

UNITED STATES DEPARTMENT OF AGRICULTURE

**Soil Survey**  
of  
**Bay County, Michigan**

By

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**Bureau of Chemistry and Soils**

In cooperation with the

**Michigan Agricultural Experiment Station**

and the

**Michigan Department of Conservation**

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# SOIL SURVEY OF BAY COUNTY, MICHIGAN

By C. H. WONSER, United States Department of Agriculture, in Charge, J. O. VEATCH and L. R. JONES, Michigan Agricultural Experiment Station, and L. R. SCHOENMANN, Michigan Department of Conservation

## COUNTY SURVEYED

Bay County is in the eastern part of the Lower Peninsula of Michigan, at the head of Saginaw Bay (fig. 1). Bay City, the county seat, is 95 miles northeast of Lansing and 110 miles northwest of Detroit. The land area is 443 square miles, or 283,520 acres.

The physiographic features are the product of glaciation and deposition of materials during the last glacial period. Saginaw Valley, the northern part of which forms the greater part of Bay County, was covered by water during much of the period of glaciation, and most of the Port Huron and the Bay City morainic systems crossing it contain much water-laid material. The main Port Huron moraine in northwestern Gibson Township is land-laid, but over the rest of the county the glacial material has been water-laid, and the land surface is nearly level. These water-laid materials have made distinct lake-plain features composed of till-plain material. Owing to the change of the lake level during the successive glacial stages, forming the glacial lakes Wayne, Warren, Grassmere-Lundy, Algonquin, and Nipissing, in succession, different beaches were built for each lake. In this county there are fairly distinct remains of the beaches of Lakes Warren, Algonquin, and Nipissing. The beaches of the other lakes either fall along some of the same lines or have been covered and destroyed (4).<sup>1</sup>

Very little change has been made in the surface features of the plain since the waters of the glacial lake receded. The old beaches have been broken and flattened out to form sand plains in places, whereas in other places the ridges remain intact.

The Algonquin beach, extending northward from Bay City to Pinconning and thence northward to the county line, is still distinct. A dendritic stream pattern has developed, but the dissection is both shallow and incomplete, as the branches to the main streams are short and considerable distance apart. Dutch Creek, the Kawkawlin River system, Pinconning River, White Feather Creek, Saganing Creek, South Branch Pine River, and Center Branch Pine River have



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

<sup>1</sup> Italic numbers in parentheses refer to literature cited, p. 30.

narrow bottoms cut from 10 to 30 feet below the surface of the lake plain to a point ranging from 1 to 2 miles from Saginaw Bay. From these points the streams have shallow valleys across the rest of the plain to the bay. Dutch Creek empties into Saginaw River which has not cut a valley to any noticeable extent below the surface of the plain. Large flat or undulating interstream areas are practically untouched by erosion, dissection, or good natural drainage. Gibson Township, drained chiefly by Saganing Creek, South Branch Pine River, and Center Branch Pine River, is better supplied with natural drainageways than the rest of the county. With the exception of strips near the shore of Saginaw Bay and small scattered areas, the entire land surface was forested at the coming of white men. There seems to be a general correlation between soil textures and drainage and the type of vegetal cover. The heavy-textured poorly drained soils, with the water table below the surface most of the year, supported mixed stands of swamp white oak, basswood, black ash, white ash, elm, red maple, and silver maple. Most of the remnants of this type of forest have had one or more species of trees removed. The well-drained or imperfectly drained sands and light sandy loams were covered by pine, as indicated by the stumps remaining, or by mixed conifers and hardwoods. All this type of land has been cut over and burned over, and that not cleared is now covered chiefly by scrubby oak, birch, poplar, and pin cherry, together with a ground cover of wintergreen, blueberry, mosses, and mixed brush.

Kentucky bluegrass and Canada bluegrass (June grass) grow abundantly on all areas not too shaded, except the marshy areas. In the marshes, marsh grasses, reeds, sedges, rushes, and cattails abound.

Most of the wells supplying water for human and livestock consumption in times of drought are deep, but shallow wells supply abundant water in seasons of normal rainfall. Flowing wells are rather common, but many of these and other deep wells yield "salty" water.

The first settlement by white men was made in 1835 near the present site of Bay City. The early settlers developed lumbering, ship-building, fishing, and salt industries. In 1855, 21 farms were in the area now included in Bay County, and with the organization of the county in 1857 agriculture speedily developed. In 1880, the county contained 1,097 farms, on which a wide variety of general farm crops was produced for sale in Bay City and distant markets, instead of a few subsistence crops, such as the early farmers grew. The population increased from 3,164 in 1860 to 38,081 in 1880. The first settlers were French and English from Detroit, but later settlers came from New York and the New England States and included people of Polish, German, French, English, and Irish descent (1).

According to the 1930 census, the total population of the county was 69,474, of which 47,355 were urban and 22,119 rural. Of the rural population, 15,372 were classed as rural farm and 6,747 as rural nonfarm. Bay City includes all the urban population. This city is a railway center for this section of the State, with the Michigan Central Railroad, Grand Trunk Western Railway, Pere Marquette Railway, and Detroit & Mackinac Railway furnishing good commu-

nication with all parts of the State. Located on Saginaw River, it is accessible to lake steamers as well as the smaller ocean craft. Munger, Auburn, Kawkawlin, Linwood, Pinconning, Bentley, and Mountforest are small towns located on railroads, which provide well-distributed trading points. Standish, the county seat of Arenac County, is a convenient trading center for Gibson Township. Paved roads extend east, southeast, south, west, and north from Bay City across the county, and excellent graveled or paved feeder roads render all parts of the county accessible throughout most of the year. Most of the remaining roads are improved dirt or gravel roads which are in fair or good condition except during very wet periods.

The rural districts have good telephone service. Electric power lines cross the county in several directions and furnish many rural districts with power and light. The county is well supplied with public and parochial schools, which are the 1- or 2-room type, except in Pinconning, Auburn, and Bay City. Churches of many denominations are located throughout the county. Rural mail delivery serves all sections.

Several important manufacturing industries, including 4 chicory factories, 3 beet-sugar factories, a cement plant, a crane and railway-wrecker factory, a dredge and shovel factory, boat yards, drydocks, several canning and pickle factories, and several cheese, butter, and milk factories, are in the county. Commercial fishing is engaged in on the bay. Coal mining was formerly a commercial industry, but in 1931 only 2 or 3 mines were in a condition to operate, and a very small tonnage of coal was produced.

#### CLIMATE

The climate of Bay County is moderated to some extent by its proximity to Lake Huron and Saginaw Bay. The summers are mild and warm, with prevailing westerly winds. The rainfall is generally well distributed throughout the year. The winters are moderately cold, the ground usually being frozen to a depth ranging from 1 to 3 feet during most of the winter, as well as being covered by snow during most of this period. Practically no difference in temperature occurs from one part of the county to another.

Plowing can often be done in the fall as late or even later than November 15, but it is often difficult to work safely much of the soil early in the spring, owing to slow drainage. Summer droughts, which are not uncommon, cause lower yields of late-summer and fall-harvested crops. The average length of the frost-free season is 150 days, extending from May 10 to October 7, but frost has occurred as late as June 3 and as early as September 11.

Table 1, compiled from the records of the United States Weather Bureau station at Bay City gives the normal monthly, seasonal, and yearly temperature and rainfall for the county.

TABLE 1.—Normal monthly, seasonal, and annual temperature and precipitation at Bay City, Bay County, Mich.

[Elevation, 596 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1931)	Total amount for the wettest year (1909)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December.....	26.4	59	-15	2.06	1.62	5.90	8.7
January.....	21.9	61	-23	1.64	1.46	3.30	11.1
February.....	20.6	62	-31	1.72	.76	6.25	11.6
Winter.....	23.0	62	-31	5.42	3.84	15.45	31.4
March.....	32.4	82	-7	2.38	1.77	2.00	7.3
April.....	44.4	89	5	2.52	1.04	6.30	1.8
May.....	56.8	96	23	3.45	2.79	3.55	(1)
Spring.....	44.5	96	-7	8.35	5.60	11.85	9.1
June.....	66.6	100	34	2.62	3.28	3.45	0
July.....	71.5	110	40	3.15	1.49	4.15	0
August.....	68.6	103	38	3.39	1.46	.73	0
Summer.....	68.9	110	34	9.16	6.23	8.33	0
September.....	62.5	96	26	2.91	2.78	2.65	0
October.....	50.5	87	15	2.60	1.25	1.60	.1
November.....	38.1	73	0	2.26	3.26	4.80	2.3
Fall.....	50.4	96	0	7.77	7.29	9.05	2.4
Year.....	46.7	110	-31	30.70	22.96	44.68	42.9

<sup>1</sup> Trace.

### AGRICULTURAL HISTORY AND STATISTICS

Bay County was first settled by lumbermen rather than by those planning to live from the soil, but as the timber supply became depleted many of the people turned to agriculture. The early farmers raised cattle and produced wheat, corn, hay, small grains, and a few other crops for their own subsistence and for sale to the lumber camps. After 1860 the number of farms increased rapidly as also did the variety and acreages of crops.

Table 2, compiled from United States census reports gives data relative to farms and farm operations in Bay County at stated periods.

TABLE 2.—Farm data for Bay County, Mich., as reported by the Federal census

Year	Rural population	Number of farms	Land in farms	Average size of farms	Average value of all farm property per farm	Assessed acre value of farm land	Farms operated by—		
							Owners	Tenants	Managers
							Percent	Percent	Percent
1880.....	10,991	1,097	Percent	Acres	Dollars	Dollars	Percent	Percent	Percent
1890.....	15,592	1,760	39.8	76.0	2,907	92.4	7.6	-----	
1900.....	21,631	3,193	69.2	64.0	3,475	88.7	11.3	-----	
1910.....	23,072	3,233	69.2	61.5	2,824	28.57	88.7	9.5	1.8
1920.....	21,994	3,216	75.2	66.0	4,200	35.72	91.7	7.9	.4
1930.....	22,119	2,901	80.4	70.9	7,432	55.81	88.3	11.3	.4
			77.4	75.7	8,111	187.61	91.3	8.5	.2

<sup>1</sup> Including buildings.

Table 3 gives the acreage and yield of the principal crops, as reported by the United States census for the years 1879, 1889, 1899, 1909, 1919, and 1929.

