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43

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Special Report on the Reconnoissance

SOIL SURVEY

of

Vilas and Portions of Adjoining Counties

WISCONSIN

by

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assisted by

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TABLE OF CONTENTS

APPENDIX

ILLUSTRATIONS

PLATES AND MAPS

MAPS IN FOLDER ATTACHED TO BACK COVER

PREFACE

The examination of the soils of the area in which the development of a forest reserve has been proposed was made in compliance with the resolution of the legislature of 1913, No. 66 A.

Resolved by the Assembly, the Senate concurring, That the geological and natural history survey be directed to make a preliminary soil survey of the lands included within the proposed boundary of the forest reserve in Forest, Iron, Oneida, Price, and Vilas Counties, such survey to be completed not later than January 1, 1915.

The primary object of this report is to so describe and classify the soils of this region as to make the report of most aid in distinguishing between those lands which have so large a value for agricultural purposes as to make it unwise for the State to use them as a forest reserve and those which have so low a value for agricultural purposes that their use as a forest reserve would be reasonable.

The examination of the soils of this area has been in somewhat greater detail than that of the remainder of the northern part of the State of which a general or reconnoissance survey is being made and on portions of which reports have already been published. On the other hand, no such degree of detail or accuracy has been attempted as has been used in the soil survey by counties in the older and more developed portions of the state in which the soil maps are intended to show with accuracy the kind of soil on each ten-acre area. In the work on which the map accompanying this report was based, the aim as to the amount of detail employed, was to see each square mile of land sufficiently well to get a good idea of the soils upon it. This was the rule adhered to in the wooded and undeveloped portions. This rule required that at least some portion of every section of land be examined, but does not mean that every forty of land was visited. Only a sufficient portion of each section was seen to enable the members of the party to trace the soil boundaries in that section. For this reason small marshes or ponds were in some cases not seen and are omitted on the map. Boundaries of many larger lakes are also inaccurate on all original maps and while many corrections were made, others could not be made on the soil map. Greater detail than this in the undeveloped parts of the area was not found practicable because of limitation of time and resources. In the more accessible townships, all roads were traversed with a plane-table and all other trails, logging roads and railroad grades were travelled on foot. Canoe and boat-trips on lakes and streams were employed where necessary to see the country. Every farm and clearing was visited. This results in a map of most detail and accuracy in the more developed townships and of less detail in the undeveloped and inaccessible ones. The total amount of field work represents the equivalent of one man's time for twenty-eight months.

The work was done, usually, by parties of two men in company who confined their efforts to a single township which was completed before work in another township was taken up. Starting from a known point in the township, the roads were first located by means of a plane-table and all soil changes and boundaries noted along them. This work was usually done with the aid of a horse or team. The more inaccessible parts of the township were then covered by following land lines, pacing with the compass to keep the correct location of the party. It was found possible to reach most of the townships from a town or from one of the summer resorts on the many lakes. In some cases camping was necessary in which a camp outfit was taken to the township under investigation and the work done from the camp as a base.

Mr. T. J. Dunnewald has been in charge of the field work during the seasons of 1913 and 1914, and has been assisted by Mr. Alfred Buser and L. R. Schoenmann of the Bureau of Soils of the United States Department of Agriculture, and by W. C. Boardman, C. B. Post, and A. R. Albert. Credit is also due to Mr. F. L. Musbach and O. I. Bergh for preliminary work on certain portions of this area

done during the summers of 1911 and 1912, and to Mr. H. Ullspberger and W. J. Geib for assistance in the correlation of soil types and in editing the report. Assistance was given by the State Board of Forestry in the compilation of data as to the lands owned by the state. The Survey is also indebted to several lumber and real estate firms and many woodsmen, forest rangers and residents of the area for information and directions which often greatly facilitated the work and increased the accuracy of portions of the map.

RECONNOISSANCE SOIL SURVEY OF VILAS AND PORTIONS OF ADJOINING COUNTIES.

CHAPTER I.

INTRODUCTION.

FACTORS IN SOIL FERTILITY AND PRINCIPLES OF SOIL CLASSIFICATION.

