concentration, illuviation, and maximum coloring from ferric oxides.
6. Parent material and geological substratum.

Layer 5 is poorly developed, and under certain conditions layers 4 and 5 coalesce.

This group of normally moist mature Podzols and podzolic soils may be further separated, on the bases of the texture and consistence of the successive layers in the profile, as follows:

(a) Soils underlain by sand and gravel or comparatively loose and pervious material in layers 4, 5, and 6.
(b) Soils having heavier or more clayey material in layers 4 and 5, whereas layer 6 is more pervious and less clayey.
(c) Soils with a comparatively loose and pervious solum underlain at a slight depth by hard rock.

The Thomastown, Grayling, Rubicon, Kalkaska, Wallace, and Au Train soils represent the first subgroup. The soils are listed in ascending order of gradations in thickness of the gray layer and thickness and development of the brown layer. The general profile for this group consists of the following layers:

1. Litter and forest mold or duff.
2. A very thin humous soil layer.
3. A highly leached gray layer.
4. A layer having brown or yellowish-brown humic and iron-oxide coloring.
5. Geological substratum which is dominantly loose and pervious sand or mixed sand and gravel.

The Au Train soil has the most highly developed gray and brown layers, and it is regarded as one of the most completely developed Podzols in the United States.

The Au Train series was first recognized in Alger County, Mich.[5] It has been mapped extensively in Alger and Luce Counties, both of which adjoin Schoolcraft County. Samples of the main horizons of this soil from Luce County were analyzed in the laboratories of the Bureau of Chemistry and Soils. The mechanical analysis is given in table 4.

TABLE 4.—*Mechanical analysis of Au Train sand*[1]

Sample No.	Horizon	Depth	Fine gravel (2–1 mm)	Coarse sand (1–0.5 mm)	Medium sand (0.5–0.25 mm)	Fine sand (0.25–0.1 mm)	Very fine sand (0.1–0.05 mm)	Silt (0.05–0.005 mm)	Clay (0.005–0 mm)	Colloid (0.002–0 mm)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
10644	A_0	0–2	0.1	2.8	14.4	22.2	2.6	5.7	5.7	4.6
10645	A_2	2–10	.8	13.2	40.3	36.4	3.7	3.5	1.4	.7
10646	B_1	10–12	.8	9.4	30.2	46.2	5.5	1.4	2.3	.8
10647	B_2	12–40	.5	5.8	32.2	60.9	6.0	.8	1.1	1.3
10648	C	40–60	.0	3.2	32.2	60.2	3.6	.1	.5	.4

[1] Determinations by H. W. Lakin and T. M. Shaw.

[5] VEATCH, J. O., SCHOENMANN, L. R., LESH, F. F., and FOSTER, Z. C. SOIL SURVEY OF ALGER COUNTY, MICHIGAN. U. S. Bur. Chem. and Soils Ser. 1929, Rept. 32, 41 pp., illus. 1934.

In sampling this profile the second horizon (A_1), which in this soil is very thin, was omitted from analysis. The first horizon, indicated in the table as A_0, is composed of leaf litter and matted organic matter, with a small percentage by mass of mineral constituents. The colloid present is chiefly organic colloid, but the organic matter is largely undecomposed or only slightly decomposed. A concentration of clay and organic matter is indicated in the B_1 horizon, although the percentages are small, since the parent material is largely sand. The chemical analysis of the whole soil is shown in table 5.