TABLE 3.—*Acreage and production of principal crops in Bay County, Mich., in stated years*

Crop	1879		1889		1899		1909		1919		1929	
	<i>Acres</i>	<i>Tons</i>										
Hay	8,825	10,959	18,325	25,614	24,674	36,007	30,868	43,186	35,573	44,641	35,377	42,534
Sugar beets					16,007	70,906	9,959	92,775	8,574	95,467	4,832	28,672
Chicory											2,032	8,965
Oats	3,065	96,815	11,260	426,851	14,422	518,630	20,973	739,397	27,831	839,677	22,223	662,252
Beans					228	2,318	2,614	37,857	18,059	312,126	19,175	187,834
Corn	2,648	94,755	4,023	115,064	10,241	254,600	17,760	611,476	17,322	767,644	10,207	271,137
Wheat	5,624	120,606	7,355	152,728	16,940	186,900	4,024	65,582	8,156	151,848	8,907	154,382
Barley	99	2,484	376	12,958	376	9,640	809	22,296	5,831	121,033	3,060	62,771
Potatoes	1,798	160,532	2,567	211,323	3,568	253,566	3,580	339,052	2,850	228,749	3,031	249,530
Rye	153	2,096	152	3,742	705	10,670	2,044	32,942	5,257	70,434	660	5,548

The 1930 census reported an expenditure of \$233,534 for labor in 1929 on the 1,284 farms reporting, or an average of \$181.88 a farm. In the same year \$199,259 was spent for feed on 1,762 farms, an average of \$115.09 a farm. The expenditure for fertilizer was \$113,209, or an average of \$77.81 for each of the 1,445 farms reporting its use.

Practically all the commercial fertilizer used is purchased ready mixed, and most of it is a complete mixture such as 2-12-2, 4-16-4, 5-15-5, or 2-8-16.<sup>2</sup> The fertilizer is usually applied at the time the crop is seeded, combination drills that seed and apply fertilizer in one operation being used. Wheat, sugar beets, chicory, potatoes, and vegetable crops receive most of the fertilizer, but many farmers produce these crops without fertilizer applications, depending on crop residues and barnyard manure to maintain soil fertility. A few farmers make applications ranging from 50 to 700 pounds per acre of complete fertilizer to practically every crop they grow. Beans receive the lighter applications, and vegetables and truck crops receive the heaviest. A small amount of lime is used in the form of sugar-factory waste, but most of the land does not need lime.

The farm labor is performed by resident whites, women and children doing much of the hand labor in the bean, sugar-beet, and chicory fields. Wages ranged from \$1 to \$3 a day, or from \$20 to \$50 a month in 1931, depending on the kind of work, the laborer, and other conditions. Many rural residents find employment in Bay City shops and factories.

According to the 1930 census, 61 percent of the tenants pay a cash rent, and the rest give a part of the crop in payment of rent.

As a rule, the farm buildings are well kept, the investment in buildings being high. Throughout the northern and western parts of the county the buildings are not so well constructed or in such good repair as in other parts. Some of the better farms are assessed at \$120 an acre for taxation at present (1931).

Table 4 gives the value of agricultural products in Bay County in 1929.

<sup>2</sup> Percentages, respectively, of nitrogen, phosphoric acid, and potash.

TABLE 4.—*Value of agricultural products in Bay County, Mich., in 1929*

Crop	Value	Livestock and products	Value
Cereals.....	\$775, 489	Domestic animals.....	\$2, 431, 295
Other grains and seeds.....	697, 173	Dairy products.....	1, 230, 446
Hay and forage.....	527, 139	Wool.....	5, 758
Vegetables.....	575, 406	Poultry.....	257, 468
Fruits and nuts.....	96, 394	Eggs.....	303, 829
Other crops.....	338, 203	Honey.....	23, 126
Total.....	3, 009, 804	Total.....	4, 251, 922
		Total agricultural products.....	7, 261, 726

Eighty-seven percent of the farmers keep either dairy or beef cattle, the herds averaging 9 cows a farm. Some of the farmers keep only 1 or 2 cows, and many keep more than 9. Several specialized dairy farms are in the county. The value of the 23,287 beef and dairy cattle on farms in 1929 was \$1,396,195. Both grade and pure-bred Jersey, Guernsey, Holstein-Friesian, Durham, and Red Polled cattle are kept, and it is difficult to state which breed predominates.

Cream is sold to creameries located in the towns and rural districts. Whole milk is sold to condensaries and to urban dairies, where it is bottled and sold to consumers.

Most of the corn crop is fed within the county, and calves, lambs, hogs, and cattle are fattened and sold for local consumption, or shipped by truck and railroad to Detroit.

Beans and wheat are sold to local elevators, whence they are shipped to consumption centers. There are flour mills in Bay City, but flour manufacturing is not especially important.

Much of the hay is consumed within the county, and the surplus is sold to buyers who sell it in cities and in southeastern United States.

Sugar beets and chicory are processed within the county. Bay County is the largest producer of chicory in the State.

The vegetables produced are sold to local canning factories, local consumers, the tourist trade, resorts along the bay, and to resort lakes north and west of the county, and some are trucked to Detroit, Saginaw, and Flint.

Sheep are kept in Gibson Township, but very few elsewhere in the county. Hogs are not extensively raised.

In 1929, 762 farms paid \$26,321 to power companies for light and power, and 1,145 farms spent \$315,052 during the year for machinery, automobiles, trucks, tractors, and implements.

A broad agricultural classification showing the present (1931) agricultural condition and the extent of occupation of the land in Bay County is set forth in table 5. It must be remembered, however, that in the land classification here shown the classes of land are relative only as applied to this county. First-class land here may not be comparable to first-class land in other parts of the United States, or even to first-class land in other parts of Michigan.

TABLE 5.—*Agricultural classification of land in Bay County, Mich.*

Soil type	Approximate acreage	Location	Class and description	Present condition and use
Wisner loam, Wisner clay loam, Kawkawlin loam, Thomas loam, Thomas clay loam, Bergland loam, Colwood loam, Bergland clay loam, Brookston loam, and burned muck over clay.	140,000	In general over southeastern part of county, also scattered areas in northern part.	(1) Very fertile land; heavy loams and clay loams; requires artificial drainage; retentive of moisture; does not need liming; responds to commercial fertilizer and manures; not stony.	90 percent cleared; used for all general-farm and special crops.
Kawkawlin sandy loam, Wauseon fine sandy loam, Wauseon loamy fine sand, Selkirk silt loam, Nester loam, Essexville sandy loam, Munuscong sandy loam, Granby loamy fine sand, and Berrien fine sandy loam.	65,000	Scattered over entire county, but predominates in northwestern part.	(2) Medium high in natural fertility; light loams and sandy loams; does not require lime; requires drainage, but is easier to drain than land in class 1.	70 percent cleared; used for general farming, dairying, and trucking; small acreages devoted to sugar beets and chicory.
Maumee loam, Ogemaw sandy loam, Iosco sandy loam, mucks, burned muck over sand, and Griffin loam.	35,000	Scattered over entire county, but predominates in northwestern part.	(3) Medium high in natural fertility; sandy loams and light loams, mucks, and stream-bottom soils.	50 percent cleared; used for pasture, hay, small grains, corn, beans, potatoes, and farm gardens.
Wallace fine sand, Bridgman fine sand, Rubicon sand, Roselawn sand, Saugatuck sand, Newton loamy sand, Arenac loamy sand, Eastport sand, and Greenwood peat.	41,000	Scattered in small areas over entire county and occurs in large areas in northwestern part.	(4) Low natural fertility; includes sands not worth the cost of clearing and draining for agricultural purposes under present conditions.	20 percent cleared; mostly not farmed; used for pasture or home sites. Many areas of Arenac loamy sand cultivated to small grains, corn, beans, farm gardens, and fruits.

## SOILS AND CROPS

Bay County is primarily an agricultural county, in which a widely diversified type of agriculture predominates, each farmer having from 2 to 4 or more sources of income during the year.

In 1929, according to the 1930 census, 137,763 acres, or 48.5 percent of the total area of the county, was cropped. One-fourth of this was devoted to hay and forage crops, one-sixth to oats, one-seventh to dry beans; and wheat and corn (for grain) each occupied one-fourteenth of the total cropped area. The remainder, or about one-third, was divided between sugar beets, chicory, barley, potatoes, rye, buckwheat, vegetables, and truck crops. The general farm rotation consists of hay, corn, oats, with varying importance given to wheat, beans, sugar beets, chicory, and potatoes as cash crops. Barley is often substituted for corn and sometimes for some other crop. Other substitutions are made by different farmers. Many farmers devote small plots to cucumbers, cabbage, cauliflower, or other truck crops as extra cash crops. Practically every farmer has a garden for home use, and nearly every farmer has a small orchard, but fruit growing is not commercially important. There are two exceptions to this rather flexible system of general agriculture—the first is practiced in Hampton Township east of Bay City, where many farmers specialize largely in truck and vegetable crops, such as peas, carrots, tomatoes, potatoes, radishes, onions, sweet corn, cauliflower, cantaloups, celery, cabbage, and some small fruits. The reason that this is a trucking

section seems to be largely owing to the preference of the farmers living in this locality to that type of agriculture. The other exception is in areas where the soil differs from the heavy dark very fertile soil on which the extensive and generalized type of agriculture depends. As the soil becomes sandier and less fertile, sugar beets and chicory, in order, are dropped from the rotations, smaller acreages are devoted to cash grain crops, and larger acreages of livestock subsistence crops are grown.

In general, the soils of the county are not stony, and none of the land is sufficiently stony to make cultivation difficult. Based on common characteristics and fertility, the soils may be classed in three main groups with a fourth, or miscellaneous, group to include organic soils, burned-over mucks, and alluvial, or stream-bottom soils. These groups are as follows: (1) Dark-colored loams and clay loams, (2) sandy loams and loams, (3) sand soils, and (4) organic soils and miscellaneous soil materials.

The following discussion of the soils and their occurrence will, in a broad way, show the areas in which the agricultural possibilities are limited, and a study of the accompanying soil map will indicate in detail the lands on which the different types of agriculture are suitable. Table 6 gives the acreage and proportionate extent of the soils mapped in Bay County.

