

# SOIL SURVEY OF THE SAGINAW AREA, MICHIGAN

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## LOCATION AND BOUNDARIES OF THE AREA.

The Saginaw area includes parts of Bay, Huron, Saginaw, and Tuscola counties, and comprises 984 square miles. It lies almost wholly within what is known as the Saginaw Valley, and is situated

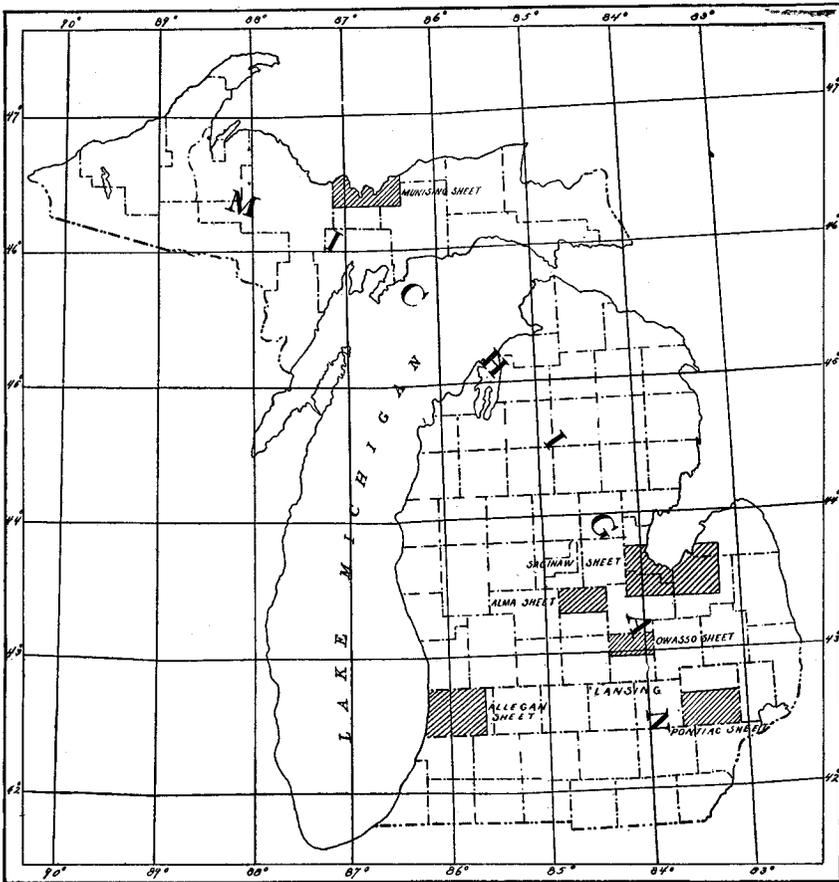


FIG. 25.—Sketch map showing location of the Saginaw area, Michigan.

between  $43^{\circ} 20'$  and  $43^{\circ} 45'$  north latitude and  $83^{\circ} 10'$  and  $84^{\circ} 10'$  west longitude. It is bounded on the north by Saginaw Bay and township 16 N., in Bay and Huron counties; on the east by Grant

Township, of Huron County, and the eastern tier of townships of Tuscola County in R. 11 E.; on the south by township 11 N. in Saginaw and Tuscola counties, except for a distance of 12 miles from the eastern edge, where an extra tier of sections is included in the survey, and on the west by Midland County and Richland Township of Saginaw County in R. 2 E.

#### HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

There were a few French trappers living among the Indians as early as 1811, but no white settlers occupied the valley until the Government erected and garrisoned Fort Saginaw in 1822. The establishment of a trading post at Fort Saginaw by the American Fur Company in 1824 brought a few more whites to the wilderness, and in less than three years settlers began to flock to the valley with the intention of making it their future home. By 1836 nearly all the land had been filed upon, either for actual occupation or for speculative purposes.

The whole area was heavily forested, and it was natural that the settlers should first direct their attention and energies to the lumbering industry. In fact, it was for a long time thought that the lands were good for little else than the timber they supported. This industry was carried forward with success until the early seventies, when it began to decline on account of the exhaustion of the supply. With the lumbermen, of course, came sawmills and large numbers of operatives. Many of these mills were located at Saginaw and Bay City, and it was about these two places that the various industries of the valley were built up.

The white settlers did very little farming until the decline of the lumbering industry. In the meantime, however, it had been fully demonstrated that the soils, when drained, were peculiarly adapted to farming, and the agricultural development of the valley began in earnest. In a period of thirty years the whole region has been transformed from a virtual wilderness into one of the best-developed and most prosperous farming sections of Michigan.

To the German immigration, which began as early as 1845, is due a great deal of the credit for the earlier agricultural development of the area, and the German element forms an important part of the present agricultural population. For the last fifteen years there has also been an influx of Poles to the area. Many of these immigrants have bought farms, but the larger number have joined the laboring classes, both in the cities and in the rural districts.

Saginaw was founded in 1822 and Bay City in 1836, but they were little more than names until after 1850. Saginaw Township, comprising a dozen or more of the present counties, was organized in

1831. In 1835 Saginaw County was organized under the Michigan Territorial government, and Tuscola in 1850 and Bay in 1857 under the State government.

The first railroad in the area was begun from Saginaw in 1859, extended to Bay City in 1867, and connected with lines to the south in 1872, giving the first railroad outlets to other parts of the country. Nearly all of the earlier transportation was by water.

## CLIMATE.

The summers in this part of Michigan are short and pleasant and the winters long and severe. July is the hottest and February the coldest month of the year. The proximity of the Great Lakes in general and Saginaw Bay in particular modifies the climate to a considerable extent, and it is not marked by sudden changes and violent extremes, although the range in temperature between the extremes of summer and winter is great. This equable character of climate, the dependable protection of the snows, and the freedom from erratic frosts are highly favorable to agricultural pursuits.

The data given in the appended tables are taken from Weather Bureau records of the stations at Saginaw and Vassar. Vassar is outside of the area, but is sufficiently near to be fairly representative of the higher portions of the area farther back from the bay front. It will be noticed that February is nearly 6 degrees colder at Vassar than at Saginaw. On the other hand, the annual rainfall is nearly 3 inches heavier at Saginaw.

At Saginaw the last killing frost in spring ranges from April 16 to May 23, and the first in fall from September 14 to October 14. The records of frost occurrence at Vassar are too fragmentary to show much. On the low, wet areas frost may be expected from one to two weeks earlier than on the higher, better drained lands. Occasionally the corn, bean, and cucumber crops are cut short by early fall frosts.

*Normal monthly and annual temperature and precipitation.*

Month.	Saginaw West Side.		Vassar.		Month.	Saginaw West Side.		Vassar.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	Inches.	° F.	Inches.		° F.	Inches.	° F.	Inches.
January .....	23.1	2.65	23.3	1.76	August .....	69.8	3.21	68.6	3.04
February .....	20.8	2.23	15.0	1.79	September .....	61.7	2.95	61.6	2.07
March .....	31.6	3.08	28.7	3.49	October .....	50.4	2.94	-----	3.16
April .....	46.2	1.95	45.8	1.45	November .....	37.7	2.53	38.2	2.22
May .....	59.0	3.11	56.4	3.11	December .....	26.9	1.90	26.1	1.34
June .....	67.9	2.87	65.1	2.53	Year .....	47.3	33.16	-----	30.44
July .....	72.8	3.69	71.0	4.48					

*Dates of first and last killing frosts.*

Year.	Saginaw.		Year.	Saginaw.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1896.....		Sept. 28	1901.....		Sept. 19
1897.....	May 23	Sept. 20	1902.....	May 11	Oct. 10
1898.....	May 6	Oct. 14	1903.....		Sept. 19
1899.....	Apr. 16	Sept. 14			
1900.....	May 5	Oct. 10	Average.....	May 6	Sept. 28

## PHYSIOGRAPHY AND GEOLOGY

The surface features of the Saginaw area fall into two main divisions—the lowlands of level or slightly rolling old glacial lake beds and the upland ridges of rolling and hilly glacial moraines.

The lacustrine lowlands occupy the whole northern, western, and central parts of the area, besides an intermorainic area between the two bodies of upland in the southeastern part, and make up about 935 square miles, or about 95 per cent of the area. As already stated, the topography of these lowlands is nearly level to slightly rolling or undulating. In elevation they vary from the level of Saginaw Bay, 580 feet above sea level, along Saginaw River and the shore of the bay, to about 700 feet at the base of the upland moraines. However, the intermorainic area is slightly higher, and rises gradually toward the southeastern corner of the survey. Numerous ridges or old beach lines are scattered throughout the lowlands. Those west of the Saginaw River extend in a general northwest-southeast direction, and nearly parallel the present bay front, while east of Saginaw River their trend is in a northeast-southwest direction, also paralleling in a general way the east front of the bay. In the western half of the survey these beaches form prominent ridges of medium to fine sand, with scarcely a trace of gravel, except in the lower depths. Some of these ridges rise to a height of from 10 to 30 feet above the adjoining level lands. In the eastern half of the survey the beach lines are not so prominently developed and are distinguished from the surrounding country by low swells or ridges, consisting of medium gravelly sand and sandy loam. Along the Saginaw River, between Saginaw and Bay City, is a considerable area so low lying as to be covered partially by water and only to a limited extent adapted to agricultural purposes. Parts of Beaver, Kawkaulin, Williams, Tittabawassee, and Thomastown townships, in the western part of the area, are quite rolling in the vicinity of some of the old beach lines, and as a whole are somewhat higher than the area farther east.

The intermorainic area previously referred to differs from the other lowlands in that it contains no heavy soils but consists of medium to coarse sands and stony sandy loams.

The morainic uplands in the southeastern part of the area occur in two bodies, separated, as before stated, by a body of lowlands. The more important of these two upland areas occurs as a ridge varying from 1 to 3 miles in width. It enters the area at Gagetown, on the eastern border, and extends in a southwesterly direction, passing just to the north and west of Caro and leaving the area about 18 miles from the southeastern corner. The other upland area occupies the extreme southeastern corner of the survey. The physiography of these uplands is characteristically that of a deposit left by a glacier during a halt of some duration.