TABLE 5.—*Chemical analysis of Au Train sand (soil)*[1]

Sample No.	Horizon	Depth	SiO_2	Fe_2O_3	Al_2O_3	MgO	CaO	K_2O	Na_2O	TiO_2
		Ins.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
10644	A_0	0- 2	51.84	0.47	2.39	0.07	0.86	0.86	0.13	0.14
10645	A_2	2-10	95.49	.16	2.12	(3)	.15	.98	.18	.09
10646	B_1	10-12	87.40	.79	4.92	.01	.26	1.96	.24	.17
10647	B_2	12-40	90.84	.50	4.29	(3)	.26	1.73	.31	.11
10648	C	40-60	92.99	.50	3.76	.02	.24	1.66	.36	.12

Sample No.	Horizon	Depth	MnO	P_2O_5	SO_3	Ignition loss	Total	Organic matter	N	pH
		Ins.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	
10644	A_0	0- 2	0.24	0.12	0.28	42.49	99.89	(2)	1.13	5.8
10645	A_2	2-10	.01	.01	.01	.68	99.88	0.63	.02	4.3
10646	B_1	10-12	.02	.06	(3)	3.70	99.53	2.11	.07	4.6
10647	B_2	12-40	.01	.03	(3)	1.41	99.49	1.02	.02	5.2
10648	C	40-60	.01	.02	(3)	.24	99.92	.10	.01	5.9

[1] Determinations by G. Edgington.
[2] Not determined.
[3] Trace.

The high organic-matter content of the A_0 horizon is indicated by the ignition loss and the percentage of nitrogen. There is a relatively high concentration of organic matter in the B_1 horizon, a smaller quantity in the B_2, and much less in the A_2 and C horizons. Such concentration of organic matter is a characteristic of Podzol soils. There is likewise a relatively high concentration of alumina in the B_1 and B_2 horizons, but only a slight concentration of iron in the B_1 horizon, although it is indicated. There is probably very little iron-bearing mineral in the parent material of the Au Train soils, which accounts for the very small concentration of iron in the horizon where it is normally found in the Podzol and podzolic soils.

The B horizon of the Au Train soils is marked by a definite color due to a concentration of organic matter or humic colloid rather than of iron. The rather high percentage of potassium throughout indicates the presence of potassic feldspars in the parent material and the retention of potassium compounds in the solum. This is not uncommon in the Podzol and podzolic soils.

Although the percentage of colloids is very small in the Au Train soils, since the material is largely sand, they were extracted and analyzed with the result given in table 6.

TABLE 6.—*Chemical analysis of Au Train sand (colloid)*[1]

Sample No.	Horizon	Depth	SiO_2	Fe_2O_3	Al_2O_3	MgO	CaO	K_2O	Na_2O	TiO_2
		Ins.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
10644	([2])	0- 2	1 00	0 25	1 08	0 53	2 73	0.83	0.89	([3])
10644	A_0	0- 2	12 35	.98	3 81	.45	1.60	.32	.40	0 11
10645	A_2	2-10	47 27	3 51	14 19	.57	.48	.62	.56	([3])
10646	B_1	10-12	11 86	6 53	16 88	.33	.54	.62	.22	([3])
10647	B_2	12-40	12 38	4.70	23 95	.25	.41	.48	36	.26
10648	C	40-60	([5])	--------	--------	--------	--------	--------	--------	--------

Sample No.	Horizon	Depth	MnO	P_2O_5	SO_3	Ignition loss	Total	Organic matter	N
		Ins.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct*
10644	([2])	0- 2	1 00	0 54	--------	90 64	[4] 99 49	72 03	5 68
10644	A_0	0- 2	.43	.37	--------	79 56	100 38	74 16	2.66
10645	A_2	2-10	.07	.37	--------	31 75	99 39	25 53	1.40
10646	B_1	10-12	.09	.39	--------	62 58	100 04	48 45	1 01
10647	B_2	12-40	.09	39	--------	57 47	100 74	40 46	.87
10648	C	40-60	--------	--------	--------	--------	--------	--------	--------

[1] Determinations by R S Holmes.
[2] The water-soluble extract of the soil.
[3] Quantities not determined
[4] Total is low due to K and Na being estimated as oxides when they are largely carbonates.
[5] No colloid in quantity sufficient for examination could be obtained.

Table 6 reveals the high percentage of organic matter in the colloids of this soil. It places the soil definitely as a Podzol of the humic or organic type. Although the analysis of the colloid does bring out more definitely than that of the whole soil a concentration of iron and alumina in the B horizon, it is noted that the percentage of colloid in the C horizon is so extremely small that extraction was not attempted.