TABLE 6.—*Acreage and proportionate extent of the soils mapped in Bay County, Mich.*

Type of soil	Acres	Per- cent	Type of soil	Acres	Per- cent
Kawkawlin loam.....	70,016	24.7	Griffin loam.....	3,648	1.3
Wisner loam.....	25,024	8.8	Aernac loamy sand.....	13,760	4.8
Wisner clay loam.....	14,400	5.1	Rubicon sand.....	1,088	.4
Thomas loam.....	2,240	.8	Wallace fine sand.....	3,584	1.3
Thomas clay loam.....	704	.2	Bridgman fine sand.....	1,088	.4
Bergland loam.....	18,432	6.5	Roselawn sand.....	128	.1
Bergland clay loam.....	448	.2	Saugatuck sand.....	7,360	2.6
Colwood loam.....	128	.1	Newton loamy sand.....	11,840	4.2
Brookston loam.....	5,440	1.9	Eastport sand.....	2,432	.8
Kawkawlin sandy loam.....	22,784	8.0	Burned muck over clay.....	3,456	1.2
Ogemaw sandy loam.....	17,856	6.3	Burned muck over sand.....	896	.3
Iosco sandy loam.....	4,032	1.4	Burned muck over marl.....	64	.1
Berrien fine sandy loam.....	4,224	1.5	Kerston muck.....	1,536	.5
Nester loam.....	576	.2	Houghton muck.....	3,776	1.3
Selkirk silt loam.....	3,328	1.2	Carlisle muck.....	768	.3
Wauseon fine sandy loam.....	10,752	3.8	Greenwood peat.....	64	.1
Wauseon loamy fine sand.....	4,352	1.5	Marsh.....	1,792	.6
Munuscong sandy loam.....	7,808	2.7	Coastal beach.....	640	.2
Essexville sandy loam.....	6,976	2.4	Made land and mine dumps.....	1,088	.4
Granby loamy fine sand.....	3,968	1.4			
Maumee loam.....	1,024	.4	Total.....	283,520	-----

#### DARK-COLORED LOAMS AND CLAY LOAMS

The group of dark-colored loams and clay loams, including the most productive soils of the county, comprises 48.3 percent of the total land area. Their occurrence is general, and small areas of some member of the group occur in every part of the county, but these soils predominate in the southern and eastern parts.

The soils of this group are dark colored, heavy textured, and high in organic matter. Probably 90 percent of the land is cleared and under cultivation. The surface soils of all these soils are neutral or alkaline; in other words, they are sweet and do not require applica-

tions of lime. Originally all were poorly drained, and some provision for artificial drainage has been necessary. Some have dense plastic topsoils that become cloddy when plowed too wet or too dry, but in general they are not difficult to manage.

Any crop adapted to the climate and a rich alkaline or neutral soil can be successfully grown on any soil of this type, if sufficient drainage is provided.

**Kawkawlin loam.**—Kawkawlin loam covers a total area of 70,016 acres, and most of it occurs throughout the central part of the county from south to north. It is a very fertile soil with slightly better natural drainage than the other soils of the group and will produce good yields of all the crops commonly grown and, with few exceptions, of all the truck and special crops.

The plow soil is gray or dark-gray mellow friable loam, in which the organic-matter content is fairly high, but not so high as in the other members of this group. The sand and silt content is high enough to insure good tilth with a minimum amount of labor. The subsoil is stiff sandy clay which, when partly dry, readily crumbles into small irregular-shaped blocks, about one-half inch in diameter, of reddish-brown color, with rust-colored spots mixed throughout. In the deeper subsoil the material is somewhat pink, with gray and brown mottlings more pronounced. The subsoil, as well as the topsoil, is retentive of moisture, and plant roots are able to penetrate the subsoil to considerable depth.

This soil occurs in rather close association with many other soils of the county, and many small bodies of other soils occur within areas mapped as Kawkawlin loam. Crop yields depend on individual practice as well as on seasonal conditions, but the following acre yields can be expected under normal conditions: Hay, 1 to 2½ tons; oats, 35 to 80 bushels; corn, 20 to 50 bushels; beans, 10 to 30 bushels; barley, 20 to 40 bushels; sugar beets, 8 to 12 tons; chicory, 7 to 10 tons; potatoes, 80 to 150 bushels; and wheat, 17 to 40 bushels.

In the southeastern and east-central parts of Beaver Township this soil varies from typical in that the topsoil is smoother and more silty. The subsoil here is also more silty, with less sand or grit. The productivity is essentially the same as in the typical soil.

**Wisner loam.**—Wisner loam occupies 25,024 acres scattered over the southern part of the county and near the bay shore along its entire length.

It differs from Kawkawlin loam in that it has poorer natural drainage, and the subsoil is drabish gray rather than reddish brown. The plow soil has a higher lime content and in many places has a darker gray color than Kawkawlin loam. The natural fertility is higher, as this soil has been less subjected to leaching, and it contains more organic matter and other plant foods. If drainage is well maintained slightly better yields may be expected from Wisner loam than from Kawkawlin loam. The Wisner soil is somewhat better adapted to sugar beets and chicory but in general is adapted to the same crops as Kawkawlin loam.

Wisner loam occurs in association with areas of other soils mapped in the county, chiefly those of the Wauseon, Kawkawlin, and Thomas series and the organic soils.

**Wisner clay loam.**—Wisner clay loam occupies 14,400 acres occurring in association with Wisner loam. It differs from the loam in having a higher content of silt and clay, with less sandy material, in the topsoil, and in many places it contains a higher content of lime. Sweetclover is often grown and plowed under to loosen the topsoil and make it easier to work. Its fertility is somewhat greater and more permanent than that of Wisner loam. Owing to the occurrence of the Wisner soils on low land near Saginaw Bay and along Saginaw and Quanicassee Rivers, dikes and pumping stations are necessary in many places to insure adequate drainage in early spring and throughout wet seasons.

**Thomas loam.**—Thomas loam occurs in association with Wisner loam and Wisner clay loam and occupies similar low level positions, so that dikes and pumping stations are required in places to provide sufficient drainage. The plow soil is very dark gray or black loam or mucky loam, which is very high in organic matter. It is friable and when well drained is as easy to cultivate as Kawkawlin loam. The subsoil is dull-gray or drab plastic sandy clay containing fragments of shells in places. At a depth of 24 or more inches the material is pink, with gray and yellow streaks. This soil is alkaline, or sweet, throughout and contains an abundance of lime. **Thomas loam** and the similar and associated Thomas clay loam are probably higher in natural fertility than any other soils in the county and will rank among the most fertile soils of the eastern United States. Thomas loam is well adapted to all general and special crops grown, and where good drainage is provided somewhat larger yields are obtained than from Kawkawlin loam.

**Thomas clay loam.**—Thomas clay loam occurs in locations similar to those occupied by Thomas loam. The essential difference between the two soils is that the clay loam contains a higher percentage of clay, silt, lime, and organic matter in the topsoil. Its drainage requirements and crop adaptations are practically identical with those of Thomas loam. Only a small part of the Thomas clay loam is cultivated, owing to the difficulty of drainage. Where drained its crop adaptation is wide.

**Bergland loam.**—Bergland loam occurs in low wet areas in the clay plains throughout the northern part of the county west of United States Highway No. 23. The surface soil in cultivated fields is very dark gray or black friable loam, high in organic matter. The subsoil is gray or mottled gray, yellow, and pink clay loam, rich in lime below a depth ranging from 15 to 20 inches. The organic matter of Bergland loam is derived chiefly from forest debris, differing from that of Thomas loam, which comes from marsh vegetation. As a rule the organic matter of Bergland loam is not so thoroughly disintegrated as is that in Thomas loam.

Probably 90 percent of this soil has been cleared and drained and put under cultivation. It has high natural fertility, is adapted to the same range of crops as Kawkawlin loam, and gives about the same yields as that soil.

**Bergland clay loam.**—Bergland clay loam differs from Bergland loam, with which it is associated, in texture of the topsoil, this layer consisting of clay loam, which makes it necessary to give more careful management regarding cultivation following rains than

with the loam. The clay loam is slightly more fertile than the loam. It is adapted to the same range of crops but gives slightly higher yields.

**Colwood loam.**—Colwood loam is mapped in southern Merritt Township and in north-central Beaver Township. Its topsoil is composed in large part of very fine sand and silt so that the dark-gray friable loam has a smooth silty feel. The subsoil is pale-yellow smooth very fine sand and silt, with some shells mixed through it. This material grades into stiff sandy clay at a depth of about 40 inches.

This soil occurs associated with the Wisner and Bergland soils on about the same level, and it requires drainage. Owing to the looser consistence of the plow soil and upper part of the subsoil, it is more easily drained than the other soils of this group. The natural fertility is nearly equal to that of Kawkawlin loam, though not so lasting, and the soil has practically the same crop adaptation. The crop yields on the two soils are similar.

**Brookston loam.**—Brookston loam is similar to the Wisner, Thomas, and Bergland loams in appearance and consistence, but the Brookston soil is distinguished from the Wisner and Thomas soils in having a lower content of lime and organic matter in the topsoil, and it differs from Bergland loam in that its organic matter is more completely decomposed and its subsoil does not contain the pink and red tints characteristic of the Bergland soil. The crop adaptation of Brookston loam is the same as of other members of this group of soils, and crop yields probably are slightly higher than those obtained on Kawkawlin loam.

#### SANDY LOAMS AND LOAMS

Soils of the group of sandy loams and loams are scattered over the entire county, but they occupy a larger percentage of the land in the northern and western parts. The topsoils are sandy loams and light loams, and these soils are lower in natural fertility than soils of the first group.

With the exception of one type, all the soils of this group require artificial drainage, though all are comparatively easy to drain, owing to the perviousness of the topsoil and subsoil. These soils are easier to cultivate but are more difficult to keep in a highly productive state than the heavier textured soils of the first group.

Good returns are obtained from the use of commercial fertilizers, as well as from animal and crop manures. These soils, as a rule, do not require applications of lime.

**Kawkawlin sandy loam.**—Kawkawlin sandy loam covers a total area of 22,784 acres, and it occurs over the western and northern parts of the county.

The plow soil is gray or dark-gray sandy loam. In most places it is underlain by a layer of gray sand ranging from 4 to 8 inches in thickness. Under this is the subsoil of red or pinkish-red sandy clay. At a depth ranging from 2 to 3 feet the subsoil becomes mottled gray, rust-brown, and pink sandy clay. In many places areas of soil included with this soil in mapping differ from the typical soil. In western Williams Township many small areas of

Kawkawlin loam and a shallow phase of Berrien fine sandy loam are included. In southeastern and east-central Beaver Township the soil varies from typical in that it contains a higher percentage of silt, giving a smoother, less gritty feel.

The topsoil ranges from slightly acid to neutral, and the subsoil is alkaline at a depth of 18 or 20 inches below the surface. A more careful rotation, with larger applications of manure and fertilizer, must be used on this soil than on such soils as the Thomas, Wisner, and Brookston, in order to give profitable returns and to maintain the productivity. The soil is not well adapted to the production of root crops, although they are profitably grown in places. Small grains, corn, beans, hay, and garden crops do very well. The surface relief of most areas is undulating, but along streams it is gently rolling.