The larger body, or ridge, at its greatest elevation rises to about 800 feet above sea level, or about 100 feet above the adjoining lowlands. Its surface is very rolling, but rarely so much so as to be a serious hindrance to cultivation. Some parts of the upland area occupying the extreme southeastern corner of the survey reach a height of about 900 feet above tide, and the topography is there more broken than in the strip farther west, yet a greater proportion of it is under cultivation.

The main drainage system of the area is the Saginaw River and its tributaries. This river has little fall, and the country on both sides is so level that artificial drainage is necessary over wide areas. The waters of the southwestern part of the area reach the Saginaw River through the Tittabawassee River, which flows in a southeasterly direction across Tittabawassee, Thomastown, and Saginaw townships, joining the Saginaw River just south of the area. In the southeastern part of the area the Cass River flows southwest across Ellington, Almer, Indian Fields, and Juniata townships, passing out of the area northeast of Vassar and emptying into the Saginaw River. Along the bay front are several small streams, the more important being the Sebewaing, Quanicassee, and Kawkawlin rivers.

The structural geology of the area is of no direct importance from an agricultural standpoint, as the underlying rocks are buried so deeply by deposits of glacial material that they have no influence upon the soils. These rocks all belong to the Carboniferous system. The Coal Measures are found everywhere in the area except along the eastern edge. Economically these deposits are of vast importance. At a depth of from 80 to 150 feet coal is found of sufficient thickness to mine profitably, giving an excellent fuel at a moderate price. Limestone from the coal mines furnishes excellent building stone, cement rock, road metal, and lime for clarifying purposes in

beet-sugar manufacture and for various other cases. Salt is also found at a depth varying from 700 or 800 feet at Saginaw to 1,050 feet at Bay City.

The surface geology consists entirely of glacial material, either as a land deposit, as with the upland ridges, or as reworked material deposited in an old lake formed about the southern extremity of the ice sheet. The lake deposits, or lowlands, were subsequently modified to some extent by wave action on the retreat of the old lake to the present position occupied by Lake Huron. These glacial deposits range from 50 to 100 feet or more in thickness, and carry only a small percentage of gravel, except east of Cass River, where there are a number of boulders strewn over the surface, and occurring to a less extent in the soil mass. The gravel is chiefly granitic.

## SOILS.

Seventeen different types of soil were recognized in the area. The name and actual and relative extent of each of these are given in the following table:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Clyde loam .....	242,496	38.5	Miami gravelly sand .....	14,176	2.2
Clyde sandy loam .....	84,608	13.4	Saginaw sandy loam .....	12,992	2.1
Miami sand .....	52,000	8.3	Clyde gravelly sand .....	10,496	1.6
Clyde fine sandy loam .....	39,104	6.2	Miami fine sandy loam .....	10,048	1.6
Miami fine sand .....	36,608	5.8	Clyde stony sandy loam .....	8,000	1.3
Muck .....	30,784	4.9	Clyde silt loam .....	3,904	.6
Clyde clay .....	26,560	4.2	Swamp .....	1,844	.2
Miami clay loam .....	26,240	4.2	Total .....	630,016	-----
Meadow .....	16,000	2.5			
Clyde sand .....	14,656	2.3			

## MIAMI SAND.

The Miami sand is a loose brown sand of medium to coarse texture, 6 to 9 inches deep, underlain to a depth of 3 feet or more by a similar sand of a reddish-brown or yellow color. The soil is generally deficient in organic matter, but the small amount present renders it loamy and more retentive of moisture. In the native state the soil is practically devoid of organic matter except in the first inch or so.

Owing to a wide range of drainage conditions, there is considerable variation in the color of both soil and subsoil. In the depressions patches of Muck are frequently found, and from these to the higher areas there is a gradation of color from dark to light. The sand for the entire depth of 3 feet may be of a light-gray color, and again

only a few inches of the surface may be a light gray, the soil soon changing to yellow or brown. More rarely the surface may be brown and the subsoil white. All these variations may occur within very limited areas, and often give a spotted appearance to a newly plowed field. The ridges, hillocks, and more broken areas in general follow the type description.

The Miami sand is the most extensive soil type east of Cass River. Smaller areas border the river on the west. Between the moraine hills lying between Caro and the bay occur numerous beach formations, which are occupied partly by this type and partly by the Miami gravelly sand, the latter being found principally on the larger ridges.

The origin of the type is somewhat varied. West of Caro it is mostly material deposited along the beaches of the glacial lakes, while to the east and south of Caro it has originated partly from material brought down by glacial streams and deposited in the old lake once covering that section, and partly from glacial deposits without the intervention of lacustrine agencies.

The topography and drainage features of the type vary in areas of different origin. Where it occupies portions of old beach lines the surface consists of low, gently rolling ridges, while in the larger areas it varies from nearly level to a ridgy, hilly, and broken topography. A few areas in the southeastern corner of the survey have the topography typical of glacial uplands. The more broken and rolling areas are generally well drained, while the level areas usually have poor drainage, and often approach the condition of true swamp.

The type is still largely in an unimproved state. Some of it is used for summer pasturage, but this is of a very poor character. The larger areas were originally heavily forested with pine, but since this has been removed swamp poplar (quaking aspen) has become the principal tree growth, and is used to a limited extent for fuel. The beaches immediately along the bay front support a scanty growth of oak, and farther inland there is a mixture of oak, maple, and beech.

The cultivated areas are devoted to the general farm crops, the yields being usually light and uncertain. Some attention is also given to dairying and to special crops, such as sugar beets, beans, potatoes, cucumbers, and fruits. This soil is unsuitable for beet culture, but the other special crops mentioned give good results when properly fertilized and cared for. Among the fruits apples, pears, cherries, grapes, and raspberries do well. This soil should be used for truck and fruit crops rather than for general farm purposes. Certain undesirable areas should be drained and reforested with pine.

Mechanical analyses of the fine earth of a representative sample of this soil are given in the following table:

*Mechanical analyses of Miami sand.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005	Clay, 0.005 to 0
			mm.	mm.	0.25 mm.	mm.	0.05 mm.	mm.	mm.
11781	NE. cor. sec. 22, T. 12 N., R 9 E.	Medium to coarse sand, 0 to 6 inches.	<i>P. ct.</i> 1.8	<i>P. ct.</i> 26.0	<i>P. ct.</i> 25.9	<i>P. ct.</i> 33.0	<i>P. ct.</i> 3.3	<i>P. ct.</i> 5.4	<i>P. ct.</i> 4.6
11782	Subsoil of 11781 .....	Medium to coarse sand, 6 to 36 inches.	2.4	37.6	27.3	24.2	2.5	2.4	2.8

MIAMI GRAVELLY SAND.

The Miami gravelly sand consists of a brown gravelly sand, of medium to coarse texture, 9 to 12 inches deep, grading through a lighter brown gravelly sand into a mixture of coarse sand and fine gravel at a depth of about 3 feet below the surface. In some places the underlying gravel comes within a few inches of the surface.

This type of soil is closely associated with the Miami sand, and except for the gravel it contains might be classed as the Miami sand. It also resembles in many respects the Clyde gravelly sand, the latter type, however, being of more value for agricultural purposes.

The Miami gravelly sand owes its origin to material deposited by wave or stream action. It occupies mainly the larger of the ridges lying between Caro and the bay and represents old beach lines. It may occur also in patches bordering or within areas of the Miami sand. Its usually rolling or ridgy topography insures good drainage.

The type produces about the same crops as are grown upon the Miami sand, but the yields are somewhat better.

The following table gives the results of mechanical analyses of a typical sample of this soil:

*Mechanical analyses of Miami gravelly sand.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005	Clay, 0.005 to 0
			mm.	mm.	0.25 mm.	mm.	0.05 mm.	mm.	mm.
11779	N. cen. SE. $\frac{1}{4}$ sec. 2, T. 12 N., R. 9 E.	Medium to coarse sand, 0 to 8 inches.	<i>P. ct.</i> 1.5	<i>P. ct.</i> 25.1	<i>P. ct.</i> 36.2	<i>P. ct.</i> 25.7	<i>P. ct.</i> 2.7	<i>P. ct.</i> 3.7	<i>P. ct.</i> 4.9
11780	Subsoil of 11779 .....	Coarse sand, 8 to 36 inches	1.7	23.5	36.3	27.0	4.0	3.2	3.8

## CLYDE SAND.

The Clyde sand is an intermediate type between the Miami sand and Miami fine sand on the one hand, and true Muck on the other, and its real character is most nearly expressed in the term "mucky sand." The soil is a dark-gray to black medium-textured sand 8 to 14 inches deep, underlain by an incoherent white sand of medium or coarse texture to a depth of  $2\frac{1}{2}$  feet, where a heavy silty clay is usually encountered. Occasionally the depth to clay is more than  $2\frac{1}{2}$  feet, and where slightly better conditions of drainage are found the subsoil consists of a light-yellow sand. A small proportion of fine gravel is found in parts of the type. The large amount of organic matter present in the soil renders it loamy and mellow and causes it to be quite retentive of moisture.

The type is of lake or stream origin and is still in process of formation along the bay front. Unlike the Miami fine sand, with which it is often associated, it has not been modified to any extent by wind action. It also differs from the fine sand in topography, occupying level areas. It is naturally poorly drained, which accounts for its mucky condition.

The larger areas occur in Bangor, Hampton, Merritt, Gilford, Wisner, Akron, and Sebawaing townships, and smaller ones are found throughout the survey, generally associated with areas of the Miami sand, the Miami fine sand, or Muck. Under better drainage conditions the greater part of the areas mapped as Meadow and Swamp along the bay front would become Clyde sand.

