WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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SOILS OF WISCONSIN

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PREFACE

The purpose of this report is to give in nontechnical language a general description of the soils of the State, a brief discussion of the crops and systems of farming to which they are adapted, and the treatments required to secure largest returns. It is hoped that this report and the map accompanying it will be of assistance to several classes of people, especially teachers of agriculture, manufacturers of farm machinery, bankers and other loan agencies, and those engaged in the canning of peas and other crops.

This report and the map accompanying it are based on the survey of the soils of the State made by the Division of Soils of the Wisconsin Geological and Natural History Survey in cooperation with the College of Agriculture and the Bureau of Soils of the U. S. Department of Agriculture. This survey has now completed a general or reconnoissance survey of the northern half of the State and a detailed survey of all but nine counties in the southern half. Use is also made of the results of field experiments on substations and experiment fields of the College of Agriculture.

Acknowledgment should be made of the assistance received from members of the State Geological Survey including Dr. Samuel Weidman, Mr. F. T. Thwaites, G. H. Smith, who made the block drawing shown in Plate I, and especially the present director, Mr. E. F. Bean. Extensive use has been made of the work of W. C. Alden of the U. S. Geological Survey on the glacial drift and of the older geological survey of the State by Dr. T. C. Chamberlain. Among those who have been longest engaged in the work of the soil survey, are: W. J. Geib, T. J. Dunnewald, E. L. Musbach, A. H. Meyer, A. C. Anderson and Drs. Guy Conrey and Martin Tosterud under whose direction a large part of the chemical analyses were made. The mechanical analyses were made by Miss Hazel Hankinson, the complete chemical analyses of four important soil types were made by Dr. W. M. Gibbs and the determination of colloids by H. H. Hull. To Miss Hankinson credit is due for assistance in proof reading and for the preparation of the table of contents and index.

THE SOILS OF WISCONSIN

CHAPTER I.

FUNCTIONS OF SOILS; PHYSICAL AND CHEMICAL

INTRODUCTION

Agriculture which provides our food and clothing is based on the growth of crops and this is largely dependent on the soil. The soil furnishes several of the elements essential for plant growth as well as serving as a reservoir for the water coming irregularly as precipitation, giving it up constantly as needed by the plant. Moreover, it absorbs the radiant energy of the sun's rays, turning it into sensible heat which affects the vital processes of the plants and determines their rate of growth. It also acts as a reservoir of plant food material added as fertilizers and permits the plants to absorb it as needed.

There is a great variation in the soil in respect to all of these functions. The chemical composition varies greatly, some soils being high in certain elements and low in certain others, while in other soils the relative amount of the elements is reversed. Again, some soils are excellent as absorbers and reservoirs of moisture while others are poor in that respect. Again, some soils are not readily warmed and remain relatively cold while others are easily warmed under the sun's rays.

Adaptation of Plants to Soils. As a result of all of these variations in the soils on which plants grow, a wide difference in the plants themselves has gradually developed, some plants being able to live on soils relatively low in a certain element such as calcium or lime, while others have so long grown in soils well supplied with that element that they can not do well without a good quantity of it. Again, certain plants such as grasses and some of the cereals have developed an extremely fine root system which is able to penetrate the compact clays and so take advantage of their large water holding capacity, while others have a coarser root system which can penetrate only the more sandy soils or those of more open structure. Again, some plants, including many grasses and cereals, can grow on relatively cool soil while others must have a well warmed soil to flourish.

Tillage. Since it is necessary to till the soil in order to produce a suitable seed bed, to destroy weeds, and to enable the soil to retain the maximum amount of moisture, the readiness with which the soil can be tilled or cultivated becomes an important factor to consider. The labor which this tillage involves and the influence which the lay of the land or topography has on the readiness with which the tillage and harvesting machinery can be used, are therefore very important factors.

Climatic Relations. Since the action of the soil as a reservoir of moisture is related to the amount and distribution of precipitation, and since the crops of any region are determined by temperature and moisture conditions, there is a very intimate relationship between the climate and the soil of any region, and it is impossible fully to consider the relation of either to agriculture independent of the other.

TOPOGRAPHY

Not only is there a close connection between the soil, the climate and the crops to which a given region is adapted, but the relationship of soils of different character within a given region is important. For instance, in a section in which a very large portion of the land is adapted to crops which can be used directly as human food, such crops may, and usually are, grown extensively. On the other hand, in a region in which the soils and topographic conditions are chiefly suitable for the growth of grass as pasture but in which the climate does not admit of continuous pasturage, whatever land there may be available for tillage is often best used for the growth of crops needed as feed during the winter season for stock pasturing on rough land during the summer season. In other words, the type of farming to which a region is adapted is influenced not only by the chemical composition and texture of the soil, but even more by the topography or lay of the land, and this must therefore be considered as an important feature in the full description of the soils of any region.

On account of the influence on tillage, by erosion and in other ways, topography is now being shown in detailed maps of the

CLASSIFICATION OF TOPOGRAPHY
IN WISCONSIN SOIL SURVEY A.R.W.

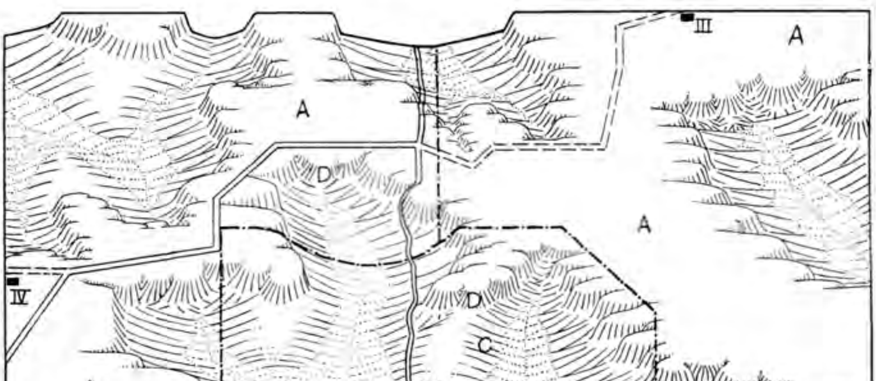


Plate I. Topographical sketch of an area in Sauk County showing four-fold classification of slopes, lettered A, B, C, and D, and the effect of topography on the individual farms indicated by Roman numerals.

soil survey. The slopes are classified in the following four classes. Class A is land which is level or so gently undulating as to cause practically no erosion and to permit the laying out of fields in any desired manner. The slope varies from nothing to four per cent. Class B is land having gentle to moderate slopes which do not interfere seriously with the laying out of fields or cause serious erosion. These slopes vary from four to nine per cent. Class C is land which is so steep as to cause serious erosion unless very carefully managed, and on which it is difficult to operate most farm machinery. Land of this class has a slope of from fifteen to thirty per cent. Class D includes land which is either too steep to be broken or which is so stony or rough as to be untillable.

Plate I is a sketch map of a small area in Sauk County illustrating this classification of slopes. It also shows the way topography affects the individual farm, both with reference to the relative portion which is tillable and to the subdivision of the farm into fields. The individual farms are indicated by roman numerals.

As will be explained later, certain types, from their mode of formation, are practically level, belonging entirely to class A, while others may include land having slopes which would require subdivision into classes B, C, or D. Since the influence of topography on agriculture is greater in the southwestern portion of the state than in any other part, the influence of topography is discussed in the chapter on that section at greater length.

TEXTURE OF SOILS

The water holding capacity of soil, its workability, and its adaptation to different crops are largely affected by the fineness of grain or texture. Texture is therefore one of the most important factors in the classification of soils. In order to determine and define accurately the texture of any given soil it is separated into grades of different sized grains, by a process known as mechanical analysis. In the system now most commonly used seven different grades or sizes of soil grains are made. Starting with the finest, these are known as: clay, silt, very fine sand, fine sand, medium sand, coarse sand, and fine gravel. The diameters of the grains in these grades expressed in millimeters are as follows: clay under .005 m.m., silt, .005 to .05 m.m., very fine sand, .05 to .1 m.m., fine sand, .1 to .25 m.m., medium sand, .25 to .5 m.m., coarse sand, .5 to 1 m.m., and fine gravel, 1 to 2 m.m. The percentage or relative amount of these different grades in any soil determines its character. If there is a large amount of the clay grade and relatively small amount of the different sizes of sands, the soil will be a clay soil. If silt predominates, it is a silt loam. The following table shows the limits of composition of the eight chief classes of soil as shown by mechanical analysis.

MECHANICAL COMPOSITION OF SOIL CLASSES

Class	
	Soils Containing Less Than 20% of Silt and Clay
1. Sand	Over 25% fine gravel, coarse and medium sand, and less than 50% fine and very fine sand.
2. Fine sand	Over 50% fine and very fine sand, or less than 25% fine gravel, coarse and medium sand.
	Soils Containing Between 20–50% of Silt and Clay
3. Sandy loam	Over 25% fine gravel, coarse and medium sand.
4. Fine sandy loam	Over 50% fine and very fine sand, or less than 25% fine gravel, coarse and medium sand.
	Soils Containing Over 50% of Silt and Clay
5. Loam	Less than 20% clay, and less than 50% silt.
6. Silt loam	Less than 20% clay, and over 50% silt.
7. Clay loam	Between 20 and 30% clay, and less than 50% silt.
8. Clay	Over 30% clay.

The class to which any soil belongs is determined in the field by the feel of the soil between the fingers. An experienced soil surveyor becomes very expert in determining in this way the class to which any soil should be assigned. The final accurate determination, however, is possible only in the laboratory by the process known as mechanical analysis.

COLLOIDS IN SOILS

The method used in mechanical analysis by which the texture of soils given in the preceding pages is determined, is given in Appendix II. In this method the sample of soil to be analyzed is, after drying, put in a large bottle nearly filled with water to which a small amount of ammonia is added and the bottle is then shaken in a machine for a number of hours in order to separate the particles of soil from one another, then the different sized grains are separated as previously described. This method was adopted a number of years ago and it was assumed that the shaking process was sufficient to separate all the grains one from another, that is to break down any clusters of grains. More recently it has been found by more careful microscopic examination and in other ways that this treatment does not, as a matter of fact, separate all the extremely fine particles of clay from the coarser particles of silt and the different sizes of sands. Moreover, this microscopic examination has shown that there is much more extremely fine material in soils than has heretofore been recognized. The individual particles of this very fine material are so minute that it would take from fifty to several hundred of them in a row to be equal to the diameter of the smallest grains of silt. This extremely fine part of the soil is called colloidal matter.

The colloidal matter of the soil is very important in many respects. On account of the very large area of surface which the immense number of these fine particles have, they hold as a very thin film a large part of the moisture which is absorbed from the saturated atmosphere or water vapor and so greatly affect the water holding capacity of the soil. While it is only with extreme difficulty that all of the colloidal matter can be actually separated from the coarser grained material of the soil, it is possible to estimate the amount of this colloidal matter in the soil without separating by determining the amount of moisture absorbed from atmosphere by a given weight of the soil. Using this method as developed by the Bureau of Soils of the United States Department of Agriculture the per cents of colloidal matter in a number of the most important soil types in the state have been determined and are given in Appendix III.

This table shows that sands have, as a rule, from 4 to 7% of colloidal matter, sandy loams and loams from 6 to 12%, silt loams containing a moderate amount of organic matter from 12 to 30% and clay from 25 to 50% while darker soils having a larger amount of organic matter contain more colloidal matter, a considerable portion of which is undoubtedly of an organic nature, than lighter colored soils of the same texture so that the Clyde and Poygan soils run as high as 60% of colloidal matter.

This colloidal matter not only affects the water holding capacity of the soil but it also acts as a cement between the larger soil grains causing them to cluster or granulate and when it is quite large in amount may under certain conditions cause the formation of such large lumps of soil held together as to give the soil very poor tilth when dry. When wet, soils having a very large amount of colloidal matter may be so plastic and sticky that it is difficult to work them. This colloidal matter may itself be caused to cluster or granulate under certain conditions so as to lessen the difficulties above mentioned.

Not only does the colloidal matter act in a physical way but it has distinct chemical properties. The well known ability of soils to absorb substances, especially such as ammonia, from a solution in which they are placed or which has passed through the soil is largely due to the colloidal matter. It may fix ammonia, potassium, calcium or other bases from solution. In doing so it frequently liberates other bases which it contains. This quality of colloidal matter, by virtue of which it can absorb plant food elements applied to the soil as fertilizers and hold them so that they are not leached out by water percolating through the soil and are returned to the soil solution gradually as plants need these elements, is a matter of great importance. It appears, therefore, that the amount and character of colloidal matter in soils has a great deal to do with the fertility of the soil. A moderate amount of colloidal matter seems necessary to a high degree of fertility while, on the other hand, an excessive amount of colloidal matter, at least of certain kinds may be injurious because it makes the physical management of the soil more difficult. This whole field of the function and character of colloidal matter in soils is one about which we undoubtedly have still a great deal to learn. It appears, probable, also, that the method of mechanical analysis will have to be greatly improved by adopting methods which will determine the entire amount of colloidal matter as well as the amount of different sized grains of the coarser portion.

WATER-HOLDING CAPACITY

The two chief factors determining the amount of water which a soil can retain from the rainfall are: first, texture, and second, organic matter. The water is held in the soil chiefly as films around the individual soil grains. Since the area of the surface of the grains in a fine textured soil is much larger than that in a coarse textured soil, and the thickness of films is essentially the same, whatever the size of the grains, it is evident that fine textured soils will hold much more than the coarse textured ones can.

Not all the water which can be retained by soils from rainfall is available to the plant because a certain thin film of moisture is held so tightly by the soil grain that the plant is unable to withdraw it. In other words, only a certain part of the total moisture which the soil is capable of holding is available for plant growth.

The roots of common crops, when the plant has reached maturity, usually extend to a depth of about four feet in this climate. A little water may be drawn up from below that depth if the soils are dried out by plants, but this does not increase the water available to the crop to any material extent.

Careful studies have shown that when very sandy soils are holding all the water they are capable of holding against the force of gravitation, they contain, in a depth of four feet, water equivalent to a layer of about three and one-half inches in depth over the surface; sandy loam soils about four inches under these conditions; silt loam soils six inches; and clay loam soils, having a good supply of organic matter in addition to the earthy matter, will hold eight inches. This means that, if no additional rains come after the beginning of rapid growth and before ripening, the silt loam soil is capable of supplying nearly twice as much water to the crop as the very sandy soil can, and the clay loam soil more than twice as much.

Moreover, the amount of water used per pound, or per ton, of dry matter produced in the growth of the crop is affected by the fertility of the soil. Crops growing on fertile soil abundantly supplied with plant food will make larger growth on a given amount of water than will crops on a soil low in fertility. Since sandy soils are in general lower in plant food than heavier soils, as well as having less water holding capacity, the lower yields they are capable of producing are the result of both factors.

Water needs of different crops. As a basis for the comparison of the crop producing power of different soils, the water requirements of a few crops growing on soils of good fertility in our climate are given in the following table:

TABLE SHOWING THE NUMBER OF ACRE-INCHES OF WATER NEEDED FOR DIFFERENT YIELDS PER ACRE OF DIFFERENT CROPS

Bushels per acre	30	50	70	100	300
Oats	5.7	7.8	11.0		
Corn	5.0	8.4	11.8		
Potatoes				2.1	6.2
Tons per acre	**2**	**4**	**8**	**12**	**16**
Clover hay	8.9	17.7			
Corn silage			11.3	17.0	22.6

DRAINAGE

Water is needed by all growing plants and is absorbed from the soil by the roots, chiefly through the fine hairs at the growing points of the roots. There can be too much water in the soil. When the soil is saturated, that is, when all the spaces between the soil grains are entirely filled with water, it excludes the air which is necessary for the growth of the roots as well as for the life of bacteria and other organisms which play an important part in soil fertility.

It is true that when the rain first falls to the ground, it contains considerable oxygen dissolved in the water, but this is quickly absorbed by the growing roots; after that, the water excludes the passing in of air from the atmosphere and becomes a serious detriment. The soil, as we say, is then water-logged. The roots are no longer able to grow in it and are limited in their growth to the unsaturated portion of the soil. If the zone of unsaturated soil is less than three feet in depth, most of the important agricultural crops do not have sufficient soil on which to draw for their plant food, nor indeed for their moisture supply. This is because it is chiefly from the soil in which water is present simply as a film around the soil grains, leaving considerable air space, that food and moisture are actually available for plant use. The result of this is that many plants will actually suffer for water because there is too much water, and because it comes too near the surface to permit the other conditions necessary for the growing roots. It is true on the other hand, that some plants are able to grow in wetter soils than others, for reasons not yet fully understood.

Because of the fact that too much water is a serious detriment, the drainage of soils is often one of the most important methods of improvement. The conditions with reference to drainage are affected by texture, by slope of the surface, and by the amount and distribution of rainfall.

The fine textured soils, of course, have a larger water-holding capacity and offer much more resistance to the movement of the water downward and laterally than soils of coarser texture. Some level land of this nature does not allow the water coming in very heavy rains to run off rapidly, but permits it to stand and force its way gradually down into the soil. This type of land is more commonly in need of artificial drainage than land having enough slope to permit a part of the rain to run off at once, as well as to cause a slow lateral seepage of the soil water itself to the natural drainage channels.

A climate in which very heavy rainfalls occur occasionally or frequently, is one in which artificial drainage is much more needed than one in which the rainfalls are of a lighter character. Southern states frequently have rainfalls of from two to four inches in twenty-four hours, and occasionally they are as high as six to eight inches, while in the northern states, rainfalls of two inches in twenty-four hours are very rare.

Since the heavier or more clayey soils are usually higher in plant food, and since level lands are more readily worked than sloping lands, it is frequently the case that lands which need drainage to give them good growing conditions for the roots of crops, are the ones which will have the greatest agricultural value when properly drained. Thorough tile drainage of clay soils frequently costs as much as $30 or $40 per acre; it not uncommonly adds three times that value to the land, however, by making what would otherwise be comparatively poor agricultural lands well adapted to the best agricultural use.

It is impossible in the space available here to give detailed instructions in regard to the construction of ditch and tile drainage systems. These are to be found in the bulletins of the Experiment Station.

CHEMICAL COMPOSITION AND FERTILITY OF SOILS

Besides the water mentioned in the last chapter, the soil furnishes a number of substances necessary for plant growth. The chief elements taken by plants from the soil are nitrogen, potassium, calcium, magnesium, sulfur, and iron. These do not exist as separate elements in the soil but as compounds containing one or more other elements besides the one necessary for plant growth. Not only are other elements associated with these essential elements as compounds, but the essential elements often occur in two or more different compounds. The element calcium, for instance, as an element is a bright, soft metal, but it occurs only in compounds in the soil. It may be combined with carbon and oxygen as calcium carbonate; or, again, it may be combined with silicon, oxygen, and other elements as silicates of which there are several different kinds. It also occurs as a nitrate, sulphate, chloride, phosphate, and other forms. The same is true of each of the other essential elements mentioned. The chemical character of the soil is, therefore, exceedingly complex.

Availability. Some compounds containing the essential elements are soluble in water so that the plant can absorb them, while others are quite insoluble and therefore not readily available. But the substances that the plants absorb need not necessarily be soluble in water, since there is a certain direct action of carbon dioxide excreted by the roots of the plants on some of the substances in the soil.

The great portion of most of the essential elements in the soil is, or originally was, in the form of silicates,—minerals which occur in such rocks as granite, schists, gneiss, etc. The processes are very slow and complex by which these compounds are broken up and other compounds produced containing the essential elements of plant food in more soluble and available form. Some of them will be discussed later in discussing the origin of soils. Part of these processes are due to the action of weather, freezing, and thawing. One of the most important chemical processes is the action on the rock or soil particles of carbon dioxide dissolved in soil moisture. This carbon dioxide is the result of oxidation of living or dead vegetable matter. The presence of decaying vegetable matter or of living organisms, such as the roots of plants, or of minute organisms, such as bacteria, molds, and other fungi, therefore, plays an important part in the decomposition of rock particles, a process by which their contents become available to the higher plants used as human food.

One of the important cases of this kind is the process by which nitrogen left in the vegetable matter of the soil when plants die

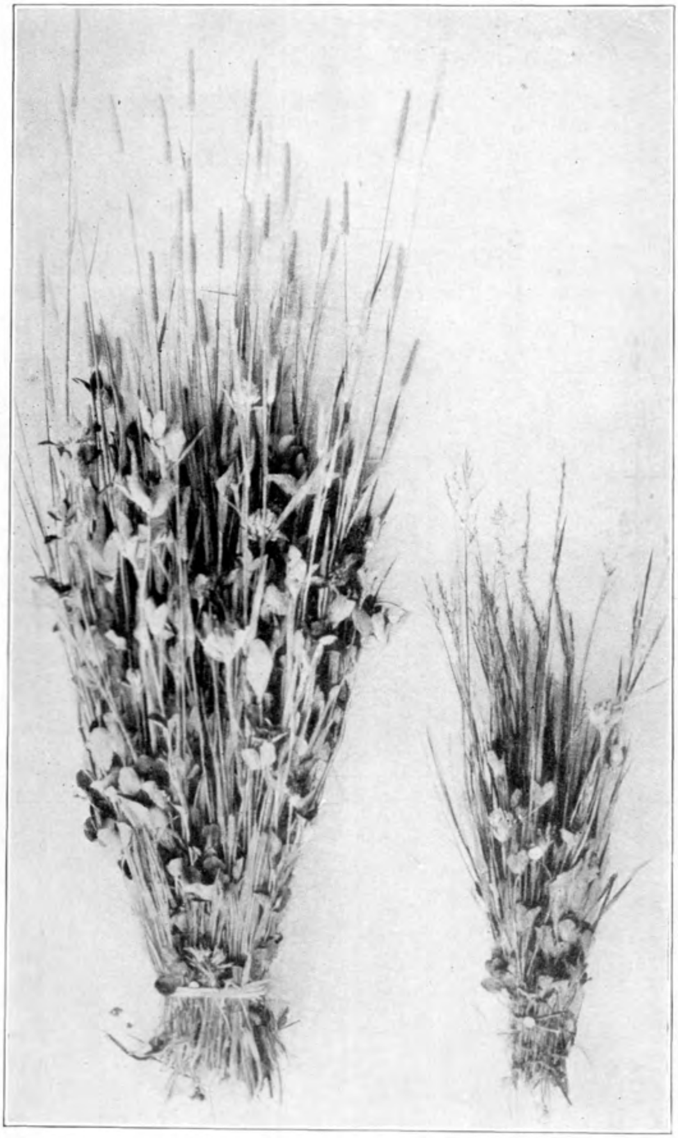


Plate II. An illustration of the effect of the use of acid phosphate on soils low in available phosphorus.

is changed into a form which is again soluble in water and available to plants. This process is called nitrification and takes place in several different stages, the more important of which are: first, formation of ammonia, which may be made by several different organisms; second, the oxidation of ammonia to nitrites; and third, the oxidation of nitrites to nitrates which are very soluble.

Cycles of Plant Food. From the foregoing it can be readily seen that elements which are absorbed from the soil by plants and left in the tissue of the plants may again become available to another set of plants through the decomposition of the first. These elements can be said to go through a cycle consisting of their absorption from the soil by the plant, their building up into plant tissue, the decaying of plant tissue in the soil when the plant dies, and the re-absorption of the elements by another living plant. In this way in nature much of the plant food in the more available form is used over and over again. It is, therefore, not necessary that all of the material which plants need be made available through the decomposition of rocks while the plants are growing; in fact, this decomposition of the inert rock particles is so slow that comparatively little growth could take place if it were limited to that source. The lichens growing on boulders or surfaces of rocks probably get a considerable portion of their material in that way, and that is probably in part the reason for their very slow growth. But plants growing in the soil are using material over and over again.

Revolving Fund of Fertility. This material used repeatedly in the growth of successive crops, either native or cultivated, constitutes what may be called a *revolving fund.* Much of the difference in fertility between different fields of the same kind of soils is due to the difference in the quantity of this revolving fund of material which undergoes rapid change from vegetable form to a form in which it is again soluble.

Stable Manure. In the case of stable manure a part of its content is already soluble in water. Part, however, is still in organic form and must decompose in the soil before becoming again available to plants.

Humus of Prairies, Muck and Peat. The high fertility of dark prairie soils and of muck when first broken is due largely to the fact that they contain a considerable amount of the essential elements in humus or vegetable matter which, through active decomposition, are set free in soluble form and again absorbed by growing plants. It is partly due also to the action of the carbon dioxide formed in this process on the rock grains of the soil itself.

Peat, on the other hand, is almost entirely made up of the vegetable matter of mosses and other plants growing in water, and as the plant dies a considerable portion of certain essential elements is dissolved out by this water and is carried away. Thus the peat is left with an extremely small amount of these elements. Since peat soil contains almost no rock particles there is nothing for the carbon dioxide to act on to supply these elements in that way. The result is that peats are extremely low in certain essential elements; particularly is this true of potassium and phosphorus, although they are abundantly supplied with nitrogen. There is, therefore a very marked difference between black prairie soils, or mucks, having only from 5 to 20 per cent of vegetable matter mixed with a large amount of earthy matter, and those soils which are almost entirely made up of vegetable matter.

Nitrogen Fixation. Since nitrogen does not occur in mineral form in most of the rocks, that element must be secured from the atmosphere of which it constitutes four-fifths. It is secured from the atmosphere by at least two quite different processes. First, through combination with oxygen caused by electrical discharges of lightning, a certain amount is brought down to the soil in rain in a form in which it can be absorbed by plants. This amount, however, is only a fraction of what actively growing crops need. Second, a much larger amount is fixed by bacteria which have the power of making the nitrogen of the soil air combine with other elements into compounds which are available to plants. Part of these organisms live separately in the soil. But another and better known class of nitrogen-fixing bacteria attach themselves to the roots of certain plants by entering the root hairs where they cause a swelling or nodule within which they live. In this way they get certain benefits from the plant or host, and in return furnish the host with nitrogen which it can use. These tubercles grow especially on a class of plants known as legumes, including clovers, alfalfa, locusts, and others. The nitrogen absorbed from the soil air in the nodules of these legumes and built up into tissues of these plants becomes available to other crops when the tissue of the legume plant decomposes and the nitrogen is nitrified in the process mentioned on page 11.

This ability on the part of the legume plants of securing nitrogen from the air, as well as their great feed value, make this family of plants of great value and practically every farm should have one-third or one-fourth of its cultivated land in these crops.

Soil Acidity: Cause and Effect. The chemist groups most compounds into three classes: first, acids; second, alkalis or bases; third, salts formed from the combination of the first two. The most characteristic thing about the group of acids is the fact that they contain hydrogen which can readily be displaced when the acid combines with alkalis or single elements. Some acids are liquid; others are solids. Some are made up of but two elements, hydrogen and one other, while others, made up of a number of elements, are complex in character. The presence of this displacable hydrogen indicates the presence of an acid. There are a number of tests by which the presence of this displacable hydrogen can be detected. Blue litmus paper and a number of other substances may be used to detect its presence.

There is evidence that the soil frequently contains several different kinds of acids. Sometimes a small amount of acetic acid, which is the acid of vinegar, is formed, but the most common kinds of acid in soils are silicates or complex compounds formed in the decomposition of certain minerals in the rock. These acid silicates consist chiefly of silicon, oxygen, and aluminum and are practically insoluble in water. They have been formed in the decomposition of the rock by the partial removal of the bases such as calcium, magnesium, potassium, and sodium which took place in the weathering process. These silicate acids exist in the soil mixed with mineral particles which still contain the metallic elements such as calcium, magnesium, potassium, and sodium.

The processes of nitrogen fixation and nitrification above mentioned do not take place so actively in soils in which there exists a considerable amount of acidity as in soils which are free from acidity. These processes do go on, however, though at a slower rate, even in distinctly acid soils. Substances containing calcium or magnesium which will combine with the soil acids, neutralizing them, therefore encourage nitrification and nitrogen fixation and frequently benefit acid soils. Particularly is this true when applied to soils on which crops that need large amounts of these elements are to be grown. But, on the other hand, the presence of acidity in the soil is no proof that there is not still a considerable amount of calcium and magnesium available to plants. As has been mentioned above, silicate minerals containing these elements still exist in the soil even in the presence of silicate acids, and through their decomposition they furnish a certain amount of calcium or lime for the growth of plants and for the nitrification of vegetable matter.

Crop Needs. In considering the fertility of different kinds of soils, account must be taken of the plant food requirements of various crops. The following table shows the amounts of the important elements of plant food taken from the soil by a few of the more important crops.

The Number of Pounds to the Acre of Nitrogen, Phosphorus, Potassium, and Calcium Removed From the Soil by Given Yields of Various Crops.

Crop	Weight of crop	Nitrogen	Phosphorus	Potassium	Calcium
	Pounds	Pounds	Pounds	Pounds	Pounds
Oats—					
Grain, 50 bu.	1,600	35	5.2	8.3	1.1
Straw	3,000	15	2.6	29.1	6.8
Total	4,600	50	7.8	37.4	7.9
Corn—					
Grain, 65 bu.	3,640	40	7.9	12.5	.7
Stalks	6,000	45	6.1	66.4	14.3
Total	9,640	85	14.0	78.9	15.0
Red Clover— Hay, 4 tons	8,000	* 170	17.5	95.0	103.0
Alfalfa— Hay, 4 tons	8,000	(200)	17.9	95.5	135.7
Timothy— Hay	3,000	16.2	3.5	17.6	3.6
Potatoes—					
224 Bu.	13,440	47	9.4	63.5	2.4
Potato Vines	4,274	20	1.2	18.0	16.2
Total	17.714	67	10.6	81.5	18.6
Cabbage— 28 tons	56,000	168	25.3	45.7	70.4

*About two-thirds of the nitrogen in clover, alfalfa and other legumes is usually secured by fixation of the nitrogen of the atmosphere and the other third is taken from the soil, while all of it is taken from the soil in the case of other plants.

It will be seen from this table that there is a great variation in the amount of the different elements taken by the different crops. The small grains, as a class, require less total amount of these elements than do those crops which make a larger total growth, such as corn, and truck crops such as cabbage, celery, etc., which produce heavy yields. Also it must be borne in mind that the feeding power of crops varies. Some crops, including especially the cereals, are capable of securing plant food from the soil when the amount of available plant food is so low that other crops would be unable to get it to any considerable extent. It is necessary to take this into account in considering the suitability of different soils and fields to the different crops.

System of Farming and Fertility. The term System of Farming is commonly used to indicate the class of product sold. Dairy farming indicates the sale of dairy products, livestock farming, of beef or other meat animals, grain farming, the sale of small grain, and truck farming, the sale of potatoes, cabbage, and other so called truck crops. There is a very important relation between the system of farming and the methods necessary for the maintenance of fertility. In dairy or livestock farming most of the crops grown are fed and the manure produced returned as a fertilizer to the soil, while in grain and truck farming a portion of the crop is entirely taken from the farm and its content of plant food lost.

It has been quite generally assumed that in the system of dairy or livestock farming, when the manure is conserved carefully and all returned to the land, there is little or no loss of plant food. This is true so far as nitrogen and potash are concerned but a portion of the phosphorus in the crops fed is secreted in the milk and bones of the animals and is never returned to the soil, and since this element exists in all soils in very small quantities, this constant though small drain eventually lowers the amount of available phosphorus to a point at which it prevents maximum yields and some form of phosphate fertilizer must be used. Wisconsin, as a whole, is now at a stage in which this general situation must be realized. The growth of sufficient legumes for feed will secure the necessary nitrogen and proper care of the manure will return a large part of the potash, but lime and phosphorus must be applied if fertility is to be maintained and increased.

Commercial Fertilizers. As pointed out above, the demand made by certain crops, especially so called truck crops, on the plant food of the soil is large, and if these crops are sold, fertilizer which will return them to the soil must be used. The profit in this system of farming is secured only when the yields are large and the use of commercial fertilizers for this purpose will undoubtedly increase greatly as increased production in these crops is undertaken. Only by giving careful consideration to the possibilities and use of fertilizers can truck growers hope to succeed in competition with those of other sections where the use of fertilizers is already fully established.

CHAPTER II.

CLIMATE, FUTURE AGRICULTURE AND FORESTRY

CLIMATE

Climate affects the kind of crops which can be grown in any section or state; it likewise influences the yields. Moreover, it affects the labor involved in the work of agriculture and the expense and maintenance of stock during the winter period. Climate and soils together determine the growth of crops on which agriculture is based. Climate includes a number of factors; among these temperature, rainfall, and light are the most important.

Temperature and Growing Season. All vital processes are affected by temperature. The growth of plants starts at a minimum, it increases in rate up to an optimum temperature, and then it decreases until a maximum temperature is reached, at which growth ceases. According to Van t'hoffs law, the rate of growth doubles for each increase of 18 degrees Fahrenheit as the temperature rises from the minimum to the optimum. Not only does the temperature affect the growth of crop plants, but also that of bacteria in the soil which have so much to do in producing fertility.

The amount of heat received from the sun during any given period, such as a week or month, depends chiefly on the angle at which the sun's rays strike the earth's surface, and on the length of day. In the latitude of Wisconsin, the days in June are much longer than they are in the equatorial region where they are never more than 12 hours in length, and the angle is sufficiently high so that the amount of heat received per day at that time is greater than that received at the equator. On the other hand, the temperature may not get quite as high here at that time as it does at the equator because the soil has been cooled off so much more during the winter and requires time to be heated. Nevertheless, the difference is comparatively small, and during the mid-summer period the temperature is as favorable for growth in our latitudes as it is at the equator. Of, course, during the winter period when the days are less than twelve hours in length and the angle of the sun's rays is low, the amount of heat received is much less and the temperature much lower. The difference in temperature between northern and southern latitudes is much less during the summer than it is

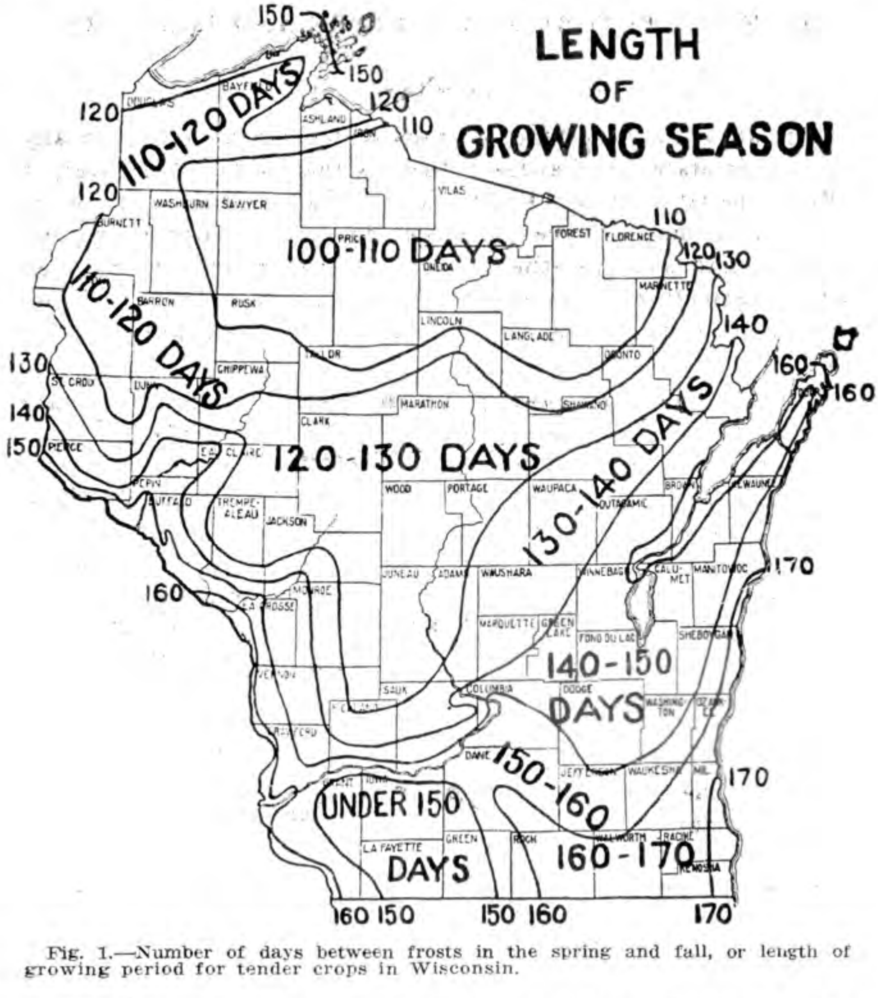


Fig. 1.—Number of days between frosts in the spring and fall, or length of growing period for tender crops in Wisconsin.

during the winter. Going southward a thousand miles during the summer, one does not find a great increase in temperature, but during the winter, one would notice a very much greater difference in that distance.

Altitude also affects temperature. In general, there is a decrease of one degree Fahrenheit for each increase of 300 feet in elevation. As a result of this, lower altitudes—say from sea level up to one thousand feet—have considerably higher temperatures than sections of the country having elevations of from four thousand to eight thousand feet, such as those of the western plain countries in the mountain region.

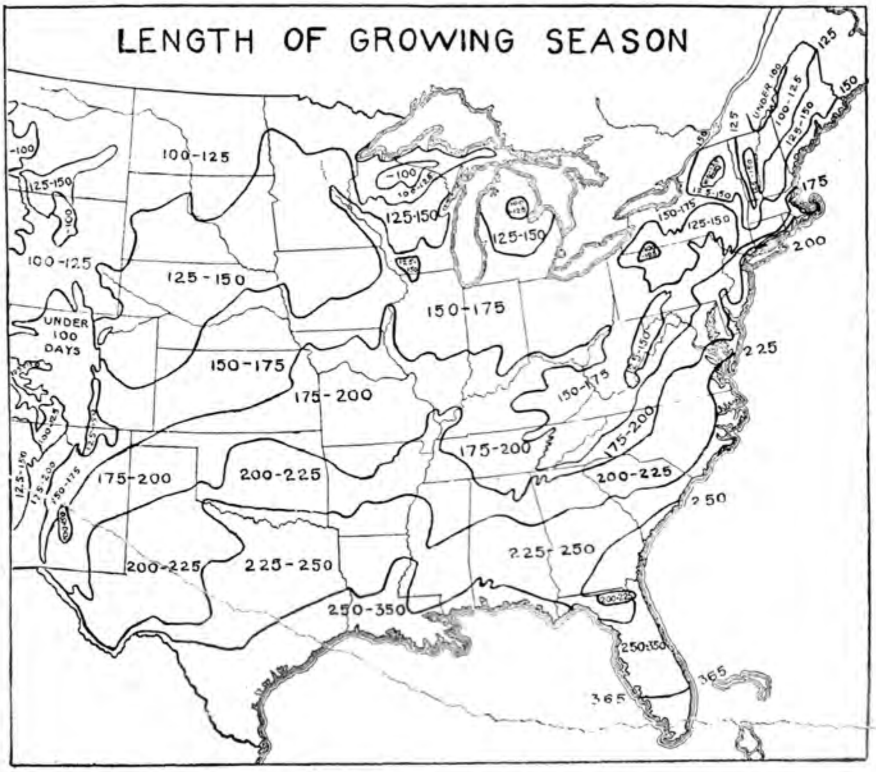


Fig. 2.—Average number of days between killing frosts in spring and fall, or length of growing period of the eastern part of the United States.

By the term "growing season" is commonly meant the period between the last killing frost in the spring and the first in the fall. This refers chiefly to relatively tender crops such as corn, potatoes, etc., which are injured by a temperature one or two degrees below the freezing point. Hardy crops, however, which are not injured unless the temperature is several degrees below freezing temperature of water, such as the grasses, clover, and small grains, can grow for some weeks in the spring before the last frost and in the fall after the first frost. We should really therefore consider two growing periods: One within which hardy crops may grow, and the other within which the tender crops can grow. Figure 1, shows the average length of growing season for the tender crops. In general, growth of the hardy crops begins about three weeks earlier in the spring and continues about three weeks longer in the fall than that of the tender crops, thus giving a period of six weeks greater duration for these crops.

The map, figure 2, shows the average length of the growing season for tender crops east of the Rocky Mountains. It will be seen that southern Wisconsin compares favorably with southern Iowa, eastern Nebraska and western Kansas. The fact that the lines limiting the length of growing seasons run southward in going from the Mississippi Valley to the Rocky Mountains is due to the increasing elevation. The effect of elevation on limiting the growing season of the eastern states is also seen. The higher latitudes of southern New York and of a large portion of Pennsylvania and the Appalachian Range generally have the effect of giving this range a comparatively short growing period. This same influence of topography is felt within the state of Wisconsin. By reference to the map showing the general elevations, figure 3, it will be seen that the northern half of the state in which the length of the growing season is much less than in the southern half the elevation is considerably greater and it is this higher elevation as much as, or more than, the more northern latitude which gives us the shorter growing period for tender crops in the northern half of the state.

As previously stated hardy crops have a longer growing season than tender crops. They will grow on an average of about twenty days before the last killing frost in the spring and about the same length of time after the first killing frost in the fall so that in Wisconsin our growing season for hardy crops is about forty days longer than that of the tender crops as shown on the map. It is true, however, that the length of time before and after killing frosts increases as one goes south so that the central southern states have a much longer growing period for hardy crops. In many parts of this portion of the country, however, the distribution of rainfall is not such as to permit them to take advantage of this longer period of available temperature.

The two most important crops affected by the length of the growing season are cotton and corn. Cotton requires an average growing season of 200 days, while good varieties of early dent field corn will mature in 115 or 120 days, the larger yielding varieties requiring 150 or 160 days. Since, as seen on the map, the length of the growing season in southern Wisconsin is

Fig. 3.—General elevations above sea-level in Wisconsin.

from 150 to 170 days, good yields of corn are practicable. Only occasionally does frost prevent maturity. On the other hand, in the northern part of the state where the altitude is somewhat higher and the length of growing season from 100 to 120 days only, the very earliest varieties only will mature on average years, and not infrequently even these do not reach maturity.

During cool nights when the temperature is nearly freezing, the cool air near the surface of the ground condenses. If there is a slope, it will flow down the slope and collect in the hollow or level piece of low land. The removal of this cold air from the higher ground lessens the tendency to frost, while its accumulation on the lower ground increases the tendency to frost. Frost is liable to occur on low or marshy ground 150 miles farther south than it occurs on hill tops or on the higher slopes. Corn can therefore be grown on high land in the northern part of the state much more safely than on low land. The same can be said of potatoes and other tender crops. The length of the growing season of the southern half of the state is sufficient to permit the growth of a very wide range of crops; only such crops as cotton and fruits characteristic of warmer sections are excepted.

It is of course true that in most southern states it is possible to grow some of the hardy crops such as small grains and pasture crops during the winter and then a tender crop such as corn or sweet potatoes during the summer, thus getting two crops in one season. It is, however, not generally practicable to grow any other crop with cotton during the same season on account of the length of period this crop requires. Therefore, the advantage of the longer growing season in the southern states has only a limited value.

Rainfall. The total amount of rainfall and its distribution through the year are both matters of the greatest importance. No single factor exerts a greater influence on agriculture than does rainfall. The amount of rainfall necessary to permit the growth of a good crop depends greatly on its distribution. A rainfall of 40 inches coming largely during the winter as it does on the Pacific Coast is by no means as good as a rainfall of 25 or 30 inches coming largely during the period when crops are making their maximum growth. This is because a large part of the winter rainfall runs off the surface in streams, since only a certain amount can be absorbed by the soil. During the summer, on the other hand, water coming one day or week may be largely absorbed from the soil before the next comes. The new moisture can then be absorbed and used. By reference to the accompanying table, it will be seen that the rainfall of Wisconsin is very fortunately distributed.

AVERAGE RAINFALL IN WISCONSIN BY MONTHS

Season	Month	Rainfall	Season	Month	Rainfall
Spring	March April May	1.8 2.8 3.7	Fall	Sept. Oct. Nov.	3.3 2.4 1.6
Summer	June July Aug.	4.1 4.0 3.3	Winter	Dec. Jan. Feb.	1.4 1.3 1.2

The amount received during the spring months is usually sufficient for the growth of grass and small grains, which start at that time; while the heavier rainfalls of June and July come just at the time when such crops as corn, alfalfa, tobacco, and potatoes, which require larger amounts of water, are making their maximum growth. There is no section of the country in which distribution of rainfall is better adapted to the crops which its growing season permits, than is this state. While dry periods during which crops suffer are not unknown, they are much less frequent than in most of the country farther south and west.

The fact that the rainfall of Wisconsin comes in the form of frequent showers is also favorable. Rainfalls of over two inches in twenty-four hours occur very seldom while in the states farther south they are much more frequent, and rainfalls of four inches are as frequent as those of two inches in this state. Wisconsin, therefore, suffers much less from erosion than do states farther south and it is possible to grow cultivated crops on steeper lands though even in this state the injury by erosion cannot be overlooked.

This uniform distribution of rainfall in light showers is also more favorable for agricultural uses of sandy soils than are heavier rainfalls. These soils are much more subject to leaching under the influence of heavy rains than are heavier soils and more frequent light showers maintain moisture in such soils better than do less frequent heavy rains. The difference in this respect between the southern and northern parts of the state even is of some importance. Cooler temperatures cause less evaporation on sandy soil and give such soils in the northern part of the state a relatively high average in comparison with heavier soils, especially for crops which do well in somewhat cooler temperatures such as potatoes.

Light. Light is the source of energy used by the green chlorophyll of plants in the manufacture of carbohydrates and other substances which go to make them up. The rate of formation of carbohydrates depends on the intensity of the light. The intensity of the light at six o'clock in the morning or afternoon of the longer days of the summer is probably about as great as can be utilized. Cloudiness, if of long duration, must of course lessen the rate of growth. It is therefore true that light conditions are somewhat better in the drier regions, but there, unless

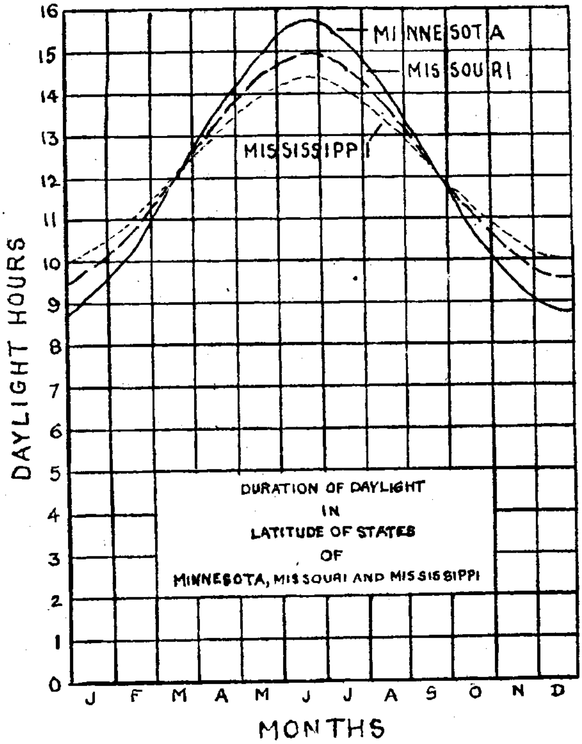


Fig. 4.—Hours of daylight during the year in the latitudes of central Mississippi, Missouri, and Minnesota.

irrigation is practiced, the supply of water limits its utilization. The amount of cloudiness in Wisconsin during the summer is little more than that unavoidably connected with a suitable rainfall.

On account of the relatively high latitude of Wisconsin this state has longer days than do the southern states. Figure 4 shows that in Minnesota at the latitude of central Wisconsin sunlight lasts from one to two hours longer during nearly four months of the year than it does in Mississippi. This longer daylight together with a favorable temperature and rainfall of the summer period makes more rapid growth possible when the supply of available plant food is sufficient and accounts for the much shorter period within which crops reach maturity in the higher latitude than in the southern. However, it also emphasizes the importance of maintaining fertility at a high stage in order to take advantage of the favorable climatic conditions during the comparatively short growing period. When advantage is taken in this way of climatic conditions the agricultural possibilities of the northern states will, therefore, compare much more favorably with those of southern states than would be assumed from the comparison of the length of growing seasons only in the two sections.

AGRICULTURAL DEVELOPMENT OF WISCONSIN

While various travelers had passed through the region of Wisconsin since the explorations of the first French voyageurs, comparatively little actual settlement took place before 1830. The fourth principal meridian which runs from the southeastern corner of Grant County north to Lake Superior was established in 1832 and during the next few years the southern portion of the state was laid off in townships and government land offices opened at Green Bay and Mineral Point in 1834. A large number of farms were established during the following ten or fifteen years but lack of transportation and farm machinery prevented important development until about 1850. By that time, however, farms were being established rapidly and, soon after, railroads provided transportation for farm products. Wheat soon became the most important crop and was grown in large amounts from 1845 until about 1880. Other special crops such as hops, tobacco and hemp were also grown during that period. The low price of wheat during the 80's, caused by the rapid expansion of wheat growing in more western prairie states, together with the damage done to this crop by the chinch bug, turned the attention of farmers to dairying which then rapidly increased, soon becoming the chief agricultural industry of the state, which it still remains.

The agricultural development of a wooded region such as that of Wisconsin is always much slower than that of the prairie regions, and this has greatly prolonged the period of development of the state. The rate of development which has occurred during the past twenty-five years is shown by the following table. This table also indicates the extent of development which has been reached.

County	Land Area Acres	Improved Land		No. of Farms	
		1900	1920	1900	1920
Barron	566,400	117,407	208,936	3,004	4,516
Bayfield	961,900	8,022	50,389	465	1,791
Burnett	550,400	32,626	79,611	1,198	1,872
Chippewa	665,000	177,658	227,691	3,050	3,729
Douglas	855,700	5,234	40,428	257	1,557
Polk	598,400	117,238	185,140	2,907	4,058
Rusk	592,000	*25,869	46,676	*1,069	1,946
Sawyer	844,800	4,871	20,511	159	823
Washburn	534,400	13,059	57,827	449	1,380
Northwest District	**6,169,000**	**501,984**	**917,209**	**12,560**	**21,672**
Ashland	692,500	13,611	36,253	489	1,131
Clark	779,500	120,964	195,802	3,456	5,116
Iron	506,900	2,320	10,010	83	381
Lincoln	577,300	23,317	45,907	924	1,586
Marathon	994,600	145,060	242,357	4,276	6,058
Oneida	757,100	7,778	28,159	350	724
Price	818,600	13,118	40,387	885	1,935
Taylor	634,200	23,392	51,944	1,168	2,260
Vilas	597,700	2,170	9,726	83	417
North District	**6,358,400**	**351,730**	**660,545**	**11,714**	**19,608**
Florence	318,100	4,312	17,514	191	349
Forest	650,900	1,573	16,950	59	535
Langlade	560,000	31,168	59,999	1,035	1,780
Marinette	905,600	47,126	107,444	1,500	2,531
Oconto	715,500	91,273	151,639	2,241	3,114
Shawano	741,100	135,322	193,770	3,140	3,977
Northeast District	**3,891,200**	**310,774**	**547,316**	**8,166**	**12,286**
Buffalo	439,700	190,607	202,321	2,242	2,089
Dunn	556,200	218,067	265,693	3,221	3,566
Eau Claire	408,300	167,618	194,467	2,066	2,368
Jackson	633,600	170,344	190,401	2,468	2,577
La Crosse	307,800	156,472	141,150	1,912	1,720
Monroe	599,700	221,533	231,049	3,730	3,519
Pepin	151,000	68,811	75,698	1,054	1,034
Pierce	360,300	192,371	208,957	3,323	3,105
St. Croix	470,400	272,843	308,086	3,143	3,290
Trempealeau	478,700	253,343	270,239	3,138	3,138
West District	**4,405,700**	**1,912,009**	**2,088,061**	**26,597**	**26,406**
Adams	437,800	125,064	148,138	1,842	1,557
Green Lake	230,400	146,426	141,371	1,753	1,507
Juneau	513,300	158,408	171,114	2,694	2,479
Marquette	292,500	127,249	133,773	1,523	1,432
Portage	519,700	189,596	250,287	3,172	3,326
Waupaca	485,800	195,122	236,807	3,662	3,770
Waushara	413,400	211,874	233,745	3,549	2,468
Wood	517,800	91,966	137,063	2,359	3,066
Central District	**3,410,700**	**1,245,705**	**1,452,298**	**20,554**	**19,605**
Brown	338,600	175,096	207,027	3,660	3,498
Calumet	207,400	142,061	145,005	2,233	2,087
Door	300,200	109,656	149,557	2,209	2,396
Fond du Lac	464,600	346,171	321,182	4,326	4,190
Kewaunee	215,700	136,282	146,626	2,193	2,065
Manitowoc	385,300	249,691	251,176	4,073	3,904
Outagamie	413,400	198,670	236,561	3,479	3,746
Sheboygan	333,400	225,569	226,734	3,572	3,664
Winnebago	293,800	201,572	186,332	2,773	2,711
East District	**2,952,400**	**1,784,768**	**1,870,200**	**28,518**	**28,261**

*1910

County	Land Area Acres	Improved Land		No. of Farms	
		1900	1920	1900	1920
Crawford	370,600	142,983	147,386	2,104	1,911
Grant	748,200	411,077	388,007	4,219	4,022
Iowa	499,800	268,334	254,424	2,547	2,527
Lafayette	410,900	287,785	272,481	2,501	2,360
Richland	377,600	187,064	186,824	2,726	2,533
Sauk	538,900	280,064	279,878	3,886	3,697
Vernon	525,400	256,524	268,541	4,235	4,101
Southwest District	**3,471,400**	**1,833,831**	**1,797,541**	**22,218**	**21,151**
Columbia	497,900	314,329	301,889	3,439	3,320
Dane	769,300	552,028	512,269	6,346	6,217
Dodge	574,100	415,926	374,939	4,994	4,633
Green	379,500	286,029	270,680	2,540	2,330
Jefferson	353,300	232,748	218,129	3,453	3,263
Rock	458,200	357,632	343,328	3,829	3,660
South District	**3,032,300**	**2,158,692**	**2,021,234**	**24,601**	**23,423**
Kenosha	180,500	124,070	112,255	1,298	1,383
Milwaukee	150,400	100,989	90,258	2,576	2,574
Ozaukee	149,100	109,054	107,739	1,728	1,727
Racine	207,400	159,366	146,456	2,118	2,215
Walworth	358,400	244,419	239,308	2,754	2,779
Washington	275,800	185,101	174,486	2,873	2,799
Waukesha	351,400	241,428	227,310	3,549	3,406
Southeast District	**1,673,000**	**1,164,427**	**1,097,812**	**16,896**	**16,883**
State	**35,364,100**	**11,246,972**	**12,452,216**	**169,795**	**189,295**

The general development of farm land at the present time as well as the distribution and amount of undeveloped land is indicated in the following table.

District	Total Area	Land in Farms
Northwest	6,169,000	2,420,853
North	6,358,400	2,042,998
Northeast	3,891,200	1,301,623
West	4,405,700	3,643,261
Central	3,410,700	2,484,309
East	2,952,400	2,603,416
Southwest	3,471,400	3,123,556
South	3,032,300	2,757,336
Southeast	1,673,000	1,471,510
Total	35,364,100	21,851,853

WISCONSIN'S FUTURE IN AGRICULTURE

A number of factors will cooperate to determine the direction Wisconsin's future development in agriculture will take.

Economic conditions including imports of competing products from other countries, labor and transportation costs will doubtless play an important part. But success will be greater to the majority of those engaged in farming if they follow those lines to which the soil and climate of the state are best adapted than if they attempt to compete in lines of farming or growing of crops in which other states or sections have an advantage over Wisconsin.

Dairying and other forms of livestock farming will probably continue to be her main lines because the rainfall is well distributed, producing good pasturage. This makes possible the utilization of much land not well adapted to other use and produces much feed with little labor while her cultivated soils are well adapted to the most important crops needed as winter feed. The education of her people in that direction has already reached a high point. Moreover, the northern location of the state makes desirable a system of farming in which the crops produced during the growing season may be manufactured into higher priced forms during the winter. Dairying offers this opportunity. In this industry Wisconsin can compete under favorable conditions with any and all other important sections of the country.

As has been shown by Jordan, Henry and Morrison, Eckles, and others, the dairy cow is the most efficient animal in its ability to transform vegetable products into human food, though the pig is a close rival. Henry and Morrison state that the dairy cow returns about six times as much edible solids in her milk for each 100 pounds of digestible nutrients in the food consumed as the steer or sheep yields in its carcass. On account of the efficiency of the dairy cow and the suitability of dairy products as human food, dairying is likely to long remain our chief agricultural industry. On account of the efficiency of good pasturage in dairying, the use of land available for pastures for that purpose is very desirable.

Beef raising will probably increase somewhat in relative importance on account of its association with the dairy industry. This offers an opportunity for the raising of calves to be grown to beef without necessitating the maintenance of the cow through the year for the production of the calf only. The southern states have some advantage over the northern in the production of beef due to their longer growing season, making possible a larger pasturage season and the utilization of more rough land for that purpose. They will not, however, have the advantage in dairying.

Conditions are also favorable for sheep raising, especially in the western and northern parts of the state. The rougher and more stony sections of these regions will furnish good pasturage at relatively small expense while the more tillable portions will produce the winter feed.

Since only 631,000 acres or 6.6 per cent of the cropped land of the state is now used for crops grown for use as human food directly, and including potatoes, wheat, canning crops, etc., the

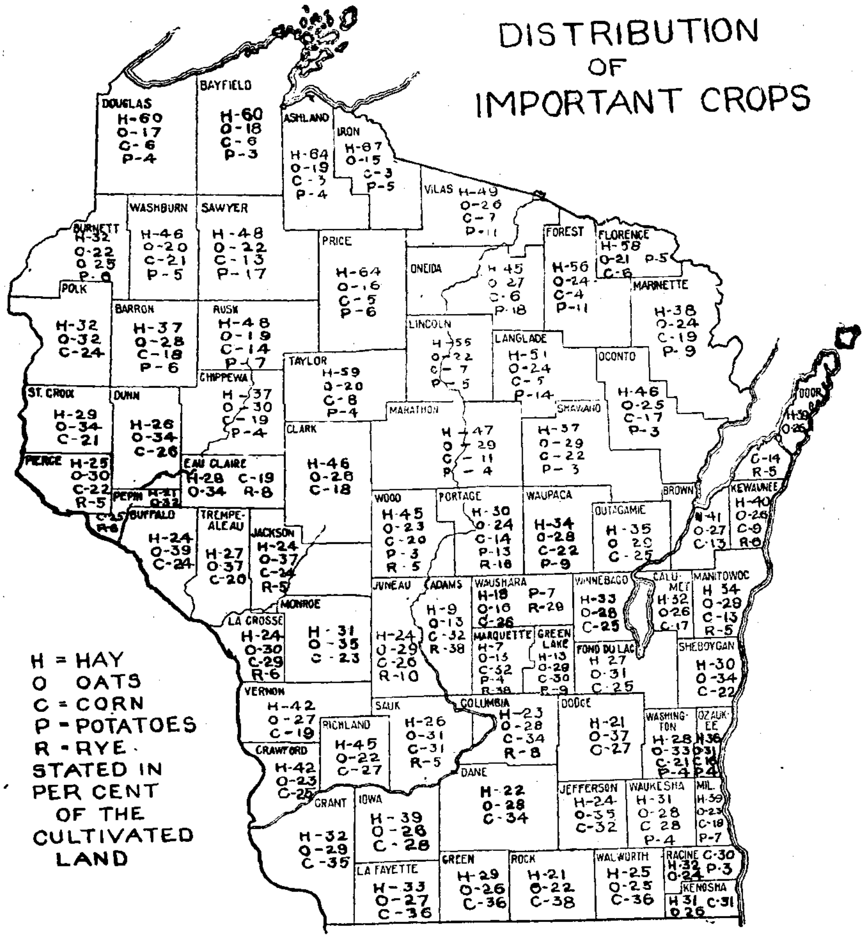


Fig. 5.—Distribution of important crops by counties in Wisconsin.

total acreage of these crops can be very greatly increased without reducing the acreage of crops used as stock feed appreciably. Moreover the development of the more suitable marsh areas for truck crops to which they are especially suited will add a very considerable acreage to these crops not now under cultivation.

A still further addition to the total production of these crops will come through the use of commercial fertilizers.

Potatoes, cabbage and other bulky vegetables constituting an important portion of human food, will probably increase in relative importance. The state includes several million acres of land well adapted to the growing of potatoes, and the climate is as well adapted to that crop as the climate of any section of the country, with the exception of portions of the New England States. Moreover, the large population in the 200 mile circle with Chicago as a center occupies an area not well adapted to that crop; it therefore offers a large market for the Wisconsin crop. Michigan is our only competitor in that field, and she has large centers to the east. The same situation exists with reference to cabbage and onions, for which we have ample areas of muck soil exceptionally well suited.

The canning industry, based on peas, sweet corn, beets and cabbage, is already growing at a remarkable rate. It would seem also destined to still further increase since the state possesses a happy combination of favorable conditions for this industry. In fact many sections have a variety of soils including those adapted to each of the crops mentioned, and the climate itself favors them. This combination of crops suitable for canning purposes makes possible the use of the expensive canning plant during a long season, thus greatly increasing the profit secured, and making it possible for the cannery to compete under favorable conditions with other canneries not so favorably located.

Sugar beets are well adapted to Wisconsin climate, and the state includes much soil exceptionally well suited to that crop. The best soils for sugar beets are the heavy silt loams well supplied with lime; and the northern location gives the cool temperature especially during the ripening period so important in the storage of sugar in the beet. It is quite probable that this industry can be profitably increased provided sugar from the beet does not receive too large competition from sugar derived from cane. Only the rate of development of the cane growing countries can determine this, since they undoubtedly have much superior possibilities when developed.

The production of wheat for human food is not likely to prove profitable in this state for a great many years, since the area suitable to that crop in the northwest, in Canada, and in other countries, is so great and is available for that crop only.

While a considerable quantity of fruit is grown, the area occupied is very small, probably not amounting to over 15 or 20 thousand acres. Moreover, there is a large area of land suitable to fruit which is not of the highest value for other crops. The total yield of these crops can be increased many fold when the demand warrants such increase.

FORESTRY IN WISCONSIN

Although Wisconsin was one of the great lumber states forty years ago, so great a part of the virgin timber has now been removed that we are already importing more lumber than we are producing. The time is rapidly coming when we must either produce our own supply through reforestation or import practically our entire lumber supply. On account of the great weight of lumber and the expense of freight from the parts of the country in which it is now produced in largest amounts it is very desirable that each state or section of the country produce as much of its own supply as possible so far as this can be done without seriously reducing the yields of other more profitable crops. It is desirable, therefore, that all land suited to forestry and not suited to other crops be put in permanent forests. While we have not yet made sufficiently accurate soil survey of all parts of the state to determine with certainty just how much land of that character we have, nevertheless the survey so far made shows approximately the area which should be considered forest land.

As shown in the table on page 49, the state contains about 4,200 square miles which has been classified as rough stony land. Of this 1,568 square miles are in the northern part of the state associated with the Kennan loam soils, 905 square miles are in the sandy areas, 415 square miles are associated with the Colby silt loams, 35 square miles are in the area of Miami loams, 100 square miles are in the Miami silt loam area in the southeastern part of the state and 1,200 square miles are in the southwestern or Knox silt loam region. With the exception of the rough land in the southwestern part of the state it would seem that all of this rough stony land occurring in fairly large areas should be considered as potentially forest land since it has relatively little agricultural value and for the most part has a capacity for forest development. The rough stony land in the southwestern portion of the state consists largely of bluff faces extending from the upper, rolling table lands to the lower slopes of the valleys. It, therefore, occurs chiefly as a comparatively narrow belt or fringe surrounding the upper parts of the valleys. It will undoubtedly prove possible to use part of this bluff land for forestry purposes but it does not seem likely that more than one half of it can ever be profitably used for that purpose since a great deal of it occurs in comparatively narrow strips which would be difficult to take care of in forest growth. It would seem reasonable to consider half of this class of land in this part of the state as potential forest land. This would give us a total of rough stony land as now classified available for forest use of 3,623 square miles.

The table above referred to shows that the state contains something over 7,000 square miles of sand or fine sand soils not including the part mapped as stony land in the sand areas. While in the opinion of some all of this land should be considered as forest and non-agricultural land a more careful consideration of the agricultural possibilities has shown by experience in many sections of the state and by experimental work on the sand substations that profitable agriculture is now possible on much of this sandy land and that with the increasing needs of the future and the increasing knowledge of its management a larger portion will be profitably used in the growing of agricultural crops. A larger portion of the more level sandy land of the central part of the state can be considered agricultural than of the more choppy and hilly areas of the northern part. Most of the sand and fine sand of the state occur in four areas of the central, northeastern, northwestern and northcentral portions. Even though all of a given tract of sandy land could be used for agricultural crops it is advantageous to leave a portion of it in wide strips as wind breaks which greatly lessen the danger of injury to crops from sand blowing. Including such belts and other areas which are of little agricultural value we estimate that one fourth of the 2,300 square miles of sand and fine sand in central Wisconsin amounting to 575 square miles should be used for forest purposes. On the same basis we estimate that one third of the 1,200 square miles in the northeastern and the same amount in the northwestern should be considered forestry land making 400 square miles in each case, and that two thirds of the 1,020 square miles in the north central part should be classified as forestry land amounting to 680 square miles, giving a total of sandy soils of 2,055.

Plate III–A. Reproduction of spruce on a burned-over peat marsh in northern Wisconsin.

Plate III–B. A virgin stand of hemlock. Shawano County.

A considerable portion of the peat and other wet lands of the state are already in woods or forests of trees which are adapted to that condition. It has been urged by Director Zon that by a gradual drainage of peat lands an improvement in the character of the timber on them can be effected and a portion of our spruce is already produced on such lands. If it should prove practicable to use half of the 450 square miles of marsh land in the north central portion of the state and one tenth of the 790 square miles in the southeastern we should have something over 300 square miles of peat forests. The other types of wet soils included in the class of "other wet soils" of the state are largely over-flow lands along streams and are to a limited extent wet sandy soils not readily classified with other types. This general group of lands amounts to 3,650 square miles in the state. If we are to assume that 20% of this class of lands in the southwestern, 10% of that in the southeastern, 20% of that in the area of sandy soils and 25% of that in the area of Kennan loam soils may be used for forests we would have a total of 516 square miles of forest lands along streams in addition to those already mentioned.

This gives a total of 6,498 square miles of land which should be considered forest land amounting to a little over 4,000,000 acres. In addition to this land which might be well used for forestry purposes in the usual sense of the word a large part of the farms of the state can undoubtedly profitably include an average of ten acres of farm wood-lot for the growing of fuel, posts, etc. It would seem reasonable to assume that 200,000 farms might in that way use 2,000,000 acres of land to advantage making a total of 6,000,000 acres of forest land.

It would, of course, be easy to say that a still larger area of land in Wisconsin should be used for forestry purposes than that above indicated but if we are successful in securing an annual acre growth of 40 cubic feet on the 4,000,000 acres we should be producing 160,000,000 cubic feet annually which would be at the rate of 40 cubic feet per capita for a population of 4,000,000. It is true that 40 cubic feet is much less than the present rate of consumption in the United States but it is three times that of Germany and is probably as high a rate as can reasonably be maintained at the time when our forests would come into production assuming that it will take ten to twenty years to get the forests established and 50 years longer to grow them.

While the estimate of land not suitable for agriculture and which could best be used for forestry above indicated is much less than many, somewhat familiar with the soils of the state, have estimated, it is based on all the work of the survey so far done and while the exact location of small tracts which should be used for forests has not been indicated it is not likely that more detailed surveys will affect the estimation of the total amount materially. When it is remembered that New York and Pennsylvania, which have been working on a forestry program for a number of years and both of which include a much larger portion of rough and stony land unsuitable for agriculture than does Wisconsin, and still in each case has less than half the area yet in forests, the unreasonableness of the project to establish more than 4,000,000 acres of forest land in Wisconsin will be more evident. Director Zon states that the total area of land in forests in the United States in 1919 amounted to 483,000,000 acres, of this 262,000,000 acres are considered as available for forestry uses only. He also states that the present rate of use of timber in the United States is nearly twenty times that of Germany per capita and that "If we were willing to reduce our living standards to the level of Germany or France the present rate of growth would provide for a population of about 235,000,000 people." It seems evident, therefore, that a full consideration of the relation of forest area in Wisconsin to that of the country as a whole would lead to the conclusion that the use of more than sufficient land to meet the needs of the state alone would not be advisable. On the other hand it certainly is a matter of the greatest importance that a beginning be made as quickly as possible in the development of forests on land which is likely never to be of any important agricultural use. A more detailed discussion of the land best adapted to forestry use in the different soil areas of the state will be found in the chapters on those areas.

CHAPTER III.

THE ORIGIN AND CLASSIFICATION OF WISCONSIN SOILS

The larger portion of most upland soils has been formed from underlying rocks of different kinds, and through the action of a number of agencies. It is of considerable help in the understanding of the character of soils and of their composition if something is known of the character of the rocks from which they were derived, and of the agencies which have produced them. Accordingly a brief outline of the geology of the state is here given.

OUTLINE OF GEOLOGICAL HISTORY OF WISCONSIN

This outline of the Geological History of Wisconsin is based on the work of the Wisconsin Geological Survey, and especially on the section on geology in "The Underground and Surface Water Supplies of Wisconsin" by Samuel Weidman and A. R. Schultz, published in 1915. As stated in this report, "The geological history of Wisconsin represented by the rock formations falls into three great periods which are widely separated from one another. The first or earliest period is the Precambrian, the second the Paleozoic, and the third is the Pleistocene or glacial."

The earliest or oldest period is the Precambrian. The rocks of this period include Huronian and Laurentian, chiefly granites, gneiss, and schists which form the large area in the central northern part of the state as shown on the map. It also includes two broad belts of igneous lava flows, chiefly gabbro and diabase, in the northwestern part of the state and the extensive area of Lake Superior sandstone bordering them. The Laurentian and Huronian rocks are the oldest and in fact represent the earliest period of geological history. The Keweenawin period within which both the igneous rocks, gabbro and diabase, and the Lake Superior sandstone were formed, constitute the period following the Laurentian, but still of very early geological age.

Fig. 6.—Geological map of Wisconsin and cross section from Marshfield to Milwaukee.

In the second or Paleozoic period, all the remaining stratified rocks of the state were formed. These as shown on the map, Fig. 6a, constitute two-thirds or more of the state, lying southeast and west of the crystalline rocks of the Laurentian period. This great series of sedimentary rocks is subdivided, as shown on the map and in the legend on page 36, into several different formations. Only the more important formations are shown on the map.

These formations were deposited as sediments in an ocean surrounding or at least extending south from the area of older crystalline rocks in the northern part of the state. They were laid down in the water of this ocean as sediments and were later solidified into hard rocks. The gradual uplift of this portion of the country in later periods left these rocks in a slightly tilted position, sloping or dipping away from the central area to the east, south, and west. This position and the relative thickness of the different formations is indicated by the cross section, extending from Marshfield in the central part of the state southeast to Milwaukee, Figure 6. The area of each formation on the surface as shown on the map is called the outcrop, while the thickness of the rock is shown in the cross sections.

The lower or oldest of these is the Cambrian sandstone. This formation covers a wide V-shaped area southeast and west of the central area of older rocks. This formation consists largely of sandstone and shale.

The main or lower body of the Cambrian sandstone is for the most part poorly cemented and varies in texture from coarse grained to very fine grained, often being of a distinctly shaly character. These shaly beds occur especially at the lower or older side of the formation, and toward the top or younger side. The more extensive shaly beds occur in the western central part of the state in Clark, Eau Claire, Chippewa, and Dunn counties. But shaly beds occur in Trempealeau, Monroe, and Juneau counties where the upper shaly portion of the Cambrian bed is exposed.

The next period following the Cambrian includes the local beds of Mendota limestone, and Madison sandstone and the Lower Magnesium limestone, St. Peters sandstone, and Galena limestone.

The Lower Magnesium limestone lying above the Cambrian sandstone over most of southern Wisconsin has an outcrop varying from 10 miles to 50 miles in the broad V-shaped belt outside of the Cambrian area. This rock is a heavily bedded dolomitic limestone containing much siliceous material or chert.

The St. Peters sandstone lying above the Lower Magnesium limestone occurs in another V-shaped area and has a thickness of from 20 to 80 feet. The St. Peters sandstone is very generally coarse and incoherent so that it is seldom strong enough for use as building stone. It consists for the most part of white quartz grains, though it occasionally has a cementing material of iron oxide which gives it a red or brown color.

The Galena and Black River limestones lying above the St. Peters sandstone have been largely eroded so that they form comparatively thin layers as now exposed. Whereas originally they varied from 100 to even as high as 350 feet, as shown by sections in the southern part of the state where they are still covered by later formations. While the Galena limestone usually lies immediately in contact with the underlying Trenton formation, it is separated from it in Pierce County by the Decorah shale which has a thickness of 30 to 40 feet.

The Silurian period is represented by the Richmond shale which was deposited above the Galena limestone and by the Niagara limestone above the Richmond. These formations occur now chiefly in the eastern part of the state, although they were originally deposited over most of the southern portion, as indicated by remnants such as that of Blue Mounds, the upper part of which shows the Richmond shale capped by a small area of Galena limestone. The Richmond shale is chiefly a heavy bed of bluish or greenish shale. It has, however, occasional thin beds of limestone, and some portions consist of a soft fine-grained sandstone. In thickness, the Richmond shale varies from 150 to 250 feet as shown by well borings, passing through the Niagara above it to the Galena below. But its softness has led to its erosion as soon as left unprotected by the erosion of the limestone above, so that its outcrop is now limited to a narrow belt bordering the Niagara limestone and forming a steep slope leading to what is called the Niagara escarpment or bluff face.