**Ogemaw sandy loam.**—Ogemaw sandy loam differs from Kawkawlin sandy loam in that the topsoil is lighter in color and texture, and the subsoil at a depth ranging from 8 to 15 inches is a coffee-brown layer of sand and fine gravel, in places cemented into a hardpan. At a depth ranging from 20 to 36 inches a somewhat pink clay occurs. The sandy layer of the profile is acid, but the clay layer contains a high percentage of lime.

Where small areas occur associated with or surrounded by areas of Kawkawlin loam or Bergland loam they are similarly cropped, but as a whole this soil is not adapted to sugar beets and chicory. The production of hay, beans, and small grains, and the raising of livestock are best suited to it. This soil requires some artificial drainage but not so much as many of the other soils in the county. The surface relief is nearly level or undulating. Ogemaw sandy loam is scattered throughout the county north of Beaver Township.

**Iosco sandy loam.**—In western Gibson Township a soil similar in general characteristics to Ogemaw sandy loam is mapped and designated Iosco sandy loam. The surface relief ranges from gently rolling to rolling, and drainage is better than that of Ogemaw sandy loam, owing to the slope. The depth of the sandy deposit over the clay layer is more variable, ranging from less than 18 inches in some places to more than 40 inches in others.

The agriculture on this soil consists of growing hay, corn, beans, and garden vegetables, with a small acreage in small grains, and in raising cattle and sheep.

**Berrien fine sandy loam.**—Berrien fine sandy loam occurs in scattered spots throughout the county south of Garfield Township.

The 6- to 8-inch plow soil consists of dark-gray or gray fine sandy loam. It is underlain by a brownish-yellow or reddish-brown sand subsoil which, in turn, is underlain by pink clay at a depth ranging from 18 to 36 inches. This soil is neutral or sweet in reaction. As it occurs chiefly in connection with the dark-colored heavier soils, the same general crops are grown, except on fields composed entirely of this soil. Sugar beets are seldom grown, though chicory is grown frequently. The drainage, surface relief, yields, and farming practices are very similar to those of Kawkawlin sandy loam.

A few small gravelly areas included with Berrien fine sandy loam occur on the terraces of Kawkawlin River and in Beaver Township. In these areas the 8- to 10-inch surface soil consists of dark-gray or

very dark gray sandy loam fairly high in organic matter. It is underlain by a layer, between depths of 10 and 15 inches, of reddish-brown slightly cemented sand, silt, and fine gravel. These two layers are neutral in reaction, and they are underlain by gray coarse calcareous sand and gravel. The depth to the underlying clay layer ranges from 4 to 10 feet. In many places the gravel subsoil is utilized for road surfacing and cement work.

**Nester loam.**—Nester loam is mapped in northwestern Gibson Township where the relief is gently rolling or rolling. The topsoil is silty loam, slightly lighter in color than Kawkawlin sandy loam. The subsoil is fairly dark reddish-brown clay or sandy clay, which, at a depth of about 20 inches, grades into light-brown mottled sandy clay. The topsoil is acid, but the subsoil is alkaline. The land is naturally fairly well drained. The agriculture on this soil consists chiefly of livestock raising and the growing of hay, corn, and small acreages of small grains and beans. Nester loam is slightly more fertile naturally than Kawkawlin sandy loam, but, owing to its small total area of less than 1 square mile, is not so important agriculturally.

**Selkirk silt loam.**—Selkirk silt loam occurs in small areas in Pinconning and Gibson Townships. It is an imperfectly drained soil having undulating surface relief. It differs from Nester loam in that it has poorer drainage and contains a higher proportion of silt in the topsoil and subsoil. Scattered areas in the southern part of the county occur on breaks near well-developed drainageways. Areas also occur as lighter colored soils in association with Kawkawlin loam, where this soil is locally called "hardpan" soil.

**Wauseon fine sandy loam.**—Wauseon fine sandy loam occurs throughout the eastern and southern parts of the county. The plow soil consists of a mixture of black organic matter and fine sand. The topsoil is neutral or alkaline in reaction, but the lower layers are high in lime. The subsoil is light-gray sand and fine gravel, underlain at a depth ranging from 18 to 36 inches by gray mottled clay. This soil has high natural fertility which is not so lasting as that of the dark-colored heavy soils. It occurs in similar positions as Wisner loam and is as difficult to drain as the Wisner soil, owing to its low position. The crops grown and farming practices are very similar to those on the Wisner soil, but lower yields are obtained and the cost of maintaining the fertility is greater. The land is easily plowed and cultivated, with little danger of injuring the tilth by working it when too wet.

**Wauseon loamy fine sand.**—Wauseon loamy fine sand is associated with Wauseon fine sandy loam. The chief difference between the two soils is that Wauseon loamy fine sand has less organic matter in the topsoil, and the depth to the clay layer is slightly greater. Sugar beets and chicory are seldom grown on this soil, but otherwise it is cropped similarly to Wauseon fine sandy loam. Yields are in general lower than on that soil.

**Munuscong sandy loam.**—Munuscong sandy loam occurs north of Beaver Township and west of United States Highway No. 23. It differs from Wauseon fine sandy loam in that the organic matter is not so well decomposed, and the sandy layer between the underlying

clay layer and the plow soil shows slight cementation and rust-brown motlings.

**Essexville sandy loam.**—Essexville sandy loam occurs along the bay shore and in areas scattered over the southern part of the county. The surface soil to a depth of 12 or 15 inches is black sandy loam or loam, consisting of a mixture of disintegrated organic matter and quartz sand. The subsoil material is gray incoherent sand, with an appreciable quantity of calcareous material. Below a depth ranging from 2 to 3 feet is a substratum of calcareous clay. In the natural condition the soil was saturated with water most of the time.

Areas of this soil occur near or in the bay and river marshes, associated with the Thomas and Wisner soils, and in these positions the land requires dikes and pumping stations to supply sufficient drainage for cropping. Farming practices are essentially the same as those on Wauseon fine sandy loam, and the yields are similar to those obtained on that soil.

**Granby loamy fine sand.**—Granby loamy fine sand occurs chiefly in Beaver Township, though areas are mapped in other places scattered over the county. It differs from Wauseon loamy fine sand in that it has less organic matter in the topsoil and is not underlain by a clay layer at a depth of 40 inches, water-logged sand extending to a depth of more than 5 feet. The plow soil is neutral, and the soil in the rest of the profile ranges from neutral to alkaline. The land requires artificial drainage to lower the water table sufficiently to produce general farm crops, and fair yields of corn, beans, small grains, hay, and truck crops may be obtained. The areas mapped in Beaver Township east of Seidler School have a higher content of silt in the profile than elsewhere in the county, which makes them more productive.

**Maumee loam.**—Maumee loam occurs chiefly along the bay marshes east and north of Kawkawlin. The upper soil layer to a depth of 6 or 8 inches is very dark gray or black loam composed of a mechanical mixture of organic matter and fine sand. The subsoil is water-logged gray medium and fine sand which extends to a depth of more than 40 inches. The greatest difference between Maumee loam and Essexville sandy loam is the greater depth to clay in the Maumee soil than in the Essexville, and the lime content is higher in the Essexville soil. Because they occur in marsh areas, most bodies of Maumee loam are not in a position to be cultivated, as the water table is high and drainage is difficult. Small scattered areas are cropped in connection with the soils with which they are associated, and they give medium yields.

**Griffin loam.**—Griffin loam is mapped along streams where mineral soil material has been deposited by water. The soil in these stream bottoms is not uniform in texture and is subject to overflow in times of high water. The texture in places is predominately clay loam, and elsewhere it is sandy. Owing to poor drainage and the fact that most of the bottoms are narrow, they are used chiefly for pasture.

#### SAND SOILS

The sand soils of the county are low in natural fertility and in general cannot be farmed profitably under present economic conditions. They are largely covered with brush, stumps, and scrub trees,

left from former lumbering operations, have been burned over, and are practically worthless for timber production. Some of these soils are too wet for farming and if drained would be too low in fertility to produce profitable crops.

**Arenac loamy sand.**—Arenac loamy sand occurs in scattered areas throughout the county south of Garfield and Fraser Townships. In places it occurs as small ridges, and in other places it covers considerable areas where the sand is from 2 to 4 feet thick.

The plow soil is grayish brown and low in organic matter. The subsoil is yellowish brown or pale coffee brown and grades into yellow slightly mottled sand at a depth of 24 inches. Clay is present in most places at a depth ranging from 3 to 6 feet. This soil does not require artificial drainage, and during short periods of drought plants suffer from lack of moisture. Where it occurs as small areas or low ridges associated with better soils, it is usually cropped in the same manner as the better or predominating soil but is given heavier applications of manure and fertilizer. In the shallow areas of this soil fair crops of hay, corn, beans, and oats are obtained, but in large areas and on ridges where the sand is 3 feet or more thick cropping is not considered profitable, and such areas are utilized chiefly for pasture. The present cut-over wood-lot growth is of small value.

**Rubicon sand.**—Rubicon sand occurs as scattered areas north of Beaver and Kawkawlin Townships. The topsoil is gray fine sand or medium sand, very low in organic matter. The subsoil is pale coffee-brown slightly cemented sand grading into yellow sand which in most places is underlain by clay at a depth ranging from 8 to 10 feet. Areas of this soil are small, and they occur chiefly on broad flat-topped ridges. The present vegetal cover is of little economic value except as early-spring and late-fall pasture. The land is of little value for cropping.

**Wallace fine sand.**—Wallace fine sand occurs as distinct ridges of sand scattered over the entire western part of the county. Its chief profile difference from Rubicon sand is the presence of a coffee-brown hardpan layer of cemented sand in the subsoil of Wallace fine sand. It is similar in value to Rubicon sand. In places where the ridges are low and narrow, they are cropped in the same manner as the surrounding soil, with small grains and hay, but returns are very low from the Wallace soil. Most of the land is uncleared, being chiefly sodded stump land, with a few second-growth oaks and pines.

**Bridgman fine sand.**—Bridgman fine sand, where it has not been disturbed, consists of light grayish-brown fine sand about 3 inches thick, overlying yellow fine sand continuous to a depth of about 30 inches, where it gives way to loose pale-yellow fine sand extending to a depth of more than 15 feet. This soil includes the sand dunes of the county, and much of it is shifted about so frequently by winds that only the areas covered by trees or other vegetation or by buildings have any degree of permanency. It is likely that these sand ridges were all forested at one time, but when the timber was removed large areas became little more than shifting sand, exposing tree roots to a depth of several feet. Bridgman fine sand has no present agricultural use.