The agricultural value of land is determined by its power to produce crops and by a set of other conditions including markets, transportation facilities, educational advantages, etc. This report will deal only with the crop producing power of the soil. This crop producing power of the soil depends on the degree to which it meets the requirements of growing crops and on its adaptability to the use of tools necessary for its cultivation.

The chief factors determining the crop producing power of a soil are the texture or fineness of grain, the topography or lay of the land, the character of the subsoil, the amount of organic or vegetable matter, and the chemical composition.

Soil Texture.—Many of the most important qualities of a soil are determined by its texture or fineness of grain. Its water-holding capacity, its tilth or condition with reference to suitability as a seed bed, its permeability to the roots of growing crops, and even its fertility to a large degree are determined by the fineness of the ultimate particles or grains of which it is composed.

In order to express the texture with any degree of definiteness, it is first necessary to separate the soil of any sample by the use of sieves and other means into several grades. This process of separation on the basis of size of grains is called "mechanical analysis". A system which has come to have general use has been worked out by the Bureau of Soils of the United States Department of Agriculture. In this system, the soil is separated into seven grades with names and limiting diameters as follows:

		Milimeters.
1.	Fine Gravel	2.000–1.000
2.	Coarse sand	1.000– .500
3.	Medium sand	.500– .250
4.	Fine sand	.250– .100
5.	Very fine sand	.100– .050
6.	Silt	.050– .005
7.	Clay	.005– .000

It will be noted that the terms sand, silt and clay as here used refer to the grades or "separates" of which any soil is composed and not to the character of the soil as a whole whether sandy, silty or clay which is determined by the relative amounts of the grades or separates of which it is composed.

Textural classification.—Soils may be classified on the basis of their texture. The system in most general use is that which has been worked out by the Bureau of Soils. In this system twelve classes of soils have been distinguished on the basis of their mechanical composition. These classes with the average mechanical composition of each are given in the following table:

TABLE 1.

Giving the Texture of Soils by Classes as Shown by their Average Mechanical Analysis.

Class of soil.	Mechanical analysis giving average percentage of soil separates in each class.						
	Fine gravel	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt	Clay
Coarse sand	10	23	21	23	9	9	5
Medium sand	3	13	20	38	12	9	5
Fine sand	--	2	12	49	20	11	4
Coarse sandy loam	9	24	16	10	10	22	9
Medium sandy loam	3	12	12	27	15	20	11
Fine sandy loam	1	2	3	29	28	27	10
Loam	3	4	4	14	15	40	20
Silt Loam	1	1	1	3	9	68	17
Clay loam	3	4	4	11	11	37	30
Sandy clay	1	6	7	27	15	14	30
Silty clay	--	1	1	2	5	60	31
Clay	1	2	2	5	7	41	42

Water holding capacity.—Most of the water on which the growth of crops depends is that which is held as capillary films around soil grains. This amount, therefore, depends on the amount of surface exposed by the soil grains and since a given weight of fine soil has more surface than the same weight of coarse soil, it follows that the waterholding power of a soil is chiefly determined by the percentage of the finer grades of soil elements. The percentage of silt and clay contained in any given soil is, therefore, relatively more important than the percentage of the coarser grades of sand.

Not only is the amount of water which a soil can hold determined by its texture, but the rise of moisture from the subsoil to replace that which is taken by the plant during its growth is greatly influenced by the texture. Fine soils are able to raise moisture from much greater depths than coarse soils can. Silt and clay loam soils may bring up water from 20 to 40, and perhaps a hundred feet during long dry season, and, while the amount of water brought up from such depths is probably never great, it may at times be of considerable importance. Coarse sands, on the other hand, cannot raise moisture from more than a few feet in depth.

Such soils as heavy clay loams and clays have this water-holding power in excess and are objectionable on this account, but as soils of this character do not exist in this area, no further consideration need be given them.