The Niagara limestone occurs as a broad belt along the eastern side of the state from the southern border to and including the Door peninsula. It varies in thickness from 200 to over 600 feet and is a pure dolomite, usually of quite pure crystalline character and gray blue color, although it is occasionally nearly white, and sometimes buff, and the upper portion is quite siliceous or cherty.

Following the formation of these limestone and sandstone beds and their slow gradual elevation above the level of the sea, they were exposed to erosion which developed an extensive drainage system of rivers and tributaries which cut into these beds. This caused the outcrop of the different formations to become very irregular so that the geological map of these rocks shows upper formations in the upland interstream areas and lower or older formations in the deeper valleys.

This period, during which an immense quantity of the material of these sedimentary rocks was removed, represents a long period in geological history, within which other sediments later solidifying into rocks were formed in other parts of the country still occupied by ocean water.

The third or final period of geological history, represented by actual deposits in Wisconsin, is the Pleistocene, or glacial period. This period is of comparatively recent geological history, though the times since the first glacial flow is estimated by geologists at a hundred thousand years or more. The ice of the glacial period accumulated at two chief centers, one in the vicinity of Hudson Bay and the other in northwestern Canada, the flow from these centers of accumulation being to the southward. The evidence of the occurrence of these great invasions of ice from the north is found in the mass of soil and stony material including bowlders of rocks of kinds not found in the underlying rocks above described, but found in the northern part of the state and Canada. The mass of soil, gravel, and bowlders dragged along the bottom of these ice sheets or glaciers as they flowed southward is called glacial drift. The country over which the ice flowed has a surface layer of this loose drift varying from little or nothing to depths of 200 or 300 feet.

A large area in southwestern Wisconsin and adjoining portions of the three adjoining states was never covered by this ice invasion as is shown by the absence of drift. This area is known as the Driftless Area of Wisconsin, and it represents a large island around which the ice flowed. Apparently the deep rock basin of Lake Superior and the high land of the northern part of the state deflected the flow to the westward; the broad valley now occupied by Lake Michigan deflected it to the eastward; and the high land of the northern part of the state offered protection from the immediate north.

This ice invasion did not occur merely once, but four or five different times, widely separated, and the extent of the driftless area or island was not exactly the same during the different ice invasions. Hence, a portion of the region north of the driftless area has evidence of having been covered by the earliest or Kansan ice sheet, other portions by the Iowan and Illinois drift, while by far the larger part of the state was covered by the last or Wisconsin drift.

Sources of Lime

Since it is important to maintain a sufficient supply of available lime in agricultural soils as an essential element in their fertility, some consideration should be given to the supply of lime within the state available for this use. There are several sources from which lime may be secured within the state borders. The most important of these of course is limestone, but in addition there are large quantities of lime in marl beds and considerable lime in the by-products of sugar beet factories, paper mills, and in wood ashes.

As will be seen from the geological map on page 36, limestones occur over a considerable area of the eastern, southern, and western portions of the state. There are also some small earlier beds of limestone in Bayfield County not shown on the map. These limestone beds were formed in different geological periods as already stated. They vary in purity and in other factors which affect the readiness with which they can be quarried and ground for agricultural use. The essential part of all limestone is their content of calcium and magnesium carbonates. In some limestones the carbonates consist entirely of calcium, while in others the carbonate contains calcium and magnesium. The latter are commonly called dolomites. It so happens that by far the larger portion of Wisconsin limestones are dolomites. These rocks contain from 20 to 45% of magnesium carbonate and from 35 to 75% of calcium carbonate.

The lower magnesium limestones are almost entirely dolomites and usually contain from 35 to 45% of magnesium carbonate and from 50 to 65% of calcium carbonate, though there are a few cases with a little more or less of these two elements than this range indicates. Mixed through the limestones there is always a certain amount of impurity including earthy matter of a clay-like nature and especially silica which forms chert.

This chert is of a flinty nature and when abundant as it is occasionally locally in lower magnesium limestone, it makes limestone difficult to grind and lowers its value.

The Galena and Black River limestones vary considerably in respect to the relative amount of magnesium and calcium carbonates they contain. In a few cases, especially in Grant, Iowa and Lafayette counties, some of the beds locally have only from 2 to 10% of magnesium carbonate and from 70 to 95% of calcium carbonate. These beds of high calcium content, however, are of comparatively small extent. The Niagara limestone which covers a considerable area in the eastern part of the state is entirely a dolomite containing from 40 to 45% of magnesium carbonate and from 50 to 55% of calcium carbonate, the impurity averaging from 2 to 6 or 7%.

So far as the value of limestone depends on its effect in correcting or reducing acidity, the limestone containing magnesium, that is the dolomites, is as effective as the more purely calcium carbonates are. In fact magnesium is as essential in plant nutrition as is calcium, though probably not as commonly lacking in sufficient amounts. So far as is now known the use of ground dolomitic limestone on soils is as beneficial as that of limestone containing very high amounts of calcium carbonate.

Marl beds occur widely distributed throughout all portions of the state which were covered by glacial ice. These beds were largely formed by small mollusk shells such as snails and by lime carbonate deposited through the action of low forms of vegetation chiefly growing in water of shallow lakes and ponds. These marl beds are frequently found at the bottom of these lakes and ponds at present, while in other cases they are found under sand or silt and clay and in some cases in low land from which the water has now disappeared. In composition these marl beds vary considerably. When quite pure, as many are, they contain from 80 to 95% of calcium carbonate and from 3 to 5% of magnesium carbonate, with a very small amount of impurities. All grades between such pure marl and those made up largely of sand or silt and clay and earthy matter are found, however, and it is important that an analysis be made before extensive work in excavation and use is undertaken. When quite pure and dry the marl is white or light gray in color and will almost entirely dissolve in any dilute acid.

The marl is excavated by means of dredges of different types and piled so as to permit it to dry out somewhat before being used. Even after drying several months in a large pile it contains from 30 to 50% water which of course adds to the weight to be hauled and applied, and the moist and lumpy condition of the material makes it difficult to apply with machinery designed to spread the drier and purer limestone, so that it must commonly be spread either with a shovel or manure spreader and from 3 to 5 or 6 loads per acre must be used to supply the amount needed. The expense of artificially drying the marl now seems prohibitive and its use will therefore probably be limited to short distances from the marl beds. It is frequently the case, however, that marl is available in sections a number of miles from railroads so that the wagon haul may be much less than that of ground limestone.

Marl beds are found quite commonly through the central sandy section of the state and more or less commonly through the entire northern half of the state outside of the region of limestone rocks.

The lime from the presses of sugar beet factories and from the paper mills has a high calcium carbonate content resembling that of marl and is also moist or wet. The material from the paper mills frequently contains poisonous sulphide at first but this disappears after standing some months.

Wood ashes contain approximately 50% of lime carbonate and even when the potash has been removed by leaching retain the lime and may be used in the same way that marl is. Considerable amounts of ashes are available at the saw mills, especially in the northern part of the state.

ORIGIN OF SOILS

Some of the properties of soils which materially affect their fertility and adaptation to different crops are the result of the origin of the soil in respect to source of the material and agency of formation.

WEATHERING OF ROCKS

The most common and widespread kind of soils with reference to origin consists of those which have been derived from underlying rocks by the gradual process of weathering. This process involves the chemical decomposition of some of the minerals through the action of carbon dioxide dissolved in water. In this process the various rock minerals are broken down mechanically

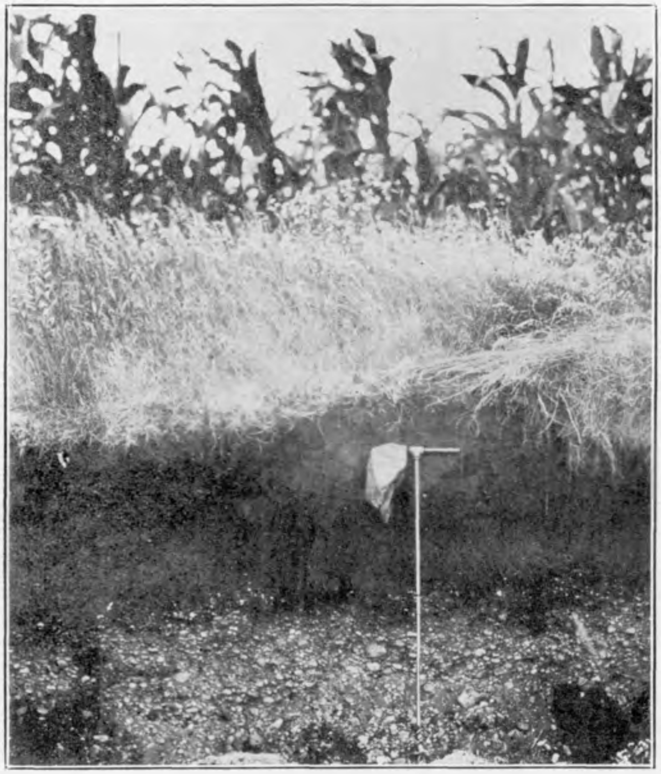


Plate IV–A. Exposure showing stratified gravel underlying surface soil in Waukesha fine sandy loam. An illustration of a condition commonly found in alluvial or terrace types.

Plate IV–B. Residual soil overlying limestone rock from which it was derived by weathering. Southwestern Wisconsin.

and decomposed chemically. The chief action is that of forming carbonates of the elements sodium, potassium, calcium, and magnesium which are soluble in water, and in a climate of moderate or large rainfall these elements are dissolved and leached down and away in the running streams. The other elements contained in the rocks such as iron, alumina, and silica are left largely as oxides because of their insolubility. The general effect of weathering of rocks into soils, therefore, is the removal of a considerable portion of certain elements and the retention of a considerable portion of certain other elements.

Besides this chemical decomposition, there is a merely physical or mechanical process of breaking up of the rock through the action of frost, an alternate expansion and contraction due to changes in temperature. This has the effect of loosening the various minerals of the rocks one from another, forming grains.

These grains are then more or less decomposed chemically as above explained. The result of this is that such soils consist of more or less completely decomposed mineral particles mixed with the products of decomposition.

RESIDUAL SOILS

This process of weathering of soils, both chemical and mechanical, is an extremely slow one. When any area of land remains for a very long period of time without being much affected by other agencies, such as ice or water working on the soils, there gradually accumulates a layer of *residual soil.*

These residual soils bear a certain relation to the rock from which they were derived. If the rock is a sandstone largely made up of quartz or silica, the residual soil derived from it is necessarily of a sandy nature, having very nearly the same mechanical composition as that of the sandstone underlying it. If the rock is a granitic or other igneous rock, the minerals of which contain considerable amounts of sodium, potassium, calcium, and magnesium, as well as silica, iron, and alumina, the first mentioned elements are to a considerable extent removed, and the soil consists largely of compounds containing silicon, aluminum, iron, and oxygen mixed with more or less of the undecomposed grains of the rock. Its chemical composition, therefore, differs very greatly from the rock from which it is derived.

In the case of soils derived from limestone, the calcium and magnesium carbonates which are its chief constituents are very largely dissolved and carried away through underground waters. Thus it is chiefly compounds of silica, iron, and alumina which were diffused through the limestone as impurities that are left to collect as a surface soil. The result of this is that residual soils derived from limestone do not differ greatly in chemical composition from those derived from granites.

The texture of residual soils is largely determined by the rocks. Those derived from the sandstones are naturally of a sandy character, though usually the texture is somewhat finer than that of the rock, since the sand particles split up more or less in the process of weathering. The texture of soils derived from granitic and other crystalline rocks is usually of a silt loam or loam character. The fineness or coarseness of this depends on the relative amount of quartz grains and unweathered mineral particles left in the soil, associated with the finer material resulting from the complete decomposition of these minerals. The texture of soils derived from limestone is usually quite fine, either clay loam or clay in character. This is because limestone soil consists largely of very fine material which was carried out to a considerable distance into the open in which the limestone was originally laid down. Associated with this clay loam or clay there is frequently a varying amount of sharp, angular flint or chert formed from silica deposited with the limestone.

The general result of all of these processes of weathering, therefore, is to make residual soils much more alike in chemical composition among themselves than were the rocks from which they were derived.

GLACIAL SOILS

One of the most important agencies affecting the soils of Wisconsin, in common with a large portion of the northern part of the United States, was the action of glacial ice. This ice accumulated as the result of a long period of very cold and moist climate in the northern part of the American continent. The ice gradually accumulated to the depth of thousands of feet, producing a pressure which compressed the snow into ice in a way similar to that in which ice is formed under horses' hoofs on the roads in the winter. In this way an enormous layer of ice was accumulated, and under pressure it was forced to flow southward from the area of accumulation. This vast sheet of slowly moving ice, several thousand feet in thickness, moved slowly southward or southeastward with a tendency to form currents along the basins of Lake Michigan and Lake Superior.

It did not, however, completely cover the state but the current moving down the Lake Superior channel flowed in a southwesterly direction, while that down the Lake Michigan and Green Bay basins flowed in a more directly southern route, with the result that a large island was left unaffected in southwestern Wisconsin, southeastern Minnesota, northwestern Illinois, and north-

Fig. 7.—Map showing portions of Wisconsin covered by glacial soil or drift, and lines showing direction of movement of the ice in the different lobes or tongues.

eastern Iowa. This area is known as the driftless or unglaciated area.

The action of the slowly moving ice consisted largely in scraping off residual soils previously formed, mixing them up, carrying them along for shorter or longer distances, and mixing the soil itself with pebbles, cobbles, and bowlders.

ALLUVIAL AND LACUSTRINE SOILS

Not only did the solid ice itself greatly affect the soils of the area over which is passed; the water, resulting from the melting of this ice when the climate became warmer, also acted on the soil, forming alluvial soils abundantly; and it even collected in large shallow lake areas within which sediment was deposited, forming so-called lacustrine soils.

OUTLINE OF CLASSIFICATION OF WISCONSIN SOILS

As we have seen, there are several qualities which affect the agricultural value and use of soils. These include texture or fineness of grain; amount of organic matter, indicated approximately by color; topography; stratigraphy, that is, variation in color and texture with depth; drainage, and others.

Most of these factors are the result of the mode of origin, i. e., the agency by which they were formed and the kind of material out of which they were formed. The classification used by the U. S. D. A. and by most states therefore is based on origin. In this classification, soils formed by a single agency, as glaciation or weathering or alluviation, and from a single source, as limestone or sandstone or granite, and having a given limit in amount of organic matter, constitute a group called a *series*. Each of these groups or series varies in texture and must be subdivided on that basis. A soil of a given series and of a definite texture such as a fine sandy loam or a silt loam is called a *type*. The type is therefore the unit of soil classification, though it is true in some cases that a type is sub-divided into two or more *phases* on account of variation in some factor such as topography or stoniness.

Some of the more important series of Wisconsin soils are the following:

Miami, derived from limestone by glaciation, of light color. This includes the Miami clay loam, silt loam, loam, and fine sandy loam. The Carrington series was formed in the same way as the Miami but occupies areas which had a prairie vegetation rather than a wooded one, and so have more humus and are dark in color. This series includes the Carrington silt loam, loam,

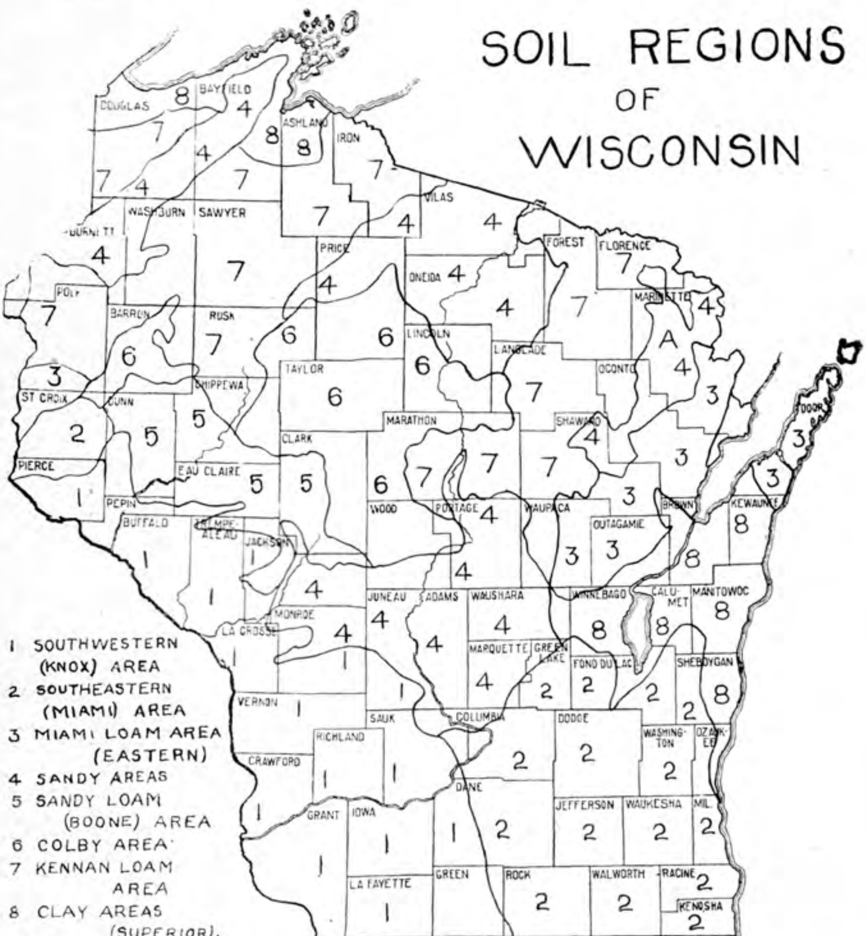


Fig. 8.—Map showing chief soil regions or areas, and corresponding with the large colored map of the state accompanying this report.

and fine sandy loam. The Knox series was formed by weathering of limestone rocks, together with Loess brought by winds from other portions of the country. It includes the Knox silt loam, loam, and fine sandy loam. The Colby soils were formed by weathering of an old glacial drift on crystalline rocks. These series were wooded and are therefore light in color. They include Colby silt loam, and loam. Altogether there are about thirty different series, including somewhat over 100 types which have been mapped.

Certain types greatly predominate in different parts of the state and on that account determine the general agricultural character of these sections. It is convenient, therefore, to subdivide the state into what may be called soil areas, each of which is characterized by one predominating series, though in all cases there are several minor series and types associated with it. The map of the state, Figure 8, shows the location of these series.

In order to show the soils of different textures and variations in other respects which occur in the different sections of the state, they have been grouped, and areas calculated as expressed in the following table:

4

EXTENT OF VARIOUS SOILS BY GEOGRAPHICAL AREAS IN WISCONSIN

54,566 square miles, total land area

	South Western	South Eastern	Miami Loams	Sandy Area	Boone Sandy Loams	Colby Area	Kennan Loam Area	Clay Area	Totals
	sq. mi.	sq. mi.	sq. mi.	sq. mi.	sq. mi.	sq. mi.	sq. mi.	sq. mi.	
Sand and fine sand	200	150	400	5,765 C —2,300 NE —1,220 NW—1,225 NC —1,020	380	--------	400	39	7,334 sq. mi. 13.8%
Sandy and fine sandy loam	400	940	2,130	275	1,600	75	4,100	505	10,025 sq. mi. 18.1%
Loam and silt loam	5,520	3,370	270	--------	100	4,800	4,200	626	18,886 sq. mi. 34.8%
Clay loam and clay	--------	190	20	--------	--------	--------	--------	3,280	3,490 sq. mi. 6.4%
Prairies	1,580	1,300	--------	40	40	--------	20	--------	2,980 sq. mi. 5.5%
Peat	40	790	425	1,415 C — 700 NE — 125 NW— 140 NC — 450	275	75	800	150	3,970 sq. mi. 7.2%
Other wet soils	980	800	300	700 C — 500 NE — 50 NW— 50 NC — 100	200	75	400	200	3,655 sq. mi. 6.6%
Rough stony land	1,200	100	35	905	5	415	668* 900†	--------	4,228 sq. mi. 7.6%
Square miles	9,920	7,640	3,580	9,100	2,600	5,440	11,486	4,800	54,566

*668 sq. mi. in large areas shown on map. †900 sq. mi. in small areas not shown on map.

From this table it will be seen that in the state as a whole, loams and silt loams of light color constitute 34.8 per cent, sandy loams and fine sandy loams, 18.1 per cent, sands and fine sands, 13.8 per cent, clay loams and clay, 6.4 per cent, dark prairie loams, chiefly silt loams and loams, 5.5 per cent, peat, 7.2 per cent, other wet soils, 6.6 per cent, and rough stony land, 7.6 per cent. In the following chapters these soil areas or sections of the state are described in detail.

RELATIVE VALUE OF MAJOR SOIL TYPES

Land values, as indicated by their selling price, depend on a number of factors. The more important of these are their fertility or crop producing power, the number of important crops to which they are adapted, location with reference to markets, educational and social conditions of the neighborhood, and their assumed speculative value. Fertility, or crop producing power, is therefore only one of several factors which go to determine the sale value of any particular piece of land. It is, however, the most fundamental and lasting factor and the one least likely to change as time goes on.

The fertility or crop producing power of land, as was explained in Chapter I, is determined primarily by texture, chemical composition and lay of the land or topography which affects the readiness with which it may be tilled and operated as a farm. The sums of these factors determine the economy with which crops may be produced in each case and therefore represent the fundamental or inherent value of the land. On this basis it is possible to make a general estimate of the relative value which should be placed on the more important types when they are compared one with another.

Since the prairie soils as they occur in Wisconsin, represented chiefly by the Carrington silt loam and the Waukesha loam and silt loam, have the best combination of those factors which go to determine economy of production, these types may be placed at the head of the list and taken as a basis of comparison for the other important types. Assuming then that the Carrington silt loam and Waukesha loam and silt loam are given a range of 85 to 100%, the other important types shown on the map may be given the following values: Miami silt loam 80 to 90%, Superior silt loam and clay loam 80 to 85%, Miami fine sandy loam, the level and moderately sloping portions of the Knox silt loam, and the Colby silt loam, each 75 to 80%, Boone fine sandy loam 65 to 70%, Kennan loams and Superior clay of Lake Superior region 65%, sandy loam and the drained peat soils in southern Wisconsin 60%, level and undulating sands and fine sands and steep land of all silt loam types 50%. These figures apply to cleared land only.

It should be understood that this estimate is made simply for the purpose of indicating the relative value of these types as determined by their inherent qualities and the climatic conditions under which they occur. These relative values must of course be considered in connection with the other factors of location with reference to markets, social and educational conditions and any assumed speculative value in determining their full value, and are given merely as a guide for use in making comparisons among the different important types of the state.

It is important that the principle be recognized that sale value of land is not necessarily an accurate guide as to the success which may be secured in farming it. The sale value represents the principal on which interest at the usual rate may be paid by the farmer above costs of operation, and it should be borne in mind that land may pay for the costs of operation and taxes, or in other words may return to the farmer a good livelihood even though it does not acquire a principal value above this cost of operation. In other words, land which has a comparatively low sale value may repay the costs of labor and furnish good homes, which is of course of the greatest importance, even though it does not have a large sale value. It is from this point of view that the question of the advisability of encouraging the further development of farms on cut-over land and sandy and marsh soils should be considered.

CHAPTER IV

SOUTHWESTERN WISCONSIN

KNOX SILT LOAM AREA

This part of Wisconsin is in many respects quite different from the remainder of the state. The rolling to rough topography, freedom from lakes and marshes and the prevalence of soils of silt loam texture is characteristic of the region as a whole. As shown on the map, the Knox silt loam predominates but there are also areas of dark prairie soil, and considerable rough stony land along the bluff faces of the valleys and some alluvial and terrace soil along the streams.

The region includes an area of over 10,000 square miles or about one-fifth of the state. This area is larger than that of any of the New England states except Maine and two-thirds as large as Switzerland. It has more land in crops and pasture than that country, famous for its dairy industry. Its agriculture is largely devoted to the various forms of livestock farming. Dairying is the predominating type of agriculture over a considerable portion. This is especially true in Green and portions of adjoining counties where the Swiss cheese industry is so well developed. This region, especially in portions of Grant and adjoining counties, is the chief beef raising section of the state and with this is very generally associated the raising of hogs. Sheep raising is noticeable in a few sections especially in western Richland and adjoining portions of Vernon and Crawford counties.

As is generally the tendency in a region of rough or rolling topography the farms of this section average considerably larger than those of other sections of the state in which the land is more level. There is still a large amount of woodland along the rougher hillsides and the improvement of this woodland constitutes an important problem in this region.

Origin of the Soil. The soils of southwestern Wisconsin constitute a group quite distinct from those of the remainder of the state. This is due largely to their origin. This region was not covered by glaciers and the topography and soils have been pro-

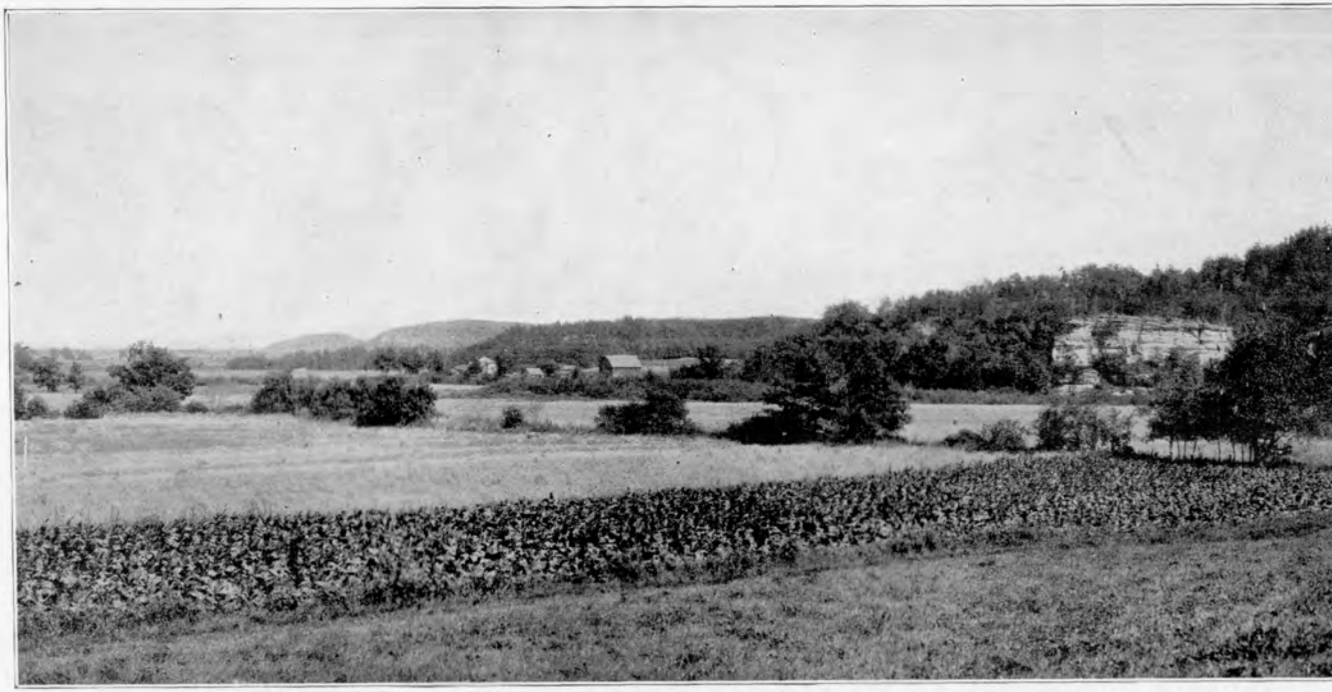


Plate V. View near New Lisbon showing bluffs along the border of the limestone region above, and the sandstone region below. The softer sandstone has been eroded down to a comparatively level condition while the limestone region is rough or undulating.

duced chiefly by erosion and weathering. The Cambrian sandstone described on page 37 extends southwest and south under the overlying rocks of the southwestern part of the state. The upper parts of this thick sandstone formation show some variation and include local beds of alternating limestone and sandstone, especially the Mendota limestone, about 35 feet in thickness, and the Madison sandstone of about the same thickness overlying it. The Cambrian sandstone outcrops as bluff-like hills quite prominently along the border line between the central sand and marsh area and the area of rougher land in southwestern Wisconsin. Overlying this Cambrian sandstone are several alternating beds of limestone and sandstone. The first one is the Lower Magnesium or Shakopee limestone, varying from 40 to 250 feet in thickness. Above this lies the St. Peter sandstone varying from a very thin layer up to over 200 feet in thickness. Above this are found the Trenton limestone, varying from 40 to over 100 feet, and then the Galena which originally varied from 125 to 250 feet in thickness.

In the vicinity of Blue Mounds there is a very small area of the Richmond shale and the Niagara limestone, which was originally between 400 and 800 feet in thickness. All of these beds of rock were originally continuous and were formed under the ocean which surrounded a large island in the northern part of the state. The gradual elevation of this island and the receding of the ocean caused the development of streams which gradually eroded much of the rock, cutting valleys and channels down into it. As this process went on, soils were produced by the slow weathering of these rocks. The soluble lime and magnesium carbonates of the limestone were gradually being dissolved out by the water falling as rain, leaving an insoluble impurity or residue to collect as the surface soil. This whole section of the state was left unaffected by the glacial ice which flowed around a large island, including southwestern Wisconsin and adjoining portions of Minnesota, Iowa, and Illinois.

Most of the soils of this region are therefore called Residual, having been derived by weathering from the rocks underlying them. On the higher and more level areas of this section, however, there is found a layer of light or buff colored silt soil called Loess, which was doubtless brought there by wind. Part of it probably came from the far western plains, although a part of it was probably derived from rock flour exposed around the borders of the glacial area where streams flowed out from under the ice. This Loess forms a blanket varying from a few inches to several feet in thickness. It has become more or less mixed with the residual soil derived from limestones and sandstones, and it is often difficult to determine just how much of the soil is made up by Loess and how much is residual. This mixture of loessial and residual soils derived from limestone, largely the Lower Magnesium, is included in the Knox series. In some areas there is no Loess mixed with the residual soil derived from limestone and such residual soil is classified in the Baxter series.

While a larger part of this portion of the state was originally wooded and the soils are of a comparatively light color, there were some portions, especially forming belts along the tops of the ridges, which were prairies and which had darker soil. The soils of this character in the western portion of the area were formed largely from the Loess and have loessial subsoils. These have been classified in the Marshall series. In the eastern part of this section, especially in eastern Iowa and Dane counties, where there is little Loess, the prairie soil is classified as Dodgeville.

The valleys of the Wisconsin, Chippewa, and other large streams which have their origin in the glaciated portion of the state and which cross this unglaciated area, have plains of sandy and gravelly soils which were brought down by the waters of these streams and deposited along their lower courses. These plains of lighter soil are mostly classified in the Plainfield series. The flood plains, especially of the smaller streams having their origin entirely in the unglaciated area, and so being derived largely from residual soils, are classified in the Genesee series, while those formed from the Loess washed down from the higher land are called Wabash.

SOIL TYPES

The most important soil types occurring in this region are the Knox silt loam, Baxter silt loam, Marshall, and Dodgeville silt loams; but small areas of alluvial types along streams include Lintonia and Genesee silt and fine sandy loams, Wabash silt loams and loams, and Plainfield fine sand. Rough stony land also constitutes a considerable percentage of this section.

Knox Silt Loam. This soil occupies the major part of the unglaciated portions of western and southwestern Wisconsin, covering a considerable portion of the area extending from Pierce

Plate VI. View of rolling country including Blue Mounds in the limestone residual area of southwestern Wisconsin.

and Dunn Counties on the north to the Illinois state line. In the earlier reports this type was sometimes called the *Hartland silt loam,* and in the reports of the Bureau of Soils of the U. S. Department of Agriculture, it is in part called *Knox,* and in part called *Union* or *Boone silt loam.*

The surface soil consists of a light brown or grayish silt loam to an average depth of 10 to 12 inches. It is comparatively low in organic matter and usually more or less acid in reaction.

The subsoil is usually a yellowish brown or buff colored compact silt loam becoming heavier and more clay-like with depth until at a depth of 18 to 24 inches it is usually a distinctly clay loam. This compact clay loam subsoil usually contains a considerable amount of sharp angular flint-like stones of chert derived from limestone. It extends to depths varying from three or four to twelve feet, at which depth the underlying limestone rock is reached. Occasional small areas are encountered in which the rock is reached at depths from one to two feet, but these constitute a very small portion of the area. No gravel or bowlders other than local rock are encountered.

The Knox silt loam was for the most part derived by weathering from the limestones, the lime carbonate of which was slowly dissolved and carried away by water. Thus the insoluble residue was left to collect as this surface blanket of soil. However, over portions of this area are found beds of fine silt loam soil free from chert material which usually characterizes limestone residual soils. This forms a more or less distinct layer above what is evidently a distinctly residual soil. This surface of soil is similar to the Loess, found extensively in Iowa and other parts of the southwest, which is generally believed by geologists to have been of wind origin. This loessial surface soil overlies a strictly residual limestone soil and when thin is mixed with it in such a way that it cannot be with certainty distinguished from it. In other places the Loess is of considerable depth. Such areas occur especially in Vernon, La Crosse, Monroe and Pierce counties. It is then mapped in the detailed surveys as the deep phase of the Knox silt loam.

Previous to the agricultural development of this region, the Knox silt loam was essentially all timbered by a mixture of hardwood trees including white and black oaks, maple, hickory, and basswood. Some sections, especially the more level upland portions such as that in Pierce county, had a considerable amount of hard maple. As is generally true, wooded land does not develop any considerable amount of organic matter and the organic content of the Knox silt loam is small, varying from 2 to 3 per cent.

Steep Phase. In the detailed survey of the earlier years during which Buffalo, La Crosse, and Juneau counties in this portion of the state were surveyed, a more simple classification of topography was used than has been developed since that time. This new classification is explained on page 3. The earlier classification simply distinguished the steep phase from the normal or rolling phase. This steep phase of the Knox silt loam corresponds essentially to class C. as now mapped.

In Iowa county the steeper phase constitutes a little over one-third of the Knox soils; in Buffalo county it is slightly over one-half; in La Crosse county also it runs a little over one-half; and in Juneau county, a little over one-fourth of the entire area of Knox soils.

The essential difference between the normal and the steep phase of the Knox silt loam is, of course, that of slope. The steep phase has the same texture and origin, although as a rule there is less depth over the underlying rock, and fragments of chert occur more abundantly on and through the surface. This is a result of the fact that on the steeper slopes erosion has been greater, causing the removal of the finer part of the soil. A larger portion of the steep phase, than of the normal phase, is still wooded and in pasture.

In so far as the steep phase is used for cultivated crops, it has the same adaptations as the normal phase, but special care must be taken to prevent erosion. This means that tilled crops such as corn or potatoes, if placed on this phase at all, should be grown only once following breaking of the sod. The ground should then be used for small grain as a nurse crop for alfalfa or some other hay crop which should be kept on the ground as much of the time as possible. Since there is more seepage along the steeper slopes than on the gentle slopes, more lime is brought to the surface on the steep phase. This also tends to make alfalfa a good crop for such land. It would seem very desirable that the growing of alfalfa be largely on the steep phase in this part of the state, especially when the farm contains but a small area of land suitable for corn and grain.

Fertility of Knox Silt Loam. When properly managed the Knox silt loam is a fertile soil. The texture gives it good water holding capacity which can, however, be increased to advantage

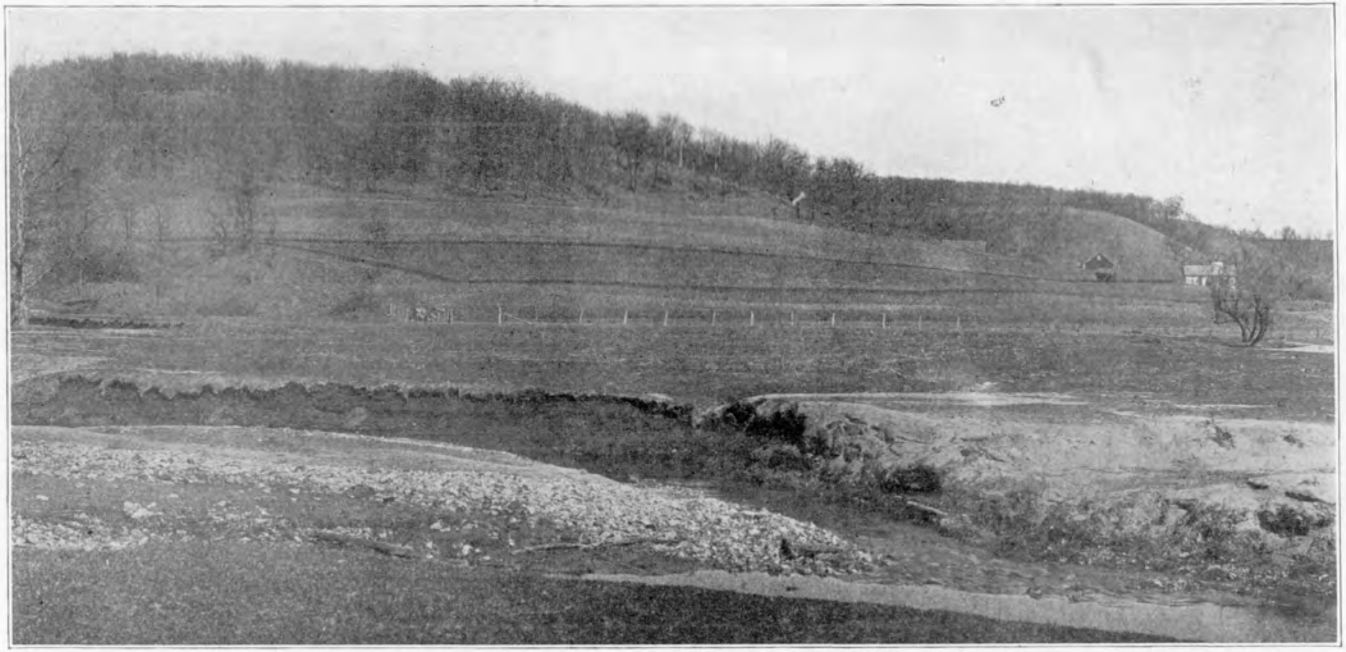


Plate VII. View in Iowa County showing long, narrow fields on side hills arranged so that tilled and untilled crops may alternate, thus reducing injury from erosion.

through the incorporation of larger amounts of organic matter. While small areas which are heavier in texture than the average and approximate a clay loam sometimes have a rather poor tilth, when plowed while wet, the soil as a whole has excellent tilth and the development of a good seed bed is not difficult.

Chemical analysis shows that this soil compares favorably in total amount of the essential elements of plant food with soils of similar texture in other parts of the state and country. The average total content of nitrogen in the surface eight inches is .12% and in the second eight inches of the subsoil .055%. The total phosphorus of both the soil and subsoil averages .045% which is equal to .1% of P_2O_5. The total content of calcium is .60%, of magnesium .52% and of calcium and magnesium carbonate .087%.

The content of nitrogen and consequently of organic matter is only moderate and all plans to increase the fertility should include methods for adding organic matter and nitrogen. In a general system of farming and especially in livestock raising this can be accomplished through putting greater emphasis on the growing of legumes which through feeding will return nitrogen to the soil in manure. In some cases the plowing under of clover or other legumes directly as green manure would be desirable when it is important to increase the organic matter quickly, since by this method all the organic matter of the crop grown is added at once to the soil while only a portion of the organic matter of the crop is returned in manure resulting from the feeding of such crops. It is also very important that the manure be protected from loss as much as possible. Only in cases of intensive growing of special crops should nitrogen be purchased in commercial form.

While the total content of phosphorus compares favorably with that of other soil of similar texture, the available phosphate is in general too low to permit maximum yields of crops of which the rainfall and climatic conditions are capable. On many fields the growing of wheat and other grains which was extensively practiced for a period of about thirty years following the first agricultural development of the region reduced the amount of phosphorus and especially that in available form to a serious extent. Studies made by C. W. Stoddart and the writer during 1905 and 1906 indicated that on a great many fields in this section, approximately one-third of the total content of phosphorus originally present in the virgin soil had been removed by this practice. The general use of some form of phosphate fertilizer supplementing manure is one of the things which will do most to increase the fertility of this soil. This element is being constantly removed in dairy products and the bones of animals sold and it must be replaced if the fertility is to be maintained or increased. On the average stock farm the use of 200 pounds of 16% acid phosphate, or its equivalent, every third year will just about make good the loss through products sold from the farm. The use of phosphate fertilizer will be found to greatly improve the growth of clover and other legumes and also to increase the yields of small grains and corn and to hasten the maturity of the latter. The advantage of the use of phosphate fertilizer on pasture is mentioned on page 68.

While the total content of calcium or lime in these soils is fairly good, it is almost entirely in the form of silicate. Practically all the lime carbonate has been gradually leached out of the soil in the process of soil formation so that while this region is generally underlaid by limestone rocks or lime carbonate, there is little in this form which is very much more available than the silicate form left in the surface soil. While most crops, and especially the cereals, are able to get a considerable amount of lime from the silicate form it is not sufficiently available to meet the demands of large yields and especially is this true of clover, alfalfa and other legumes which require very large amounts of this element.

There is an abundant source of lime carbonate in the rocks of this region, however, and the expense of grinding and application to the land is not great and a large part of the labor involved can be done by the farmer himself. The use of two or three tons of ground limestone per acre on land being seeded to alfalfa is one of the most important means of increasing the fertility of the soil of this region and its use on the main fields of the farm which are in a rotation of corn, grain and clover will be found to materially increase the yields of these crops. This application of lime should be made for each reseeding of alfalfa and is best made when the ground is being fitted for corn the year preceeding that in which the alfalfa will be sown. On the other fields of the farm in the three year rotation above mentioned the application of two tons of ground limestone per acre once in six or nine years will be sufficient to maintain a good supply of this element in available form.

The total content of potash in the Knox silt loam is relatively large as it is in most soils of this texture. The chemical analysis shows the average amount of K_2O in both soil and subsoil to be 1.8%. This means that an acre to the depth of eight inches has approximately 36,000 pounds of this substance. Since but 50 to 75 pounds are needed annually for average staple crops there would be an abundant supply of potash for a long period of years if it were all available. Experience has shown, however, that while there is a sufficiently large part of it available each year to supply a good growth of many crops there is occasionally an insufficient amount to supply the needs of heavy crops, especially of those which take relatively large amounts of this substance.

Manure, carefully managed, especially to prevent the loss of the liquid portion and to prevent leaching, contains large amounts of this substance and its use in reasonable quantities will meet the demands of most crops for this element. Moreover, the decomposition of organic matter has the effect of making the inert potash of the soil become soluble and available so that a farm practice which will maintain a good supply of active organic matter in the soil of this region will undoubtedly have the result of securing sufficient potash for most crops. It is only in the case of certain crops such as sugar beets, tobacco, and alfalfa, when grown without much manure, that further supplies of available potash should be added in the form of commercial fertilizers.

While the yields of all staple crops in this section now compare favorably with those in the best sections of the remainder of the state, they will undoubtedly be increased one-fourth or more by the use of the methods above outlined and the improvement of pastures discussed on page —; together with this, improvement in yields of cultivated land will greatly increase the total yields and profits of the farm.

The Knox silt loam in common with other types of silt loam texture is especially adapted to grass and hay, or pasture, to small grains and to clover and alfalfa. It also produces good yields of corn when the fertility is maintained at a high stage. Among the special crops peas is the one best adapted to soils of this texture though good yields of sugar beets may also be secured. It is less well suited to the growing of the commercial crop potatoes or to crops which require a more mellow or warmer soil. The crops to which it is best adapted, therefore, are those which are naturally involved in any livestock system of farming to which the region as a whole is so well adapted.

Baxter Silt Loam. In parts of this region, notably in southern Juneau, Richland, Vernon, and Monroe counties, the soil derived by weathering from the underlying limestone is somewhat heavier than the Knox silt loam. It varies from a heavy silt loam to a clay loam in texture and the subsoil has a dark red color formed by the oxidation of iron which it contains. This soil has been mapped as the *Baxter silt loam.* In general, it contains a larger amount of chert and other stony material than does the Knox, and it shows practically no modification by loessial material mentioned in the description of the Knox silt loam. Owing to its somewhat heavier texture, the under drainage of this soil on level or gently sloping areas is not so good as that of the Knox silt loam. The timber growth and its general agricultural use and value are essentially the same as that of the Knox silt loam.

Marshall Silt Loam. Several areas of dark prairie soils are found on the more level ridges in this section of the state, notably on Military Ridge in Iowa county, in Grant county, and on the broad undulating ridge of southern Monroe and Vernon counties. The organic matter of these dark prairie soils was formed through the slow decomposition of the fine felt-like root systems of the original grasses of these prairie areas. The earthy matter of the surface soil is of a silt loam texture, the same as that of the Knox silt loam. The loessial phase, however, is more fully developed in these prairie areas than in the steeply sloping areas of the Knox silt loam from which apparently the loess has been more largely removed by erosion. Indeed, the subsoil from one to two, or even three, feet in depth underlying the surface soil of the Marshall silt loam is quite generally more or less loessial.

Dodgeville Silt Loam. In eastern Iowa, western Dane, and in western Green counties, occur areas of prairie soils which were originally prairies similar to those of the Marshall silt loam above described. They have, however, a somewhat lower content of organic matter, and they do not have the loessial subsoil. In other words, they have a more distinctly residual subsoil derived from limestone. These areas are mapped as *Dodgeville silt loam.*

Fertility of Prairie Soils. The Marshall and Dodgeville silt loams constitute the chief types of what were originally prairies in this section of the state. These soils are similar in chemical composition to the Knox silt loam as given on page 57. They

Plate VIII. Typical view of rolling country in southwestern Wisconsin showing deep valleys, the lower and steeper slopes of which are wooded, and rolling upland between.

have, however, more organic matter giving them a darker color and a larger total amount of nitrogen. The average content of nitrogen in the surface eight inches of the Marshall silt loam is 0.27% and in the second eight inches .1%. There is also a somewhat larger total amount of phosphorus in these soils; that in the surface eight inches of Marshall silt loam being .072% and in the subsoil .056%. Their total content of calcium is approximately the same as that in the Knox silt loam.

While these soils had a considerably higher degree of fertility than the lighter colored Knox soils for a number of years after being first broken, due to their larger amount of organic matter and ready availability of nitrogen and phosphorus, it must be remembered that the 75 years of cultivation to which these soils have now been subjected has removed a large portion of the readily available nitrogen and phosphorus. Studies made by the writer on these soils twenty years ago indicated that land which had then been cropped forty to fifty years without the return of much plant food in manure had lost approximately one-third of their total original content of nitrogen and phosphorus. While these soils still retain more organic matter than the Knox soils and are darker in color, it is now becoming evident that the nitrogen and phosphorus removed in crops must be replaced or even increased if the fertility is to be maintained or improved. The larger content of organic matter gives these soils a larger water holding capacity and this justifies the use of methods of increasing the fertility to a high state such as those discussed with reference to the Knox silt loam.

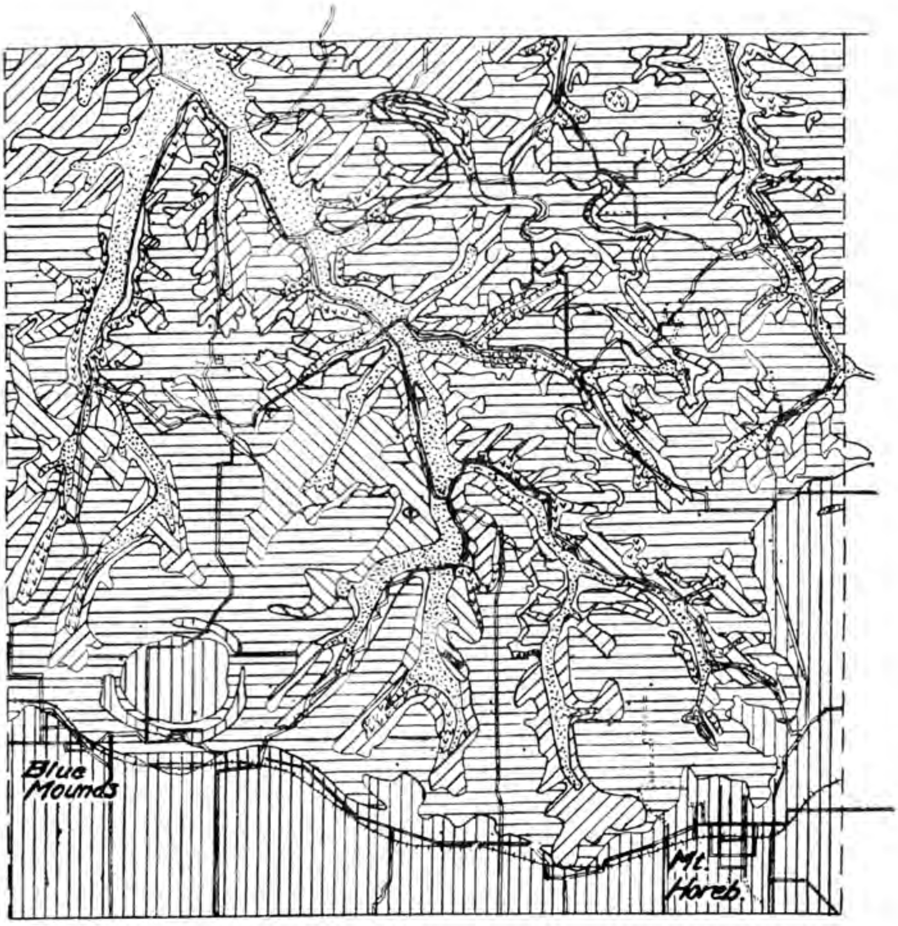
The condition with reference to lime in the prairie soils is essentially the same as that in soils originally wooded, and the use of lime as discussed with reference to the Knox silt loam on page 58 is very important.

These dark prairie soils are in general adapted to the same group of crops which do well on the Knox silt loam but the existence of larger amounts of organic matter which increases the water holding capacity, improves tilth and attracts a larger amount of the sun's heat, makes them somewhat better adapted to corn and other rank growing crops than are the soils of lighter color. Since a large portion of the land on the farms located on prairie soils is tillable, it is practical to grow such cash crops as peas, sweet corn and sugar beets which are adapted to this soil, whenever there is profit in so doing.

Vernon County Tobacco Area. A considerable portion of the tobacco grown in Vernon and adjoining counties is grown on the dark prairie soils, chiefly of Marshall series. It has been the practice on many farms in this region for a considerable number of years to grow a few acres of tobacco on farms, the balance of which is devoted to general farming including dairying and other livestock raising. On account of the high degree of fertility necessary to secure large yields of tobacco a considerable portion of the manure of the farm has been used on the tobacco fields. Moreover, it is customary to keep the same field in tobacco a number of years at a time, although there is a tendency more recently to change about with other crops somewhat.

This practice of using a good deal of the manure from the farm on a small area has, in many cases, had the effect of permitting the balance of the farm to run down more or less in fertility. This is sometimes quite serious in its results. It is especially likely to exhaust the available phosphorus of the soil which is rather low at best. In some instances the yields of corn, grain, and clover on such fields have been reduced to less than one-half what would be considered good yields. Field trials made by the writer a number of years ago in this section show that the yields of corn, oats, and clover on such fields could be increased from 30% to 50% by an application of 300 pounds of acid phosphate. There are two methods which may be used to overcome this difficulty. One is to alternate the tobacco crop with one of clover or some other legume, the entire growth for the season of which is plowed under, thereby increasing the nitrogen of the soil and making the potash and phosphoric acid which it has absorbed from the soil available to the succeeding tobacco crop. When this is done, some phosphate at least should be used for the clover and also for the tobacco following. The other method is to use commercial fertilizer for the tobacco in part or entirely so that the manure of the farm may be used on the other fields needing it.

Valley Soils. The broad valleys of the Wisconsin, Chippewa, and Black Rivers, extending across this region from the central portion of the state which was covered by glacial ice, have terraces formed by sand and other material carried by the water resulting from the melting of the glacial ice. These terrace areas are for the most part of sandy texture and have been mapped as *Plainfield sand.* For more complete discussion of the Plainfield sand and fine sand, see pages 106 and 112.



KEY TO SOIL MAP

KNOX SILT LOAM
ROUGH STONY LAND
KNOX SI. L. STEEP PHASE
DODGEVILLE SILT LOAM
WABASH SILT LOAM
BOONE FINE SANDY LOAM

Fig. 9.—Detailed soil map, on the scale of three-fourths inch to the mile, of an area in the vicinity of Blue Mounds.

The valleys of streams arising within the driftless area itself have bottom soils which are commonly made up of material washed from higher surrounding land. These soils have a loam or silt loam texture. The valleys vary in width from that of a few rods along smaller streams to sixty or more rods in width on larger streams.

The dark colored more level land of the broader terraces along the lower stretches of the larger streams has been mapped as *Wabash silt loam.* This is usually subject to overflow at times of high water. These terraces are characterized by a high degree of fertility, making them excellent agricultural land when capable of good drainage. The light colored soils of upper terraces are mapped as *Lintonia silt loam or loam.*

Rough Stony Land. The bluff land, which is incapable of tillage either because of steepness or because the rock actually outcrops, has been mapped as rough stony land. These bluffs occur very generally in this region as narrow bands separating the valley proper from the more level upland but in some portions they form the tops of the ridges. The amount and distribution of this type are shown on the map and its utilization has been discussed in previous pages.

As an illustration of the relation of the various soil types above described to each other a detailed map of the soils of a township in the vicinity of Blue Mounds is shown in figure 9. It will be seen that most farms in an area of this character include two or more types of soil, or at least they include a considerable variation in topography.

TOPOGRAPHY

The topography of the driftless area of southwestern and western Wisconsin is rolling or rough. In some sections it can be described as consisting of rolling upland with deep valleys; while in other sections such as western Jackson and much of Trempealeau counties, it can be described as made up of wide valleys with gradually increasing slopes up to steep but comparatively narrow ridges.

The influence of this topography on the agriculture is very important. In the first place, it affects the amount or percentage of the land which is available for tillage. It also influences the arrangement of the farm and the outlines of the fields. Its effect on erosion is of course very important. And it has a controlling influence on the location of both wagon roads and railroads, therefore affecting all phases of transportation.

With reference to its effect on agriculture, the land may be subdivided into four classes as given on page 3.

In the classification of soils as outlined in chapter III, some types, on account of their mode of origin, are essentially all level or have very gentle undulations. This includes such alluvial series as Plainfield, Waukesha, Wabash, and Genesee. Other series and types such as the Knox, Marshall, Boone, etc., not being of alluvial origin, vary from gently undulating to very rough in topography, and are therefore subdivided into phases or classes as above mentioned.

The controlling importance of topography on the agriculture of the driftless or southwestern part of the state is such that it must be considered at some length. In this section topography not only determines the kind of crops to which it is best adapted, but it even determines the line or system of farming best adapted to these conditions. When all the land of a farm is capable of ready tillage, the farmer is at liberty to raise such crops as he desires; he may, if he wishes, largely engage in the growing of crops to be marketed directly. When, however, any considerable portion of the farm is so rough or steep that it is useful only as pasturage, he must use it for that purpose, if for any. In that case, he is obliged to use all or a portion of the remaining tillable land for the growing of crops to be used as winter feed for the stock maintained in pasture during the summer. It is true that more feed can be produced in tilled crops per acre than can be secured in pasturage. But since a portion (usually approximating one-fourth of the land being tilled) is used for the growing of feed for work horses, the result is that, when the untilled land approximates one-half of the total, essentially all the tillable land must be used for producing feed.

As an illustration of the way land of these different classes is distributed among the farms of a given region, an area in the unglaciated section of southwestern Wisconsin is shown on the accompanying map, figure 10. This area covers nine square miles and includes forty-five farms, having an average of 120 acres. These farms have been classified into four groups designated as W, X, Y, and Z, respectively. The farms designated as W have three-quarters or more of their area in land of (a) and (b) topography. Those in group X have between one-half and three-quarters of their area in these two classes. Those in

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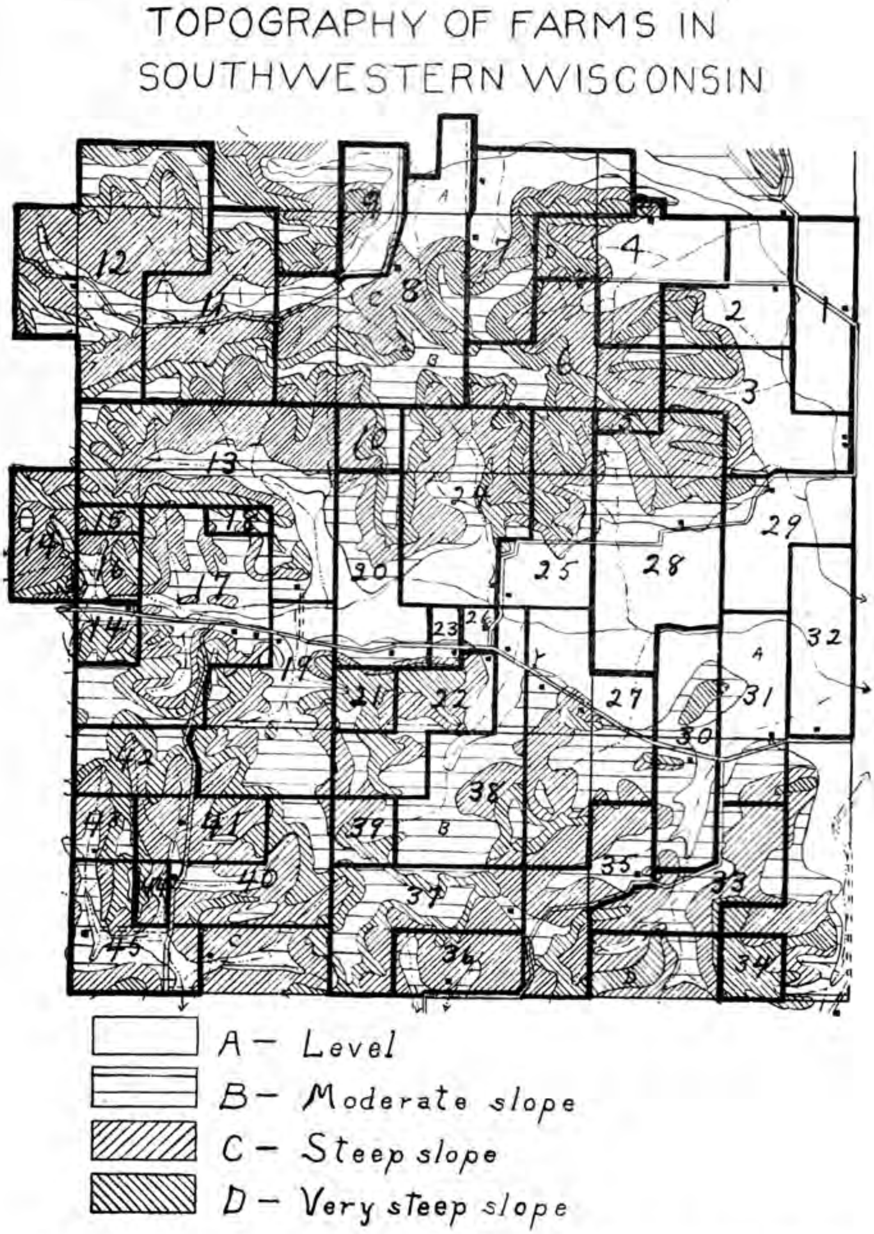

Fig. 10.—Map, on the scale of three-fourths inch to the mile, of an area in Sauk County showing topography as classified into four grades of slope and also showing the boundaries of the 45 farms in this area.

group Y have between one-third and one-half, while those in group Z have one-third or less of their acreage in these classes of topography. Classified in this way, it was found that there are 10 W farms, 10 X farms, 10 Y farms, and 15 Z farms.

We can assume that it requires one-half the acreage of a farm entirely devoted to stock raising to produce the winter feed necessary for stock which can be pastured on the other half, in addition to that needed for the work horses producing these crops. It would then appear that on 20 of these 45 farms, there is a somewhat greater acreage of good tillable land than is necessary to produce the winter feed for stock pastured on the remainder. A portion of it therefore may, if conditions favor it, be used for the production of cash crops, and on 10 out of the 20 farms, one-fourth or more of the acreage could be so used.

On 10 other farms, namely those in group Y, the tillable land, if intensively cultivated, will nearly or quite produce the winter feed for stock which may be pastured on the remainder. Thus, essentially all of the farm in these cases can be efficiently utilized for stock raising. On the remaining 15 farms of group Z the amount of tillable land is so small that it is not capable of producing winter feed for sufficient stock to utilize efficiently as pasture all the untillable land. There is, therefore, an excess of rough land which might be used for forestry purposes of some kind, if this can be efficiently so used.

On these 45 farms, 64.7 per cent or nearly two-thirds of the tillable land having (a) and (b) topography is included in 10 farms. This is a condition fairly representative of southwestern Wisconsin in the unglaciated region. This section of the state includes about 8,000 square miles. Using the above described area of nine square miles as a basis, this section would include approximately 40,000 farms of an average of 120 acres each. Of these 40,000, 8,890 farms would be similar to those in group W above, farms on which cash crops might be grown on a more or less important acreage. A similar number could produce a small acreage of cash crops, while the same number of additional farms should be entirely devoted to stock. In addition to this 13,330 farms similar to those of group Z would include more rough land than could be profitably used as pasture, and this should presumably be devoted to forestry purposes.

In this section of the state, the most common type of upland soil is the Knox silt loam, part of which is gently to moderately rolling, while part is steep. With this is a considerable amount of rough and stony land forming bluffs where rock outcrops or where blocks of stone, falling down from the higher hillsides, make tillage inpracticable. In Iowa county, approximately 127,000 acres are included in the steep phase and the rough and stony land, while the undulating and rolling area amounts to 177,000 acres. In La Crosse county, the steep Knox and rough and stony land amounts to 101,000 acres, while the area of lesser slopes covers something over 66,000 acres. In western Jackson county, the areas are 89,800 and 74,000 acres, respectively.

In the driftless area as a whole, one-half or more of the acreage of probably three-fourths of the farms is too steep for satisfactory tillage. On the other hand, the soils and climate are very favorable to pasturage. The soil, being a silt or clay loam, has an excellent water holding capacity and is adapted to the fine root system of the grasses. On portions of it, the lime has been reduced by leaching; nevertheless, abundant supplies exist in the underlying rocks which can be crushed and applied to the surface soil readily replacing that element. Moderate applications of phosphate are all that is needed in addition to make the soil productive for legumes, for they can secure their nitrogen by fixation. The use of white and sweet clover will to a considerable extent supply the nitrogen, although in cases where these cannot be grown, the use of a light application of manure or even of a nitrogen fertilizer may be desirable.

On many of the better pastures in this region, from one to two acres will supply feed for an average cow during a five or six month period; while in many sections of the grazing districts of the great plains, from eight to twelve acres are used. It is quite possible, therefore, to assign a value of $50 to $75 an acre even to the steep lands of this region in comparison with land in the west having a value of but $6 to $10 per acre.

The pasture season in this region is about six months in length, but it is usually necessary to supplement the pasture a part of the time. It is probably nearly right to figure pasturage as equal to five months feed, leaving seven months to be provided from the cultivated lands. The feed for a good dairy cow for these seven months at present farm prices is worth about $50 or $55. Thus it would be possible to assign a value of $35 to the product of the one or one and one-half acres of pasture which will provide equivalent food for five months.

The cost of the pasture feed is only for interest, taxes, and fencing, or, at average values, $10 for five months or $2 per month, while the cost of feed during the winter is $7 or $8. The pasture is therefore by all means the most profitable land used for producing dairy feed, and the same is undoubtedly true in the case of beef cattle, and sheep.

Roughness of topography is, therefore, not a serious drawback. When it will support good pasture, rough land should not be rated far below more level land in value, so long as it does not constitute a larger portion of the farm than can well be used for pasture.

The land having gentle slopes or that which is nearly level could be used for the growing of crops to be marketed directly. This relation to the steeper pasture land, however, means that a larger gross return from the farm as a whole can usually be secured by following some line of stock raising in which the tillable land is used for the growing of winter feed. The soils of the valleys and lower slopes of this region are for the most part well adapted to corn, alfalfa, and small grains which constitute the greater portion of the feed needed.

While the majority of farms in this region as at present laid out, include a fair amount of tillable land associated with the rougher pasture land, there are some sections in which the farms consist very largely of rough land not suited to tillage. Under these conditions, it would be better if a farm unit could be made large enough and so arranged as to include at least a third of tillable land for the growing of winter feed. This increase in the size of farms, when devoted to the raising of live stock such as, beef cattle, or sheep would undoubtedly be more economical than smaller farms.

Wood Land. Much of the rough stony land and part of the steeper phase of the Knox silt loam in this region is still in timber, chiefly hard woods such as oak, basswood, elm, and maple. While this timber is even now of great value as fire wood, for posts, and even to a limited extent as saw-logs, there is undoubtedly a considerable opportunity to increase its value with proper care.

It is impracticable in this report to go into details in the discussion of the management of wood land. However, it may be pointed out that one of the most important things contributing to the improvement of young trees is the exclusion of livestock. They, by browsing and tramping, kill off the seedlings and small trees. Likewise, by tramping on the surface soil, they cause it to lose the porous and loose condition of the natural wood mulch which is so desirable for the growth of trees. With a little attention to this matter, natural reproduction will often fill out gaps in an otherwise fair stand, although in some cases transplanting may be essential to the best results.

Proper care in the cutting of timber, limiting it to such thinning as will be beneficial, and the burning and trimming of the branches at the proper time are other important matters.

The great increase in cost of timber at present makes the conservation and the possibilities of woodland in this region more and more important. The single item of firewood probably means an average of $75 to $100 annually to each farmer, and the saving by the growing of posts may be another important item. Much of this section is exceptionally well adapted to the growing of yellow locust, a tree which produces most durable posts at a very rapid rate. Even a few good saw-logs of white oak have a high value on the farm for such special uses as whippletrees, tongues, stoneboats, etc., and command a high price when sold for such purposes. It is very probable, also, that pine can be grown successfully in this section of the state. But the very scattered distribution of it on the rough land would make fire protection and the cutting of the timber expensive matters.

Soil Erosion. One of the great difficulties resulting from the rough topography in this region is that of erosion. Erosion is detrimental in several ways. It frequently causes the formation of gullies and ravines which break up fields and make their tillage impracticable. Even when it does not do harm to this extent, erosion on the surface removes the more fertile part of the soil, especially the organic matter, thus causing serious loss in fertility. It is therefore of the greatest importance that farmers in this region do everything possible to reduce and control erosion.

This control includes the prevention of the development of gullies and ravines, or it implies using some means to fill them. Keeping the ravines or draws in grass is the most generally used method, and when carefully managed it is ordinarily successful. In many cases, the farmer reduces the width of these grass strips to a point where erosion or gullying begins at their side, thus causing two new gullies in place of the original one. The grass strip must be sufficiently wide to include on each side toward the center a slope sufficient to carry the water from every rain. In some cases where the use of such grass protection is insufficient, more expensive methods, including sluice-ways of wood or con-

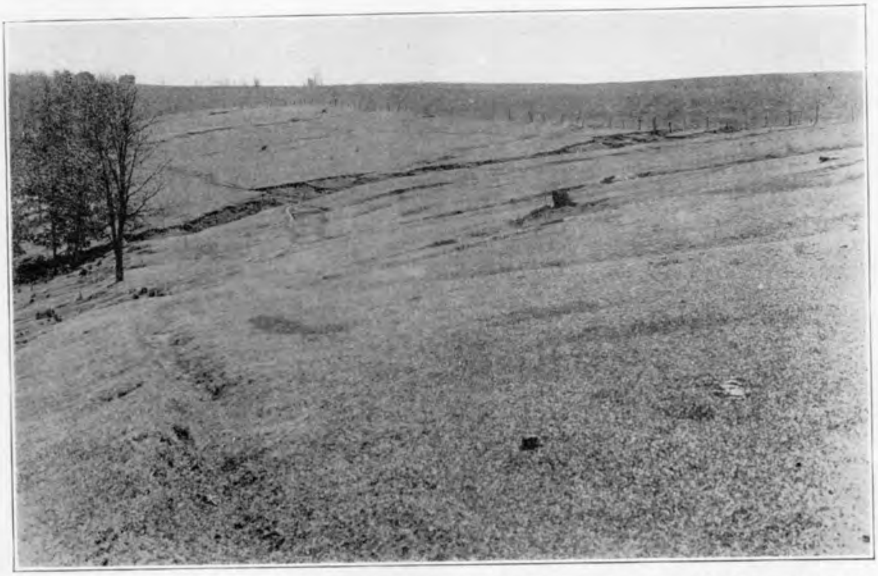

Plate IX–A. Showing gullies developed by erosion on steep land after the protecting wood had been cut off.

Plate IX–B. Harvesting firewood, leaving younger trees for further growth. Usually the amount of timber left should be larger than shown in this illustration.

crete, are necessary to carry the water down to a lower level without permitting it to cause erosion.

In many cases, gullies which have already been formed can be stopped from further development, or even largely filled, through the construction of dams which will cause the accumulation of silt and soil above them, while permitting the water itself to continue on down the slope. Different forms of dams have been used for this purpose. In some cases a solid concrete or masonry dam is built, provided with a tile flue, so arranged as to draw off the water above the dam before it reaches the crest and carry it down without permitting it to cause erosion.

A so-called porous dam has been devised for this purpose by Mr. Muhleisen, a farmer in Buffalo county. As originally used, this consisted of a line of closely woven wire fences, attached to posts driven in a line across the channel of the ravine and secured by suitable wing braces at the sides. Such a dam has the effect of accumulating brush, rubbish, and gravel brought down the ravine while allowing the water itself to pass on. This rubbish gradually lessens the flow of water in the lower part so that the earthy matter collects, building up a soil. Thus when properly managed and protected by seeding of grass, such filled gullies can be turned into pasture land. A succession of such dams is of course necessary in a long or steep channel or gully.

The erosion of the surface soil on tilled land can be lessened by keeping the land as much as possible in grass, for hay, or pasture, and having tilled crops on the ground as little as possible. Sometimes, tilled land, having enough slopes to cause considerable erosion, can be laid out in comparatively long and narrow fields with the narrow dimension up and down the slope. When these fields are used ultimately for clover and grass crops, the length of slope exposed to erosion can be reduced, and the tendency toward the accumulation of little rivulets on the tilled ground can be greatly lessened. This accumulation of little streams which develops in tilled land leads to the development of gullies. Therefore, the shorter the distance down the slope exposed to this action, the smaller are the rivulets produced, and the less the damage. It is for that reason, as well as others, that the growth of alfalfa on these hillsides is so important. It not only produces the best forage, but, since it can be maintained on the ground several years, it greatly lessens erosion and can be grown on quite steep land without danger when carefully managed.

CLIMATE

The climate of western Wisconsin does not vary greatly from that of the state as a whole which has been described on page 17. Nevertheless, the topography does produce some important modifications. The range in altitude between the highlands of this portion of the state and the lowlands along the Wisconsin and Mississippi Rivers is over 500 feet and this is sufficient to have some influence on temperature and rainfall. The higher areas have an average temperature of about three degrees less than that in the lowlands and an average length of growing season of from 10 to 20 days less. On the other hand, the slopes of this rolling country give excellent air drainage so that there is less danger of light frosts in spring and fall than there is in hollows of the eastern and more level portion of the state. The result of this is that corn and other tender crops are quite as safe though earlier varieties should be grown, as a rule, than are necessary on the level areas of lower elevation. This is especially true with reference to the higher parts of the northern portion of this area.

The good air drainage and somewhat cooler temperature are suited to such fruits as apples and cherries which do well on the hill-slopes of this region. The climatic conditions of this section also appear to have a good effect on dairy products, especially cheese.

The rainfall of this region is not noticeably different than that of the other parts of the state though it is somewhat higher on the uplands than on the lowlands due to to the effect of the cooler temperature in causing greater condensation from the moisture bearing winds. The average rainfall of this section by months is as follows: Jan. 1.4 inches, Feb. 1.3 inches, Mar. 2.1 inches, Apr. 2.9 inches, May 4. inches, June 4.2 inches, July 3.8 inches, Aug. 3.3 inches, Sept. 3.3 inches, Oct. 2.4 inches, Nov. 1.8 inches and Dec. 1.4 inches. This distribution of moisture is very favorable to the growth of the crops to which the soil and agricultural requirements are best adapted. The amount received in the earlier months is normally sufficient for the best growth of cereals as well as grasses while the higher rainfalls of June and July are particularly favorable to corn. It is true that the rainfalls of the fall months are not infrequently insufficient for the best growth of pasture grasses and supplementary feeds are frequently needed during that period. For more information with reference to the climate the reader is referred to page 17.

CHAPTER V

SOUTHEASTERN GLACIATED LIMESTONE AREA

MIAMI SILT LOAM AREA

As will be seen from the geological map on page 36, the southeastern portion of the state is underlain chiefly by limestone rocks and was covered by the last glacial ice sheet. This applies also to a smaller area in St. Croix and Polk counties. The soils of these regions consist largely of silt loam, though there is also some fine sandy loam and even a small amount of sandy soils and considerable marsh land.