**Roselawn sand.**—Roselawn sand occurs in northwestern Gibson Township. It consists of sand material more than 10 feet deep, gray

in the upper layers and yellow below, that in most places is dry and easily blown by wind if not covered by vegetation. Stones and coarse gravel are scattered through it. This sand is low in natural fertility, and little attempt is made to farm it.

**Saugatuck sand.**—Saugatuck sand occurs as undulating or level areas of poorly drained sand scattered over the county north of Beaver and Kawkawlin Townships. Under cultivation, the plow soil has a gray or ash-gray color mixed with reddish brown in places where the coffee-brown hardpan layer of cemented sand has been plowed up. This brown layer is not everywhere hardened into a hardpan, but it usually is when dry. Beneath this layer is the subsoil of water-logged gray sand. Small areas are sometimes cultivated, and small yields of corn, oats, beans, hay, potatoes, and cucumbers are obtained. The natural fertility is low, and the cost of building up the productivity of the land and maintaining it, together with the drainage it requires, makes this an unprofitable soil.

Most of the Saugatuck sand mapped is uncleared land, consisting of cut-over and burned-over pineland, and a large acreage has gone back to State ownership, on account of delinquent taxes.

**Newton loamy sand.**—Newton loamy sand is scattered over the central and northern parts of the county. The areas occupy lower positions than Saugatuck sand areas and therefore are more poorly drained. The topsoil of Newton loamy sand contains slightly more organic matter than does that of Saugatuck sand, and the coffee-brown layer in the subsoil is lacking. The subsoil is water-logged gray sand extending downward to a depth of 5 feet or deeper. Perhaps 20 percent of the land has been cleared and drained, and fair crops of corn, beans, oats, hay, and garden crops are obtained. The cost of maintaining a good state of fertility over a long period, together with the cost of clearing and draining, make this a soil of doubtful value for ordinary farming.

**Eastport sand.**—To a depth of 6 or 8 inches Eastport sand consists of dark-gray or grayish-brown sand. This is underlain by gray or yellowish-gray sand continuous to a depth of more than 4 feet. The reaction is neutral or slightly alkaline. The material of this soil is too recently accumulated to have developed a profile. A little organic matter is contained in the surface soil material.

This soil occupies long narrow ridges in proximity to Saginaw Bay. The ridges have undoubtedly been formed by wave action in recent geologic time. They are now covered with scrub red oak, a few white pine, and a sparse growth of grass. They rise from 6 to 8 feet above the adjacent coastal beach, and on some of them under-drainage is imperfect. The production of crops is not attempted on this soil.

#### ORGANIC SOILS AND MISCELLANEOUS SOIL MATERIALS

**Burned muck.**—Under the classification of burned muck is mapped a large area of organic soils which have been considerably changed by burning. As they exist today they show wide differences. In some places practically all the visible organic matter has been removed or has been incorporated in the soil so that the surface soil resembles that of poorly drained mineral soils such as the

Brookston, Maumee, and Thomas. At the other extreme are areas where only part of the muck covering has been removed and there remains a layer, from 2 to 3 feet thick, of muck mingled with the ash of the material burned above it. This residue in many places is still in process of removal, as the organic matter gradually wastes away and oxidizes under cultivation.

The mineral soil which underlies the muck is of three kinds: (1) Heavy gritty or plastic clay in which various shades of gray predominate, but in which there may be mottling of yellow and yellowish brown; (2) gray sand or loamy sand, mottled in many places with yellow or rust brown; and (3) marl. It was not everywhere practical to closely separate these three classes, but their general locations are indicated on the soil map.

Burned muck over clay develops into soils comparable in crop adaptation and yields obtained to the Thomas and Wisner soils. Burned muck over sand usually develops into a soil similar to Maumee loam in fertility and crop adaptation. If the clay substratum lies at a slight depth beneath the sand, a fair soil, such as Wauseon fine sandy loam, may be developed.

**Kerston muck.**—Kerston muck is mapped along Dutch Creek, Saginaw River, and Kawkawlin River, where the stream-bottom material consists of mucky alluvium, or alternating layers of muck and mineral soil. In most places the material is swampy and too wet for cultivation. The drainage problem is too difficult for Kerston muck to be utilized for cultivated crops under present conditions, but it has some use as pasture land.

**Houghton muck.**—Houghton muck has a thin surface layer of brown fibrous loose stringy material grading into black or dark-brown fine smooth well-decomposed muck. Variations in the stage of decomposition occur, so that over the same area the soil is not uniform. Around the margins of the marshes different quantities of mineral soil from adjoining higher land have been washed in and incorporated with the vegetable matter. The muck has been formed from sedges, grasses, and aquatic vegetation.

The natural vegetation is principally marsh plants such as wire grass, cattails, reeds, and rushes. Alder, aspen, and willow are also present in places.

The muck deposits range in depth from 1 to more than 3 feet, becoming browner and less well decomposed as depth increases. Most of the Houghton muck land is uncleared and undrained. Agricultural utilization would require expensive reclamation in most areas.

**Carlisle muck.**—Carlisle muck is an unimportant type of organic soil because of its small total acreage and poor drainage. It consists of organic deposits derived chiefly from woody material, and it is distinguished from Houghton muck by the presence of woody fragments. The material in many places is derived from marsh plants below a depth ranging from 20 to 30 inches. The total depth of this muck has about the same range as Houghton muck.

**Greenwood peat.**—Greenwood peat occurs in sections 24 and 25 of Kawkawlin Township, and in a few very small areas scattered throughout the northwestern part of the county. It is a raw acid peat composed of only slightly disintegrated plant remains.

Blueberries, leatherleaf, and mosses are the chief plants that thrive on this land. It has no present agricultural use.

**Marsh.**—Marsh is mapped along the bay shore and river banks where very little organic matter has been deposited. The areas are usually covered by water and are characterized by a shallow-water type of vegetation.

**Coastal beach.**—The comparatively weed-free areas that extend to the water's edge but are not generally covered by water are mapped as coastal beach.

**Made land and mine dumps.**—Made land includes areas in which the surface materials have been placed by man in such a way that the natural characteristics of the land have been materially changed, as along Saginaw River where material dredged from the river has been placed, or at the location of the lumber mill at Pinconning. Mine dumps include material carried to the surface in mining and quarrying operations.

### SOILS AND THEIR INTERPRETATION

Bay County is at the head of Saginaw Bay on the eastern side of the Lower Peninsula of Michigan. It occupies a transitional position between the region of podzol soils and the region of gray-brown podzolic soils. Where local conditions and the character of the parent materials are particularly favorable, a typical podzol profile has developed. Except on the narrow Port Huron moraine which crosses the extreme northwestern corner of the county, mature soils have developed on sandy materials which occur as old beach lines of glacial lakes and as small narrow strips on breaks to streams that have been well drained for considerable time. Most of the soils of these well-drained areas are distinct podzols. No mature soils are in the southern part of the county, owing to the poor natural drainage of that section. Therefore no well-developed gray-brown podzolic soils are in the county.

Approximately 90 percent of the area of the county has immature and dark-colored soils developed under poor drainage; a much smaller total area is occupied by lighter colored and imperfectly drained soils; and a third group of soils, the well-developed well-drained true podzols, occupy only a small part of the county.

The mature podzol soils were originally covered by mixed coniferous forests consisting chiefly of white pine, together with a few scattered oaks.

The dark-colored soils, except narrow strips of marshland along the bay shore and small isolated areas, were entirely covered by deciduous forests. This type of forest consisted chiefly of elm, white ash, black ash, red maple, silver maple, basswood, and swamp white oak. The marsh vegetation consisted of sedges, reeds, cattails, rushes, and marsh grasses.

The water table was near or at the surface of the ground for sufficiently long periods of the year that leaching was limited, and the organic matter of these soils is still high. The organic matter is well decomposed and well incorporated into the topsoil.

The organic-matter content of the light-colored soils is very low, and, especially in the drier areas, much of it has been destroyed by fire, as most of these soils have been burned over repeatedly. The organic matter in the light-colored soils is not so well decomposed as that in the dark-colored soils of the southern part of the county, and it is not well mixed with the topsoil.

Two types of parent material have influenced the physical characteristics of the soils of Bay County. The substratum material over the greater part is calcareous till clay. It is compact and contains a small quantity of gravel but practically no stones or boulders. From this kind of material most of the soils, the loams and the clay loams, have developed. In places separate and distinct layers of fine sand and medium sand have been deposited on the clay. The sand is glacial material that has been carried, assorted, and deposited by wind and water. The quartz content is high, with a very low carbonate content. In some places it occurs as a mixture of fine sand and medium sand, and in others the sand is predominately fine, with some silty material mixed throughout. The deposits range in thickness from 1 foot to more than 12 feet. In places the sand deposits occur over large nearly level areas and elsewhere as distinct ridges. From this sandy parent material, sandy loam and sand soils have developed.

The dark-colored soils occur generally over the county, with small spots and ridges of light-colored better drained soils mixed in. The group of dark-colored soils is well represented by a profile of Wisner loam as seen in section 25, Hampton Township, 2 miles from Bay City in a wood lot in which underbrush has been replaced by bluegrass sod. This profile is described as follows:

- 0 to 5 inches, very dark gray (nearly black when wet) calcareous humous loam.
- 5 to 10 inches, dull-gray calcareous loam.
- 10 to 24 inches, gray and yellow mottled calcareous friable clay.
- 24 to 40 inches, mottled pale-red, yellow, and gray compact, blocky, highly calcareous till clay.

The forest cover here is swamp white oak, elm, red maple, white ash, shagbark hickory, and red oak. This forest is probably virgin, but probably one or more species of trees have been removed.

The Thomas soils constitute an example of a younger stage of soil development than the Wisner soils. Forest vegetation has not yet invaded these soils, as they have a higher water table than the Wisner soils and support a marsh vegetation. They have darker colored topsoils, owing to a higher organic-matter content, also a higher content of lime carbonate in the topsoils.

Kawkawlin loam represents a more advanced stage of soil development than the Wisner soils. The organic matter and carbonate content of the topsoil have been reduced, so that the surface layer is dark gray and is neutral in reaction. A distinct light-gray sub-surface layer, which is also free of lime, has developed. A reddish-brown, mottled with rust brown, B horizon 6 or 8 inches thick has developed. This soil supports a forest cover very similar to that on Wisner loam.

Ogemaw sandy loam has a well-developed podzol profile, but it is kept imperfectly drained by the presence of impervious clay at a

depth ranging from 30 to 40 inches. It originally supported a dense stand of white pine. Its profile consists of the following layers:

- (1) A layer of leaf mold and litter.
- (2) A very thin gray humous soil layer.
- (3) An ash-gray leached layer.
- (4) Coffee-brown sand, which is hard when dry but softens on soaking.
- (5) Water-logged sand underlain by tight till clay.