The Hiawatha, Strongs, Bohemian, Blue Lake, and Trenary soils represent the second subgroup. They have a layer of maximum concentration of clay, maximum illuviation, and maximum coloring from ferric oxides, which is only poorly developed and not everywhere discernible. In some soils, such as those of the Trenary series, a secondary gray, or leached, layer is present where the parent material is friable sandy clay drift, and a compact fifth layer is developed.

Longrie loam is representative of the third subgroup and is underlain at a slight depth by hard rock.

The accumulation of litter and duff under an old forest and under conditions of good drainage is normally from 2 to 4 inches thick. The thickness increases as the moisture conditions approach those of swamp, whereas at the other extreme there is little more than an inch of fluffy sandy mold on the driest sand plains. True humous soil is absent or is developed only as a thin layer. Generally it is most noticeable where the soil is decidedly limy or alkaline in reaction.

The gray highly leached horizon is normally from 4 to 8 inches thick, but under exceptional conditions may range from 18 to 24 inches in thickness. General observation indicates that the greater thickness and lighter color of the gray layer is associated with the stronger and thicker development of the brown layer. In most places, a sharp line separates the gray layer from the brown layer.

The brown (humic) layer of illuviation, or concentration of organic matter and sesquioxides, is commonly from 6 to 12 inches thick, but in places is from 24 to 60 inches thick. The base of this layer is not sharply marked, especially in places where the parent material is loose sand. The maximum thickness and intensity of coloring apparently occur where the parent material is loose or incoherent sand, under conditions of moderately high average moisture; and the minimum development is where the parent material is either relatively impervious clay or very dry sand and gravel, as in the Rubicon and Grayling soils. The most intense color is at the top. Cementation differs in the different soils and within individual soils, but it seems to be associated with the content of iron oxide or organic matter and moisture, reaching its maximum with a maximum content of iron oxide or organic matter, as in the Au Train soils, or in places where there is frequent saturation and a high water table, but also a wide range of fluctuation throughout the year, as in the Saugatuck soils. There is also a relationship between texture and the density and color of the brown layer. In the fine-textured soils, where the color is a richer brown, lighter brown, or buff, cementation is very slight.

The depth to which carbonates have been removed in the soil-forming process is, in general, between 30 and 40 inches, but it varies with the amount of carbonates originally present, texture of the parent material, and relief. Phosphorus and potash also are removed in the soil-forming process, but most clearly so in layer 3. Nitrogen is highest in the organic accumulation on the surface and is present in appreciable quantities in layer 4.

The soils developed under conditions of excessive moisture or poor drainage have the following generalized profile:

1. A dark-gray or black surface layer of organic matter.
2. A gray or drab layer slightly or not at all colored by organic matter.
3. A layer containing maximum concentration of clay and maximum coherence or plasticity, or one containing maximum yellow or brown coloration and maximum cementation from iron oxides.
4. The substratum, or parent material.

These soils are less completely leached of carbonates than the well-drained soils and, given the same material, are generally more fertile as measured by the total content of nitrogen, calcium, phosphorus, and potash. Where the parent material is calcic or basic, the soils commonly exhibit a neutral or alkaline reaction from the surface downward. Humic matter and iron compounds cause layer 3 to have a splotched appearance, or a solid yellow or brown color, and a more or less cemented hardpan.

An additional leached or bleached layer is present in places at the point of contact where sand overlies relatively impervious clay or indurated bedrock at a slight depth. This is caused by permanent waterlogging and lateral movement of water.

The Saugatuck, Ogemaw, Brimley, Newton, Granby, Ruse, Munuscong, and Bruce soils have this general profile. The Saugatuck, Ogemaw, and Brimley soils have the maximum yellow or brown coloration and cementation from iron oxides or organic matter in layer 3.