Preceding glaciation this part of the country was doubtless more or less similar to that of the southwestern unglaciated portion and probably had a rough topography with fully developed drainage. The effect of glaciation has been to grind off the hill tops, and to fill up the valleys quite largely, thus producing an undulating or gently rolling topography. The well established drainage lines or valleys originally existing were largely filled and lakes and marshes were left scattered over it. Moreover, the streams issuing from the ice as it receded toward the close of the glacial period carried large amounts of sand and gravel with which the valleys were filled, leaving broad flood plains with finer soils overlying these sand and gravel beds. Since the glacial period the streams have cut shallow channels into these beds, leaving them now as terraces varying from 10 to 50 feet above the present level of the streams.

The glacial ice sheet also left many ridges or moraines which have been formed at the edge of the ice, marking lines at which it stood for some time. These ridges or moraines consist in part of material pushed forward by the ice and in part of sand and gravel deposited by streams which flowed either on the surface of the ice or underneath it and dropped a part of their load at the margin where their velocity was checked.

In addition to these moraines, there are numerous oval shaped hills having their longer diameter in the direction of the movement of the ice and varying from one-quarter of a mile to two or three miles in length and from twenty or thirty feet to one-hundred feet in height, which were formed by the accumulation of clay and stone underneath the solid ice itself, the ice flowing over and around these patches gradually adding to the mass and building it up into its present form. Such hills are called drumlins.

The whole region therefore, is one of very considerable variation in soil character, including a wide range of texture from clay or clay loam to sandy loam, though the silt loams greatly predominate. There are also a very large number of marshes scattered over this region and along the streams broad terraces, the surface soil of which is usually silt loam or loam in texture, though some are of fine sandy loam or sandy loam. The majority of these terraces are underlaid at comparatively shallow depth by stratified sand and gravel.

Practically all of this region previous to settlement was more or less heavily wooded, chiefly by hard woods. The surface soils therefore contain only a moderate amount of organic matter, since the leaves and vegetable matter falling to the ground in a forest quickly decay and do not become incorporated with the soil itself. There are, however, some areas of dark prairie soils scattered over this region. These areas mark the sections occupied by grass prairies previous to settlement and the larger amount of organic matter contained in the surface soil is due to the slow decomposition of the fine roots of these grasses.

The most important series of soils occurring in this region is the *Miami,* which includes those formed from limestone material by ice action and were wooded, so that they are relatively low in organic matter. This series includes the Miami clay loam, Miami silt loam, Miami loam, and Miami fine sandy loam. Soils formed on the terraces above mentioned are, in the case of those which were wooded and for that reason low in organic matter, placed in the *Fox* series when of a silt loam or fine sandy loam texture, and in the *Plainfield* series when of sandy loam or sand texture, while those which were of prairie character, and so developed larger amounts of organic matter giving them a darker color, have been classified in the *Waukesha* series. The dark soils formed on uplands in prairie areas are classified as *Carrington* series, which includes the Carrington silt loam, Carrington loam, and Carrington fine sandy loams. The morainic ridges of glacial material are grouped in the *Rodman* series. The marsh areas are usually of peat, while their borders, consisting

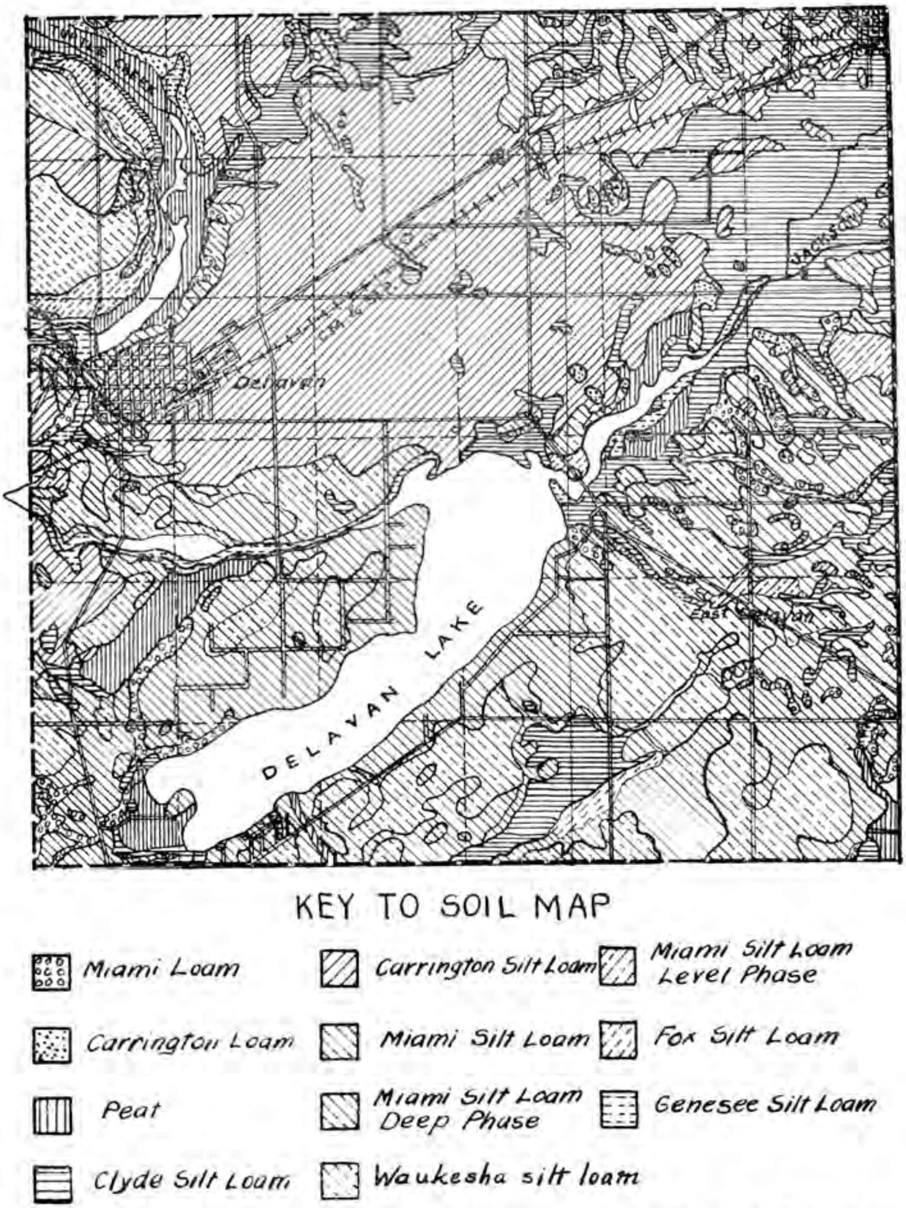

Fig. 11.—Detailed map, on the scale of three-fourths inch to the mile, of an area including Delavan.

of dark earthy soils high in organic matter and black in color, are placed in the *Clyde* series and include the Clyde clay loam, silt loam, fine sandy loam, and loam.

As an illustration of the detailed mapping of the soils in the southeastern part of the state, the township of Delavan in Walworth county is shown in figure 11. This map is on the scale of an inch to the mile and it can readily be seen that most farms of a quarter section or more in size must contain two or more different types or phases of soils. It especially shows the irregular distribution of the marshland. There are comparatively few entire sections of land in this part of the state having but a single type of soil, and the interrelation of soil types on a farm unit is a matter of great importance.

Miami Soils. The Miami soils include the clay loam, silt loam, normal and deep phase, loam and fine sandy loam covering the larger portion of the region of southeastern Wisconsin which is overlaid with limestone rocks and was covered by the ice of the last glacial period. These soils were formed by the mixing of the surface soil previously there with ground limestone formed from the action of the ice on the overlying rocks.

Stoniness. While the bulk of the soil material of the Miami soil types is made up of residual soils originally existing on this area, there was brought to it by the ice from the north a very considerable quantity of stony material. These stones vary all the way from gravel, through cobbles, to bowlders of large size. They include granites, gneiss, basalt and other kinds of rock which occur in the northern part of the state and of Canada from which the ice came. The amount of this stony material varies greatly. In many fields on these types, comparatively few stones large enough to interfere with tillage are found, while on many other fields they are quite abundant and not infrequently are they so numerous that they have not yet been removed and these tracts are used chiefly as pasture. While on the whole the amount of large stone is not as great as that on the Kennan loam and silt loam in the northern part of the state, it was nevertheless an important factor in the clearing and development of this region, and the fact that they have not materially retarded the agricultural development of this section is an indication that stoniness, in the northern part of the state, will not be found to be a permanent difficulty in the agricultural use of most of the land, the soils of which are otherwise well adapted to farming.

Plate X. View on Miami silt loam—deep phase—Fond du Lac County.

The Miami Silt Loam. The Miami silt loam is subdivided into the normal and deep phase. The normal phase of the Miami silt loam has an undulating to rolling topography with short hills, most of which have gentle to moderate slopes, but occasionally slopes too steep for cultivation occur.

The surface soil of this type to an average depth of from 10 to 14 inches consists of a grayish to yellowish brown silt loam. This is underlaid by a yellowish silty clay loam to a depth of 18 to 20 inches where a reddish brown gritty clay loam is usually encountered. At depths of from 2 to 4 feet there is usually more sandy and gravelly material, a large part of which is of limestone. This gravelly material in the subsoil is usually sufficient to give the Miami silt loam good under-drainage and it is only on more level areas and where the portion of clay in the subsoil is unusually large that under-drainage is inadequate and this condition forms but a small fraction of the type. The amount of organic matter in the surface soil is only moderate since all of this type was originally wooded chiefly with hardwood timber which does not lead to the accumulation of much organic matter in the soil.

The deep phase of the Miami silt loam occurs in most of the counties of this part of the state but chiefly in Fond du Lac, Dodge, Dane and Waukesha counties. The surface soil of this phase is somewhat deeper than that of the normal phase, but the chief difference is that it is undulating or gently rolling with longer slopes and less abrupt hills, and it also differs in the fact that stones and bowlders are less common on it than on the normal phase. On many areas the surface soil to a depth of 2 or 3 feet is largely free from stone and is largely made up of silt resembling the loess soils of wind-blown origin which occur in larger areas in the western portion of the state as described on pages 53 and 54.

The Miami Clay Loam. The Miami clay loam occurs chiefly in the eastern part of the state along the border between the red clay area and the Miami area. The surface soil of the clay loam is a brownish gray silt or silty clay loam to a depth of 8 to 10 inches underlain by a brown clay loam which at about 2 feet grades into a stiff, tenacious chocolate clay loam or red clay. The depth of the surface soil is quite variable and erosion has removed much of it on the steeper slopes so that the surface soil of such areas is frequently quite clayey. The topography of the Miami clay loam is similar to that of the silt loam, though on the whole there is less relief and the larger portion is more nearly level. On account of the heavy clayey character of the subsoil as well as the more nearly level topography the under-drainage of this type is not so good as that of the silt loam and tiling is necessary to give proper drainage on a considerable portion of the type. The heavier character of the soil of this type gives it a somewhat less range of crop adaptation. It is especially adapted to the grasses for pasture or hay and to the small grains, especially oats, wheat and barley, and its high lime content is favorable to clover and alfalfa except on the more poorly drained portions; corn also produces high yields on well managed fields. Among the special crops peas and sugar beets are best adapted to this soil. It is too heavy for satisfactory market potato raising.

Miami Loam and Fine Sandy Loam. Miami loam and fine sandy loam occur in most of the counties of this portion of the state forming about 10% of the area in Fond du Lac county, 20% in Jefferson county, 7% in Waukesha county, 22% in Columbia county and 3% in Dane county. These soils usually occur associated with the morainic belts of rougher country and along marsh borders. The surface soil of these types is a light brown loam or fine sandy loam to an average depth of 10 inches and contains only a moderate amount of organic matter. The subsoil is a brown, heavy fine sandy loam or sandy clay loam mixed with gravelly or sandy loam usually containing some bowlders at from 2 to 3 feet and some gravel. Knolls are quite common.

The texture of these soils while sufficiently heavy to carry good grass and small grain crops is better adapted to special crops such as potatoes and truck crops generally than are the heavier silt and clay loam types. This is particularly true in Columbia county in which considerable areas of the fine sandy loam occur. More sandy and gravelly soils than those above described are found associated with them forming from 1 to 2 per cent to as high as 14 per cent in some counties. These soils are described in the detailed survey as Miami sandy loam and gravelly sandy loam. They are usually undulating to rolling while the gravelly and sandy loam is usually quite rough. The poorer portions of this type are quite commonly left in wood-lots and permanent pastures but the more level areas which are generally quite free from stone are especially adapted to truck and garden crops and the use of these areas in this part of the state for these crops will undoubtedly increase in the future on account of the short distances of transportation to large centers of population.

Fertility of Miami Soils. In the amount of essential elements of plant food the Miami silt loam and clay loam are usually well supplied and well balanced. The average content of the silt loam is as follows: nitrogen, .15% in the surface eight inches and .065% in the second eight inches; phosphorus, .06% in both depths, which is equivalent to about .14% of P_2O_5; potassium, 2.15%, equal to 2.58% of K_2O. The total calcium content is .72% in the surface eight inches and the soil averages .1% of calcium carbonate in the surface eight inches and .64% in the second eight inches, although there is considerable variation from place to place as has been previously stated.

The Miami clay loam shows the following average chemical composition: total nitrogen, .14% in the surface eight inches and .075% in the second eight inches; .05% of phosphorus in the surface eight inches and .06% in the second corresponding to .115% and .138% of P_2O_5, respectively; 2.6% of potassium, equivalent to 3.12% of K_2O. The total content of calcium is 1.2%, while the amount of calcium carbonate averages from .2% in the surface eight inches to from 1% to 5% or more in the second eight inches.

The organic matter averages about 2.75% in the surface eight inches of both types. It is evident that the organic matter and nitrogen should be increased to reach the highest productivity of which these soils are capable, and this constitutes the most important general improvement needed in these soils. The abundance of lime and potash and consequently the availability of phosphorus makes the increase of nitrogen through the growth of legumes comparatively easy and farm practices in all systems of agriculture in this section should include plans to increase the nitrogen and organic matter by this means.

The content of phosphorus is good in comparison with other soils of similar texture, and the presence of calcium in carbonate form tends to make it available. Nevertheless, as in practically all soils, the total of this element is small and permanent fertility of the soil will require the return of at least as much, or more, phosphorus as is sold from the farm. The general practice of applying 200 to 250 pounds of 16% acid phosphate, or its equivalent, once in three or four years will, on the average dairy farm on which most crops are fed and manure returned, maintain the phosphorus content.

Lime Requirement. Since the Miami soils were formed by the action of glacial ice grinding off some of the underlying limestone and mixing it with the residual soil existing previously, and since this glaciation was of recent geological occurrence, these soils still retain a large amount of lime carbonate. This is true almost universally so far as the subsoil is concerned. On some parts of these soil types, however, the lime carbonate has been leached from the surface soil to the depth of from one to three feet to such an extent that the use of ground limestone or other form of lime will prove profitable at least for those crops which require relatively large amounts of available lime, such as alfalfa and sweet clover. The extent of this leaching is greater on the upper portions of the hills than on the lower slopes and in the valleys. On the whole, probably on not more than one-fourth of the area of the Miami soils will the use of lime for alfalfa be found necessary for many years to come. This abundance of lime in the soils of this region constitutes one of their greatest assets.

Carrington Soils. As shown on the map there are a number of areas of dark prairie soils scattered over the eastern portion of the state. A part of these dark prairie soils are rolling in topography and have the same subsoil as that of the Miami soils which was formed by direct ice action. The other portion forms level plains or terraced areas along some of the main streams, especially that of the Rock River where it is called Rock Prairie. These dark soils of undulating to rolling topography and till subsoil are in the Carrington series while the level plain-like areas along main streams which are of alluvial origin, the soil having been deposited in the broad streams formed by melting ice, are classified in the Waukesha series. The Carrington soil forms considerable areas in Fond du Lac, Columbia, Dane, Rock, Racine and Kenosha counties. The topography of these Carrington, prairie soils varies from practically level to gently rolling with gentle slopes for the most part though in some areas the surface is quite rough and more broken. A distinction is made in the detailed survey between these rough broken areas and those of more gentle slopes. Most of the soil of the Carrington series is silt loam though there are small areas of loam and fine sandy loam.

The surface soil of the Carrington silt loam to a depth of about one foot is dark brown or black silt loam with a much larger amount of organic matter than is contained in the Miami soils.

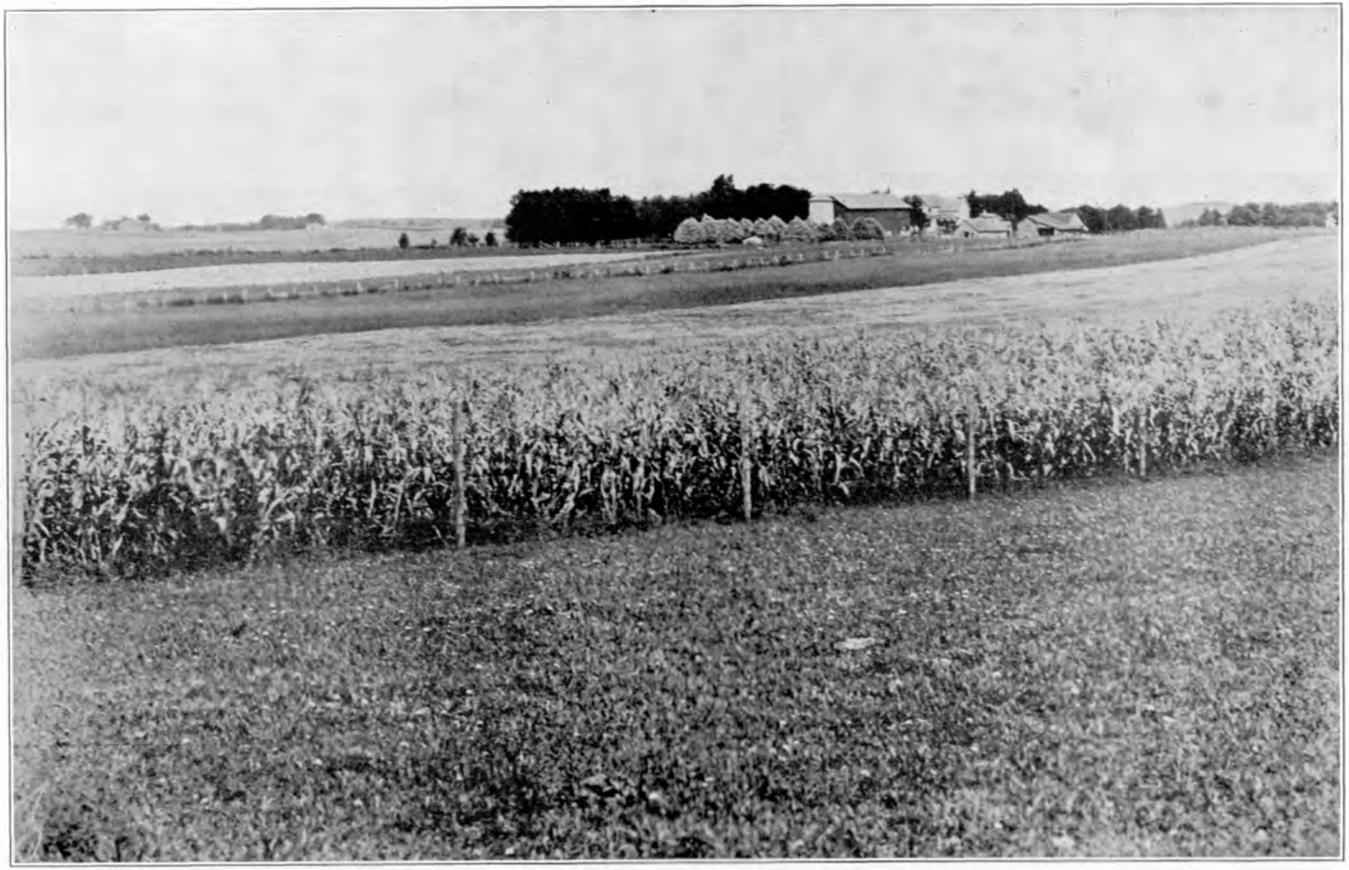

Plate XI. View of Carrington silt loam in Fond du Lac County.

These areas of dark soil were originally prairies covered with grass vegetation, the decomposition of the roots of which leaves much more humus or organic matter in the soil than does the vegetable matter of forest growth. The subsoil of the Carrington silt loam is very generally a buff or brown colored soil very high in silt and of a loessial character. The depth of this subsoil varies from two to four or five feet and it is comparatively free from stone. Below the loess subsoil stony and gravelly till, ice formed material, occurs, as in the case of the Miami soils.

Owing to the high water holding capacity of the Carrington soils the drainage of level areas is frequently rather inadequate and tiling is an important improvement. The large amount of organic matter of these soils with its higher nitrogen content gives them a higher degree of fertility and they are especially adapted to corn and other rank growing crops. These soils as well as those of the Waukesha series described later, are the chief soils on which tobacco is grown in Wisconsin, both in the southeastern and in the Vernon county region.

The fact that these prairie areas required no clearing to bring them under cultivation resulted in their being developed earlier than most of the Miami soil and they have, therefore, been subjected to longer periods of cropping especially where they were in crops during the earlier period when wheat raising was much more common than at present. Partly as a result of this fact and partly, probably, because of the large amount of organic matter the surface soils of these prairie types are more acid than those of the Miami soils and the phosphorus is less available. The use of some form of lime and of phosphate fertilizer is, therefore, quite generally helpful in maintaining the high state of fertility which the large water-holding capacity of these soils warrants. While they are especially adapted to crops making rank growth such as corn, tobacco and sugar beets, they give excellent yields of the small grains and of clover and alfalfa; especially does alfalfa do well when lime and phosphates are used.

Waukesha Series. The dark prairie soils forming plains or terraced areas in the larger valleys constitute the Waukesha series. Soils of this character include a wide range in texture so that silt loams, loams, fine sandy loams, and sandy loams are mapped in the detailed survey of the counties in this section of the state. The Waukesha silt loam is an extensive type especially in Rock county where it forms a large part of the well known Rock Prairie. The soil of this type to a depth of 10 inches on the average is a dark brown or black silt loam with a high content of organic matter. The subsoil becomes lighter in color with depth and is a yellowish brown compact silt loam containing increasing amounts of fine sand with depth and rests on stratified beds of sand and gravel which are reached at depths varying from 2½ to 6 feet. On account of the influence of depth on water holding capacity, a distinction is made in the detailed survey between areas in which the sandy and gravelly subsoil is less than 3 feet from the surface and those on which it is not reached until a greater distance.

The Waukesha silt loam, on account of its level surface, high fertility and good under drainage, is well adapted to a wide range of crops and is one of the most valuable soils of the state. The Waukesha loam and fine sandy loam vary in amount and occur chiefly in Waukesha and Rock counties with small areas in other counties. Soils of these types are similar to the silt loam but are of lighter texture and the sandy and gravelly subsoil is usually met at a shallower distance. These soils, while they do not have as large water holding capacity as the silt loam, are better adapted to truck crops, particularly potatoes.

Fox Soils. Part of the level terraced areas along the streams of the southeastern part of the state formed by the deposition of sand, gravel and silt, have darker surface soils as above described but part, owing to the fact that they were wooded before clearing, have light colored surface soils lower in organic matter. The latter are classified in the Fox series and this series includes silt loams, loams and fine sandy loams. The texture of the surface soils and the character of the subsoil of the Fox soils is similar to that of the Waukesha above described. Their low content of organic matter has tended to lessen the loss of lime from the surface soil and they are, therefore, not usually as acid as are the Waukesha series. They have the same general crop adaptations but their somewhat lower water holding capacity means that the yields of rank growing crops such as corn or tobacco are less. They are especially adapted to truck crops.

Rodman Series. The moraines forming belts of from 1 to 3 or 4 miles in width bordering the area covered by the ice sheet and also forming a medial moraine between the Green Bay and Lake Superior lobes of ice have considerable areas of rough, hilly and choppy land and very stony, gravelly and sandy soils. Soils

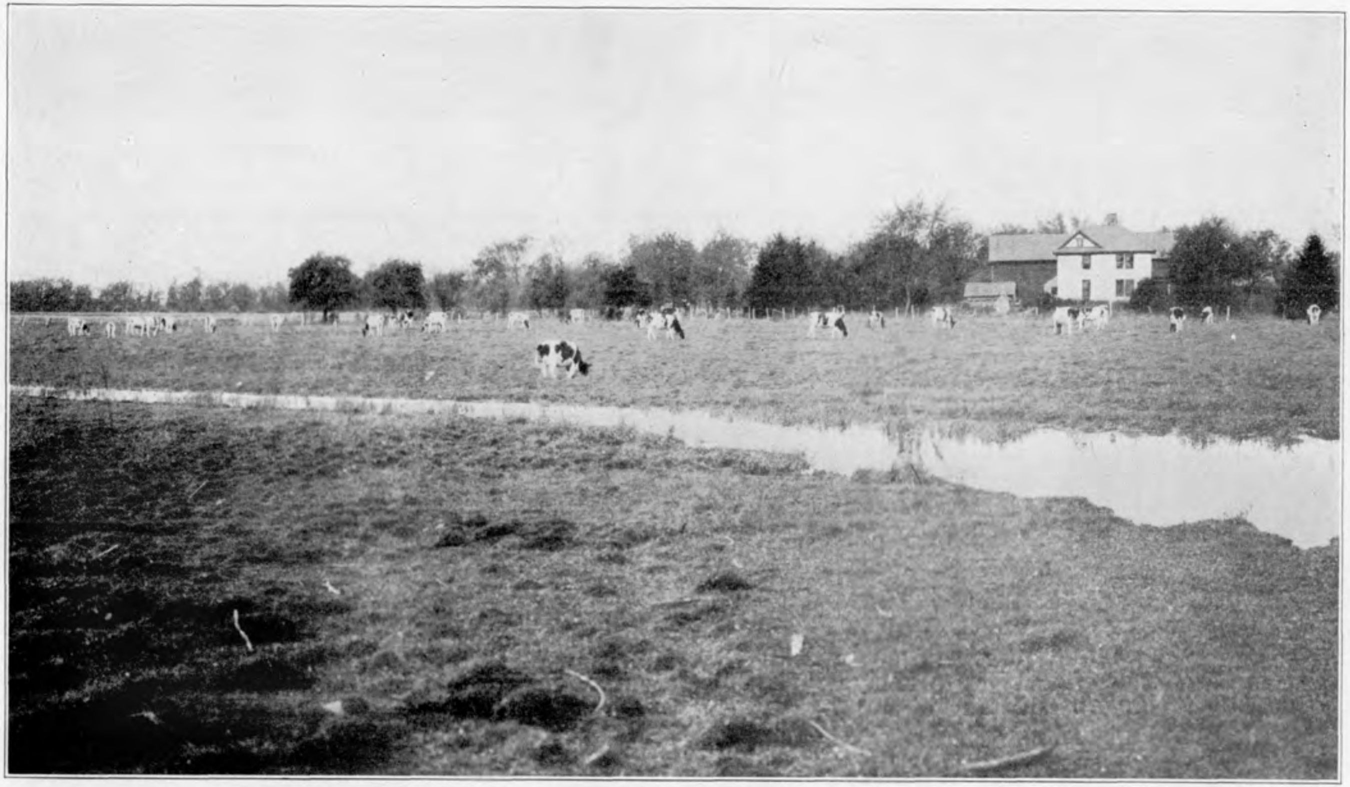

Plate XII. View on Clyde silt loam bordering a stream. This type of soil is quite generally used as pasture but when drained produces excellent crops.

of this general character with comparatively low agricultural value are classified in the Rodman series. They are not extensive as a whole but in a few sections constitute considerable areas. A few of the larger of these areas have been shown as rough and stony land on the map. Most of the soils of this character are used as permanent pastures which, however, are of low value and some carry a scattered growth of timber valuable chiefly as fire wood.

Marsh Soils. In addition to the upland soils already described the southeastern portion of the state contains considerable areas of marsh land including peat, muck and marsh border soils. The latter are chiefly included in the Clyde series. There are about 790 square miles or 505,600 acres of peat in this portion of the state and 800 square miles or 512,000 areas of muck, Clyde soils and other wet types.

The full development of these marsh soils will add greatly to the agricultural possibilities of this section of the state. It is true, of course, that small portions of this marsh land, especially of the Clyde or marsh border series, are already in use as pasture, and considerable drainage has been installed which makes possible their tillage. Nevertheless only a small per cent of the entire area of marsh lands in this region is yet contributing much to the agricultural production. Since marsh land constitutes about 20 per cent of the entire area and these soils have large producing power when drained and properly fertilized, it is probable that the agricultural production of the region can be increased by at least one-fourth through their full utilization.

Peat. Areas of peat varying from a few acres to several thousand acres in extent occur in practically every county in this portion of the state. The peat was formed through the growth of different kinds of vegetation largely mosses, grasses and sedges which grew in the shallow lakes and ponds left at the close of the glacial period. As this vegetation accumulated it generally filled up these bodies of water forming the marshes.

The peat in its present condition occurs in different stages of decomposition. It is frequently brown and fibrous showing the vegetation from which it was formed but in many cases it has undergone more or less decomposition forming a black mass of vegetable matter not showing the structure of the vegetation from which it was formed except that of trees or shrubs which were imbedded in it. As stated on page 119, the term peat is limited to organic soil having 50 per cent or more of organic matter and less than 50 per cent of earthy material. As a matter of fact, by far the larger portion of the peats of the state contain 75 or more per cent of organic matter and it very commonly has as high as 90 per cent. Nitrogen which is an essential element in the organic matter of all soils is very high in peat running from 2 to as high as 4 per cent in the peats of this region in comparison with .1 per cent to .3 per cent which is a common amount in the upland soils.

Phosphoric acid expressed in per cent varies from .2 to .4 per cent while potassium which constitutes from 1½ to 2½ per cent in the case of upland earthy soils forms but .05 to .2 per cent in the case of peat. In comparing the composition of peat soils with upland soils it must also be borne in mind that the weight of dry material in the case of peat is very much less than that of upland soils. The dry material in one cubic foot of peat usually weighs from 11 to 14 pounds while in the upland soils it weighs from 65 to 75 pounds.

While peat soils in many sections of the country are quite acid because the decomposition of the vegetable matter tends to develop acidity, those in this section of the state are very seldom found to be acid. The lime from the upland soils surrounding the peat marshes is dissolved out and carried to the marshes by the water from rains percolating through it. It is, therefore, only toward the center of relatively large areas of peat in this part of the state that they are found to be acid.

The chief requisite in the agricultural development of marsh lands is, of course, their drainage. The character of the drainage system will, of course, vary with the size of the area to be drained. In the larger marshes large dredged ditches are necessary as outlets while in smaller areas tile can be used for this purpose with best results. In all cases lateral lines of tile properly placed are necessary to make it practicable to undertake the growing of cultivated crops. Since the soft, light peat settles on drainage it is desirable that the lateral lines be placed deeper than in the case of wet clayey soils. Moreover, the distance from which tile will draw water depends partly on depth so that when lateral lines are placed as deep as 4 feet in peat better results are secured than when they are placed at a lesser depth. The spaces between these laterals are dependent on the thoroughness of the drainage desired which in turn will depend on the fall available and the kind of crops it is desired to raise on the ground. When the ground is to be put in condition to grow cultivated crops such as corn or potatoes it is ordinarily necessary to have lines of tile not more than 6 rods apart and in many cases when the subsoil is heavy a distance of 4 rods gives very much better results. On the other hand, if the land is to be used only for hay or pasture the tile may be placed at a greater distance varying from 8 to 12 rods depending on local conditions. The expense of drainage will, of course, vary with the cost of outlet and distances between laterals; under present conditions the cost ranges from twenty or twenty-five dollars an acre when the system is one which will fit the ground for pasture or hay only to forty or even fifty dollars an acre when thoroughly drained for cultivated crops.

On account of the great difference between the chemical composition of peats and upland earthy soils there is a great difference in their fertilizer requirements or in the methods necessary to maintain a high state of fertility. It is frequently thought that muck or peat soils should be very productive without the use of fertilizers; this idea probably arises from the fact that upland soils having a dark color such as black prairie soils are very productive for a number of years after being first brought under cultivation even without the use of manure or other fertilizer, but such soils have only from 5 to 15 per cent of organic matter and from 85 to 95 per cent of earthy material; they, therefore, have a very fair supply of nitrogen but also have a larger amount of phosphorus and especially of potash than do peat soils. As a matter of fact peat soils are extremely unbalanced,—they have so small an amount of potassium which is just as essential to plant growth as any other element that while crops will sometimes make a fair growth for two or three years after the land is brought under cultivation, after that yields are extremely small unless potassium in some form is added.

In many peat soils phosphorus is also deficient and must be supplied but in the peat soils of southeastern Wisconsin only part of the marshes show need of potash fertilizers. However, the total amount of phosphate in these soils is small and there can be no doubt that in time this element must also be supplied to maintain good yields. The potash and some phosphate would be supplied if stable manure were used as a fertilizer but since stable manure contains an important amount of nitrogen with which these soils are already abundantly supplied it should be used on upland soils whenever the farm includes such soils and commercial fertilizers containing potash and when necessary phosphate should be used on the peat land. As already stated, practically all of the peats of this part of the state are well supplied with lime. An illustration of the returns secured from the use of potash fertilizers is shown in the accompanying table giving the yields of corn and hay on the deep peat land of the University Farm at Madison.

YIELDS OF CORN AND HAY ON PEAT

At Madison. Average of 5 years 1919 to 1923.

Treatment on Corn	Bu. Corn	Lbs. Hay
12 tons manure	70.6	3,625
200 lbs. muriate of potash broadcast	67.7	3,645
200 lbs. muriate of potash—400 lbs. 16% acid phosphate	68.1	4,010
125 lbs. 0-10-10 in hill	39.6	2,450
No treatment	22.8	2,205

On this field a rotation of corn, oats or barley and timothy or alsike for hay is grown. The grain here was a failure two years out of five and the yields are therefore not given. The fertilizers were applied when the ground was being fitted for corn and no further application was made during the remainder of the rotation. It will be seen that 200 pounds of muriate of potash costing about $5.00 gave practically as good results as 12 tons of manure which would be valued at not less than $2.00 a ton. It is also seen in this case that very little additional benefit is secured through the use of a phosphate fertilizer in addition to the potash. It must be remembered, however, that some marshes in this section do show a need of phosphate in addition and when good results are not secured with potash alone an application of phosphate should be tried.

It is possible in the case of corn or other hilled crops to get a somewhat more efficient use of commercial fertilizer by applying it in the hill than broadcast, and for corn alone it is probable that 75 to 80 pounds of high grade muriate of potash applied with a corn planter having a fertilizer attachment, so that the potash will be dropped near the seed but still have a small amount of soil to protect it from injury, will give as large yields as 200 pounds spread broadcast. On the other hand, fertilizer applied in this way will, of course, be of little or no benefit to grain or grass crops following and they must be fertilized separately if the hill application is made for corn. The yields of the untreated plot on this field are higher than the average of untreated peat land in this part of the state and in many cases the benefit of potash fertilizer is even more marked than in this instance.

On account of the large water holding capacity of these soils and also of the large supply of nitrogen available to crops, such soils are especially adapted to crops making a heavy, rank growth such as corn, grasses for pasture or hay, cabbage, celery and others. They are not so well adapted to the small grains which are apt to be so weak-stemmed as to lodge badly and fail to fill well. The two chief uses of this class of land in this part of the state in connection with the dairy system of farming which is most common, therefore, are corn, hay and pasture. When well drained these lands produce heavy yields of clover and even alfalfa as well as timothy and other true grasses. When the ground is properly managed, excellent pasturage can also be developed. On account of the loose character of the peat it is necessary to develop a grass sod by heavy seeding including some of the best pasture grasses such as blue grass or meadow fescue and cut it for hay two or three years before permitting stock to pasture on it. When handled in this way and properly fertilized, exceptionally fine pasturage can be developed on such land.

Among the special crops to which peat is adapted in this part of the state are potatoes, cabbage, celery and sugar beets. It is often thought that the quality of potatoes grown on marsh land is not as good as that of those grown on upland soils but when this land is properly fertilized, especially with potash and, when necessary, phosphate, and good drainage is provided, not only can exceptionally large yields be secured but the quality is just as good as of those grown on upland soils. Cabbage and celery are, of course, generally recognized as crops especially adapted to marsh land. This is largely because of the large amount of moisture and the high nitrogen content of the soil.

Muck. As stated on page 119, soils having from 15 to 50% of organic matter are called muck. This definition is somewhat different from that frequently given for muck. By some the term muck is applied to all marsh soil high in organic matter including true peat. Muck soils, as defined in the Wisconsin survey, do not occur extensively in the southeastern part of the state. Moreover, they are so much like the peat, as above described, both with reference to treatment need and crops to which they are adapted that no special description of them is necessary.

Clyde or Marsh Border Soils. The Clyde series of soils is used to indicate the soils occurring usually along the border of marshes of peat or muck and which form a gradation from the true upland soils to the muck or peat. Frequently soils of this character also occur along small streams and level or flat areas with rather poor drainage but not bordered by muck or peat. These soils are commonly black on account of organic matter which varies from 5 to 15% in amount. The earthy matter constitutes from 85 to 95%. The subsoil varies in texture from clay to silt loam and sands, and the types of the Clyde series therefore include the clay loam, silt loam, loam and fine sandy loams. The organic matter of these soils and the resulting dark color extends to depths varying from 6 or 8 inches to 2 or more feet. Very commonly the subsoil is of a bluish character due to the reduction of the iron from the ferric to the ferrous condition.

The chemical composition of these soils partakes somewhat of the nature of both peat or muck and of upland soils. They have a relatively large amount of nitrogen in comparison with upland soils but they also have a very much larger content of potash and a somewhat higher amount of phosphate than do peat or muck. While they are often rather unproductive for the first year or two after drainage unless potash fertilizer is used, this difficulty commonly diminishes with time and after a few years their fertility resembles that of good upland soils and they require the same general fertilizer treatment. The large water holding capacity of these soils makes them adapted to practically the same crops to which peat and mucks are adapted and in this portion of the state corn, grass and hay are the chief crops which should be grown on lands of this character. The lighter types such as the Clyde fine sandy loam when well drained are especially adapted to potatoes and other truck crops.

Relation of Marsh Land to Upland. One of the most important reasons for the development of marsh lands in this part of the state lies in the fact that they are so closely associated with upland soils. While there are a few large marshes, by far the larger portion of the total area of marsh land occurs as small tracts widely distributed. In some sections, as for instance, in Jefferson county, a very large portion of the farms contain some marsh land. In that county 90% of the quarter sections have a few acres or more of marsh land. In other counties it is not so

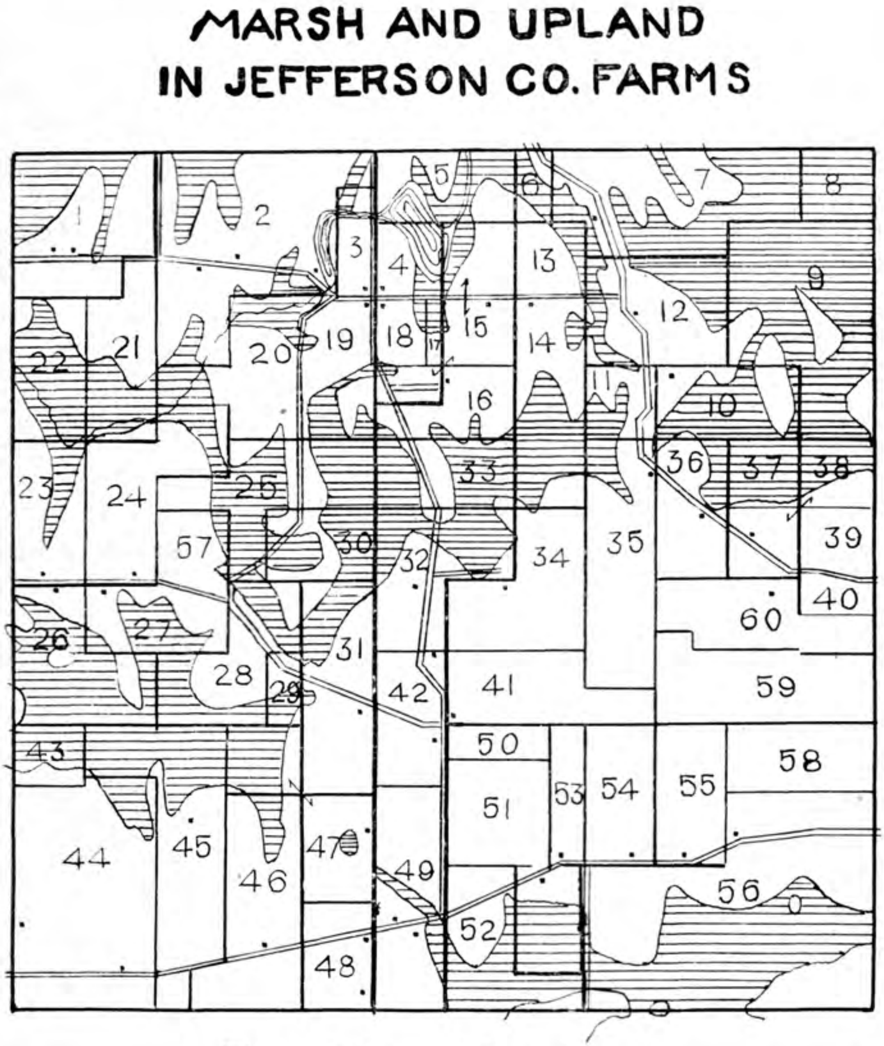

Fig. 12.—Detailed map, on the scale of three-fourths inch to the mile, of an area in Jefferson County showing marsh and upland and farm boundaries of 60 farms.

widely distributed. When a farm contains some marsh land as well as upland the marsh can be used to very much better advantage than when the entire farm consists of marsh soils. The marsh land can be used as pasture, for hay or for corn while the upland is used to a larger extent for small grain. Moreover, the manure of the farm can be used to best advantage on the upland while potash and, when necessary, phosphate fertilizers are used on the marsh lands. When properly developed the marsh land on the thousands of dairy farms in this section of the state can be made to greatly increase the total crops of the farm and greater pasturage is secured.

As an illustration of the way this distribution of marsh land affects the farm unit, an area of nine square miles, having a total percentage of marsh land approximately the same as that for the eastern portion of the state, is represented on the accompanying map, Fig. 12. This area includes 60 farms, of which 12 or 20 per cent contain no marsh land; 12 have from 5 to 10 per cent of marsh land; 19 have from 10 to 50 per cent; 11 from 50 to 75 per cent; and 6 have more than 75 per cent. Twenty-four out of these 60 farms, or 40 per cent, have so little marsh that failure to use it does not greatly reduce the acreage of tillable land. Thirty, or just half the total number, have both marsh and upland in such relative amounts that both must be used to secure anything like full development of the farm, and moreover the use of each type of land for the purposes to which it is best adapted increases the efficiency of the farm as a whole very materially. On only 6, or 10 per cent, of the farms of this section is more than 75 per cent of the acreage made up of marsh land. This interrelation of marsh and upland is characteristic of very extensive portions of the area of the United States covered by the Wisconsin glaciation.

CLIMATE

The climate of the areas of Miami soils in the southeastern part of the state and in the western portion does not differ greatly from that of the state as a whole. Nevertheless it is important to note, (see map page 18), the fact that these sections have a relatively long growing period, especially that of the southeastern part. In this section the frost period varies from 150 to 170 days, and in this respect compares favorably with a large part of the best agricultural sections of the Mississippi valley. The length of the growing season is as great as that of central Iowa and of central and western Kansas, regions which are considerably farther south. The region of Miami soils in St. Croix and Polk counties has a somewhat shorter growing season, though even there it is sufficiently long for the growth of good varieties of corn. The comparatively low altitude of this section of the state, as well as its relation to Lake Michigan, contributes to the lengthening of the growing period. It is, of course, true here, as elsewhere, that marsh lands are somewhat more subject to frost than the high lands, but here the growing period, even on marsh lands, is practically always sufficient for the maturing of high yielding varieties of corn, as well as for the growth of potatoes and other tender crops.

The rainfall of this section is somewhat greater than that of the average of the state as a whole, being about 31 inches. This rainfall is well distributed through the growing season, about 21 inches of it coming in the six months period, April to September, inclusive. This rainfall increases through the spring months to a maximum of 4 inches in July and decreases gradually to a rainfall of about two and one-half inches in October. Climatic conditions are therefore favorable to a wide range of crops, including, with the exception of some fruits, all those which can be grown north of the Ohio River.

Systems of Farming. On account of the variety and high fertility in general of the soils of this section of the state, as well as the climate and the nearness to very large markets, the agriculture of this region is very diversified and rapidly becoming highly developed. While dairying is the most extensive type of farming, and will doubtless remain so for some time on account of the demand for whole milk in Chicago, Milwaukee, and other cities, there is also a rapidly growing truck and special crop industry. The chief pea canning region of the state has for many years been in this section, and the lime content of the soils of this region, together with the fact that a relatively large portion of the individual farms are susceptible of tillage, will undoubtedly permit the continuance of this as well as other cash crops. The most extensive truck crop section of the state is that of Racine and Kenosha counties, portions of which have been for many years largely devoted to the growing of cabbage, onions, and other market crops. This region includes a large amount of marsh land, which, when drained and properly fertilized, is especially adapted to the growing of these crops.

The chief tobacco growing section of the state is located on the heavy, dark prairie soils of Dane, Rock and Columbia counties. While it is possible that the quality of this crop would be somewhat higher if grown on lighter soils the total yield would be less.

The growing of these special crops will require greater attention to the use of fertilizers than is necessary in the case of dairy or other livestock farming, and the success secured in their production in the future will, to a considerable degree, depend upon the increase in the knowledge of the use of fertilizers by farmers engaged in these lines.

On account of the large supply of plant food in the soils of this section, especially of lime carbonate, and the excellent climate, together with the close proximity to large and increasing markets, the agricultural prospects of this portion of the state are very bright.

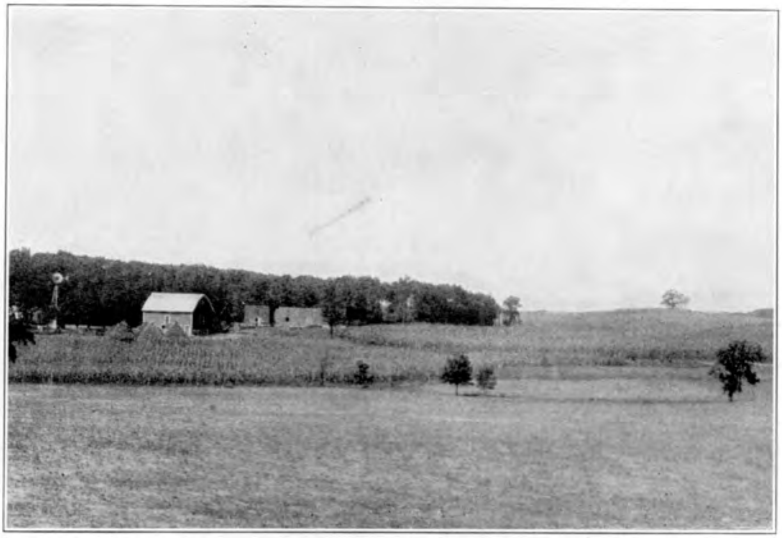

Plate XIII–A. View on Miami fine sandy loam. Jefferson County.

XIII–B. A demonstration of the benefit of phosphate fertilizers on Miami fine sandy loam in Marinette County.

CHAPTER VI

MIAMI FINE SANDY LOAM AREA

The areas in which the Miami fine sandy loam soils and other types similar to it predominate and which are shown in light brown color on the map occur in several different portions of the state. The largest area is that forming a belt running northeast and southwest through Marinette, Oconto, Outagamie, and Waupaca counties. A large portion of Door Peninsula and a considerable area in Kewaunee and northern Washburn counties are also characterized by soils of this type. Other areas occur in Green Lake, Columbia, Jefferson, Waukesha and Washington counties in the southeastern part of the state, and in St. Croix and Polk counties in the northwestern portion.

These soils were formed by the action of the ice of the last glacial period on the underlying limestone and sandstone rocks. The soils, therefore, consist of a mixture of the residual soils, previously existing over these rocks, with fresh ground limestone and sand derived from them, and also with sand, a part of which was brought by the ice and part derived from sandy areas over which the ice spread from the limestone area.

In the northeastern portion of the state the tongue of the glacier extending down the length of Green Bay flowed out from the center axis in all directions as shown in the glacial map on page 45. It, therefore, moved over limestone rocks first and then spread over a portion of the region underlaid by the Cambrian sandstone and in so doing formed this mixture of limestone soil with that from sandstone. The same general conditions led to the formation of these fine sandy loam soils containing limestone in the other portion of the state shown on the map.

In Outagamie, Shawano and Waupaca counties these fine sandy loam soils are found overlying a subsoil of the heavy red clay which forms the surface soil of the region south of Green Bay and surrounding Lake Winnebago. In the detailed survey these soils are classified as the Superior loam and fine sandy loam.

Associated with these soils formed by the direct ice action, as above described, are areas of alluvial soils in the form of overwash plains and terraces, resulting from the action of the water at the close of the glacial period. These alluvial soils, however, are made up of the same material having been merely reworked and deposited by water.

There is also a considerable amount of marsh land including peat and muck as well as marsh border soils scattered over all of the area in which the Miami fine sandy loam predominates. In some cases these marshes are sufficiently large to show on the general map, while in others they are too small to be indicated.

There is considerable variation in the texture of the soils included in this group and shown in the light brown color on the map. Some portions have the texture of a loam. This is especially true of the eastern portion of the belt lying west of Green Bay. In other areas of limited extent the soil is of a sandy loam but the fine sandy loam predominates throughout these areas.

Description of Chief Soil Types. The chief soil types included in the area shown on this general map as the Miami fine sandy loam are: Miami fine sandy loam and Miami loam, and Superior loam and fine sandy loam. The Superior loam and fine sandy loam occupy most of the area shown on the map in light brown in Shawano, Outagamie and Waupaca counties, while the Miami loam and fine sandy loam are the chief types in all of the other areas indicated as belonging to this group.

Topography. The topography of the Miami and Superior loams and fine sandy loams show some variation. In the chief tract of this group of soil types, namely that lying west and southwest of Green Bay, the topography is gently undulating or moderately rolling. While there are some marshes and some depressions of wet land there is very little rough, hilly land and the slopes are in general so moderate that a very large part of the land is tillable. The same statement applies to these soils in St. Croix and Polk counties in the western part of the state and to much of it in the areas of these types in the southeastern part. In a few sections, however, especially in Columbia county, the topography of the Miami fine sandy loams is somewhat rougher in character, and some slopes are quite steep, though even here a large portion of the land is tillable.

Miami Fine Sandy Loam. The Miami fine sandy loam proper is the most important type in the group of those included under

Plate XIV. View on Miami fine sandy loam in Columbia County.

Plate XV. View on Superior fine sandy loam in Outagamie County.

this general name. The surface soil consists of a brown or light brown sandy loam to an average depth of 10 to 12 inches. The amount of organic matter in general is small, but in the slight depressions which are common a larger amount of it has accumulated, giving the soil a darker color. Immediately below this surface soil there is usually a yellow or yellowish brown fine sand extending to a depth of 20 inches; below this it gradually blends into a somewhat compact sandy loam or gritty clay loam. This heavier material extends to a depth of 26 to 30 inches, below which there is unsorted glacial till consisting of a yellowish brown sand or sandy loam mixed with varying amounts of gravel and stone. Stones and bowlders are irregularly distributed, but they are seldom present in sufficient numbers to interfere seriously with cultivation. In fact they have been largely removed in the process of clearing and improvement. A considerable part of this stony material, including the gravel and bowlders, is of limestone.

Poorly Drained Phase. Small areas of this soil type are low and level and poorly drained. These poorly drained areas are scattered through Oconto county, chiefly in Morgan, Oconto Falls, Gillette and Stiles townships.

Miami Loam. A portion of the soils of this area, chiefly in the eastern part of the belt west of Green Bay above described, are somewhat heavier than the Miami fine sandy loams; they are classified as the Miami loam. These soils most commonly have as a subsoil the reddish brown silty loam or clay loam, which represents an extension of the Superior clay formation under the Miami soils.

Superior Fine Sandy Loam. The Superior fine sandy loam, especially the rolling phase, is another of the important soil types of this group; it occurs chiefly in Shawano, Outagamie and Waupaca counties. The surface soil of this type, as a rule, to a depth of 10 inches is a grayish brown or brown fine sandy loam and is rather low in organic matter. The surface soil rests on a yellowish brown fine sandy loam. This extends to a depth of 20 inches, resting on a heavy, compact pinkish or red clay loam or clay subsoil. The Superior soil always has this heavier red clay subsoil, while only a relatively small portion of the Miami soils have a subsoil of this kind; when they do it is reached only at a greater depth.

While there is some gravel and a few bowlders on the Superior fine sandy loam, on the whole it is not a stony soil. A large part of the stony material that does exist is of limestone, and the soil itself has a considerable amount of lime in it. It is, therefore, seldom acid. The surface of the Superior soils is undulating or gently rolling, but it is practically all tillable.

Crop Adaptation. The intermediate texture of these soils gives them a wide range of crop adaptation. They are sufficiently heavy to support a good growth of grass, either as pasture or as meadow, and are also adapted to the cereals; but their texture is sufficiently light to give them excellent tilth and they warm up readily so that they are well adapted to such crops as corn, potatoes, and other such crops. They are well supplied with lime and so have one of the essential requirements for the growth of crops requiring a large amount of that element such as legumes, sugar beets, and barley.

Fruit. The proximity of large bodies of water to the areas of these soils in the eastern part of the state has the effect of retarding the development of fruit buds in the spring until the general advancement of the season carries them out of danger of late frosts. This is especially true of Door Peninsula and the rolling topography of that area together with the well drained character of most of the subsoil makes that section especially well adapted to fruit, particularly apples and cherries.

Chemical Composition and Fertility. Chemical analysis shows that the average content of the essential elements of plant food in the soils is as follows: nitrogen, .11%; potassium, 1.6%, equivalent to 1.92% of K_2O; phosphorus, .04%, equivalent to .09% of P_2O_5; and total calcium, .51%, and of calcium carbonate, about .08%. The average content of organic matter is a little over 2%.

A study of their composition indicates that the phosphorus is relatively low, especially in Marinette and Oconto counties. This is true even in the virgin soils of this region and it has been further reduced by crops which have been removed from many of the fields of this section. Many of the fields first cleared 40 to 50 years ago were used for the growing of hay and grain which was sold in the lumber camps of this and adjoining sections, thus removing an important part of the phosphorus of the soil. More recently the development of dairying has tended to lessen this drain on the phosphorus but it still takes place and probably the most important practice necessary for the improvement of these lands is that of systematic use of some form of phosphate fertilizer. The amount needed will, of course, depend on the crop and system of farming. In a dairy system the general practice of applying 200 to 250 pounds of 16% acid phosphate, or its equivalent, every three or four years, together with the use of manure will maintain the phosphorus content of these soils. This addition of phosphate will be found to improve the yields and quality of grain, greatly increase the yield of clover and other legumes as well as of corn and to hasten the maturity of the latter. In the growing of special crops larger amounts of phosphate should be used.

The rather marked need of phosphate above mentioned applies especially to the areas in Marinette, Oconto and adjoining counties, as has been shown by the remarkable improvement made in many crops by Mr. Drewry, County Agent of Marinette county. How general the marked need of phosphate exists in other areas of these soils has not yet been determined.

The total potash content of the Miami fine sandy loam, as indicated by the chemical composition above given, is moderately high but it must be remembered that the availability of this element depends to a considerable extent on its association with decomposing organic matter. Also, it must be borne in mind that the draft on the available potash in the soil of any given farm depends to a considerable extent on whether crops containing potash are sold directly or are fed and the manure returned to the soil. Under livestock systems of farming, with careful management of the manure, the supply of available potash in these soils can be readily maintained in practically all cases, but if a considerable quantity of potatoes, sugar beets, hay, or other crops containing potash are sold from the farm a return of available potash in commercial fertilizers will be found necessary to maintain high yields.

The lime content of these soils, as shown by analysis and as can be readily understood from their mode of formation, is high. In comparatively few cases is it found necessary to make an application of lime even for those crops such as alfalfa which require large amounts of this element. This content of lime, a portion of which is in carbonate form and therefore very available, is one of the marked advantages these soils possess. Nevertheless, it is altogether possible that some areas may be found in which the lime carbonate of the surface soil has been reduced and has reached a point at which the use of lime may be profitable. This condition is most likely to occur on the higher portions of hillsides and on the more sandy areas.

As indicated by analyses the content of organic matter and nitrogen in the soil is not high and it will be generally found that the use of methods of increasing the organic matter and nitrogen will very materially increase yields. The growing of legumes in connection with dairying or other livestock raising is the most practicable method in this system of farming. When the growing of a cash crop is followed extensively, the use of a legume as a green manuring crop will have the effect of increasing both the organic matter and the nitrogen content, and is therefore preferable to the purchase of any considerable portion of the nitrogen needed in the form of commercial fertilizers. Nevertheless, the use of moderate amounts of readily available nitrogen fertilizers is frequently profitable in the growing of special cash crops. The need of nitrogen is especially marked in the growing of tree fruits as indicated by the experience of apple and cherry growers in Door County. As far as practicable this nitrogen should be secured through the growing of legumes but the use of readily available nitrogen such as that in ammonium sulphate and nitrate of soda is frequently necessary to secure the best results.

Marsh Soils. There are considerable areas of marsh and marsh border soils scattered over all the areas of Miami fine sandy loam. Some of this land is simply poorly drained land with from 5% to 15% of organic matter and in detailed surveys is mapped as Clyde soils. These occur along the streams and shallow valleys and around the border of peat and muck marshes. When drained these soils can be developed into excellent agricultural land adapted to a wide range of crops. Soils of this character occur to a greater extent in the southeastern part of the state and a more complete description and discussion of their agricultural management will be found on page 88.

The larger marsh areas consist of muck and peat. Muck soils are those marsh soils having from 15% to 50% of organic matter, the balance being made up of earthy matter similar to that of the upland surrounding them. Peat soils contain from 50% to 95% of organic matter, and by far the larger portion of the peat soils have from 75% to 95%. These marshes vary in depth from a foot or two to many feet, the average in this section being from two to four feet. The subsoil is, in general, of the same character as that of the uplands surrounding them; namely, loam and fine sandy loam, but occasionally a heavier subsoil is encountered and in some sections beds of sand are

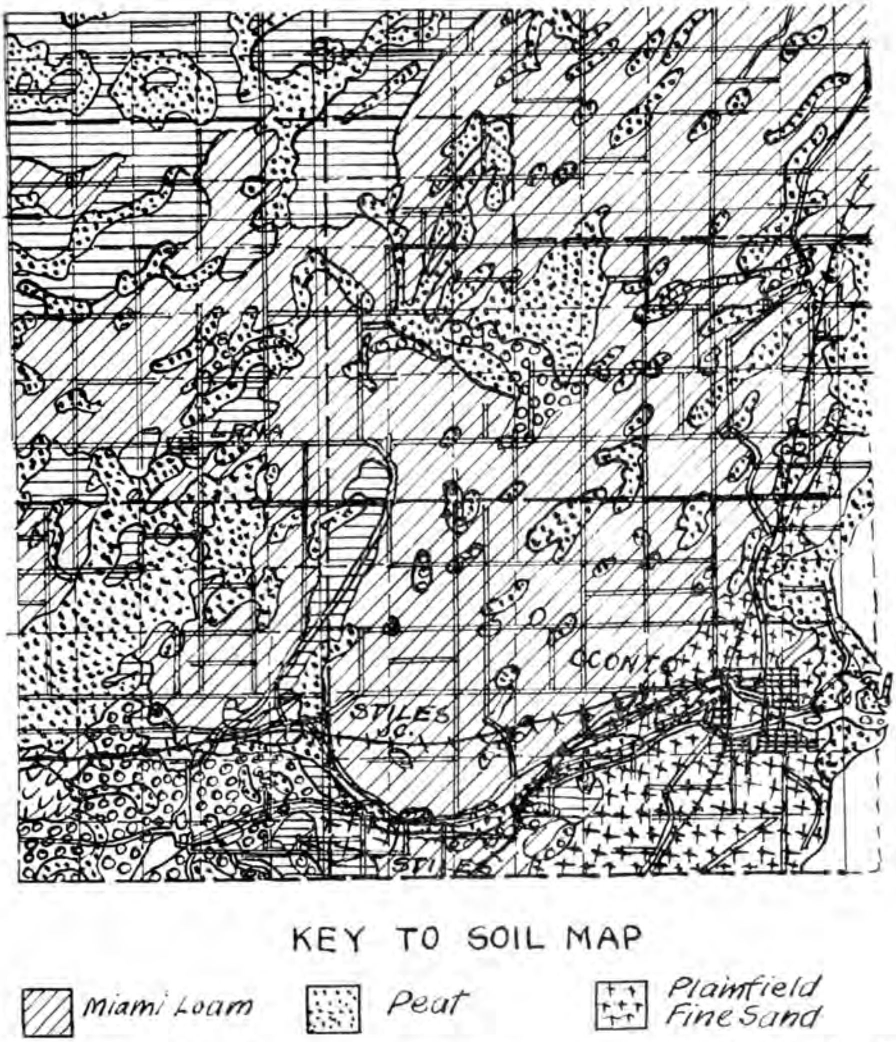

Fig. 13.—Map of portion of Oconto County, on the scale of three miles to the inch.

found underlying the marshes. Since a considerable amount of lime is gradually being leached out of the soil surrounding these marshes and carried down into them, they are for the most part not acid and have a good lime content. They are, of course, abundantly supplied with nitrogen in the organic matter so that the only elements of plant food which should be added in the form of fertilizers is phosphate and potassium.

The marshes of this section are in part wooded with alder, black ash, spruce, tamarack, and other water loving trees; in part, however, they are open grass marshes with a covering of water grasses and sedges. As the land of this region becomes more fully developed for agricultural uses the drainage and improvement of the marsh land will be found to add greatly to the output of the farms of this region.

As is true of marsh land generally, the marshes of this region are more subject to frosts than the upland soils. This is partly due to the drainage of cold air from upperland down on to them during nights of high radiation, and in part to the fact that the peat soil is a very poor conductor of heat so that the heat from the sun does not penetrate to as great a depth as in upland soils during the day and, therefore, retains less heat to be radiated during the night and so reaches a lower temperature which may result in reaching the freezing point while the surface soil of the upland remains above the freezing temperature. However, the location of this region is such as to be influenced somewhat by the temperature of the waters of Green Bay and Lake Michigan and frost does not occur as frequently during the spring and fall as on marsh lands further inland. The fertilizer requirements of these soils are more fully stated on page 83.

Interrelation of Soil Types. The accompanying illustration figure 13, is a detailed map of the soils of a portion of Oconto County. This will serve as an illustration of the way the different types of soil in this region are associated. The map is on the scale of three miles to the inch. It will be seen that while many farms of a quarter section in area are situated entirely on one or another of the different types which occur, many have two or more types of soil. Especially is it true that a very considerable number of the farms of this region have some marsh land as well as upland on them. This fact should be taken into consideration in the development of the farm. By making the best use of the soil of that type the value of the farm as a whole is increased. The marsh land, when drained, can be developed into

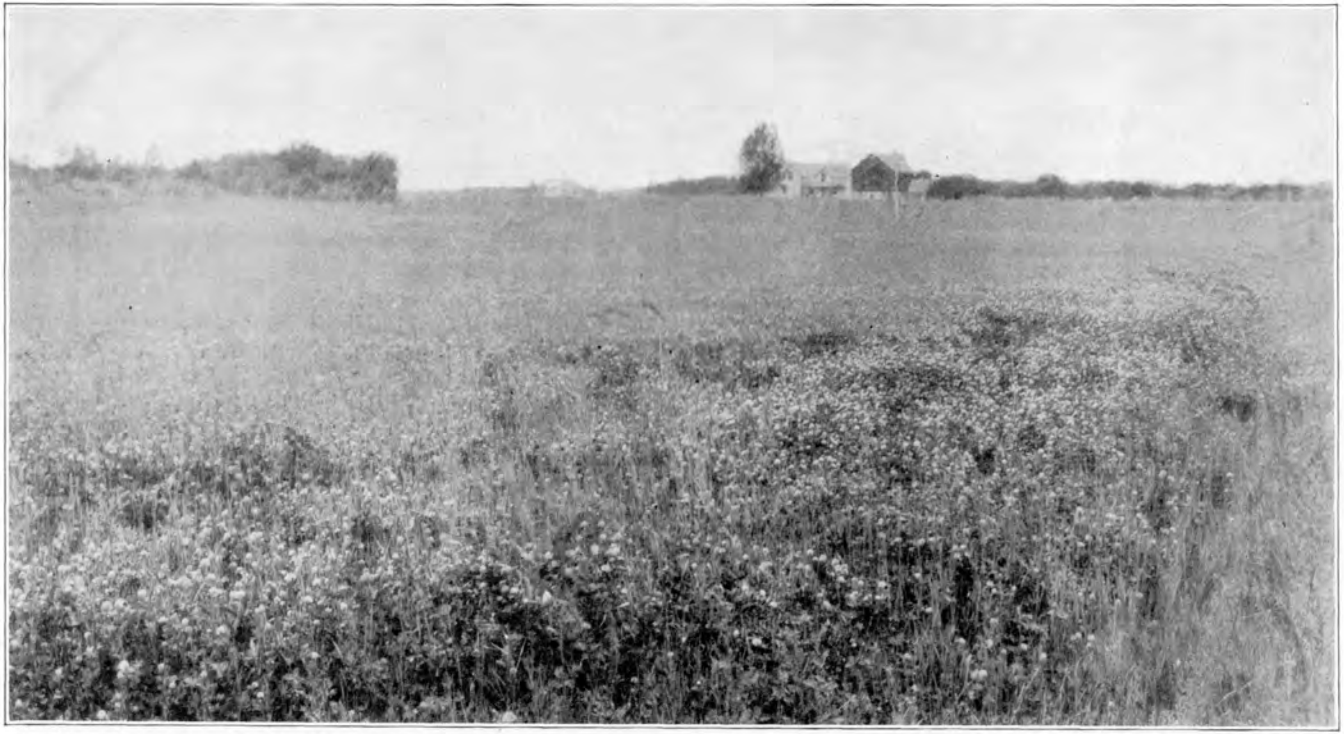

Plate XVI. View of excellent field of clover on Miami fine sandy loam which had been treated with phosphate fertilizer. Marinette County.

excellent land for pasture, hay, and when not too subject to frost, for corn; while the upland soils are particularly fitted for small grains, potatoes, and other special crops. Since the marsh soil requires only phosphate and potash, fertilizers containing these elements should be used on them, leaving practically all of the manure of the farm to be used on the upland soil which needs the nitrogen it contains as well as the phosphate and potash.

Climate. The climatic conditions of the regions of Miami fine sandy loam soils are of course essentially the same as those of the eastern part of the state in general. It is important to notice that, as shown on the map on page 21, the elevations of these areas are low in comparison with that of the central northern part of the state and this gives these regions longer growing period, as shown on the map on page 18. The character of the soil, as well as of the climate of these regions, is favorable to high agricultural development.

CHAPTER VII

AREAS OF SANDY SOILS

Sandy soils occupy about 7,300 square miles, or 13.8 per cent of the area of the state. Their utilization and development for the best purposes to which they are adapted, therefore, constitutes one of the most important agricultural problems of the state.

These sandy soils include medium sand, fine sand, and sandy loams as defined and described on page 4. Sands and fine sands contain less than 20% of silt and clay combined, while sandy loam soils contain more than 20%. Soils of all of these three grades are such as are generally classed as very sandy soils by farmers. Sandy loam, while having sufficient fine earthy matter in it to give it a somewhat higher water holding capacity than the true sands, is still a loose, open soil which will not puddle or clod appreciably, even though worked while wet. These soils occur chiefly in four different areas and are shown in light yellow on the map. The central area includes about 2,300 square miles, the northeastern 1,220, the area in Vilas and adjoining counties in the north-north central portions 1,020, and that in the northwestern part of the state 1,225. Associated with these sandy soils in all four sections are considerable areas of marsh soils, and the interrelation of the marsh and sandy soils is a matter of considerable importance. These four areas are described separately in the following pages and the discussion of their management and crops and systems of farming to which adapted will be found beginning on page 112.

CENTRAL SANDY AREA

Sandy and marsh soils occupy a large area in central Wisconsin including most of Adams, Waushara, Marquette, and Juneau Counties and parts of Wood, Jackson, Monroe, Portage, Waupaca, and Green Lake and Columbia counties. These sandy soils were largely derived from the Cambrian or Potsdam sandstone. This sandstone forms a bed of 500 to 1000 feet in thickness ly-

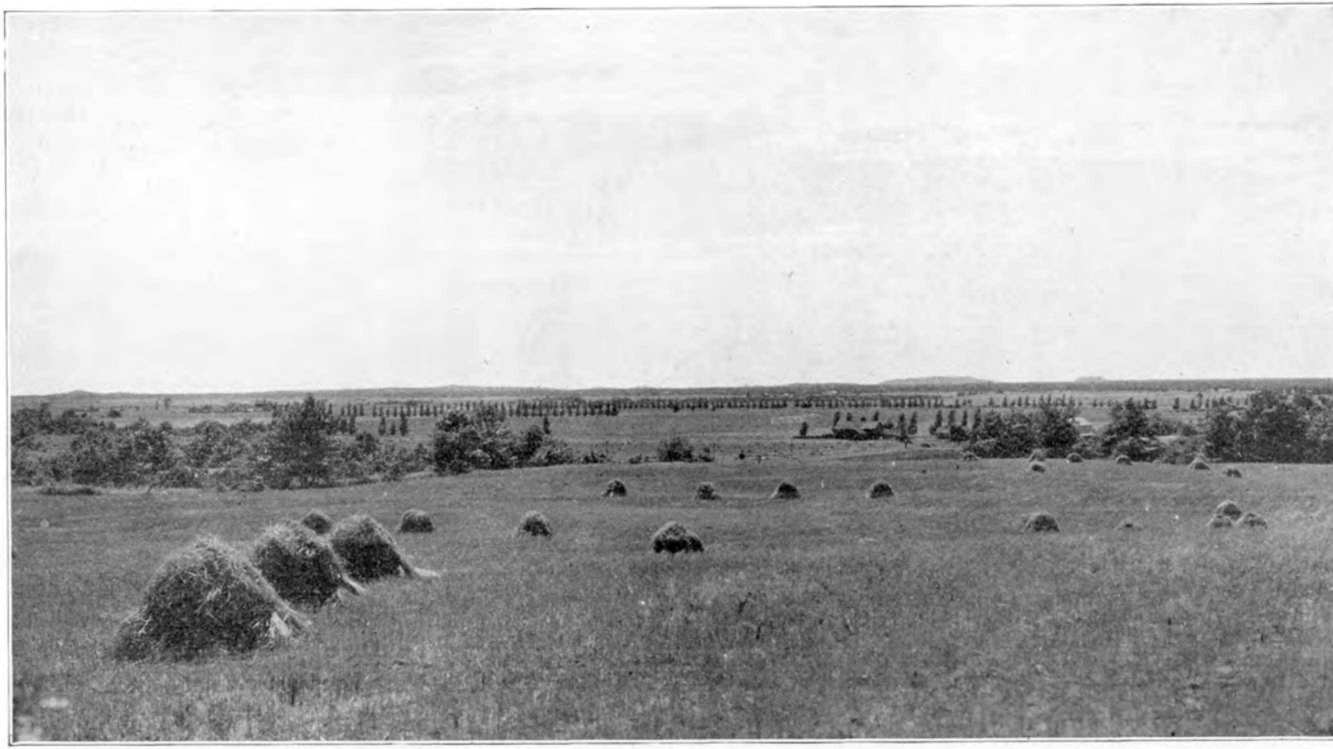

Plate XVII. View across the central sandy area looking west from the moraine at Coloma.

ing on granitic and other crystalline rocks which formed an island in the ocean around the shores of which the sand was deposited which later solidified into the sandstone. As the sandstone dips or slopes very gradually away from the granitic area, as shown in figure 6, page 36, it outcrops or is exposed at the surface over a broad belt varying from 15 miles up to 60 miles in width.

The Cambrian sandstone varies from a coarse grained friable sandstone to a very fine shale. The coarser or sandstone portion predominates in the central or eastern part while the shale is found chiefly in the western part in Jackson, Monroe, Clark, Eau Claire, and Chippewa counties. The coarser sandstone naturally formed sandy soils, while the shale gave rise to a soil of finer texture, usually a fine sandy loam, described in Chapter VIII.

The ice of the last glacial period, in flowing down the valley of Green Bay and the Fox River and spreading out fan-like from the central axis as shown in figure 7, carried some of the heavier soils from the limestone section out onto the sandstone region so that some areas of heavier soils are found than those which could be derived from the sandstone itself. But by far the greater portion of the soils even in the area over which the ice passed was derived from the sandstone and are of a sandy character. Stony material varying all the way from gravel and cobbles up to large bowlders is found irregularly distributed over the glaciated area in some places being so thick as to interfere seriously with the agricultural use of the land.