Newton loamy sand, developed from sand parent material, is analogous to Wisner loam which developed from clay parent material. It supports a cover chiefly of alder, with intermixed birch and poplar, and an undercover of lichens, mosses, blueberries, and mixed marsh grasses.

In the southeastern part there are no mature soils, but mature soils, which are podzols, most of them with hardpans, are scattered throughout the rest of the county.

A typical profile of Wallace fine sand, as it occurs on a distinct ridge of burned-over white pine stump land, now sodded with bluegrass and pastured, in the SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 4, Gibson Township, is described as follows:

- 0 to 2 inches, gray organic topsoil of mixed fine sand and medium sand. The material has a loose single-grained structure, with the organic matter forming a mechanical mixture with the sand. It is acid in reaction.
- 2 to 14 inches, leached ash-gray fine sand and medium sand, which are loose, incoherent, and acid.
- 14 to 20 inches, coffee-brown cemented sand hardpan layer which is acid in reaction and is fissured and soft in spots, so that it is permeable to water.
- 20 to 36 inches +, yellow fine sand and medium sand, which are loose, incoherent, and acid.

A description of the profile of Nester loam<sup>3</sup> as it occurs in the SW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 19, Gibson Township, is as follows:

- 0 to 3 inches, dark-gray silty loam, the small granules of which are about one-eighth inch in diameter. The organic-matter content is fairly high and the reaction is acid.
- 3 to 9 inches, ash-gray or pale yellowish-brown loam, with a platy structure and acid in reaction.
- 9 to 20 inches, dark reddish-brown clay streaked with gray near the top of the layer and solid reddish brown at the bottom. The material has a coarse blocky structure, is slightly acid at the top of this layer, and neutral at the bottom.
- 20 to 36 inches, light-brown, streaked with gray and rust brown, sandy calcareous till clay of massive structure.

The total extent of this mature Nester soil is small. The soil is fairly permeable to moisture to a depth ranging from 2 to 3 feet, water passing through wormholes, root channels, and fissures. It is also very retentive of moisture.

Rubicon sand, another inextensive soil, differs from the Wallace soil chiefly in that the horizon corresponding to the hardpan of the Wallace soil has not become generally cemented. The B horizon is brown, and its textural profile is similar to that of the Wallace soil.

The organic soils of the county all originally developed chiefly from aquatic and marsh vegetation. As the water table was lowered

<sup>3</sup>No virgin area of this soil was found, but this spot had been but slightly disturbed by cultivation.

in some of these areas, forest vegetation invaded them, so that some mucks are composed of remains of both marsh vegetation and woody material. All the mucks occur on nearly the same level as the poorly drained mineral soils that predominate in the county. Many areas of these mineral soils have been artificially drained to make them suitable for agriculture, and this has resulted in the overdraining of many muck areas, causing them to become too well drained. To remedy this, much of the organic material has been burned off, and many of the muck areas have been burned down to the clay or sand material underlying them, are in the process of burning, or are likely to be burned at an early date, so that some sort of a mineral soil profile will eventually develop.

The alluvial deposits are of small extent and consist chiefly of shallow recent deposits of local origin. The mineral alluvium was mapped as Griffin loam. The forest cover consists of elm, ash, hickory, soft maple, and numerous varieties of brush. The areas of mucky alluvium are mapped as Kerston muck, and they support both marsh and forest vegetation. Soft maple is the predominant forest tree, and cattails and marsh grasses grow extensively in the marshy areas.

Table 7 gives the pH values of samples of Brookston loam and Brookston clay loam, taken at different depths. These determinations were made by the hydrogen-electrode method.

TABLE 7.—pH determinations of two soils from Bay County, Mich.

Soil type and sample no.	Depth	pH	Soil type and sample no.	Depth	pH
Brookston loam:	<i>Inches</i>		Brookston clay loam:	<i>Inches</i>	
305052.....	0-8	7.73	305055.....	0-4	7.42
305053.....	8-20	7.96	305056.....	4-20	7.45
305054.....	20-36	7.96	305057.....	20-36	7.65

#### SOIL MANAGEMENT<sup>4</sup>

Successful soil management involves a knowledge of the chemical and physical character of the whole soil profile to such depths as the roots of plants may penetrate. In connection with crop production the soil must be considered from the point of view of (1) supplying food for the plant, (2) tillage, and (3) water relationships. These points will be discussed in relation to the soils of Bay County in the following paragraphs.

The thrifty and profitable growth of crops is dependent not only on the presence of an ample supply of food elements but also on a chemical and physical condition of the soil, which favors growth and renders the nutrient elements more available to the plant. Several factors deserve special mention in this connection. (1) Organic matter, or humus, is outstanding in its favorable influence on soils. (2) The abundance or deficiency of lime has an important bearing on soil conditions and crop growth. (3) Commercial fertilizer may be used where the natural supply of available food elements is insuffi-

<sup>4</sup>This section of the report was written by C. E. Millar and J. O. Veatch of the Michigan Agricultural Experiment Station.

cient to produce the desired yield or quality of crops. (4) Farm manure also is depended on to supply plant food and organic matter to the soil, and hence its care, application, and reinforcement are pertinent problems.

From an agricultural point of view the content of organic matter in all the naturally well-drained mineral soils of this county is generally low or medium. Therefore, the soil-management system must include practices by which organic matter is supplied if productivity is to be maintained for any length of time.

In general, the farmer depends on barnyard manure and on the roots and stubble left in the ground after harvest to maintain the humus content of his soil. Unfortunately the supply of manure is limited on most farms, and it is therefore necessary to resort to special practices to supply organic matter. The use of catch crops, such as the seeding of sweetclover or other clover in a small grain, and then plowing under the clover the following spring for a cultivated crop, has been found practical by farmers on heavier soils containing sufficient lime to grow legumes. On lighter soils and those too sour to grow legumes, rye may frequently be seeded in the fall and plowed under for a cultivated crop late the following spring. On all soils a sod crop, composed of alfalfa, clover, or clover plus a grass crop, should be seeded as frequently as possible, as the sod-producing crops are the most efficient in putting organic matter into the soil. All straw and similar crop residues should be carefully saved and fed to livestock or utilized for bedding in stables to increase the manure supply.

Peat and muck are available locally, and a limited use may be made of these to increase the organic content or to improve the tilth of the soil, although usually the cost of excavation and application render their general use impractical under present economic conditions. However, where land is located near a source of supply, peat or muck may be used, particularly for the production of high-acre-value crops.

Following is a grouping of the soils of Bay County according to their content of organic matter:

(1) Soils having a low content (2 percent or less) of organic matter, including Arenac loamy sand, Bridgman fine sand, coastal beach, Eastport sand, Iosco sandy loam, Roselawn sand, Rubicon sand, Saugatuck sand, and Wallace fine sand; (2) soils having a medium content (2 to 4 percent) of organic matter, including Berrien fine sandy loam, Kawkawlin loam, Kawkawlin sandy loam, Nester loam, Newton loamy sand, Ogemaw sandy loam, and Selkirk silt loam; and (3) soils having a high content (more than 4 percent) of organic matter, including Brookston loam, Bergland clay loam, Bergland loam, Colwood loam, Essexville sandy loam, Granby loamy fine sand, Griffin loam, Maumee loam, Munuscong sandy loam, Thomas loam, Thomas clay loam, marsh, peats and mucks, Wauseon fine sandy loam, Wauseon loamy fine sand, Wisner loam, and Wisner clay loam.

It is in the group of soils having a low content of organic matter that an increase in this constituent is most essential for profitable crop production. The amount of organic matter in very few places has been increased above the average and above that originally

present when the land was first placed under cultivation, but in the large majority of places there has been a perceptible loss. Plans to increase the humus content of these soils should occupy a prominent place in the soil-management system.

In the soils of the intermediate group, the content of organic matter has reached a level at which maintenance of the supply is essential, and in many places an increase is necessary for the most profitable utilization of the land. In the few places where erosion has taken place, the amount of organic matter present may be actually less than in soils of the first group.

Most of the soils of the third group contain sufficient organic matter, and no special effort need be made to increase the supply. Some of the soils included in this group, however, are so heavy that an increase in organic matter is necessary to improve the tilth. In many fields, areas occur which are not so rich in humus as is the soil as a whole, and on such areas applications of manure bring profitable returns. The physical condition and plant-food relationships of muck and other soils very high in humus are sometimes improved by plowing under a green-manure crop.

Lime is applied to sour soils, primarily to correct their acid condition, in order that alfalfa, sweetclover, red clover, and alsike clover may be more successfully grown. The inclusion of these legumes in the rotation insures the production of hay with a high protein content, thereby increasing the livestock-carrying capacity of the farm and cutting down the expenditure for concentrated feed. The growing of legumes also results in a decided increase in the yields of other crops in the rotation. In addition, legumes, when inoculated, draw nitrogen from the air, and if the hay is fed the nitrogen may be added to the soil in the form of manure for the use of other crops.

Lime not only corrects the acid condition of the soil but supplies the plant-food element, calcium, which if present in insufficient quantity results in limited crop growth. Lime also contributes to an efficient use of plant food applied in commercial fertilizer and manure. Bacterial activities are influenced decidedly by the lime content of soils. Decay of organic matter, with the subsequent production of soluble nitrogen and the liberation of available mineral plant nutrients, proceeds more energetically in a soil containing adequate lime.

Recommendations for the use of lime are generally based on the degree of acidity of the surface, or plow, layer, although it is now recognized that the chemical and physical character of the whole soil penetrable by plant roots and the fertility of the soil must be taken into consideration. Failure of a soil to produce satisfactory stands of alfalfa or the clovers in favorable seasons may be taken as an indication of a deficiency of lime. The most rapid method of determining whether or not a soil is in need of lime is by the use of simple colorimetric tests, such as Soiltext, which may be procured from the county agricultural agent or from the soils department of the Michigan State College. No field should be seeded to alfalfa or clover without first determining whether or not lime is needed. In table 8 the soils of Bay County are grouped according to their acidity and their lime requirement.