Topography.—The topography or the "lay of the land," as it is often called, affects the agricultural value in several ways. It influences the readiness with which several farm machines can be operated, it determines to a large extent the amount of erosion which the soil is subjected to; it influences the depth to ground water in the soil, and so determines the distance through which moisture must be raised capillarily to reach crops during dry seasons. The last mentioned point is of special importance in this region, since coarse textured or sandy soils are unable to bring up water from any considerable depth and the rough hummocky areas of sandy soils, therefore, have much less value than do the level lands of the same texture.

On account of the influence of topography, it is desirable to distinguish two classes among the types of soil, first including those which are undulating or rough and second those which are level. The undulating and rough soils are those which were formed by the solid ice of the glacial sheet which extended down from the northeast during the last glacial period and in moving across the country brought much of the surface soil from regions to the northeastward and piled them up, giving this area its present surface. The level stretches of this region were formed by the sands and alluvial material carried by running streams and issuing from this glacial sheet. They are, therefore, stratified and it is quite commonly found that the subsoil is coarser than the surface soil. The sandy soils of undulating or rough topography are included in the Vilas series, while those of fine sandy loam and silt loam texture are included in the Kennan series. The stratified sandy soils with level surface are grouped under the Plainfield series and those of fine sandy loam or heavier texture are put in the Antigo series.

Organic matter.—Organic or vegetable matter affects the fertility of the soil by increasing its water-holding capacity; by furnishing the source of part of the nitrogen and playing an important part in causing the chemical changes by which the mineral elements in the soil become available to crops. All of the soils of this region, except those of the marshes, are relatively low in organic matter as is commonly true of soils of wooded regions. The large amount of organic matter found in black prairie soils is chiefly formed by the fine roots of grasses. The leaves and roots of trees decompose almost completely, leaving but very little organic matter or humus. The maintenance of fertility in these soils will depend, therefore, to a considerable extent on the use of methods calculated to maintain and increase the amount of vegetable matter. The marsh lands of this region are very largely composed of vegetable matter, chiefly derived from sphagnum moss which grew in the many shallow lakes and ponds left at the close of the glacial period. These marsh soils may be subdivided into Peat and Muck—the Peat including those having 50 per cent or more of vegetable matter, and the Muck those having less than 50 per cent. By far the largest portion of the marsh soils of this region are Peat.

Chemical composition.—As ordinarily used, the term "fertility of the soil" refers to the supply of the chemical elements of plant food furnished by the soil, but only a small portion of any one of these essential elements is in a form which can be absorbed by the plant at any one time or during any single season. The bulk of these elements must become available very slowly through changes of a chemical character. The methods used in the chemical analysis of soils are, therefore, of two classes, first those used for the purpose of determining the amount which is available at any one time, to show the immediate fertility of the soil, and second those used to determine the total amount of each of the essential elements. Methods of the first class have not reached a sufficient degree of refinement to be used with any high degree of accuracy and moreover the determination of the total amount of each of the elements is of far greater importance, since it shows the supply which may be drawn on during a long period of years and is, therefore, of greater service in determining the true value of the land.

The chemical analyses given in the following pages are those resulting from the use of methods in which the total amount of each of the essential elements is determined. This supply of total plant food considered in connection with the topography and texture of the soil and the amount of organic matter will serve as the best guide in an estimation of the fertility which these soils may show under cultivation.

CHAPTER II.

DESCRIPTION OF PLAINFIELD SOILS.

PLAINFIELD SAND.

Extent and Distribution.—The Plainfield sand comprises approximately a total area of 145 square miles. It occurs in large irregular areas, each of them generally several square miles in extent. The largest are found between Sayner and St. Germain Lake in (T 40-R 8); between Conover and State line in (T 41-R 10) (T 42-R 10) (T 42-R 9); bordering the Wisconsin River in (T39-8); South of Crawling Stone Lake in (T 40-R 5); west of Trout Lake in (T 41-R 6) (T42-R6); about Boulder Jct. in (T42-R7) and about Rest Lake in (T42-R5) (T42-R4).

Topography and Drainage—The surface features or topography of the Plainfield sand consist of a level, generally unbroken, plain. Some variations occur in small areas where the plain is pitted, that is, having a group or series of bowl-shaped depressions. In other places broad gentle undulations occur, but in the larger areas, typically developed, the topography is a level plain.