This glaciated sandy section is undulating and sometimes rolling and even rough in topography and includes some level areas in which water deposited sands or sandy loams occur. Shallow lakes were abundant and in many cases later dried up gradually and were filled with marsh vegetation forming marsh soils, often peat.

The border of the glaciated area is formed by a belt of rolling or of rough hummocky topography mostly all sand and gravel, called the Moraine. This moraine runs through the central sandy area practically in a north and south direction through Marquette, Waushara, and Portage counties as shown in figure 7. West of this moraine and occupying a large part of Adams and adjoining counties there existed towards the close of the glacial period a large shallow lake caused by the damming of the Wisconsin River Valley by the ice where it crossed this valley in the vicinity of Kilbourn. A deposit of clay, most of which is of a distinctly red color and contains considerable lime or calcareous matter, was deposited more or less generally in this lake, the deposit being apparently thicker toward the southern portion of the lake. A large amount of sand was carried by the streams resulting from the melting of the ice across the moraine and out into this lake, and was laid down as a stratified bed of sandy soil covering most of the beds of clay above mentioned. The final melting of the ice in the valley of the Wisconsin River caused the drainage of this lake. This bed of water-laid sandy soil is quite thick near the moraine and gets thinner farther to the west. Scattered over the area of the old lake are a number of hills of sandstone which were islands in this lake. The drainage of the lake was gradual and there existed some smaller shallow lakes and ponds for some time after the main area had been drained. In these smaller lakes and ponds water vegetation grew which led to the development of marsh soils, a large part of which is peat. In the shallow valleys of the streams the grasses developed considerable black organic matter forming what are called Dunning soils. Some areas especially in the moraine and even east of it, had at one time a marshy character but have been so thoroughly drained that they are now simply darker sandy soils and are classed in the Waukesha series, but the larger portions of these water deposited sandy soils have very little organic matter and are classified in the Plainfield series.

West of the Wisconsin River and even in the western portion of Adams County in sections too high to be covered by the waters of the lake above mentioned, the soils were largely derived by the weathering of the sandstone and when they are quite sandy and have very little organic matter they are classified in the Boone series. These occur in Juneau, Wood, Jackson, Monroe, and Clark counties to a considerable extent. Where the Cambrian rock was largely of shale, the soils derived by weathering are of finer texture, chiefly of a fine sandy loam and when poorly drained are classified in the Vesper series.

The most important upland soil types in this area are the Coloma sand and sandy loam, Plainfield sand and fine sand and Boone sand and fine sand. The Dunning series includes the marsh border land lying between the upland and the peat and muck areas.

The Coloma soils resulting from the work of the ice on the

Plate XVIII. View of the central sandy area looking east from the bluff at Necedah and showing isolated bluffs in the lowland area once occupied by glacial Lake Wisconsin.

residual sand originally covering the area are found east of the moraine which, as shown on the map, extends north and south through the western part of Portage, Waushara and Marquette counties. This is a region of undulating or rolling topography and the soil varies in texture including Coloma sand, Coloma fine sand, Coloma sandy loam and smaller amounts of Coloma stony and gravelly sand and of Coloma loam. The soils of these different textures occur irregularly distributed throughout this region.

Of these the Coloma sand constitutes much the larger portion. This soil is a gray or light brown, loose sand with relatively little organic matter to a depth of eight inches. The subsoil is a brownish yellow, loose sand, usually extending to a depth of from four to eight inches below which it frequently becomes coarser and contains some gravel. Occasionally a layer containing a little more clay than usual gives the sand a somewhat sticky character and increases its water holding capacity. The occurrence of these layers of heavier matter gives the field in which they occur a better quality than the average.

On some fields of the Coloma sand a certain amount of wind blown sand has collected into slight hills or hummocks. This wind blown sand has had most of the fine material and organic matter removed and is therefore of lower agricultural value than that which has not been subjected to wind action. The native vegetation of most of this area of Coloma sand was black or scrub oak with some poplar and a variable amount of undergrowth.

The Coloma sandy loam which amounts approximately to a quarter of the area of the sandy portion, is a distinctly better soil than the Coloma sand having from two to three times as much silt as the latter in the surface soil and from two to three times as much silt and clay in the subsoil. The surface eight inches is of a medium sandy loam texture while the subsoil when wet has commonly a distinct stickiness due to the higher amount of silt and clay which it contains. This condition is usually found to a depth of about 26 inches below which it is quite common to find a mixture of sand and gravel extending to a depth of three or four feet. The areas of Coloma sandy loam are dispersed irregularly through this section and so are closely associated with the Coloma sand. Many farms contain some of each; comparatively few farms are on Coloma sand entirely.

The morainic belt described on page 103 is largely made up of rather choppy hills and ridges and consists largely of gravel and sand, often quite stony, and was largely mapped as the Coloma stony sand.

The Plainfield soils were formed by stream and to some extent lake action and by outwash from the moraine itself. The most extensive and characteristic area forms a broad belt along the west side of the moraine in western Portage, Waushara and Marquette counties and extends westward over a considerable portion of Adams county. Smaller areas of level sandy land formed in small shallow and temporary lakes are found in the area east of the moraine. On the whole the Plainfield soils are more uniform in character than the Coloma soils. They are practically level and, for the most part, are quite uniform in texture though occasionally a thin layer of finer sand or even silty material is found at varying depth below the surface. The Plainfield soils are more extensive than the Coloma soils covering at least twice as large an area, a larger portion of this being in the broad area of eastern Adams and adjoining counties, but extensive areas are also found in Juneau, Jackson and Monroe counties where they were developed in either the shallow water of the glacial lake occupying the Wisconsin valley toward the close of the glacial period or in the valleys of the streams connected with the lake.

While these soils are, in general, about the same as the Coloma soils their more level topography has the effect of keeping the water table somewhat nearer the surface so that over considerable portions of the Plainfield sands and fine sands the moisture of the water table is reached by deep rooted crops more readily than on the Coloma soils, as a rule. Moreover, the more level surface of the Plainfield sands makes their cultivation easier and on the whole the Plainfield soils, therefore, have a somewhat higher value. Nevertheless, since many farms in the area of Coloma soils have some sandy loam which increases their value, where the amount of this sandy loam is important the farms are of higher value than those entirely located on Plainfield sand and fine sands.

Black, imperfectly drained soils of the Dunning series occur extensively along the borders of the marshes which are found chiefly in the area originally covered by the glacial lake above mentioned.

The soils of the Dunning series vary all the way from black sands through fine sands, sandy loams to even fine sandy loams.

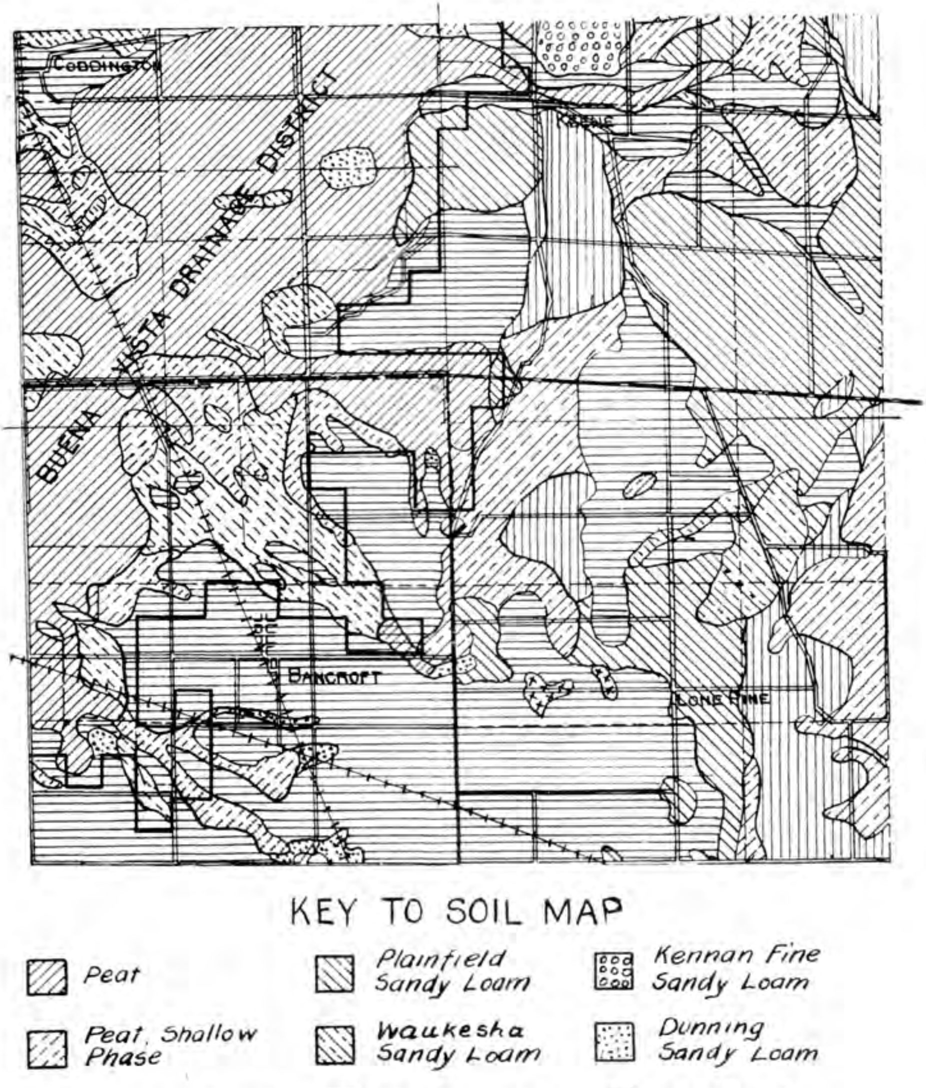

Fig. 14.—Map of an area in Portage County, on the scale of three-fourths inch to the mile, showing relation of the different types of soil in that part of the state.

The total amount of organic matter varies from three or four per cent, which is only enough to give color to the sand, to 10 or 15% which marks the transition to muck. These areas of Dunning soils are very irregularly distributed occurring not only along the border of the marshes but along shallow streams and water courses forming "draws." They occur, therefore, on a very large portion of the farms of this section and when properly managed have an important relation to the farm as a whole. Their larger content of organic matter and higher water holding capacity make it possible to increase their productivity through the use of lime and phosphate or manure to a higher degree than is easily reached in the case of the lighter colored sands of the Plainfield series. They are intermediate in character between the latter and the peat and muck soils described later.

The Boone sands and fine sands were derived by weathering from the sandstone rocks of this region and are, therefore, of residual character and they occur in the area that was not glaciated nor affected by the waters which deposited the sands of the Plainfield series. Boone soils are found chiefly in Jackson and Juneau counties. They are very similar in character to the Coloma sands and fine sands, but, on the whole, have a somewhat lower agricultural value and a lower content of plant food. In some portions of these areas the Boone sands rest as a blanket on the underlying sandstone and when the depth of the soil over the rock is shallow it, of course, greatly lessens the possibility of agricultural use.

The accompanying illustration, figure 14, taken from the detailed map of a portion of Portage county shows the way in which the various soils just described are associated. It will be clear from the map that most of the farms of this region contain two or more types of soil and many of them contain some marsh or Dunning soils as well as those of the upland types.

NORTHEASTERN SANDY AREA

The area of sandy soil in the northeastern part of the state occupies a considerable portion of Marinette county and portions of Oconto, Shawano, Forest and Langlade counties. The sandy soils of Marinette and Oconto counties were in part derived from the Cambrian sandstone which underlies a portion of the area that they cover and in part by the action of water on glacial drift. The sandy areas in the other counties mentioned are largely composed of sandy material derived through the action of water on the glacial till.

The chief types of sandy soils in this region have been classified as the Vilas fine sand and sandy loam, which occupies about 600,000 acres; Plainfield sand and fine sand, occupying about 260,000 acres; and the Coloma fine sand which covers 130,000 acres. There are also smaller areas of other sandy types.

The Vilas fine sand and sandy loams are undulating to rolling in topography and are composed of sands which have been derived in part from the Cambrian sandstone, and in part from the granitic rocks of the region in Wisconsin and Michigan north and east of their present location. They, therefore, have a larger content of feldspar, hornblende, mica and other minerals found in granitic rocks than is found in the Cambrian sandstone from which by far the larger portion of the sandy soils in the central part of the state were derived. They, therefore, contain somewhat larger total amounts of potash, lime, magnesium and phosphorus than do the latter. This somewhat better chemical composition may give them a little higher degree of fertility, especially when sufficient organic matter has been developed in them to react with the minerals of the soil and cause these elements to became available. It is not likely, however, that this difference will ever be very great so that the fertility is very similar to that of sandy soils in general as discussed on page 112.

The Plainfield sands and fine sands of this region are very similar in physical character to those of the central part of the state though they also have a somewhat higher content of plant food elements since they were derived from the same source as the Vilas sands above described. The distribution of these soils in this part of the state is shown in detail on the map accompanying the report of the soils of northeastern Wisconsin.

VILAS AND ADJOINING COUNTIES

The large area of sandy soils in the north central part of the state covers a large portion of Vilas, and a considerable part of Oneida counties with smaller portions in Price, Lincoln and Langlade counties adjoining. The sandy soils of this region were largely brought to it by the ice from an area of sandstone rocks in Michigan lying north of this section. These soils include the Vilas sand and fine sand and Vilas sandy loam, undulating and rolling phase, which were left by the ice without being reworked by running water, and the Plainfield sand and fine sand which were formed from the same material but were deposited by streams from the ice and occur in part in terraces along these streams and in part as broad plains of overwash from the ice surface.

The materials of the sands of this section were to a considerable extent derived from the sandstone of northern Michigan above mentioned which is quite similar to that of the Cambrian sandstone of central Wisconsin, but a considerable portion of the sands of this section were formed by sorting of glacial matter derived from granitic rocks and have, therefore, a composition similar to that of the sands of northeastern Wisconsin above described.

This whole region of sandy soils is one of great unevenness, marshes and lakes abound and the sandy land itself is in part rough and hilly, frequently having a choppy appearance of a morainic character. This has the effect of lowering its agricultural value although it is still true that there are considerable areas of level or gently undulating land which can be used for agricultural purposes when conditions justify it.

Of the sandy soils in this section about 345,000 acres were classified as the Vilas sandy loam which is undulating to rolling in character; 105,000 acres of the rolling phase of Vilas sandy loam, which is much rougher; 93,000 acres of Vilas sand; 87,000 acres of Vilas stony sand, and about 200,000 acres of Plainfield sand and fine sand. This area also includes about 580,000 acres of peat and muck land and smaller areas of heavier soils such as Mellen and Kennan fine sandy loams and Antigo loams and fine sandy loams similar to those described on pages 155 and 163. A more detailed description of the soils of this section with maps showing their location is given in the Reconnoissance Soil Survey of the northern part of north central Wisconsin.

The higher altitude and more northerly location of this region give it a somewhat shorter growing period as shown in the map on page 18. This makes the growing of corn especially less certain though the earliest varieties can usually be grown to a silage or fodder stage. It also increases somewhat the risk in the potato crop. On the other hand, there is less evaporation from the soils of this section than from soils of similar texture in the central part of the state and rye, clover, and other hardy staple crops will do somewhat better than in the southern section. The general management and requirements of these soils are essentially as discussed on page 112.

The marsh lands of this region consist very largely of peat, a portion of which are in the form of open grass marshes while another portion, probably larger in area, is wooded with spruce, cedar, and other marsh loving trees. The northerly latitude and higher altitude of this region make the marsh lands even more subject to frosts than they are in the central part of the state which will limit the agricultural uses materially. Comparatively little has yet been done in their development though wild hay is frequently cut on them. Their use for this purpose can be greatly improved through drainage and applications of proper fertilizers as discussed on page 114.

NORTHWESTERN AREA

The area of sandy soils in the northwestern portion of the state forms a broad belt through Bayfield, Douglas, Washburn and Burnett counties. The northern portion of this area, largely in Bayfield county, is very rough and irregular in character and has been classified as rough land, as shown on the map. The remainder forms a belt from ten to twenty miles in width extending southwest. This section is largely of a plain character though small portions of it are quite rough and broken and of morainic character. Lakes are widely distributed over a large portion of this plain and there are considerable areas of marsh land largely of peat. The soils of the plain or level portion of the area are classified as Plainfield sands and fine sands while the rougher morainic portions are of the Vilas series. The sandy soils of this section were largely derived by glacial and water action from the Lake Superior and Potsdam sandstone underlying this section as shown on the geological map on page 36.

In chemical composition these soils are, therefore, very similar to those of the central part of the state though they have a somewhat larger content of calcium, magnesium, and potassium. Their agricultural value and adaptation is, therefore, much the same as that of the sandy soil of the central part of the state but modified by the more northerly position and higher altitude. While a portion of this area can undoubtedly be developed for agricultural use when conditions warrant it, it would seem that a considerable portion could be better used for forestry purposes.

Tree growth, especially of jack pine, is distinctly better than on similar soils in the central part of the state.

There are some limited areas of soils of heavier texture including sandy loams and fine sandy loams in the general areas indicated as occupied by sandy soils on the map, and these, of course, have higher agricultural value.

The marsh soils of this region are for the most part of an open meadow character and of less depth of peat and muck than is commonly the case in the central northern portion of the state. Some of this marsh land lies along streams of considerable size and so can be drained only with difficulty; while other marsh tracts can be more readily drained and with proper management, especially the use of potash and perhaps phosphate fertilizers, hardy crops, particularly hay, can be grown.

UTILITY OF SANDY SOILS

Since the state includes so much sandy soil, the problems of its improvement are very important. Very sandy soils present several difficulties for the farmer to contend with, but they also have some advantages. They have low water-holding capacity. They are low in plant food and they are subject to blowing which injures crops just starting to grow. On the other hand, sandy soils are easily worked. There is no loss of time after rains before they can be worked and they warm up quickly in the spring. Moreover, they can be purchased at a much lower price per acre than heavier soils so that a farm represents a much smaller investment. One-third or more of the gross return on higher priced lands is taken in interest or rental charges. If the difficulties mentioned can be met, these sandy soils can be farmed successfully; that is, the farmer will be able to make a good livelihood on them.

The question then is: To what extent can these difficulties be met, and what average yields can they produce in comparison with heavier soils? The first difficulty mentioned, that of low water-holding capacity, is very hard to overcome to any considerable extent. Some benefit is secured by increasing the organic matter. This can be accomplished best by plowing under green crops but the use of stable manure increases the organic matter somewhat. However it should be remembered that in the feeding of crops 2/3 or 3/4 of the total organic matter is decomposed in digestion so that only about 1/3 as much organic mat-

Plate XIX. Alfalfa on Plainfield sand on the Experiment Farm at Hancock.

ter is returned to the soil in the manure as was contained in the crops which were fed.

In considering the benefits from the addition of organic matter, it should be borne in mind that organic matter or humus holds from six to seven times its weight of water, a large portion of which can be withdrawn by crops for their use and this recurs with every good rain, so that the addition of one thousand pounds of humus to the acre will mean that several thousand pounds of water will be made available to the crops growing on it during the season.

Crops Suited to Sandy Soil. Tillage of the land tends to oxidize or decompose the organic matter so that it is easier to accumulate organic matter in the soil under crops which are not tilled, such as small grains, clover, alfalfa, or grasses, and this principle should be kept in mind in planning the rotation. Nevertheless, corn uses water very economically, that is, it requires a smaller amount of water per pound of dry matter produced than practically any other crop, it grows well on lighter soils when sufficiently fertile and it makes the best feed to use in connection with legume hay. Hence, corn should be considered one of the staple crops on lighter soils in all sections where the growing season is sufficient for it. Rye, by getting a good root system developed in the fall, is able to start growth very quickly in the spring and mature before the period of the year is reached when droughts are liable to occur. Alfalfa, on account of its very deep root system and its ability to withstand long drought, as well as the fact that it will stay on the land two to five years without reseeding, is one of the best crops on these soils. Moreover, its very high protein content and excellence as hay makes it of great value used as feed in connection with corn. Also being a legume, it gathers its nitrogen from the air and supplies that element for other crops when the manure from its feeding is used.

Clover, though a legume and an excellent hay, has difficulty on these soils in that being a biennial it makes but one year's growth after the year in which it is sown, and when sown with rye or other grain as a nurse crop it is apt to be left without sufficient moisture since that is taken by the grain crop and it fails to make a catch. It seems likely, therefore, that alfalfa can be used to better advantage than clover on these lands. Nevertheless, if the soil is sufficiently moist and in fairly good condition, it is often worth while to seed clover on the rye or other grain to be left

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the year following if it succeeds in making a good stand. It can then be plowed under as green manure or used as pasture if it is not absolutely needed as hay. When favorable fall rains occur rye or vetch should be sown in corn or other interdrilled crops at the last cultivation and may be used for pasture or be plowed under in the spring in fitting them for the following crops. Soybeans is a crop which is able to make fair growth on quite poor soils and offers some return as a cash crop as well as making good legume feed when other crops are not successful.

Corn, rye, alfalfa, soybeans, and clover are therefore among the best crops for these soils. These crops are best used as feed and therefore the line of farming which seems best adapted to such lands is one in which the growing of livestock plays an important part, and so long as dairy products maintain a fair price, dairying should be followed quite generally on these lands.

Potatoes do well on these lands when fertility is maintained and in seasons having a good amount and distribution of rainfall. However, they involve so large an expenditure for seed, spraying, and labor and the risk of drought is so large that they cannot be considered well adapted to most sandy soils and should be grown only to a limited extent. This is particularly true in the central sandy area where potatoes suffer more than in the north and they should be chiefly grown on sandy loam soils.

Other special crops such as cucumbers, melons, navy beans and strawberries do well.

Fertilizers for Sandy Soils. The low plant food naturally existing in these soils must be supplemented. This includes nitrogen, phosphorus, calcium or lime, and potash. The nitrogen can be maintained through the growth of legumes such as alfalfa, clover and soybeans.

There is a double benefit from the use of fertilizers on sandy soils; they permit greater growth of the crops as they do on heavier soils, and they have the effect of increasing the efficiency of the limited moisture in these soils since plants which are making rapid growth use less water per pound of dry matter produced than do plants which are making slower growth. Moreover, fertilizer used in growing green manuring crops is used over again when these crops decompose in the soil and become available to the following crops.

Some phosphorus must be added through the use of fertilizers.

Plate XX–A. Field of potatoes on Plainfield sand.

Plate XX–B. Drainage ditch through peat marsh i n central Wisconsin showing sand underlying peat.

A uniform practice of using about 200 pounds of 16% acid phosphate, or equivalent amount of other grade, per acre once in the rotation of three or four years will maintain the phosphorus on the dairy farm. More is needed on special crops.

The calcium may be supplied either in ground limestone, marl, or other form. While these sandy soils as a rule are only moderately acid, still they have only a small amount of available lime. This substance is needed by all crops. When clover, alfalfa, or other legume is grown on the field in rotation with other crops and sufficient lime is used in fitting the ground for the legume, there will be enough lime left for the other crops following. But if no legume is grown some lime should be used for other crops. One ton of good ground limestone, or equivalent amount in other form, per acre every four to six years will supply the lime needed by most non-legume crops. Many garden plants need more.

If the manure is well taken care of, it will return most of the potash in crops to be used over again and will cause more of that already in the soil to become available and be added to the revolving fund in the organic matter in the manure. The use of abundant bedding or other absorbent to take up all the urine in which most of the potash occurs, is a matter of the greatest importance on sandy farms. But the use of some potash in fertilizer form is frequently profitable in addition to manure. This is especially true on "worn out" sandy soils and on alfalfa, potatoes and other crops needing large amounts of potash.

The growing of alfalfa is the starting point in the improvement of such lands. The use of from two to three tons of ground limestone, or an equivalent amount of marl, which may mean from three to four tons per acre if it is quite moist or if it contains considerable impurity, is necessary the first time the land is seeded to this crop. To this should be added 300 to 400 pounds of 16% acid phosphate or an equivalent amount of higher grades, and 100 pounds of muriate of potash. Inoculation of all alfalfa seed is essential. The use of at least a light application of well rotted manure is a great help in getting a catch of alfalfa as it retains moisture available for the seedling. If manure cannot be used, 100 pounds of muriate of potash should be applied per acre in addition to lime and phosphate. In general, it is best to sow early in the spring and this may be on a very light stand of rye or without a nurse crop entirely. The seed should be drilled in a little deeper than on heavier soils and the use of a corrugated roller, which will compress the soil and yet will leave the surface roughened, is very helpful; or a smooth roller followed by a light drag may be used. A small field of alfalfa should be seeded each year since there is less danger of winter killing on the younger fields than on the older.

When success in the growing of alfalfa has been reached it becomes the source of feed containing the nitrogen and leads to the production of manure of good quality which is available for corn and other crops.

Wind-breaks. Wind storms do more damage in a region of sandy soils than they do on heavier land both because of the injury to young crops by blown sand and because they cause the snow to collect irregularly resulting in the irregular distribution of moisture when it melts. The use of wind-breaks of jack pine or other trees to prevent this trouble is discussed under the head of Forestry on page 31.

The use of rye or other cover crop is also very helpful in preventing blowing of sand and should be used for this purpose as much as possible wherever the blowing of sand is likely to occur. The arrangement of land in long narrow fields so that part of them will be under crop during April and May and will protect the others which are bare at this time is also beneficial. These winds are most commonly from the west and where practical the fields should be long north and south, but even where it is necessary that they should be practically east and west they are still beneficial because it is seldom that the wind will blow directly from the west.

Pasture. On farms including only sandy soils, one of the difficulties in stock farming is that these lands are poorly adapted to pasture. The true grasses do not do well on such soils so that there is practically no permanent pasture. When a good catch of clover is secured and there is enough alfalfa to produce the hay needed, the clover may be used as pasture. It should not be pastured in the fall of the year it is sown as this will kill it out, leaving practically no pasture for the next year. When clover is not available, rye may be used for a short pasture season. The white biennial sweet clover, sown in the way described for alfalfa, under favorable rainfall makes excellent growth and may be used as pasture or as a soiling crop, but in many cases pasturage must be supplemented by silage.

A considerable portion of the farms of the sandy areas include some marsh or meadow land as well as the upland sandy

Plate XXI. View of rough Vilas sand. Bayfield County.

soil. On such farms the meadow or marsh land may be used as permanent pasture or hay land. The narrow strips of meadow land along streams usually have a black sandy loam soil, while the larger marshes are composed of peat for the most part. The black sandy loam meadow strips are low in phosphorus and lime and an application of from one to two tons of ground limestone or marl per acre as a top-dressing, once in four to six years, will undoubtedly be very helpful not only in promoting better growth and tending to encourage the better grasses such as blue grass and even clover, but it will also increase the lime content of these grasses which leads to production of better bone in the animals fed. These lands are also very low in phosphate and the practice of applying a top-dressing of about 200 lbs. of 16% acid phosphate or its equivalent in other grades every two or three years will greatly improve the pasturage. Lime and phosphorus are both needed to get the best results. On farms containing such meadow land as well as upland sandy soils, the most of the manure should be used on the sandy land while the use of moderate amounts of lime and phosphate or of a fertilizer containing both phosphate and potash will maintain the fertility of the meadow land which already contains a large amount of nitrogen in the organic matter. Where the marsh land is of peaty character, its treatment should be that described on page 122.

Peat as Fertilizer on Sand. On such farms it is often practicable to use some of the peat as a top-dressing on the sandy land. Peat which has been dug out of the ditch and allowed to dry a few months and then applied at the rate of 15 to 20 loads to the acre, distributed with a manure spreader, will add a large amount of nitrogen and organic matter needed by the sandy soil and if this is supplemented by the use of 200 pounds of 16% acid phosphate or its equivalent of other form and 50 to 75 pounds of muriate of potash, it makes a very good substitute for barnyard manure and is a great aid in developing the fertility of such land.

On the experimental field on Plainfield sand at Sparta, a comparison was made of barnyard manure used at the rate of fifteen loads per acre, once in four years, with twenty-five loads of peat of a low grade supplemented with 100 pounds of muriate of potash and 200 pounds of acid phosphate per acre. The yields of corn the first year were distinctly in favor of manure but this difference gradually decreased. In 1913, the fifth year of the experiment after the second application of both manure and peat, the yield with peat supplemented with phosphate and potash was 43.5 bushels to the acre and on the plot treated with manure it was 56.5 bushels per acre while that on the untreated plots was 18.5 bushels. The use of peat in this way is practicable only when the haul from its source to the land on which it is to be applied is short, since large amounts must be used. The peat should also be as dry as possible and consist largely of organic matter, since any sand or earthy matter it contains is of little value and adds greatly to the weight. Lime should be used with the peat treatment whenever it would be used on the same land with manure or other fertilizer treatment.

Yields on Sandy Soils. Based on the experience on the Hancock Station and elsewhere it is estimated that during years of average rainfall and with good farm practice on farms on which most of the crops are fed to stock and the manure returned to the land, and the loss of phosphorus in milk and animals sold is made good by purchase of phosphate, yields of 8 tons of corn silage, 16 bushels of rye and two tons of alfalfa hay can be grown on the medium and fine sands of the state. On such farms most of the manure should be used on the corn, together with 200 pounds of 16% acid phosphate or its equivalent, and lime, phosphate and some potash should be used on the alfalfa ground.

On these farms the rye would be sold and suitable concentrates purchased. The crops of three, or at most four, acres would furnish feed for a dairy cow. A farm of 100 acres should supply feed for 20 cows, 10 hogs and three work horses and five acres of potatoes or other special crop could be raised. These yields are not more than two-thirds those secured on good silt loams but the investment is not more than half as much and the labor of tillage is much less. In the opinion of the writer, greater relative improvement can be made in the management of sandy soils than of heavier soils through the use of lime and other fertilizers, the selection of crops better adapted to them, growing these crops in the best sequence or rotation, and in other ways. Whether these improvements would be sufficient to permit very sandy soils to be farmed with profit under economic conditions as they at present exist may be a question, but that they can be farmed with profit in the near future when the demand for food has increased can scarcely be doubted. To make this possible, however, it will be necessary to prevent speculation from raising the selling price of the land itself. The capital on which interest charges can be paid in addition to operating expenses will always be low in comparison with heavier lands.

The experience at Spooner, Crivitz and elsewhere indicates that under the same conditions yields of 10 tons of corn silage or 45 bushels of corn, 20 bushels of rye, 40 bushels of oats, two tons of clover and two and a half tons of alfalfa can be grown on the sandy loams.

Mixed Sand and Peat Farms. Throughout the sandy area of the state marshes of peat and muck soil are widely distributed. The result of this is that a very large number of the farms include both. Probably more than half the quarter sections of all the sandy area in the state have at least 10 acres of one and the balance made up of the other kind of soil. When this is the case the farm as a whole is benefited by the fact that it contains two quite different types of soil. The sandy soil is adapted to some crops which do not do well on the peat, and vice versa. To take advantage of this relation the farmer should use a large part of the manure produced on the farm on the upland or sandy soils and use the special fertilizer containing potash or potash and phosphate, when that is needed, on the peat. By the use of the marsh or peat land for root crops and hay and pasture, if in sufficient amount, and using the upland for corn, rye and alfalfa, the total yield on the farm can be increased greatly.

MARSH SOILS OF SANDY AREAS

There are approximately 1,000,000 acres of marsh soils in the areas of sandy soils. For convenience, marsh soils may be classified into peat, muck, and marsh border types. In the work of our survey we have limited the term "peat" to soils having 50% or more of organic matter and less than 50% of earthy matter; "Muck" to soils having between 15 and 50% of organic matter; and "Marsh Border Soils" to those occurring along the border of marshes and elsewhere and having between 5 and 15% of organic matter. Soils of the last mentioned character in these sections are classified in the Dunning series.

Peat is further subdivided into deep, medium and shallow phase. The first being over three feet in depth, the second between eighteen inches and three feet, and the third less than eighteen inches and usually over six inches. It would have been better if the term "peat" had been limited to soils having 70% or more of organic matter. The use of the terms "peat" and "muck" varies in different sections of the country. In some sections only the coarse, undecomposed fibrous matter is called "peat," while any soil, no matter how high in organic matter, but so far decomposed that the fibre tissue of the plants which formed it has been destroyed, and usually having a black color, is called "muck." However, as will be explained later, the chief difference in composition and fertility between peat soils and all other soils is due to the amount of vegetable matter they contain, rather than its stage of decomposition, so that the amount of earthy matter a soil contains mixed with the organic matter is the thing of greatest importance.

Origin. Peat soils have for the most part been formed through the growth of vegetables of various kinds. In some cases it was largely sphagnum or other mosses which grew in shallow ponds and lakes such as were left very thickly scattered over the area left by the glacial ice sheet. In other cases the bulk of the vegetable matter was made up of sedges and grasses. Often this sedge and grass type of peat overlies a layer of moss peat.

Peat Vegetation. These peat marshes are now covered with a great variety of vegetation. A portion of them are covered chiefly by tree growth such as tamarack, spruce, alder, black ash and willows. The grass vegetation varies from a variety of sedges including wire grass to grasses including Blue Joint and others. The cost of improving marsh land of course is greatly affected by the form of vegetation covering it. Tree growth even though the roots are commonly very shallow is much more difficult to remove in the processes of clearing.

Chemical Composition. The greatest difference in the fertility between marsh land and upland soils is due to the very great difference in their chemical composition. Upland earthy soils being formed from rocks containing practically all the essential elements of plant food, except nitrogen, are relatively higher in the elements, calcium, potassium and phosphorus though they may be quite low in nitrogen unless a considerable amount of organic matter or humus has been forming on them. Marsh soils, on the other hand, being formed by the accumulation of vegetable matter are high in nitrogen but are practically always low in potassium which is gradually leached out as the vegetable matter accumulates and are often low in calcium and phosphorus when expressed on percentage basis. Furthermore, peat soils are always very light. A cubic foot of peat taken from a bog, thoroughly dried and then weighed, will be found to weigh only from 10 to 16 pounds while a cubic foot of earthy soil weighs from 65 to 100 pounds or from 4 to 10 times as much. The result of this difference in weight is that the amount of plant food per cubic foot or per acre to a given depth is very much less in the peat soil than in the earthy soil even though they were percentagely the same based on dry weight. The following table shows the average chemical composition of marsh and upland soils expressed both percentagely and in pounds per acre to a depth of 8 inches.

AVERAGE COMPOSITION OF UPLAND AND PEAT SOILS

Element	Per Cent		Pounds per acre to a depth of 8 ins.	
	Upland soils	Peat	Upland soils	Peat
Nitrogen	.15	2.5	3,000.	12,500.
Phosphorus	.06	0.12	1,200.	600.
Potassium	2.00	0.25	40,000.	1,250.

While the amount of the different elements which are in a form available to crops is not strictly proportional to the total amount in the soil, still such very great differences as exist between upland and peat soils do determine the relative amounts which are available and show those which must be supplied by fertilizers.

The radical difference in chemical composition between peat and upland soils above mentioned must be recognized in any plans for the development and agricultural use of these soils. It is evident that they are abundantly supplied with nitrogen so far as the total amount present is concerned. This nitrogen, however, is contained in organic or vegetable matter in forms not immediately available to growing plants and must be made available through processes of decay which are largely carried on by fungi and bacteria in the soil. These organisms, however, are quite commonly lacking in newly cleared peat land. To such an extent is this often true that peat can be used as an antiseptic substance for the dressing of wounds. In order to encourage the processes of decomposition necessary to make the nitrogen available, organisms which cause it must be introduced. While this will take place to a considerable extent without artificial stimulus through dust blown from surrounding land and otherwise, the use of a light dressing of manure is very beneficial, probably largely because it inoculates the soil with a variety of organisms which set up the processes of decay and nitrification. In colder countries it is rather general practice to use nitrogen fertilizers even on peat soils because of the slowness of the processes of decomposition and nitrification. In our climate, however, it is not often necessary to use fertilizers containing nitrogen providing suitable conditions for decay and nitrification are provided.

Potassium or potash, which is necessary to the growth of all plants, exists in very limited amount in peat soils. In some cases the amount is so small as to be barely more than a trace while in other cases there is a sufficient supply to permit fair growth at least for two or three years without further addition, but there need be very few exceptions to the statement that an application of potash in some form is necessary to the best results in the development of marsh soils. The amount needed will depend largely on the crops to be grown. Small grain such as rye, oats or barley need comparatively small amounts of this element for good yields while other crops making heavier growth such as corn, cabbage, or sugar beets require much larger amounts. An application of 100 pounds of high grade Muriate of Potash containing 50% of potash may be sufficient for an acre of small grain but for corn, 200 pounds, and for a heavy crop of sugar beets or cabbage, from 200 to 300 pounds, is necessary.

Whether potash fertilizer must be used regularly year by year on these lands depends very largely on whether the entire crop is moved from the land and sold or the major portion is fed and the manure returned to the land. The following table shows the amount of potash in different crops and in different portions of the crops.

AMOUNT OF POTASSIUM IN CROPS

Crop and Yield	Pounds of Potassium (K)	
	In Seed	In Straw or Stalks
Alfalfa hay—4 tons	----------	95.
Red Clover—4 tons	----------	95.
Oats—5 Bushels	7.5	31.
Corn—65 Bushels	12.0	66.
Potatoes—200 Bushels	53(tubers)	20.
Sugar Beets—15 Tons	82(roots)	----------

From this it will be seen that in general the larger portion of the potash is contained in the stalks and leaves of plants and a very small part in grain. If, therefore, the stalk and straw of most crops grown on these lands is used for feed or bedding and the manure returned, it is possible to return to the soil the larger portion of the potash which has been used in the growing of the crops so that much less need be added in the form of fertilizers thereafter. It should be borne in mind, however, that in the digestion of the animal a relatively large portion of the potash is excreted in the liquid manure and the smaller portion in the solid manure. Unless an abundance of absorbent or bedding is used and great care is taken to prevent the leaching of manure before it is applied to the land, the larger portion of the potash may be lost even though the bulk of the crops is fed. Peat itself is an excellent absorbent and its use in stables for that purpose on marsh lands is very desirable. It is also important that the manure be spread as soon as possible after being moved from the stable or if not it should be protected from leaching by being kept under a roof.

In general when heavy growing truck crops such as cabbage, onions and sugar beets are grown, considerable amounts of potash should be used as fertilizers to secure good results. In dairy or other forms of livestock farming careful management of the manure will reduce very materially the amount of potash needed. It is recognized, however, in all countries in which peat farming has been practiced for many years that it is very important that potash fertilizers be used even in stock farming during the first three or four years after peat land is broken and that a sufficient amount be added continually after that to replace any losses which may occur due to leaching of manure or to the sale of any crops.

Lime or Calcium. Lime or calcium is one of the essential elements of plant food. This element occurs in upland or earthy soils in two quite different forms. It exists in many silicate minerals such as occur in granite and other igneous rocks and as carbonate in limestones. The sandy soils underlying practically all of this central area of the state contain some silicate minerals having calcium but the decomposition of such minerals is very slow and especially in sandy soils where the grains are coarse the amount lost out from them from year to year is quite small. The calcium in carbonate form such as occurs in limestone on the other hand is much more readily soluble.

Since the ice in flowing down the Green Bay basin during the ice period flowed across the limestone region east of the portion of the central part of the state, it ground up much of this limestone mixing it with the surface soil and carrying more or less of it on across a portion of the sandy area to the moraine which formed the border of the ice sheet. The water passing down through the sandy upland soils surrounding marshes east of the moraine dissolved some of this lime and carried it into the marshes. Moreover, streams arising in these marshes and flowing westward across or through the moraine carried some lime to the marshes farther west. As a result of this there is a small or moderate supply of lime in many of the marshes of the sandy area east of the moraine and even in those bordering the moraine on the west, but marsh lands lying farther west in the sandy area such as those in Juneau, Monroe, Jackson and Wood counties have much less lime. The addition of lime as a fertilizer will, therefore, probably prove necessary in the western portions of this area. This has already been shown by experiments at Pray, Sprague and other points. The use of a ton of ground limestone or its equivalent of marl per acre every two or three years or of two or three tons per acre less frequently will probably prove profitable. For crops such as alfalfa, clover, sugar beets, cabbage and onions larger amounts are needed than for small grains or grasses such as timothy or Blue Joint.

In the use of lime on marsh soils it should be remembered that there is often a tendency for water to move upward in marsh lands due to pressure of water in the higher lands surrounding. This has a tendency to bring lime or other soluble matter up to the surface of marsh lands so that as they overflow the water carries the lime away. In consequence, it is desirable that any lime applied be mixed with the soil down to a good depth rather than be applied as a surface dressing only.

Phosphorus. While it is true that expressed percentagely peat soils contain a fair amount of phosphorus, the very light weight of the peat means that there is relatively a very small amount of this element in an acre to a given depth in comparison with that in upland earthy soils. The availability of phosphorus already in the soils depends in part on the rapidity of decomposition in the soil and in part on the amount of lime it contains. When there is a fair amount of lime in peat soil the phosphorus seems to be largely combined with it and to be more readily available than when there is a very small amount of lime, in which case the phosphorus seems to be more largely combined with iron and aluminum in forms which are much less soluble and available to plants. It is a matter of common experience consistent with this explanation that marsh lands which have a fair natural supply of lime are not so markedly deficient in phosphorus as those in the central and western portion of this area where the lime content is small. The use of phosphate fertilizers on peat at Coddington near the moraine has not so far proven necessary to secure fair yields, while further west at Pray, Sprague and Mather, phosphate has proven quite beneficial.

It should, however, be remembered that phosphorus exists in all soils in very small amounts and that it is subject to loss from the farm in practically all systems of farming, including dairying or other forms of stock farming. A considerable portion of the phosphorus in feed is fixed in the bones of animals even that secreted in the milk going to the bones of young growing animals so that it is never returned to the soil. Even though phosphate fertilizers may not prove necessary or profitable during the first few years of cropping of peat lands, it is to be expected that a moderate use of them will prove necessary and profitable in later years. Trials should therefore be made from time to time to determine what benefit may be secured from their use.

FROST ON MARSH LANDS

It has been well known for a long time that low ground adjacent to high ground is more subject to frosts in late spring and early fall than the high land is. This is because the cool layer of air forming in contact with the surface soil which becomes cool through radiation of its heat during the night is heavier than the warm air higher up and flows down the hill sides, collecting in low areas leading to formation of frost and higher on the hillside it is replaced by warmer air from above, thus keeping the temperature up and lessening the danger of frost. On the extensive plain of the sand and marsh region in the central part of the state, however, there is little opportunity for this air drainage since there is very little relief between the marsh and the sandy portions. Nevertheless, experience has shown that the peat lands of this region are much more subject to frosts than the sandy soil only a few feet higher. In the study made by the writer of conditions on cranberry marshes in 1904 and 1905 and reported in the 21st annual report of the Wisconsin Experiment Station, this tendency to frost was shown to be due to the low heat conducting power of peat in comparison with earthy soils. In the summer of the years mentioned, temperature on the peat was found to be from 8° to 12° lower than those on sandy islands a few rods away and but 1 to 3 feet higher; in fact plots of peat ground covered with a few inches of sand were often free from frost while the berries on peat adjacent were ruined by frost. This explanation of the tendency to freeze on broad peat lands was later studied by Professor Cox of the U. S. Weather Bureau with similar conclusions.

Peat soils have lower power of conducting heat than earthy soils, so that the subsoil of peat is not warmed as much as upland soils during the day. Therefore, radiation of heat during the night causes them to reach lower temperatures, often resulting in frost on peat lands when no frost is formed on uplands surrounding it. In general, it may be stated that the probability of frost on peat soils of any given locality is approximately the same as that on upland soils having good air drainage 150 miles farther north.

DRAINAGE CONDITION ON MARSH LAND

The wetness of marsh soils in their native condition is usually too great to permit the growth of many cultivated plants and to interfere with the operations necessary for their seeding and harvest. The first step in the improvement of these lands, therefore, is drainage. Most of the large marshes of the central part of the state have been supplied with outlet ditches. These in many cases were constructed by straightening and deepening the channels of streams previously existing. These outlet ditches are for the most part a mile apart, thus furnishing outlets to most quarter sections of land. During dry seasons the major part of this land is now sufficiently drained for the growth of staple farm crops during the growing season, though considerable portions are still too wet early in the spring to give suitable conditions for working, and during wet seasons large portions are too wet for any but hay crops or pasture. It will be necessary to install laterals of small ditches or tile over a considerable portion of these marshes in order to produce sufficient drainage for many of the crops it is desired to grow. These laterals can usually be 10 to 20 rods apart when laid sufficiently deep so that the expense of drainage is very much less

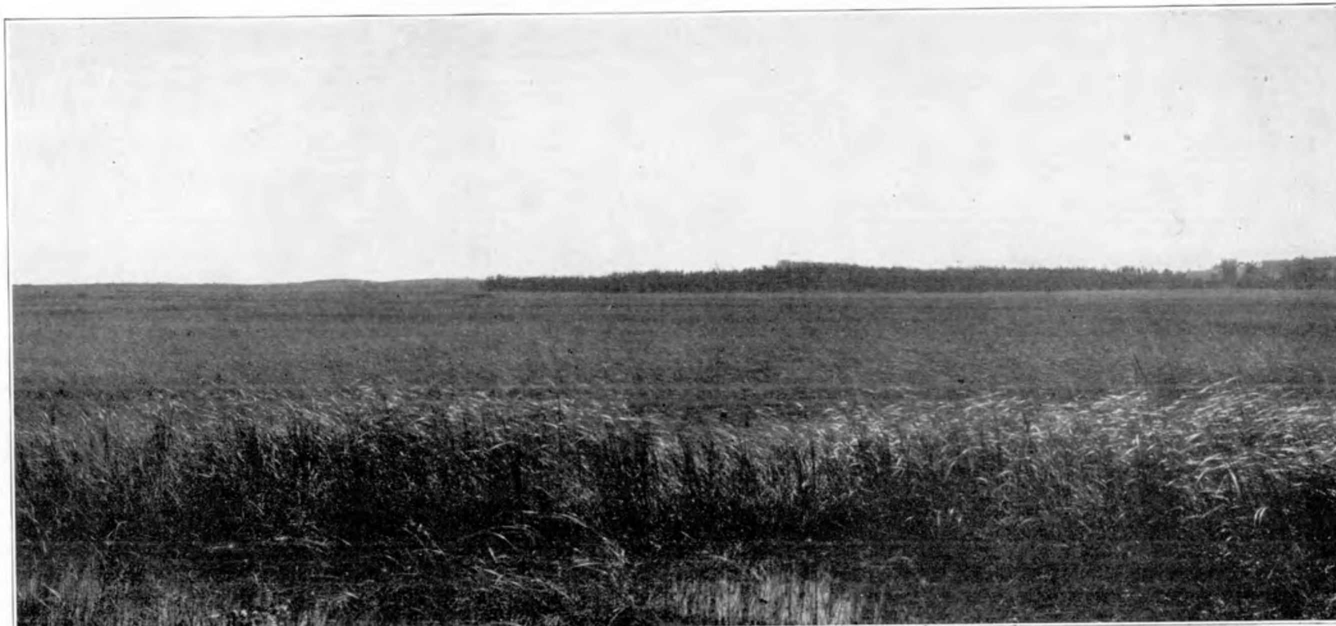

Plate XXII. View of typical grass marsh in central Wisconsin. Near Endeavor.

than in the case of level clay land where tile must be much closer. The average cost of the outlet ditches in this section has been from $6 to $10 per acre and an average expense of an equal amount will furnish good drainage for all staple crops.

CROPS ADAPTED TO MARSH LANDS

In selecting crops for these marsh lands the chemical character or fertility of the soil, the relation to frost and drainage conditions must all be taken into account. The tendency to frost on these lands in central Wisconsin results in considerable risk to tender crops such as corn and potatoes, though this danger is not sufficiently great to make it unwise for each farmer to grow a small acreage of such crops, but the chief reliance should be placed on crops less subject to frost such as grasses and clovers for hay, small grain, and hardy root and vegetable crops.

The large water holding capacity of these soils and the abundance of nitrogen make them well adapted to crops growing throughout the season such as grasses for hay and pasture and to crops making rank heavy growth such as corn, cabbage, beets, hemp, and sun flowers when the elements of phosphorus and potassium are supplied as previously shown necessary. Truck crops such as cabbage, onions and celery can be grown very successfully on these lands but of course only a very small portion of the land is needed for these crops. The entire acreage in cabbage in the state is only from 10 to 15,000 acres and in sugar beets only from 10 to 20,000 acres. Moreover, the weight and bulkiness of these crops is such as to make it practicable to grow them only where shipping facilities by rail or truck to consuming centers are good. The larger portion of these crops produced for shipment in the state is grown in the southeastern portion, tributary to Chicago and Milwaukee. It is not probable, therefore, that these crops can be extensively grown to advantage in this section of the state. The other crops mentioned include sugar and canning beets, and hemp may be grown to advantage when market conditions and prices are favorable.

For the most part these lands must be used for the production of staple crops used directly as human food or as feed for stock. Under present conditions chief reliance should undoubtedly be placed on crops used for stock feed such as pasture and hay grasses, legumes with the hardy roots and some corn or sun flowers as silage for winter feeding. When properly fertilized through manuring, supplemented by lime, potash and phosphate as needed, excellent yields of these crops can be secured, as the results of experiments and individual trials over a long period have already shown. Following are the results of trials made by the Experiment Station at a number of points on peat land of this character.

YIELD AND TREATMENT OF POTATOES ON PEAT SOIL AT MARINETTE—1907

Plots	Treatment pounds per acre	Bushels per acre of salable potatoes
1	Blank	88.
2	Manure 10,000	138.8
3	Manure 20,000	185.1
4	Manure 30,000	218.8
5	Blank	86.0
9	Ashes 2,000	146.6
12	Ashes 2,000, acid phosphate 300	196.6
13	Lime 800; potash 50; phosphate 200	160.0
14	Lime 1,600; potash 50; phosphate 200	126.0
15	Lime 2,400; potash 50; phosphate 200	105.3
16	Blank	66.6
19	Potash 50; acid phosphate 400	164.0
	Treatment and Yield of peat soil at Phillips	(1906)
R	Blank	2,727 lbs. hay (acre)
S	Sulphate of potash 100 pounds per acre	
S	Acid phosphate 275 pounds per acre	4,906 lbs. hay (acre)

Yield of Hay on Peat at Marinette in 1905. On the same tract of land on which the potato yield of 1907 above given was secured, several varieties of grasses were grown, being seeded in 1904 and harvested in 1905. The yields and treatments are given in the following table. On these plots 320 pounds of 14% acid phosphate and 135 pounds of high grade sulphate of potash were used either alone or together and in comparison with them a treatment of 16 loads of manure per acre was applied on another plot.

HAY PER ACRE ON VIRGIN PEAT SOIL UNDER TREATMENT WITH VARIOUS FERTILIZERS

Treatment	Timothy and alsike clover	Fall Meadow oats	Meadow fescue	Fowl meadow grass
	lbs.	lbs.	lbs.	lbs.
Potash	160	224	576	512
Acid phosphate	960	1,024	1,600	1,984
Acid phosphate and potash	2,080	2,080	1,792	2,430
No Treatment	----------	192	416	448
16 loads of manure per acre	2,816	2,400	2,080	2,272
Acid phosphate and potash	2,400	1,344	1,280	2,560
Potash	----------	128	480	832
Acid phosphate	896	1,280	960	1,760

The result of this trial indicates that on this peat tract phosphate is more beneficial than potash used alone but that the largest returns are secured when both are used.

Yields at Coddington. More information regarding the yields and crops on peat is being secured from the Experiment Farm at Coddington. This ground is located near the border of the area covered by glacial ice and the peat has a fair amount of lime, probably largely brought to it by streams coming from the glaciated area so that it is not acid. It does not show marked need of phosphate at present. It is quite probable that the need of phosphate will develop later since the total supply of phosphorus in the soil is small.

A portion of this farm is devoted to a four year rotation of corn, oats, rye and clover. For the first four years all of the fertilizer treatment was applied at the time the ground was being fitted for corn and consisted of eight tons of manure on certain plots, 150 pounds of muriate of potash spread broadcast on other plots, and on still others phosphate as well as potash was used. The average yield on the plot receiving potash alone was about 5½ tons of silage corn, 40.6 bushels of oats, 22.8 bushels of rye and 2011 pounds of hay. Following the application of eight tons of manure the yields of silage corn averaged 5½ tons, of oats 34 bushels, rye 17 bushels and hay 2009 pounds. On all plots receiving no treatment the yields averaged 3½ tons of silage corn, 20 bushels of oats, 8 bushels of rye and 1860 pounds of hay.

On another portion of the farm a five year rotation of roots, corn, hay or pasture is followed and plots for different fertilizer treatments laid out. An initial application of six loads of manure was applied to all at the beginning and for the root crops

500 pounds of an 0-10-15 fertilizer was used. The yields secured were,—potatoes, 147 bushels; carrots, 437 bushels; and clover 1945 pounds.

On the third field treated with 400 pounds of 0-8-24, oat and pea hay yielded 4,600 pounds, Alaska peas 12 bushels of dried peas, hemp 11,672 pounds of straw yield, 625 pounds of line hemp and 1115 pounds of tow, while without fertilizer the yield of line hemp was 50 pounds and of tow 330 pounds. Millet yielded 467 pounds at a two year average on the same field, parsnips 8 2/3 tons, alfalfa 3890 pounds, alsike and timothy 4370, sunflower silage at a two year average 16.3 tons and canning beets as a three year average 7129 pounds per acre.

Cranberries. Cranberries were found growing wild on the marshes of central Wisconsin and have for many years been cultivated in that section. At first the only effort made in increasing their yield was through the control of water used for protecting them from frost and to increase their growth during very dry seasons. This was done by the construction of low dikes along the lower sides of the marshes and also by the construction of dikes or dams for impounding of water on land above, and of ditches leading the water to the marshes. Later, better preparation of the cultivated bogs was provided by scalping the surface of the marsh, thus securing a level, uniform area on which cranberries were transplanted in such a way that the flooding and drainage of the water could be more adequately controlled. Still more recently further improvement has been made by the sanding of these prepared beds, either before transplanting or later, thus making it possible to reduce the amount of other vegetation and also to increase the temperature of the surface soil leading to better growth and earlier ripening of the fruit.

Wisconsin has for many years ranked third in the United States in the production of cranberries, following Massachusetts and New Jersey. In recent years the area in bearing vines has been approximately 3000 acres, but the maintenance of an adequate supply of water for their growth and protection has required the use of several times that area of other marsh land lying above the cranberry marshes proper.

This section of the state includes many tracts unusually well suited to the growth of cranberries, including land having the slight but uniform slope necessary for the location of the cranberry beds so that water can be used on them to advantage, the presence of moderately coarse and clean sand suitable for use on the beds, and convenient access to railroads for shipment. The growing of this crop encounters many problems in the control of insect and fungus enemies, of weeds, and of temperature conditions. The cranberry plant does best on an acid marsh soil, and such land is usually low in available phosphorus and potash and in wet condition also of available nitrogen. Nevertheless, profitable growth of the plant and fruit requires a fair amount of these elements in available form. The use of fertilizers, therefore, is an important means of increasing the yield on Wisconsin marshes in general, but the proper form and kind of fertilizers is a matter requiring special study. While much progress has already been made in the improvement of cultural methods along all of these lines there is reason to believe that still greater improvements can be made and that this fruit, which is native to this state and not widely grown, may increase greatly in productivity.

Marsh Soil Development in Other States. Marsh soils varying from muck as defined in the Wisconsin classification of peat, in different degrees of decomposition and varying in depth from shallow peat a few inches in depth to beds of many feet have been drained and brought under cultivation in a number of other states, notably Indiana, Illinois, New York, Michigan and Minnesota under climatic conditions similar to those of this state. These soils include not only the range in character and material above mentioned but also a variation in lime content and degree of acidity and also in the character of subsoil,—some having a very sandy subsoil similar to that which is most common in southern Wisconsin and others having a silt or clay loam subsoil. Among the earlier sections to be developed was that of the Kankakee Marsh of Indiana extending up the Kankakee River to the vicinity of South Bend. A little later peat marshes in Indiana were developed and more recently those of Michigan and Minnesota.

In all of these sections the experience in determining crops to which they are adapted and line of treatment required has been essentially the same as stated in the foregoing pages for the marshes of central Wisconsin. The universal need of potash fertilizers except where considerable amounts of stable manure are used is recognized. In many cases, especially in Indiana, marshes requiring phosphates as well as potash are encountered and the use of lime is frequently found necessary to obtain the best results. One of the functions of lime and of phosphorus on these soils, especially in Indiana, is that of making insoluble what are now soluble aluminum salts in the soil. In that form they are injurious to plants but when fixed by precipitation with lime or phosphate their toxic action is neutralized.

These soils are used in many of these sections not only for the growing of staple crops but also for special market crops, particularly potatoes, cabbage, onions and celery. These are grown extensively on Michigan and Indiana marshes and more recently on the large marsh areas of southern Minnesota where exceptional yields of high quality potatoes have been grown with proper fertilization. To such an extent have the marsh or muck areas of New York state been developed and used for special truck crops that these lands are now among the most high priced lands in the state, commanding considerably larger prices than excellent upland soils do.

Peat Lands of Europe. The development of peat land in Europe has been in progress for about fifty years. In the German Empire, previous to 1914, there were about 5,000,000 acres of peat lands, a larger portion being in Northern Prussia with smaller areas widely scattered through the remainder of the Empire. These soils are in part low in lime and in part are well supplied with lime, the latter being especially true of the peat lands located on the alluvial subsoils from certain rivers and along the shore of the North Sea, while the low lying peats are located on the sand plains which furnish little or no lime. Experience in Germany has been the chief basis for students of marsh soils in this country and the results found in this country. The peat soils here as well are all alike in the fact that they require potash. They vary as ours do with reference to need of phosphate and lime treatment. Moreover, since part of these lands are much further north and the summer temperature is reduced by the presence of the North Sea, conditions are not as favorable for nitrification as they are here and the use of some form of nitrogen fertilizer is frequently found profitable. Authorities in that country especially emphasize the importance of the application of a potash treatment every year and base the amount needed on the amount which will be removed by the crops to be grown.

Sweden has approximately 12,000,000 acres of peat and maintains three active experiment stations for their study. The development of moors and fens in England and Scotland has been in progress for 150 years and the beneficial results from the liming of peat bogs low in the element in the latter country is one of historical importance.

These instances are but a few of those which might be given as illustrations of the extent of marsh land being developed for agricultural uses.

HISTORY OF DRAINAGE DISTRICTS IN CENTRAL WISCONSIN

Space will not permit an extended history of the drainage districts and marsh land development in this portion of the state but a very brief statement is necessary to an understanding of the present situation.

During the middle nineties of the last century there were a few years of unusual dryness. This had the effect of lowering the water table and of leading to fires which burned grass and moss as well as some of the peat of quite extensive areas; it also made possible the growing of crops without extensive drainage. Grass and other seed sown in the ashes of these burned-over areas grew well and in many cases gave excellent yields, due undoubtedly to the potash from the burning peat. This experience induced many to undertake more extensive reclamation and this together with the experience in Indiana and Illinois led speculators from those states to purchase large tracts in Wisconsin and caused them to be organized into drainage districts. Bonds were issued, with the proceeds of which main outlet ditches were put in and the land sold to settlers at a handsome profit above cost and expense. These settlers, however, knew nothing of the particular requirements of this kind of soil and while in some instances fair results were secured for a year or two, the on-coming of winter seasons and the prevalence of fires resulted in many failures simply because people did not know the special needs of these lands, and were taken advantage of by speculators who either did not themselves know the particular requirements of this soil or did not wish that these requirements be known by the purchasers.

FORESTRY IN SANDY SECTIONS

There are several advantages in using a part of the farm in sandy sections for tree growth; in the first place, these soils are relatively low in price so that the investment is less when such land is used for forestry than in the case of higher priced land;

second, there is considerable use for wood on the farm itself as fuel, posts and other building material; and third, they can be used as wind breaks preventing sand storms which do much injury to young crops and they also lessen the drifting of snow sc that the moisture resulting from its melting in the spring is more evenly distributed.

Most of the land of these sandy sections was originally wooded and in fact there is still considerable wood land scattered over even the central sandy section and a large portion of the northern sections are simply cut-over wooded land. The most common tree on the very lightest sandy soils is the jack pine, but there is usually some Norway and even white pine associated with it, especially where the soils are of better character, such as sandy loams or fine sandy loams. In many sections there is considerable hardwood, especially on the Plainfield soils, chiefly of black oak and poplar.

While jack pine has not in the past been considered a very valuable wood, it is coming into use in large quantities as pulp wood, box wood, etc., and the demand is constantly increasing. Pulp wood is now worth about $8.00 per cord at the mill, of which there are several in the central section. The use of proper preservatives makes jack pine valuable for posts and other purposes. The jack pine reseeds readily when the ground is in condition to receive the seed. It will spread twenty to thirty rods from seed bearing trees and if the ground is not too closely covered with vegetation or has been worked recently the seeds germinate readily and a good stand is easily secured. The accompanying illustration, Plate XXIIIA, is from a photograph taken of a field of about forty acres in Adams county which was seeded from a few rows of jack pine along the fence. The evenness of the stand indicates that the seed germinated at a definite time,—doubtless when the land was in best condition to receive it. Plate XXIIIB is from a photograph of jack pine in Bayfield County.

Studies made by the United States Forest Service in cooperation with the State Department of Conservation show that pine is making very satisfactory growth in many sections of the state as well as of Minnesota and Michigan. They have examined typical areas, in all 130 in number, of which 67 are in Wisconsin, 42 in Michigan and 21 in Minnesota. They classified the sites or tracts on the basis of their adaptation to the growing of jack pine into good, fair and poor. They find that the heights of the

Plate XXIII–A. Showing reproduction of jack pine in abandoned field adjoining a stand of older jack pine.

Plate XXIII—B. An excellent stand of virgin jack pine on Plainfield sand in Bayfield County.

average dominant trees on these tracts are as shown in the following table.

TOTAL HEIGHT—FEET

Age—Years	Site Quality		
	Good	Medium	Poor
20	31	25	18
30	44	35	27
40	56	45	34
50	66	53	40

The diameters breast high of these trees are given in the following table.

DIAMETER BREAST HIGH—INCHES

Age—Years	Site Quality		
	Good	Medium	Poor
20	3.7	2.9	2.3
30	5.1	4.1	3.2
40	6.6	5.2	4.1
50	8.5	6.4	5.0

Expressed as cord wood the yields of the same trees would be as indicated in the following table.

VOLUME PER ACRE—CORDS

Age—Years	Site Quality		
	Good	Medium	Poor
20	10	5	3
30	26	17	8
40	37	27	17
50	43	33	22

Expressed as board feet using the International Log Rule the yields are given in the following table which shows the lumber from logs with a top diameter inside the bark of five inches or over, and in addition the amount of pulp wood from smaller timber on the same land.

Site Quality	Good		Medium		Poor	
Age—Years	Vol. per Acre	Add. Pulpwood	Vol. per Acre	Add. Pulpwood	Vol. per Acre	Add. Pulpwood
	Board feet	Cords	Board Feet	Cords	Board Feet	Cords
20	500	9				
30	3,000	16	1,000	14	500	8
40	9,500	12	3,500	16	1,000	13
50	16,000	7	7,500	11	2,500	14

Willis M. Baker, Associate State Forester in New Jersey, in discussing probable profits from forestry in that state on sandy soils says, "The seedlings and the labor for a plantation of trees spaced six feet apart will ordinarily cost from $8 to $15 per acre and will average from $10 to $12". He further states that, "A plantation of pine on fairly good forest soils which will be unfit for profitable farming will ordinarily yield 20,000 board feet of saw logs per acre in forty years, worth $200 standing in the forest at present stumpage price, yielding about 6% on the original investment. By forty years from now timber stumpage may easily be worth twice as much as at present, or be even more valuable, and is sure to increase considerably as timber becomes scarcer. Furthermore, this timber now worth $200 per acre standing in the forest is worth at least $400 cut into logs and delivered at a sawmill or manufacturing plant." This estimate of 20,000 board feet in forty years is considerably above that found on the very sandy soils in Wisconsin. Nevertheless, the yields produced in the sandy sections of this state have shown, as the examination above described indicates, that very fair returns on the investment can reasonably be expected whenever fire-protection and relief from excessive taxation during the period of growth can be provided. The amount and distribution of the sandy soils of the state which, in the judgment of the writer, should be used for forestry purposes is discussed on page 32.

Plate XXIV. Boone fine sandy loam. Eau Claire County.

Plate XXV. View of Vesper silt loam in Wood County.

CHAPTER VIII

AREA OF BOONE FINE SANDY LOAM

The soils of the area shown in light pinkish brown on the map as the Boone fine sandy loam include several somewhat distinct types of soil as they are classified and mapped in more detailed reports. The chief type is the Boone fine sandy loam proper which was originally mapped as the Auburn loam in the report on the south part of northwestern Wisconsin by Samuel Weidman. With this type, on the general map accompanying this report, are included areas of glacial soils chiefly of fine sandy loam texture on the Bayfield peninsula and in Rusk County along the Chippewa and Flambeau rivers. Also included in this general class are considerable areas of alluvial soil in Dunn, Eau Claire, and adjoining counties, part of which were mapped as the Rice Lake loams and part as the Chetek sandy loam in the report on the south part of northwestern Wisconsin. These areas will be described later.

Boone Fine Sandy Loams. The main areas of the Boone fine sandy loams proper occupy a considerable portion of Dunn and Eau Claire counties and smaller portions of Clark, Jackson, Portage, Wood and Monroe counties. The Boone fine sandy loam proper is a residual soil derived by weathering from Cambrian shales and sandstones.

The topography of these soils shows considerable variation. For the most part it consists of moderately steep slopes running up to rather sharp ridges with bluff like faces. In some cases there is some level or undulating upland on these ridges. In other sections the topography is more gently undulating or even quite level but the predominating topography is that of the long, moderate slopes above described. This topography was produced by the erosion of the sandstone and shales. The accompanying detailed map of an area near Black River Falls will serve as an illustration of local conditions throughout much of this region.

In texture the Boone fine sandy loams as shown on this gen-

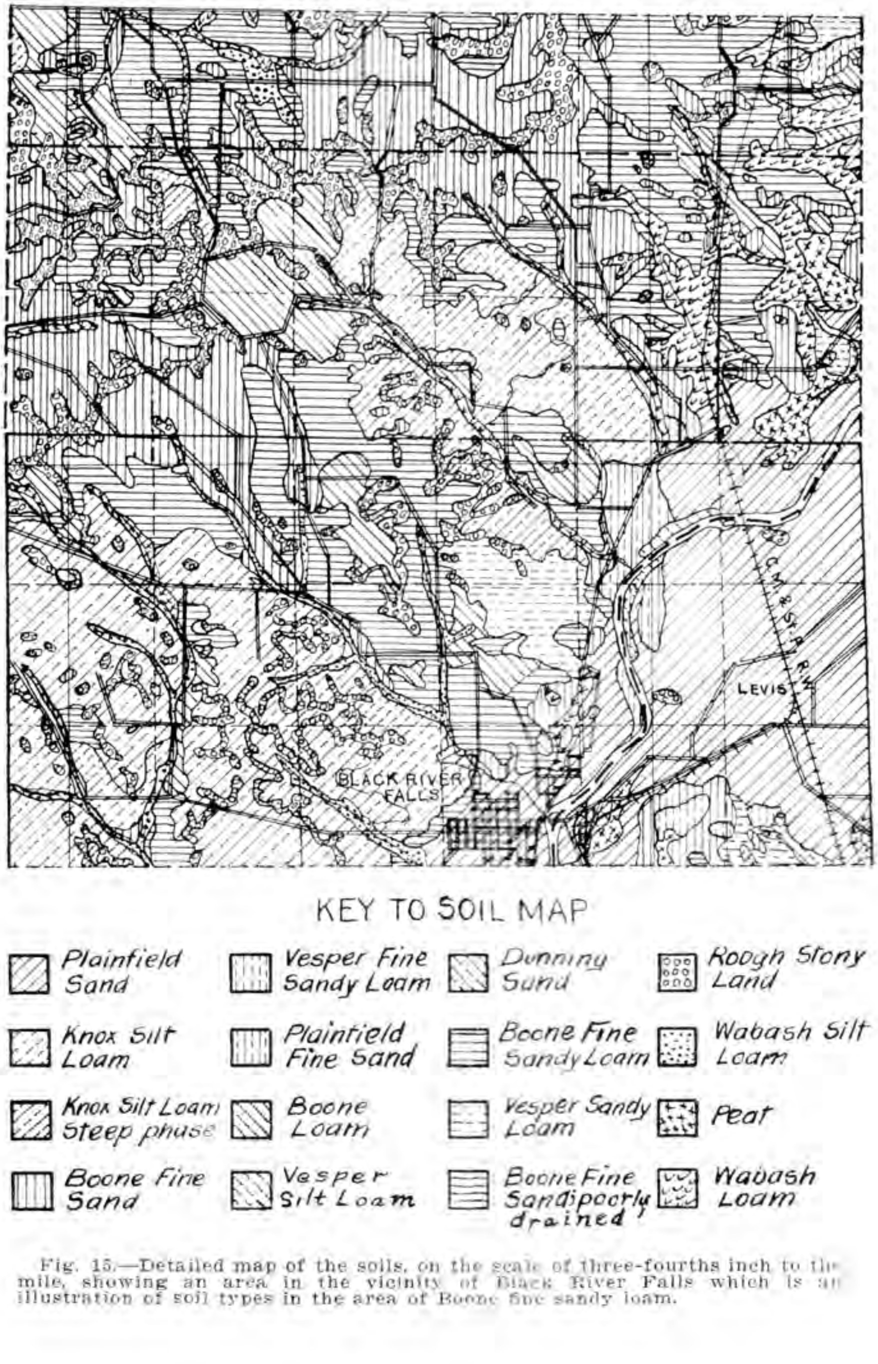

Fig. 15.—Detailed map of the soils, on the scale of three-fourths inch to the mile, showing an area in the vicinity of Black River Falls which is an illustration of soil types in the area of Boone fine sandy loam.

eral map include considerable variation. In some sections they are sufficiently heavy to be classed as silt loam, and in others would be called sandy loam, but the predominating texture of the surface soil is that of a fine sandy loam. This soil is in general of a light grayish brown color with a small or moderate amount of organic matter. In general, soil of this texture extends to a depth of from two and one-half to three and one-half feet, below which it becomes more sandy. The entire depth of the soil to underlying rock is also quite variable. For the most part it is from three to five feet in depth, but in some places it is much thinner and occasionally there is only a foot or so of soil overlying the rock, while in other places, especially on the lower slopes, the soil is many feet in depth before the underlying rock is reached.

The main portion of the soils of this type in Dunn and Eau Claire counties is a region of high agricultural value and one adapted to a wide range of agricultural crops and types of farming. These soils are sufficiently heavy to support a good growth of grass, either as pasture or meadow, as well as the small grains, but it is also a soil which warms up readily in the spring and is well adapted to corn and to such special crops as potatoes and tobacco.

The steeper slopes and rougher ridges of this area are still wooded to a considerable extent, including chiefly black oak and poplar, with some red and bur oak, birch, and a few maple. These rougher ridges, when not adapted to use as pastures, should be left wooded and an effort made to increase the growth of wood by fencing them off from pastures, which will tend to increase reproduction of trees and maintain the woodland mulch which is very beneficial to tree growth. Even replanting would be profitable in some sections. While this woodland would be chiefly valuable in this section as a source of fire wood there might also be some revenue from log timber.

In chemical composition the Boone fine sandy loams of this main area show a relatively low content of available lime, since they were derived by weathering from sandstones and shales, having little of that element. The use of lime in some form will be found, as time goes on, to be important for the maintenance of a high state of fertility. They are also somewhat low in available phosphorus. In dairy or other forms of livestock farming the use of lime and moderate amounts of phosphate fertilizers, together with the growth of clover, alfalfa, and other legumes needed as hay, will supply the nitrogen and maintain a high state of productivity. When special crops are grown to any extent on the farm, larger amounts of fertilizers will be needed, though even then the major portion of the nitrogen should be secured through the growth of legumes either to be used directly as green manuring crops or as feed for stock, the manure from which is returned to the soil. But when any considerable portion of the farm is used for these special crops larger amounts of fertilizers containing phosphorus, potash, and even nitrogen will be needed.

On the steeper slopes there is often considerable erosion unless care is taken to protect the soil by a covering of sod, either that of land used as pasture or as hay land. In many cases such slopes can be maintained in alfalfa by thorough preparation, including application of ground limestone and rather heavy applications of phosphate.

Vesper Soils. Along the border between the Boone fine sandy loam soils and the Colby silt loam, especially in Clark, Jackson, Wood and Portage counties, the soils are of a somewhat different character from those just described. In these sections the Cambrian shales overlying the granitic rocks of the Colby area are comparatively thin and the slopes are very gentle. The soils are therefore for the most part rather poorly drained and are frequently rather shallow overlying the shale rock. Soils of this character are classified in the Vesper series in the detailed survey. These soils are in general similar to the Boone fine sandy loam proper in chemical composition but are even lower in lime content and more acid, and their content of available phosphorus is also less. Tile drainage is frequently necessary to permit their agricultural use and applications of lime and phosphate fertilizers and the growth of legumes to increase the nitrogen and organic matter are necessary to improve their fertility. When properly drained, limed and fertilized these soils are capable of good agricultural development except when the soil over the rock is too thin.