Where artificial drainage has been resorted to, the Clyde sand is one of the most desirable soils of the area for truck farming, and under careful management nearly all of the general crops can be grown with satisfactory results. To maintain the productivity of this soil, it is necessary to keep it well supplied with organic matter, or else it reverts to a physical condition more nearly like that of the other sandy soils of the area. With level topography and a comparatively shallow clay subsoil, this type is, however, more susceptible of lasting improvement than either of the other sandy types.

The areas shown in the eastern part of the area are used largely for general farming, and in a small way also for dairying, while those occurring in the western part of the survey are used for a diversity of crops. Besides corn, oats, wheat, timothy, clover, and buckwheat, of the general farming crops, beets and chicory are extensively grown. In fact, the Saginaw sandy loam and Clyde sand are the principal chicory soils of the area. Corn will yield on an average from 20 to 35 bushels per acre, wheat from 15 to 30 bushels, beets from 10 to 15 tons, chicory about 10 tons, and the other crops proportionately well. On the western half of the areas a large acreage is devoted to trucking. Cabbage, cauliflower, tomatoes, potatoes, onions, cucumbers, and beans are the principal truck crops.

Areas lying along the shore of the bay are used only for summer pasturage.

The following table gives the results of mechanical analyses of typical samples of the Clyde sand:

*Mechanical analyses of Clyde sand.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.06 mm.	Silt, 0.06 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
11775	SE. cor. of SW. ¼ sec. 32, T. 14 N., R. 6 E.	Black medium sand, 0 to 9 inches.	0.2	2.8	26.7	58.8	4.3	2.8	3.9
11777	W. side of SW. ¼ sec. 22, T. 14 N., R. 6 E.	Black medium sand, 0 to 14 inches.	1.2	7.2	23.6	48.7	6.7	7.3	5.1
11776	Subsoil of 11775 .....	Gray medium sand, 9 to 36 inches.	.2	4.8	27.4	61.7	3.6	.5	1.5
11778	Subsoil of 11777 .....	Medium sand, 14 to 30 inches.	1.0	7.1	24.4	57.3	4.9	1.9	3.0

MIAMI FINE SAND.

The Miami fine sand is a medium to fine incoherent brown or gray sand from 6 to 9 inches deep, underlain by a similar textured sand of a reddish-brown color, generally changing to a lighter color in the lower depths. The sand ranges from 3 to 30 feet in depth, and is almost entirely devoid of gravel, except just above the clay line, where a streak of gravelly medium to coarse sand is usually found, similar to the material composing the Miami gravelly sand.

Nearly all of the larger areas of this type are poorly drained, and in the depressions the soil grades toward Muck or the Clyde sand. Except in such areas the type carries a very small proportion of organic matter.

The surface features range from slightly undulating and hilly in some of the larger areas to ridges in the old beach lines, from 5 to 25 feet above the adjoining lowlands. The ridges are fairly well drained, while the intervening depressions and level areas usually have poor drainage.

This soil is entirely of lake origin, being derived either from beach deposits subsequently drifted into ridges and hillocks by the winds, or from materials forming the deltas of some of the streams flowing into the glacial lakes already referred to as covering at one time the greater part of the territory included in the survey. These delta areas, too, have been modified to some extent by wind and wave action. A considerable area at the mouth of the Kawkawlin River and a larger area bordering the Cass River in Juniata Township are believed to be delta deposits, while the remaining areas are mainly old beach lines.

The largest area mapped is south of Watrousville, in Juniata Township, and many others are found in the vicinity of Bay City and west of Saginaw and Tittabawassee rivers. One prominent ridge extends from Bay City through Kawkawlin and out of the area in section 3 of Kawkawlin Township; another begins just north of West Saginaw and extends in a generally northwesterly direction, passing out of the area in the northeastern corner of Beaver Township; still another beach ridge lies west of the Tittabawassee River. The eastern and southern edge of the latter area is very abrupt, rising to a height of about 30 feet above the level lands at the base, but on the west side it gradually slopes away and spreads out almost imperceptibly into the Clyde loam. The area in Juniata Township is uniformly a fine sand; the other areas are mixtures of the two grades characteristic of the type.

All areas of the Miami fine sand, except some of the more recent beach lines, were originally heavily timbered with pine, as was the case with the Miami sand. Since the pine has been removed poplar, willow, cottonwood, and birch constitute the principal forest growth. Some of the better-drained ridges support a growth of oak.

Some corn, oats, rye, timothy, clover, buckwheat, and in a more limited way, Hungarian millet, potatoes, cucumbers, beans, and sugar beets are grown on the Miami fine sand. Cucumbers, potatoes, and rye do well with proper cultivation, but the other crops mentioned give light and uncertain yields. Apples and berries also do fairly well. Much of the type ought to be reforested to pine rather than cultivated to farm crops. At present large areas are valuable only for what pasturage they afford.

The results of mechanical analyses of this soil are given in the following table:

*Mechanical analyses of Miami fine sand.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.		
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
11785	SE. cor. sec. 28, T. 12 N., R. 3 E.	Fine sand, 0 to 36 inches.	0.1	0.2	0.2	72.1	21.9	2.0	2.7
11783	SE. cor. sec. 8, T. 14 N., R. 5 E.	Medium to fine sand, 0 to 6 inches.	.1	2.8	31.0	58.6	2.5	1.7	3.0
11178	Sec. 14, Frankentlust Tp.	Medium to fine sand, 0 to 8 inches.	.4	8.8	27.8	53.5	4.1	1.9	3.4
11784	Subsoil of 11783 .....	Medium to fine sand, 6 to 36 inches.	.0	2.0	32.1	63.1	.8	.2	1.5
11179	Subsoil of 11178 .....	Medium sand, 8 to 36 inches.	.5	11.7	29.0	46.4	8.0	2.1	2.3

## CLYDE GRAVELLY SAND.

The soil of the Clyde gravelly sand, to a depth of from 9 to 12 inches, is a medium-textured, dark-brown loamy sand, or light sandy loam, carrying from 5 to 20 per cent of gravel from one-half to 1 inch in diameter. The subsoil is a rather coarse, incoherent gravelly sand, grading into a mixture of coarse sand and fine gravel at a depth of from 24 to 30 inches. Clay is found at from 4 to 8 feet below the surface. The soil contains a normal amount of organic matter and does not bake or clod under cultivation. The type as a whole is naturally well drained.

The topography varies from gentle slopes along the glacial foothills to low, broad, gently rolling ridges, representing old beach lines, farther out in the lowlands. The type occurs only as the result of beach or shallow-water deposition, although in places it has been influenced to some extent by local wash from the higher lands. The Miami gravelly sand and this type are of the same origin, and are often found associated, but they differ in that the Clyde gravelly sand is more level, more loamy, and a better soil for agricultural purposes.

This soil is found in strips from one-eighth to 1 mile wide on each side of the glacial uplands west of the Cass River, and also as far west as Fairgrove, Akron, and Unionville. Very little specialized farming is practiced on this soil, although all the crops of the area are grown to some extent. Fairly good yields of corn, oats, wheat, rye, timothy, clover, and buckwheat are obtained. Sugar beets, beans, potatoes, and other special crops are grown on a more limited acreage. Sugar beets do fairly well, and the main difficulty is that of getting a good stand. This soil is well adapted to fruit and truck crops and should be devoted more largely to their production.

The following table gives the mechanical analyses of fine earth of typical samples of this soil:

*Mechanical analyses of Clyde gravelly sand.*

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
11773	Con. sec. 34, T. 14 N., R. 8 E.	Sandy, 0 to 9 inches .....	4.2	16.1	21.4	36.6	4.6	8.5	8.2
11771	E. con. sec. 36, T. 13 N. R. 8 E.	Gravelly sand, 0 to 9 inches.	2.3	13.3	19.3	35.8	8.0	12.3	8.4
11774	Subsoil of 11773 .....	Coarse gravelly sand, 9 to 36 inches.	3.5	16.8	27.5	38.5	4.0	3.6	5.8
11772	Subsoil of 11771 .....	Medium to coarse sand, 9 to 36 inches.	2.2	15.3	23.2	36.0	7.6	7.5	7.6

## CLYDE SANDY LOAM.

The Clyde sandy loam, in typically developed areas, is a dark-gray or brown medium-textured sandy loam from 8 to 12 inches deep, resting on material of similar texture but lighter color, underlain at 18 inches by a drab or brownish mottled light sandy clay, sometimes tending more toward a sticky sandy loam. Scattered through both soil and subsoil is a small quantity of rounded and subangular crystalline gravel from one-half to 1 inch in diameter, and occasionally some coarser gravel is strewn over the surface. Nowhere, however, is the amount of gravel sufficient to change the structural characteristics of the soil. The soil carries a fair percentage of organic matter, is easily brought into a good tilth, and does not bake or clod to any extent.

A shallower and heavier phase of the type is a sticky, gray medium to fine sandy loam 8 to 12 inches deep, underlain by a sandy clay. Areas of this character are usually not very large and are a gradation between the typical sandy loam and the Clyde loam. Here the soil crusts and clods rather badly, and generally gives unsatisfactory results when used for crops requiring clean culture. However, for grasses and the small grains the difference is less marked and often inappreciable.

The Clyde sandy loam occurs mostly west of the Saginaw River, and to a less extent in all the townships of the area west of the glacial uplands passing just to the north and west of Caro. An extensive area extends from Saginaw to the northwestern corner of the survey. Around Bay City to the east and northwest are many smaller areas.

The larger areas have a level to gently rolling topography, and are slightly higher than the adjoining areas of the Clyde loam. Occasionally there is a broad, shallow depression, or perhaps a low, broad swell or ridge. The natural drainage of the type is fairly good, but artificial drainage is necessary in places.