TABLE 8.—*Grouping of the soils of Bay County, Mich., according to acidity and need for lime*

Soil types	Acidity	Acre requirement of lime <sup>1</sup>
Selkirk silt loam and Nester loam.....	Strong to slightly acid surface layers; clay high in lime at a slight depth.	1 to 3 tons; in many places not necessary.
Rubicon sand, Bridgman fine sand, Arenac loamy sand, Berrien fine sandy loam, Newton loamy sand, Ogemaw sandy loam, Roselawn sand, Iosco sandy loam, Saugatuck sand, and Wallace fine sand.	Strong to medium acid to a depth ranging from 3 to 5 feet.	2 to 4 tons.
Kawkawlin loam, Kawkawlin sandy loam, Eastport sand, Brookston loam, Thomas clay loam, Wisner clay loam, Wisner loam, coastal beach, Bergland clay loam, Bergland loam, Granby loamy fine sand, Griffin loam, Munuscong sandy loam, Essexville sandy loam, Colwood loam, Wauseon fine sandy loam, Wauseon loamy fine sand, burned muck (over clay), burned muck (over sand), and burned muck (over marl).	Very slightly acid to high in lime, or alkaline in reaction, both in surface and subsurface layers.	Generally none.
Carlisle muck, Kerston muck, Maumee loam, and Houghton muck.	Medium acid to alkaline muck soils.	None.
Greenwood peat.....	Strongly to very strongly acid peats and mucks.	2 to 12 tons.

<sup>1</sup> For mineral soils in relation to legumes—alfalfa, sweetclover, and June clover—in terms of ground limestone; for mucks, except in relation to such crops as blueberries and cranberries.

Further information concerning lime may be obtained from Special Bulletin 91 (7) of the Michigan Agricultural Experiment Station.

Limestone is the most commonly used commercial form of lime for correcting soil acidity. Three grades, known as screenings, limestone meal, and pulverized limestone, are on the market, and all give satisfactory results when used properly and applied in adequate quantity. The limestone meal is most commonly used, as it sells at a moderate price and contains sufficient fine material to produce immediate results.

The refuse lime from beet-sugar factories is an economical source of supply to the farmers located near such plants. The sludge lime obtained from the refuse piles contains considerable moisture in addition to some dirt. A number of analyses show the lime from these piles to contain from 50 to 60 percent of pure lime carbonate. Because of the moisture content, which makes the lime somewhat sticky, the manure spreader is the only implement that will spread it satisfactorily. For a soil that is strongly acid, from 4 to 6 cubic yards of the lime to the acre should be applied. It is advisable to make the application several months or even a year or more before seeding alfalfa, sweetclover, or other clover, in order that the lime may be thoroughly mixed through the soil and correct the acid condition. The lime may be plowed under, provided the application is made a year or more before seeding the legume. In making use of this sludge lime, care should be exercised to obtain lime free from quack-grass roots or other noxious weeds.

Occasionally, cleanings from the lime kiln and slaker may be obtained. This lime is much more concentrated than the sludge lime, and from 1½ to 2 tons to the acre are usually sufficient for a strongly acid soil. When obtained in large lumps, or "hardheads", these must be allowed to slake or crumble before the lime can be evenly

distributed over the field. Many of the large lumps contain a core of hard rock which must be separated from the lime before it can be applied through a manure spreader or other type of distributor. The lime is frequently screened at the factory to remove the hard rock. If the screen used is sufficiently fine the lime may be applied with the manure spreader; if not, it must be rescreened or applied with a shovel.

Hydrated lime may be used satisfactorily when the price warrants. It should be used in proportion to its neutralizing power which is printed on the package. For example, if the neutralizing power is 135 it will require 100/135, or 74 percent, as much of this material as of pure limestone, to correct the same amount of soil acidity.

If the amount of available plant food in a soil is not adequate to produce such large crops as are desirable, and if the supply of barnyard manure is not sufficient to supply the need, the deficiency should be made up by the use of commercial fertilizer. It is not practical to attempt to give in this report specific recommendations for the use of commercial fertilizers on individual soils, because a large number of factors must be taken into consideration, such as the kind of crop, the previous crop history of the field, the use of lime and manure in conjunction, the time and method of application, and the condition of the particular soil. However, a few general suggestions may be made.

The mineral soils of Michigan, with few exceptions, contain insufficient available phosphate for large yields of crops. For muck and peat soils there is a like deficiency of available potash. It is evident, therefore, in selecting a fertilizer for use on a mineral soil, that phosphate should be the first element considered, with the quantities of nitrogen and potash varied in accordance with the crop requirement and the soil deficiency, and that potash should be given major consideration in choosing a fertilizer for muck soil.

The need for nitrogen differs greatly in the different soil types and in different fields on the same farm. The nitrogen supply of a soil is contained in the humus, or organic matter, and therefore some idea of the need for nitrogen may be obtained by considering the darkness of the soil, which is an indication of the humus content. The sandy soils are, as a whole, more likely to be in need of nitrogen than the heavier soils. The quantity of nitrogen which should be included in the fertilizer used on these soils depends on the kind of crop grown and the previous treatment of the soil. The application of manure or the plowing under of a leguminous sod within the preceding year or two will reduce the percentage of nitrogen needed in the fertilizer for general farm crops. Special crops, such as truck crops and early potatoes, should receive a fertilizer containing from medium to high percentages of nitrogen.

The need for additional nitrogen is not so great in the soils containing a medium percentage of organic matter. Unless manure is applied or a leguminous sod is plowed under every 2 or 3 years, however, at least a small percentage of nitrogen in the fertilizer for the most commonly grown crops is advisable.

The presence of nitrogen in the fertilizer is not so important for those soils containing a high percentage of organic matter. In the

production of special, high-acre-value crops, some nitrogen is desirable, especially on fields in which the organic content of the soil has not been maintained well above the lower limit set for the soils of this group.

The need for potash in the fertilizer is most urgent in sandy soils, primarily because the rate of availability of the natural soil potash is very slow, and the total supply is also much less than in heavy soils. For grain crops a low to medium percentage of potash should be included in the fertilizer unless the land has been recently well manured. For truck crops and other high-potash-consuming crops, such as potatoes, alfalfa, the clovers, and root crops, a medium to high percentage of potash is advisable.

Small percentages of potash are usually sufficient for the grain crops grown on heavy soils, and when the land is systematically manured fertilizer containing no potash will usually give satisfactory results. For sugar beets, potatoes, and similar potash-loving crops there should be at least medium percentages of potash in the fertilizer.

Potash demands first consideration in choosing a fertilizer for muck and peat soils, percentages ranging from 15 to 32 percent being recommended. The fertilizer should usually contain from one-fourth to one-half as much phosphate as potash, depending on the crop grown, character of the soil, and previous fertilizer treatment. The percentage of nitrogen should range from 0 to 6 percent, depending on the natural characteristics of the muck and the requirements of the crop grown.

Soil amendments, or correctives, which are beginning to receive some attention in a practical way, are manganese compounds, sulphur, and copper sulphate. As yet, manganese compounds have not given sufficient promise in experimental trials to warrant recommending their common use on Michigan soils. On some high-lime and alkaline muck soils in other counties, applications of sulphur have proved beneficial for certain crops, especially onions and celery. Copper sulphate has proved of advantage on very acid mucks in the growing of onions, spinach, lettuce, and tomatoes.

For a more detailed discussion of the management and fertilization of muck soils refer to Special Bulletin 136 (6), Circular Bulletin 103 (2), and Extension Bulletin 123 (3) of the Michigan Agricultural Experiment Station. More specific information regarding the analysis of fertilizer which should be used for different crops when grown on the different soils of the county may be obtained from Circular Bulletin 53 of the Michigan Agricultural Experiment Station (5).

Many of the soils are not naturally sufficiently well drained for agricultural use, owing to flat relief, high water table, or underlying highly retentive clay. For such soils artificial drainage, preferably by tiling, is the first prerequisite for their successful use for cultivated crops. In planning the drainage system, it should be remembered that a suitable outlet is the first requirement. Until such outlet is obtainable, no further steps toward installing a system should be taken. The distance between tile lines is determined by soil conditions. In very heavy clay soils it is sometimes necessary to place drains 3 rods apart, whereas in very porous soils, tile lines

may be as much as 6 rods apart. The distance between drains in loam soils ranges from 4 to 5 rods. In sandy soils underlain by clay near enough to the surface that the tile must be laid in it, the drains must be placed closer together than they would be if the soil were uniform in texture to the depth of the tile.

The size of tile to be used in any case varies with (1) the area of land the line must drain, (2) whether it is to carry only the excess water due to rainfall on the area, or whether additional water from springs, seepage spots, or surface drainage from adjacent areas must be carried, (3) the length of the tile line, and (4) the fall or grade of the drain. It is usually assumed that under average conditions, with a fall of 3 inches to 100 feet, a 5-inch tile will drain 20 acres; a 6-inch tile will drain 30 acres; and an 8-inch tile will drain 70 acres. In few places is it considered advisable to use a tile less than 4 inches in diameter and then only as a lateral. In case the line is to be unusually long, or if water from laterals is to empty into it, the size of tile should be increased from place to place as the outlet is approached.

Every drainage system should be laid so that there is a gradual fall from the extreme end to the outlet. Where possible, a fall of 3 inches to 100 feet is desirable. With good construction a fall of 2 inches to 100 feet will prove satisfactory, and in some places necessity may demand that the grade be as low as 1 inch or even less to 100 feet. Under such conditions the greatest care should be exercised in laying the tile. Naturally with less fall a larger tile should be used.

In general, it is an economy to obtain advice concerning the drainage of any area of land from a drainage engineer or other person especially qualified for such work. Assistance will be particularly needed in running levels to determine direction of flow and the setting of grade stakes.

Excessive drainage of mucks and peats may be as unfavorable as an excessively wet condition, and it is therefore especially important that the tile be placed at a proper depth and that, where the soil is to be used for the intensive production of special crops, dams be provided for controlling the height of the water table. The drainage of these soils requires special consideration, and advice should be obtained from a specialist in the handling of such lands.

The soils requiring tile drainage are the soils of the Munuscong, Brookston, Ogemaw, Bergland, Maumee, Essexville, Saugatuck, Granby, Wisner, Thomas, Griffin, Wauseon, Newton, and Colwood series, also marsh, peats, and mucks.

There are rather inextensive areas of sandy soil which are so poorly retentive of water that moisture deficiency rather than a small supply of plant food is the chief factor in limiting crop production. Where water from streams, lakes, or shallow wells is available at low cost, irrigation might be practical on these soils for a few crops of high acre value, such as flowers, some small fruits, and truck crops. Increase in the organic matter of the plow layer of these soils may be helpful in retaining moisture, but it cannot be expected to overcome entirely the natural deficiency of the soils.

Soils on which moisture is likely to be a limiting factor for crop production are the Bridgman, Roselawn, Wallace, and Rubicon.

Certain soils of the county, namely, Berrien sandy loam, the Kawkawlin soils, Nester soils, Selkirk soils, and Eastport sand, occupy intermediate positions as regards moisture supply. These soils are for the most part naturally sufficiently well drained for agricultural purposes and at the same time are sufficiently moisture retentive, or have the water table near enough to the surface, that crops do not suffer greatly from drought in normal seasons.