ALLUVIAL SOILS

As above stated there are important areas of alluvial soils included in the areas of Boone fine sandy loams as shown on this general map. These soils occur along the main valleys, especially in Barron, Chippewa, Dunn and Eau Claire counties. Part of these soils were mapped as the Rice Lake loams and part as the Chetek sandy loams in the report on the south part of northwestern Wisconsin.

Rice Lake Loams. The larger areas of Rice Lake loams occur in the vicinity of Rice Lake and northwestern Barron County along the Chippewa and O'Neil rivers in Chippewa County, and as an irregular belt along the upper portion of Cedar River and extending southward through Dunn County, between Menomonie and Elk Mound, to the Chippewa River. Smaller areas occur along the other streams of this section.

The Rice Lake loam soils are level or very gently undulating in topography, have considerable organic matter, are moderately dark in color and are underlaid at depths of from one to three feet by sandy and gravelly subsoils. These Rice Lake loams are soils of high fertility and wide crop adaptation. The chief sections of commercial potato growing of this region are located on them. The maintenance of a high state of fertility is not difficult when the methods described with reference to the Boone fine sandy loams proper above mentioned are practiced.

Prairie Soils. Some areas of land which were originally prairie occur in this section. These were chiefly located on portions of the Rice Lake loam above described. The largest one of these, that known as the Rusk Prairie, lies east of Menomonie as shown on the map. Other important prairies are the Truax Prairie west of Eau Claire, and Eagle Prairie north of Chippewa Falls. These prairie soils are similar to other portions of the Rice Lake loam in so far as the earthy matter of the soil is concerned but have a somewhat larger amount of organic matter, giving them a darker color. Such prairie soils are usually found to be lower in available lime than those of other areas, and are now somewhat lower in available phosphorus, probably because of the fact that they were more readily cleared and brought under cultivation than the wooded areas and have therefore experienced a longer period of croppage. They are, of course, excellent soils so far as physical character is concerned and proper attention to lime and phosphate needs will readily permit the maintenance of a high degree of fertility.

Chetek Sandy Loams. The Chetek sandy loams are soils of alluvial origin occurring in the main valleys of this region and differ from the Rice Lake Loams just described chiefly in having less organic matter and in being of a more sandy texture. In general, this soil is a medium sandy loam to a depth of eight to ten inches, the subsoil becoming somewhat coarser and occasionally gravelly in character. Its agricultural character is indicated by its texture. With proper care, including the use of lime and phosphate and the growth of legumes, a good state of fertility can be readily maintained. While it is sufficiently heavy to carry fair pasturage and produce good yields of small grain it is especially adapted to crops requiring a relatively warm soil, such as potatoes, tobacco, sweet corn, cucumbers, and other truck crops.

Fig. 16.—View of fruit farm near Bayfield.

GLACIAL SANDY LOAMS

As previously stated, two areas of glacial sandy loam soils are included with the Boone fine sandy loams on this general map. One of these occurs on the Bayfield peninsula and the other along the Flambeau and Chippewa rivers in Rusk County. The fine sandy loam soils of the Bayfield peninsula occur chiefly on the west and eastern slopes, extending from the top of the main ridge to the shores of Lake Superior, though in places on the lower slopes they are interrupted by areas of red clay. The eastern portion of this ridge is one of long, gentle slopes and on account of its proximity to the waters of the lake is adapted to the growing of several kinds of fruits for which this region has become known. A more detailed discussion of this region will be found in the special report on a portion of Bayfield peninsula in bulletin 31 of soil series 5.

The second area of glaciated sandy loam soils, above mentioned, occurs in Rusk County, chiefly between the Flambeau and Chippewa Rivers. This area varies in topography, portions of it being quite rough and irregular with numerous small lakes and marshes, while other portions are more level. The soil also varies in texture from that of the loam or even silt loam to that of a sandy loam, and small tracts along the streams are of a distinctly sandy character. These soils resemble those of the Coloma sandy loam as described on page 105.

CHAPTER IX

COLBY SILT LOAM AREA

The area of Colby silt loam shown on the map in blue is one of the most important and rapidly developing agriculture sections of the state. It occupies an area of about 8,000 square miles, or 5,000,000 acres, of which the larger portion is in one body, with a smaller area in Barron County. The larger body is nearly divided by the belt of rough country running northwest and southwest through Taylor County. As a whole the area of Colby silt loam is undulating or gently rolling. It was originally heavily wooded with mixed white and Norway pine and hardwood timber. All of the pine has now been removed and the hardwood timber is being cut as the country is cleared and developed. The accompanying map of a township in the vicinity of Marshfield will serve as an illustration of the local variations in this region.

Origin. The underlying rocks of the larger portion of this soil, as will be seen from the geological map on page 36, are granites and gneisses with some more basic rocks which occurred as intrusions. A portion of the southern part of the area is underlaid by sandstone. The Colby silt loam was originally formed by glaciation of this region during one of the earliest glacial periods. While the portion of this soil lying northwest of the belt of rough country in Taylor County, previously mentioned and which constitutes the moraine of the last glacial period, was overrun by the ice of that period it was not greatly modified by it. The ice did not deposit much new drift, except in the moraine itself. It did mix with it a small amount of sandy material making the soil of this portion of the area a little lighter and it left it somewhat more stony than that in the southern or main portion, but on the whole the soil is very uniform throughout the region. The body of the soil, as we now find it, was originally formed from granitic rocks by glaciation, but the glacial character of a region recently covered by the ice, such as that of the Kennan loams having abundant

Plate XXVI–A. View on rolling phase of Colby silt loam in Clark County.

Plate XXVI–B. View on level phase of Colby silt loam in Marathon County.

lakes and marshes and more irregular surface, has been largely modified in the Colby area during the long period which has elapsed since its formation. The lakes and marshes have been largely drained through the deepening of the channels and the surface soil has been weathered until its character resembles that of a residual soil formed from granitic rocks.

Since this region was originally wooded the soil did not accumulate a very large amount of organic matter except in the small area of marshes and on poorly drained land. On the whole the surface is of a dark gray color.

Texture. The surface soil of this type to an average depth of ten inches consists of a smooth, friable silt loam. Portions of it are quite loess-like and of a light brown color and may be of wind origin similar to that of the Loess soils found in the area of the Knox silt loam described on page 55. Sufficient study has not yet been given this phase to establish its loessial character or to map it separately from the soils of more strictly till origin.

The subsoil is frequently mottled with rusty brown, yellow, and drab, indicating rather poor under drainage in its original wooded condition. To a depth of three feet the texture of the soil is quite uniform except that there is a somewhat higher portion of fine sand and clay in the lower part and at that depth it is usually a compact, clay loam. This compact portion of the subsoil is frequently referred to as a hardpan because it interferes somewhat with the movement of the water through it, but it is not a true hardpan in the sense in which that term is used in western states. The texture of this soil is such as to give it excellent tilth. Tillage readily develops an exceptionally good seed bed.

The mechanical analysis of the Colby silt loam is given in the following table.

Depth	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt	Clay
0"— 8".......	.2	3.5	2.6	4.0	5.7	70.3	13.6
8"—24".......	.3	3.5	3.7	5.8	7.0	64.3	15.4
24"—36".......	.4	7.2	8.5	14.8	11.5	34.9	22.9

The percentage of silt in the surface soil is very high while that of clay is about average for silt loams, and the third foot has the texture of clay loam.

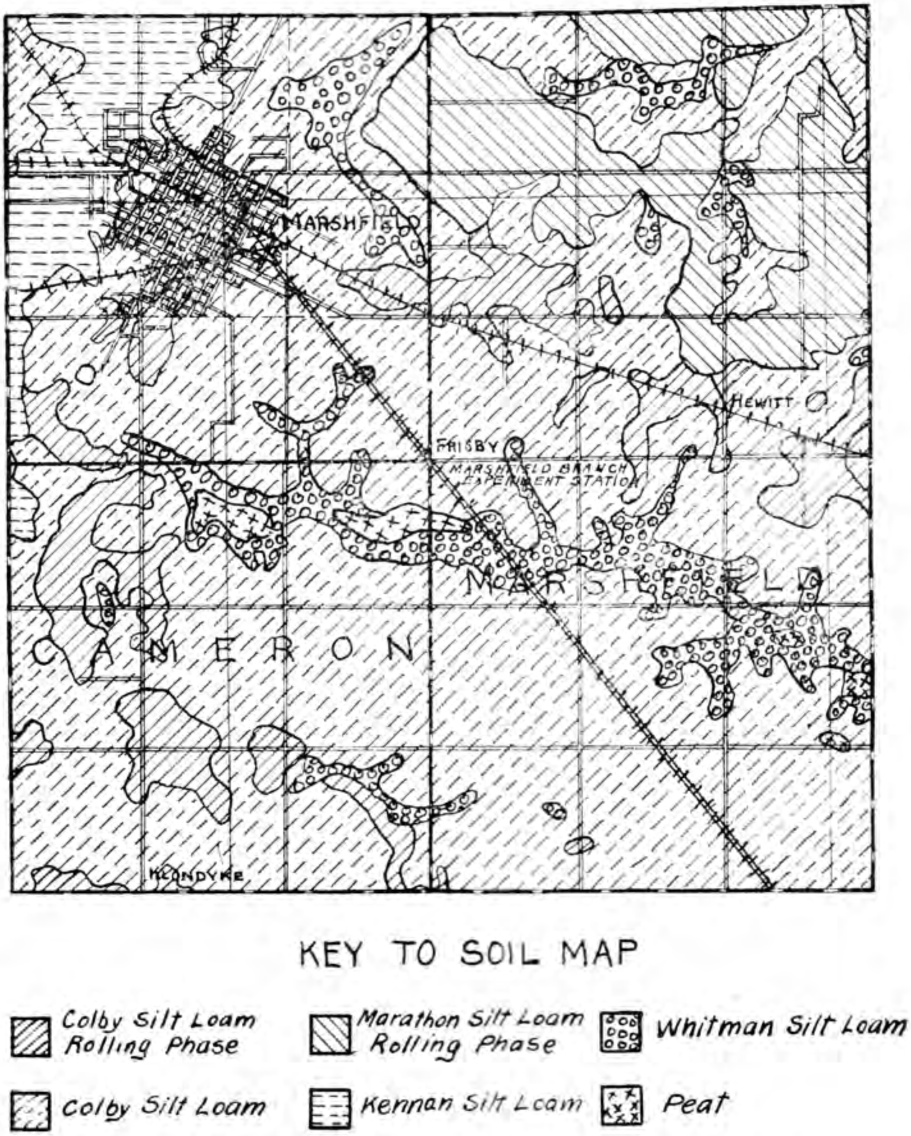

Fig. 17.—Detailed map, on the scale of three-fourths inch to the mile, of an area of Colby silt loam and associated types.

Topography and Drainage. As above stated the topography of the Colby silt loam areas varies from level to gently undulating with some portions moderately rolling. The slopes, however, are all smooth and there is practically no rough or broken land. Practically the entire area is capable of tillage. In the more detailed map of the south part of north central Wisconsin accompanying the report on the soils of that section, the topography of the Colby area is subdivided into a level phase and an undulating or rolling phase, the two portions being of about equal extent. The surface drainage of the rolling phase is good and that of the level phase is usually sufficient to remove all surface water, though it is occasionally necessary to dig small surface drains or to lay out plow lands so that dead furrows may aid in the removal of surface water.

Owing to the rather heavy character of the subsoil, the underdrainage, especially of the level phase, is sometimes inadequate for the best growing conditions of crops requiring thorough drainage. The texture of the soil is sufficiently fine to give it a large water holding capacity but it does not contain sufficient clay to cause it to check and crack during dry seasons as heavier soils do. The result is that the soil retains its rather compact structure and the water does not move through the subsoil with great freedom. Underdrainage by tiling is found desirable on the more level portions. Nevertheless the clearing of the country and the removal of old logs and underbrush on the wetter tracts is having a noticeable effect in improving the drainage of the more level portions of the areas to a marked extent. Moreover, some of these level areas are found to have seams of sand in their subsoils which improve underdrainage so that single lines of tile or open ditches are sufficient to give satisfactory drainage for strips of considerable width which were originally quite wet. The portion of Colby silt loam, therefore, which will require tile drainage to make it tillable is relatively small and in many cases these portions may be used without drainage as pasture land to excellent advantage.

The influence of tile drainage on the level phase of this soil, which was originally quite wet, is well shown in the experience on a portion of the substation farm at Marshfield. On this field, lines of lateral tile four rods apart were laid to an average depth of two and one-half feet, discharging into a main tile at one side of the field. This field was then laid out in a rotation of tilled crops, barley, and alfalfa, the crops running across the lines of tile. These crops were harvested in strips one rod in width running along the tile in such a way as to determine the influence of drainage on them. The results are given in the following table.

Distance of plot from tile	Corn 3 yr. ave.	Barley 4 year ave.	Potatoes 6 year ave.	Alfalfa 1st year 4 yr. ave.	Alfalfa 2nd year 3 yr. ave.
Rods	Bushels	Bushels	Bushels	Pounds	Pounds
4	51.22	28.26	154.11	3,243	3,087
3	57.21	29.02	162.79	3,387	3,046
2	57.22	29.89	172.44	3,587	3,297
1	58.66	30.15	192.88	3,818	3,327

It is evident that the benefit is especially large on the tilled crops, corn and potatoes, but it was also pronounced on the alfalfa. The influence of this tiling was more marked in the earlier years of the experiment and is now becoming less as the result of the ditching of the somewhat marshy strip on which the tiled portion bordered.

Chemical Composition and Fertility. The chemical composition as indicated by complete analysis shows this soil to have approximately the same composition as other silt loam soils of the state in general. The average composition of the surface soil is as follows: Nitrogen .2%, phosphorus .072%, potassium 1.5%, calcium .6%, magnesium .56%. The reaction varies from moderately to strongly acid and the average amount of lime carbonate or limestone required to entirely neutralize the acidity to a depth of 8 inches varies from four to six tons per acre.

In spite of this rather high degree of acidity there is sufficient available lime to meet the requirements of practically all crops, at least for a considerable number of years after the land is brought under cultivation. Heavy crops of red clover and other hay, as well as grain are grown without liming for a number of years. The available lime, however, is gradually being reduced and higher yields are possible through the addition of ground limestone or other form of lime. This benefit of liming is especially marked on alfalfa, sweet clover, sugar beets, and barley, but is noticeable on other crops, especially on land which has been farmed thirty to forty years.

The supply of phosphorus and potash in this soil is as large as that of the Miami, Knox, and other silt loams of the southern part of the state. The necessity for supplying additional amounts of these elements in the form of commercial fertilizers depends largely on the system of farming being followed. In the case of dairy or other livestock systems of farming, unless considerable concentrates, especially bran and oil meal which are high in phosphorus, are used, moderate amounts of phosphate fertilizers will be found profitable, as on practically all other soils. When the manure on such farms is carefully handled so as to absorb practically all of the urine, and leaching is prevented, it will maintain the supply of available potash. When crops are sold directly from the farm rather than fed, this will cause an additional drain on the supply of these elements in available form and commercial fertilizers should be used to compensate for this drain. In this case it should be remembered that the phosphorus goes largely to the seed of the plant so that it is removed when grain or other seed is sold, while the potash goes largely to the leaves and stalk of the plant and is sold from the farm only when root crops, hay, straw, and other roughage are sold.

The supply of organic matter and nitrogen in the Colby silt loam averages well with that in most other silt loams of the state, but is not large. Under dairying or other form of livestock farming, the growth of sufficient legumes to meet requirements for feed will lead to an increase in the total nitrogen in the soil of the farm, providing not less than one-fourth of the cultivated land on the farm is in clover, alfalfa, or other legume.

Climate of Colby Area. The area of Colby soils, lying as it does in the central northern portion of the state, has a climate representing nearly the average of the state as a whole. The general altitude varies from about 1000 feet in the southern portion of the area to about 1400 feet in the northern portion. This variation in altitude, together with the latitude, causes a general shortening of the growing period from the south toward the north. The average frost free period varies from about 125 days in the southern portion to 110 days in the northern part. The average date of the last killing frost varies from May 20th in the southern part to June 1st in the northern part; and the average date of the first killing frost in the fall varies from September 15th in the southern, to September 1st in the northern part. There is, however, some local variation due to topography. Air drainage, resulting from the night cooling of air in contact with the soil, produces a tendency to light frosts on low level areas to which the cold air from higher surrounding land flows. Lack of sufficient soil drainage on these lower tracts, causing them to remain cooler, further increases the tendency to frosts which will disappear as these lower lands are more fully cleared and drained. The result of the air drainage is that the higher and more rolling portions of the area are less subject to frost and are therefore somewhat better adapted to corn than the low level portions are.

While the frost free period or that available for the growing of corn, potatoes, and other tender crops is rather short producing an element of risk in the growing of such crops, nevertheless this risk is not sufficient to prevent these crops from being considered staple crops of the region. While corn frequently fails to mature as hard grain it seldom fails to reach a good silage stage, and the longer daylight of this northerly region permits it to make very rapid growth when the soil is sufficiently fertile.

While the frost free period available for the growing of tender crops is comparatively short, the period available for the growing of hardy crops including grasses, hay, and pasture, small grains and others is very much longer. The pasture season usually extends from early in May until the middle or latter part of October.

The annual rainfall of this region averages about 31 inches. Its distribution by months at the Marshfield Station for the nine years from 1913 to 1921 inclusive is as follows: January 1.40, February .86, March 1.65, April 2.71, May 4.25, June 4.79, July 3.76, August 3.58, September 2.83, October 2.70, November 2.11, and December 1.21. It will be seen that 12.7 inches, or practically 40% of the annual rainfall comes during the three months, May, June and July. This gives ample water supply even for crops needing large amounts, such as corn and hay. While the rainfall is less in the fall months it is usually sufficient, in connection with the good water holding capacity of the soil, to maintain pastures which are properly fertilized. The occurrence of drought periods during the fall, to which the states farther south are so subject and which not uncommonly occur even in the southern portion of Wisconsin, are quite rare in the northern half of the state, and pasturage during that season is therefore much more reliable. Since snow usually remains throughout the winter and accumulates, it gives excellent portection to grass and hay crops to which this region is especially adapted. The winters, as in all sections of this latitude, are long, making a long feeding period which is essentially the only drawback with which this region has to contend.

Crop Adaptation. The fine texture of this soil makes it especially well adapted to the grasses to be used either as hay or pasture and to small grains, but the tilth of the soil is so good generally that corn, clover, and peas grow exceptionally well. With the use of moderate amounts of lime, alfalfa and sweet clover also do well on all but the lowest and most poorly drained portions. While heavy yields of potatoes and root crops can also be produced on this soil, they are somewhat harder to harvest during wet seasons and it is not so well adapted to the growing of such crops on a market scale as are somewhat lighter soils. Peas have proven especially well adapted to this soil and the fact that practically all land of this type is tillable, so that the farmer is not obliged to use a larger portion of the farm for pasture than he desires, permits him to grow this or other cash crops when profitable and he is suitably situated with regard to markets. Under these conditions peas appear to be one of the best special crops for this soil.

System of Farming. Dairying has developed into the chief line of agriculture on this type. Excellent pasturage and hay crops, together with the fact that corn, at least to silage stage, is dependable, have made this region one of the chief dairy sections of the state. Moreover, the fact that excellent pasturage can be secured on new land by the removal of underbrush, and seeding without the removal of stumps, is an additional factor which has encouraged dairying. It should be remembered, however, that the feeding off of pastures removes the elements of fertility just as the removal of crops from cultivated land does, and that the maintenance of good pasturage requires the use of fertilizers. Moderate applications of lime and phosphate are very beneficial on old pastures. The fact that practically all the land of this type is capable of tillage makes it possible to introduce cash crops adapted to the soil to excellent advantage as side lines in dairying. The raising of peas and other crops for canning purposes and of grains for seed are important lines to which this soil is well adapted.

The Marshfield Experiment Station is located on a typical tract of the level phase of the Colby silt loam. The land had been farmed between fifteen and twenty years before the Station was stablished in 1913.

On this Station experiment fields have been maintained in a series of plots on which a four-year rotation of corn, barley, oats and clover were grown. Trials have been made with different fertilizer treatments. The plots which have received no manure or other treatment since the Experiment Station was established, though they had received some irregular manure treatment before that time, have produced average yields of 38½ bushels of corn, 15½ bushels of barley, 54½ bushels of oats, and 2,475 pounds of clover. With manure only, at the rate of 10 tons to the acre for each rotation and applied to the corn, the yields of corn have been about 54 bushels; of oats, about 56 bushels; and of clover, 4,800 pounds. Phosphate in addition to manure has increased the yields of corn about 2½ bushels, of barley 4 bushels, of oats 1½ bushels and of clover 400 pounds, and lime alone in addition to manure has produced about the same increases.

The gains from liming increased somewhat during the last few years and it would appear that in time liming will be distinctly beneficial on this land for a rotation of staple crops including clover. Nevertheless, it is evident that the supply of lime is satisfactory so far as the major crops to which this region is adapted at present. The benefit to alfalfa and sweet clover is, of course, more marked and on barley it is also pronounced. The manure used on this land comes from a herd of cows receiving more than the average amount of concentrates and is probably above the average in quality. While the increases from the use of phosphate under these conditions have not been large, they have shown a profit above cost of the treatment and it is entirely probable that the general use of moderate amounts of phosphate fertilizers supplementing the manure will be found profitable even on the dairy farms of this region and will show a still greater profit on cash crops. Treatments of potash fertilizers show little or no gain, when used in addition to manure, for small grains, corn, or clover. The same is true of gypsum.

Woodland. As already stated, the region of the Colby soils was originally heavily wooded. A large part of the merchantable timber has been removed but there still remains a very considerable area of good firewood and some tracts which with

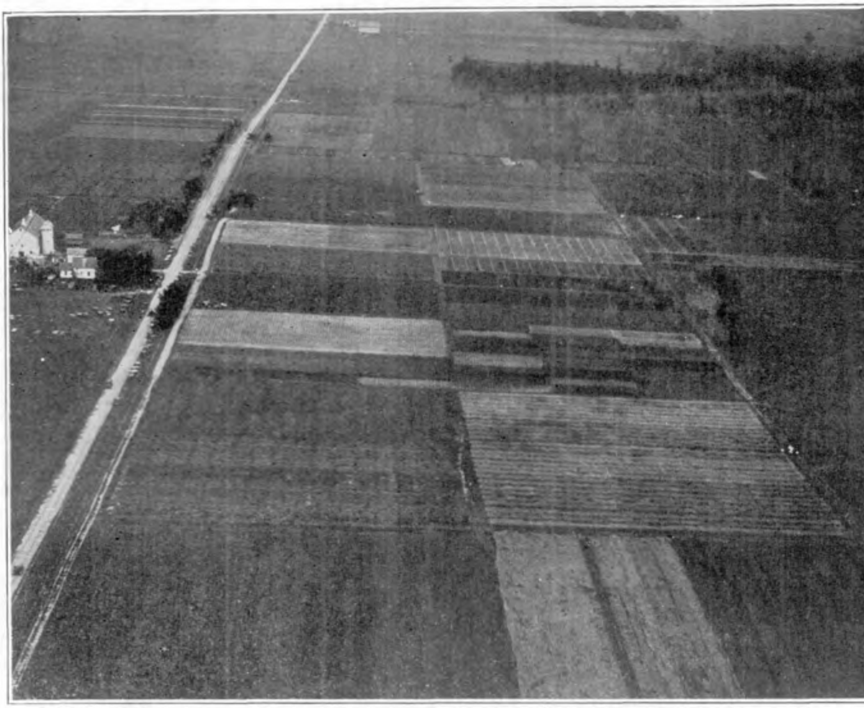

Plate XXVII. View of Experiment Farm at Marshfield on Colby silt loam, taken from airplane.

proper management would produce timber. Since practically all the area of these soils is susceptible of high agricultural development, the use of much of it for strictly forestry purposes does not seem warranted. On the other hand the value of the remaining hardwood as fuel, windbreaks, and for minor local timber use is such as to repay any care which may be given to its management. The fencing out of stock from such tracts protects the young trees and permits the development of the loose surface mulch which is so beneficial to the growth of tree vegetation. Such care of tracts having a fair stand until the time when they are needed for full agricultural development will be well repaid. This, of course, does not refer to the development as pasture of stump land previously discussed.

Marathon Soils. Included with the Colby soils on this general map are some areas which in the detailed map of the South Part of North Central Wisconsin were classified in the Marathon series. The more important of these is a narrow belt of Marathon silt loam along the eastern side of the area shown as Colby soils in central Marathon county. The surface soil of this type is essentially the same as the typical Colby silt loam, but the subsoil has more gravel from disintegrated granite from which it was derived by weathering. This strip, therefore, has somewhat better underdrainage than the typical Colby soils have. In other respects, however, it is essentially the same as the Colby silt loam. There are also some small areas of Marathon fine sandy loam.

Whitman Silt Loam. Along the borders of streams and marshes through this region of Colby silt loam there are strips of Whitman silt loam from a few rods to 30 or 40 rods in width, and a few wider areas occur. This soil is of alluvial origin and is dark gray or black in color containing relatively large amounts of organic matter. The subsoil is a heavy silt loam grading down gradually into a silty clay loam or clay loam which is usually mottled. This subsoil is quite compact and extends to a depth of over three feet. Occasionally stratified sand is found in the lower subsoil.

This soil, on account of its relation to streams and level surfaces, as well as on account of its texture, has poor drainage. When cleared it is chiefly used as pasture and for the cutting of wild hay. A considerable portion of it, however, is sufficiently high above the normal level of streams and borders to permit the installation of tile drainage which will greatly improve its agricultural possibilities. Even though such land is used for the raising of hay or as pasture, tile drainage together with proper fertilization, probably including the use of lime, will very greatly improve the yields and also the quality of grass which may be grown.

Peat. While there is relatively little peat in the area of Colby silt loam there are a few marshes of this character. These are shown on the more detailed map accompanying the Reconnoissance Soil Survey of the Southern part of North Central Wisconsin. The peat of this section is similar, in general, to that of the central part of the state, described on page 119. However, it appears to be of a somewhat more acid character and it responds to lime and phosphate in addition to potash to a greater extent than do the marshes of the central portion of the state. Moreover, the peat marshes of the Colby region have in general a silt or clay subsoil rather than one of sand and this fact must be taken into consideration in their drainage. Very little development of peat marshes of this section has yet been undertaken, but when conditions warrant their improvement they will undoubtedly be found to have the same special requirements and crop adaptations discussed in the description of peat lands in the central part of the state, see pages 119 to 130.

Rough Land. As shown on the map, there is a belt of rough land from three to six miles in width and about 40 miles long extending from the northeast part of Chippewa county north eastward through Taylor county into southeastern Price county. This belt of rough land is a part of the moraine of the last glacial ice sheet. It is a belt of rough, hilly country with small, deep potholes. The material is largely a fine sandy loam with a considerable amount of cobbles and larger stone. While a small portion of it is sufficiently level to permit tillage and a few farms have been developed on it, this tract as a whole is too rough and choppy to develop into good agricultural land and it would seem better that the larger portion of it be used for forestry purposes. This use is discussed on page 31. There are a few other similar areas of rough land included in the general area of Colby silt loams but they are too small to show on a map of this scale.

CHAPTER X

KENNAN LOAMS

The soils which are shown on the map as the Kennan loams in a gray color are the most important soils in the northern part of the state, covering approximately 11,000 square miles or 1/5 of the total area of Wisconsin. These soils for the most part lie over granitic or basaltic rocks and were formed from them by glaciation of the original weathered soils. In some areas, however, these soils overlie sandstone rocks on to which they were carried by the ice.

These soils show considerable variation in texture including fine sandy loam, loams, and silt loams. They also vary considerably in topography and stoniness. No detailed maps have yet been made in this region but the most important variations were shown in the maps and reports on the soils of north northwestern, northeastern, and north north-central Wisconsin, published as Soil Survey Bulletins 32, 47, and 50 respectively.

In the northwestern portion of the area the soils here included in the Kennan loams were to a considerable extent mapped as the Mellen fine sandy loam and loam. These soils occur in the separated, triangular area in Douglas county and forming a belt across Bayfield, Ashland and Iron counties constitute the northern part of the main area of Kennan loams on the soil map of the state.

The soil of these areas to a depth of 8 to 10 inches is a brown to reddish brown loam and fine sandy loam which in virgin condition contains a fair amount of organic matter to a depth of two or three inches. The subsoil grades into a lighter colored sandy loam at an average depth of 24 to 30 inches, below which it becomes heavier. Stoniness is quite common over most of this soil type but is very irregularly distributed and most tracts of 80 acres have considerable portions sufficiently free from stones to permit easy clearing and breaking.

The topography of these areas is undulating or gently rolling and there are frequently small marshy strips along the shallow streams and some broad peat marshes.

A portion of these soils in Washburn county is more rolling and rougher in topography than those above described and in this section include small tracts of a sandy loam texture.

South of these sections and forming the large area in Polk and southern Washburn, most of Sawyer and the southern portion of Ashland counties, the soils in general are somewhat heavier in texture and are, for the most part, silt loam. The topography of this section is undulating or gently rolling in character with some areas of marsh land and with marshes along the streams. The soil is, in general, of a light brown color and has a moderate amount of organic matter. The subsoil to a depth of 18 to 24 inches is yellowish or light buff in color and of a silty or clay loam texture. It is frequently mottled with iron stains, especially on more level areas where the under drainage is somewhat deficient. Below 24 inches the subsoil is frequently of reddish color and to some extent is of a heavier character so that it is sometimes spoken of as a hardpan, though only on a very small fraction of the area does it interfere with the drainage. At greater depths the soil is of a reddish color and includes loose sand and gravel extending down to the underlying rocks which are reached at variable depths.

In the northeastern portion of the state where the Kennan loams form a broad belt extending from Waupaca county to the Michigan line there is also some variation in the texture of the soil and in the lay of the land or topography. The western portion of this eastern belt through Shawano, Langlade, and Forest counties is more rolling in character, including some long, high ridges, which, however, have smooth slopes so that they are largely capable of agricultural development, though on a few areas the soil over the underlying rocks is comparatively thin and so stony as to render them non-agricultural in character. The silt loam soil on these slopes is thinner near the tops and increases in thickness toward the bottom, usually being three feet or more in depth on the lower slopes and in the valleys. On the lower hills with broader tops, the soil is generally quite deep.

Along the eastern side of this belt, including considerable tracts in Marinette, Oconto and Shawano counties, the soil, in general, is somewhat lighter in texture, being for the most part a fine sandy loam. In this section, also, the topography varies considerably, being in part undulating or gently rolling with narrow marsh areas along the streams, while in other sections, especially in Marinette county, there are higher and more broken

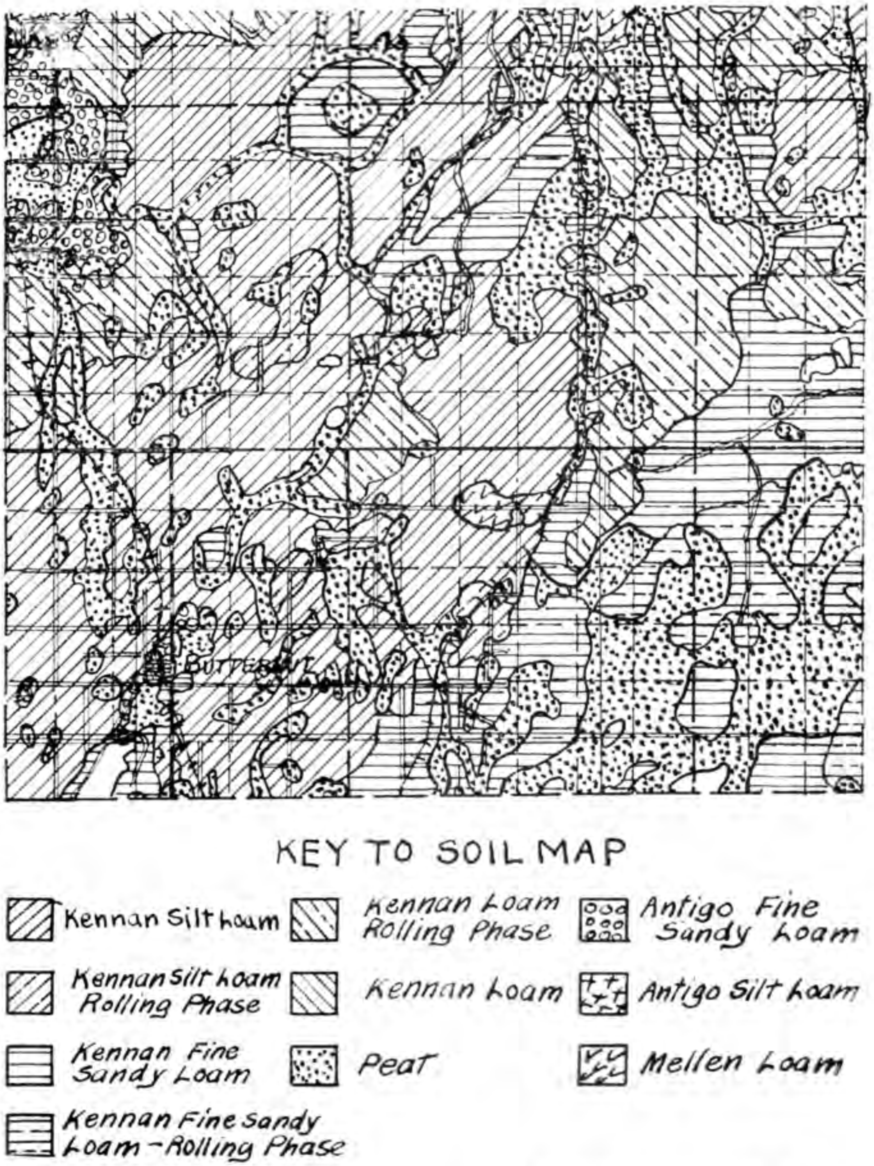

Fig. 18.—Map of an area in Ashland County showing interrelation of soil types in an average area of the Kennan soil region.

ridges of granitic rock which frequently have comparatively thin surface soils.

Throughout the area of Kennan soils, above described, the drainage of the uplands is almost universally good. There is sufficient slope to give good surface drainage and the subsoil contains sufficient sand and gravel in the deeper portions to produce good under drainage. The marsh lands, of course, will require drainage by open ditches or tile to permit their use for cultivated crops, though some of them are sufficiently dry to permit the cutting of wild hay during the drier portions of the summer. The peat soils are discussed on page 163.

The accompanying map of a township in southern Ashland county will serve to show the local variation in these soils.

Crops Adapted to Kennan Soils. The Kennan loams, being of an intermediate texture are adapted to a wide range of crops. They are sufficiently heavy to carry good grass as pasture or meadow, as well as small grains, and still they are for the most part not too heavy for satisfactory use for the growing of potatoes or other special crops for which heavy soils are not well adapted. While these soils in general are acid, they have a fair supply of available lime when first broken, and red clover and peas make excellent growth.

Fertility of Kennan Soil. The texture of these soils as above stated is adapted to a wide range of crops. The chemical composition of the Kennan loams, in general, compares favorably with that of other soils of similar texture throughout the state and country as a whole.

The average per cent of total content of plant food elements in the surface soils of the Kennan loams is as follows: total nitrogen, .15; total phosphorus, .56; total potash, 1.73; total calcium, .57 and in the subsoil; total nitrogen, .05; total phosphorus, .45; total potash, 1.7 total calcium, .60. The average content of calcium carbonate in the surface soil is .18 and in the subsoil, .06. The average content of organic matter in the surface soil is 3.4 and in the subsoil 1.2. Being formed from granitic rocks they do not have much lime carbonate but do have a good amount of calcium or lime in other forms. While they all are moderately acid, they furnish enough lime for good crops even of clover for several years after being broken, though additional lime should be used for alfalfa or for sweet clover which need larger amounts of that element than other staple crops require. In time varying from ten to twenty-five years after being first

Plate XXVIII. Kennan silt loam in Forest County.

broken, the available lime of these soils will be reduced to a point at which the addition of ground limestone or some other form of lime will doubtless prove profitable for clover and even for other crops. This has been the experience in sections of New York and the New England states where soils of similar character occur and have been cropped for a long period.

The content of organic matter in these soils is not very high since the whole region was originally forested and under these conditions only a limited amount of organic matter accumulates in well drained soils. The use of stable manure or of green manuring crops, principally legumes, will be found necessary to maintain a sufficiently large amount of organic matter to give these soils the highest fertility of which they are capable. The phosphorus content of the Kennan soils averages well with other soils of similar texture in this and other states, but, as is almost universally the case, the use of some form of phosphate fertilizer will be found necessary to keep the fertility at a high state. The use of phosphate is particularly desirable in this section of the state because of its effect in hastening the maturity of the crop which, especially in the case of corn, is very desirable on account of the shortness of the growing season of this region.

The practice necessary to maintain and increase fertility will, of course, vary somewhat with the system of farming followed. On the dairy or stock farm the growth of clover and other legumes needed as hay will maintain the nitrogen supply of the farm. For this growth moderate amounts of lime are needed when the land has been under cultivation from 15 to 20 years following its original clearing. Moderate amounts of phosphate should be used to replace the phosphorus sold in dairy products and the bones of animals. Proper care of the manure should maintain a good condition with reference to nitrogen and potassium.

On the other hand, when any considerable amounts of special crops such as potatoes are sold, more attention must be paid to replacing the plant food lost. Under these conditions fertilizers containing phosphate, potassium, and in some cases even nitrogen will be needed and it must be borne in mind that the large yields which may be secured when fertility is kept at a high stage through the use of fertilizers are the yields which produce a profit to the grower.

Climate. Climatic conditions throughout this region are favorable to the growth of most of the staple crops. The rainfall is well distributed, especially during the summer and early fall months and the soils are sufficiently retentive of moisture to permit its use for growing crops. Temperature conditions show considerable variation. Portions of this region of Kennan loams have a high altitude which lowers the temperature during the growing months somewhat. This is especially true in portions of Douglas, Ashland, and particularly on the higher ridges of Forest and Langlade counties. In these sections the altitudes of 1,500 to 1,600 feet are reached and at this elevation the temperatures are frequently not satisfactory for the growth of corn although it is quite suitable for small grain, potatoes and other crops. It is also true that air drainage from the higher regions may collect in hollows on the lower slopes and in the poorly drained areas to such an extent as to produce light summer frosts constituting some danger to corn on such areas. The amount of such land, however, is comparatively small and the earlier varieties of corn are generally grown and in only rare years fail to reach at least a good silage stage. The length of the growing period for tender crops is shown in the map on page 18, and the average rainfall is given in the table on page 23.

It will be seen from the map showing the length of the growing period and from the table giving rainfall, that climatic conditions of this region are generally very favorable to the grasses both for pasture and hay, to the small grains, and to such special crops as potatoes and the hardy root crops. Moreover, the clearing off of the forest cover of this region is improving air drainage and lessening the occurrence of the light summer frosts above mentioned.

Not only are the temperature and rainfall conditions of this section favorable to many crops, but the greater duration of light in this northern section in comparison with more southerly locations has an importance influence. The greater length of day in this latitude encourages more rapid growth which to some extent makes up for the shorter growing period.

Agricultural Possibilities of the Kennan Loams. The Kennan loam soils, up to the present, have been cleared and developed for agricultural uses only to a limited extent and while they offer many attractions in respect to fertility and climatic conditions, they also present some difficulties so that there is some difference of opinion as to the wisdom of encouraging further agricultural development in this region in the near future.

Plate XXIX. Farm on Kennan loam showing use of stump land as pasture.

There are two chief difficulties which the agricultural development of the Kennan soils encounters,—stumps and stones. The soils of this region were originally entirely forested. These forests included the white and Norway pines, hemlock, birch, maple, basswood and others. The relative amount of pine and hardwoods varied in these sections. In many tracts, especially in the northeastern sections of the state, hemlock predominated while in the northwestern sections on these soils white and Norway pine constituted practically half of the tree growth, the balance being largely made up of birch and maple with small amounts of basswood, oak and other trees. The stumps left on the removal of this timber must, of course, be removed before the land can be brought under cultivation. The hardwood stumps rot out in the course of five to ten years so that they can be readily removed but the pine stumps do not rot to any considerable extent even in a long period of time and must be removed by blasting or by the use of a stump pulling machine. The expense of clearing the land of stumps and rotted down timber varies, of course, depending on the size and number of stumps per acre. The cost, under present conditions, of removing stumps by explosives varies from 20 to 40 dollars per acre. It should be borne in mind, however, that in the usual process of developing a farm the settler does not undertake to remove the stumps from the whole tract at once but selects those areas where they are less abundant and most easily removed first and then adds to the size of the fields gradually as time and means permit. He is thus able to utilize in clearing time which is not otherwise demanded in his farming operations. The actual money cost of the land clearing is, therefore, much lower than would be involved in a process of entirely clearing the land at once. Moreover, a very considerable use of stump land as pasturage is possible. When a farm is one-third to one-half cleared of stumps, the remaining portion can be used as pasture thus making the farm practically as productive as though it were all cleared.

Stones. While the Kennan loams were as above stated formed from granitic rocks and are characterized by more or less stoniness throughout, they vary greatly in the degree of stoniness. Many tracts of forty acres or over are almost entirely free from stones, others have an amount of stones which can be cleared without excessive cost or labor while others are so stony as to make their clearing impracticable under present conditions. The stone varies in size from cobbles to bowlders measuring as great as 12 to 15 feet in diameter. Since the stones are largely imbedded in the soil and frequently nearly covered with the leaves and vegetable mold of the forest they are not readily seen and the full extent of stoniness is not definitely known until actual clearing is undertaken. On account of this difficulty in determining the stoniness and also on account of its great variation within short distances it was not practicable to map the stoniness in the general surveys of the soils of this section of the state on which this report is based. A more careful examination of the amount of stoniness was made by Mr. Dunnewald in the examination of certain portions under the State Soils Laboratory. He reports that out of 116 forties so examined in Rusk county 60 forties contained an amount of stone estimated at 10 to 15 loads per acre which he called moderately stony. Five forties were classed as very stony, estimated to contain 15 to 20 or more loads per acre and the balance or 51 forties had relatively small amounts of stone. In an examination of 16,054 forties, mainly in Price county, Mr. Dunnewald found that 560 forties or 34% were moderately stony or were very stony in spots while 111 forties or 19% were so stony as to be practically untillable, leaving 47% of the forties on which stones were relatively few in number. This section however is more stony than the average of the Kennan loam area as a whole. Mr. Dunnewald estimates from the experience of several years' work in field mapping of these soils that of the Kennan loam 30% should be classified as moderately stony, that is having from 5 to 15 wagon loads of stones per acre, and 12% as very stony, that is having from 15 to 20, or more, loads of stones per acre, leaving 58% of the land which, in his judgment, has an amount of stoniness which would not seriously interfere in its development for agricultural purposes.

As in the case of stumps, stones may not be a serious drawback when they occur in tracts which can be used as pasture while other tracts relatively free from stone are cleared for crops and the farm may as a whole be profitable. This is undoubtedly the case in much the larger part of the Kennan loam area. Attention is called again to the fact that the larger areas of very stony or rough ground are mapped as such and are not included in Kennan loams. A detailed survey of the soils of the northern half of the state, and especially of the Kennan loam area, should be made to determine just what tracts are practica-

Plate XXX. Typical view of rough, stony land in the area of Kennan loams.

ble as farms and what should be devoted to forestry purposes. This matter is discussed further on page 31.

Antigo Soils. While the Kennan soils, as above described, and which were left in their present condition by the ice itself, constitute the larger portion of the soils of this area, there are some level alluvial areas. These were formed as sediments deposited in bodies of water resulting from the melting of the glacial ice and are classified in the Antigo series. They occur in small areas distributed over the sections mapped as Kennan silt loam. The two most important areas of this type of soil occur in Polk county in the vicinity of Milltown, and in Langlade county to the west and north of the city of Antigo. These soils vary some in texture, including loams and silt loams. The soil and subsoil are of fine texture and extend from two to three and one-half feet, and are there underlaid by stratified sand and gravel. This layer of sand and gravel has the effect of giving these soils good underdrainage except on small areas having heavy subsoil, while the nearly level surface and almost entire freedom from stones of the surface soil make them especially well adapted to crops requiring the use of special machinery. They are therefore extensively used for the growing of potatoes along with other staple farm crops. These areas were originally heavily wooded and the surface soil has about the same amount of organic matter and the same general chemical composition as that of the Kennan soils. In fact the material of the Antigo soils is the same as that of the Kennan soils, having being merely washed down and re-deposited in their formation. The general management for the maintenance of fertility, therefore, is practically the same as that required in the case of the Kennan soil.

Marsh Soils. There are considerable areas of marsh lands in the sections in which the Kennan loams constitute the predominating soils. Some of the larger areas of these marsh lands are indicated on the map, but besides these there are large numbers of small marsh areas which could not be shown on this general map.

The marsh soils include peat and muck, the former being much greater in extent. The peat varies in depth from one or two feet in most shallow marshes to 15 or 20 feet in the deeper ones, but depths of from three to five feet are most common. The peat also varies somewhat in its physical character. In some sections where the marshes are quite wet the surface is largely covered with moss and the upper layers, at least, of the peat are brown and fibrous in character. In other marshes which are not so wet the surface vegetation is more largely made up of cresses and sedges and the peat has undergone more decomposition, becoming firmer and blacker in color. While the larger portion of these marshes is moss covered, many marshes are overgrown with trees capable of growing on poorly drained land, including tamarack, spruce, alder and others.

The subsoil of most of the marshes of the Kennan area is similar to the upland in texture, that is, it is of silt loam or loam character, but in some cases layers of sand or even gravel are encountered in the subsoil underlying the peat. The drainage possibilities of these marshes depend in part on the character of the subsoil and in part on the relation to streams which may serve as an outlet for open ditch or tile mains. While there are a considerable number of small bogs or marshes having no outlet and which cannot readily be drained, by far the larger area of the marshland region is physically capable of drainage when conditions warrant it. The wooded marshes will, of course, be very much more expensive to reclaim, and reclamation will naturally begin with those marshes which are already of a drier character and have an open grass vegetation with firmer peat.

In considering the agricultural possibilities of these marsh soils the temperature conditions must be taken into account. The organic character and the open structure of the peat soils prevents them from conducting heat, received at the surface from the sun, downward into the body of the soil as rapidly as in the case of upland soils. The result is that peat soils, while they may warm up quickly on the surface under sunshine, cool off very quickly at night and this, together with the drainage of cold air onto them from surrounding uplands, renders them more liable to frost. This fact, together with the higher altitude in this region and the more northerly latitude, makes these marshes unsuited for tender crops. Nevertheless, potatoes have been grown on some of these marshes successfully, and when drainage is good and the peat has been firmed somewhat by tillage and the use of a heavy roller, the danger from frost will be somewhat lessened. Still these lands are best adapted to frost resisting crops such as grass for hay and the hardy root crops.

The peat soils of this section are quite acid and not very well supplied with lime, and as is generally the case, they are low in potash and frequently also deficient in phosphorus. The use of lime and fertilizers containing these elements will therefore be necessary to permit them to produce the large crops of which their moisture holding capacity makes them capable. Unleached wood ashes, which are quite frequently available in this region, furnish an excellent source of lime and potash, and when used at the rate of one to two tons per acre give good results. Stable manure also contains considerable potash but should be used on upland soils as a rule rather than on marsh lands.

As an illustration of the agricultural possibilities and character of the peat of this section are the results on a marsh two miles south of Phillips, belonging to Mr. DeWitt Van Ostrand. This field was originally a tamarack and spruce swamp and was cleared in 1903 and 1904. The soil was a very coarse peat overlaid by clay and covered with a dense mass of sphagnum moss. This moss was partially burned in the clearing, the land was plowed in the fall of 1904, and crops grown in 1905 and 1906. Trials were made by the writer of the effect of various fertilizer treatments. Alsike and timothy were seeded on a portion of this marsh in the spring of 1905 and in the spring of 1906 it was subdivided into plots for fertilizer tests and the fertilizer applied as a top dressing. The untreated yield was 2,727 pounds per acre. With 100 pounds of sulphate of potash and 275 pounds of 16% acid phosphate the yield was 4,848 pounds per acre. On another portion of this marsh which was cleared and broken in 1906, trials with lime at different rates, in addition to phosphate and potash fertilizers, were made in 1907 on barley. Unfortunately, however, the drainage was inadequate that year and the crop did not do well, but the growth was sufficient to demonstrate the need of lime as well as potash and phosphate for that crop.

While conditions at present do not seem to warrant the expense of drainage and reclamation of any considerable part of the marsh lands of this region, there are many cases where conditions for drainage are favorable and the expense of clearing would be relatively small. In this way the use of these lands for the production of hay and root crops in connection with dairy farming would prove profitable, and their use to a limited extent for the growing of truck crops would also be practicable.

CHAPTER XI

SUPERIOR RED CLAY AND CLAY LOAM AREA

The only heavy clay soils of Wisconsin are those included in the area shown on the map as Superior red clay and clay loam. These soils occur in two widely separated sections, first, that south of Lake Superior and, second, that in the vicinity of Green Bay and Lake Michigan, largely in the valley of the Fox River and along the shore of Lake Michigan.

Lake Superior Area. The area of red clay in the Lake Superior region can be again subdivided into two portions, first, that lying south of the western end of the Lake and second, that lying north of the Lake in the vicinity of Ashland. These two portions are separated by the high broad ridge of sandy soils forming the Bayfield peninsula. The clay soils of both sections were deposited in the water resulting from the melting of the ice from the glacier occupying the basin of Lake Superior during the retreat of the ice.

The western area forms a belt from 12 to 20 miles in width constituting, before it was eroded, a broad plain sloping toward the Lake from the highlands to the south. The upper border of this plain has an elevation of from 400 to 500 feet above the level of Lake Superior so that the average slope toward the Lake is approximately 30 feet to the mile, but the slope is greater toward the upper or southern edge and gets somewhat less toward the Lake.

Along the upper border of this section are areas of sand and sandy loam overlying the red clay subsoil. These constitute shore deposits made by the lake when it reached that level. The streams rising in the higher country to the south and flowing across this belt of red clay have cut sharp V-shaped valleys into it to a depth of 40 to 100 feet and lateral ravines cutting back into the plain have given the larger portion of it surface drainage though there are still considerable areas of quite level and poorly drained land lying between these ravines. On these level portions there are slight depressions in which organic matter has accumulated from a few inches to two or three feet in depth, but aside from these depressions there is relatively little organic matter in the surface soils. This region was originally heavily wooded and, in fact, still contains a considerable amount of timber. The timber included chiefly white and Norway pine, birch, and maple.

Fig. 19.—View in cut-over area of Superior clay, Douglas county.

The area of Superior clay near Ashland is more variable than that in the vicinity of Superior. South of the bay it is quite level and poorly drained. The lower portions of the land sloping up to the highlands are in part underlaid by seams and sand. The upper slopes and table-land above, however, are of typical Superior clay.

Texture. This soil is a heavy red clay extending many feet in depth with little change in the texture of the subsoil. The following table shows the mechanical analysis of the clay, from which it is seen that approximately 80% of it consists of true clay and silt, thus making it a very heavy soil.

MECHANICAL ANALYSIS OF SUPERIOR CLAY

Description	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt	Clay
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Typical Superior Clay:							
Soil	.3	1.8	2.0	6.4	7.3	38.8	43.4
Subsoil	.1	1.5	2.9	8.0	5.4	36.9	45.2
Modified Superior clay:							
Soil	.6	2.8	4.7	11.6	12.6	31.3	36.4
Subsoil	.9	3.9	6.0	13.9	14.2	29.8	31.3

Soil of this texture holds a very large amount of water and when wet of course is difficult to cultivate. The more level areas will require underdrainage by tiling to fit them well for agricultural use but the sloping sides of the valleys and ravines give those portions good drainage. It is thought by many that the very heavy character of this soil will make it difficult or possibly impracticable to use tile for under drainage. There is one characteristic of this soil, however, which makes it entirely practicable to secure good results with tile drainage; that is the fact that the soil, when drying out checks and cracks deeply and considerable water from rains following such a dry period escapes through these checks and cracks into the subsoil and if tile drained will be removed entirely. Most of these checks and cracks which develop during dry periods continue to increase if the water moving down through them is removed by tile drainage, so that the tilth or workableness of the soil improves from year to year.

This fact was fully demonstrated by a system of tile installed by Professor E. R. Jones on the Douglas County Poor Farm in 1905. A portion of this farm had been so wet that it was very difficult to cut hay on it during the summer. It was drained in the fall by lines of tile placed at different distances apart. In one portion of the field the tiles were 40 and in another 60 and in another 80 feet apart. The next season a very marked improvement in drainage was observed and this improvement continued for several years. After two or three years the soil had acquired a good working condition and the water from a heavy shower was found discharging from the tile within half an hour after the rain began.

In the spring of 1906 following the installation of the tile the soil was still too wet to work and plant at the usual time but was planted to corn on the eleventh of June. The effect of drainage in drying up the soil so that it could become warm and could be fitted for the germination and growing of corn is shown in the following table.

GROWTH OF CORN ON TILED AND UNTILED LAND AT SUPERIOR, 1906

	Untiled land	Distance between laterals		
		80 feet	60 feet	40 feet
Average height of corn	4 feet	5 feet	5.6 feet	5.8 feet
Average stand	25 per cent	40 per cent	80 per cent	95 per cent

In the fall of 1906 a field of about six acres was tiled on a tract of Superior clay east of Ashland. This land had been in meadow for ten or twelve years and was in a relatively low state of fertility. The lateral lines were laid at distances of 70 feet apart at a depth varying from two to three and a half feet. The following spring this tract was laid out in a four year rotation consisting of: first, cultivated crops; second, small grain; third, clover and fourth, mixed clover and timothy. The yields during the following five years while this field was under observation showed increases due to drainage running from 25 to 75%. The relative increases will, of course, depend on the wetness and coldness of the season and the character of the crop.

The expense of tiling will, of course, depend to a considerable extent on the distance between laterals. Distances of the above tile indicate that placing tiles 50 feet apart will give excellent drainage in this red clay soil, but even a distance of 70 feet will produce very good results. Over much of the area of this soil only single lines of tile run through the depressions or sags in the field will be sufficient to make the field as a whole tillable.

Increasing the amount of organic matter in this soil by the use of stable manure and plowing under green crops, especially clover, will greatly aid in improvement of the tilth and working quality. Care must be taken not to plow or cultivate this soil when too wet as that will puddle it and lead to the formation of clods which will last two or three years.

Crop Adaptation. The heavy texture of these soils together with the rather low temperature which the large water content and the northern location give them makes these soils less well adapted to such crops as corn and potatoes. On the other hand, their large water holding capacity and good fertility, in most respects, makes them well adapted to grasses both for pasturage and hay and to the small grains, particularly barley, oats and wheat. Peas also do exceptionally well on this soil.

Since these heavy soils are especially adapted to grasses and to hay and small grain crops this section is developing chiefly in dairying. The principal difficulty in this system of farming in this section is with reference to corn which is less well adapted to this soil and climate than the other crops mentioned. Nevertheless corn to silage stage can be grown on the better drained portions or on land which is tile drained and its place may to some extent be taken by hardy root crops, especially rutabagas. The fact that this section is in the process of clearing so that pasturage can be secured on land before stumps are removed gives dairying or other form of livestock raising an advantage over any system of cash crop growing. In some portions of this soil area steep land along ravines will continue to be available chiefly for pasturage.

The fact that this soil is harder to plow and fit as a seedbed makes the growing of hay crops which may be kept on the land for several years especially desirable, and this fact together with this adaptation to pasture grasses further encourages the livestock industry. In many cases it would be advantageous to tile drain certain fields on the farm so as to better fit them for the growing of corn which might then be grown continuously for some years at a time while the other fields of the farm are kept in alfalfa or other hay and small grain, thus getting better results with corn and reducing the amount of land which must be plowed each year. On those farms on which land is largely tillable and has been entirely cleared, the growing of small grain, flax, peas, and other cash crops to which the soil is adapted may be followed profitably.

Climate of Superior Region. The climate of this region of clay soils in the vicinity of Lake Superior is modified to a considerable extent through the influence of the lake. This large body of water absorbs the heat of the sun during the summer so that the temperature over it does not rise as rapidly as over land areas and winds from the lake toward the land are cool, keeping the average temperature of the summer in that section somewhat lower than that of the inland portions of the state. On the other hand, this heat absorbed by the lake during the summer is given out during the fall months lessening somewhat the tendency to early fall frosts and prolonging the growing period for hardy crops, especially grasses. The advance of spring is

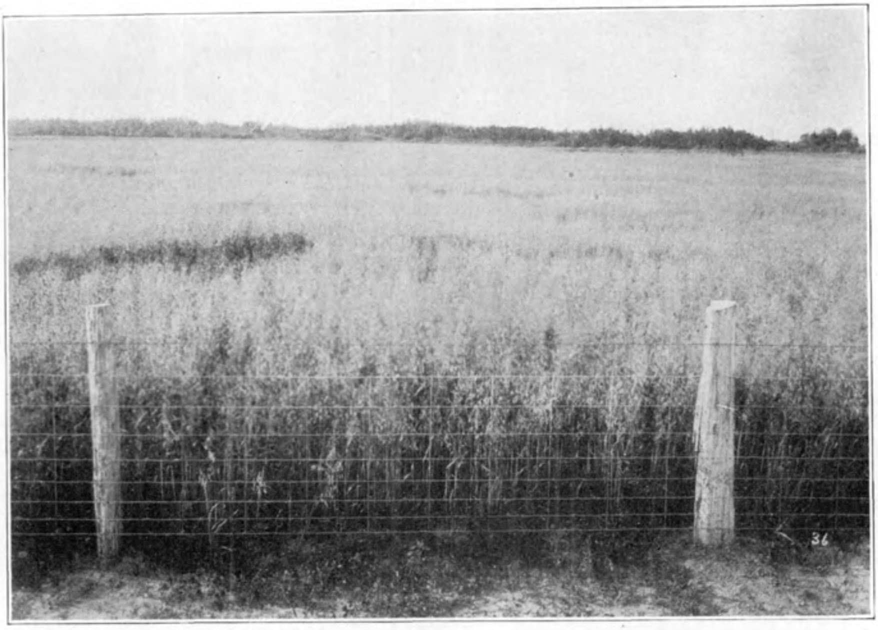

Plate XXXI. Field of oats on Superior clay. Douglas County.

retarded by the cold winds from the lake. The season, therefore, is shifted a little in comparison with that of the inland sections. The effect of this influence of the lake is to increase the length of frost free season in comparison with that of the regions 25 miles or so inland, but the lower average temperature of this frost free season neutralizes the increasing length so far as the growing of corn and other crops requiring warm weather is concerned.

The rainfall of this section is essentially the same as that of other northern portions of the state though the larger water holding capacity of the soil has the effect of making it seem greater.

Chemical Composition and Fertility. The average total content of plant food elements in the surface eight inches of the Superior clay of the northwestern part of the state, expressed as per cent is as follows: Nitrogen .101, Phosphorus, .042, Potassium 2.58. The average amount of organic matter in the surface eight inches is 2.11%, and in the subsoil .59%.

As is quite generally true of lake formed or lacustrine soils the Superior clay contains considerable lime as calcium carbonate. While it varies considerably from field to field the average amount of calcium carbonate found in the surface eight inches by analyses so far made is 2.04% and in the depth from 8 to 24 inches, 4.63%. While there is, therefore, a good supply of lime in the soils of most fields of this region even for crops of high lime requirement there are a considerable number of fields, especially on upper slopes of the more rolling portions, from which the lime carbonate has been removed by leaching to such an extent that liming will be beneficial for alfalfa or other crops of high lime requirement. The portion of this area which will need this treatment has not yet been definitely determined, and field trials with liming should be made when conditions indicate a possible need of lime.

The phosphorus content of this soil is rather low and unavailable and a large number of experiments in this section show that fields which have been cropped a number of years and on which yields have decreased considerably owe this decrease chiefly to the lack of sufficient available phosphorus and respond remarkably to treatments with phosphate fertilizers.

The relatively low total content of phosphorus in this soil together with its natural wetness and coldness makes the use of phosphate fertilizers on it of great importance. A number of trials on several fields indicate that very profitable returns in general can be expected from its use. The increases from its use varied from 3 to 4 per cent to as high as 20 per cent on corn, and on clover as high as 40 per cent while in the case of clover seed, the development of which requires a relatively high content of phosphorus in the soil, the increase in yield in some cases has been over 50 per cent.

The amount of organic matter and nitrogen is also in many cases rather low and a practice of plowing under some legume as green manuring crops should be followed unless considerable amounts of stable manure are available. This practice will improve the tilth as well as the fertility.

The potash content of this soil is very high as is quite generally the case with heavy clay soils. It is of course true that only a very small fraction of the total potash is available to plants at any one time, but the total amount in this case is so large that it will probably be able to meet the potash requirements of even those crops needing large amounts of that element. So far experimental work on this type has not shown need for application of potash in commercial fertilizer form. In all forms of livestock farming in which the larger portion of the crops grown are fed and the manure returned, the potash of these crops is recovered in the manure and so added in available form to the soil to be used over again.

RED CLAY LOAM OF THE GREEN BAY AND LAKE MICHIGAN REGION

The Superior clay loam of the eastern part of the state occupies a large area in the Fox River valley and Lake Winnebago region which was the center of the Green Bay lobe of glacial ice and also covers a considerable area bordering Lake Michigan extending from Milwaukee to Sturgeon Bay. In this region there is more variation in the texture of the soil than in the Lake Superior area. There are small areas of Superior clay and some Superior loam and fine sandy loam as well as of Poygan and other marsh soil types, but by far the larger portion of the area consists of Superior clay loam having a somewhat lighter texture than that of the Superior clay above described.

The topography of this region varies from nearly level or gently undulating to moderately rolling. It has been subdivided in the detailed surveys into a level and a rolling phase, the former amounting in all to probably not more than one-fourth

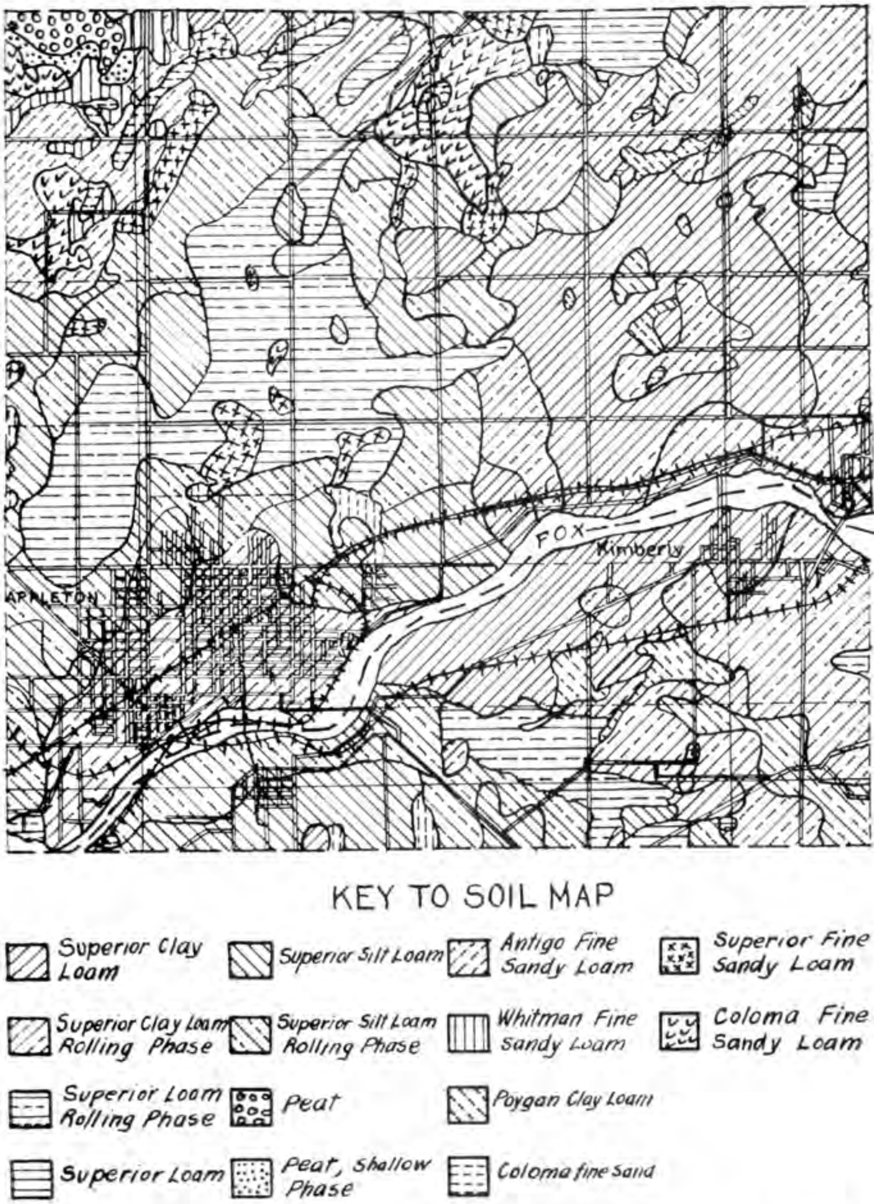

Fig. 20.—Detailed map, on the scale of three-fourths inch to the mile, of an area in the Fox River Valley showing the interrelation of Superior clay loam and associated soil types.

of the area, while the rolling phase constitutes about three-fourths of the area. On the level phase slight depressions or hollows are of rather common occurrence. The bottoms of these are usually not more than two to three feet below the general level and they can ordinarily be drained by single lines of tile. More organic matter has usually collected in these depressions than occurs on the remainder of the land.

Stoniness of the Superior clay loam is quite variable. On the level phase there are in general comparatively few stone and indeed the type as a whole could not be considered very stony. Nevertheless there are some areas in which bowlders and smaller stone are sufficiently abundant to interfere with clearing and cultivation.

Texture and Drainage. The texture of the Superior or red clay loam is shown by the mechanical analysis of average samples from Kewaunee county given in the following table.

MECHANICAL ANALYSES OF SUPERIOR CLAY LOAM

Description	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt	Clay
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Soil	0.8	3.0	4.6	12.2	9.0	41.5	29.2
Subsoil	.5	1.6	3.3	9.1	5.7	39.3	40.4

It will be seen that the texture is not so heavy as that of the Superior clay of the Lake Superior region, nevertheless it is sufficiently heavy to make it distinctly more difficult to work and to maintain in good tilth than in the case of silt loams and lighter soils. Care in plowing and other tillage operations is necessary to prevent puddling and to maintain good tilth. The incorporation of organic matter through the use of manure or plowing under of green manuring crops is very helpful in improving the tilth.

The surface slope of the larger portion of this type is sufficient to give good surface drainage and for the most part it is unnecessary to use tile for underdrainage. On more level areas tile drainage is frequently necessary to give sufficient underdrainage for tilled crops. A large amount of tile has already been installed on these level areas but there is still opportunity for considerable improvement of other areas not so well drained.

Climate and Crop Adaptation. This portion of the state being farther south and having in general a lower elevation than

Plate XXXII. Farm on Superior clay loam in Fond du Lac County

that of the red clay area of the Lake Superior region has a somewhat warmer climate. Moreover, the prevailing winds being from the west, the influence of Lake Michigan is less than that of Lake Superior. Sections twenty miles or more from the Lake have a climate similar to that of central and southern Wisconsin. Nearer the Lake the influence of the water is more or less marked. This, together with the heavy character of the soil makes this part of the region less well adapted to corn. The low altitude and the influence of the Lake tend to increase the length of the growing season as indicated on the map on page 18, but for corn which requires a relatively high temperature the longer growing season is somewhat neutralized.

The texture of the soil and climatic conditions on the whole are most favorable to the grasses for hay and pasture, small grains, and peas, the latter being the most important special crop of this section. These conditions make the region of this soil type on the whole better adapted to dairying and other forms of livestock raising than for the growing of special or market crops. Nevertheless certain special crops can be grown to advantage, particularly on the soils having good amounts of organic matter. This applies especially to cabbage, onions, and celery.

Chemical Composition and Fertility. The chemical composition of the Superior clay loam is very similar to that of the Superior clay already described, see page 171. Its relatively high lime content makes it especially well adapted to alfalfa, barley, and sweet clover. Since a larger portion of this soil type has been farmed for fifty to seventy-five years and the original supply of phosphorus in the soil was comparatively small, the use of phosphate fertilizers in this section is important. While on dairy farms on which a considerable amount of bran and oil meal are fed the necessity for additional phosphate is not marked, it is probable that on the very great majority of the farms of this region the use of phosphate will be found one of the most helpful means of increasing crop yields. Yields of small grains and especially of clover and alfalfa will be materially increased by the use of phosphate and the maturity of corn hastened from one to two weeks, an advantage which is of considerable importance in this region especially.

While, as above stated, this soil naturally contains considerable lime carbonate there are some patches or fields from which it has been so largely leached that the use of ground limestone will be found helpful, especially for alfalfa and sweet clover.

Superior Loam Soils. Scattered over this region of Superior soils are areas in which the surface soil is of a loam or fine sandy loam character overlying the heavier clay loam subsoil. The depth of this lighter surface soil varies from a few inches to as much as three feet. Such soils have been mapped in the detailed maps of counties in this section as Superior loam and fine sandy loam. Their lighter surface soil gives them better surface drainage so that they warm up more quickly in the spring than do the heavier soils, while the heavier subsoil gives them sufficient waterholding capacity to produce excellent crops. They are adapted to a wider range of crops than the heavier soils are, especially including corn and potatoes. Soils of this kind resemble in their agricultural character the Miami fine sandy loam and loam occurring extensively in the region west of Green Bay and described on page 93.

Poygan Clay and Clay Loam. There are tracts of considerable extent, especially west of Lake Winnebago, of poorly drained land, the surface soils of which are high in organic matter running commonly from 10 to 20% while the subsoil is the red clay or clay loam above described. These Poygan soils are similar in chemical composition and in agricultural characteristics to the Clyde soils described on page 83. They are apt to be deficient in available potash so that the use of potash fertilizers will undoubtedly be generally profitable unless stable manure is used. When the farm contains some of the upland Superior clay or clay loam as well as some Poygan soil the manure should be used on the uplands and the fertilizers especially high in potash should be used on the Poygan soils. These soils, on account of their high nitrogen content and water holding capacity, are especially adapted to the growing of crops making a heavy growth such as cabbage, root crops and grasses for hay or pasture.

These soils naturally require drainage as the first step in their development and on account of the heavy character of the subsoil, laterals should be closer than is necessary on wet soils of lighter texture. Distances of 60 to 80 feet will give good results. More thorough drainage, of course, is necessary for land to be used for tilled crops in order to secure such drainage as will permit cultivation even during wet seasons, while land to be used chiefly for hay or pasture needs less complete drainage.

APPENDIX

I. List of Soil Series in Wisconsin.

II. Mechanical Analyses of Wisconsin Soils.

III. Colloidal Matter in Wisconsin Soils.

IV. Chemical Analyses of Wisconsin Soils.

V. Complete Analysis of Four Important Soil Types.

VI. Reports of Geological and Natural History Survey on Wisconsin Soils.

APPENDIX I

LIST OF SOIL SERIES MAPPED IN WISCONSIN

It will be noted that this list includes names of series used in the earlier work of the Survey which were later combined with the series as they are mapped in the present organization.

SOIL SERIES IN WISCONSIN

Antigo Series. Light brown soils of alluvial origin in glaciated region of crystalline rocks. Chiefly overwash plains, with sand and gravel at from one to three feet below the surface. Includes fine sandy loam, loam, and silt loam.

Auburn Series. Name used by Wiedman for soils later called Boone, which see.

Baldwin Series. Name used by Wiedman for soils in St. Croix and Pierce counties, now called Miami series.

Baxter Series. Red stony soils of residual origin from limestone in the western part of the state. Series includes silt loam and clay loam.

Boone Series. Light colored timbered soils derived by weathering from sandstone and shale. Includes sand, fine sand, sandy loam, fine sandy loam, and loam.

Carrington Series. Dark colored prairie soils of glaciated region on subsoil of loess or limestone till.

Chelsea Series. Name used by Wiedman for soils of morainic belt of the last glacial drift. Now subdivided into other series, chiefly Kennan.

Clyde Series. Marsh border soils in glaciated region of limestone area having from 5 to 15% of organic matter. Series includes sandy loam, fine sandy loam, loam, silt loam, and clay loam, with the heavy types predominating.

Colby Series. Light brown soils in region of crystalline rocks, chiefly of the older glaciation. Chiefly silt loam with a small amount of loam.

Coloma Series. Light colored soils of glacial till in region of Potsdam sandstone. Includes sand, fine sand, and sandy loam.

Cushing Series. Name used by Wiedman for light colored glacial soils, chiefly loams, occurring in Polk and St. Croix counties. Now called Miami loams.

Dodgeville Series. Dark colored prairie soils of unglaciated region overlying residual soils from limestone. Includes loam and silt loam, the latter predominating.

Dunning Series. Dark colored, poorly drained soils of marsh and stream borders in sandstone region. Includes sands, fine sands, and sandy loams.

Fox Series. Light colored soils of river terraces and overwash plains in glaciated areas of limestone region. Subsoil—stratified sand and gravel. Includes fine sandy loam, loam and silt loam.

Genesee Series. Light colored alluvial soils including first bottoms or present flood plains. Of little agricultural value except for pasture. Occurs in all sections of the state.