The origin of this soil is somewhat varied. The large area paralleling the Tittabawassee River is a water-laid moraine. It seems that this broad elevation was above water before the lower lands on each side and received considerable sandy beach deposits, portions of which have been mapped as a sand. Some of the areas in the vicinity of Bay City also occupy the remnants of an old water-laid moraine, while the remaining areas throughout the survey are derived from beach or shallow-water deposits laid down in somewhat the same way as the Saginaw sandy loam, but now at a higher level and better drained. The large morainic area is formed of the typical Clyde sandy loam as far north as the middle of Williams Township, from which point to the northern corner of Beaver Township it assumes a

more variable character, though conforming generally to the shallow-phase description. Nearly all the small areas around Bay City should also be grouped with the shallower phase.

Nearly all of the Clyde sandy loam is devoted to general farming and dairying, the production of sugar beets, beans, potatoes, apples, pears, grapes, etc., being followed also, though less extensively. The crop yields are good, and for general farming this soil ranks next to the Clyde loam—the best general-purpose soil of the area. The smaller areas are undesirable for the production of sugar beets because of the undulating topography and variability in soil texture. These variations often occur within the limits of a small field, making it impossible to give each a separate treatment, and as a result the beets will be quite irregular in size and quality. Uniform areas, however, give a good growth of beets of excellent quality, and about 10 tons is considered a fair average yield. For beets, especially, the organic content of the soil should be kept as high as possible, and this is best done by following a good system of rotation and giving the fields liberal applications of stable manure.

The results of mechanical analyses of the fine earth of this soil are given in the following table:

*Mechanical analyses of Clyde sandy loam.*

No.	Locality.	Description.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
11788	SW. cor. of SE. $\frac{1}{4}$ sec. 12, T. 14 N., R. 8 E.	Medium sandy loam, 0 to 12 inches.	2.4	11.6	11.4	29.1	10.3	21.3	13.2
11786	NW. cor. sec. 13, T. 13 N., R. 3 E.	Medium sandy loam, 0 to 14 inches.	.9	12.6	18.3	28.3	8.5	16.1	14.7
11174	$\frac{1}{4}$ mile NW. of Kaw-kawlin.	Medium sandy loam, 0 to 10 inches.	1.0	5.8	14.9	29.2	18.0	17.8	18.1
11787	Subsoil of 11786 .....	Coarse sandy loam, 14 to 36 inches.	.9	10.3	16.8	26.3	7.3	16.4	21.7
11175	Subsoil of 11174 .....	Sticky sandy loam, 10 to 36 inches.	1.8	7.2	13.6	24.3	11.1	18.2	23.6
11789	Subsoil of 11788 .....	Light loam, 12 to 36 inches.	2.7	10.1	11.2	20.7	10.1	21.4	23.7

## SAGINAW SANDY LOAM.

The Saginaw sandy loam is a more loamy phase of the materials which give rise to the Clyde sand, and its origin, mode of occurrence, and drainage features are essentially the same as those of that type, namely, lacustrine deposition, level topography, and naturally deficient drainage. The soil to a depth of from 12 to 15 inches is a dark-gray to black medium-textured sandy loam carrying a high percentage of organic matter, which has accumulated as a result of poor drainage conditions. The soil is loose, mellow, and easily kept in good tilth. The subsoil is a dark-gray sandy loam of about the same texture as the soil to a depth of from 2 to 2½ feet, where it is underlain by a heavy blue silty clay.

Occupying, as it generally does, an intermediate position between the Clyde sand and Clyde loam, the type varies from a sandy loam, as above described, to a heavier gray or black sandy loam underlain by clay at less than 2 feet. The heavier areas have a tendency to clod and bake, partly on account of the heavy character of the soil and partly because these areas are either now or else recently have been in a poorly drained condition.

The principal areas of the Saginaw sandy loam are found in Bangor, Hampton, Merritt, Frankenlust, Saginaw, Buena Vista, Akron, Wisner, and Sebewaing townships. Smaller areas are found in other parts of the survey. Areas extending along the Saginaw River are rather more sandy than the remainder of the type.

When properly drained, this is a very desirable soil for a great variety of crops. The soil contains considerable organic matter, retains moisture well, is sandy enough to be easily handled, and at the same time is susceptible of lasting improvement, as clay is rarely over 2½ feet below the surface. In places trucking is the principal industry, and such crops as cabbage, cauliflower, tomatoes, potatoes, cucumbers, cantaloupes, and beans are grown with very satisfactory results. Sugar beets and chicory do well, this being one of the principal chicory soils of the area. In respect to general crops, some corn, wheat, oats, timothy, clover, buckwheat, etc., are grown. Beets will yield from 10 to 20 tons per acre, chicory about 10 tons, corn from 35 to 50 bushels, and wheat from 15 to 30 bushels. In connection with general farming some cattle are generally kept for dairy purposes.

Parts of the type are still undrained and used only for summer pasturage. Some of the lands mapped as Meadow between Bay City and Saginaw would be classed as the Saginaw sandy loam if reclaimed.

The following table gives the results of mechanical analyses of representative samples of this soil type:

*Mechanical analyses of Saginaw sandy loam.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.		
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
11792	NW. cor. sec. 2, Merritt Tp.	Medium sandy loam, 0 to 14 inches.	1.0	8.5	21.3	43.9	7.9	10.6	6.6
11790	E. cen. sec. 21, T. 14 N., R. 6 E.	Medium sandy loam, 0 to 12 inches.	.7	6.9	22.0	33.5	8.7	19.5	8.7
11793	Subsoil of 11792.....	Medium sand, 14 to 30 inches.	1.1	8.5	19.5	48.8	8.8	8.2	4.7
11791	Subsoil of 11790.....	Medium sandy loam, 12 to 24 inches.	1.9	9.0	20.1	34.0	8.5	16.5	9.2

CLYDE STONY SANDY LOAM.

The Clyde stony sandy loam is a medium-textured, gravelly sandy loam, 18 to 24 inches deep, underlain by a sandy loam or mottled brown clay loam containing a small amount of gravel. The color of the soil varies from a dark brown near the surface to a lighter brown in the lower depths. The soil proper is from 10 to 12 inches deep, and generally contains from 5 to 10 per cent of gravel from one-half inch to 2 inches in diameter.

A more noticeable characteristic of the type is the large number of boulders strewn over the surface and occurring to a less extent below the surface. These boulders are mainly of granite and range from large rounded gravel to angular fragments 2 or 3 feet in diameter. In bringing the soil under cultivation the larger gravel and boulders are removed and piled in large heaps or else hauled away and used for building purposes or for the construction of fences around the fields. With the stones removed from the surface, the soil is a good friable sandy loam, slightly more porous than is usual with soils of this class on account of the small gravel present. A few local areas are entirely free from gravel.

Excepting a few small areas in Columbia Township, this type is found only east of the Cass River, where it is associated with the Miami sand. It is of glacial or lake origin, has level to generally rolling topography, and is naturally fairly well drained in the larger areas. Some of the smaller areas receive seepage from the higher lands, while others are hemmed in on all sides by more elevated areas of sand and have only a sluggish drainage outlet, if any at all.

The greater part of this soil type is in an improved state and used mainly for general farming. Sugar beets, beans, cucumbers, and potatoes are grown on a small scale. Corn will yield from 25 to 40 bushels, oats from 20 to 50 bushels, wheat from 15 to 20 bushels, beans from 10 to 20 bushels, hay from 1 to 1½ tons, and sugar beets anywhere from 7 to 15 tons, per acre.

The results of mechanical analyses of the fine earth of this soil are given in the following table:

*Mechanical analyses of Clyde stony sandy loam.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.	mm.	mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
11769	S. cen. of SW. ¼ sec. 8, T. 12 N., R. 10 E.	Medium sandy loam, 0 to 12 inches.	1.0	6.2	13.1	40.8	11.5	18.5	8.7
11767	NW. cor. sec. 15, T. 12 N., R. 10 E.	Medium sandy loam, 0 to 10 inches.	1.5	6.2	10.6	44.3	13.2	14.0	9.7
11770	Subsoil of 11769 .....	Sandy loam, 12 to 36 inches.	1.1	6.2	12.9	40.3	10.5	18.0	10.5
11768	Subsoil of 11767 .....	Sandy loam, 10 to 36 inches.	1.0	4.9	10.7	41.1	14.8	15.0	11.8

CLYDE FINE SANDY LOAM.

The soil of the Clyde fine sandy loam, to a depth of from 9 to 12 inches, is a very fine sand to fine sandy loam of a brownish-gray or brown color, very homogeneous in texture, friable, and easily kept in good tilth. The subsoil is a brown or yellow fine sand or fine sandy loam to a depth of 2 feet or more below the surface, overlying a clay similar to the subsoil of the Clyde loam. Both soil and subsoil are entirely devoid of gravel.

This soil is found principally west of the Saginaw River. Two large areas parallel the Tittabawassee River, one on each side. Other large areas are found in Williams, Beaver, Kawkawlin, and Monitor townships. Several smaller areas were mapped in other parts of the survey, the most important being in Brookfield Township.

The type is slightly undulating to rolling in topography, and a field under cultivation will often present a billowy appearance from the numerous small hillocks and narrow depressions running in all directions. Again, whole farms will be nearly level. Some of the smaller areas are wind-blown beach deposits, occurring in the form of low ridges, while the larger areas seem to be the result of deltas formed in the old lakes that once covered the area. These areas have

subsequently been modified by wind and wave action on the subsidence of the lake. The broad strips along the Tittabawassee River no doubt represent ancient deltas, as do the large areas in Beaver, Kawkawlin, and Monitor townships. The areas in Williams Township seem to be mostly wind-blown beach deposits.

The drainage of the type varies largely with the state of development and local physiography. In an undeveloped state the ridges are generally high enough to be naturally well drained, while the intervening depressions are often in a swampy condition. A growth of tamarack is commonly found in the narrow, mucky strips, which support also a jungle of water-loving plants. Where farmed the drainage of the type has, of course, been improved by artificial means.

Besides the products of general farming and dairying, sugar beets, beans, and potatoes are important crops, and, to a less extent, chicory, apples, pears, grapes, and vegetables. Corn will yield from 20 to 40 bushels per acre, oats from 30 to 60 bushels, beans from 10 to 25 bushels, hay from 1 to 1½ tons, beets from 10 to 15 tons, and chicory from 7 to 12 tons.