Unconsolidated geologic materials not appreciably altered by soil-forming processes are represented mainly by recent alluvium which occupies the valleys of streams. Part of this land is very moist or swampy, and part of it is sufficiently high and well drained to show slight development of a profile. The alluvium is local in origin, and the more poorly drained parts commonly contain a sufficiently large proportion of organic matter to mask the rock color. A not uncommon feature of the deposits is alternate layers of mineral alluvium and muck. The organic matter of these deposits is partly decomposed. Ewen loam and Moye fine sandy loam are representative of this group. In the group, also, are the recent dunes, beach, and wind-laid deposits, the wave-washed strand along Lake Michigan, and some nearly barren hard rock areas.

The organic soils are represented by a number of types which exhibit a considerable range in chemical and physical properties. Practically all are high in organic matter; that is, they contain 75 percent or more of combustible matter. More or less complete alteration, represented by a nearly black or dark-brown color, destruction of the botanical character of the plant remains, and development of a loamy granular crumb structure in the oldest of these soils generally does not take place below a depth of 15 inches. In the most acid and peaty type, Greenwood peat, practically no alteration has taken place, although there is much greater fluctuation in the water table than in the more woody and less acid organic soils—Carbondale muck and Rifle peat. Most of the organic soils range from slightly to very strongly acid, although a small proportion of them are nearly neutral in reaction and relatively high in lime. In general, the most acid soils are associated with sands and the least calcareous rocks and glacial deposits, but in a number of places the acidity seems to depend on the height of the water table, stagnation or slow movement of drainage water, and kind of vegetation, as the adjacent soils and drift may be limy and the drainage water alkaline.

Most of the drainage water of Seney Swamp is high in iron, as evidenced by iron concretions and deposits or mounds of bog iron on the surface, especially where the land has been burned over, and by deposition of iron along drainage ditches. Probably most of this iron is derived from the ferruginous sands and sandstones which border this wet plain on the north and which underlie a considerable part of it, and is transported as a bicarbonate solution. It is probably deposited as siderite in the presence of organic matter without access to air, or as limonite in the presence of air.

Most of the organic deposits appear to have been accumulated in valleys or on flat plains, where water is stagnant, rather than in lakes, although the lake-filled type is also extensive. As a rule the valley deposits and those accumulated on wet plains and seepage slopes are not very thick, and the peat is in contact with sand, clay, or rock.

The mineral soil types which have been differentiated occur in a gradational series according to the differences in the moisture or drainage conditions under which the soil has developed. Such a moisture series can be recognized for soils developed from each of the following kinds of parent material: (1) Calcareous stony and friable clayey drift, (2) noncalcareous clayey drift, (3) loose incoherent sands, (4) uniform silt and very fine sand, (5) sand over indurated bedrock, or pervious unconsolidated gravel, cobbles, and stones.

The lithologic composition of the glacial deposits, which have directly influenced the chemical and physical character of the soils, bears, in turn, a close relationship to the old underlying geological formations. Although there is considerable admixture of detritus from Canada, the drift is largely of local origin. The amount of limestone gravel and boulders, and therefore of calcium and magnesium carbonates in the drift and soils, is in conformity with the direction of the ice movement, the absence of limestone and highly calcareous geologic formations on the north, and the predominance of limestone formations in the southern and eastern parts of the county. The soils in the northern part of the county are developed predominantly from red sandstone, gray sandstone, quartzite, and acid igneous rocks, and they have a strongly acid reaction in the solum. The soils are more alkaline to the south, owing to the greater influence from limestone in the drift, especially where the deposits are shallow over the bedrock.

The land formations were laid down during the last stages of the glacial period, so that the physiography is in a comparatively young stage of development. The minor topographic forms are almost entirely constructional, as streams have not yet had time to develop complete dendritic systems. Extensive areas, therefore, remain flat and undrained, and a large total area of soils has developed under conditions of excessive moisture. On the other hand, the pervious character and thickness of many deposits have allowed the development of soils under low moisture conditions, notwithstanding the fact that the land may be level, as on the high-lying sand and hardwood plains. Whether soils on the moraines, above old lake levels, are wet or dry depends largely on differences in texture of the glacial debris, rather than on the stage of stream cutting or slope of the land surface.