The soils of Bay County are largely of heavy texture—loams, silt loams, and clay loams. A number of soils, particularly Kawkawlin loam, Nester loam, Selkirk silt loam, Bergland clay loam and loam, Thomas clay loam and loam, and Wisner clay loam and loam require heavy teams or high-power tractors, and they have a tendency to clod or to "run". The tillage defects may be overcome to some extent by increasing the content of organic matter through plowing under sweetclover or sod of alfalfa and clover, or by other means suggested under the part of this section dealing with organic matter.

Fall plowing of the heavier soils and especially those which have reached a poor physical condition is advisable, as freezing and thawing during the winter will help to restore their granular condition. Fall plowing also allows earlier seeding of spring grains. A disk harrow is a useful implement in preparing good seed beds on these soils, and a roller, preferably of the cultipacker type, is valuable.

Fall plowing of the sandier soils is not advisable, as the surface soil is so loose that serious blowing frequently results. It is desirable to have these soils covered with a sod-producing crop or by a cover crop of rye in winter, in order to prevent leaching of valuable plant food. The more frequently these soils can grow a sod-producing crop, preferably alfalfa or one of the clovers, the easier it will be to maintain their fertility. A cultipacker or similar type of roller is almost indispensable in tilling the sandier soils.

Soils with a rolling relief are subject to damage caused by water running over the surface and washing away the plow soil. Severe erosion may take place on slopes ranging from 5- to 10-percent gradient, and on slopes of 15 percent or more erosion is so destructive that it is not advisable to place such land under cultivation. Erosion can be prevented to some extent by plowing and running the crop rows across the slopes rather than in the same direction as the slope. Seeding to sweetclover or alfalfa and leaving the land in these crops for several years is one means of decreasing erosion and of restoring the productiveness of the soil. On land that has been so severely eroded that its productivity has been greatly lessened, it is advisable to seed grasses for permanent pasture or to plant trees. Water erosion is not of wide occurrence on the soils of this county, but it has been destructive in a few places on the more hilly land in Gibson and Mount Forest Townships and elsewhere on steep slopes bordering streams.

Wind erosion may be especially destructive on Rubicon sand, Bridgman fine sand, Arenac loamy sand, Roselawn sand, Wallace fine sand, and the more highly decomposed mucks. Not only is the surface soil blown away sufficiently to reduce the fertility of the land, but young crops, particularly seedings of clover, alfalfa, and sweetclover, on the sandy soils, and onions, on the mucks, are severely damaged. Seeding with a companion crop where the soil is strong

enough to support two crops, or seeding a legume in late spring or summer after the period of high winds is over, are methods of avoiding damage to seedings on sandy soils.

Soil blowing is controlled on muck by planting trees, especially willows, around the field, and, when growing onions, by planting a row of barley between every 3 rows of onions, or strips of 5 rows of rye at intervals across the field. Strips of burlap or bags may also be used to construct windbreaks across the field.

A large proportion of the original muck and peat land has been burned over at some time since the settlement of this section, either through accident or for the purpose of destroying the organic layer. The practice of burning for the purpose of land improvement may be justified where the muck lies at about the same level as the contiguous mineral soil and where the purpose is to utilize the burned-over land for the production of general farm crops. The removal of the muck or peat covering obviates the difficulty of providing favorable drainage for both muck and mineral soils occurring in the same field and allows the adoption of a uniform practice in the cultivation of crops. Burning is seldom advisable where the purpose is to use land primarily for the production of truck crops. It is also doubtful whether any benefit would result from burning deposits of peat which are 3 or more feet thick. Burning may increase the productivity of very acid mucks for crops that are sensitive to soil acidity. On the other hand, burning may decrease productivity if the muck is not strongly acid, owing to an accumulation of ash and an excessive amount of soluble salts. The unfavorable condition is sometimes remedied by plowing up the substratum, by removal of the excess lime and other salts in drainage water, or by neutralizing the acidity with soil amendments.

#### SUMMARY

Bay County is in the eastern part of the Lower Peninsula of Michigan and covers an area of 443 square miles. The urban population of the county is 47,355, and the rural, 22,119. Bay City, the county seat, is an important trading center and industrial city. It is a lake port and is connected with other important cities of the State by railways.

The county is well supplied with good roads, electric power, telephones, churches, and schools.

The surface relief is in general undulating but is almost flat in places.

The summers are of medium length and are mild or warm. Sudden changes of temperature are prevented to a great extent by the influence of Saginaw Bay and Lake Huron. The average frost-free period is from May 10 to October 7. In many years plowing can be done until November 15 or even later. The mean annual rainfall of 30.7 inches is well distributed throughout the year. The ground is usually frozen and covered with snow during the winter.

About three-fourths of the total area of the county had originally poor natural drainage. About 50 percent of the total area is now composed of once poorly drained heavy-textured very fertile soils that have been artificially drained and are used for general farm-

ing and dairying. Good yields of hay, oats, corn, wheat, barley, sugar beets, chicory, vegetables, truck crops, and crops of less importance are obtained.

The lighter textured soils give smaller yields and for the most part are not planted to sugar beets and chicory.

The sand soils of the county are very low in natural fertility and should not be farmed.

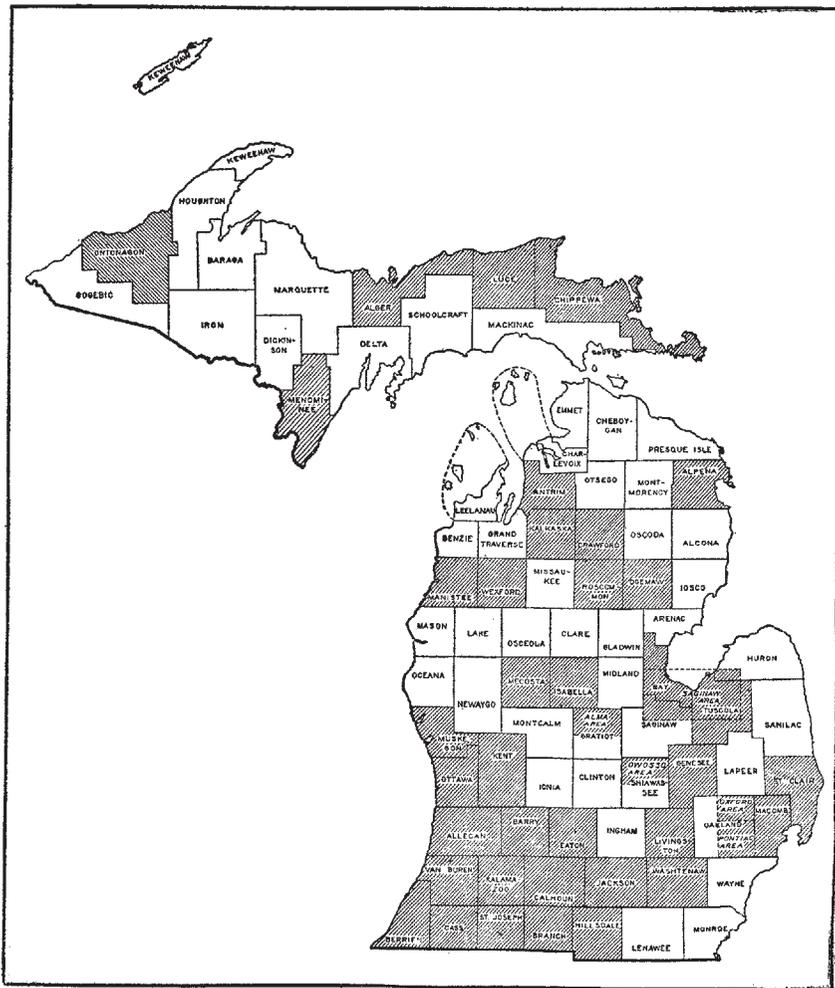
Considerable areas of State-owned land are in the county, but a comparison of a map published in 1930, showing State-owned land, and the soil map shows that the State owns practically none of the heavy-textured fertile soil areas. Some farms of first and second quality, scattered over the county, are now vacant. Large areas of very fertile soils along the bay shore may be utilized when economic conditions make it possible to dike the bay and install pumping stations for drainage. The most desirable cottage and summer-home sites along the bay shore have been largely taken up, but a large part of the shore is undesirable as building sites, on account of marsh areas extending inland from the water's edge, as well as because of the shallow water in the bay. The marshes make ideal duck-breeding grounds, and the bay shore and Saginaw River marshes are very popular with duck hunters.

#### LITERATURE CITED

- (1) BUTTERFIELD, G. E.  
1918. BAY COUNTY PAST AND PRESENT. 212 pp., illus. Bay City, Mich.
- (2) HARMER, P. M.  
1927. PREVENTION OF WIND INJURY TO CROPS ON MUCK LAND. Mich. Agr. Expt. Sta. Circ. Bull. 103, 8 pp., illus.
- (3) ———  
1932. MUCK SOIL MANAGEMENT FOR ONION PRODUCTION. Mich. Agr. Col. Ext. Bull. 123. 23 pp., illus.
- (4) LEVERETT, F., and TAYLOR, F. B.  
1915. THE PLEISTOCENE OF INDIANA AND MICHIGAN, AND THE HISTORY OF THE GREAT LAKES. U.S. Geol. Survey Monog. 53. 529 pp., illus.
- (5) MCCOOL, M. M., GRANTHAM, G. M., and HARMER, P. M.  
1923. STANDARD FERTILIZERS FOR MICHIGAN. Mich. Agr. Expt. Sta. Circ. Bull. 53, [4] pp.
- (6) ——— and HARMER, P. M.  
1925. THE MUCK SOILS OF MICHIGAN. THEIR MANAGEMENT FOR THE PRODUCTION OF GENERAL CROPS. Mich. Agr. Expt. Sta. Spec. Bull. 136. 78 pp., illus.
- (7) ——— and MILLAR, C. E.  
1929. SOME GENERAL INFORMATION ON LIME AND ITS USES AND FUNCTIONS IN SOILS. Mich. Agr. Expt. Sta. Spec. Bull. 91, 16 pp., illus. (Revised.)

Authority for printing soil survey reports in this form is carried in Public Act No. 269, Seventy-second Congress, second session, making appropriations for the Department of Agriculture, as follows:

There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than two hundred and fifty copies shall be for the use of each Senator from the State and not more than one thousand copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.



Areas surveyed in Michigan, shown by shading. Detailed surveys shown by north-east-southwest hatching; reconnaissance surveys shown by north-west-south-east hatching.

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