The more level areas are well adapted to sugar beets, but, as with the Clyde sandy loam, in order to get uniformly good results it will be necessary to keep the soil liberally supplied with organic matter, which can be accomplished by applying manure and practicing a well-planned system of rotation. Though this is a porous soil tile drainage will prove very beneficial, especially where beets are to be grown. The comparatively shallow depth to clay subjects some of the lower lying areas to sidehill seepage, a condition that can best be provided against by tile drains.

The results of mechanical analyses of this soil are given in the following table:

*Mechanical analyses of Clyde fine sandy loam.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005	Clay, 0.005 to 0
			mm.	mm.	0.25 mm.	mm.	0.05 mm.	mm.	
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
11794	W. cen. sec. 23, T. 12 N., R. 3 E.	Very fine sand, 0 to 12 inches.	0.1	0.2	0.3	18.7	64.5	8.9	6.8
11796	NW. cor. sec. 28, T. 14 N., R. 3 E.	Very fine sandy loam, 0 to 9 inches.	.1	.7	.9	12.7	35.0	41.4	8.7
11795	Subsoil of 11794	Fine sand, 12 to 36 inches.	.0	.3	.2	34.8	49.7	12.2	2.6
11797	Subsoil of 11796	Fine sandy loam, 9 to 30 inches.	.0	.4	.6	18.9	41.5	30.1	8.3

## MIAMI FINE SANDY LOAM.

The Miami fine sandy loam is a medium to fine sandy loam, 18 to 24 inches deep, underlain by a brown mottled clay loam. The color of the soil is a brownish gray to a depth of about 12 inches, below which it is a light brown to the clay line. The soil contains a rather small percentage of organic matter, and on drying after a rain the surface often has a light ashy appearance. It also has a tendency to bake and crust to a limited extent when used for crops requiring clean cultivation. A small amount of gravel is common to the type, being more abundant in the soil than in the subsoil.

A lighter phase of the Miami fine sandy loam, which occurs so intermixed with typical areas that the two can not well be separated, is a slightly gravelly fine sand, 18 to 24 inches deep, overlying the clay, with surface features and colorations about the same as in typical areas. This phase is used for the same crops, and the yields are essentially the same as with the typical soil.

The Miami fine sandy loam is found only in the eastern part of the area. The larger areas are in the southeastern corner of the survey, between Gagetown and Cass River, along the eastern border. Smaller areas are scattered through the morainic uplands extending in a southwesterly direction from Gagetown.

The topography is that of typical morainic uplands, very hilly and undulating, with local variations in elevation from 10 to 50 or more feet. The general elevation is about 100 feet above the leveler lowlands. The drainage, as a rule, is very good, and in some places on the ridges and hillsides excessive. Some of the depressions are springy and often contain small areas of Muck.

Nearly all of this type of soil is cultivated to general farm crops, and in a limited way to sugar beets, beans, and potatoes. Some attention is also given to dairying and to apples, pears, and grapes, to which fruits it is specially adapted. The crop yields range from light to medium, being somewhat variable on account of the broken topography occupied by the type.

The following table gives the results of mechanical analyses of the fine earth of samples of the soil and subsoil of this type:

*Mechanical analyses of Miami fine sandy loam.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.		
11761	N. cen. sec. 4, T. 11 N., R. 10 E.	Fine sandy loam, 0 to 18 inches.	P. ct. 1.3	P. ct. 8.0	P. ct. 11.4	P. ct. 27.3	P. ct. 11.5	P. ct. 26.7	P. ct. 13.6
11759	E. cen. NE. ¼ sec. 18, T. 12 N., R. 8 E.	Fine sandy loam, 0 to 18 inches.	3.5	10.5	14.7	22.8	8.2	22.3	17.9
11762	Subsoil of 11761 .....	Clay loam, 18 to 36 inches.	.5	4.9	8.9	22.1	11.2	25.8	26.6
11760	Subsoil of 11759 .....	Clay loam, 18 to 36 inches.	1.9	8.5	8.9	17.5	8.8	26.4	27.9

CLYDE SILT LOAM.

The Clyde silt loam is a light to chocolate-brown silt loam 10 inches deep, resting upon a similar silt loam of a lemon-yellow color and containing little or no organic matter. The texture is very homogeneous to a depth of 3 feet, and gravel is entirely absent, except for a number of bowlders strewn over the surface, which are removed when the land is being brought under cultivation. The soil is very friable and easily kept in good tilth.

The type is of very limited extent, and occurs in a single area lying north of Gagetown, in Brookfield Township. Its origin is somewhat uncertain, but it seems to be derived, as is the greater part of the Clyde fine sandy loam, from material carried by streams into the glacial lake and there deposited. The topography of the type is somewhat rolling and its drainage fairly good.

The soil is devoted to general farm crops, and in a limited way to the production of chicory. It is well adapted to grain and hay, and the yields are good.

The results of a mechanical analysis of this soil are given in the following table:

*Mechanical analysis of Clyde silt loam.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.		
11806	SW. cor. of NE. ¼ sec. 26, T. 15 N., R. 10 E.	Friable silty loam, 0 to 36 inches.	P. ct. 0.2	P. ct. 0.9	P. ct. 1.0	P. ct. 2.9	P. ct. 11.5	P. ct. 64.9	P. ct. 18.2

## MIAMI CLAY LOAM.

The Miami clay loam occurs in two phases, which are very intimately associated and seem to be of the same agricultural value. The more extensive phase, and therefore what may be considered the typical soil, is a friable brown loam of a silty nature, 8 to 12 inches deep, underlain by a mottled brown clay loam to undetermined depths. The other phase is a light-brown fine sandy loam, 8 to 12 inches deep, underlain by the same kind of clay loam as above described. A very small amount of gravel is common in soil and subsoil of both developments of the type.

There are other minor variations in the type, as a result of different conditions of drainage and a consequent difference in the organic matter content of the soil. The areas occupying knolls and ridges generally carry a low percentage of organic matter and the soil is of a light-brown color, often appearing very light at the surface, and this is true whether the areas are typical or of the lighter phase of the soil. In the draws the soil takes on a blacker color, and except where there has been considerable coarse wash from the hillsides it resembles the Clyde loam of the lowlands. All of these variations may occur in a field of 10 acres or less, and except in a general way the topography offers no index as to what kind of soil is to be expected in certain places.

The Miami clay loam is a typical morainic upland soil, with local elevations varying from 10 to 40 feet and reaching a general elevation of 100 feet above the adjoining lowlands. The natural drainage is very good, except in small depressions with impeded or obstructed outlets.

The type occurs as a prominent ridge running through Juniata, Indian Fields, Almer, Ellington, and Elmwood townships in a northeasterly direction, paralleling the Cass River. A few small areas are found in the southeastern corner of the survey, associated with the Miami fine sandy loam.

Besides the general farm crops, sugar beets and beans are grown to a considerable extent. On most of the farms at least a few dairy cattle are kept. The crop yields are not so good as those on the Clyde loam of the lowlands. The yield per acre of corn ranges from 20 to 40 bushels; of oats, from 40 to 60 bushels; of wheat, from 15 to 20 bushels; of beans, from 10 to 25 bushels; of hay, from 1 to 2 tons, and of beets, from 7 to 15 tons.

The main difficulty in beet culture is getting a good stand. The trouble is due largely to the fact that the soil does not contain a sufficient quantity of organic matter to keep it from baking and crusting, and many of the young plants fail to break through the hardened surface. There are two remedies for this condition—either to look after these soil crusts when the young plants are coming up or else—

and this gives more lasting results—to incorporate larger amounts of organic matter with the soil by proper crop rotation and the application of stable manure.

The results of mechanical analyses of fine earth of this soil are given in the following table:

*Mechanical analyses of Miami clay loam.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.		
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
11763	E. cen. of NE. $\frac{1}{4}$ sec. 12, T. 12 N., R. 8 E.	Light friable loam, 0 to 9 inches.	0.5	6.3	9.4	24.2	9.9	28.3	21.2
11765	N. cen. sec. 27, T. 13 N., R. 9 E.	Medium loam, 0 to 9 inches.	.7	5.2	7.5	19.3	10.1	32.6	24.1
11764	Subsoil of 11763 .....	Friable clay loam, 9 to 36 inches.	.4	5.4	6.8	24.7	10.8	28.1	23.3
11766	Subsoil of 11765 .....	Clay loam, 9 to 36 inches..	1.6	3.9	5.5	13.8	9.2	33.4	31.9

CLYDE LOAM.

The soil of the Clyde loam ranges from a moderately friable loam to a rather heavy compact loam of a dark-gray, brown, or black color and from 8 to 12 inches deep. This rests upon a sandy or silty drab-colored clay, somewhat streaked and mottled with iron stains. On account of former inadequate drainage the soil is still largely in a puddled, compact state, sticky and impervious when wet and very hard when dry. The effect of poor drainage is emphasized where the type is found in low-lying areas that have been under cultivation only a short time. Here the soil proper is usually shallow and sticky, and clods badly when plowed. If these clods are allowed to dry before the field has been rolled or harrowed they are very hard to crush, and it is almost impossible to reduce the soil to good tilth.

In the native state the soil possesses marked clayey properties to within a few inches of the surface, where there is an accumulation of organic matter, but the more mucky areas are naturally loamy and mellow. The type is best developed in the older settled and better drained areas. The soil here is mellow and does not bake or clod to a great extent. The subsoil, too, is more friable and pervious to water.

This soil occurs in every township west of Cass River and is by far the most extensive type of the area. In places it is developed almost to the exclusion of all other types. Only four small areas, aggregating less than one-fourth of a square mile, were mapped east

of Cass River. The type is being extended from year to year by burning off large areas of peat.