Kennan Series. Light colored soils, sometimes reddish or pinkish in subsoil. Of last glacial region in area of crystalline rocks. Includes silt loam, loam, and fine sandy loam.

Knox Series. Light colored soils of unglaciated limestone section, usually with loess predominating, but frequently including some residual limestone material.

Lintonia Series. Light colored soils in unglaciated region, largely of colluvial origin as wash from glacial uplands. Frequently occurs in terrace formation.

Marathon Series. Name used by Wiedman for light colored residual soils from granite in unglaciated area. Chiefly in Marathon county. Includes sandy loam, fine sandy loam, loam and silt loam. Subsoil—disintegrated granite of gravelly character.

Marshall Series. Dark colored prairie soils, unglaciated region, with subsoil of loess. Chiefly in limestone region. Includes loam and silt loam, the latter predominating.

Mellen Series. Light brown or slightly reddish brown soils of glacial origin in region of crystalline rocks. Chiefly in Douglash, Ashland, and Iron counties. Very similar to Kennan soils. Includes sandy loam, fine sandy loam, loam, and silt loam.

Meridean Series. Name used by Wiedman for sandy soils of terrace formation along the Chippewa, Red Cedar, and Eau Galle rivers. Now classified as Plainfield. Includes sandy types.

Miami Series. Light brown glacial till soils of limestone region. Includes fine sandy loam, loam and silt loam, the latter predominating. Deep and normal phases, the former gently rolling with soil and subsoil largely stone free and frequently loess-like surface soil; the latter more irregular in topography—usually more stony and of glacial till.

Milltown Series. Name used by Wiedman for soil now called Antigo, which see.

Muck. Marsh or poorly drained soils in which organic matter ranges from 15% to 50%.

Peat. Marsh soil containing over 50% of organic matter subdivided on the basis of depth into shallow and deep phases.

Plainfield Series. Light colored terrace or outwash soils. Chiefly in glaciated area and including sands, fine sands, and sandy loams.

Poygan Series. Dark colored, originally poorly drained soils, with subsoil of red clay or silt loam.

Rice Lake Loams. Name used by Wiedman in report on southern part of northwestern Wisconsin for dark colored alluvial soils underlaid by sand and gravel. Includes fine sandy loam, loam and some silt loam.

Rodman Series. The series includes the sandy and gravelly, hilly soil of the last glaciation in the limestone region. Includes kanes and eskers of the moraine.

Sterling Sand. Name used by Wiedman for sands along rivers of the southern part of northwestern Wisconsin. Same as the Plainfield sand of a newer classification.

Superior Series. The series includes the red clay soils of Lake Superior and Michigan region, part of which retains its original lacustrine character, but the larger part of which has been reworked by ice into till. Includes silt loam, clay loam and clay; it also includes sandy loam and fine sandy loam characterized by sandy surface soils with heavy subsoils similar to those above mentioned.

Thornapple Series. Name used by Wiedman for glacial sandy soils in the report on the southern part of northwestern Wisconsin. Equivalent to Vilas series in a newer classification.

Vesper Series. Poorly drained soils of light color originating from Potsdam sandstone and shale in central Wisconsin. Includes fine sandy loam, loam, and silt loam.

Vilas Series. Includes light colored sandy soils of glacial till origin in region of crystalline rocks. Includes undulating ground moraine and rough, hilly terminal and lateral moraines. Series includes sands, fine sands and sandy loams.

Wabash Series. This series includes the dark colored, alluvial, and level soils on the first bottom land along streams in unglaciated region. Silt loam and loam predominate.

Waukesha Series. This includes the dark colored soils occurring as terraces along streams and as overwash plains in the glaciated section, chiefly in the limestone region. Includes sandy loams, fine sandy loams, loams, and silt loams.

Webster Series. Name used by Musbach in the report on the northern part of northwestern Wisconsin for level or gently undulating soils of alluvial origin having a clay loam subsoil and underlaid by stratified sand and gravel. Equivalent to Antigo series of present classification.

Whitman Series. Includes the dark gray or black, poorly drained, alluvial soils of glaciated and unglaciated crystalline rock region. Chiefly loam and silt loam.

APPENDIX II

METHODS OF MAKING MECHANICAL ANALYSES OF SOILS

The method of making mechanical analyses of soils developed by the United States Bureau of Soils, with some variations, is in general use.

A five-gram sample is taken from each soil to be analyzed. Each sample, with water and a few drops of ammonia, is then placed in a shaker bottle and shaken by motor power until all the particles are thoroughly deflocculated. The length of time needed for this depends upon the coarseness or fineness of the soils to be analyzed.

After the soil samples have been transferred to suitable test tubes, distilled water under pressure is used for agitating them, each sample in suspension being then placed in a centrifuge. This throws down the heavier particles, and the clay particles alone are left in suspension. Correct size of particles is then determined by means of a high power microscope, and if none are found to be too large, the clay is decanted. This operation is repeated until approximately all the clay has been poured off. The clay water is evaporated and the clay dried and weighed.

To separate silts from sands, the Bureau method uses alternate agitating and settling of the particles. The suspended material is poured off after a fixed time has passed, the size of particles being carefully tested under the microscope, so that only those of silt size shall be decanted. This is repeated until when the remaining sediment is tested under the microscope no particles of silt size can be found. The silt is dried and weighed, the sand, after drying, is separated into five groups by means of accurately sized sieves, and each of these groups is weighed. Percentages are then determined from all the results.

At Wisconsin, the method differs in the fact that 10-gram samples are used, and that the samples are run in duplicate. In addition to this, well-timed air pressure is used in decanting the silt and clay suspension from the sands, after which the silt is thrown down by means of the centrifuge, and the clay is poured off. This process is repeated until accurate separations have been made. Microscope tests are frequently used, as in the Bureau method, to check the size of particles. A large part of the mechanical analyses here recorded, were made by Miss Hazel Hankinson.

MECHANICAL ANALYSES OF SOILS

Soils are made up of a large number of particles which vary in size. The soils are divided into classes according to the percentage of particles of different sizes which they contain.

The soil particles classified according to their diameters are: coarse gravel, larger than 2 mm.; 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.; and clay, smaller than 0.005 mm.

The *Classes* of soils based upon the percentage content of the different separates are:

SOILS CONTAINING LESS THAN 20% SILT AND CLAY

Coarse Sand—Over 25% fine gravel and coarse sand, and less than 50% of any other grade of sand.
Sand—Over 25% fine gravel, coarse and medium sand, and less than 50% fine sand.
Fine Sand—Over 50% fine sand, or less than 25% fine gravel, coarse and medium sand.
Very Fine Sand—Over 50% very fine sand.

SOILS CONTAINING BETWEEN 20–50% OF SILT AND CLAY

Sandy Loam—Over 25%fine gravel, coarse and medium sand.
Fine Sandy Loam—Over 50% fine sand or less than 25% fine gravel, coarse and medium sand.
Sandy Clay—Less than 20% Silt.

SOILS CONTAINING OVER 50% OF SILT AND CLAY

Loam—Less than 20% clay, and less than 50% silt.
Silt Loam—Less than 20% clay, and over 50% silt.
Clay Loam—Between 20 and 30% clay, and less than 50% silt.
Silty Clay Loam—Between 20 and 30% clay, and over 50% silt.
Clay—Over 30% Clay.

MECHANICAL ANALYSES OF SOILS

Analyses given in per cent

Location		Sample Number	Field Classification	Layer	F. G.	C. S.	M. S.	F. S.	V.F.S.	Silt	Clay
County	Land Survey										
Washburn	Composite	413	Antigo Silt Loam	A	.2	3.0	3.3	3.8	12.0	68.8	8.7
				B	.3	2.6	3.0	3.5	11.6	65.8	13.4
Outagamie	Composite	1,259	Antigo Very Fine Sandy Loam*	A	.01	.5	.4	2.9	71.5	19.9	4.2
Oneida	Composite	790	Antigo Fine Sandy Loam	A	.2	7.0	18.4	18.9	20.6	26.5	7.4
				B	.3	7.1	17.8	20.9	22.3	23.7	6.5
				C	.3	8.4	22.1	23.8	19.5	17.7	7.8
Outagamie	T23N., R16E	1,260	Antigo Fine Sandy Loam	A	.00	.3	.5	.9	71.4	24.5	3.8
Eau Claire†	T 26, R 9	12	Auburn Loam (Boone)	A	.2	6.9	11.1	13.1	14.9	42.7	10.5
				B	.0	5.3	9.6	14.4	15.1	43.0	12.5
Dunn†	T 27, R 12	110	Auburn Loam* (Boone)	A	.5	15.0	18.0	17.6	12.9	26.6	9.7
				B	.5	14.3	17.3	19.0	18.9	21.1	9.3
Barron†	T 32, R 13	158	Auburn Loam* (Boone)	A	.1	3.3	5.9	11.6	9.6	57.1	11.9
				B	.0	4.1	6.4	15.3	15.4	39.6	19.0
St. Croix†	Composite	122	Baldwin Silt Loam*(Miami)	A	.0	8.8	9.11	13.1	12.5	45.7	10.3
				B	.4	9.0	11.7	15.4	15.4	32.5	15.2
St. Croix†	T 30, R 17W	125	Baldwin Silt Loam*(Miami)	A	.0	6.9	8.9	11.0	15.5	48.0	9.3
				B	.3	7.9	20.0	16.4	15.0	32.4	16.0
St. Croix†	Composite	130	Baldwin Silt Loam(Miami)	A	.0	6.2	5.9	9.4	12.8	55.4	9.9
				B	.3	10.6	11.5	17.2	11.2	38.	11.0
Clark	Composite	952	Boone Fine Sandy Loam*	A	.1	7.3	11.8	26.6	30.3	16.9	6.5
				B	.2	8.3	9.4	22.7	34.4	14.9	9.0
				C	.5	6.7	7.6	20.3	31.6	17.8	14.3
Buffalo†			Bates Silt Loam	A	0.0	0.4	0.4	1.4	13.2	68.5	15.9
				B	.0	.2	.2	1.5	16.6	66.7	14.9
Rock	T4N., R11E	1,402	Bellefontaine Silt Loam	A	0.0	2.1	10.5	16.8	18.7	40.9	13.1
				B	.04	3.2	16.0	27.3	15.2	20.1	19.2
				C	0.0	2.6	12.6	21.5	19.1	24.0	21.1

Juneau	T 17, R 3 E	451	Boone Fine Sand	A	.09	3.95	17.63	57.90	12.45	3.60	4.72
				B	.06	4.80	19.97	56.95	12.16	2.37	3.80
				C	.00	5.25	21.34	59.97	10.46	.95	1.90
La Crosse†			Boone Fine Sand	A	0.1	4.8	16.6	55.8	8.6	9.3	4.3
				B	.2	4.9	17.0	58.4	8.6	6.6	4.4
La Crosse†			Boone Fine Sandy Loam	A	0.2	5.9	13.5	54.9	5.8	14.7	5.1
				B	.2	6.3	14.9	54.2	5.7	13.0	5.2
Iowa†		23,855	Boone Fine Sandy Loam	A	0.0	6.1	16.6	39.5	11.8	19.0	7.1
		23,856		B	.0	3.2	9.6	30.0	15.6	28.0	13.5
La Crosse	T 18, R 6 W	527	Boone Fine Sandy Loam	A	.00	2.2	10.6	55.0	15.7	10.9	4.8
				B	.0	1.8	9.5	57.2	16.7	9.0	4.9
				C	.0	1.4	9.9	69.7	14.1	2.0	2.3
Jackson	Composite	1,315	Boone Fine Sand	A	.00	10.17	21.50	44.44	16.15	4.55	3.13
				B	.07	12.43	21.52	46.69	12.77	3.00	3.09
				C	1.02	15.37	23.84	46.82	10.48	.66	1.60
Juneau	T 14 N., R 5 E	1,375	Boone Fine Sand	A	0.0	2.09	12.30	59.30	9.18	9.38	5.38
				B	.02	2.72	13.20	58.40	9.03	8.84	5.88
				C	.05	2.47	12.17	67.08	6.44	3.65	6.23
Juneau	T 15 N., R 4 E	1,376	Boone Fine Sand	A	.03	1.49	4.72	50.81	29.95	6.66	5.75
				B	.04	1.30	4.73	42.59	37.41	6.38	7.08
				C	.04	1.60	4.75	47.76	28.51	3.28	15.53
Juneau	T 17, R 5	1,377	Boone Fine Sand	A	.05	2.52	12.36	60.81	13.48	3.49	5.39
				B	.07	2.86	11.51	61.60	16.14	2.08	4.00
				C	.04	1.40	8.74	68.48	17.06	.50	1.37
Adams	T 19 N., R 5 E	1,379	Boone Fine Sand	A	.01	3.33	3.55	72.51	9.22	5.64	6.63
				B	.01	.44	4.70	75.22	8.29	3.89	5.22
				C	.03	.46	5.08	82.21	7.93	.46	1.29
Adams	T 19 N., R 5 E.	1,380	Boone Fine Sand	A	0.0	2.08	9.28	72.70	5.08	4.10	5.74
				B	0.01	.23	9.25	75.20	5.55	1.97	3.87
				C	0.0	.39	18.26	72.63	2.73	.22	.77
Eau Claire	T 26, R 6 W.	1,400	Boone Fine Sand	A	.00	6.87	26.95	48.56	8.21	5.69	3.80
				B	.00	7.81	27.96	47.33	7.30	5.77	4.07
				C	.00	6.16	26.03	53.76	7.41	3.45	3.16
Columbia†			Boone Sand	A	0.8	16.4	20.2	29.9	4.0	21.7	6.9
				B	.3	21.0	29.1	82.7	2.2	10.1	4.5

†Bureau Analysis. *Mechanical analysis showed that the soil belonged in an adjacent class.

MECHANICAL ANALYSES OF SOILS—Continued

Analyses given in per cent

Location		Sample Number	Field Classification	Layer	F. G.	C. S.	M. S.	F. S.	V.F.S.	Silt	Clay
County	Land Survey										
Racine	T 3 N., R 20 E.	1,475	Carrington Silty Clay Loam*	A	.0	.9	2.0	5.8	15.0	42.4	33.8
				B	.05	1.1	2.0	5.6	16.2	32.6	43.1
				C	.01	1.8	2.1	5.0	14.3	37.2	38.9
Kenosha	T 1 N, R 20 E.	1,324	Carrington Clay Loam	A	0.0	2.0	3.4	8.7	17.4	45.4	24.9
				B	.05	1.4	1.9	5.4	13.4	39.6	40.0
				C	.05	2.0	2.0	4.9	16.9	45.6	28.6
Kenosha	T 2 N, R 2 E.	1,341	Carrington Clay Loam	A	0.0	2.0	3.4	8.3	15.2	44.5	27.9
				B	.03	1.3	2.5	6.4	12.0	33.7	44.4
				C	.03	1.3	1.5	4.1	13.5	39.4	40.1
Fond du Lac	T 14 N., R 15 E.	382	Carrington Silt Loam	A	.0	.3	.2	.7	28.9	53.1	18.2
				B	.0	.02	.03	.2	30.0	52.3	19.2
				C	.0	.1	.2	1.5	31.4	49.2	19.3
Walworth	Composite	1,447	Carrington Silt Loam	A	.0	.7	1.3	1.7	14.5	54.3	28.0
				B	.0	.3	.7	1.0	15.0	52.8	30.4
				C	.0	.7	1.4	2.9	20.3	44.0	32.0
Columbia†			Carrington Silt Loam (deep phase)	A	0.0	1.0	2.2	5.0	7.5	62.9	21.1
				B	.4	1.5	4.2	11.5	5.5	58.1	18.5
Polk†	Composite	136	Chelsea Silt Loam	A	0.2	7.4	4.3	4.2	14.2	57.3	11.8
Polk†	T 34, R 17 W.	140	Chelsea Silt Loam	A	0.1	5.7	4.0	4.0	19.4	53.6	12.8
				B	0.0	3.3	3.2	3.0	27.2	46.3	16.8
--†			Chelsea Loam*	A	7.8	12.8	10.3	28.4	15.8	15.2	9.1
				B	11.0	14.7	10.0	27.7	16.7	12.4	7.5
Chippewa†	Composite	10	Chetek Sandy Loam (Marshall)	A	.2	28.1	22.0	14.6	2.9	21.2	11.0
				B	.4	20.7	23.4	16.8	2.6	28.7	7.4
Barron†		160	Chetek Sandy Loam	A	.1	25.5	23.6	16.5	2.0	22.6	9.1
				B	.2	25.4	24.2	18.7	2.8	18.5	9.6
Waukesha†			Clyde Silty Clay Loam	A	0.0	0.2	0.3	1.1	1.0	67.1	30.3
				B	.0	.3	.4	1.7	2.3	65.8	29.2
Waukesha			Clyde Sandy Loam	A	0.0	12.7	26.3	29.2	3.3	20.7	7.3
				B	.5	15.1	31.5	38.1	4.5	6.1	4.1

Waukesha	T 5 N, R 20 E	242	Clyde Silty Clay Loam*	A	.05	1.10	4.8	11.2	18.3	40.1	26.5
				B	.03	1.40	2.6	4.4	10.8	42.8	40.8
Walworth	Composite	1,448	Clyde Silt Loam*	A	.0	1.9	4.6	15.0	19.0	39.3	22.0
				B	.0	.9	1.6	3.6	20.2	48.8	26.1
Columbia†			Clyde Silt Loam	A	0.0	0.2	0.8	6.1	8.8	63.9	19.9
				B	.0	.3	.8	4.1	7.7	73.9	13.1
Columbia†			Clyde Loam	A	0.5	10.8	10.8	11.8	4.0	37.9	23.6
				B	.2	11.5	13.2	17.5	11.2	22.1	23.9
Kewaunee†			Clyde Silt Loam	A	0.2	9.1	4.4	10.0	5.0	52.4	18.2
				B	.3	1.5	1.7	6.2	6.9	71.0	12.2
Racine†			Clyde Fine Sandy Loam	A	0.3	1.6	3.4	53.0	20.1	12.9	8.1
				B	.1	1.1	3.4	67.4	19.5	4.2	4.1
Racine†			Clyde Clay Loam	A	0.2	1.5	2.7	11.2	5.4	52.0	26.9
				B	.1	1.0	1.4	9.1	5.9	46.6	35.6
Chippewa	T 29, R 5 W	119†	Colby Silt Loam	A	.0	2.5	1.6	3.3	20.3	58.7	13.7
				B	.0	0.6	0.5	0.7	20.5	63.5	14.0
Barron	Composite	154†	Colby Silt Loam	A	.1	3.2	4.0	3.6	12.6	61.9	13.6
				B	.0	3.2	4.7	3.2	19.7	51.2	17.3
Marinette†			Coloma Loam	A	0.4	3.5	5.5	9.4	19.9	52.2	8.6
				B	1.1	5.1	7.6	12.8	24.6	40.1	7.8
Waushara†			Coloma Loam	A	0.8	7.8	14.9	19.5	12.1	30.8	14.3
				B	.5	6.6	17.3	24.9	19.2	19.7	11.7
Price	Composite	907	Colby Fine Sandy Loam	A	.2	3.0	9.1	25.8	29.3	24.8	7.0
				B	.1	3.5	9.6	28.4	31.3	21.7	5.8
Columbia	Composite	618	Coloma Fine Sandy Loam	A	.3	7.5	18.4	33.4	16.0	18.4	5.4
				B	.2	5.8	13.9	30.8	16.0	18.5	13.7
				C	.1	6.3	16.2	38.9	11.6	10.8	15.4
Marinette†			Coloma Fine Sandy Loam	A	0.6	6.5	10.8	20.4	20.6	34.0	6.8
				B	1.4	7.6	8.8	17.6	24.0	32.9	7.2
Waushara	T 18 N, R 11 E	62	Coloma Sandy Loam	A	.3	11.7	22.4	24.6	14.6	19.0	8.7
				B	.5	10.9	20.0	21.7	15.1	19.4	13.6
Waushara	T 19 N, R 9 E	1,387	Coloma Sandy Loam*	A	.12	7.59	17.11	44.74	16.35	8.70	5.54
				B	.10	8.49	17.51	46.20	16.61	6.15	4.85
				C	.08	7.81	15.23	43.52	18.09	5.96	9.83

†Bureau Analysis. *Mechanical analysis showed that the soil belonged in an adjacent class.

MECHANICAL ANALYSES OF SOILS—Continued

Analyses given in per cent

Location		Sample Number	Field Classification	Layer	F. G.	C. S.	M. S.	F. S.	V. F. S.	Silt	Clay
County	Land Survey										
Waushara	T 19 N, R 9 E	1,388	Coloma Sandy Loam*	A	.25	13.38	23.24	38.64	11.87	8.26	4.91
				B	.48	20.53	25.37	38.86	9.57	6.26	3.73
				C	.15	9.69	18.23	39.35	16.38	6.63	9.58
Portage	T 22 N, R 22 E	1,392	Coloma Sandy Loam	A	.16	8.33	17.45	31.26	20.10	14.82	7.90
				B	.16	9.21	17.30	32.04	18.92	14.49	7.53
				C	.26	12.94	30.49	41.77	6.41	3.06	5.17
Waushara	T 19, R 8 E	1,416	Coloma Sandy Loam*	A	.3	13.4	22.5	35.4	13.9	11.1	3.7
				B	.3	11.8	21.5	40.0	14.4	8.1	3.7
				C	.6	20.5	28.1	30.5	7.6	5.8	6.9
				D	.1	9.1	19.4	55.6	11.2	2.3	2.2
Waushara†			Coloma Sandy Loam	A	0.6	12.8	20.0	33.0	10.6	17.3	5.9
				B	.6	9.8	18.5	40.2	7.2	10.4	12.8
Outagamie	Composite	1,261	Coloma Very Fine Sand	A	.00	.3	.5	26.6	64.8	4.6	3.2
Waushara	T 19, R 8 E.	1,413	Coloma Fine Sand	A	.0	9.7	22.2	48.3	11.1	6.6	2.8
				B	.5	10.9	21.5	47.9	11.7	5.5	2.7
Waushara	T19, R8E.	1,414	Coloma Fine Sand	A	.1	4.7	12.7	62.2	13.4	4.5	3.0
				B	.1	4.2	12.6	64.2	13.2	3.3	2.1
				C	.1	4.2	10.6	63.7	17.2	2.3	1.9
				D	.3	7.0	13.4	52.4	20.3	3.7	3.2
Marinette†			Coloma Fine Sand	A	0.1	5.5	14.6	35.4	23.4	15.2	5.2
				B	.1	4.6	13.6	41.9	29.9	7.1	2.4
Columbia†		311,553	Coloma Fine Sand	A	0.2	9.5	22.4	56.7	3.8	4.6	2.5
		311,554		B	.0	6.2	19.4	64.0	5.3	3.4	1.6
Adams	T 16 N., R 7 E.	1,432	Coloma Fine Sand	A	.1	4.7	14.6	63.0	10.0	3.8	3.6
				B	.2	5.9	16.2	61.6	9.4	3.1	3.4
				C	.1	5.2	17.9	68.4	6.8	.7	1.2
Waushara	T 18 N., R 8 E.	1,385	Coloma Sand	A	.16	15.47	26.28	41.08	9.68	4.52	2.70
				B	.27	15.63	24.86	39.72	11.31	5.06	3.06
				C	.33	14.54	23.45	41.25	12.17	4.05	5.21

Waushara	T 19 N., R 9 E.	1,389	Coloma Sand	A	.09	8.56	22.92	43.07	12.21	7.62	5.76
				B	.05	7.87	22.53	46.79	11.42	6.30	4.94
				C	.18	9.40	26.16	45.43	9.61	3.71	5.32
Portage	T 22 N., R 9 E.	1,391	Coloma Sand	A	.24	12.83	24.99	32.54	27.02	10.33	5.65
				B	.32	14.04	24.06	33.68	12.98	9.44	5.19
				C	.34	16.53	26.89	32.52	10.49	5.20	8.20
Waushara	T 19, R 8 E.	1,412	Coloma Sand	A	.1	18.1	33.8	34.2	5.5	4.2	4.3
				B	.1	23.3	36.2	29.9	3.4	3.3	4.1
				C	.2	27.2	38.3	27.0	2.6	0.7	2.7
				D	.1	19.4	32.8	38.4	4.9	1.8	2.6
Waushara†			Coloma Sand	A	0.4	12.7	18.1	43.2	4.5	6.2	4.9
				B	1.1	13.1	29.7	43.3	4.0	4.9	3.8
Waushara	T 19, R 8 E.	1,415	Coloma Sand	A	.3	23.0	31.1	30.9	4.9	7.0	3.4
				B	.8	20.2	29.5	34.4	5.1	6.2	4.1
Waushara†			Coloma Gravelly Sand	A	10.9	47.3	20.5	12.4	5.0	2.4	1.5
Waushara†			Coloma Gravelly Sand	A	24.2	50.7	15.8	4.4	2.4	1.7	0.7
				B	10.7	52.3	20.7	9.3	1.6	1.5	3.2
St. Croix	Composite	127†	Cushing Loam (Miami Silt)	A	.5	9.6	8.6	9.5	21.8	43.3	6.4
				B	.4	8.4	7.8	8.8	24.5	36.2	18.8
Polk	Composite	138†	Cushing Loam* (Miami)	A	.0	5.1	4.7	16.0	11.2	62.5	10.4
				B	.1	5.7	5.4	6.4	18.9	45.5	17.8
Polk	T 36, R 19	142†	Cushing Loam (Miami)	A	.7	9.5	9.3	18.3	25.4	26.5	10.2
				B	.5	6.9	8.6	18.2	21.8	26.4	17.6
Polk	Composite	151†	Cushing Silt Loam (Miami)	A	.1	12.6	15.4	16.2	10.7	35.8	8.9
				B	.0	13.2	12.9	14.2	13.4	31.2	14.4
Dane	T 5 N., R 7 E.	1,105	Dodgeville Silt Loam (shallow phase)	A	.00	.1	.3	2.5	25.9	50.2	21.3
				B	.00	.1	.1	1.8	23.0	46.4	28.7
Dane†			Dodgeville Silt Loam	A	0.1	0.2	5.2	1.6	11.4	69.2	17.3
				B	.2	.4	4.4	1.2	7.7	60.7	29.6
Iowa†			Dodgeville Silt Loam	A	0.0	0.3	0.7	0.9	14.7	59.5	23.7
				B	.0	.1	.1	.4	2.6	68.7	28.1
Dane†			Dodgeville Fine Sandy Loam	A	0.2	0.4	0.0	36.3	11.1	37.1	9.8
				B	.1	.4	.2	36.7	12.8	34.9	11.0

†Bureau Analysis. *Mechanical analysis showed that the soil belonged in an adjacent class.

MECHANICAL ANALYSES OF SOILS—Continued

Analyses given in per cent

Location		Sample Number	Field Classification	Layer	F. G.	C. S.	M. S.	F. S.	V. F. S.	Silt	Clay
County	Land Survey										
Racine†			Dunkirk Fine Sandy Loam	A B	0.3 .1	2.6 3.8	9.8 22.7	54.1 58.0	17.4 7.9	9.1 3.6	6.3 3.7
Marinette†			Dunkirk Sand	A B	0.1 .0	0.6 .2	2.9 5.4	59.8 73.6	18.5 16.3	11.8 2.5	6.0 1.8
Kewaunee†			Dunkirk Sand	A B	2.9 .6	9.0 4.7	24.1 23.1	49.7 65.6	1.9 1.6	6.9 1.6	5.7 2.7
Wood	T 22 N., R 4 E.	1,062	Dunning Fine Sandy Loam*	A B	.3 .5	4.1 8.9	15.5 15.3	60.0 58.0	5.5 7.6	5.8 5.5	8.2 4.4
Dane†			Fox Loam	A B	0.4 1.0	6.8 5.6	13.8 11.6	25.9 25.6	4.0 3.8	38.4 31.7	10.6 20.5
Kewaunee†			Fox Silt Loam	A B	0.9 10.1	4.2 14.9	5.5 16.1	10.3 26.2	19.7 11.1	53.1 13.3	5.8 7.8
Rock	T 4 N., R 13 E.	857	Fox Silt Loam	A B	.0 .0	.5 .4	1.4 1.1	2.4 2.1	18.3 17.8	61.3 47.6	15.3 31.1
Kewaunee†			Fox Sand	A B	2.0 .9	13.5 9.3	22.2 18.2	40.3 55.8	8.2 5.0	9.2 5.7	4.6 5.2
Kewaunee†			Genesee Loam	A B	0.7 .2	4.6 1.8	7.7 3.7	21.3 11.9	13.3 10.9	35.4 43.8	16.7 26.8
Kewaunee			Genesee Fine Sandy Loam	A	4.0	8.4	10.2	19.7	8.0	34.7	14.7
		311,701†	Gloucester Silt Loam	A B	2.0 3.4	6.0 14.1	6.7 18.4	9.8 25.3	9.6 11.3	52.4 21.0	13.0 6.6
		311,754†	Gloucester Silt Loam	A B	4.0 3.8	18.0 14.2	19.2 24.0	22.6 27.8	7.8 8.0	20.4 15.5	7.9 6.8
N. Cen. Wis.†			Gloucester Silt Loam	A B	1.8 2.7	7.5 12.2	6.8 11.1	10.8 15.9	13.3 12.1	49.5 39.7	10.2 5.9
N. E. Wis.†			Gloucester Silt Loam	A B	2.0 3.4	6.0 14.1	7.2 18.4	9.8 25.3	9.6 11.3	52.4 21.0	13.0 6.6

Marathon	Composite	979	Gloucester Fine Sandy Loam*	A	.8	12.5	19.1	20.1	16.6	21.2	8.7
				B	.5	14.5	21.3	24.0	16.0	15.6	6.9
				C	1.5	14.4	20.8	21.6	17.0	15.6	8.2
N. Cent. Wis.†			Gloucester Fine Sandy Loam	A	3.2	9.3	10.2	22.9	13.2	31.2	9.9
				B	3.6	9.8	12.2	30.2	13.4	22.0	8.9
N. E. Wis.†			Gloucester Sandy Loam	A	4.0	18.0	19.2	22.6	7.8	20.4	7.9
				B	3.8	14.2	24.0	27.8	8.0	15.5	6.8
Chippewa	T 29, R 9	9†	Hartland Silt Loam	A	.1	1.3	1.4	2.2	22.1	62.1	10.1
				B	.0	.1	.2	.5	7.3	78.7	12.9
La Crosse†			Knox Silt Loam	A	0.1	0.6	0.5	1.2	5.3	80.8	11.6
				B	.0	.1	.1	.6	5.4	72.2	21.4
Dunn	T 27, R 14 W.	113†	Hartland Silt Loam	A	.4	1.6	1.4	7.2	27.5	51.8	9.9
				B	.0	.6	.5	2.0	32.1	53.9	10.4
Iowa			Knox Silt Loam	A	0.0	0.5	0.5	1.5	17.1	65.7	14.3
				B	0.0	.2	.3	1.0	7.5	67.3	23.5
Pepin	Composite	118†	Hartland Silt Loam	A	.0	.9	.7	3.3	18.7	65.1	11.5
				B	.0	.2	.3	2.1	27.8	56.5	13.0
La Crosse†			Knox Fine Sand	A	0.1	1.0	7.7	69.2	13.2	4.4	4.5
				B	.0	1.2	8.1	70.9	13.5	2.9	3.3
Chippewa	T 31, R 5 W.	120†	Kennan Silt Loam	A	.0	2.5	1.8	3.0	18.5	60.3	14.7
				B	.0	0.7	0.7	1.3	29.1	52.6	15.4
Rusk	T 34, R 8 W.	165†	Kennan Silt Loam	A	.1	2.3	2.4	4.0	12.1	67.7	11.2
				B	.2	1.9	2.2	3.6	25.1	55.3	11.5
Sawyer	T 37 N, R 7 W.	540	Kennan Silt Loam*	A	1.9	8.2	5.7	7.2	23.0	44.1	9.6
				B	2.9	8.8	7.0	8.0	26.3	35.7	10.9
Sawyer	T 39 N, R 5 W.	548	Kennan Silt Loam*	A	1.1	1.9	1.5	3.3	29.2	44.0	18.8
				B	1.8	3.2	2.2	4.3	37.3	36.4	14.6
Oneida	Composite	889	Kennan Silt Loam*	A	.07	3.0	8.3	11.1	27.6	42.0	7.3
				B	.04	2.2	6.5	9.2	29.2	42.9	10.1
Florence	T 40 N, R 18 E.	721	Kennan Fine Sandy Loam	A	.1	3.2	11.4	20.8	32.0	21.7	5.2
				B	.1	3.5	12.5	27.5	34.4	17.3	4.4
				C	.1	3.1	13.5	31.1	34.4	14.2	3.0

†Bureau Analysis. *Mechanical analysis showed that the soil belonged in an adjacent class.

MECHANICAL ANALYSES OF SOILS—Continued

Analyses given in per cent

Location		Sample Number	Field Classification	Layer	F. G.	C. S.	M. S.	F. S.	V. F. S.	Silt	Clay
County	Land Survey										
Door†			Kewaunee Loam	A	1.0	3.6	4.5	20.8	23.1	37.6	8.9
				B	.7	3.7	5.2	22.8	19.1	30.2	18.5
Kewaunee†			Kewaunee Loam	A	2.0	4.7	8.5	20.2	13.7	41.7	8.7
				B	.9	3.0	6.5	20.2	11.3	34.6	22.6
Door†			Kewaunee Clay Loam	A	0.5	3.3	4.4	20.0	11.4	35.3	25.2
				B	1.0	3.5	4.7	19.9	14.0	29.5	27.4
Kewaunee†			Kewaunee Clay Loam	A	0.8	3.0	4.6	12.2	9.0	41.5	29.2
				B	.5	1.6	3.3	9.1	5.7	39.3	40.4
N. Part. N. Cent.†			Kewaunee Fine Sandy Loam	A	1.0	1.5	1.8	19.9	33.6	32.1	9.8
				B	.0	.6	.8	4.4	26.2	46.5	21.7
Kewaunee†			Kewaunee Fine Sandy Loam	A	0.4	5.0	17.7	38.4	13.4	14.7	10.2
				B	.0	6.3	23.0	40.0	13.4	10.2	6.6
Marathon	Composite	989	Marathon Loam	A	.2	10.0	20.9	24.9	15.2	20.3	8.3
				B	1.1	10.8	22.0	27.7	16.5	15.1	6.7
				C	.3	12.8	21.4	26.1	15.7	15.0	8.6
Iowa†			Marshall Silt Loam	A	0.0	0.5	0.3	0.6	23.1	54.0	20.9
				B	.0	.2	.2	.3	.3	68.0	31.1
Racine†			Marshall Loam	A	1.1	10.5	11.5	16.8	12.7	24.1	22.5
				B	1.0	8.1	8.1	13.7	16.0	29.4	23.2
Racine†			Marshall Clay Loam	A	0.8	2.3	4.0	10.1	9.4	44.1	29.1
				B	.5	2.8	3.7	11.1	16.4	37.0	27.7
N. E. Wis.†			Merrimac Silt Loam	A	0.7	3.2	4.1	4.0	14.3	65.3	8.6
				B	3.0	11.7	12.8	7.0	11.9	44.8	8.7
Outagamie†			Merrimac Very Fine Sandy	A	0.2	0.4	0.2	9.9	64.2	20.1	4.9
				B	.1	.2	.3	12.3	68.2	15.7	3.0
Buffalo†			La Crosse Silt Loam	A	0.0	0.3	0.4	1.6	10.9	73.4	13.4
				B	.0	.1	.2	.6	11.4	72.3	15.4

Dane†			La Crosse Silt Loam	A	0.0	2.0	5.2	12.5	3.0	54.6	22.5
				B	.6	1.6	4.6	10.7	7.7	53.7	20.9
La Crosse†			LaCrosse Fine Sandy Loam	A	0.1	0.7	4.5	57.7	15.5	15.7	5.5
				B	.0	.7	4.8	62.3	15.8	12.9	4.0
La Crosse†			La Crosse Sandy Loam	A	0.3	9.2	27.3	38.2	3.4	14.3	7.1
				B	.1	11.2	30.1	36.6	4.3	12.1	5.5
Walworth	T 1 N., R 15 E.	1,406	Lindley Silt Loam	B	.04	1.2	3.2	6.1	16.1	41.9	33.2
				C	.3	6.3	15.3	28.9	15.6	14.1	22.0
Iowa†			Lintonia Silt Loam	A	0.0	0.2	0.4	1.0	13.2	73.6	11.2
				B	.0	.0	.0	1.5	7.6	78.8	12.2
			Mellen Silt Loam	A	.3	5.1	4.0	4.6	12.4	64.4	8.9
				B	.3	6.1	6.0	7.1	11.9	58.7	9.9
Douglas	Composite	647	Mellen Loam	A	.2	4.1	10.8	26.2	28.9	21.7	7.7
				B	.3	5.0	13.0	31.7	27.9	15.1	6.5
		†	Mellen Loam	A	.7	10.5	14.5	27.4	14.3	26.7	6.2
				B	.4	9.0	15.2	32.8	17.1	19.9	5.9
N. Pt., N. Cent.†			Mellen Loam	A	3.0	5.8	6.0	23.6	18.6	30.6	12.1
				B	3.4	6.6	6.5	22.6	19.8	32.3	8.9
Iron	Composite	895	Mellen Fine Sandy Loam	A	.2	4.5	9.2	23.9	33.1	20.7	7.4
				B	.2	4.2	9.7	25.8	34.8	18.5	6.4
				C	.3	6.4	12.8	26.6	32.5	15.6	5.7
Eau Claire	Composite	11†	Meridean Sandy Loam*	A	.5	18.2	23.7	24.4	9.6	18.7	9.7
				B	.1	16.5	23.9	26.1	10.0	14.6	8.5
Dunn	Composite	112†	Meridean Sandy Loam	A	.0	12.5	17.2	20.7	17.8	23.3	8.2
				B	.2	12.6	16.8	21.9	19.9	20.5	8.1
		311,713†	Merrimac Silt Loam	A	0.7	3.2	4.1	4.0	14.3	65.3	8.6
				B	3.0	11.7	12.8	7.0	11.9	44.8	8.7
Lincoln Marathon	Composite	988	Merrimac Fine Sandy Loam*	A	.3	14.6	22.5	20.5	11.5	21.7	8.0
				B	.5	18.2	25.1	19.9	11.8	17.0	7.0
				C	1.4	18.4	27.2	33.4	8.7	5.8	4.7
Polk	Composite	146†	Milltown Loam	A	.0	7.7	9.9	14.2	23.9	36.0	8.0
				B	.0	9.9	12.8	17.4	22.0	24.7	13.2
Door†			Miami Loam	A	1.4	4.1	5.4	28.2	17.5	34.2	9.0
				B	1.6	4.2	5.8	33.3	19.8	25.9	9.6

†Bureau Analysis. *Mechanical analysis showed that the soil belonged in an adjacent class.

MECHANICAL ANALYSES OF SOILS—Continued

Analyses given in per cent

Location: County	Location: Land Survey	Sample Number	Field Classification	Layer	F. G.	C. S.	M. S.	F. S.	V. F. S.	Silt	Clay
Kewaunee†			Miami Loam	A	2.9	6.1	8.4	19.9	11.6	43.4	7.7
				B	1.5	2.9	4.1	9.8	19.5	51.4	10.7
Racine†			Miami Loam	A	0.4	5.1	6.1	10.8	14.0	44.4	18.5
				B	.5	3.1	3.5	9.1	11.4	41.5	30.3
Racine	T 3 N., R 20 E.	1,476	Miami Silty Clay Loam	A	.02	.5	1.9	4.7	12.7	52.3	27.5
				B	.00	.7	1.4	4.0	12.6	32.7	51.3
				C	.01	1.4	1.7	4.6	13.2	41.7	39.6
Waukesha	Composite	172	Miami Clay Loam	A	.17	1.70	2.48	7.81	19.10	45.12	24.39
				B	.17	1.51	2.09	6.26	17.78	36.27	37.60
Racine†			Miami Clay Loam	A	0.8	4.0	4.0	11.5	12.4	43.2	23.2
				B	.5	2.0	2.2	8.4	6.8	44.0	36.1
Kenosha	T 1 N., R 22 E.	1,342	Miami Clay Loam	A	.1	1.8	2.9	7.7	19.5	49.3	20.2
				B	.0	1.7	2.1	5.1	14.8	39.8	38.0
Waukesha	T 8 N., R 18 E	236	Miami Silt Loam	A	0.0	.59	.71	1.04	22.32	61.73	13.90
				B	0.0	.59	.65	.84	21.94	54.24	29.87
Kenosha	T 2 N., R 22 E.	1,330	Miami Silt Loam*	A	.0	2.0	2.7	7.1	17.2	48.6	23.6
				B	.0	1.1	1.2	3.6	11.8	39.7	44.3
				C	.0	1.0	1.2	3.2	13.5	45.3	36.1
Kenosha	Composite	1,352	Miami Silt Loam	A	.0	1.8	3.8	8.0	21.7	52.9	13.2
				B	.1	1.8	3.7	7.2	21.5	40.8	25.8
				C	.1	1.0	2.2	4.2	21.5	47.2	24.1
Rock	T 4 N., R 14 E.	1,405	Miami Silt Loam	A	.0	.5	.6	1.2	21.7	62.3	16.7
				B	.0	.2	.4	.7	19.2	50.8	30.9
Walworth	T 1 N., R 15 E.	1,406	Miami Silt Loam	B	.04	1.2	3.2	6.1	16.1	41.9	33.2
				C	.3	6.3	15.3	28.9	15.6	14.1	22.0
Rock	T 1 N., R 13 E.	1,408	Miami Silt Loam	A	.0	.4	1.1	2.1	21.2	56.4	18.5
				B	.05	.8	2.0	3.8	19.7	44.6	28.2
				C	.2	4.2	9.8	19.2	17.4	23.9	24.9

Dane	T 9 N., R 12 E.	1,410	Miami Silt Loam	A	.0	.3	.3	.9	26.6	57.1	14.2
				B	.0	.1	.2	.3	25.4	47.3	26.3
				C	.0	.1	.2	.4	24.2	47.2	27.7
Walworth	Composite	1,444	Miami Silt Loam	A	.05	1.4	2.4	3.2	18.4	61.2	13.6
				B	.00	.6	.9	1.9	15.9	50.5	33.6
				C	.04	1.3	2.2	4.2	17.4	43.0	33.6
Walworth	Composite	1,445	Miami Silt Loam	A	.2	2.6	5.5	10.8	20.3	48.8	12.9
				B	.1	2.4	5.7	12.5	19.8	30.4	30.8
				C	.1	3.0	6.4	14.9	24.7	27.9	22.1
Green Lake	T 16 N., R 13 E.	1,529	Miami Silt Loam*	A	.0	.15	1.0	10.5	45.3	34.0	9.2
Green Lake	T 16 N., R 13 E.	1,531	Miami Loam	A	.0	.9	3.6	11.0	35.1	42.1	7.4
Door	T 32 N., R 28 E.	1,183	Miami Gravelly Loam	A	.3	5.4	11.0	20.9	27.9	26.4	8.0
				B	.3	7.2	10.5	20.6	35.3	17.2	8.6
Waukesha†			Miami Gravelly Sandy Loam	A	0.9	13.5	18.4	25.4	5.5	25.9	9.9
				B	4.1	14.8	18.3	23.6	6.4	13.4	19.0
Marinette†			Miami Fine Sandy Loam	A	0.9	5.9	9.4	24.6	18.5	33.1	7.4
				B	1.7	7.0	8.4	24.5	19.5	27.5	11.1
Marinette†			Miami Fine Sandy Loam (Light phase)	A	0.7	6.2	12.5	29.4	14.8	29.9	6.3
				B	1.3	7.3	13.3	28.7	16.5	22.7	10.2
Green Lake	T 17 N., R 13 E.	1,530	Miami Very Fine Sandy Loam	A	.0	.8	6.3	29.6	34.3	23.5	5.6
Columbia	T 11 N., R 10 E.	1,372	Miami Fine Sand	A	0.0	2.28	7.35	58.93	15.59	6.27	7.53
				B	.10	2.11	5.95	50.91	19.92	8.07	13.45
				C	.16	2.55	7.79	47.89	23.49	8.62	12.07
Waukesha†			Plainfield Silt Loam	A	0.6	2.6	3.1	4.1	2.8	76.2	10.8
				B	.7	2.9	3.9	4.9	3.7	66.9	16.6
Waukesha†			Plainfield Loam	A	0.1	2.3	8.2	22.9	12.7	37.6	16.1
				B	.6	4.9	10.3	15.7	9.9	29.7	28.7
Iowa	T 8, R 3	213	Plainfield Sandy Loam*	A	.07	4.84	20.69	44.13	17.09	6.95	6.36
				B	0.13	5.87	26.50	51.35	6.27	4.21	5.65
				C	.06	4.69	28.06	58.13	5.01	1.40	2.82
Iowa	T 8, R 1 E.	217	Plainfield Sandy Loam	A	.26	15.95	30.21	15.70	7.09	16.90	14.08
				B	.27	14.72	33.40	19.80	10.58	10.28	11.86
				C	.45	22.11	44.89	24.26	2.46	2.41	3.38

†Bureau Analysis.   *Mechanical analysis showed that the soil belonged in an adjacent class.

MECHANICAL ANALYSES OF SOILS—Continued

Analyses given in per cent

Location: County	Location: Land Survey	Sample Number	Field Classification	Layer	F. G.	C. S.	M. S.	F. S.	V. F. S.	Silt	Clay
Washburn	Composite	588	Plainfield Sandy Loam*	A	7.0	24.1	26.1	25.6	2.5	6.6	7.5
				B	17.6	23.4	23.9	24.3	1.8	3.9	5.1
				C	20.9	36.9	20.8	15.2	.7	1.8	3.6
Waushara	T 21 N., R 9 E.	1,390	Plainfield Sandy Loam*	A	.27	20.35	26.70	27.39	11.15	8.03	5.95
				B	.39	15.73	19.21	29.65	17.58	10.35	7.19
				C	.41	17.59	22.11	29.01	14.94	7.70	8.21
Burnett			Plainfield Sandy Loam*	A	5.7	18.9	18.6	24.7	7.9	15.6	8.4
				B	8.9	13.0	14.5	26.3	14.2	14.7	8.1
				C	14.0	12.8	11.8	27.0	13.1	12.2	9.2
Iowa†			Plainfield Sandy Loam	A	0.5	8.2	37.4	38.4	1.7	9.6	4.0
				B	.3	7.5	41.8	41.0	1.3	4.0	3.8
Jackson	T 20 N., R 2 W.	1,313	Plainfield Fine Sand*	A	.01	13.13	30.08	45.91	3.71	3.36	3.60
				B	.00	14.16	31.51	46.36	2.85	2.52	3.01
				C	.42	14.94	33.10	47.13	2.36	.70	1.25
Columbia	T 12 N., R 10 E.	1,373	Plainfield Fine Sand	A	.05	3.19	9.59	63.51	12.23	5.79	5.22
				B	.0	1.30	6.92	64.32	14.40	5.49	5.27
				C	.0	.76	7.30	64.91	20.58	2.56	2.04
Columbia	T 13 N., R 8 E.	1,374	Plainfield Fine Sand	A	.04	.24	5.91	64.28	12.99	8.98	6.36
				B	.0	.27	3.96	64.01	13.81	8.14	6.22
				C	.0	.12	2.49	68.61	13.92	7.77	5.23
Adams	T 18 N., R 5 E.	1,436	Plainfield Fine Sand	A	.02	3.7	17.7	57.6	12.1	5.2	3.6
				B	.1	3.9	19.6	58.2	10.7	3.8	3.3
				C	.1	4.8	21.5	57.6	9.8	3.0	2.9
Green Lake	T 17 N., R 12 E.	1,532	Plainfield Fine Sand	A	.0	2.9	11.0	44.6	34.2	4.3	2.9
				B	.0	1.3	11.2	43.8	37.4	4.3	3.1
Green Lake	T 17 N., R 12 E.	1,528	Plainfield Fine Sand	A	.0	.8	5.5	41.3	45.6	3.8	3.1
Barron	Composite	160	Plainfield Sand*	A	0.1	25.5	23.6	16.5	2.0	22.6	9.1
				B	0.2	25.4	24.2	18.7	2.8	18.5	9.6
Juneau	T 18, 19, 20, R 4 E.	469	Plainfield Sand	A	.21	15.63	38.28	33.42	3.73	3.71	5.56

Burnett	Composite	517	Plainfield Sand	A	0.1	10.5	27.2	50.6	4.4	3.9	3.2
				B	0.1	6.4	25.8	54.6	7.1	3.1	2.9
				C	0.0	2.7	21.4	66.4	6.2	1.8	1.4
Juneau	T 19, R 4 E.	1,378	Plainfield Sand	A	.04	14.64	34.49	34.81	3.69	5.42	6.34
				B	.57	16.20	30.84	37.72	6.11	4.43	5.34
				C	.44	13.19	35.40	40.72	4.03	1.50	3.93
Adams	T 19 N., R 6 E.	1,381	Plainfield Sand	A	.15	7.85	34.58	43.43	3.66	2.92	3.96
				B	.24	8.89	34.05	45.38	3.56	1.78	3.09
				C	.18	8.91	36.79	45.79	3.34	.40	1.25
Waushara	T 19, R 8 E.	1,382	Plainfield Sand	A	.25	19.73	35.93	33.39	3.40	3.18	3.97
				B	.45	23.26	35.12	31.82	2.99	2.81	3.71
				C	.44	24.64	42.84	27.80	1.14	1.12	2.22
Adams	T 19, R 6	1,383	Plainfield Sand	A	.03	5.91	32.23	46.98	6.82	3.40	4.66
				B	.09	6.79	32.01	47.42	6.62	3.24	3.95
				C	.13	7.77	27.58	51.21	10.19	1.32	1.91
Waushara†			Plainfield Sand	A	0.4	11.7	19.6	42.3	12.4	8.4	5.4
				B	.7	10.4	21.5	46.0	14.9	3.3	2.9
Waukesha†			Plainfield Sand	A	0.5	13.3	41.6	31.5	2.1	7.2	3.5
				B	.1	14.3	39.9	29.3	2.3	9.0	4.0
Eau Claire	T 26, R 6	15	Plainfield Sand	A	1.1	12.4	13.5	44.0	17.4	7.8	4.6
				B	0.0	17.1	14.1	43.1	18.1	4.3	3.3
Adams	T 17 N., R 6 E.	1,384	Plainfield Sand	A	.09	8.67	21.03	50.02	14.14	2.70	4.09
				B	.23	7.64	18.64	52.19	15.00	2.47	4.10
				C	.14	8.68	18.40	56.26	14.44	.49	1.71
Marinette†			Plainfield Sand	A	0.5	17.8	30.9	33.9	5.8	6.5	4.5
				B	.5	17.2	31.1	38.8	6.5	2.7	3.0
Waushara	Composite	1,386	Plainfield Sand	A	0.15	14.64	26.32	39.56	5.44	5.29	3.25
				B	.15	17.79	34.78	37.70	3.35	3.46	.92
				C	.17	18.15	34.42	40.53	2.93	1.53	2.53
Portage	T 22 N., R 9 E.	1,393	Plainfield Sand	A	.46	21.04	30.37	25.46	8.55	8.55	5.15
				B	.42	19.16	30.48	28.92	8.50	7.10	5.48
				C	1.13	34.33	32.86	20.77	3.16	2.96	4.79
Wood	T 22 N., R 6 E.	1,394	Plainfield Sand	A	0.29	25.39	42.04	21.24	2.36	4.22	4.53
				B	0.25	26.15	40.94	23.68	2.77	2.80	3.44
				C	.49	26.59	38.55	27.18	3.93	1.28	.88

†Bureau Analysis. *Mechanical analysis showed that the soil belonged in an adjacent class.

MECHANICAL ANALYSES OF SOILS—Continued

Analyses given in per cent

Location: County	Location: Land Survey	Sample Number	Field Classification	Layer	F. G.	C. S.	M. S.	F. S.	V. F. S.	Silt	Clay
Eau Claire	T 27, R 5 W.	1,397	Plainfield Sand	A	.23	26.63	27.89	28.46	5.15	6.22	5.66
				B	.33	33.82	28.35	24.95	3.23	4.29	5.12
				C	.42	33.47	31.10	26.88	2.93	2.15	3.12
Eau Claire	T 26, R 6 W.	1,399	Plainfield Sand	A	.17	23.12	22.48	31.65	13.19	5.05	4.25
				B	.05	29.66	23.60	29.56	9.96	3.64	3.73
				C	.09	30.78	23.90	28.90	10.20	2.92	3.38
Waushara		1,417	Plainfield Sand	A	.3	24.4	33.3	31.0	3.8	3.7	4.0
				B	.5	25.2	32.8	30.5	4.0	7.0	3.7
				C	3.5	27.5	32.6	31.7	2.7	2.0	3.6
			Plainfield Sand	A	1.3	24.9	30.0	21.8	3.2	13.1	5.6
				B	.4	18.7	32.1	29.9	4.5	9.8	4.8
				C	.9	27.5	34.8	30.2	3.1	1.8	2.2
Kewaunee†			Poygan Silt Loam	A	0.0	1.7	3.8	11.4	11.8	53.6	17.3
				B	.6	2.5	4.2	12.7	9.5	38.7	31.5
Waushara†			Poygan Clay Loam	A	0.7	3.9	5.7	11.3	8.3	45.5	24.2
				B	.2	1.4	2.3	9.2	12.4	44.7	29.6
Waushara†			Poygan Clay	A	0.3	2.2	5.5	9.2	3.1	33.4	46.2
				B	.0	.9	2.0	11.2	10.5	30.5	44.7
Fond du Lac	T 15 N., R 17 E.	347	Poygan Clay*	A	.02	.4	1.8	7.0	26.4	43.2	21.8
				B	.30	1.9	2.0	4.8	20.0	32.7	39.8
Outagamie†			Poygan Fine Sandy Loam	A	0.0	1.2	1.5	67.3	10.4	14.3	5.3
				B	.3	2.3	7.3	16.7	16.0	43.5	13.8
Outagamie†			Poygan Sand	A	0.5	7.1	45.8	29.6	2.3	10.7	3.4
				B	.7	5.8	35.0	33.2	5.3	10.3	9.8
Chippewa	Composite	6†	Rice Lake Loam	A	.2	12.5	11.4	9.1	7.2	46.8	12.4
				B	.3	11.3	11.9	10.4	5.7	47.1	13.2
Dunn	Composite	108†	Rice Lake Loam	A	.4	18.0	14.3	10.0	9.6	32.3	14.8
				B	.4	11.9	14.3	12.1	16.4	29.8	15.1

St. Croix	Composite	124†	Rice Lake Loam	A	.3	11.9	9.8	9.0	13.9	35.2	19.3
				B	.0	11.5	9.6	8.9	18.9	33.5	17.3
Barron	Composite	155†	Rice Lake Loam	A	.3	20.6	14.9	9.1	4.0	36.3	14.2
				B	.2	20.1	14.7	11.3	8.8	28.7	15.4
Barron & Dunn	Composite	157†	Rice Lake Loam*	A	.2	3.5	6.5	8.1	10.5	59.2	11.9
				B	.0	2.4	6.3	5.4	10.1	64.0	13.8
Kewaunee†			Rodman Sandy Loam	A	1.2	5.7	10.5	41.3	20.7	16.6	4.1
				B	.2	1.5	9.3	56.6	24.3	4.8	3.2
Kewaunee†			Rodman Fine Sand	A	0.1	2.9	15.0	64.3	8.3	5.2	3.9
				B	.0	1.7	16.7	67.0	9.7	1.9	2.9
Racine†			Sioux Sandy Loam	A	9.7	13.1	16.2	26.9	6.9	16.1	11.1
				B	9.7	12.2	15.7	31.0	4.4	14.7	12.5
La Crosse†			Sioux Sand	A	0.0	20.8	41.7	26.7	2.7	3.9	3.8
				B	.0	20.5	45.0	27.4	3.0	1.8	2.0
La Crosse†			Sioux Gravelly Sandy Loam	A	7.2	18.9	3.7	10.1	19.6	25.5	14.7
				B	19.1	27.6	4.2	9.3	14.1	15.8	9.7
N. Pt., N. Cen.†			Spencer Silt Loam	A	1.1	4.0	3.5	11.0	12.1	54.8	13.1
				B	2.1	6.4	6.0	17.0	12.4	47.7	8.2
		†	Spencer Silt Loam	A	0.6	2.2	2.5	5.0	6.2	67.4	16.2
				B	1.5	3.5	5.0	7.2	14.4	57.9	10.7
N. Pt., N. Cen.†			Spencer Fine Sandy Loam	A	2.3	13.6	14.2	25.6	8.5	25.2	10.4
				B	1.8	11.3	14.7	26.3	9.9	28.7	7.1
Dunn	Composite	106†	Sterling Sand (Plainfield Sand)	A	.3	20.8	24.8	33.6	5.7	7.0	6.9
				B	.4	22.5	28.6	31.1	5.5	6.2	6.1
Pepin	Composite	117†	Sterling Sand (Plainfield Sand)	A	.7	15.4	27.7	34.5	9.2	7.8	5.0
				B	.6	14.2	24.9	37.3	9.0	7.3	6.0
Polk	Composite	145†	Sterling Sand (Plainfield Sand)	A	.0	5.9	22.4	46.5	15.7	4.9	4.2
				B	.3	7.2	26.5	46.2	12.5	3.7	3.7
		†	Superior Clay	A	.3	1.8	2.0	6.4	7.3	38.8	43.4
				B	.1	1.5	2.9	8.0	5.4	36.9	45.2
		†	Superior Clay	A	.6	2.8	4.7	11.6	12.6	31.3	36.4
				B	.9	3.9	6.0	13.9	14.2	29.8	31.3

†Bureau Analysis. *Mechanical analysis showed that the soil belonged in an adjacent class.

MECHANICAL ANALYSES OF SOILS—Continued

Analyses given in per cent

Location		Sample Number	Field Classification	Layer	F. G.	C. S.	M. S.	F. S.	V. F. S.	Silt	Clay
County	Land Survey										
Bayfield	T 47, R 4 W.	41	Superior Clay	A	.2	1.7	3.1	9.3	15.9	28.8	40.7
				B	.2	1.5	2.5	8.3	16.8	23.8	49.2
Adams	T 14 N., R 7 E.	1,424	Superior Clay Loam	A	.3	5.2	7.9	17.7	17.2	36.2	14.9
				B	.4	6.6	9.5	19.5	14.4	25.2	24.3
				C	.1	2.0	3.0	5.8	7.3	37.7	44.4
Waushara†			Superior Clay Loam	A	0.0	2.5	8.6	25.4	1.9	36.8	24.4
				B	.0	1.1	5.3	16.1	2.6	25.7	49.2
				C	.0	1.2	16.2	68.6	2.3	.7	11.2
			Superior Silt Loam	A	.4	.9	.8	2.0	1.6	82.1	12.4
				B	.0	.0	.0	1.0	4.6	67.1	27.4
Adams	T 14 N., R 6 E.	1,422	Superior Silt Loam*	A	.1	1.3	1.7	5.7	11.4	52.0	27.3
				B	.0	.4	.6	3.4	11.1	32.5	52.5
				C	.0	.1	.4	4.4	13.4	29.3	53.2
Waushara†			Superior Loam	A	1.2	10.3	23.2	24.7	4.4	17.6	18.6
				B	.4	3.0	5.3	9.5	8.4	38.9	34.4
Adams	T 18 N., R 5 E.	1,434	Superior Fine Sandy Loam	A	.1	3.0	7.2	14.0	50.6	18.3	5.4
				B	.0	1.0	2.8	7.6	60.4	20.8	6.4
				C	.0	1.3	3.7	11.0	65.8	12.2	5.7
Marinette†			Superior Fine Sandy Loam	A	0.3	5.5	14.7	51.3	13.6	11.1	3.2
				B	.0	0.4	1.0	3.3	4.0	53.6	37.7
Outagamie†			Superior Fine Sandy Loam	A	0.8	5.0	6.4	42.5	17.2	21.2	6.8
				B	.0	2.8	2.8	11.6	7.8	51.6	23.4
Waushara†			Superior Sandy Loam	A	0.0	8.5	17.0	36.0	10.7	12.2	15.7
				B	.0	7.2	12.7	44.3	13.9	9.4	12.1
				C	.0	1.8	2.3	13.8	7.5	53.8	20.7
		†	Superior Sandy Loam*	A	2.8	14.3	20.4	25.5	14.7	14.1	18.1
				B	1.4	6.4	8.9	14.6	11.2	23.3	34.2

Douglas	T 47, R 13 W.	652	Superior Sandy Loam	A	4.0	14.3	12.8	29.4	14.2	15.7	9.2
				B	1.0	7.5	8.9	24.3	13.6	17.1	27.6
Rusk	Composite	163†	Thornapple Sandy Loam* (Plainfield)	A	.1	15.1	23.5	30.8	11.1	13.6	6.5
				B	.4	13.6	23.3	33.8	10.1	14.6	5.9
Rusk		164†	Thornapple Sandy Loam (Plainfield)	A	1.1	28.2	22.7	15.7	5.6	20.3	4.6
Eau Claire	T 26, R 6 W	1,401	Vesper Silt Loam	A	.03	2.20	2.63	6.70	26.80	45.10	17.29
				B	.13	3.76	5.10	21.64	31.06	21.92	16.76
				C	.00	1.51	1.74	6.01	26.82	24.89	40.34
Jackson	T 22 N., R 1 E.	1,316	Vesper Fine Sandy Loam	A	.00	5.08	10.99	35.17	27.74	13.35	6.92
				B	.01	6.61	12.48	35.23	21.73	11.82	11.12
				C	.10	5.80	12.57	50.08	11.92	7.48	12.06
Jackson	Composite	1,317	Vesper Fine Sandy Loam	A	.00	4.46	9.34	33.90	33.14	12.81	5.90
				B	.10	6.7	10.8	32.1	29.7	11.1	9.9
				C	.1	2.4	4.0	36.0	35.7	9.0	13.6
Oneida	Composite	879	Vilas Sandy Loam	A	.2	7.5	17.6	26.2	20.6	19.3	7.8
				B	.4	9.2	20.9	32.5	18.9	13.2	5.1
Florence	T 39 N., R 19 E.	722	Vilas Fine Sand*	A	.3	11.3	24.5	26.0	19.0	15.0	3.8
				B	.3	13.5	25.3	26.5	18.2	12.0	3.8
Oneida	Composite	740	Vilas Sand	A	.1	5.5	23.2	49.4	11.1	6.6	3.7
				B	.1	5.2	23.6	50.3	11.6	5.1	2.9
Iowa†			Wabash Silt Loam	A	0.0	0.4	0.9	4.4	2.9	77.5	14.0
				B	.0	1.1	2.4	7.1	16.8	51.7	20.8
Iowa†			Wabash Loam	A	0.0	0.4	1.5	5.1	28.1	42.3	22.3
				B	.0	.2	.4	6.7	31.3	40.2	20.8
Walworth	Composite	1,455	Waukesha Silt Loam	A	.0	.2	.3	.9	17.7	58.4	26.3
				B	.0	.1	.2	.3	17.1	49.2	33.3
				C	.0	.05	.1	.5	20.2	48.0	31.2
Waukesha	T 6 N., R 19 E.	30	Waukesha Loam*	A	.17	3.73	8.86	11.55	15.21	37.97	22.83
				B	.24	3.28	8.95	12.85	17.24	33.76	24.17
Dane†			Waukesha Fine Sandy Loam	A	0.9	13.2	25.6	26.2	5.6	17.3	11.4
				B	.8	15.2	26.0	25.4	6.0	16.3	10.3

†Bureau Analysis.

*Mechanical analysis showed that the soil belonged in an adjacent class.

MECHANICAL ANALYSES OF SOILS—Continued

Analyses given in per cent

Location		Sample	Field Classification	Layer	F. G.	C. S.	M. S.	F. S.	V.F.S.	Silt	Clay
County	Land Survey										
Waushara†			Waukesha Sandy Loam	A	0.3	10.0	22.7	35.4	7.1	12.6	11.9
				B	.7	6.8	15.5	39.8	13.1	11.9	12.2
Adams	T 18 N., R 4 E.	1,435	Waukesha Sand	A	.3	13.5	28.9	36.3	8.7	6.0	5.8
				B	.4	12.7	25.5	39.2	8.5	6.5	5.3
				C	.8	16.7	34.6	35.1	5.4	4.4	3.1
Waushara†			Waukesha Sand	A	0.7	31.7	29.5	21.9	3.4	5.6	6.9
				B	1.0	23.3	29.3	28.5	3.0	7.9	7.1
Outagamie	Composite	1,272	Whitman Very Fine Sandy Loam*	A	.00	.2	.9	11.9	66.1	16.4	4.4
Outagamie†			Whitman Fine Sandy Loam	A	0.3	1.1	0.7	51.7	20.8	17.9	7.4
				B	.0	.0	.3	34.2	50.1	12.4	3.0
Outagamie†			Whitman Loam	A	0.1	0.7	0.5	25.7	44.7	23.8	4.1
				B	.0	.0	.3	16.8	64.4	17.0	1.5

†Bureau Analysis. *Mechanical analysis showed that the soil belonged in an adjacent class.

APPENDIX III

COLLOIDAL MATTER IN WISCONSIN SOILS

On account of the importance of the colloidal matter in soils as discussed in the chapter on mechanical analysis we have undertaken the determination of the colloids in the soil types of the state. This work, however, was started only recently and the results as given in the following table are considered tentative.

The percents of colloid as given in the following table have been secured by the use of the moisture absorption method as developed at the Bureau of Soils of the United States Department of Agriculture chiefly by Doctors Gile and Davis. In this method there were employed four grams of air-dried soil which were weighed into a glass weighing dish and spread in a thin layer over the bottom. It was then exposed to the atmosphere in a dessicator over a 2% solution of sulphuric acid at a pressure just below the boiling point for 120 hours. The amount of moisture absorbed under this condition is determined by reweighing and the colloidal content calculated on the assumption that each gram of colloidal matter absorbs 3/10 of a gram of moisture under these conditions.

Since a considerable portion of the organic matter of the soils is in colloidal form and some colloidal matter remains attached to the silt and even the fine sands in the method of mechanical analysis still in use, it has been considered desirable to show the content of silt, clay and organic matter in the soils in which the amount of colloids is given as far as these have been determined and they are, therefore, included in the table.

Soil Type	Soil Survey Number	% Silt	% Clay	% Organic Matter	% Colloids
Baxter Silt Loam	468			1.84	18.92
Baxter Silt Loam	247			1.79	12.57
Boone Fine Sandy Loam	1,312				6.80
Boone Fine Sandy Loam	1,092				11.64
Boone Fine Sandy Loam	1,094				11.20
Boone Fine Sandy Loam	527	10.9	4.8	3.19	5.39
Boone Fine Sand	227				9.84
Boone Fine Sand	218				5.62
Carrington Silt Loam	494			4.31	21.27
Carrington Silt Loam	382	53.1	18.2	6.19	25.49
Carrington Silt Loam	478			8.19	32.42
Carrington Silt Loam	474			6.78	28.14
Carrington Silt Loam	479			5.79	21.25
Carrington Silt Loam	506			5.72	23.75
Clyde Silt Loam	508			14.71	60.22
Clyde Silt Loam	687				46.15
Clyde Silt Loam	678				40.37
Clyde Silt Loam	611			5.64	27.80
Clyde Silty Clay Loam	242	40.1	26.5	10.9	52.68
Colby Silt Loam	154	61.9	13.6		13.78
Colby Silt Loam	119	58.7	13.7		19.09
Coloma Sandy Loam	62	19.0	8.7	1.25	11.76
Kennan Silt Loam	165	67.7	11.2		16.23
Kennan Silt Loam	540	44.1	9.6		10.28
Kennan Silt Loam	120	60.3	14.7	3.54	17.54
Kennan Silt Loam	548	44.0	18.8	3.83	17.32
Knox Silt Loam	1,524				15.18
Knox Silt Loam	14				14.37
Knox Silt Loam	9	62.1	10.1		12.79
Miami Clay Loam	1,330	48.6	23.6		17.22
Miami Clay Loam	172	45.12	24.39	2.60	20.86
Miami Silt Loam	507			1.30	14.89
Miami Silt Loam	480			3.21	18.10
Miami Silt Loam	476			1.93	15.99
Plainfield Sand	145	4.9	4.2	1.28	6.15
Plainfield Sand	517	3.9	3.2	1.92	5.70
Plainfield Sandy Loam	213	6.95	6.36	1.62	4.93
Plainfield Sandy Loam	163	13.60	5.90		6.74
Plainfield Sandy Loam	217	16.90	14.08	2.09	11.58
Plainfield Sandy Loam	164	20.30	6.50		6.65
Plainfield Sandy Loam	588	6.60	7.50	2.10	8.19
Poygan Clay	319			8.05	45.04
Poygan Clay Loam	19				35.41
Poygan Clay Loam	21				42.36
Superior Clay	262			3.90	35.22
Superior Clay	33			1.12	25.69
Superior Clay	34			0.82	25.59
Superior Clay Loam	17				13.75

Soil Type	Soil Survey Number	% Silt	% Clay	% Organic Matter	% Colloids
Superior Clay Loam	328				32.92
Superior Clay Loam	18				16.34
Vesper Fine Sandy Loam	1,316	13.35	6.92		7.13
Vesper Fine Sandy Loam	1,317	12.81	5.90		6.24
Waukesha Silt Loam	437			4.20	20.92
Waukesha Silt Loam	438			1.61	12.57

APPENDIX IV

CHEMICAL ANALYSES OF SOILS

Chemical analyses were made on soils of the different types in order to see what variation existed in the same type and among the different types.

PHOSPHORUS was converted into a soluble form by fusion with sodium carbonate. The mixture was dissolved from the crucible with hydrochloric acid. The silica was removed by filtration after dehydrating to destroy the colloidal condition of the silica. The phosphorus was precipitated from the solution as ammonium phospho-molybdate. The phosphorus in the ammonium phospho-molybdate was determined by titration with standard sodium hydroxide.

POTASSIUM was determined by the J. L. Smith method. Soil was mixed with ammonium chloride and fused with calcium carbonate in order to convert the potassium into water soluble salts. The potassium was extracted from the fused mass with water. After removing everything but potassium and sodium from the solution, the potassium was precipitated and weighed as potassium platinic chloride.

NITROGEN. A modified Kjeldahl method was used to determine the nitrogen. Soil was digested with sulphuric acid to convert the nitrogen in the soil into ammonium sulphate. The ammonia was distilled from the ammonium sulphate and titrated.

ORGANIC MATTER was determined mostly wet by combustion with sulphuric and potassium dichromate. The loss on ignition was used to determine the organic matter in peats and mucks.

CALCIUM CARBONATE was determined by weighing the carbon dioxide liberated from the soil by phosphoric acid.

ACIDITY. A piece of good litmus paper was placed in moist soil for a definite time to make the litmus test.

The Truog Test is based on the liberation of hydrogen sulphide by soil acids from chemicals which are added. The depth of color produced on a lead acetate paper indicates the degree of acidity.

Symbols used to indicate the differences in acidity are: N.A.—no acidity, V.S.A.—very slightly acid, S.A.—slightly acid, A.—acid (medium), M.A.—medium acidity, St.A.—strongly acid and V.St.A.—very strongly acid.

LIME REQUIREMENT was found by the Vietch method. Equal weights of soil were treated with different amounts of lime water until one amount was found which left the soil slightly alkaline. The approximate amount of lime needed was calculated from the weight of soil and the amount of lime water used.

CALCIUM and MAGNESIUM. The soil was fused with sodium carbonate and the mixture obtained dissolved in acid. After removing silica, iron and aluminum from solution, the calcium was precipitated as the oxalate. The calcium oxalate was separated by filtration and the amount of calcium determined by titration with a standard potassium permanganate solution.

Sodium ammonium acid phosphate was added to the filtrate to precipitate the magnesium. The precipitate obtained was ignited and weighed as magnesium pyro-phosphate. The percentage of magnesium was calculated from this weight.

Most of the chemical analyses here recorded were made by or under the supervision of Dr. Guy Conrey.