The great diversity of soil types and their intimate association in small bodies, in many places, are traceable to the lithologic heterogeneity of the parent soil material, to variations in moisture corresponding to variations in thickness of comparatively pervious material over comparatively impervious clay or impenetrable bedrock, and to topographic diversity, expressed in Pleistocene formations, such as moraines, outwash plains, till plains, lake beds, and old shore lines.

With the exception of areas of marsh, peat bogs, and lakes, all the land in this county originally was forested. In most places the forest cover was dense, even junglelike in some of the wetter situations, but on some of the dried land, as on the dry sand plains, there was a comparatively open growth of pines and a shrubby or herbaceous undergrowth. The native vegetation has been an important factor in the development of soil characteristics, but, as is generally true, the vegetation is both a cause and an effect of soil differences. The surface layer, or accumulation of organic matter, together with the thinness of the humous soil, can be attributed to forest vegetation, and the underlying gray and brown layers are at least influenced by forest vegetation. Observation does not reveal any constant relationship between the thickness or intensity of coloring of horizons and a particular type of forest vegetation. In places where hardwood and pine forests are contiguous on the same plain, with no observable differences in the parent material or relief, the brown horizon in the soil supporting a hardwood forest is darker and thicker than under the corresponding layer under a pine forest. The composition, texture, and other physical properties of the organic soils are clearly related to the kind of vegetation growing on these soils.

SUMMARY

Schoolcraft County is in the east-central part of the Upper Peninsula of Michigan, with Lake Michigan forming the southern boundary.

Long cold winters, short pleasant summers, and a well-distributed moderately high average annual rainfall characterize the climate. The rainfall is sufficient, but the short growing season, with a low mean temperature, limits crop diversification and the maturing of certain crops. The climate is favorable to the production of hay, small grains, root crops, and pasture grasses, or to an agriculture based on raising cattle and producing forage and potatoes.

The soil materials consisting of unconsolidated clays, sands, and gravels were accumulated by glacial processes; that is, they were both ice-laid and water-laid. They form a covering of varying thickness over the underlying limestones and sandstones. But even in places where bedrock is near the surface, it is doubtful whether or not it has contributed to the material from which the soils were formed.

The deposition of material by the late Wisconsin glacier formed a plain, as a whole, but several distinct topographic divisions, resulting from glacial action and postglacial dissection, comprise local inequalities of altitude and give variety to the land surface. The greater part of the county consists of nearly level sand plains or poorly drained and extremely wet soils, such as peats and mucks, which develop on flat slightly depressed plains, old lake beds, in certain types of lakes, or on permanently wet slopes. The rolling sandy hills in the northwestern part of the county and the broadly rolling upland in the southern and eastern parts interrupt the otherwise level continuity.

The county lies within the cut-over area of the Great Lakes region, formerly covered by hardwood forests, hardwood-coniferous forests, pine forests, and swamp-coniferous forests. Only a few small tracts of virgin timber remain.

The county lies within the region of Podzol soils in north-central and northeastern United States. These soils are characterized by a layer of forest litter and humus, a gray or leached surface layer, and a brown layer of acid humus and iron oxide accumulation. Soluble mineral matter, especially carbonates, has been leached from the lower layers.

The soils of the county may be classified in two groups: (1) Mineral soils and (2) organic soils. The mineral soils may be divided into two major divisions on the basis of the average content of water in the solum: (1) Soils containing normal moisture for the region and (2) soils permanently, or for considerable periods, completely saturated.

The mineral soils in the first division range from those low in organic matter, with sandy surface soils and open porous subsoils leached of mineral matter and excessively drained, to those moderately high in organic matter, with fine sandy loam or very fine sandy loam surface soils underlain by clay, sandy clay, or limestone bedrock at

a slight depth, in which leaching of mineral matter has not progressed so far as in the more sandy soils, and in which the moisture content is more favorable. The poorly drained mineral soils contain more organic matter and are not so highly leached of mineral matter as are the normally moist soils.