The Clyde loam has an almost level surface. A slight unevenness sometimes occurs in the form of low knolls and shallow depressions, and occasionally as low, broad swells with intervening broad, shallow depressions, through some of which the small streams of the area flow.

The drainage of the type is naturally very poor on account of the level character of the country. The small streams were inadequate for thorough drainage, but they have been straightened and enlarged and supplemented by an extensive system of open drains, and altogether fair surface drainage now exists. The open drains are being supplemented by tile drains, and this phase of the drainage question is receiving more attention every year. The type is derived from glacial-lake deposits that have not been modified to any extent by subsequent stream action.

A very large part of this soil type is in an improved state, and the remainder is susceptible of improvement. The usual crops of the area are successfully grown. Dairying is an important industry, receiving some attention by nearly all farmers. Corn will yield from 40 to 60 bushels per acre, oats from 40 to 60 bushels, wheat from 15 to 30 bushels, and the other grains, including rye, barley, and buckwheat, proportionately well. Timothy and clover yield from 1 to 2 tons, and sugar beets from 10 to 20 tons, per acre. All the fruit and truck crops of the section are grown on a small scale.

The Clyde loam is the principal sugar-beet soil of the area, and offers advantages for a further extension of this important industry.

The results of mechanical analyses of samples of this soil are given in the following table:

*Mechanical analyses of Clyde loam.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.		
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
11176	2 miles W. of Kaw-kawlin.	Loam, 0 to 12 inches.....	0.5	4.2	8.5	17.1	21.0	26.1	22.6
11798	N. cen. sec. 22, T. 13 N., R. 8 E.	Medium loam, 0 to 9 inches.	1.1	4.1	7.4	18.8	9.7	33.4	25.5
11800	SE. cor. sec. 17, Buena Vista Tp.	Mellow loam, 0 to 12 inches.	.9	5.1	7.8	15.7	8.1	27.7	34.8
11177	Subsoil of 11176.....	Clay loam, 12 to 36 inches.	.8	4.9	8.6	16.9	19.3	24.7	24.6
11799	Subsoil of 11798.....	Clay loam, 9 to 36 inches.	1.1	4.6	7.3	18.4	8.3	31.2	28.6
11801	Subsoil of 11800.....	Clay, 12 to 36 inches.....	.7	3.6	6.8	13.0	6.9	27.1	41.7

The following samples contain more than one-half per cent of calcium carbonate ( $\text{CaCO}_3$ ): No. 11799, 3.1 per cent; No. 11801, 5.3 per cent.

## CLYDE CLAY.

The soil of the Clyde clay to a depth of from 6 to 9 inches is a silty clay loam of a somewhat marly nature. The color and structural characteristics vary directly with the amount of organic matter present. Where the percentage of organic matter is low the soil is of a rather light gray color, is compact, and bakes and clods badly under the plow, while where the proportion of organic matter is higher the soil is of a darker, blackish color and a more loamy, friable nature. The subsoil is a bluish or drab-colored clay, very tenacious, and practically impervious to water.

The marked clayey properties of this soil are not due altogether to the actual heaviness of the soil material, but partly to a puddled condition of the soil particles as a result of a long-continued waterlogged condition, giving it a compact, clammy consistency. Some of the larger areas mapped as this type were originally covered with accumulations of peat, under which were marly accumulations often an inch or so in thickness. When the superficial organic matter was burned off the marl was left, which accounts for the marly properties of the soil already mentioned.

The Clyde clay is the heaviest phase of the old lake bottom deposits and occupies low, wet level areas where sufficient drainage has been provided to make farming practicable. Its origin is about the same as that of the Clyde loam, except in the case of the large areas skirting the meadow lands between Bay City and Saginaw. Here both the Meadow and the Clyde clay areas occupy a small lake bottom that existed after the surrounding lands had appeared permanently above water level, and it is possible that a considerable amount of the fine material brought down by Saginaw River was deposited in this lake for quite a long time. That portion of the lake bed mapped as Meadow if reclaimed would be mainly classed as the Clyde clay.

The next largest area occupies a part of an old swamp bed in Brookfield Township, in the northeastern corner of the survey. The greater part of this area was originally covered with peat, which has recently been burned off, leaving the underlying clay with just enough organic matter and ashy material to render it fairly loamy. Other areas are found associated with areas mapped as Muck in Buena Vista, Merritt, and Gilford townships. Two small areas were also found in the southern part of Thomastown Township.

The greater part of the type is in an improved state and is used for general farming and for sugar beets and truck crops. With good drainage the yields would be about the same as those on the Clyde loam. However, the type as a whole is not under the best conditions of drainage, and the crops are somewhat uncertain.

Until better drainage is provided the possibilities of this soil will never be realized. Better drainage and deeper and more thorough

plowing will go a long way toward making it one of the most desirable soils of the area for general farming and for beet production. Some of the lighter textured soils are better suited for truck crops.

The results of mechanical analyses of samples of this soil are given in the following table:

*Mechanical analyses of Clyde clay.*

No.	Locality.	Description.	Fine gravel, 2 to 1	Coarse sand, 1 to 0.5	Medium sand, 0.5 to	Fine sand, 0.25 to 0.1	Very fine sand, 0.1 to	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
			mm.	mm.	0.25 mm.	mm.	0.05 mm.		
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
11804	S. cen. sec. 8, Buena Vista Tp.	Silty clay loam, 0 to 7 inches.	0.7	6.8	6.3	15.7	4.1	30.3	35.7
11802	E. cen. of NE. $\frac{1}{4}$ sec. 8, T. 12 N., R. 6 E.	Heavy clay loam, 0 to 9 inches.	.6	8.1	7.1	12.8	5.1	28.2	38.0
11805	Subsoil of 11804 .....	Clay, 7 to 36 inches .....	.7	4.5	6.6	12.8	4.9	20.9	49.5
11803	Subsoil of 11802 .....	Clay, 9 to 36 inches .....	.9	3.2	2.4	7.0	4.2	30.1	51.8

The following samples contain more than one-half per cent of calcium carbonate ( $\text{CaCO}_3$ ): No. 11802, 1.3 per cent; No. 11803, 24 per cent; No. 11804, 8.4 per cent; No. 11805, 18.7 per cent.

#### MUCK.

True Muck consists of an accumulation of vegetable remains in an advanced stage of decomposition, usually black in color, very finely divided, and very mellow. In the present areas there are large bodies answering this description, but the material varies and ranges from almost pure organic matter to a mixture of organic matter with varying though small proportions of earthy material. The depth ranges from 1 to 3 or more feet, at which depths clay, or more rarely sand, is found. Where the material is almost wholly organic matter in the earlier stages of decay the areas would be classed as Peat, but no attempt was made to separate such areas in this survey. In the deeper Muck areas at the line of contact between the soil and clay subsoil there is usually found a stratum of marly material from 1 to 6 inches in thickness.

The largest areas of Muck extend in an almost continuous strip from east of Saginaw to within 2 miles of Akron on the west. This strip once continued over large areas in Merritt, Gilford, and Wisner townships, but as a result of fires at least half of the original area has been burned over, which has so changed its character that it can now be mapped as the Clyde loam or Clyde clay. Other areas are found along the bay front and in the southeastern and other parts of the survey.

Muck originates in low, wet areas where swampy conditions have continued over very long periods. Such areas support a luxuriant

growth of water-loving grasses, rushes, and sometimes thick forests of tamarack or elm, and the organic remains of these plants, accumulating faster than they decay, give rise to the material constituting the type as mapped in the Saginaw area.

Only a very small proportion of the Muck is under cultivation, the chief crops being corn, hay, and sugar beets, with smaller acreages in cabbages and onions. Though Muck is an ideal soil for potatoes, celery, and onions, very little attention is given to such crops. Peppermint growing might prove profitable here, as it has on the Muck soils of other parts of Michigan.

Instead of using Muck for what it is particularly adapted to, the farmers of the Saginaw area seem usually to prefer to burn the more peaty areas off and use the underlying soil for general farming. This is advisable in some instances, but the wholesale destruction of these peaty accumulations is not to be commended. In all cases where the soil is burned care should be taken that enough organic matter is left to be incorporated with the underlying clay or sand, which is often nearly devoid of organic matter.

#### MEADOW.

The Meadow, as classified in the Saginaw area, includes areas along the bay front and stream courses where the water table is permanently maintained within a few inches of the surface or where the surface is subject to intermittent overflows. Such areas are unfit for any of the cultivated crops, but generally support a rank growth of water-loving grasses and rushes, affording some summer pasturage and, in the better places, a limited quantity of hay. The areas bordering the streams are usually in forest.

The largest area of Meadow extends along the Saginaw River from Saginaw to Bay City. This area is very level and is occasionally overflowed to a depth of several feet. The water table is nowhere more than from 6 to 12 inches below the surface, and some small patches are actually under water the year round. These wetter places are of a real swampy nature, but their mode of occurrence was such that they were not included as Swamp. This whole area is practically treeless, and is covered everywhere with coarse grasses and rushes. Other areas of similar character are found along the bay front.

The greater part of the Meadow strip along the Tittabawassee River is fairly dry during the summer months, and in a few places is being farmed. Corn and hay are the principal crops grown, and they do well in favorable seasons, but the uncertainty of yield, due to wet seasons and overflows, makes farming unsatisfactory. This strip is partly forested and affords good summer pasturage.

The strips of Meadow along the smaller streams are more variable in character and often approach a swampy condition.

The reclamation of the larger areas of Meadow, especially the one between Saginaw and Bay City, would be a profitable investment. The feasibility of such an undertaking is illustrated in the Fifield farm, which covers portions of sections 27, 28, 33, and 34 of Zilwaukee Township. This farm has been reclaimed from the condition of Meadow and could be mapped as Clyde clay, and much of the remainder of this Meadow area could be changed in like manner. If undertaken in a systematic and businesslike manner the whole area along the Saginaw River could be diked and drained at a much less cost than the land would be worth under cultivation, while in its present condition it is practically of no agricultural value.