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO^3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
Antigo Silt Loam													
	Eau Claire & Dunn	182A	0.061	1.94	0.169	3.03	0.136	A.		2,000			Composite of No. 7 –111
		B	0.061	1.46	0.058	0.45	0.072	S.A.		2,000			
	Langlade	752A							V.S.A.		0.86	0.295	
	Langlade	753A	0.069	1.90	0.180	4.04		V.A.	A.	5,000	0.735	0.27	Composite, virgin.
		B	0.049	1.91	0.071	1.63		V.A.	V.A.	5,000			
	Langlade	754A							M.A.—		0.745	0.355	
NE¼NE½ Sec 13 T41N, R8W	Sawyer	544A	0.044	1.72	0.087	1.89	0.031	S.A.		2,000			Cropped
		B	0.034	1.62	0.053	1.00	0.008	S.A.		2,000			
	Sawyer and Bayfield	423A	0.055	2.06	0.145	3.77	0.037	A.		5,000			Composite, Virgin
		B	0.034	1.91	0.037	0.64	0.003	A.		2,000			
Antigo Fine Sandy Loam													
T38, R11E	Oneida	739A	0.045	1.45	0.113	2.99		A.		2,000			Composite, Cropped
		B	0.033	1.08	0.041	0.65		A.		2,000			
	Price	905						V.A.			0.78	0.33	
SE¼ NE¼ Sec 17 T41, R11E	Vilas	846A	0.053	1.18	0.103			V.A.		5,000			Virgin.
		B	0.047	1.37	0.079			A.		2,000			
SW¼SW¼ Sec 17 T40, R10E	Vilas	742A	0.064	1.51	0.146	3.43		A.		2,000			
		B	0.041	1.17	0.048	1.13		A.		2,000			
Bates Silt Loam													
SE¼NE¼ Sec 28 T20N, R11W	Buffalo	536A	0.086	1.97	0.166			S.A.	V.S.A.				Cropped.
		B	0.080	2.00	0.130			A.	A.		0.53	0.185	
NE¼NE¼ Sec 11 T24, R11W	Buffalo	710A	0.076	1.77	0.188			S.A.	S.A.				Cropped.
		B	0.062	1.82	0.070			A.	A.		0.585	0.30	
SW¼NW¼Sec 10 T21N, R11W	Buffalo	712A						S.A.	S.A.		0.635	0.425	Cropped.
		B						A.	A.		0.595	0.315	
SW¼SE¼ Sec 19 T23N, R4W	Jackson	1,279A							M.A.+		0.595	0.445	Cropped.
		B											

						Baxter Silt Loam							
SE¼SW¼ Sec 34 T14, R4E	Juneau	247A	0.058	1.35	0.101	1.79	0.015	S.A.	------	2,000	------	------	
		B	0.053	1.97	0.039	0.55	------	S.A.	------	500	------	------	
SE¼NW¼ Sec 11 T15N, R2E	Juneau	468A	0.041	1.36	0.102	1.84	0.102	S.A.	------	2,000	------	------	Cropped.
		B	0.038	1.00	0.065	0.60	0.034	V.S.A.	------	2,000	------	------	
						Boone Loam							
------	Dunn& Barron	184A	0.059	2.47	0.037	0.63	0.071	A.	------	2,000	------	------	Composite of No. 12, 109, 110, 158
	Eau Claire	184B	0.052	1.92	0.112	2.19	0.125	S.A.	------	2,000	------	------	
						Boone Fine Sandy Loam							
SE¼NE¼ Sec 16 T24, R10W	Buffalo	704A	0.054	1.20	0.126	------	------	A.	A.	------	------	------	Cropped.
		B	0.041	1.33	0.051	------	------	S.A.	A.	------	------	------	
SW¼NW¼Sec 24 T24, R11W	Buffalo	705A	0.054	1.27	0.089	------	------	S.A.	S.A.	------	------	------	Cropped. Rolling phase
		B	0.046	1.32	0.036	------	------	S.A.	S.A.	------	------	------	
SE¼SW¼ Sec 9 T24, R11W	Buffalo	708A	0.065	1.32	0.086	------	------	S.A.	V.S.A.	------	0.428	0.458	Cropped.
		B	0.050	1.35	0.037	------	------	S.A.	V.S.A.	------	------	------	
------	Clark	948A	------	------	------	------	------	------	A.	------	0.26	0.125	Composite, virgin.
------	Clark	952A	0.023	2.30	0.066	------	------	S.A.	A.	------	------	------	Composite, virgin.
		B	0.016	3.15	0.027	------	------	S.A.	V.A.	------	------	------	
------	Clark	953A	0.021	------	0.075	------	------	A.	V.A.	------	0.18	0.13	Composite, virgin.
		B	0.024	------	0.039	------	------	A.	V.A.	------	------	------	
SW¼SW¼ Sec 2 T24N, R3W	Clark	954A	------	------	------	------	------	V.A.	V.A.	------	0.145	0.109	Virgin.
		B	------	------	------	------	------	V.A.	A.	------	------	------	
NW¼NW¼S. 28 T8N, R6E	Dane	789A	------	------	------	------	------	------	V.S.A.	------	0.355	0.105	Cropped.
SE¼SE¼ Sec 25 T8, R2E	Iowa	215A	0.057	1.11	0.048	1.03	0.187	N.A.	------	500	0.243	0.308	Cropped.
		B	0.056	0.89	0.038	1.26	0.125	N.A.	------	500	------	------	
						Boone Fine Sandy Loam							
NE¼SW¼ Sec 10 T15, R4E	Juneau	256A	0.042	1.16	0.097	2.54	0.065	A.	------	500	0.413	0.405	Cropped.
		B	0.040	1.41	0.036	0.50	0.033	S.A.	------	500	------	------	
SE¼NE¼ Sec 9 T17, R7W	La Crosse	435A	0.030	0.90	0.090	1.71	0.063	S.A.	------	2,000	------	------	Cropped
		B	0.040	0.93	0.046	0.91	0.008	S.A.	------	2,000	------	------	
NW¼SW¼ Sec 9 T18, R6W	La Crosse	491A	0.049	0.93	0.093	2.11	0.008	A.	------	5,000	0.275	0.324	Cropped
		B	0.024	1.01	0.040	0.59	0.038	A.	------	2,000	------	------	
SE¼NW¼ Sec 10 T18, R6W	La Crosse	527A	0.027	0.71	0.059	3.19	0.134	N.A.	------	2,000	0.229	0.260	Cropped.
		B	0.022	0.55	0.037	0.56	0.029	N.A.	------	2,000	------	------	

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
						Boone Fine Sand							
SW¼NE¼ Sec 17 T14N, R6E	Adams	1,429A									0.035		Cropped
		B											
NW¼NW¼ S. 13 T24, R10W	Buffalo	703A	0.054	0.64	0.046			A.	S.A.		0.164	0.199	Cropped.
		B	0.050	0.58	0.031			A.	A.				
	Clark	947A						S.A.	A.		0.04	0.02	Composite, virgin.
		B						S.A.	S.A.				
	Clark	959A						A.	A.		0.04	0.24	Composite.
		B						A.	A.				
T23, R4W	Jackson	1,320							M.A.—		0.125	0.11	Composite.
NW¼SE¼ Sec 8 T15, R5E	Juneau	221A	0.028	0.73	0.082	1.67	0.011	A.		2,000			Cropped.
		B	0.020	0.68	0.052	0.56	0.039	S.A.		2,000			Loamy phase.
NW¼SE¼ Sec 16 T15N, R2E	Juneau	455A	0.083	0.59	0.068	1.54		N.A.	N.A.	500	0.164	0.157	Virgin.
		B	0.064	0.84	0.017	0.39		S.A.		2,000			
	Juneau	670A	0.026	0.65	0.081	1.62	0.025						Composite, cropped of No. 218–227
		B	0.026	0.62	0.044	0.79	0.036						
	Juneau	671A	0.040	0.72	0.066	1.65	0.029	S.A.		2,000	0.164	0.222	Low phase, Composite of No. 250-451–453
		B	0.028	0.45	0.021	0.24	0.020	S.A.		2,000			
SE¼SE¼ Sec 28 T15N, R5	Juneau	218A						V.S.A.					
		B						V.S.A.					
NW¼NE¼ Sec 9 T18, R6W	La Crosse	490A	0.028	0.66	0.041	0.73	0.080	A.		2,000			Virgin.
		B	0.028	0.60	0.029	0.41	0.009	S.A.		2,000			
SW¼SE¼ Sec 4 T16, R7W	La Crosse	440A	0.043	1.37	0.048	0.96	0.090	A.	M.A.	2,000	0.687	0.274	Cropped
		B	0.031	1.41	0.027	0.85	0.014	S.A.		500			
NW¼NW¼ Sec 7 T17, R7W	La Crosse	441A	0.022	1.45	0.048	0.80	0.018	A.		2,000	0.631	0.302	Cropped.
		B	0.027	1.35	0.032	0.41	0.021	V.S.A.		500			
						Carrington Clay Loam							
SE¼SE¼ Sec 26 T5, R20E	Waukesha	241A	0.065	2.64	0.428	8.31	0.476	N.A.		500			Cropped.
		B	0.038	1.48	0.035	0.67	0.321	N.A.		500			

Carrington Silty Clay Loam													
	Racine	1,475							V.S.A.		0.775	0.65	
Carrington Loam													
SE¼NE¼ Sec 10 T13N, R12E	Columbia	493A	0.071	1.39	0.253	4.81		A.	A.				Cropped.
		B	0.056	1.50	0.130	2.11		A.	V.A.				
NE¼SE¼ Sec 25 T11N, R10E	Columbia	496A	0.057	1.39	0.194	3.67		A.	A.	2,000			Cropped.
		B	0.048	1.50	0.095	1.81		A.	A.	2,000			
SW¼NW¼Sec 32 T5N, R13E	Jefferson	697A	0.063		0.202		0.405	N.A.	S.A.				Cropped.
		B	0.057		0.170		2.503	N.A.	N.A.				
NE¼NW¼Sec 34 T5N, R19E	Waukesha	295A	0.057	1.41	0.164	3.13	0.044	A.		2,000			
		B	0.038	1.46	0.084	1.66	0.018	A.		2,000			
Carrington Silt Loam													
NE¼SW¼ Sec 28 T12N, R13E	Columbia	494A	0.057		0.245	4.31		A.	St.A.	2,000	0.654	0.621	Cropped
		B	0.059		0.119	2.09		A.	A.	5,000	0.805	0.55	
NW¼NE¼Sec 30 T11N, R10E	Columbia	506A	0.093		0.284	5.72		A.	A.	5,000			Cropped.
		B	0.055		0.124	2.23		A.	V.S.A.	5,000	0.505	0.50	
SW¼SW¼ Sec 30 T10N, R10E	Columbia	595A	0.056	1.77	0.237	5.16		A.	A.	5,000			Cropped.
		B	0.045	1.81	0.116	1.76		A.	A.	2,000			
T10N, R9&10E	Columbia	596A	0.069		0.148	5.08		V.S.A.	St.A.	2,000	0.723	0.679	Composite.
		B	0.047		0.110	1.72		S.A.		500	0.46	0.655	
NW¼SE¼ Sec 28 T12N, R13E	Columbia	497A											Cropped.
		B									0.485	0.49	
SW¼SE¼ Sec 16 T10N, R9E	Columbia	597A											Cropped.
		B									0.53	0.355	
SW¼SE¼ Sec 1 T13N, R13E	Dodge	473A	0.080	1.47	0.236			A.	A.				Cropped.
		B	0.047	1.69	0.069			V.S.A.	A.				
SE¼SW¼ Sec 35 T16N, R15E	Fond du Lac	364A	0.071	2.08	0.232	4.40	0.056	S.A.		2,000			Cropped.
		B	0.050	2.14	0.080	4.35	0.125	N.A.		2,000	0.58	0.08	
NW¼SW¼ Sec 3 T14N, R15E	Fond du Lac	382A	0.091	1.89	0.310	6.19	0.052	A.		2,000			Cropped.
		B	0.076	1.99	0.132	2.37	0.410	S.A.		500	0.64	0.65	
	Fond du Lac	474A	0.088	1.87	0.322	6.78	0.179	A.	M.A.	2,000	0.690	0.515	Composite, cropped
		B	0.050	1.93	0.100	1.82	0.241	V.S.A.		2,000	0.715	0.45	
NW¼NW¼Sec 7 T15N, R14E	Fond du Lac	478A	0.167	1.92	0.415	8.19	0.080	A.		5,000			Cropped.
		B	0.128	2.17	0.158	3.25	0.228	A.		5,000	0.52	0.22	

Location		Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity		Lime Rqt.	Total Ca.	Total Mg.	Remarks
Land Survey	County							Litmus	Truog Test				
Carrington Silt Loam—Continued													
NE¼NW¼Sec 27 T16N, R14E	Fond du Lac	479A	0.077	2.04	0.273	5.79	0.047	A.	M.A.	2,000	0.628	0.508	Cropped.
		B	0.034	1.98	0.085	1.39	0.038	V.S.A.		2,000	0.57	0.57	
NE¼NE¼ Sec 33 T15N, R14E	Fond du Lac	381A						A.					Cropped.
		B						S.A.			0.775	0.56	
SW¼NW¼Sec 19 T5N, R13E	Jefferson	694A	0.067		0.267			A.	M.A.		0.573	0.474	Cropped
		B	0.058		0.079			A.	A.		0.325	0.325	
SW¼SE¼Sec 26 T3N, R20E	Racine	1,475									0.775	0.65	Cropped.
	Rock	1,302A									0.45	0.565	Composite.
		B											
	Rock	1,303A											Composite
		B									0.37	0.525	
Carrington Gravelly Loam													
	Fond du Lac	471A	0.119	1.89	0.320	5.92	4.460	S.A.		500			(from near Ripon)
		B	0.057	1.54	0.055	0.47	37.936	N.A.		500			Composite
Carrington Fine Sandy Loan													
SW¼SE¼ Sec 17 T11N, R12E	Columbia	510A	0.045	1.09	0.148	2.92		A.	A.	2,000			Cropped.
		B	0.050	1.18	0.071	1.14		A.	A.	2,000			
NE¼SW¼ Sec 30 T11N, R11E	Columbia	629A	0.053		0.090	2.79		A.	V.A.	2,000			Cropped.
		B	0.045		0.060	1.66		S.A.	V.A.	2,000			
SW¼SE¼ Sec 10 T5N, R13E	Jefferson	695A	0.110		0.250			A.	A.				Cropped.
		B	0.108		0.110			S.A.	A.				
Clyde Clay Loam													
	Fond du Lac	338A	0.138	1.55	0.768	14.41	0.667	N.A.		500	1.84	0.973	Composite, virgin
		B	0.080	1.85	0.143	3.00	0.711	N.A.		500			
SW¼NE¼ Sec 35 T16N, R15E	Fond du Lac	362A	0.154	1.56	0.768	9.99	4.905	N.A.		500	2.850	1.370	
		B	0.081	1.69	0.140	1.15	18.118	N.A.		500			
SW¼NE¼ Sec 26 T5N, R15E	Jefferson	570A	0.129		0.529	8.51	2.490	N.A.					Cropped.
		B	0.073		0.144		36.030	N.A.	N.A.				
SE¼NE¼ Sec 10 T5N, R14E	Jefferson	701A	0.111		0.443		0.446	N.A.	N.A.				Cropped
		B	0.083		0.087		16.314	N.A.	N.A.				

						Clyde Silty Clay Loam							
	Pierce	1,533B									1.155	0.435	Composite.
SW¼NE¼ Sec 16 T6N, R20E	Waukesha	31A	0.107	2.09	0.458	8.68	0.417	N.A.		500			Cropped.
		B	0.075	2.39	0.106	1.88	0.232	N.A.		500			
	Waukesha	173A	0.116	2.12	0.401	7.76	0.389	N.A.		500			Composite.
		B	0.078	2.52	0.121	1.70	3.526	N.A.		500			
NE¼NE¼ Sec 26 T8N, R20E	Waukesha	229A	0.102	2.30	0.484	13.51	1.834	N.A.		500			Cropped.
		B	0.070	2.25	0.124	1.77	5.089	S.A.		500			
SW¼NE¼ Sec 11 T5N, R20E	Waukesha	242A	0.132	2.25	0.610	10.90	2.620	N.A.		500	2.38	1.45	Cropped.
		B	0.053	2.64	0.125	2.21	1.865	N.A.		500			
						Clyde Silt Loam							
NE¼NW¼Sec25 T10N, R13E	Columbia	508A	0.135		0.910	14.71	0.098	N.A.	N.A.	500			Cropped.
		B	0.056		0.213	3.36	nil	N.A.	N.A.	500			
SW¼NW¼Sec17 T12N, R8E	Columbia	611A	0.116		0.332	5.64		S.A.	A.	500	1,020	0.633	Cropped.
		B	0.078		0.125	1.90		S.A.	S.A.	500			
	Jefferson	678A	0.123		0.346		20.940	N.A.	N.A.				Composite.
		B	0.083		0.134		21.600	N.A.	N.A.				
SE¼SE¼ Sec 4 T6N, R14E	Jefferson	687A	0.135		0.579		2.167	N.A.	N.A.		1.86	1.15	Cropped.
		B	0.077		0.565		15.180	N.A.	N.A.				
	Walworth	1,459A									1.50	0.70	Composite, cropped
						Clyde Loam							
NE¼SW¼ Sec 1 T11N, R11E	Columbia	641A	0.107	1.29	0.427	5.30	5.240	N.A.	N.A.	500			Perm. Pasture.
		B	0.054				5.510	N.A.	N.A.	500			
NE¼SW¼ Sec 16 T5N, R14E	Jefferson	700A	0.095		0.488			V.S.A.	S.A.				Cropped.
		B	0.045		0.190			N.A.	N.A.				
NW¼SW¼ Sec 2 T4N, R13E	Rock	853									1.23	0.52	Cropped.
NW¼NE¼Sec24 T6N, R19E	Waukesha	26A	0.086	1.28	0.479	8.20	0.523	N.A.		500			Perm. Pasture.
		B	0.026	1.55	0.087	1.78	0.805	N.A.		500			
	Waukesha	175A	0.060	1.56	0.113	1.74	0.105	A.		500			Composite, virgin.
		B	0.043	1.66	0.050	0.46	0.041	A.		500			
Sec.4 T7N, R19E	Waukesha	237A	0.120	1.56	0.575	9.82	0.024	N.A.		500			Composite Virgin.
		B	0.059	1.76	0.110	2.00	0.327	N.A.		500			

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
Clyde Sandy Loam													
SW¼SW¼ Sec 23 T6N, R16E	Jefferson	566A	0.055		0.138			N.A.	V.S.A.				Virgin.
		B	0.022		0.077			N.A.	N.A.				
	Waukesha	174A	0.073	1.66	0.443	7.74	0.664	N.A.		500			Composite, cropped
		B	0.099	1.62	0.108	1.57	5.999	N.A.		500			
Clyde Fine Sand													
NE¼SW¼ Sec 8 T12N, R13E	Columbia	499A	0.054	0.55	0.237	4.07		A.	A.	2,000			Cropped.
		B	0.022	0.60	0.056	0.54		V.S.A.	V.S.A.	500			
NW¼SW¼ Sec 2 T12, R10E	Columbia	643A	0.044	0.55	0.210	3.17		V.S.A.	V.S.A.	500			Cropped.
		B	0.013	0.60	0.045	0.29		N.A.	N.A.	500			
Clyde Fine Sandy Loam													
SE¼SE¼ Sec 31 T12, R12E	Columbia	640A	0.054		0.364	6.51	0.043	V.S.A.	N.A.	500			Perm. pasture
		B	0.037		0.125	2.15	nil	S.A.	N.A.	500			
NW¼NW¼ Sec 9 T11, R11E	Columbia	642A	0.035	0.60	0.244	4.43	nil	V.S.A.	N.A.	500			Perm. pasture.
		B	0.028	0.68	0.076	1.15	nil	N.A.	N.A.	500			
NE¼NE¼ Sec 32 T13N, R16E	Jefferson	557A	0.049		0.374	4.40	5.250	N.A.	N.A.				Perm. pasture
		B	0.038		0.192	2.56	2.435	N.A.	N.A.				
NW¼SE¼ Sec 5 T5N, R20E	Waukesha	28A	0.037	1.37	0.117	2.74	0.101	S.A.		500			Perm. pasture.
		B	0.022	1.31	0.037	0.79	0.089	N.A.		500			
Colby Silt Loam													
	Langlade	756A	0.064	1.78	0.178	3.68		A.	St.A.	5,000	0.66	0.30	Composite, virgin.
		B	0.048	1.77	0.072	1.55		A.	V.A.	5,000			
	Lincoln	354A	0.084	1.18	0.226	4.57	0.099	S.A.	A.	2,000	0.622	0.695	Composite, cropped
		B	0.052	1.55	0.076	0.98	0.043	S.A.	V.A.	5,000			
	Marathon and Clark	350A	0.070	1.64	0.234	4.40	0.166	S.A.	A.	5,000			Composite, cropped
		B	0.065	1.74	0.068	0.85	0.035	S.A.	V.A.	5,000			
	Oneida	884A	0.080		0.131	2.98			V.A.				Composite, virgin.
		B	0.053		0.042	0.65			V.A.				

	Polk and Barron	189A	0.055	1.88	0.143	2.89	0.175	N.A.		2,000	0.830	0.622	Composite, cropped of No. 138, 148, 154.
		B	0.042	1.82	0.042	0.58	0.032	S.A.		5,000			
NE¼NE¼ Sec 31 T24N, R6E	Portage	998A	0.038					A.	A.				Cropped 4 yrs.
		B	0.032					A.	V.A.				
T35N, R4W	Rusk	922A	0.048		0.107	2.00		A.	A.		0.703	0.741	Composite, cropped
		B	0.061		0.022			A.	V.A.				
	Wood	351A	0.086	1.38	0.212	3.77	0.200	A.	A.	2,000	0.315	0.752	Composite, virgin.
		B	0.057	1.85	0.054	0.84	0.030	A.	V.A.	5,000			
T25N, R2E	Wood	940A						A.	A.		0.525	0.405	
		B						V.A.	V.A.				Cropped, composite
T25N, R2E	Wood	941A	0.059					S.A.A.	A.				
		B	0.039					V.A.	V.A.				Virgin, composite.
T25N, R2E	Wood	942A						S.A.	S.A.		0.54	0.39	
		B						V.A.	V.A.				Cropped, composite
T25N, R5E	Wood	966A	0.061					A.					
		B	0.047					S.A.	A.				Cropped, composite
	Wood	1,056A	0.060										
		B	0.043										Composite, virgin.
	Wood	1,057A	0.060										
		B	0.049										Composite, cropped
SE¼NE¼ Sec 29 T24N, R4E	Wood	1,060A	0.096										Virgin.
		B	0.069										
		1,147A	0.073										Composite of No. 945, 949, 967, 992
		B	0.038										
Colby Fine Sandy Loam													
T35N, R11E	Oneida	885A	0.048		0.116	3.73			V.A.				Composite, virgin.
		B	0.030		0.047	1.66			V.A.				
T37&38N, R1E	Price	907A	0.032		0.071	1.85		A.	V.A.				Composite, virgin.
		B	0.036		0.033	0.60		S.A.	A.				
Coloma Loam													
NW¼NE¼ Sec22 T20N, R10E	Waushara	54A	0.038	1.41	0.177	3.13	0.118	A.		2,000			
		B	0.031	1.71	0.055	0.55	0.036	S.A.		2,000			Cropped.

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	CaCO^{3}	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
Coloma Fine Sandy Loam													
NW¼SE¼ Sec 7 T13N, R7E	Columbia	498A	0.035	1.06	0.070	1.81	nil	A.	V.S.A.	500			Cropped.
		B	0.031	1.06	0.033	1.05	nil	S.A.	V.S.A.	500			
T13N, R7&8E	Columbia	618A	0.028	1.06	0.069	1.30	nil	S.A.	V.S.A.	500			Composite, cropped
		B	0.043	1.06	0.037	0.50	nil	V.S.A.		500			
Coloma Sandy Loam													
SE¼SW¼ Sec 22 T19N, R11E	Waushara	47A	0.029	1.24	0.094	1.35	0.082	A.		500			Cropped.
		B	0.030	1.01	0.055	0.46	0.038	S.A.		2,000			
NW¼NW¼Sec 4 T18N, R11E	Waushara	62A	0.032	0.30	0.137	1.25	0.075	S.A.					Cropped.
		B	0.029	1.67	0.056	0.53	0.034	S.A.					
Coloma Fine Sand													
NE¼NE¼ Sec 15 T16N, R7E	Adams	1,432A							M.A.		0.132		Cropped.
		B											
SE¼NE¼ Sec 12 T13N, R7E	Columbia	616A	0.027		0.038	0.43	nil	V.S.A.	V.S.A.	500			Cropped.
		B	0.029		0.024	0.26	nil	N.A.	N.A.	500			
T13, R7 & 8E	Columbia	617A	0.027	0.056	0.055	0.88	nil	V.S.A.	S.A.	500			Composite, cropped
		B	0.032	0.050	0.030	0.33	nil	N.A.	N.A.	500			(away from Miami)
SE¼NW¼ Sec 18 T13N, R9E	Columbia	623A	0.042		0.057	0.82		A.	A.	500	0.284	0.314	Cropped.
		B	0.040		0.040	0.34		S.A.	A.	500			
T13, R8 & 9E	Columbia	624A	0.035		0.056	0.87	nil	V.S.A.	S.A.	500	0.299	0.352	Composite, cropped
		B	0.032		0.032	0.43	nil	V.S.A.	V.S.A.	500			
SE¼NE¼ Sec 16 T28, R17E	Oconto	774A	0.071	1.84	0.063		0.035	A.	S.A.	500			
		B	0.063	2.16	0.024		0.014	S.A.	S.A.	500			(Miami border)
NW¼NW¼S. 27 T28, R20E	Oconto	811A	0.054	1.68	0.057		0.026	A.	A.	2,000	0.368	0.389	Virgin.
		B	0.035	1.59	0.018		0.012	S.A.	A.	500			
NW¼SW¼Sec25 T28, R19E	Oconto	829A	0.079		0.038	1.31	0.037	A.	S.A.	500	0.304	0.351	
		B	0.065		0.015	0.42		S.A.	S.A.	500			
T27N, R15&16E	Shawano	817A	0.045	1.33	0.051	0.71		A.	A.	500	0.292	0.378	Composite, virgin.
		B	0.050	1.32	0.027	0.85		S.A.	A.	500			

Coloma Sand													
NW¼SE¼ Sec 23 T16N, R7E	Adams	1,431A									0.125	0.095	Cropped.
		B											
SE¼SE¼ Sec 5 T19N, R10E	Waushara	48A	0.027	0.88	0.080	1.27	0.068	N.A.		2,000			Cropped.
		B	0.023	0.89	0.037	0.29	0.037	N.A.		2,000			Heavier than typical.
NE¼SE¼ Sec 36 T19N, R11E	Waushara	49A		0.55	0.067	0.63	0.048	S.A.	M.A.—	2,000	0.203	0.303	Cropped.
		B		0.37	0.029	0.22	0.031	S.A.					
NE¼SE¼ Sec 36 T19N, R11E	Waushara	50A	0.030	0.43	0.116	0.97	0.051	S.A.	M.A.—	2,000	0.278	0.296	Virgin.
		B	0.021	0.40	0.079	0.27	0.013	N.A.		2,000			Comparable to No. 49.
SW¼SE¼ Sec 16 T19N, R10E	Waushara	66A	0.035	0.59	0.110	1.57	0.057	A.		2,000			Cropped.
		B	0.029	0.57	0.056	0.62	0.023	A.		2,000			
Coloma Gravelly Sand													
	Bayfield	207A	0.025	1.32	0.077	1.72	0.057	A.					Cropped.
		B	0.029	1.93	0.060	1.46	0.118	S.A.					
SW¼SW¼ Sec 7 Wautoma	Waushara	63A	0.024	1.24	0.160	2.94	0.056	A.					Cropped.
		B	0.033	1.44	0.090	1.40	0.034	A.					
Dodgeville Silt Loam													
	Dane	833A	0.144										
		B	0.125										
Sec. 14 T6, R5E	Iowa	4A	0.071	1.85	0.313	6.23	0.200	S.A.		500			Cropped.
		B	0.074	1.88	0.238	4.50	2.905	N.A.		500			
Dunning Fine Sandy Loam													
NE¼NE¼ Sec 28 T13N, R8E	Columbia	620A	0.048	1.07	0.234	4.86			A.				Cropped.
		B	0.021	1.21	0.034	0.95			A.				
Dunning Sandy Loam													
SW¼NW¼ Sec 6 T20N, R7E	Adams	1,439									0.37	0.145	Virgin.
NE¼NW¼Sec 32 T21N, R8E	Portage	934A						V.S.A.	V.S.A.		0.48	0.16	Virgin.
		B						N.A.	N.A.				
Dunnin Sand													
NW¼SE¼ Sec 1 T20N, R6E	Adams	1,438A							S.A.		0.275	0.06	Cropped.
		B											
	Jackson	1,371							V.S.A.		0.08	0.04	

Location		Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO^{3}$	Acidity		Lime Rqt.	Total Ca.	Total Mg.	Remarks
Land Survey	County							Litmus	Truog Test				
						Dunning Sand—Continued							
SE¼NE¼ Sec 12 T16N, R3E	Juneau	253A	0.041	0.47	0.148		0.080	A.		5,000			Cropped.
		B	0.020	0.51	0.053	1.15	0.026	A.		2,000			
NW¼NE¼ Sec33 T23N, R8E	Portage	1,024A						V.A.	S.A.		0.62	0.11	
		B						A.	V.S.A.				
T22N, R5E	Wood	935A	0.056								0.435	0.065	Composite, virgin.
		B	0.022										
						Dunning Fine Sand							
SW¼NW¼ Sec24 T22N, R3E	Wood	1,063A									0.19	0.11	Virgin.
SW¼NW¼Sec 32 T21N, R3E	Wood	1,074A	0.039		8.69								
		B	0.016		2.53								
						Fox Silt Loam							
SW¼SE¼ Sec 15 T12N, R9E	Columbia	612A	0.092	1.49	0.177	3.75		A.	A.	2,000	0.862	0.573	Cropped.
		B	0.076	2.45	0.062	0.78		S.A.	A.	2,000			
T16N, R19E	Fond du Lac	312A	0.060	2.03	0.159	3.03	0.051	N.A.		500			Composite, cropped
		B	0.052	2.18	0.092	1.14	0.073	N.A.		500			
T13N, R19E	Fond du Lac	481A	0.051			.565			S.A.		0.652	0.568	Composite, cropped
		B	0.054			0.55							
SE¼NE¼ Sec 23 T7N, R13E	Jefferson	679A	0.053		0.135			S.A.	N.A.				Cropped.
		B	0.053		0.060			S.A.	A.				
SW¼SE¼ Sec 3 T6N, R14E	Jefferson	686A	0.048		0.166			S.A.	N.A.		0.750	0.590	Cropped. (Deep phase)
		B	0.043		0.069			S.A.	A.				
NW¼NW¼S. 32 T6N, R14E	Jefferson	691A	0.044		0.142			S.A.	N.A.		0.581	0.535	Cropped.
		B	0.039		0.072			V.S.A.	V.S.A.				
SE¼SE¼ Sec 29 T23N, R24E	Kewaunee	404A	0.049		0.144			N.A.		500			Cropped.
		B	0.044		0.068			N.A.		500			
SE¼SE¼ Sec 13 T23N, R23E	Kewaunee	405A	0.056		0.144			N.A.		500			Cropped.
		B	0.056		0.041			N.A.		500			

SW¼NE¼ Sec 25 T27N, R15W	Pierce	1,536A	--------	--------	--------	--------	--------	--------	--------	--------	0.75	0.39	
SW¼SW¼ Sec 21 T4N, R13E	Rock	857	--------	--------	--------	--------	--------	S.A.	--------	--------	0.60	0.215	Cropped
NW¼NE¼Sec27 T7N, R17E	Waukesha	280A	0.042	1.67	0.101	1.98	0.184	S.A.	--------	2,000	--------	--------	Cropped. (Light phase)
		B	0.046	1.58	0.061	0.96	0.069	N.A.	--------	2,000	--------	--------	
T8N, R17E	Waukesha	287A	0.048	2.03	0.155	3.20	0.054	A.	--------	500	0.673	0.521	Composite, cropped
		B	0.050	2.05	0.073	1.23	0.044	S.A.	--------	2,000	--------	--------	

Fox Loam

NW¼SW¼Sec26 T7N, R15E	Jefferson	556A	0.040	--------	0.103	1.83	--------	N.A.	V.S.A.	--------	--------	--------	Cropped.
		B	0.045	--------	0.062	0.84	--------	S.A.	N.A.	--------	--------	--------	
NE¼SE¼ Sec 32 T6N, R14E	Jefferson	692A	0.043	--------	0.113	--------	0.035	A.	A.	--------	--------	--------	Cropped.
		B	0.037	--------	0.057	--------	nil	N.A.	V.S.A.	--------	--------	--------	
NW¼NW¼S. 36 T7N, R17E	Waukesha	286A	0.031	1.54	0.099	1.86	0.041	S.A.	--------	500	--------	--------	Cropped.
		B	0.043	1.58	0.049	0.80	0.022	N.A.	--------	500	--------	--------	

Fox Fine Sandy Loam

NW¼SE¼ Sec 10 T12N, R10E	Columbia	633A	0.048	1.01	0.149	2.79	--------	S.A.	A.	2,000	--------	--------	
		B	0.040	1.07	0.072	1.15	--------	V.S.A.	S.A.	500	--------	--------	
SE¼NW¼ Sec 20 T5N, R16E	Jefferson	558A	0.025	--------	0.081	1.40	0.060	S.A.	N.A.	--------	--------	--------	Cropped.
		B	0.022	--------	0.047	0.96	--------	S.A.	V.S.A.				
NE¼SW¼ Sec 7 T6N, R13E	Jefferson	681A	0.025	--------	0.078	--------	--------	S.A.	V.S.A.	--------	--------	--------	Cropped. (Darker than typical)
		B	0.031	--------	0.054	--------	--------	S.A.	S.A.	--------	--------	--------	
Sec. 13—Sec. 14 T28N, R18E	Oconto	768A	0.050	2.05	0.087	--------	0.053	A.	V.S.A.	500	--------	--------	Composite Cropped.
		B	0.039	2.03	0.032	--------	0.420	V.S.A.	V.S.A.	2,000	--------	--------	
SW¼SW¼ Sec 10 T6N, R17E	Waukesha	278A	0.036	1.26	0.068	1.22	0.137	N.A.	--------	500	--------	--------	Cropped.
		B	0.031	1.27	0.031	0.50	0.029	N.A.	--------	500	--------	--------	
NW¼NW¼ S. 20 T7N, R17E	Waukesha	277A	0.041	1.39	0.064	1.41	0.032	N.A.	--------	500	--------	--------	Cropped.
		B	0.036	1.42	0.032	0.56	0.036	N.A.	--------	500	--------	--------	

Fox Sandy Loam

NW¼NW¼ S. 5 T22N, R24E	Kewaunee	409A	0.038	--------	0.142	--------	--------	N.A.	--------	500	--------	--------	Cropped.
		B	0.026	--------	0.046	--------	--------	N.A.	--------	500	--------	--------	

Fox Gravelly Sandy Loam

SE¼NW¼ Sec 20 T24N, R24E	Kewaunee	399A	0.053	--------	0.122	--------	--------	N.A.	--------	500	--------	--------	Cropped.
		B	0.054	--------	0.100	--------	--------	N.A.	--------	500	--------	--------	

Location		Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity		Lime Rqt.	Total Ca.	Total Mg.	Remarks
Land Survey	County							Litmus	Truog Test				
					Genesee Silty Clay Loam								
N ½SW ¼ Sec 4 T18N, R10W	Buffalo	717A B	0.243 0.185	1.96 1.96	0.342 0.173	----- -----	A. S.A.	A. A.	----- -----	----- -----	----- -----	----- -----	Delta Land Co. Virgin.
NW¼NW¼S. 10 T16N, R10W	Buffalo	718A B	0.330 0.268	1.53 1.53	0.181 0.104	----- -----	S.A. S.A.	A. S.A.	----- -----	----- -----	----- -----	----- -----	Delta Land Co. Virgin
					Kennan Silt Loam								
Sec. 27 T14N, R3E	Ashland	576A	0.025	1.50	0.139	4.52	0.313	V.A.	-----	5,000	-----	-----	Virgin.
Sec. 14 & 15 T31, R5W	Chippewa	120A B	0.073 0.037	1.84 1.86	0.176 0.039	3.54 0.55	0.229 0.051	V.A. V.A.	----- -----	5,000 5,000	----- -----	----- -----	Composite, virgin.
T31N, R12&13E	Langlade	775A	-----	-----	-----	-----	-----	V.A.	V.A.	2,000	0.055	0.335	Composite.
T31, R13&14E	Langlade	776A B	0.072 0.067	----- -----	0.132 0.058	3.19 1.51	----- -----	A. A.	A. V.A.	5,000 5,000	0.552	0.370	Composite, virgin.
NW¼NE¼ Sec14 T38, R9E	Oneida	766A B	0.051 0.036	1.32 1.23	0.12 0.040	----- -----	----- -----	A. A.—	-----	2,000 2,000	----- -----	----- -----	Cropped.
-----	Oneida	875A B	0.051 0.053	----- -----	0.096 0.041	2.80 1.32	----- -----	V.A. V.A.	----- -----	----- -----	0.550	0.393	Composite, virgin.
-----	Price	374A B	0.057 0.074	0.98 1.63	0.089 0.092	2.06 1.51	0.123 0.150	A. A.	A. V.A.	2,000 2,000	----- -----	----- -----	Composite, virgin.
-----	Price	909	-----	-----	-----	-----	-----	-----	V.A.	-----	0.795	0.48	Virgin.
NW¼SE¼ Sec32 T39N, R5W	Sawyer	548A B	0.046	1.70	0.209	3.83	0.268	V.A.	-----	5,000	-----	-----	Virgin.
-----	Sawyer	659A B	0.044 0.035	1.86 1.82	0.105 0.065	2.05 1.27	0.078 0.041	S.A. A.	----- -----	2,000 5,000	0.587	0.432	Composite, Virgin of No. 540, 541
----- T28N, R11E	Shawano	759A B	0.054 0.041	2.04 1.96	0.096 0.050	2.07 1.18	----- -----	A. A.	A. A.	2,000 2,000	0.525	0.354	Composite, virgin.
NE¼NE¼ Sec 6 T41N, R12E	Vilas	848A B	0.072 0.042	1.28 1.30	----- -----	----- -----	----- -----	V.A. A.	St.A.	5,000 5,000	0.446	0.408	Virgin.

					Kennan Silt Loam, Rolling Phase								
T41N, R1W	Ashland	925A	0.054	-----	0.158	3.71	-----	V.A.	A.	-----	-----	-----	Composite, virgin.
		B	0.047	-----	0.068	1.59	-----	A.	V.A.	-----	-----	-----	
NE¼NW¼ S. 35 T40N, R17E	Florence	719A	0.089	-----	0.143	3.35	-----	V.A.	V.A.	5,000	-----	-----	Virgin.
		B	0.072	-----	0.082	2.26	-----	A.	V.A.	5,000	-----	-----	
SE¼SE¼ Sec 33 T37N, R17E	Marinette	92A	0.064	2.09	0.125	2.83	0.165	V.A.	-----	5,000	-----	-----	
		B	-----	-----	-----	-----	-----	V.A.	-----	5,000	-----	-----	
SW¼SW¼ Sec 16 T35N, R17E	Marinette	102A	0.028	1.84	0.124	3.82	0.309	V.A.	-----	5,000	-----	-----	
		B	-----	-----	-----	-----	-----	V.A.	-----	5,000	-----	-----	
SE¼NW¼ Sec 11 T26N, R12E	Shawano	760A	0.065	-----	0.210	4.02	0.046	N.A.	V.S.A.	500	-----	-----	Cropped.
		B	0.042	-----	0.061	1.15	0.018	V.S.A.	S.A.	2,000	-----	-----	
T29, R12E	Shawano	806A	0.053	2.03	0.151	3.55	-----	S.A.	S.A.	2,000	-----	-----	Composite, cropped
		B	0.034	2.21	0.059	1.52	-----	A.	A.	2,000	-----	-----	
-----	Shawano	841A	0.069	-----	0.113	2.33	0.033	V.A.	S.A.	2,000	-----	-----	
		B	0.057	-----	0.053	1.35	0.016	V.A.	A.	2,000	-----	-----	
					Kennan Loam								
-----	Ashland	660A	0.057	1.40	0.222	3.92	0.150	A.	-----	5,000	-----	-----	Composite Virgin of No. 572, 575
		B	0.046	0.51	0.096	1.95	0.149	V.A.	-----	5,000	-----	-----	
-----	Ashland	928A	0.052	-----	0.108	2.66	-----	V.A.	V.A.	-----	-----	-----	Composite, virgin (Chelsea Loam)
		B	0.049	-----	0.066	1.58	-----	V.A.	V.A.	-----	-----	-----	
-----	Sawyer	661A	0.059	1.38	0.072	1.58	0.088	A.	-----	2,000	-----	-----	Composite, virgin of No. 542, 543, 545 547.
		B	0.049	1.32	0.044	1.12	0.042	A.	-----	2,000	-----	-----	
T32N, R1 & 2E	Taylor	349A	0.057	1.45	0.063	2.43	0.043	A.	-----	2,000	-----	-----	(Chelsea Loam) Composite, cropped
		B	0.061	1.46	0.036	0.85	0.043	A.	-----	2,000	-----	-----	
-----	Taylor	353A	0.074	1.19	0.212	4.32	0.101	S.A.	-----	5,000	-----	-----	(Chelsea Loam) Composite, cropped
		B	0.057	1.46	0.070	0.99	0.052	S.A.	-----	2,000	-----	-----	
-----	Taylor	368A	0.065	2.74	0.122	1.76	0.157	A.	-----	2,000	-----	-----	(Chelsea Loam)
-----	Washburn	412A	0.058	1.77	0.125	3.25	0.038	S.A.	-----	2,000	-----	-----	(Chelsea Loam) Composite, virgin.
		B	0.030	1.66	0.029	0.46	0.006	A.	-----	2,000	-----	-----	
					Chelsea Loam								
-----	Taylor	353A	0.074	1.19	0.212	-----	0.100	S.A.	-----	-----	-----	-----	Composite, cropped
		B	0.057	1.46	0.070	-----	0.052	S.A.	-----	-----	-----	-----	
-----	Taylor	368	0.065	2.74	0.122	1.76	-----	A.	-----	-----	-----	-----	

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
Gloucester Loam													
SE¼SE¼ Sec 26 T32N, R5E	Lincoln	970A	0.052					A.	S.A.				Virgin
		B	0.030					V.S.A.	A.				
Kennan Fine Sandy Loam													
NE¼SW¼ Sec 9 T38N, R19E	Florence	726A	0.041	2.05	0.083	2.05		V.A.		2,000	0.39	0.31	Virgin.
		B	0.040	2.12	0.038	1.12		A.		2,000			
T40N, R18E	Florence	721A									0.605	0.105	
T34N, R10&11E	Langlade	778A	0.060	2.05	0.093	2.70		A.	V.A.	5,000			Composite, virgin.
		B	0.051		0.051	1.56		A.	V.A.	5,000			
NE¼NE¼ Sec 20 T31, R16E	Oconto	737A	0.062	2.05	0.076	1.95		A.	V.A.	2,000			Virgin
		B	0.040	2.12	0.025	0.95		S.A.	A.	500			
T29, R12E	Shawano	807A	0.064	2.05	0.020	2.66	0.035	S.A.	S.A.	2,000			Composite, cropped
		B	0.036	2.12	0.059	1.31	0.014	V.S.A.	S.A.	2,000			
Sec. 19–20 T41, R11E	Vilas	847A	0.074	1.32	0.135			V.A.		2,000			Composite, virgin.
		B	0.042	1.43				A.		5,000			
T43N, R9E	Vilas	781A	0.067	1.26	0.092	3.10		A.		2,000			Virgin.
		B	0.060	1.31	0.045	1.44		A.		2,000			
		1,151A	0.046								0.66	0.375	Composite of No. 957, 979, 995
		B	0.024										
Knox Silt Loam													
SE¼SW¼ Sec 20 T19, R11W	Buffalo	537A	0.067	1.73	0.104			V.S.A.	V.S.A.				Cropped.
		B	0.071	1.64	0.032			V.S.A.	S.A.		0.715	0.54	
NE¼SW¼ Sec 29 T23N, R11W	Buffalo	749A	0.096	1.72	0.097			V.S.A.	V.S.A.		0.672	0.546	Cropped.
		B	0.063	1.88	0.112			V.S.A.	S.A.				
NW¼NE¼ Sec10 T22N, R13W	Buffalo	522A						S.A.	N.A.				Cropped.
		B						S.A.	A.		0.70	0.325	
NW¼NE¼Sec14 T21N R11W	Buffalo	713A						V.S.A.	V.S.A.		0.735	0.545	Cropped.
		B						N.A.	N.A.		1.655	0.575	

T 7 & 8 N R 6 E	Dane	786A	------	------	------	------	------	------	S.A.	------	0.535	0.30	
SE¼SE¼ Sec 29 T7, R6	Dane	788	------	------	------	------	------	------	V.S.A.	------	0.575	0.40	Cropped.
------	Iowa	103A B	0.041 0.050	1.79 1.87	0.106 0.043	2.04 0.59	0.080 0.078	V.S.A. A.	------ ------	------ ------	0.475	0.48	Cropped.
Sec. 1 T5N, R4E	Iowa	1A B	0.031 0.038	1.95 1.81	0.130 0.073	2.40 1.12	0.123 0.082	S.A. S.A.	------ ------	500 2,000	0.50	0.49	Cropped.
Sec. 21 T7N, R5E	Iowa	2A B	0.032 0.038	1.95 1.99	0.101 0.049	1.86 0.45	0.127 0.053	S.A. A.	------ ------	500 2,000	0.435	0.58	Cropped.
Sec. 21 T7N, R5E	Iowa	3A	0.042	1.93	0.171	3.62	0.164	S.A.	------	500	------	------	Virgin. Comparable with No. 2
------	Iowa	74A B	0.051 0.041	1.79 1.88	0.161 0.057	2.88 0.87	0.108 0.077	S.A. S.A.	------ ------	500 ------	0.62	------	N. of Edmund. (Composite)
------	Iowa	75A B	0.068 0.041	1.78 1.84	0.168 0.088	3.20 0.26	0.118 0.044	S.A. S.A.	------ ------	2,000 2,000	------	------	Vicinity of Rewey. (Composite)
NW¼NE¼Sec21 T7N, R2E	Iowa	78A B	0.039 0.048	1.95 1.94	0.123 0.049	4.36 0.61	0.090 0.042	V.S.A. V.S.A.	------ ------	500 500	0.52	0.55	Cropped.
NE¼SW¼ Sec 19 T8N, R2E	Iowa	80A B	0.043 0.063	1.84 1.88	0.080 0.035	1.44 0.44	0.063 0.041	A. A.	S.A. ------	2,000 2,000	0.599	0.693	Cropped.
		187A B	0.073 0.059	1.95 1.96	0.165 0.046	3.02 0.69	0.171 0.058	N.A. S.A.	------ ------	2,000 2,000	------	------	Composite, cropped of No. 9, 13, 113, 119.
NW¼SE¼ Sec 14 T24N, R5W	Jackson	1,278A B	------	------	------	------	------	------	M.A.	------	0.66	0.225	Cropped.
NE¼NW¼ Sec 9 T15, R3E	Juneau	248A B	0.046 0.046	1.30 1.35	0.115 0.060	1.90 0.83	0.010 0.008	S.A. S.A.	------ ------	500 500	------	------	Steep phase. Cropped.
T15N, R4E	Juneau	251A B	0.047 0.042	1.43 1.60	0.128 0.060	2.38 0.87	0.057 0.030	S.A. S.A.	------ ------	500 2,000	------	------	Composite.
------	Juneau	332A B	0.055 0.048	2.08 2.67	0.098 0.053	1.71 0.71	0.128 0.042	N.A. S.A.	S.A. ------	500 500	0.491	0.664	Steep phase, Composite.
SE¼NE¼ Sec 35 T16, R2	Juneau	333A B	0.036 0.029	2.06 1.93	0.082 0.054	1.46 0.81	0.036 0.008	S.A. S.A.	------ ------	500 500	------	------	

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
					Knox Silt Loam—Continued								
----------	Juneau	668A	0.044	1.23	0.106	1.90	0.010	----	----	----	----	----	Composite of No. 248, 256
		B	----	1.38	0.048	0.83	0.006	----	----	----	----	----	
----------	LaCrosse	433A	0.037	1.65	0.108	2.75	0.078	S.A.	----	500	----	----	Vicinity of Halmen Composite.
SW¼NW¼Sec28 T18, R6W	LaCrosse	489A	0.049	1.81	0.092	2.61	0.031	S.A.	----	500	----	----	Cropped.
		B	0.047	2.20	0.041	1.91	0.020	N.A.	----	2,000	0.57	0.47	
NE¼NE¼ Sec 31 T18, R7W	LaCrosse	524A	0.059	1.67	0.121	2.44	0.072	N.A.	S.A.	500	0.730	0.853	Cropped.
		B	0.041	1.73	0.054	1.15	0.019	S.A.	----	2,000	----	----	
----------	LaCrosse	526A	0.039	1.40	0.118	2.13	0.128	N.A.	----	2,000	0.501	0.749	N. of Mindora. Composite.
		B											
NE¼SW¼SE¼ S.30, T15N, R6W	LaCrosse	375A	0.059	1.77	0.145	3.24	0.057	N.A.					
		B	0.045	1.77	0.013	0.39	0.009	A	----	----	0.52	0.44	Cropped.
					Lintonia Silt Loam								
NW¼SE¼ Sec 23 T22, R13W	Buffalo	520A	0.073	2.00	0.116	----	----	V.S.A.	V.S.A.	----	----	----	Cropped.
		B	0.077	1.65	0.035	----	----	V.S.A.	S.A.				
SE¼NE¼ Sec 26 T8, R2E	Iowa	216A	0.177	2.06	0.206	4.22	0.123	S.A.	----	500	----	----	Cropped.
		B	0.059	1.40	0.078	1.37	0.056	S.A.	----	2,000	----	----	
NE¼SW¼ Sec 26 T15N, R2E	Juneau	330A	0.065	1.67	0.141	2.96	0.097	S.A.	----	500	----	----	Cropped.
		B	0.091	1.82	0.042	0.46	0.180	S.A.	----	2,000	----	----	
					Lindley Silt Loam								
T1N, R15E	Walworth	1,451	----	----	----	----	----	----	----	----	0.54	0.335	
					Lintonia Fine Sandy Loam								
NE¼SE¼ Sec 32 T20, R11W	Buffalo	535A	0.041	----	0.130	----	----	S.A.	V.S.A.	----	----	----	Cropped.
		B	0.043	----	0.023	----	----	V.S.A.	V.S.A.				
SW¼SW¼ Sec 10 T24, R11W	Buffalo	706A	0.047	1.22	0.074	----	----	S.A.	S.A.	----	----	----	Cropped.
		B	0.043	1.15	0.028	----	----	V.S.A.	V.S.A.	----	----	----	

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						Marshall Silt Loam							
SW¼NE¼ Sec 32 T8N, R1E	Iowa	70A	0.061	1.78	0.245	4.31	0.081	S.A.	St.A.	2,000	0.620	0.612	Cropped.
		B	0.064	1.81	0.108	1.48	0.067	S.A.	---	2,000	0.435	0.55	
SW¼NE¼ Sec 32 T6N, R1E	Iowa	71A	0.098	1.82	0.384	6.72	0.092	S.A.	M.A.+	2,000	0.684	0.804	Virgin Comparable to No. 70.
SE¼SW¼ Sec 20 T5, R1E	Iowa	72A	0.067	1.76	0.232	3.96	0.091	S.A.	St.A.	2,000	0.609	0.744	Cropped.
		B	0.047	1.81	0.103	1.34	0.020	S.A.	---	2,000	0.455	0.525	
SW¼SW¼ Sec 28 T6, R2E	Iowa	76A	0.076	1.72	0.270	7.92	0.087	A.	---	5,000	---	---	Cropped.
		B	0.045	1.83	0.094	1.71	0.049	S.A.	---	2,000	0.435	0.555	
SW¼SW¼ Sec 27 T7N, R1E	Iowa	77A	0.060	1.74	0.203	4.08	0.071	A.	---	2,000	---	---	Cropped.
		B	0.066	1.74	0.093	1.72	0.061	A.	---	2,000	0.51	0.53	
T25N, R2E	Wood	939A	0.036	---	---	---	---	S.A.	S.A.	---	---	---	Composite, cropped
		B	0.073	---	---	---	---	A.	V.A.	---	---	---	
						Marathon Loam							
T28N, R8&9E	Marathon	357A	0.061	1.01	0.108	3.51	---	A.	---	5,000	---	---	Composite, cropped
		B	0.044	1.69	0.059	0.82	---	A.	---	5,000	---	---	
SE¼NE¼ Sec 9 T28N, R9E	Marathon	984A	0.055	---	---	---	---	A.	V.A.	---	---	---	Virgin
		B	0.096	---	---	---	---	S.A.	A.	---	---	---	
						Marathon Silt Loam							
T29N, R8&9E	Marathon	980A	0.066	---	---	---	---	S.A.	S.A.	---	0.695	0.365	Virgin, composite.
		B	0.048	---	---	---	---	S.A.	A.	---	---	---	
T27,28,29N, R6E	Marathon	981A	0.066	---	---	---	---	V.S.A.	V.S.A.	---	0.85	0.365	Composite.
		B	0.048	---	---	---	---	V.A.	A.	---	---	---	
NE¼SW¼ Sec 10 T24, R6E	Portage	996A	0.060	---	---	---	---	S.A.	S.A.	---	0.59	0.44	
		B	0.036	---	---	---	---	A.	A.	---	---	---	
NW¼NW¼ S. 34 T24N, R6E	Portage	997A	0.047	---	---	---	---	---	---	---	---	---	
		B	0.031	---	---	---	---	---	---	---	---	---	
						Marathon Fine Sandy Loam							
---	Marathon	989A	---	---	---	---	---	S.A.	S.A.	---	0.88	0.40	Virgin, composite.
		B	---	---	---	---	---	V.S.A.	S.A.	---	---	---	
NW¼SW¼ S. 19 T25N, R6E	Portage	1,000A	0.029	---	---	---	---	---	V.S.A.	---	---	---	Cultivated
		B	0.024	---	---	---	---	---	V.S.A.	---	---	---	
T25N, R5E	Wood	965A	0.040	---	---	---	---	S.A.	V.S.A.	---	---	---	Virgin.
		B	0.030	---	---	---	---	S.A.	V.S.A.	---	---	---	

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
						Marathon Sandy Loam							
	Marathon	983						S.A.	S.A.		0.62	0.14	Virgin, composite.
								S.A.	S.A.				
						Mellen Silt Loam							
SW¼SE¼ Sec 32 T43N, R15W	Douglas	591A	0.044	2.18	0.089	1.58	0.075	S.A.		2,000	0.67	0.32	Virgin.
		B	0.055	2.34	0.041	0.63	0.024	S.A.		2,000			
	Iron	902A	0.104		0.265	5.18		V.A.	St.A.		1.13	1.595	Level phase.
		B	0.080		0.178	3.99		V.A.					Composite, virgin.
T45&46N, R1E	Iron	903A	0.073		0.188	4.26		V.A.					Rolling phase.
		B	0.060		0.130	1.23		V.A.					Composite, virgin.
	Washburn	417A	0.058	1.90	0.161	3.08	0.019	A.		2,000			Composite, virgin.
		B	0.036	1.87	0.038	0.45	0.013	S.A.		2,000			Comparable with No. 418.
	Washburn	418A	0.045	2.49	0.112	2.60	0.018	S.A.		2,000			Composite, cropped
		B	0.031	2.05	0.034	0.43	0.005	S.A.		2,000			Comparable with No. 417.
						Mellen Loam							
	Ashland	530A	0.048	2.12	0.189	5.13	0.037	V.A.		5,000			Composite, virgin of No. 273, 276.
		B	0.040	2.14	0.065	1.78	0.048	V.A.		5,000			
SW¼SW¼ Sec 28 T43N, R3W	Ashland	573A	0.035	1.59	0.132	2.60	0.133	A.		5,000	0.40	0.30	Virgin.
		B	0.045	1.35	0.097	2.05	0.111	S.A.		5,000			
	Ashland	273A									0.58	0.395	Composite, virgin.
		B											
	Bayfield	421A	0.046	1.50	0.117	2.51	0.254	V.A.		2,000			Composite, virgin.
	Bayfield and Douglas	531A	0.058	2.44	0.093	3.00	0.035	V.A.		2,000			(Sandy Loam)
		B	0.059	2.40	0.034	0.83	0.027	V.A.		2,000			Composite, virgin of No. 263, 271
T47N, R14W	Douglas	651A	0.045	2.33	0.075	1.99	0.064	S.A.		5,000			Composite, virgin.
		B	0.047	2.27	0.057	1.37	0.059	S.A.		5,000			
	Douglas	663A	0.038	2.23	0.072	1.99	0.254	A.		5,000			Composite, virgin of No. 647, 649.

T45N, R1E	Iron	904A	0.079		0.212	4.84			V.A.				Composite, virgin.
		B	0.068		0.114	2.84			V.A.				
T45N, R11&12W	Douglas	647									0.36	0.26	Composite, virgin.

Mellen Fine Sandy Loam

T46N, R2E	Iron	895A	0.070		0.103	2.97		V.A.			0.665	0.405	Composite, virgin.
		B	0.062		0.078	1.32		V.A.					

Meridean Sandy Loam

	Dunn & Eau Claire	183A	0.176	1.30	0.207	4.09	0.121	S.A.		5,000			Composite, cropped of No. 8, 112.
		B	0.152	1.79	0.094	2.40	0.094	S.A.		2,000			
	Eau Claire	11A	0.071	1.25	0.147	2.90	0.063						Composite, cropped
		B	0.063	1.44	0.088	1.59	0.058						

Miami Clay Loam

SE¼NE¼ Sec 3 T6N, R20E	Waukesha	27A	0.060	2.59	0.134	2.75	0.298	S.A.		500			Cropped.
		B	0.044	2.89	0.069	1.08	4.141	N.A.		500			
NW¼SW¼ Sec 25 T7N, R20E	Waukesha	168A	0.052	2.40	0.113	2.87	0.119	A.		2,000			Virgin.
		B	0.050	2.47	0.083	1.80	0.147	A.		2,000			
T6&7N, R20E	Waukesha	172A	0.046	2.55	0.151	2.60	0.232	S.A.		500			Composite, cropped
		B	0.049	2.87	0.090	0.98	6.311	N.A.		500			
NW¼NW¼ S. 10 T7N, R20E	Waukesha	176A	0.043	2.80	0.168	2.94	0.155	N.A.		500			Cropped.
		B	0.049	3.00	0.082	0.96	0.884	N.A.		500			
NW¼NW¼ S. 10 T7N, R20E	Waukesha	228A	0.062	2.80	0.141	2.81	2.178	N.A.		500			Cropped.
		B	0.059	2.88	0.045	0.70	3.192	N.A.		500			
NE¼NE¼ Sec 23 T8N, R20E	Waukesha	230A	0.059	2.71	0.177	2.83	0.368	S.A.		500			Cropped.
		B	0.060	2.54	0.106	1.47	5.148	S.A.		500			
T7&8N, R20E	Waukesha	385A	0.036	2.44	0.114	2.16	0.127	N.A.		500			Composite, cropped
		B	0.061	1.94	0.052	0.55	0.084	N.A.		500			

Miami Silty Clay Loam

SW¼NW¼ S. 24 T3N, R20E	Racine	1,476						S.A.			0.575	0.515	

Location		Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity		Lime Rqt.	Total Ca.	Total Mg.	Remarks
Land Survey	County							Litmus	Truog Test				
Miami Silt Loam													
NW¼SW¼S. 19 T10N, R12E	Columbia	507A	0.069		0.140	1.30		A.	S.A.	500			Cropped
		B	0.057		0.070	0.88		S.A.	S.A.	500			
T1 1&12N, R8E	Columbia	610A	0.055	1.96	0.123	2.48		A.	S.A.	500			Composite, cropped
		B	0.055	1.97	0.117	0.69		S.A.	A.	2,000	0.505	0.52	From Baraboo Quartzite range.
NW¼SW¼ S. 14 T12N, R12E	Columbia	639A	0.052		0.129			S.A.	V.S.A.	500	0.858	0.439	Cropped.
		B	0.043		0.059			S.A.	A.	2,000	0.535	0.38	
SW¼NE¼ Sec 30 T12N, R8E	Columbia	613A						S.A.	V.S.A.	500			Cropped.
		B						S.A.	V.A.	2,000	0.49	0.43	
T8N, R8E	Dane	803A	0.041						V.S.A.		0.675	0.36	Composite
		B	0.051								0.833	0.565	
NW¼ Sec 2 T9N, R12E	Dane	1,410A					0.03						
		B					0.00						
		C					0.00						
SW¼ Sec 35 T8N, R12E	Dane	1,411A					0.01						
		B					0.00						
		C					0.01						
T16&17N, R19E	Fond du Lac	321A	0.053	2.83	0.117	2.34	0.045	N.A.		500			Composite, cropped
		B	0.057	2.38	0.059	0.94	0.081	N.A.		500			
SE¼NE¼ Sec 8 T15N, R18E	Fond du Lac	323A	0.059	2.38	0.141	2.61	0.122	N.A.		500			Cropped.
		B	0.069	2.33	0.057	0.84	0.084	N.A.		500			
SE¼NE¼ Sec 30 T14N, R15E	Fond du Lac	472A	0.057	2.10	0.136	2.54	0.056	S.A.		2,000			Cropped.
		B	0.058	2.15	0.048	0.48	0.033	V.S.A.		2,000	0.72	0.26	
T13N, R19E	Fond du Lac	480A	0.064	2.13	0.161	3.21	0.184	N.A.	V.S.A.	500	1.02	0.695	Composite, cropped
		B	0.056	2.18	0.066	1.04	0.030	N.A.		2,000	0.685	0.54	
SW¼NE¼ Sec 2 T15N, R15E	Fond du Lac	365A	0.055	2.04	0.133	2.42	0.052	N.A.		500			Cropped.
		B	0.050	2.08	0.054	0.75	0.030	N.A.		500	0.615	0.64	

SE¼SE¼ Sec 16 T17N, R19E	Fond du Lac	304A											Cropped.
		B									0.69	0.58	
NW¼NE¼ Sec 7 T14N, R14E	Fond du Lac	380A											Cropped.
		B									0.535	0.505	
T14N, R15E	Fond du Lac	476A				1.93	0.130						Composite.
		B	0.058			2.36	0.035				0.655	0.37	
T6N, R15E	Jefferson	672A	0.067		0.174		5.100	V.S.A.	N.A.				Composite, cropped
		B	0.059		0.075		1.735	N.A.	V.S.A.				
T8N, R15E	Jefferson	677A	0.062		0.154			V.S.A.	V.S.A.				Composite, cropped
		B	0.046		0.060			V.S.A.	S.A.				
T7N, R16E	Jefferson	675A	0.069		0.208		0.512	A.	N.A.				
		B	0.071		0.070		0.555	A.	N.A.				
	Jefferson	689A	0.049		0.160			A.	V.S.A.				Composite.
		B	0.051		0.069			V.A.	S.A.		0.465	0.23	
SW¼NW¼S. 34 T6N, R14E	Jefferson	690A	0.052		0.135			S.A.	V.S.A.		0.726	0.544	Hoard farm,
		B	0.045		0.065			S.A.	S.A.		0.42	0.22	Cropped.
SE¼SE¼SW¼ S.18, T7N, R13E	Jefferson	682A						S.A.	V.S.A.				Cropped.
		B						S.A.	V.S.A.		0.52	0.31	
T28N, R18E	Oconto	769A						S.A.			0.55	0.215	
SE¼SE¼ Sec 4 T27N, R15W	Pierce	1,535A									0.93	0.375	
	Polk and St. Croix	179A	0.037	1.94	0.111	2.26	0.100	N.A.					Composite of No. 136, 151, 127.
		B	0.036	1.72	0.037	0.57	0.043	N.A.					
NW¼ Sec 22 T4N, R14E	Rock	1,405A					0.06						
		B					0.01						
		C					0.53						
SW¼ Sec 24 T1N, R13E	Rock	1,407A					0.04						
		B					0.01						
		C					0.00						
SW¼ Sec 15 T1N, R13E	Rock	1,408A					0.01						
		B					0.00						
		C					0.00						
Sec 26 T31N, R15W	St. Croix	1,537A									0.59	0.375	

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
						Miami Silt Loam—Continued							
T1N, R15E	Walworth	1,451						S.A.			0.540	0.335	Composite.
T1N, R15E	Walworth	1,454						S.A.			0.515	0.335	Composite.
T1N, R17E	Walworth	1,457									0.570	0.335	Composite.
NW¼SW¼ S. 28 T7N, R20E	Waukesha	166A	0.081	1.96	0.219	4.79	0.229	S.A.		500			Virgin.
		B	0.083	2.15	0.070	1.24	1.822	N.A.		500			
SE¼NW¼ Sec 2 T7N, R19E	Waukesha	231A	0.049	2.43	0.150	2.20	0.259	N.A.		500			Cropped.
		B	0.048	2.16	0.080	0.76	0.614	S.A.		500	10.74	3.85	
SE¼NE¼ Sec 24 T8N, R18E	Waukesha	236A	0.055	2.17	0.132	2.36	0.045	A.		500			Cropped.
		B	0.057	2.08	0.061	0.99	0.031	A.		500	0.495	0.605	
SW¼SW¼Sec29 T8N, R19E	Waukesha	238A	0.039	2.07	0.115	2.22	0.173	A.		500			Cropped.
		B	0.052	1.96	0.068	1.12	3.842	A.		500	1.395	1.045	
SW¼SW¼ Sec 30 T8N, R19E	Waukesha	239A	0.051	2.10	0.172	2.97	0.061	A.		500			Virgin.
		B	0.054	2.07	0.084	1.60	0.454	A.		500	0.605	0.625	
	Waukesha	384A	0.051	2.08	0.138	2.52	0.065	N.A.		500	0.821	0.579	Composite, cropped
		B	0.050	2.10	0.067	1.00	0.034	N.A.		500	0.605	0.545	
						Miami Loam							
T37&38, R18& 19W	Burnett	513A	0.041	1.84	0.125	2.54	0.014	S.A.	S.A.				Virgin composite.
		B	0.034	1.86	0.036	0.53	0.010	S.A.	A.				
T37 & 38, R18 & 19W	Burnett	514A	0.034	2.17	0.113	2.25	0.015	N.A.					Cropped, composite
		B	0.026	1.90	0.039	0.46	0.0137	N.A.					
SE¼SW¼ Sec 32 T11N, R11E	Columbia	630A	0.051	1.40	0.169	3.36		S.A.	S.A.				Cropped.
		B	0.044	1.45	0.075	1.09		V.S.A.	S.A.				
T7N, R16E	Jefferson	675A	0.069		0.208		0.512	A.					
		B	0.071		0.070		0.555	A.					Composite.
NE¼NE¼ Sec 17 T5N, R13E	Jefferson	696A	0.062		0.140			V.S.A.	V.S.A.				
		B	0.048		0.059			N.A.	V.S.A.				

T23N, R23E	Kewaunee	391A	0.052		0.158			N.A.		500			Composite, cropped
		B	0.045		0.051			N.A.		500			
NW¼NW¼ S. 14 T23N, R23E	Kewaunee	396A	0.066		0.130			N.A.		500			Cropped.
		B	0.054		0.045			N.A.		500			
NW¼NW¼ S. 11 T22N, R23E	Kewaunee	397A	0.085		0.149			S.A.		500			Cropped.
		B	0.055				0.054	V.S.A.		500			
	Marinette	202A	0.051	2.15	0.176	3.42	0.186	N.A.		500			Composite of No. 85, 91, 98.
		B						N.A.		500			
NE¼SE¼ Sec 16 T6N, R19E	Waukesha	29A	0.067	1.80	0.095	2.12	0.212	S.A.		500			Cropped.
		B	0.042	1.79	0.057	1.01	0.543	N.A.		500			
	Waukesha	167A	0.048	1.90	0.113	2.36	0.252	S.A.		500			Composite, cropped
		B	0.055	1.94	0.058	1.02	0.707	A.		500			
SW¼SE¼ Sec 36 T5N, R18E	Waukesha	339A	0.029	1.71	0.114	2.09	0.033	S.A.		500			
		B	0.029	1.76	0.046	0.80	0.037	S.A.		500			

Miami Loam (Baldwin & Cushing)

	Polk & St. Croix	179A	0.037	1.61	0.111	2.26	0.100	N.A.		2,000			Cushing Loam. Composite of No. 127, 136, 151.
		B	0.036	1.72	0.037	0.57	0.043	N.A.		2,000			
	St. Croix	181A	0.036	1.70	0.131	2.48	0.125	S.A.		2,000			Baldwin Loam. Composite of No. 122, 128, 130.
		B	0.043	1.70	0.042	0.55	0.151						
	St. Coix	188A	0.035	1.69	0.132	2.69	0.096	A.		2,000			Baldwin Loam. Composite of No. 125, 126, 129.
		B	0.053	1.50	0.062	0.90	0.047	S.A.		2,000			

Miami Gravelly Loam

SE¼NW¼ Sec 32 T16N, R19E	Fond du Lac	308A	0.077	1.87	0.118	2.12	5.414	N.A.		500			Cropped.
		B	0.075	1.49	0.066	1.68	33.783	N.A.		500			
NW¼NW¼S. 27 T16N, R18E	Fond du Lac	314A	0.130	2.11	0.113	2.39	0.900	N.A.		500			Cropped.
		B	0.159	1.94	0.064	1.22	11.684	N.A.		500			
	Fond du Lac	534A	0.062	2.03	0.124	2.17	4.682	N.A.		500			Cropped, composite of No.366, 367
		B	0.062	1.84	0.075	1.01	12.390	N.A.		500			

Location		Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity		Lime Rqt.	Total Ca.	Total Mg.	Remarks
Land Survey	County							Litmus	Truog Test				
						Miami Fine Sandy Loam							
SW¼SE¼ Sec 12 T11, R12	Columbia----	509A	0.052	--------	0.115	2.19	--------	V.S.A.	N.A.	500	--------	--------	Cropped.
		B	0.039	--------	0.062	0.91	0.283	N.A.	N.A.	500	--------	--------	
T10&11N, R8&9E	Columbia----	600A	0.040	--------	0.089	1.62	nil	S.A.	V.S.A.	500	--------	--------	Composite, cropped S.W. of Poynette
		B	0.042	--------	0.040	0.56	nil	V.S.A.	V.S.A.	500	--------	--------	
T11N, R9&10E --	Columbia----	602A	0.046	1.80	0.097	1.70	nil	A.	S.A.	500	--------	--------	Composite, cropped Heavy phase.
		B	0.041	1.84	0.056	0.69	nil	A.	S.A.	500	--------	--------	
T13N, R9E------	Columbia----	625A	0.036	--------	0.064	1.13	nil	V.S.A.	V.S.A.	500	--------	--------	Composite, cropped near Coloma area
		B	0.036	--------	0.042	0.57	nil	S.A.	S.A.	500	--------	--------	
T13N, R10E-----	Columbia----	635A	0.045	6.36	0.112	2.01	nil	S.A.	S.A.	500	--------	--------	Composite, cropped N. of Pardeeville.
		B	0.042	--------	0.046	--------	nil	V.S.A.	S.A.	500	--------	--------	
T11N, R11E-----	Columbia----	636A	0.039	1.80	0.061	1.33	--------	A.	N.A.	500	0.452	0.336	Composite, cropped S. E. of Rio.
		B	0.039	1.84	0.034	0.47	--------	S.A.	S.A.	500	--------	--------	
SW¼SW¼ S. 4-- T8N, R8E	Dane--------	802	--------	--------	--------	--------	--------	V.S.A.	--------	--------	0.27	0.12	Cropped.
---------------	Jefferson----	699A	0.051	--------	0.093	--------	0.267	N.A.	N.A.	--------	--------	--------	Composite Cropped.
		B	0.047	--------	0.061	--------	0.040	N.A.	N.A.	--------	--------	--------	
SW¼SW¼ S. 2-- T5N, R16E	Jefferson----	561A	0.045	--------	0.078	--------	--------	S.A.	S.A.	--------	0.562	0.367	Cropped.
		B	0.038	--------	0.049	--------	--------	S.A.	V.S.A.	--------	--------	--------	
---------------	Marinette----	201A	0.035	1.87	0.102	1.98	0.104	V.A.	--------	2,000	--------	--------	Composite of No. 86, 87, 90, 97, 109
		B	--------	--------	--------	--------	--------	A.	--------	2,000	--------	--------	
T28, R18E-------	Oconto-------	769	--------	--------	--------	--------	--------	--------	--------	--------	0.55	0.217	Virgin.
NE¼SW¼ S. 25 T29, R21E	Oconto-------	813A	0.048	2.02	0.169	--------	0.070	V.S.A.	V.S.A.	500	--------	--------	Cropped.
		B	0.070	2.09	0.025	--------	0.025	N.A.	V.S.A.	500	--------	--------	
NE¼SE¼ Sec 26 T29, R20E	Oconto-------	816A	0.028	2.02	0.048	1.67	0.060	S.A.	S.A.	500	0.619	0.321	Virgin.
		B	0.032	2.09	0.025	0.67	0.025	V.S.A.	N.A.	500	--------	--------	Light phase.