From the point of view of utilization, the soils may be combined in three groups as follows: (1) Agricultural soils, (2) forest soils, and (3) miscellaneous soils and land types. The agricultural soils include soils having high or medium natural fertility, favorable relief, and good or fair moisture content, also some poorly drained soils, comparatively high in organic matter and mineral content, which, if properly drained, would produce fair crops or provide excellent pasture. The forest soils are not designated forest soils because they will produce better trees—in fact they will not—but because their low natural fertility, poor or excessive drainage, or unfavorable topography render them unsuitable for cultivated crops. Probably their best utilization is for the production of trees and for related enterprises, such as recreation areas, game refuges, feeding grounds for game, and hunting preserves.

The agricultural soils are underlain for the most part by clay, sandy clay, silty material, or limestone bedrock. The well-drained agricultural soils include Blue Lake very fine sandy loam, Blue Lake fine sandy loam, Longrie very fine sandy loam, Longrie loam, Trenary fine sandy loam, Trenary loam, Bohemian very fine sandy loam, and Kalkaska fine sandy loam. Agricultural soils which are naturally poorly drained include Ogemaw fine sandy loam, Ruse fine sandy loam, Munuscong fine sandy loam, Brimley very fine sandy loam, and Bruce silt loam. These soils are intimately associated in the southern and eastern parts of the county. In most areas of the better drained soils, carbonates are leached to a depth ranging from 30 to 40 inches. The climate limits the diversity of crops that can be grown on these soils.

Favorable tillage properties, adequate natural drainage, and the acid condition of the surface soil of the Blue Lake, Longrie, and Bohemian soils, together with favorable climate, provide excellent conditions for the production of potatoes of high quality. This is the principal cash crop. It has been demonstrated that average acre yields can be increased by the use of fertilizers, and it seems practicable to increase the total output for the county. Hay is naturally adapted to this section and, together with small grains and potatoes, is included in the common rotation. Yields of hay and small grains are not so high as those obtained on some of the heavier soils in other parts of the peninsula. The Trenary soils, especially Trenary loam, are better suited to hay and grains than are the other soils.

Although the poorly drained soils contain a higher percentage of organic matter and are not leached of mineral matter to the same extent as are the well-drained soils, they are not extensively utilized, on account of the excessive cost of drainage and the limited demand for crops. Where cleared and drained they produce good yields of hay and small grains and provide excellent pasture.

Good pastures, the good shipping qualities of dairy products, and the fact that the greater part of the feed can be produced locally makes dairying the most promising livestock enterprise for this section.

The forest soils comprise five groups: Loamy sands and stony loams of the hardwood uplands and plains, including the loamy sands of the Strongs, Blue Lake, Kalkaska, and Au Train series, Hiawatha loamy fine sand, and Rodman stony loam, all dry sandy soils; dry sands of the pine uplands and plains, including Roselawn sand, Rubicon sand, Grayling sand, Thomastown loamy fine sand, Rubicon loamy fine sand, Wallace fine sand, and Bridgman fine sand; wet and poorly drained sandy mineral soils, including Newton sand and Granby sand, which are excessively wet and support a hardwood-coniferous forest, and Saugatuck sand, in which the water table fluctuates, and which originally supported a mixed hardwood and pine forest; stream-bottom or alluvial soils characterized by a hardwood-coniferous forest, including Ewen loam which is periodically overflowed and Moye fine sandy loam which is seldom covered with water; and organic soils, including Carbondale muck, Rifle peat, Spalding peat, Houghton muck, and Kerston muck, which have an excessively high water table and originally supported a coniferous forest; Greenwood peat, which is covered with shrubs; and the Wallace-Houghton complex and Wallace-Rifle complex, which have a grass and reed vegetation or coniferous forest in the swales, and pine on the knolls.

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