#### SWAMP.

Swamp is an earlier stage of the conditions giving rise to Meadow lands and refers to areas partially covered by water and of no agricultural value except for such pasturage as is afforded by rank water grasses and rushes during dry seasons. Only three limited areas of Swamp were mapped, two along the bay front and one occupying a small island in Cass River, 2 miles south of Caro. The area in Wisner Township lies immediately along the water, while the larger area to the northwest of Bay City occupies a low depression, with an inlet from the bay, and is only partially covered by water, except when the higher tides occur.

#### DRAINAGE.

The Saginaw Valley proper, in which a greater portion of the area surveyed lies, is level to gently rolling, and in places only a foot or so above the level of Saginaw Bay. The general slope of the valley is gentle, and the secondary streams are small and sluggish. The more rolling lands are usually sufficiently high to afford fair natural drainage, but these areas are generally underlain by an impervious clay at a depth of 10 feet or less, thus causing much of the underground water of the higher areas to appear again at the surface on the lower levels. As a result of these conditions of poor natural drainage a large proportion of the area was originally in a semiswampy condition, imparting to some of the heavier types of soil a compact, impervious consistency that has not yet been entirely corrected by better drainage.

A large percentage of the area is now under cultivation, but a great deal of artificial drainage was necessary before any extensive use of the land was possible. Nearly all of the small streams have been straightened and enlarged, or else supplanted by large open ditches or canals, often many miles in length and emptying directly into the

larger streams or bay. Except in undeveloped areas, ditches of various sizes are found along nearly every section line and sometimes along half sections. Some of these are only large enough to remove surface water in wet seasons, but others provide both surface and sub-surface drainage, the latter in places to a depth of 6 or 8 feet below the surface.

Notwithstanding the extent of these improvements, the most important problem confronting the agricultural interests of the area is still that of drainage. In wet seasons some of the most important crops are little better than failures, while in dry seasons the same soils lose their moisture rapidly by surface evaporation, or else become hard and impervious, making it difficult for the roots to penetrate the soil and reach the moisture present at greater depths. A wet soil is cold, often compact, impervious, and hard to keep in good tilth. If of the heavier types it bakes and clods badly at the surface. The crops will be shallow rooted and irregularly developed over the field. Such soils are poorly aerated, and the biological and chemical changes necessary to a productive soil go on very slowly. On the other hand, thorough drainage not only removes all surplus water to below the root zone, but renders the soil warmer, gives better aeration, improves structure and effectively deepens the soil, besides improving the chemical constitution. The effect of good drainage is pronounced upon any of the ordinary farm crops, but especially so with those crops where quality counts for as much as quantity, as with the sugar beet.

These facts are being realized by the better class of farmers, and they are not only seeking better general drainage outlets, but are also making considerable headway in tile-draining their lands. Their verdict is that the cost of tiling, where properly done, is often paid for in the increased yields of a single crop. Others admit the benefit to be derived from tile drainage, but for one reason or another are slow about making such improvements. Around railroad stations where tile can be had easily the greater amount of tiling is done, and it is safe to say that if there were more tile factories scattered through the area there would be a vast extension of this important branch of drainage.

Considerable areas covered by the survey are still in an undeveloped state because of a lack of drainage. Among these may be mentioned the large Meadow and Muck areas, and parts of the Miami sand areas. These would be very valuable lands if reclaimed, and with few exceptions reclamation is feasible.

In Michigan drainage is made a public work under the direct charge of county drainage commissioners appointed every two years by the county supervisors. The law is such that much more extensive systems are made possible than if left to individual effort, and

the cost to the farmer is generally less than it would otherwise be. Where the county constructs a drain the farmers to be benefited are assessed an amount proportional to the benefits received.

#### AGRICULTURAL METHODS.

Though quite a variety of crops is grown in the area, not a great deal has been done in the line of specialization. On the other hand, it is quite common for a single farmer to grow nearly all of these crops regardless of the soil type or types he has to cultivate. The tendency to-day, however, is more toward specialization, and the necessity for more intensive methods is being more keenly felt as new crops are introduced and as the agricultural industries grow older.

The farmers may be divided into two general classes—those devoting all of their time to a system of general farming, in connection with which are kept at least a few dairy cattle and more rarely beef cattle and sheep, and those dividing their attention between the foregoing system and the production of special crops, as sugar beets, beans, potatoes, chicory, cucumbers, and many others of less importance. A few farmers devote all their time to trucking, while a few others have gone into dairying on an extensive scale. In either of the two principal systems of farming the scheme is generally such that much of the crude products of the farm, usually commanding low prices in the market, is consumed at home by dairy and beef cattle, and thus converted into products commanding much higher prices. Besides this, the systems have the advantage of returning to the soil from year to year great quantities of fertilizing materials that under another system would be lost.

The methods of tilling, cultivation, and harvesting are not essentially different from those of other sections of the North Central States. All of the latest improved machinery is being used. Some of the farmers prepare their soils and cultivate their crops in a very thorough manner, but with others there is a decided lack of thoroughness. In preparing the seed bed the plowing is often shallow, and as a result much of the rainfall runs off instead of soaking into the soil, and the crops suffer unnecessarily from short droughts. This condition is aggravated by a failure to keep the fields properly mulched by frequent cultivations during the dry weather. The difference in the crop yields is as great as the difference in the agricultural methods employed, and careful preparation and cultivation are well paid for in the increased yields.

Sod and stubble lands intended for corn are usually given one plowing in the fall and allowed to stand until the following spring, when they are again broken and harrowed to reduce the clods. The

plowing ranges from 4 to 8 inches in depth, and is done with a two or four horse turning or rotary disk plow. Many of the farmers wait until spring to do their plowing, especially if the soils to be used for corn were clean cultivated the preceding year. As soon as the danger of frost has passed the corn is planted in rows usually about  $3\frac{1}{2}$  feet apart. The distance in the rows varies from 18 inches to 3 feet. The corn is planted with listers or some other form of planter. From two to four grains are put in a hill, and all are allowed to mature. Some farmers plant their corn in check rows, so that it can be cultivated in both directions. The after cultivation is done with harrows and cultivators made for the purpose.

When the corn is ripe it is cut with harvesters or by hand and shocked to cure. Later in the fall the corn is husked and the fodder is housed for roughage.

Some spring wheat is planted, but the greater proportion of this crop is planted in the late summer or early fall, in August and September, so that the young plants will have time to make a fair growth and become well established in the soil before the winter sets in. For this crop the soil is broken once or twice with a two or four horse turning plow and then harrowed and rolled to reduce the clods. In case manure is applied it is distributed broadcast over the fields before they are plowed. When the soil is in shape the wheat is drilled in. The other small grains are planted in the same way, except that the time of planting varies somewhat. Oats, being easily winterkilled, are planted in early spring, as soon as the soil can be handled without injury.

The small grain crops are ripe in July and August. Nearly all of the harvesting is done with self-binders. When cut the grain is shocked in the field to dry and then hauled to the barn and stored or stacked on the outside to stand until the thrashing machines make their rounds later in the season. The straw is stacked and used for roughage and stable litter.

Grass lands are prepared as for corn or wheat. If grown separately, the clover may be sown along with the wheat or oats, which acts as a nurse crop the first year. Much of the timothy is planted separately, but some plant timothy and clover together. The mixed hay is supposed to represent more nearly a balanced ration for stock than either separately. The main difficulty with this system is that the clover blackens with the least exposure to rain during the process of curing, and thus reduces the market value of the hay. The second crop of clover is generally cut for the seed.

The most urgent needs of the sugar-beet crop are more attention to soil adaptations, better seed, better drainage, more thorough preparation and cultivation of the soil, and the elimination of as much hand labor as possible by machinery. The growing of sugar beets being decidedly

a matter of intensive farming, it is difficult for the ordinary farmer to realize the real needs of this crop. The drainage situation of the area most seriously concerns the sugar-beet industry, as this crop will not develop properly in a soil kept too wet, and, moreover, the sugar content in crops grown on such soils is proportionately low.

The testimony obtained shows that there are a few soils which under no circumstances can be recommended for the crop; that there are several upon which, by careful treatment and in favorable seasons, excellent results may be obtained; and that there are a few, but these among the most widely distributed, which give the best results from year to year and are the ones upon which the industry should be chiefly developed. Those which should be avoided are the light sandy types, including the Miami sand and the Miami fine sand. Under this heading would come such gravelly soils as are composed chiefly of sand or gravel. Among those which may, under favorable circumstances, produce good results, but which can not be unqualifiedly recommended, are the upland soils, the Muck soils, the Clyde fine sandy loam, the Clyde clay, and the Clyde sand. Those which are considered excellent soils for beets, and upon which it is recommended that the industry be mainly developed, are the Clyde loam, the Clyde sandy loam, and the Saginaw sandy loam. Of these three the latter is relatively so limited in extent that it can hardly be considered an important beet type. The Clyde loam is the best, producing the most uniform and satisfactory results. It is the most widely distributed of all the lowland types, covering, in all probability, considerably more than half the area of the old lake bed formation and 38 per cent of the area of the Saginaw survey.

The Clyde sandy loam is also of wide distribution and should be ranked second to the Clyde loam as a sugar-beet type. The character of this soil is a little more variable, and results are not quite so uniform, but on the whole it is to be highly recommended as a beet soil.

The facts obtained point also to the conclusion that even among the types best suited to beet growing different methods are required to meet the needs of each soil, and the grower must study these characteristics to the end that he may adapt his methods to the particular requirements of each.

Apparently little difference was found in the sugar-producing power of the various kinds of soil, those which average lower being the ones which tend to produce a large beet, such as the Muck soils. But the difference, though comparatively small, is of considerable importance in view of the necessity for maintaining a high standard of quality.

Chicory soils are prepared and handled about the same as for sugar beets, and the growth of the two crops requires about the same

amount of labor. The methods of handling the truck soils are quite varied, and can not be separately treated here. In general, however, soils intended for trucking are prepared much more thoroughly than for any of the general farm crops, and in places fertilizers and stable manures are liberally used.