NW¼ Sec 26 T1N, R11E	Rock	1,409A	--------	--------	--------	--------	0.0	--------	--------	--------	--------	--------	
		B	--------	--------	--------	--------	0.0	--------	--------	--------	--------	--------	
		C	--------	--------	--------	--------	0.01	--------	--------	--------	--------	--------	
SW¼SW¼ Sec 2 T4N, R13E	Rock	854	--------	--------	--------	--------	--------	V.S.A.	--------	--------	0.048	0.20	
T26, R16E	Shawano	826A	0.056	2.02	0.076	--------	0.035	V.S.A.	S.A.	500	0.614	0.459	Composite, virgin.
		B	0.044	2.09	0.031	--------	0.007	N.A.	V.S.A.	500	--------	--------	
--------	Shawano	819	--------	--------	--------	--------	--------	S.A.	--------	--------	0.49	0.215	Cropped. (Comp.)
NW¼SW¼ S. 21 T5N, R18E	Waukesha	240A	0.048	1.44	0.098	1.83	0.056	N.A.	V.S.A.	500	0.587	0.404	Cropped.
		B	0.033	1.46	0.047	0.83	0.535	S.A.	--------	500	--------	--------	
Miami Sandy Loam													
T13N, R19E	Fond du Lac	482A	0.045	1.45	0.077	3.89	0.651	S.A.	--------	500	--------	--------	Composite, cropped
		B	0.038	1.42	0.033	0.73	0.046	V.S.A.	--------	2,000	--------	--------	
Miami Gravelly Sandy Loam													
SW¼NE¼ Sec 33 T6N, R16E	Jefferson	568A	--------	--------	0.089	--------	--------	N.A.	V.S.A.	--------	--------	--------	
		B	0.053	--------	0.074	--------	--------	V.S.A.	S.A.	--------	--------	--------	
SE¼NE¼ Sec 2 T5N, R18E	Waukesha	169A	0.049	1.64	0.118	1.84	0.034	S.A.	--------	500	--------	--------	Cropped.
		B	0.056	1.81	0.063	0.67	0.305	S.A.	--------	500	--------	--------	
SW¼NW¼ S. 31 T6N, R20E	Waukesha	170A	0.043	1.75	0.119	2.02	0.137	A.	--------	500	--------	--------	Cropped.
		B	0.056	1.79	0.066	0.70	0.325	S.A.	--------	500	--------	--------	
T6N, R19E	Waukesha	171A	0.067	1.77	0.124	1.93	0.181	A.	--------	500	--------	--------	Composite, cropped
		B	0.065	1.92	0.070	0.68	2.673	S.A.	--------	500	--------	--------	
NE¼SE¼ Sec 14 T8N, R17E	Waukesha	284A	0.040	1.77	0.094	1.73	0.048	N.A.	--------	500	--------	--------	Cropped.
		B	0.048	1.77	0.050	0.71	0.023	--------	--------	500	--------	--------	
Miami Fine Sand													
T10&11N, R8&9E	Columbia	598A	0.031	0.65	0.078	1.33	--------	A.	A.	500	--------	--------	Composite, cropped
		B	0.029	0.79	0.044	0.53	--------	S.A.	S.A.	500	--------	--------	
NW¼NE¼ S. 28 T12, R10E	Columbia	632A	0.035	0.65	0.051	0.71	nil	S.A.	V.S.A.	500	--------	--------	Cropped.
		B	0.054	0.79	0.040	0.33	nil	V.S.A.	V.S.A.	500	--------	--------	
T11&12N, R9& 10E	Columbia	634A	0.036	0.65	0.064	0.99	nil	A.	S.A.	500	--------	--------	Composite, cropped
		B	0.030	0.79	0.037	0.43	nil	V.S.A.	S.A.	500	--------	--------	
NE¼NE¼ Sec 21 T13N, R9E	Columbia	621A	--------	--------	--------	--------	--------	S.A.	--------	500	--------	--------	
		B	--------	--------	--------	--------	--------	S.A.	--------	500	--------	--------	

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO^3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
Miami Fine Sand—Continued													
SE¼NE¼ Sec 15 T5N, R16E	Jefferson	565A	0.032		0.067			S.A.	V.S.A.				Cropped.
		B	0.029		0.037			N.A.	N.A.				
SW¼SW¼ S. 2 T4N, R13E	Rock	854A									0.48	0.20	Cropped.
Miami Sand													
NW¼NW¼ S. 22 T5N, R17E	Waukesha	208A	0.025	0.82	0.061		0.036	N.A.		500			Cropped.
		B	0.025	1.33	0.042		0.021	S.A.		500			
NE¼NE¼ Sec 29 T5N, R17E	Waukesha	209A	0.022	1.03	0.050	0.72	0.032	A.		500			Cropped.
		B	0.021	0.85	0.034	0.36	0.022	S.A.		500			
NW¼SE¼ S. 28 T5N, R17E	Waukesha	211A	0.025	1.03	0.049	0.62	0.051	S.A.		2,000			
		B	0.025	1.41	0.036	0.31	0.032	S.A.		2,000			
Muck													
NE¼SW¼ Sec 7 T12N, R11E	Columbia	638A	0.121	0.30	2.057	35.8		S.A.	V.S.A.	500			
		B	0.072	0.36	0.947	21.6		V.S.A.	V.S.A.	500			
SW¼NE¼ Sec 19 T8, R3E	Iowa	214A	0.142	1.73	0.883	23.37	0.189	S.A.		500	18.13		
		B					0.083						
NW¼NE¼ S. 11 T28N, R20E	Oconto	810A	0.111	1.13	1.390	51.03		V.S.A.	V.S.A.	500			From limestone (Miami) area.
		B	0.061	0.89	0.612	12.16		V.S.A.	N.A.	500			
NE¼SE¼ S. 28 T29N, R22E	Oconto	815A	0.127	1.83	0.939	28.30		V.S.A.	N.A.	500			From Dunkirk (Plainfield) area.
		B	0.054	2.59	0.579			N.A.	N.A.	500			

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Loss on ignition	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
Peat													
T41N, R1W	Ashland	926A	0.119	0.18	1.774	81.86		A.	V.A.				Composite, virgin.
		B	0.109	0.17	1.640	38.11		V.S.A.	S.A.				
T41N, R1E	Ashland	929A	0.102	0.30	1.476	81.39		S.A.	S.A.				Virgin.
		B	0.070	0.24	1.391	80.91		S.A.	S.A.				
T45N, R5&6W	Bayfield	369A	0.072	0.45	1.984	96.50		A.		2,000			Composite, virgin.
		B	0.058	0.55	1.888	81.70		A.		5,000			
SW¼NE¼ S. 8 T24, R11W	Buffalo	707A	0.249	0.23	2.905	75.76		S.A.	S.A.				
		B	0.164	0.28	2.261	75.83		S.A.	S.A.				
T38&39N, R18 &19W	Burnett	518A	0.135	0.79	2.727	70.1		A.		5,000			Composite.
		B	0.071	0.88	2.038	54.1		A.		5,000			Hay Marsh.
Sec. 8 & 17 T24N, R3W	Clark	958A						V.A.	V.A.		0.14	0.12	Virgin.
		B						V.A.	V.A.				
SE¼NE¼ Sec 9 T13N, R7E	Columbia	504A	0.125	0.14	3.020	86.0		A.	V.S.A.	500			
		B	0.208	0.28	2.679	77.2		A.	S.A.	500			
T13N, R7E	Columbia	614A	0.268	0.17	3.620	77.10		A.	V.S.A.	500			
		B	0.126	0.18	3.308	81.8		A.	V.S.A.	500			
SE¼NW¼ S. 4 T12N, R11E	Columbia	637A	0.117	0.22	1.317	83.4		N.A.	N.A.	500			
		B	0.153	0.12	1.663	86.1		N.A.	V.S.A.	500			
NE¼NE¼ Sec 24 T8N, R6E	Dane	804A	0.223			79.02							
		B	0.147			84.02							
	Dane	842A	0.144	0.33		83.89							
T7N, R11E	Dane	843A	0.131	0.28		86.03					1.80	0.31	
NW¼NW¼ S. 33 T9N, R6E	Dane	798A	0.214			79.84					2.36	0.255	
		B	0.140			78.74							
SW¼SE¼ S. 27 T9N, R6E	Dane	799									3.40	0.480	
T8N, R11&12E	Dane	844A	0.135	0.44		66.46							

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Loss on ignition	CaCO³	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
						Peat—Continued							
Sec. 11 & 12 T47, R11W	Douglas	260A	0.088	0.23	2.140	82.40		V.A.		5,000			Virgin.
		B	0.074	0.33	1.811	71.70		V.A.		5,000			
	Dunn, Polk	185A	0.258	0.45	2.909	57.37		N.A.		500			Composite, virgin. N. 116, 137.
		B	0.145	0.36	2.650	63.21		N.A.		2,000			
SE¼SW¼ S. 27 T16N, R19E	Fond du Lac	335A	0.205	0.30	3.705	85.05		A.		5,000			Hay Marsh.
		B	0.177	0.25	3.871	81.47		A.		5,000			
NE¼NW¼ S. 21 T17N, R19E	Fond du Lac	337A	0.207	0.44	3.962	81.40		S.A.		5,000			Hay Marsh.
		B	0.116	0.35	3.276	74.22		S.A.		5,000			
NW¼SE¼ S. 21 T16N, R16E	Fond du Lac	358A	0.180	0.23	2.680			S.A.		500			
		B	0.131	0.30	2.171			S.A.		500			
NE¼NE¼ Sec. 7 T15N, R16E	Fond du Lac	360A	0.141	0.16	3.899			N.A.		500			Hay Marsh.
		B	0.131	0.19	4,045			N.A.		500			
	Jackson	1,365A									0.175		
NW¼NW¼ S. 13 T6N, R16E	Jefferson	555A	0.121		3.667	83.60		A.	V.S.A.				
		B	0.135		3.658	84.70		A.	S.A.				
NE¼SW¼ S. 8 T5N, R16E	Jefferson	569A	0.177		2.883	79.20		N.A.	S.A.				
		B	0.103		2.555	80.00		N.A.	S.A.				
NE¼NW¼ S. 20 T7N, R13E	Jefferson	683A	0.064		1.740	57.55	49.155	N.A.	N.A.				
		B	0.081		2.289	64.30	38.88	N.A.	N.A.				
NW¼NE¼ S. 8 T6N, R14E	Jefferson	688A	0.097		3.328	82.65		N.A.	S.A.				
		B	0.075		1.651	50.80		N.A.	S.A.				
NE¼SW¼ S. 24 T16N, R2E	Juneau	329A	0.122	0.77	1.472	50.60		V.A.		2,000			County poor farm.
		B	0.115	1.34	0.540			A.		2,000			
SW¼NW¼ S. 26 T17, R2E	Juneau	454A	0.122	0.27	3.119			V.A.		5,000			
		B	0.093	0.23	2.016			V.A.		2,000			
SE¼SW¼ S. 32 T17W, R7W	LaCrosse	439A	0.187	0.29	2.736			A.		2,000			
		B		1.35									

Sec. 33 & 28	Marathon	355A	0.125	0.46	2.136	86.00		V.A.		5,000			Virgin.
T28, R9E		B	0.099	0.39	2.094	19.90		V.A.		5,000			
SE¼ Sec. 9	Oconto	744A	0.123	0.21	2.770	79.56		N.A.	A.	2,000			Peshtigo Brook marsh, from Coloma area.
T30, R18E		B	0.093	0.21	2.880	80.99		N.A.	S.A.	500			
NE¼SW¼ S. 19	Oconto	831A	0.200	0.38	2.880	83.12		S.A.	S.A.	500			From Limestone area (Miami)
T27N, R20E		B	0.188	0.37	2.815	81.17		S.A.	A.	2,000			
NE¼NW¼ S. 17	Oconto	814A	0.125	0.38	2.900	73.61		A.	S.A.	500			From Dunkirk (Plainfield) area
T28N, R22E		B	0.069	2.68	0.858	23.57		V.S.A.	V.S.A.	500			
T38&39, R10E	Oneida	738A		0.79	1.347	46.07		V.A.		5,000			Thunder Lake marsh. Comp.
		B		1.24	0.444	16.78		V.A.		5,000			
Sec. 12	Oneida	865A	0.074		1.289	95.43		V.A.		5,000			
T39N, R5E		B	0.064		1.391	95.53		V.A.		5,000			
Sec. 31	Oneida	868A	0.084		1.868	86.32		V.A.		5,000			
T38N, R8E		B	0.057		1.661	88.68		A.		5,000			
T35N, R11E &	Oneida	876A	0.123		1.947	87.83							Composite, virgin.
T36N, R9E		B	0.095		1.938	92.67							
SW¼NW¼ S. 33	Portage	931A	0.071			89.04		V.A.	V.A.		0.605	0.46	Virgin.
T23N, R7E		B	0.047			90.90		V.A.	V.A.				
T25N, R6E	Portage	1,004A	0.100			75.61		V.A.	V.A.				Virgin.
		B	0.083			72.09		A.	V.A.				Virgin.
NE¼SW¼ S. 33	Portage	1,025A	0.031			40.4		V.S.A.	V.S.A.				
T23N, R8E		B	0.053			15.02		S.A.	A.				
	Portage	1,027A	0.150			73.5		N.A.	N.A.		3.64	0.395	Composite, virgin.
		B	0.143			62.4		N.A.	S.A.				
T38N, R1E	Price	910A	0.141		1.731	82.43		V.A.	V.A.		0.49	0.11	Composite, virgin.
		B	0.104		1.940	86.23		V.A.	V.A.				
NE¼ Sec. 10	Price	915A	0.123		1.984	92.42		V.A.	V.A.				Virgin.
T39N, R1W		B	0.098		1.856	94.13		V.A.	V.A.				
T29, R12E	Shawano	805A	0.093	0.23	0.830	82.77		A.	A.				Vic. of Mattoon.
		B	0.072	0.36	1.624	75.30		A.	S.A.	500			From Coloma area
	Sheboygan	233A	0.127	0.25	3.556	84.50							Sheboygan Marsh "Lower"
		B	0.104	0.39	3.359	79.00							

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Loss on ignition	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
						Peat—Continued							
	Sheboygan	234A	0.157	0.42	3.325	79.50							Sheboygan Marsh "Central"
		B	0.134	0.61	3.079	74.10							
	Sheboygan	235A	0.187	0.55	3.192	77.00							Sheboygan Marsh "Upper". Cropped.
		B	0.117	0.39	2.062	79.40							
SE¼SW¼ Sec 26 T37N, R1W	Taylor	1,038A				90.6		A.	A.				Virgin.
		B				93.3		S.A.	S.A.				
SE¼NW¼ Sec 3 T41, R10E	Vilas	845A	0.086	0.20	1.829	90.70		V.A.		5,000			Denton's marsh.
		B	0.065	0.23	1.504	90.00		V.A.		5,000			
T3N, R15E	Walworth	388A	0.169	0.33									Duck Creek D.D. The Narrows
		B	0.139	0.37									
T8N, R15E	Walworth	389A	0.192	0.14		81.85							Duck Creek D. D. Redenius farm.
		B	0.096	0.18		87.43							
T3N, R15E	Walworth	390A	0.153	0.20		83.60							Duck Creek D. D. The Upper End
		B	0.105	0.17		85.71							
T1N, R18E	Walworth	1,449A									2.55	0.535	Virgin.
		B											
SE¼SE¼ Sec 18 T7N, R17E	Waukesha	279A	0.262	0.14	3.768	77.27		A.		5,000			
		B	0.129	0.13	3.465	79.69		A.		5,000			
NW¼ Sec 16 T8N, R17E	Waukesha	281A	0.055	0.19	2.489	88.40		V.A.		5,000			
		B	0.079	0.13	2.527	93.40		V.A.		5,000			
NE¼NE¼ Sec 10 T7N, R17E	Waukesha	282A	0.081	0.08	2.742	84.76		N.A.		500			
		B	0.093	0.07	3.165	87.00		N.A.		2,000			
Sec. 13 & 21 T6N, R17E	Waukesha	283A	0.179	0.23	3.295	74.37		N.A.		2,000			
		B	0.184	0.22	3.035	72.44		S.A.		2,000			
Sec 14 & 23 T5N, R18E	Waukesha	296A	0.092	0.11	3.259	83.16		N.A.		500			Mukwanago marsh
		B	0.087	0.17	3.066	80.93		N.A.		500			

SE¼ Sec 10 T8N, R19E	Waukesha	297A B	0.125 0.067	0.10 0.18	2.625 3.233	80.93 85.29		S.A. N.A.		2,000 2,000			
NE¼NW¼ S. 22 T8N, R20E	Waukesha	298A B	0.155 0.125	0.25 0.08	2.808 3.127	79.09 80.98		S.A. S.A.		5,000 2,000			
SE¼SW¼ Sec 16 T7N, R19E	Waukesha	348A B	0.142 0.122	0.09 0.07	3.631 3.520	64.86 87.86		N.A. N.A.		500 500			
NE¼SE¼ Sec 34 T20N, R8E	Waushara	57A B	0.182 0.053	0.25 0.44	3.509 2.746	 77.60		S.A. N.A.		2,000 2,000			Virgin.
NW¼SE¼ S. 26 T18N, R13E	Waushara	728A B	0.122 0.111	0.20 0.23	3.125 3.366	92.10 86.93							
T 18 & 19, R13E	Waushara	729A B	0.154 0.100	0.25 0.25	2.923 2.735	 87.60							
Sec. 14 T18N, R13E	Waushara	730A B	0.128 0.108	0.24 0.25	1.643 2.415	 86.80							
Sec. 26 T19N, R13E	Waushara	731A B	0.152 0.100	0.24 0.25	3.065 2.980	88.80 85.90		A. A.					
NW¼SW¼ Sec 4 T19N, R13E	Waushara	732A B	0.158 0.109	0.20 0.18	2.960 2.758	89.70 90.70		A. A.					
NE¼NW¼ S. 27 T18N, R12E	Waushara	733A B	0.145 0.100	0.28 0.23	3.360 3.297	 87.50		A. A.					
SE¼NE¼ Sec 10 T25N, R5E	Wood	964A B				69.2 41.6		A. A.	A. A		0.68	0.34	Virgin.
SE¼SE¼ Sec 24 T21N, R2E	Wood	1,075A B	0.178 0.096			96.4 91.1							Virgin.
NW¼NE¼ S. 5 T21N, R3E	Wood	1,076A B	0.104 0.078			88.8 88.4							Virgin.
SE¼NW¼ S. 15 T21N, R2E	Wood	1,077A B	0.103 0.077										Plowed once.
Sec. 26 T22N, R4E	Wood	1,080A B	0.099 0.104			67.71 84.23							

Location		Soil No.	Total P.	Total K.	Total N.	Organic Matter	CaCO^3	Acidity		Lime Rqt.	Total Ca.	Total Mg.	Remarks
Land Survey	County							Litmus	Truog Test				
Plainfield Fine Sandy Loam													
SW¼SW¼ S. 15 T20N, R12E	Buffalo	539A	0.058	-----	0.056	-----	-----	V.S.A.	N.A.	-----	-----	-----	Cropped.
		B	0.047	-----	0.037	-----	-----	V.S.A.	V.S.A.	-----	-----	-----	
Plainfield Sandy Loam													
NE¼NE¼ Sec 2 T20N, R5E	Adams	1,442A	-----	-----	-----	-----	-----	-----	-----	-----	0.42	0.275	Cropped.
		B											
T38N, R15W	Burnett	583A	0.038	1.38	0.070	1.64	0.044	N.A.	M.A.	500	0.572	0.356	Composite, virgin.
SE¼NE¼ Sec 1 T13N, R6E	Columbia	502A	0.037	0.89	0.044	0.79	-----	A.	S.A.	500	0.401	0.253	Cropped.
		B	0.024	0.55	0.026	0.17	-----	A.	N.A.	500	-----	-----	
NW¼ Sec. 15 T35N, R15E	Forest	655A	0.051	1.97	0.139	3.49	-----	V.A.	S.A.	2,000	0.819	0.515	Cropped.
		B	0.037	1.76	0.057	1.56	-----	S.A.	V.A.	5,000	-----	-----	
T12N, R12W	Iowa	387A	0.053	1.21	0.105	2.07	0.027	N.A.	-----	5,000	-----	-----	
		B	0.047	1.31	0.065	1.25	0.023	S.A.	-----	2,000	-----	-----	Cropped.
NE¼SW¼ Sec 20 T8NR5E	Iowa	217A	0.061	1.11	0.109	2.09	0.022	N.A.	-----	500	-----	-----	
		B	0.056	0.83	0.065	1.28	0.016	N.A.	-----	500	-----	-----	
SW¼NW¼ S. 22 T8, R3E	Iowa	213A	0.047	0.85	0.067	1.62	0.020	V.S.A.	-----	2,000	-----	-----	Cropped.
		B	0.039	0.80	0.054	1.18	0.022	V.S.A.	-----	2,000	-----	-----	
-----	Rusk-Polk	180A	0.053	1.36	0.067	1.66	0.051	A.	-----	2,000	-----	-----	Thornapple sandy loam. Comp. of No. 141, 143, 163 164.
		B	0.057	1.34	0.038	0.67	0.096	S.A.	-----	2,000	-----	-----	
T41N, R9W	Sawyer	424A	0.030	1.50	0.067	2.15	0.031	V.A.	-----	5,000	-----	-----	Nemakagon River bottom. Comp., virgin.
		B	0.017	1.41	0.020	0.37	0.006	A.	-----	2,000	-----	-----	
T41N, R9W	Sawyer	425A	0.038	1.37	0.064	1.79	0.063	V.A.	M.A.	2,000	0.499	0.371	Comp., cropped.
		B	0.028	1.25	0.024	0.39	0.010	V.A.	-----	2,000	-----	-----	Comp. to No. 424
T42N, R11&12W	Washburn	416A	0.042	1.44	0.080	2.98	0.071	A.	-----	5,000	-----	-----	Composite, virgin.
		B	0.024	1.46	0.022	0.38	0.008	A.	-----	2,000	-----	-----	
-----	Washburn	533A	0.032	1.41	0.063	2.12	0.031	A.	-----	2,000	-----	-----	Spooner exp. farm.
		B	0.030	1.47	0.019	0.62	0.006	A.	-----	2,000	-----	-----	Composite.

T40&41N, R10 11 & 12	Washburn	588A	0.029	0.77	0.070	2.10	0.115	A.		2,000			Composite, virgin.
NW¼NW¼ S. 1 T38N, R10W	Washburn	658A	0.041	1.30	0.077	1.82	0.054	S.A.	M.A.	2,000	0.668	0.578	Virgin.
		B	0.036	1.23	0.046	0.87	0.025	V.S.A.		2,000			
		665A	0.036	1.41	0.099	2.00	0.042	S.A.		2,000			Composite, virgin. No. 594, 605

Plainfield Fine Sand

SW¼SW¼ S. 14 T18N, R5E	Adams	1,436									0.25	0.09	Cropped.
SE¼SW¼ S. 14 T23N, R11W	Buffalo	714A	0.062		0.076			A.	A.				Cropped.
		B	0.051		0.044			S.A.	S.A.				
SW¼SW¼ S. 15 T11N, R11E	Columbia	495A	0.032	0.99	0.042	0.79		A.	A.	2,000			Virgin.
		B	0.021	0.95	0.027	0.32		A.	A.	2,000			
T11N, R 8 & 9E	Columbia	599A	0.040	0.77	0.081	1.23		S.A.	A.	500			(Dekorra Twp.) Composite, cropped
		B	0.031	0.74	0.040	0.46		S.A.	A.	500			
T13N, R 7 & 8 E	Columbia	619A	0.046		0.080	1.54		A.	A.	2,000			(Tn. of Lewiston) Composite, cropped
		B	0.031		0.037	0.58		S.A.	A.	2,000			
SW¼SW¼ S. 34 T6N, R16E	Jefferson	563A	0.037		0.075	0.97		S.A.	S.A.				Cropped.
		B	0.029		0.038	0.17		N.A.	N.A.				
	Marinette	203A	0.020	1.76	0.125	3.06	0.111	S.A.		5,000			(Dunkirk F. Sand) Comp. No. 82, 83 84.
		B						A.		2,000			
NE¼SE¼ Sec 30 T28, R22E	Oconto	812A	0.041	1.46	0.055		0.0[illegible]6	V.A.	V.A.	2,000			(Dunkirk F. Sand) Cropped.
		B	0.018	1.27	0.011		0.012	S.A.	S.A.	500			
NE¼ Sec 18 T27N, R20E	Oconto	832A	0.013	1.33	0.050	2.03		S.A.	A.	2,000			(Poorly drained phase). Virgin.
		B	0.025	1.34	0.025	1.36		A.	A.	500			
NE¼NW¼ S. 24 T39, R10E	Oneida	741A	0.063	0.87	0.068	2.14		A.		2,000			Cropped.
		B	0.030	1.08	0.026	0.72		A.		2,000			
NE¼SW¼ Sec 33 T38N, R9E	Oneida	764A	0.049	1.00	0.073	2.11		S.A.		2,000			Cropped.
		B	0.043	1.06	0.027	0.71		V.S.A.		2,000			
SE¼NE¼ Sec 8 T39N, R6E	Oneida	863A	0.059	1.06	0.099			A.		2,000			Cropped.
		B	0.033	0.18	0.049			S.A.		2,000			
T27N, R16E	Shawano	818A	0.047		0.094	3.46		V.A.	V.A.	5,000			Composite, virgin.
		B	0.029		0.041	1.62		A.	A.	500			

Location		Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity		Lime Rqt.	Total Ca.	Total Mg.	Remarks
Land Survey	County							Litmus	Truog Test				
Plainfield Fine Sand—Continued													
SW¼ Sec. 9 T26N, R16E	Shawano	828A	0.035	1.33	0.061		0.026	A.	V.A.	5,000			Virgin.
		B	0.028	1.34	0.038		0.041	A.	S.A.	500			
SW¼SW¼ S. 18 T41N, R12E	Vilas	849A	0.047	0.21	0.082			A.		2,000			Virgin.
		B	0.037	1.17	0.049			S.A.		2,000			
T4&43N, R10E	Vilas	780A	0.058	1.12	0.078	3.16		A.		2,000			
		B	0.039	1.31	0.037	1.39		A.		2,000			
SE¼NW¼ S. 27 T40N, R6E	Vilas	862A	0.041	0.97	0.079			V.A.		2,000			Cropped.
		B	0.032	0.97	0.032			S.A.		2,000			
T21&22N, R3E	Wood	1,064A	0.029										Composite, virgin.
		B	0.029										
T21&22N, R3E	Wood	1,065A	0.036										Composite, cropped
		B	0.028										
Plainfield Sand													
	Bayfield	532A	0.029	1.68	0.062	2.00	0.015	A.		5,000			Composite, virgin. No. 264, 275.
		B	0.021	1.60	0.022	0.39	0.010	S.A.		2,000			
	Bayfield	371A	0.022	1.19	0.061	2.03	0.019	V.A.		5,000			Composite, virgin.
		B	0.016	1.35	0.029	0.87	0.006	A.		2,000			
SE¼SE¼ Sec 23 T20N, R12E	Buffalo	538A	0.054	0.85	0.061			S.A.	S.A.				Cropped.
		B	0.050	1.05	0.045			A.	S.A.				
T38, R19W	Burnett	516A	0.026	1.47	0.057	0.96	0.015	V.A.		2,000			Composite, cropped Comp. with No.517
		B	0.023	1.59	0.031	0.42	0.003	V.A.		2,000			
T39, R18W	Burnett	517A	0.026	1.42	0.039	1.92	0.014	S.A.		2,000			Composite, virgin. Comp. with No.516
		B	0.021	1.50	0.030	0.422	0.007	S.A.		2,000			
T39N, R16W	Burnett	579A	0.022	1.29	0.040	0.90	0.039	A.		2,000			Jack Oak area. Composite, virgin.
SE¼NE¼ Sec 8 T41N, R15W	Burnett	593A	0.023	1.24	0.038	1.08	0.023	S.A.		2,000			Cropped.
		B	0.013	1.23	0.020	0.33	0.007	A.		2,000			

T39&40N, R17, 18, 19W	Burnett	606A	0.021	1.23	0.057	1.39	0.026	A.	--------	2,000	--------	--------	Composite, virgin.
		B	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	Comp. with No.607
T39&40N, R17, 18, 19W	Burnett	607A	0.023	0.68	0.062	1.51	0.033	S.A.	--------	2,000	--------	--------	Composite, cropped
		B	0.012	1.07	0.035	0.61	0.023	S.A.	--------	2,000	--------	--------	Comp. with No.606
SE¼SE¼ Sec 33 T40N, R18W	Burnett	608A	0.020	1.29	0.063	1.48	0.039	A.	--------	2,000		--------	Cropped. Comp. with No.609
SE¼SW¼ Sec 33 T40N, R18W	Burnett	609A	0.012	1.24	0.073	1.55	0.033	A.	--------	2,000	--------	--------	Virgin. Comp. with No.608
--------	Burnett	664A	0.021	1.29	0.050	1.06	0.026	A.	--------	2,000	--------	--------	Composite, virgin. No. 590, 592, 603
SW¼NW¼ S. 1 T13N, R6E	Columbia	511A	0.025	0.71	0.043	0.85	nil	V.S.A.	V.S.A.	500	--------	--------	Cropped.
		B	0.017	0.37	0.020	0.23	nil	V.S.A.	V.S.A.	500	--------	--------	
--------	Dunn-Barron	190A	0.042	1.26	0.082	1.89	0.071	S.A.	--------	5,000	--------	--------	Comp. of No. 161, 15, 105, 106, 117, 156, 160.
		B	0.035	1.27	0.041	0.65	0.048	N.A.	--------	2,000	--------	--------	
NE¼NW¼ S. 31 T40N, R18E	Florence	720A	0.044	1.46	0.047	1.33	0.018	A.	A.	2,000	0.283	0.443	Virgin.
		B	0.021	1.27	0.025	0.59	nil	A.	A.	500	--------	--------	
NE¼SW¼ S. 7 T8N, R2E	Iowa	232A	0.038	0.80	0.081	1.28	0.047	N.A.	--------	2,000	--------	--------	Cropped.
		B	0.050	0.81	0.056	1.00	0.011	N.A.	--------	2,000	--------	--------	
SE¼SE¼ S. 8 T8N, R5E	Iowa	386A	0.056	0.65	0.060	1.12	0.013	V.S.A.	--------	2,000	--------	--------	Cropped.
		B	0.043	0.71	0.057	0.24	0.021	V.S.A.	--------	2,000	--------	--------	
--------	Iron	896A	--------	--------	--------	--------	--------	--------	A.	--------	0.375	0.025	
NW¼NW¼ S. 35 T6N, R16E	Jefferson	564A	0.037	--------	0.070	--------	--------	S.A.	S.A.	--------	--------	--------	Cropped.
		B	0.025	--------	0.044	--------	--------	V.S.A.	V.S.A.	--------	--------	--------	
T15N, R3E & T14N, R3E	Juneau	252A	0.030	0.40	0.057	1.20	0.047	A.	--------	2,000	--------	--------	Composite.
		B	0.020	0.68	0.029	0.66	0.092	A.	--------	2,000	--------	--------	
T20N, R4E	Juneau	457A	0.032	0.59	0.068	--------	--------	A.	--------	2,000	--------	--------	Composite.
T18, 19, 20N, R4E	Juneau	469A	0.032	0.43	0.062	--------	--------	A.	--------	2,000	--------	--------	Composite.
NW¼SW¼ S. 29 T24N, R24E	Kewaunee	553A	0.033	--------	0.038	--------	--------	A.	--------	2,000	--------	--------	Cropped.
		B	0.040	--------	0.016	--------	--------	A.	--------	2,000	--------	--------	
SW¼NW¼ S. 18 T25N, R25E	Kewaunee	554A	0.019	--------	0.053	--------	--------	A.	--------	2,000	--------	--------	Dunkirk Sand.
		B	0.020	--------	0.046	--------	--------	A.	--------	2,000	--------	--------	Cropped.

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
					Plainfield Sand—Continued								
SW¼SE¼ S. 17 T16N, R7W	LaCrosse	427A	0.029	1.10	0.069	1.71	0.206	A.	—	2,000	—	—	Cropped.
		B	0.026	1.16	0.055	1.42	0.411	A.	—	2,000	—	—	
NW¼NE¼ S. 35 T18N, R8W	LaCrosse	432A	0.036	0.48	0.058	1.09	0.023	A.	—	2,000	—	—	Cropped.
		B	0.044	0.51	0.048	1.66	0.022	S.A.	—	2,000	—	—	
NW¼NW¼ S. 9 T15N, R17W	LaCrosse	436A	0.034	1.13	0.054	1.23	0.044	S.A.	—	2,000	—	—	Cropped.
		B	0.030	1.09	0.048	0.84	0.014	S.A.	—	2,000	—	—	
T34N, R11E	Langlade	779A	0.051	—	—	—	0.019	A.	V.A.	2,000	0.355	0.569	Composite, virgin.
		B	0.032	—	—	—	0.012	S.A.	A.	2,000	—	—	
—	Marinette	199A	0.080	1.59	0.061	1.08	0.078	A.	—	5,000	—	—	Composite. No. 88, 89, 96
		B	—	—	—	—	—	N.A.	—	2,000	—	—	
SW¼ Sec. 12 T32, R17E	Oconto	734A	0.042	1.46	0.043	1.31	—	A.	A.	2,000	0.268	0.527	Virgin.
		B	0.027	1.27	0.018	0.39	—	A.	A.	—	—	—	
Sec. 18 T38N, R6E	Oneida	873A	0.051	0.76	—	—	—	V.A.	—	2,000	0.273	0.347	Composite, virgin.
		B	0.031	0.94	0.027	—	—	A.	—	500	—	—	
T36N, R19W	Polk	145A	0.025	1.73	0.053	1.28	0.060	S.A.	—	5,000	—	—	Composite, virgin.
		B	0.037	1.75	0.019	0.43	0.047	—	—	—	—	—	
NW¼NW¼ S. 33 T22N, R7E	Portage	930A	—	—	—	—	—	S.A.	A.	—	0.29	0.14	Virgin.
		B	—	—	—	—	—	S.A.	A.	—	—	—	
S½SW¼ S. 32 T23N, R7E	Portage	932A	—	—	—	—	—	A.	A.	—	—	—	Virgin.
		B	—	—	—	—	—	S.A.	S.A.	—	—	—	
—	Portage	1,023A	0.037	—	—	—	—	A.	A.	—	0.275	0.11	Composite.
		B	0.032	—	—	—	—	A.	A.	—	—	—	
T22N, R6&7E	Portage	933A	0.033	—	—	—	—	A.	A.	—	—	—	Composite.
		B	0.033	—	—	—	—	S.A.	S.A.	—	—	—	
T42N, R7E	Vilas	919A	0.052	—	0.096	—	—	V.A.	—	2,000	0.491	0.522	Composite, virgin.
		B	0.045	—	—	—	—	A.	St.A.	500	—	—	

Sec. 24 & 25 T41N, R9E	Vilas	743A	0.042	1.19	0.047	1.61		S.A.	M.A.+	2,000	0.33	0.19	Virgin.
		B	0.029	1.01	0.025	0.67		V.S.A.		500			
	Vilas	861A	0.042	1.11	0.057			V.A.	S.A.	2,000	0.24	0.185	Composite, virgin.
		B	0.027	0.89	0.056			A.		2,000			
	Vilas	882A	0.052	1.29	0.063			V.A.		2,000			Composite, virgin.
		B	0.041	1.12	0.033			A.		2,000			
	Vilas	1,319A							M.A.—		0.15		
NE¼NE¼ Sec 32 T40, R10E	Vilas	785A	0.068	1.21	0.094	3.06			A.	5,000			Cropped.
		B	0.042	1.15	0.028	0.98			A	5,000			
T40N, R13W	Washburn	419A	0.028	1.38	0.048	1.20	0.0165	A.		2,000			Composite, cropped
		B	0.028	1.86	0.019	0.17	0.024	A.		2,000			
T40N, R13W	Washburn	420A	0.034	1.56	0.063	2.200	0.021	A.		2,000			Composite, virgin.
		B	0.027	1.70	0.023	0.860	0.002	S.A.		2,000			
NE¼NE¼ S. 36 T5N, R17E	Waukesha	210A	0.020	0.86	0.053	0.56	0.062	A.		500			
		B	0.035	1.00	0.029	0.41	0.030	S.A.		500			
SW¼NW¼ S. 21 T18N, R12E	Waushara	25A	0.027	1.02	0.083	1.31	0.044	A.		2,000			Cropped.
		B	0.034	0.99	0.054	0.72	0.028	A.		2,000			
NE¼NE¼ Sec 17	Waushara	53A	0.037	0.78	0.064	1.05	0.045	S.A.					Cropped.
		B	0.027	0.77	0.045	0.44	0.027	N.A.					
SE¼SW¼ Sec 22 T18N, R13E	Waushara	23A	0.035	0.79	0.130	2.63	0.091	A.		5,000			
		B	0.013	0.78	0.034	0.31	0.053	A.		2,000			
SW¼SW¼ Sec 11 T20N, R8E	Waushara	56A	0.030	1.14	0.104	1.71	0.063	A.					Cropped.
		B	0.026	1.31	0.061	0.61	0.033	S.A.					
T 21 & 22N, R 5 & 6E	Wood	937A						S.A.	S.A.				Composite, virgin.
		B						S.A.	S.A.				
	Wood	1,083A							M.A.—		0.39	0.185	Composite, cropped
		B									0.304	0.281	
	Wood	936							S.A.		0.24	0.135	

Poygan Clay

	Fond du Lac	319A	0.115	2.22	0.480	8.05	0.478	N.A.		500			Composite.
		B	0.087	2.66	0.222	3.86	3.187	N.A.		500			

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
						Poygan Clay Loam							
--------	Waushara	194A	0.056	2.82	0.330	6.32	0.140	S.A.	--------	2,000	--------	--------	Composite, cropped of No. 19, 21, 22, 51.
		B	0.060	3.17	0.085	0.59	12.935	N.A.	--------	500	--------	--------	
NE¼SE¼NE Sec 34, T19N, R13E	Waushara	19A	0.040	--------	--------	--------	--------	--------	--------	--------	--------	--------	Cropped.
		B	0.053	--------	--------	--------	--------	--------	--------	--------	--------	--------	
N½NE½SW¼ Sec 24, T18N, R13E	Waushara	21A	0.082	--------	--------	--------	--------	--------	--------	--------	--------	--------	Cropped.
		B	0.062	--------	--------	--------	--------	--------	--------	--------	--------	--------	
W½SW¼NW¼ Sec 36, T19N, R13E	Waushara	22A	0.076	--------	--------	--------	--------	--------	--------	--------	--------	--------	Cropped.
		B	0.062	--------	--------	--------	--------	--------	--------	--------	--------	--------	
						Poygan Silty Clay Loam							
--------	Walworth	1,466A	--------	--------	--------	--------	--------	--------	--------	--------	1.44	0.74	
						Poygan Silt Loam							
NE¼SE¼, Sec 33 T18N, R13E	Waushara	24A	0.053	1.42	0.220	4.79	0.021	V.A.	--------	5,000	--------	--------	Cropped.
		B	0.052	2.32	0.029	0.21	3.978	A.	--------	500	--------	--------	
						Poygan Fine Sandy Loam							
SE¼NE¼ Sec 27 T17N, R18E	Fond du Lac	315A	0.096	1.79	0.488	8.10	1.089	N.A.	--------	500	--------	--------	Cropped.
		B	0.058	1.75	0.172	3.48	10.550	N.A.	--------	500	--------	--------	
SW¼ Sec 4 T26, R21E	Oconto	830A	0.086	1.69	0.289	--------	--------	N.A.	N.A.	500	--------	--------	Virgin.
		B	0.028	1.45	0.055	--------	--------	N.A.	N.A.	500	--------	--------	
						Superior Clay							
T46&47, R4&5W	Ashland and Bayfield	268A	0.048	2.67	0.025	2.85	3.72	N.A.	--------	500	--------	--------	Composite, virgin.
		B	0.058	3.00	0.041	0.498	0.218	N.A.	--------	500	--------	--------	
T47&48, R2–3–4W	Ashland	373A	0.035	2.640	0.087	2.51	0.045	S.A.	--------	--------	--------	--------	
		B	0.041	3.060	0.039	0.620	0.311	N.A.	--------	--------	--------	--------	
Sec 29, T51, R4W	Bayfield	32A	0.030	2.44	0.075	0.92	6.772	N.A.	--------	500	--------	--------	
		B	0.035	2.45	0.041	0.35	8.213	N.A.	--------	500	--------	--------	

Sec 14, T50N, R5W	Bayfield	33A	0.054	2.28	0.066	1.12	6.489	N.A.	--------	500	--------	--------	
		B	0.027	2.36	0.036	0.30	8.355	N.A.	--------	500	--------	--------	
--------	Bayfield	34A	0.049	2.32	0.083	0.82	6.176	N.A.	--------	500	--------	--------	Madeline Island Exp. Orchard
		B	0.041	2.35	0.036	0.30	7.066	N.A.	--------	500	--------	--------	
Sec 22, T47, R4W	Bayfield	41A	0.029	2.45	0.101	2.47	0.090	A.	--------	5,000	--------	--------	
		B	0.033	2.65	0.039	0.50	6.381	N.A.	--------	500	--------	--------	
SW¼SW¼ Sec 32 T47, R5W	Bayfield	272A	0.046	2.78	0.145	3.38	0.026	V.S.A.	--------	5,000	0.933	1.44	Cropped.
		B	0.055	3.20	0.047	0.55	0.238	N.A.	--------	500	--------	--------	
--------	Bayfield	46A	0.022	--------	--------	--------	--------	--------	--------	5,000	--------	--------	
--------	Bayfield	205A	0.053	--------	--------	--------	--------	--------	--------	--------	--------	--------	Composite of 32, 35, 34, 41
		B	0.067	--------	--------	--------	--------	--------	--------	--------	--------	--------	
T47&48, R11W	Douglas	262A	0.050	2.50	0.165	3.90	0.044	V.S.A.	A.	5,000	--------	--------	Composite, virgin.
		B	0.038	2.76	0.058	0.83	1.40	N.A.	--------	500	--------	--------	
SE¼NE¼, Sec 12 T48N, R12W	Douglas	646A	0.043	2.72	0.132	2.98	0.029	S.A.	A.	5,000	--------	--------	Cropped.
		B	0.048	2.68	0.072	1.05	2.621	N.A.	--------	500	--------	--------	
--------	Douglas	662A	0.038	2.72	0.116	2.52	0.084	V.S.A.	--------	5,000	0.807	1.63	Composite, virgin. No. 644, 648, 650
		B	0.047	2.78	0.071	1.18	0.799	N.A.	--------	500	--------	--------	

Superior Clay Loam

T15N, R16E	Fond du Lac	346	--------	--------	--------	--------	--------	--------	--------	--------	1.64	1.78	
SW¼NW¼, S. 31 T16, R4E	Juneau	226A	0.063	1.38	0.164	0.74	0.034	S.A.	--------	2,000	--------	--------	Cropped.
		B	0.050	2.32	0.053	0.57	0.013	S.A.	--------	2,000	--------	--------	
SW¼SW¼, S. 15 T23N, R24E	Kewaunee	392A	0.042	--------	0.107	--------	--------	V.S.A.	--------	500	--------	--------	Cropped.
		B	0.076	--------	0.042	--------	--------	N.A.	--------	500	--------	--------	
--------	Waushara	197A	0.049	2.38	0.161	2.86	0.118	S.A.	--------	2,000	--------	--------	Composite, cropped No. 17, 18, 59.
		B	0.039	3.24	0.070	0.87	0.259	N.A.	--------	500	--------	--------	
S½SE¼ Sec 27 T18N, R13E	Waushara	17A	0.022	--------	--------	--------	--------	--------	--------	--------	--------	--------	Cropped.
		B	0.040	--------	--------	--------	--------	--------	--------	--------	--------	--------	
SW¼SW¼ S. 5 T18N, R13E	Waushara	18A	0.049	--------	--------	--------	--------	--------	--------	--------	--------	--------	Cropped.
		B	0.058	--------	--------	--------	--------	--------	--------	--------	--------	--------	

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
Superior Clay Loam, Rolling Phase													
NE¼SW¼ Sec 30 T17N, R19E	Fond du Lac	310A	0.051	2.37	0.125	2.07	0.065	S.A.	V.S.A.	2,000			Cropped.
		B	0.077	2.90	0.064	0.87	2.217	N.A.	N.A.	500			
SE¼NE¼ Sec 18 T15, R18E	Fond du Lac	327A	0.064	2.97	0.189	3.93	0.041	S.A.		500			Cropped.
		B	0.054	3.22	0.074	0.96	0.074	N.A.		500			
T16N, R16&17E	Fond du Lac	340A	0.054	2.66	0.169	3.69	0.269	N.A.		500			Composite, cropped
		B	0.068	2.77	0.068	0.97	10.128	N.A.		500			
SE¼SE¼ Sec 13 T15N, R16E	Fond du Lac	346A	0.062	2.94	0.134	2.56	3.131	N.A.		500	1.780	1.640	Cropped.
		B	0.071	2.63	0.036	0.31	20.814	N.A.		500			
SW¼NW¼ S. 13 T22N, R24E	Kewaunee	393A	0.064		0.141			V.S.A.		500			Cropped.
		B	0.073		0.051			N.A.		500			
NE¼NE¼ Sec 22 T25N, R23E	Kewaunee	394A	0.048		0.077			A.		2,000			Cropped.
		B	0.078		0.059			S.A.		500			
NW¼NE¼ S. 20 T22N, R25E	Kewaunee	395A	0.053		0.158			V.S.A.		500			Cropped.
		B	0.084		0.054			N.A.		500			
T25N, R23E	Kewaunee	400A	0.083		0.076			V.S.A.		500			Composite, cropped
		B	0.083		0.067			N.A.		500			
NE¼NE¼ Sec 8 T23N, R23E	Kewaunee	401A	0.057		0.098			S.A.		2,000			Cropped.
		B	0.075		0.040			N.A.		500			
T22N, R24E	Kewaunee	402A	0.046		0.126			S.A.		2,000			Composite, cropped
		B	0.065		0.052			N.A.		500			
SW¼SW¼ S. 16 T24N, R23E	Kewaunee	403A	0.068		0.113			V.S.A.		2,000			Cropped.
		B	0.085		0.058			N.A.		500			
NE¼SE¼ S. 10 T25N, R25E	Kewaunee	550A	0.041		0.103			N.A.		500	0.988	0.890	Cropped.
		B	0.058		0.063			N.A.		500			
NE¼SW¼ S. 31 T28N, R21E	Oconto	809A	0.055	3.22	0.109	2.07	0.151	N.A.	N.A.	500	1.02	0.970	Cropped.
		B	0.067	2.12	0.046	1.02	19.662	N.A.	N.A.	500			

Superior Silt Loam													
Sec 23 T50N, R5W	Bayfield	36A	0.032	2.38	0.115	2.40	0.025	A.		2,000			
		B	0.034	2.80	0.059	1.15	8.522	N.A.		500			
Superior Loam													
	Waushara	196A	0.030	2.36	0.254	4.73	0.116	A.		2,000			Composite, cropped of No. 52, 60.
		B	0.018	2.98	0.105	1.43	1.661	N.A.		500			
Superior Loam, Rolling Phase													
NW¼NW¼ S. 13 T38N, R18E	Florence	725A	0.031	2.08	0.057	1.59		S.A.	A.	2,000			Virgin.
		B	0.048	2.11	0.038	0.94		V.S.A.	S.A.	5,000			
T25N, R24&25E	Kewaunee	549A	0.048		0.086			N.A.		500			Composite, cropped
		B	0.064		0.046			N.A.		500			
NW¼SE¼ S. 8 T25N, R25E	Kewaunee	551A	0.054		0.156			N.A.		500			Cropped.
		B	0.051		0.056			N.A.		500			
Superior Fine Sandy Loam, Rolling Phase													
SE¼SE¼ S. 3 T39N, R18E	Florence	724A	0.045		0.078	2.04		A.	S.A.	2,000			Virgin.
		B	0.038		0.037	0.95		A.	S.A.	2,000			
NW¼NW¼ S. 7 T25N, R25E	Kewaunee	552A	0.033		0.170			A.		5,000			Cropped.
		B	0.047		0.053			N.A.		500			
T47N, R1W	Iron	898							A.		0.595	0.160	Virgin, composite.
Superior Fine Sandy Loam, Rolling Phase													
NW¼NE¼ S. 15 T29N, R17E	Oconto	745A	0.067	1.78	0.137	3.01	0.044	V.S.A.	S.A.	500			Virgin.
		B	0.037	1.94	0.028	0.52	0.011	S.A.	V.S.A.	2,000			
T26N, R17E	Shawano	820A	0.049		0.124	2.92	0.088	N.A.	N.A.	500			Composite, cropped
		B	0.048		0.056	1.10	0.201	N.A.	V.S.A.	500			
T25N, R17E	Shawano	821									0.53	0.255	Cropped.
Superior Fine Sandy Loam													
	Juneau	669A	0.031	0.32	0.081	1.91	0.032	S.A.		2,000			Composite, cropped No. 249, 254
		B	0.045	0.67	0.040	1.71	0.036	S.A.		2,000			
NW¼NW¼ S. 32 T37N, R19E	Marinette	93A	0.021	2.00	0.055	1.17	0.039			2,000			
		B						S.A.		5,000			
SE¼NE¼ Sec 25 T25, R16E	Shawano	824A	0.044	2.36	0.079			N.A.	V.S.A.	500			Cropped.
		B	0.042	2.54	0.031			V.S.A.	S.A.	2,000			
T25, R16&17E	Shawano	825A	0.041		0.158			A.	V.S.A.	500			Composite, cropped
		B	0.037		0.065			V.S.A.	S.A.	2,000			

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
Superior Sandy Loam													
	Bayfield	35A	0.034	1.08	0.092	2.05	0.264	V.A.		2,000			Madeline Island.
		B	0.044	1.89	0.068	0.59	0.748	S.A.		500			
SE¼ Sec 35 T47, R5W	Bayfield	37A	0.040	0.56	0.040	1.18	1.119	A.		2,000			(Superior Sand)
		B	0.024	0.79	0.028	0.61	0.204	A.		500			
T50N, R5W	Bayfield	38A	0.019	0.74	0.047	1.88	0.187	V.A.		5,000			(Superior Sand)
		B	0.032	0.76	0.023	0.59	0.173	A.		5,000			
NW¼ Sec 36 T49, R5W	Bayfield	39A	0.035	0.61	0.049	1.01	0.066	A.		5,000			(Superior Sand)
		B	0.025	0.69	0.033	0.52	0.057	A.		5,000			
T50N, R5W	Bayfield	40A	0.019	1.67	0.067	2.35	0.080	V.A.		5,000			
		B	0.033	1.99	0.053	1.54	0.111	S.A.		5,000			
T49N, R5W	Bayfield	42A	0.029	1.87	0.074	2.08	0.166	S.A.		2,000			
		B	0.040	2.24	0.053	1.37	0.459	N.A.		500			
	Bayfield	44A	0.013										
	Bayfield	45A	0.040										
	Bayfield	204A	0.036										Composite of No. 37, 38, 39.
		B	0.036										
	Bayfield	206A	0.048										Composite of No. 35, 40, 42.
		B	0.053										
NE¼NW¼ S. 14 T18N, R12E	Waushara	61A	0.021	1.36	0.298	5.65	0.106	N.A.		500			Cropped.
		B	0.028	1.60	0.048	0.41	0.075	S.A.		500			
NE¼NE¼SE¼ Sec 15, T18N, R13E	Waushara	20A	0.036										Cropped.
		B	0.031										

Superior Fine Sand													
T25N, R16&17E	Shawano	823A	0.012	1.77	0.061			A.	A.	2,000			Composite, virgin.
		B	0.011	2.08	0.033			S.A.	S.A.	500			
Rice Lake Loam (Antigo)													
T34, R11&12W	Barron	155A	0.056	1.43	0.114	2.62	0.124	V.A.		2,000			Composite.
		B	0.042	1.41	0.042	0.72	0.075	V.A.		2,000			
	Barron, Polk	191A	0.055	1.71	0.142	3.00	0.143	N.A.		500			Composite. 6, 146, 147, 150, 159.
		B	0.049	1.80	0.058	0.67	0.073	S.A.		500			
	Dunn, St. Croix	186A	0.066	1.46	0.186	3.67	0.114	V.A.		5,000			(Dark Phase) Composite 5, 10, 108, 121, 123, 124, 139 153, 157.
		B	0.038	1.45	0.073	1.59	0.077	V.A.		2,000			
	Eau Claire & Dunn	182A	0.061	1.94	0.169	3.03	0.136	A.		2,000			(Silt Loam) Composite No. 7, 111.
		B	0.061	1.46	0.058	0.45	0.072	S.A.		2,000			
Rodman Fine Sandy Loam													
NE¼SE¼ Sec 23 T5N, R13E	Jefferson	559A	0.035		0.066			S.A.	V.S.A.				Cropped.
		B	0.038		0.043			S.A.	V.S.A.				
Rodman Gravelly Sandy Loam													
SW¼SW¼ S. 22 T7N, R13E	Jefferson	680A	0.041		0.085			V.S.A.	V.S.A.				Cropped.
		B	0.035		0.048			V.S.A.	V.S.A.				
Rodman Fine Sand													
SW¼NW¼ S. 35 T5N, R16E	Jefferson	560A	0.034		0.062			S.A.	S.A.				Cropped.
		B	0.032		0.037			S.A.	N.A.				
Rodman Sand													
SE¼NE¼ S. 20 T20N, R24E	Kewaunee	406A	0.034		0.067			N.A.		500			Cropped.
		B	0.036		0.030			N.A.		500			
Vesper Silt Loam													
	Wood	1,050A	0.035										Composite, cropped
		B	0.009										
T23N, R2&3 E	Wood	1,051A	0.033					V.S.A.			0.375	0.30	Composite, virgin.
		B	0.026										
T23N, R4E	Wood	1,054A						V.S.A.			0.560	0.38	Composite, virgin.
T23N, R3E	Wood	1,055A	0.062										Composite, cropped
		B	0.032										

Location		Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity		Lime Rqt.	Total Ca.	Total Mg.	Remarks
Land Survey	County							Litmus	Truog Test				
Vesper Fine Sandy Loam													
T22N, R3W	Jackson	1,317						V.S.A.			0.07	0.06	
Vilas Sandy Loam													
T33&34N, R9 & 10E	Langlade	755A	0.038	0.97	0.097	2.92		A.	V.A.	5,000			Composite, virgin.
		B	0.035	1.56	0.066	2.14		A.	A.	5,000			
T32, R14E	Langlade	777A	0.052	0.97	0.10	2.93		V.A.	A.	2,000	0.471	0.400	Composite, virgin.
		B	0.057	1.56	0.065	2.11		V.A.	V.A.	2,000			
SW¼ Sec 35 T37N, R19E	Marinette	94A	0.069	2.14	0.083	1.45	0.156	A.		2,000			
		B						A.		5,000			
NE¼NW¼ S. 26 T38N, R9E	Oneida	765A	0.050	1.55	0.063	2.07		V.S.A.		2,000			Cropped.
		B	0.041	1.56	0.030	1.05		V.S.A.		2,000			
SE¼ Sec 15 T38N, R6E	Oneida	870A	0.057		0.103			V.A.		500			Virgin.
		B	0.052		0.052			A.		2,000			
Sec 24 T39N, R6E	Oneida	866A	0.069		0.079			V.A.		2,000			Virgin.
		B	0.052		0.050			A.		2,000			
W½NE¼ Sec. 31 T39N, R10E	Oneida	767A									0.345	0.085	
SE¼NE¼ S. 9 T38N, R6E	Oneida	871A	0.061		0.093					2,000			Cropped.
		B	0.057		0.071					2,000			
NW¼SW¼ S. 16 T26N, R12E	Shawano	761A	0.038	0.97	0.108	5.08		V.A.	V.A.	5,000	0.492	0.380	Cropped.
		B	0.031	1.56	0.053	1.73		V.A.	A.	5,000			
T41N, R6E	Vilas	921A	0.064		0.080			V.A.		2,000			Composite, virgin.
		B	0.045		0.044			V.A.		2,000			
Sec 27, 34, 35 T40, R9E	Vilas	784A	0.063	1.20	0.052			A.		2,000	0.443	0.414	Composite, virgin.
		B	0.056	1.21	0.025			A.		2,000			

Vilas Sandy Loam, Rolling Phase

Sec 17 & 18 T39N, R6E	Oneida	864A	0.063		0.064			A.		2,000			Composite, virgin.
		B	0.056		0.050			V.A.		2,000			
Sec 29 T38N, R7E	Oneida	867A	0.072		0.068			V.A.		2,000	0.803	0.496	Composite, virgin.
		B	0.054		0.088			A.		2,000			
Sec. 10, 11 T42N, R9E	Vilas	782A	0.062	1.15	0.047	1.58		S.A.		2,000	0.442	0.403	Composite, virgin.
		B	0.063	1.21	0.030	0.95		S.A.		2,000			

Vilas Fine Sand

NE¼NE¼ Sec 6 T39N, R19E	Florence	722A	0.046	1.22	0.044	1.38		A.	A.	2,000	0.36	0.095	Virgin.
		B	0.028		0.025	0.65		A.	A.	2,000			
SW¼NE¼ S. 22 T39N, R18E	Florence	723									0.20	0.205	
	Marinette	200A	0.038	1.38	0.071	1.66	0.096	A.		5,000			Composite of No. 81, 95, 99, 101. (Some Coloma included).
		B						S.A.		500			

Vilas Sand

SW¼ Sec 24 T39N, R14E	Forest	667A	0.047	0.97	0.039	1.33		V.A.	A.	2,000			Virgin.
		B	0.040	0.88	0.018	1.05		A.	A.	500			
T47N, R1W	Iron	897							V.A.		0.21	0.10	
Sec 10 & 11 T38N, R11E	Oneida	740A	0.052	0.79	0.047	1.52		A.		2,000	0.41	0.07	Composite, virgin.
		B		1.21	0.026	0.62		A.		2,000			
Sec 36 T38N, R7E	Oneida	869A	0.053	1.02	0.076			A.		2,000			Virgin.
		B	0.045	1.09	0.032			S.A.		2,000			
	Sawyer	661A	0.059	1.38	0.072	1.58	0.088	A.		2,000			Virgin, Composite of No. 542, 543, 545, 547.
		B	0.049	1.32	0.044	1.12	0.042	A.		2,000			
SE¼SW¼ S. 9 T26N, R12E	Shawano	763A	0.042	1.06	0.114		0.037	A.	S.A.	500			Cropped.
		B	0.025	1.18	0.033		0.014	A.	A.	2,000			
Sec 26 & 27 T41N, R11E	Vilas	850A	0.025	0.92	0.059			V.A.		2,000			Virgin.
		B	0.022	1.01	0.036			A.		2,000			
NW¼SE¼ S. 12 T39N, R7E	Vilas	291A									0.435	0.14	Virgin.

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
Vilas Stony Sand													
Sec 17 & 18 T38N, R6E	Oneida	872A	0.065	0.98	0.123			A.		5,000			Virgin.
		B	0.039	1.11	0.037			A.		2,000			
Wabash Silt Loam													
NW¼NW¼ S.15 T8N, R1E	Iowa	104A	0.066	1.67	0.207	3.95	0.085	A.		2,000			Cropped.
		B	0.068	1.74	0.093	1.67	0.045	A.		2,000			
NW¼NW¼ S. 2 T7N, R3E	Iowa	212A	0.141	2.22	0.344	6.56	0.025	N.A.		500			Cropped.
		B	0.119	2.08	0.232	4.81	0.066	A.		2,000			
NW¼SW¼ S. 20 T15N, R6W	La Crosse	376A	0.059	1.87	0.370	7.64	0.068	A.		5,000			Cropped.
		B	0.055	1.69	0.127	2.75	0.070	S.A.		5,000			
NW¼NE¼ S. 31 T18, R7W	La Crosse	431A	0.055	1.72	0.287	5.75	0.220	A.		2,000			Cropped.
		B	0.061	1.80	0.153	3.21	0.044	S.A.		2,000			
SE¼NW¼ S. 21 T18N, R6W	La Crosse	523A	0.135	1.67	0.397	9.42	0.213	A.		5,000			Cropped.
		B	0.090	1.84	0.231	5.54	0.047	S.A.		5,000			
Wabash Loam													
SW¼SE¼ S. 15 T4N, R1E	Iowa	73A	0.136	1.71	0.408	7.34	0.161	S.A.		500			Cropped.
		B	0.029	2.00	0.075	0.89	0.028	A.		2,000			
NW¼NE¼ S. 28 T7N, R2E	Iowa	79A	0.071	1.83	0.181	3.40	0.123	N.A.		500			Cropped.
		B	0.119	1.93	0.204	4.01	0.088	S.A.		500			
NE¼NE¼ Sec 16 T16N, R5W	La Crosse	428A	0.031	1.83	0.110	2.83	1.806	N.A.		500			Cropped.
		B	0.043	1.85	0.122	2.86	1.019	N.A.		500			
Waukesha (La Crosse) Silty Clay Loam													
SW¼SE¼ S. 32 T15N, R4E	Juneau	225A	0.124	1.24	0.505	7.45	0.100	V.S.A.		500			Virgin.
		B	0.061	1.54	0.050	0.93	0.035	N.A.		500			
Waukesha Silt Loam													
SE¼NE¼ Sec 16 T21, R11W	Buffalo	711A	0.087		0.226			S.A.	A.				
		B	0.072		0.120			S.A.	A.				
NE¼NW¼ S. 2 T24N, R11W	Buffalo	709A	0.091		0.255			A.	A.				
		B	0.085		0.211			V.A.	V.A.				
T8N, R6E	Dane	790A	0.050										
		B	0.041										

SE¼NE¼ Sec 27 T17N, R6W	La Crosse	377A	0.071	1.72	0.240	4.81	0.056	A.	--------	2,000	--------	--------	Cropped.
		B	0.045	1.52	0.135	2.85	0.022	A.	--------	2,000	0.67	0.345	
SE¼NE¼ Sec 36 T17N, R6W	La Crosse	378A	0.046	1.34	0.139	2.52	0.037	S.A.	--------	2,000	--------	--------	Cropped.
		B	0.032	1.25	0.049	0.88	0.026	S.A.	--------	2,000	0.42	0.36	
NE¼NE¼ Sec 9 T16N, R5W	La Crosse	437A	0.073	1.69	0.211	4.20	0.037	S.A.	--------	5,000	--------	--------	Cropped.
		B	0.046	1.72	0.102	1.72	0.020	N.A.	--------	2,000	0.437	0.505	
NW¼NW¼ S. 33 T17N, R5W	La Crosse	438A	0.053	1.47	0.094	1.61	0.128	N.A.	--------	500	--------	--------	Coarse phase.
		B	0.051	1.49	0.043	0.72	0.039	N.A.	--------	2,000	0.430	0.345	Cropped.
NW¼SW¼ S. 21 T18N, R6W	La Crosse	525A	0.093	1.62	0.304	6.01	0.051	V.A.	--------	5,000	--------	--------	Cropped.
		B	0.068	1.36	0.137	2.42	0.013	S.A.	--------	5,000	0.555	0.35	
SW¼SW¼ S. 25 T3N, R18E	Walworth	1,470	--------	--------	--------	--------	--------	--------	--------	--------	0.530	0.30	
						Waukesha Loam							
NE¼NE¼ Sec 16 T6N, R19E	Waukesha	30A	0.073	1.68	0.260	5.33	0.226	A.	--------	2,000	--------	--------	Cropped.
		B	0.051	1.77	0.109	1.84	0.195	S.A.	--------	2,000	--------	--------	
NW¼NW¼ S. 24 T5N, R17E	Waukesha	177A	0.060	1.49	0.202	3.51	0.136	A.	--------	2,000	--------	--------	Cropped.
		B	0.054	1.58	0.132	1.96	0.099	A.	--------	2,000	--------	--------	
T5N, R17&18E	Waukesha	178A	0.073	1.56	0.220	3.80	0.046	A.	--------	500	--------	--------	Composite, cropped
		B	0.055	1.69	0.129	2.00	0.319	A.	--------	2,000	--------	--------	
SW¼SE¼ Sec 10 T7N, R17E	Waukesha	266A	0.059	1.61	0.212	4.78	0.063	S.A.	--------	2,000	--------	--------	Cropped.
		B	0.049	1.66	0.111	2.00	0.042	A.	--------	2,000	--------	--------	
						Waukesha Gravelly Loam							
NE¼NW¼ Sec 1 T5N, R17E	Waukesha	243A	0.065	1.24	0.245	4.33	0.082	N.A.	--------	500	--------	--------	Cropped.
		B	0.044	1.12	0.045	0.78	0.128	N.A.	--------	500	--------	--------	
						Waukesha Fine Sandy Loam							
NW¼NW¼ S. 10 T8N, R6E	Dane	795A	0.034	--------	--------	--------	--------	--------	S.A.	--------	0.355	0.16	
NW¼NW¼ S. 6 T16N, R5W	La Crosse	379A	0.035	0.83	0.073	1.46	0.111	S.A.	--------	500	--------	--------	Cropped.
		B	0.033	0.67	0.031	0.73	0.019	N.A.	--------	500	--------	--------	
SE¼SW¼ S. 10 T16N, R6W	La Crosse	429A	0.023	0.95	0.059	1.33	0.220	S.A.	--------	2,000	--------	--------	Cropped.
		B	0.024	1.50	0.025	0.81	0.030	N.A.	--------	500	--------	--------	
SE¼NW¼ S. 36 T18, R8W	La Crosse	434A	0.028	1.42	0.061	1.18	0.139	S.A.	--------	2,000	--------	--------	Cropped.
		B	0.030	1.37	0.046	0.83	0.039	S.A.	--------	2,000	--------	--------	
SE¼SW¼ S. 29 T23N, R9E	Portage	1,019A	0.064	--------	--------	--------	--------	S.A.	V.A.	--------	--------	--------	Cropped.
		B	0.046	--------	--------	--------	--------	A.	A.	--------	--------	--------	

Location: Land Survey	Location: County	Soil No.	Total P.	Total K.	Total N.	Organic Matter	$CaCO_3$	Acidity: Litmus	Acidity: Truog Test	Lime Rqt.	Total Ca.	Total Mg.	Remarks
Waukesha Sandy Loam													
SE¼SW¼ Sec 35 T17N, R5W	La Crosse	426A	0.033	0.66	0.088	2.48	0.138	A.		2,000			Cropped.
		B	0.030	0.57	0.042	3.26	0.037	S.A.		500			
SE¼SE¼ Sec 13 T20N, R9E	Waushara	55A	0.020	1.29	0.186	3.39	0.058	V.A.		5,000			Cropped.
		B	0.021	1.41	0.098	1.41	0.046	V.A.		5,000			
SE¼SW¼ Sec 26 T20N, R9E	Waushara	64A	0.024	1.24	0.160	2.94	0.056	A.		5,000			Cropped.
		B	0.033	1.44	0.091	1.40	0.034	A.		5,000			
Waukesha Sand													
SW¼SW¼ Sec 1 T18N, R4E	Adams	1,435A									0.26	0.20	Cropped.
T23&24N, R8E	Portage	1,015A						V.A.	A.		0.30	0.095	Composite.
		B						A.	A.				
SW¼SE¼ Sec 4 T18N, R8E	Waushara	58A	0.078	1.04	0.144	2.33	0.047	A.		2,000			Cropped.
		B	0.038	1.20	0.087	1.16	0.044	A.		2,000			
Webster Loam													
T 38 & 39, R16 & 17W	Burnett	578A	0.034	1.35	0.098	2.13	0.030	A.		2,000	0.285	0.155	Composite, cropped
		B	0.016	1.16	0.035	0.61	0.017	S.A.		2,000			
Whitman Silt Loam													
SE¼SE¼ Sec 8 T31N, R16E	Lincoln	976A	0.102					A.	A.				Virgin.
		B	0.056					A.	A.				
SW¼SW¼ Sec 10 T24N, R6E	Portage	1,001A	0.126			17.84		S.A.	A.				Virgin.
		B	0.053			6.85		S.A.	A.				
NW¼NW¼ S. 25 T23N, R4E	Wood	1,058A	0.071			10.27							Cropped.
		B	0.027			2.46							
NE¼SW¼ S. 16 T23N, R4E	Wood	1,061A	0.092			13.01							
		B	0.105			3.2							

APPENDIX V. COMPLETE ANALYSIS OF FOUR IMPORTANT SOIL TYPES

COMPLETE ANALYSES. METHODS

The complete analysis of the soils herein reported was accomplished by means of twelve separate fusions or soil solutions. These twelve determination procedures are outlined below.

1. Sodium carbonate fusion to determine silica, iron, aluminum, titanium, manganese, calcium, magnesium, and strontium. Use one gram of 100 mesh soil. (Hillebrand)
2. J. Lawrence Smith fusion. Calcium carbonate and ammonium chloride to determine sodium and potassium. Use one to two grams of 100 mesh soil.
3. Sodium carbonate fusion to determine barium, zirconium, chromium, and rare earths. Use two to four grams of soil. (Hillebrand)
4. Sodium carbonate sodium nitrate fusion to determine vanadium, (chromium), arsenic, and molybdum. Use five grams of soil. (Hillebrand)
5. Sodium peroxide fusion to determine sulphur. Use ten grams of soil. (Shedd's modification of Hart and Peterson method).
6. Nitric acid extraction to determine phosphorus. Two grams of soil.
7. Kjeldahl digestion to determine nitrogen. Ten grams of soil.
8. Combustion in electric furnace to determine carbon. Two grams of soil.
9. Ignition to determine loss.
10. Moisture below 110° C.
11. Acidity, active. (Truog)
12. Acidity, latent. (Truog)

In general the methods used in these analyses apply to the analysis of silicate rocks, as outlined by Hillebrand in bulletin 700, U.S.G.S., The Analysis of Silicate and Carbonate Rocks. In certain procedures it is necessary to alter the methods for soil because of the organic matter present. Consequently the methods used throughout the analyses are given in detail. Unless otherwise stated the methods are compiled from those outlined by Hillebrand. In cases where it is necessary to vary the procedure, mention will be made of such variation. These analyses were made by Mr. W. M. Gibbs.

Element	Miami silt loam	Colby silt loam	Superior clay loam	Sparta sand
	Percentage	Percentage	Percentage	Percentage
SiO_2	78.36	71.35	73.01	96.14
TiO_2	.682	.612	.637	.068
Al_2O_3	8.197	9.671	9.536	.836
Fe_2O_3	2.365	3.437	3.163	.948
MnO	.197	.272	.108	.0174
Cr_2O_3	.006	.004	.013	N. P.
V_2O_5	.109	.089	.117	.022
R. earths	.040	.068	Doubtful	present
ZrO_2	.044	.045	.017	.007
MoO_2	N. F.	N. F.	N. F.	N. F.
CaO	Sr. 1.136	.955	.974	Sr. .154
BaO	.073	.060	.0867	.006
SrO	Not found	.077	.153	Not found
MgO	.666	.685	.114	.040
K_2O	2.264	2.227	2.907	.236
Na_2O	1.302	1.293	1.196	1.040
P_2O_5	.159	.224	.220	.046
SO_3	.074	.091	.055	.007
Loss on ignition	5.085	8.907	6.364	1.016
H_2O 100° C.	1.66	2.55	1.96	.53
C	1.45	2.75	2.000	Not run
Total acidity	6.3T	20.37 T	13.7 T	10.00 T
Active acidity	2.08 T	7.286 T	4.794 T	3.157 T
N	.118	.216	.115	.028
Total	100.756	100.067	98.670	100.355

APPENDIX VI

REPORTS ON WISCONSIN SOILS

Bulletin No. XI. Economic Series No. 7.
Preliminary Report on the Soils and Agricultural Conditions of North Central Wisconsin. Samuel Weidman.

Bulletin No. XXIII. Economic Series No. 14.
Reconnoissance Soil Survey of Northwestern Wisconsin.

Bulletin No. 24. Soil Series No. 1 (Economic Series No. 15)
Reconnoissance Survey of Marinette County. (Out of Print)

Bulletin No. 28. Soil Series No. 2.
Waushara County. (Out of Print)

Bulletin No. 29. Soil Series No. 3.
Waukesha County.

Bulletin No. 30. Soil Series No. 4.
Iowa County.

Bulletin No. 31. Soil Series No. 5.
Bayfield Area.

Bulletin No. 32. Soil Series No. 6.
North Part of Northwest Wisconsin. (Out of Print)

Bulletin No. 37. Soil Series No. 7.
Fond du Lac County. (Out of Print)

Bulletin No. 38. Soil Series No. 8.
Juneau County.

Bulletin No. 39. Soil Series No. 9.
Kewaunee County.

Bulletin No. 40. Soil Series No. 10.
La Crosse County.

Bulletin No. 43. Soil Series No. 11.
Vilas and Portions of Adjoining Counties. (Out of Print)

Bulletin No. 47. Soil Series No. 12.
Northeastern Wisconsin.

Bulletin No. 48. Soil Series No. 13.
Jefferson County.

Bulletin No. 49. Soil Series No. 14.
Columbia County.

Bulletin No. 50. Soil Series No. 15.
North Central Wisconsin.

Bulletin No. 52A. Soil Series No. 16.
South Part of North Central Wisconsin.

Bulletin No. 52B. Soil Series No. 17.
Wood County.

Bulletin No. 52C. Soil Series No. 18.
Portage County.

Bulletin No. 52D. Soil Series No. 19.
Door County.

Bulletin No. 53A. Soil Series No. 20.
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Bulletin No. 53B. Soil Series No. 21.
Rock County.

Bulletin No. 54A. Soil Series No. 23.
Buffalo County.

Bulletin No. 54B. Soil Series No. 24.
Jackson County.

Bulletin No. 54C. Soil Series No. 25.
Waupaca County.

Bulletin No. 54D. Soil Series No. 26.
Outagamie County.

Bulletin No. 55. Soil Series No. 27.
Report and Map (General) of the North Half of Wisconsin.

Bulletin No. 56A. Soil Series No. 28.
Milwaukee County.

Bulletin No. 56B. Soil Series No. 29.
Racine and Kenosha Areas.

Bulletin No. 56C. Soil Series No. 30.
Walworth County.

Bulletin No. 59D. Soil Series No. 44.
Adams County.

Bulletin No. 59C. Soil Series No. 33.
Washington and Ozaukee.

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