The stock, including dairy and beef cattle, sheep, and horses, grown for market, are pastured during the summer on the unimproved lands and on other areas reserved for the purpose, and sometimes on the grass lands after the hay has been cut. In the winter all of the stock has to be housed and cared for.

Dairying is an important industry. The milk is handled by creameries and cheese factories located at convenient intervals throughout the area. These are generally run on an independent basis and a fixed price is paid for the milk. The creamery prices are for the butter fat, while the skim milk goes back to the farmer for feeding purposes.

A more or less satisfactory rotation is practiced by all the farmers. There are several systems in operation, some of which are followed out without having any special object in view, while others are designed to get the best results from the soil without impairment of its productiveness. The number of crops used in the rotation varies with different farmers. A system followed by a great many of the beet and bean growers includes a six-year rotation, as follows: Two years in timothy or clover, followed by corn, beans, beets, and wheat or oats, succeeding each in the order named.

#### AGRICULTURAL CONDITIONS.

On many of the better types of soil mapped there is general prosperity among the farmers. A majority of them are out of debt and saving money. The farmhouse is usually a well-built two-story frame or brick building, painted and kept in good order. The out-buildings are as good as those to be found in any agricultural community. The barns are usually large and have a concrete, stone, or brick basement. The cost of building these farmhouses ranges from \$1,000 to \$2,500 each, and occasionally more, while the range in the cost of the barns is from \$800 to \$2,500. An outlay of \$5,000 in farm buildings is of not uncommon occurrence.

There is a less thrifty class who are making only an indifferent living as a result of a bad start, poor soils, or infrugal methods. At least a few of this class are to be found in all parts of the area, but more generally on some of the less desirable soils.

Taken as a whole, the best improvements in the area are to be found on the Clyde loam, with the Clyde sandy loam second, while the poorest improvements are on the Miami sand and Miami fine sand. Here the farms are very scattering and generally poorly equipped,

except where some of the special crops to which these soils are best adapted are being grown.

Nearly all of the farmers have the advantage of rural free delivery, and some of them have telephone connections with Saginaw, Bay City, and other smaller towns.

One of the strongest evidences of the agricultural capabilities of the soils of the area and its general prosperity is that many farmers who started in the area with little, if any, capital, living at first in small, rudely constructed cabins that could hardly be called comfortable, after a period of years are found replacing these by the better class of residences characteristic of the area.

The proportion of mortgaged farms in some parts of the area is higher than in other sections of Michigan. This is not the result of a depressed condition among the farmers, but rather is due to the fact that the agricultural methods of the area are comparatively new, and large initial expenditures were necessary before the best soils could be fitted for agricultural purposes. Many of these mortgages have been incurred for drainage and other permanent improvements.

A large proportion of the farms are operated by the owners personally. Some of the larger holdings are operated by salaried overseers. According to the census of 1900, 81.3 per cent of the farms in Bay County are operated by the owners, 77.6 per cent in Saginaw County, and 77.3 per cent in Tuscola County. Of the total number of acres in farms, 66.5 per cent are improved in Bay County, 66.1 per cent in Saginaw County, and 67.8 in Tuscola County. About the same proportions hold for the part of Huron County included in the survey.

A certain cash sum per acre is usually paid for rented lands. This varies with the character of the soil and the uses to which it is to be put. Any of the better soils, when used for the general crops, rent for about \$5 an acre, while if they are to be used for beet production they rent for \$8 and sometimes as high as \$10 an acre.

Not a great deal of the improved lands is for sale. The prices range from a nominal sum for the least desirable areas of the Miami sand and Miami fine sand to \$50 or more an acre for the better types. Anywhere from \$50 to \$80 an acre is being asked for the Clyde loam, while for the Clyde sandy loam \$50 an acre is considered a fair price. The best areas of the Miami sand and Miami fine sand sell for about \$25 an acre. The price paid for any type is usually in direct proportion to its recognized value for the production of the crops now grown. Undeveloped lands can be had for \$10 to \$25 an acre, depending upon the type of soil and the conditions of drainage.

The farms of the area are generally small, but there are occasional holdings of 640 acres or more in one body. The larger holdings

are sometimes operated as a whole by the owner, or they may be subdivided and tenanted. The census of 1900 gives the average size of farms in Bay County is 61.5 acres, in Saginaw County as 74.8 acres, and in Tuscola County as 80.8 acres. As operated, the general run of farms is from 40 to 160 acres each.

In the general farming line the question of labor is not of serious concern, as the greater part of the work is done by the farmer and his family, except during harvest season, when considerable extra help is needed. By cooperating among themselves the farmers can do most of the harvesting without much outside help. Temporary help is drawn largely from the near-by cities, and during harvest season from outside points. Regular farm hands are paid about the rates usual throughout the North, namely, from \$18 to \$25 a month with board. For transient help \$1 a day is paid, except during harvest season, when the rates are considerably higher.

The sugar-beet industry requires a great deal of hand labor, but as yet the growers have had little trouble in getting all they needed. Boys, girls, and women are largely employed in thinning and weeding the crop. Their pay ranges from 75 cents to \$1 a day.

During the past fifteen years a great many Poles have come into the Saginaw Valley. A number of these, as already mentioned, have rented or bought farms, while the remainder have joined the laboring class, of which they at present form the majority. They are usually thorough, and on the whole make very satisfactory laborers.

The principal agricultural products are corn, oats, wheat, hay, sugar beets, beans, and potatoes. There are many other crops of relatively less importance, among which may be mentioned barley, rye, buckwheat, cucumbers, beans, cabbage, cauliflower, tomatoes, and onions, and among the fruits grapes, apples, and pears. Dairying is practiced on a small scale by a large number of farmers and quite extensively by a few others. Some attention is also given to beef cattle, sheep, and horses.

Except on the sandier soils, the corn yields are usually good, but in some seasons the crop is injured by wet or cold spells during the growing season, and occasionally by early fall frosts, which not only reduce the yields, but injure the quality of the corn. When badly bitten by frost the corn is not considered good for seed purposes, and much of the fodder is allowed to go to waste. According to the census of 1900 the average yield of corn for Bay County was 25.8 bushels per acre, for Saginaw County 30.8 bushels, and for Tuscola County 30.5 bushels. These averages would be much higher were not so much corn planted on the sandier types of soil.

The wheat crop sometimes is seriously injured by rust, and on account of this disease the acreage in this crop has fallen off for the

past few years. The oats crop is also injured to some extent by rust and smut. The other small grains do well. The heavier soils of the area are well adapted to wheat and oats, and the yields are ordinarily very good where the soil is properly drained and prepared.

All of the hays grown are of excellent quality, and the yields are good.

Nearly all of the vegetables grown do well and find a ready market. There is undoubtedly a need for further development in the line of trucking. Potatoes do well and usually command good prices.

The fruits grown are generally for home use and for local markets. The quality and yields are good. The production of fruit for market purposes should be taken up in a more systematic way, so that a ready and reliable market could be built up for all the fruits produced.

The sugar-beet crop has passed the experimental stage and has proved well adapted to the climate and certain soil types of the area. The quality of the beets is generally very good and the yields from indifferent to good, depending largely upon physical conditions of the soil, the type of soil used, and the care and skill used in the cultivation of the crop. The factories have not yet reached the stage where they can pick the best growers, the result being that many farmers not qualified to grow good beets, and as many others with undesirable soils, are given contracts in order to get a running supply. Many of these farmers get light yields and are naturally dissatisfied with the returns. They do a great deal toward discouraging other farmers from growing beets. In so far as possible the factories should induce only those farmers to enter upon the cultivation of this crop who are prepared to do the intensive work necessary to success and who have the types of soil best adapted to the production of large yields of beets of high sugar content.

As the agricultural developments of the area are comparatively new, not a great deal of attention has been paid to special adaptation of soils to crops. The greater number of farmers have followed the customary system of general farming regardless of the soils used. As a result, soils peculiarly adapted to certain crops are not being used to any extent, if at all, for those crops. However, the tendency now is toward specialized farming, in which at least broad soil adaptations are recognized. So, instead of finding certain crops growing indiscriminately on all soil types, they will be found to be confined largely to a single soil type or to a group of soil types possessing some characteristics in common. An instance of this kind is seen in chicory production. The Clyde sand and the Saginaw sandy loam are the principal chicory soils; but this crop is grown to a more limited extent on other sandy types, though very rarely on the heavy soils. The principal sugar-beet soil is the

Clyde loam, which has been found to give the most satisfactory results. Local markets are a large determining factor in growing truck crops. In the vicinity of Bay City nearly all of the trucking is done on the Clyde sand and the Saginaw sandy loam, while near Saginaw the Clyde loam and the Clyde clay are now largely used.

The area is provided with an extensive system of railroads, along which are stations and sidings at convenient intervals. Some of these roads are main lines, affording quick service to all outside points, while the others are branch lines centering at Bay City and Saginaw. The area also has river and lake transportation facilities, but these are not used very extensively for handling agricultural products. There are public highways on nearly every section line, and in places on half-section lines. Some of these are hardly passable in wet seasons, but when dry they are fairly good. All of the principal roads leading out of Bay City have been macadamized for several miles. In Tuscola County many of the roads have been graveled and thus greatly improved. Saginaw County has done very little in the line of permanent road improvements.

Saginaw and Bay City afford good local markets for much of the agricultural products of the area. Large amounts of truck are consumed in these two places. The bean crop goes to outside markets, while the cucumbers are temporarily taken care of by salting stations located in several of the towns throughout the area. Local flour mills consume large quantities of wheat. With the exception of a small amount of chicory grown in the vicinity of Gagetown, which is used by a factory to the east of the area, the chicory crop is handled by a branch factory at Bay City. The beet crop is consumed by factories in Bay City, Saginaw, Caro, and Sebawaing. There are four factories in Bay City and one in each of the other places named. All outside markets are easily reached from the area.

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