Because of the open, rather loose structure of the Plainfield sand, the natural drainage is good and often excessive. In some places, the surface attains a certain compactness, but the general looseness of the subsoil permits the rapid percolation of all rainfall. The effect of this excessive drainage is seen in the quick drying of the soil and lack of water puddles after a heavy rain. The vegetation also shows the effects, the trees, if any, being drought-resisting varities and the plant vegetation of a kind that requires a minimum of moisture. The difference in resistance to drought between the Plainfield sand and the Plainfield fine sand is noticeable in the vegetation, the latter bearing generally larger timber with a greater percentage of white pine, with plenty of popular and birch appearing in the second growth. The frequent lack of moisture restricts the growth of these varities on the Plainfield sand where, if any timber is present, it consists largely of Jack or Norway pine and the second growth is generally very meagre.

An exception to this general state of excessive drainage on the Plainfield sand type is found on the areas bordering the Manitowish marshes between Powell and Manitowish in (T42-R4). Here the type consists of bare flat sand areas but slightly elevated above the peat marsh which almost entirely surrounds them. Here the water table is so near the surface that the soil is more or less continuously wet and numerous wet grassgrown swales and flats are scattered over the sand areas.

These areas cover about two to three square miles of territory lying in Sections 8, 13, 15, 16, 17 and 21 of (T42-R4).

Texture and Composition.—The Plainfield sand in this area has been deposited as outwash plains by water coming from the melting of the glacial ice. The material was doubtless derived from the granitic rocks upon which it lies and in part brought down from the Keewanawan sandstone farther north. Being assorted by the water from the melting glacier, the finer material was largely carried away, leaving the heavier sand grains deposited in horizontal layers. This horizontal stratification may be noted in most any sand pit or road cut in this kind of soil.

The surface soil has from 1 to 2 inches of grayish medium to fine sand on 8 to 10 inches of medium brown or yellowish—brown sand. Yellow medium to fine sand is found at 10 to 12 inches which may extend to 40 inches or more or may be followed by a medium coarse sandy layer containing varying amounts of gravel at 24 to 30 inches. Where the gravel layer is present, it is underlaid by a layer of coarse yellow sand.

The texture of the soil is quite uniform, the bulk of the sand grains generally running from a fine to medium sand. Greater amounts of coarse sand are often found in connection with exposures of gravel or in low-lying areas near marshes and poorly drained areas. Variations occur in the amount of gravel exposed and in the depth of the surface sand over the gravelly layer. In (T41-R10) north of

Conover, the sand grains of this soil are finer than typical and some of the soil is a fine sand, but the character of the vegetation and water-holding capacity resemble those of the Plainfield sand and, therefore, no separation was made in this case. These variations are not of sufficient note or extent to change or affect the general agricultural value of those portions of the type affected.

The following table shows the percent of particles of different sizes in typical samples of this soil.

TABLE 2.

Mechanical Analysis of Plainfield Sand.

Gravel.	Sand.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Soil A	2.54	15.79	29.43	28.54	8.84	8.49	5.76
Subsoil B	4.03	14.57	30.3	31.11	9.87	6.17	4.15
Soil A	6.85	22.44	21.20	27.08	4.71	9.61	9.92
Subsoil B	9.10	18.43	21.58	37.37	5.42	4.75	3.34

On the virgin soil, the surface inch or two is somewhat dark, due to an accumulation of organic matter but this disappears quickly where the soil is burned over a few times or where it has been cultivated. The soil is generally acid to litmus.

Native Vegetation.—The original timber growth of the Plainfield sand, examples of which are now to be seen only in a few scattered places, consisted largely of Norway and Jack pine often of large size, with some white pine in places. Extensive areas appear to have had no timber on them for a long time past, as no stumps or other signs of timber are to be seen. Woodsmen also report that when the timber on these plains was first cut, there were open areas, bare of timber in some places.

The second growth, where any has escaped the repeated fires, consists mainly of small Jacks and Norways. Poplar and birch second growth is absent or meagre. The ground cover consists of sweet fern, brake and blue-berry bushes with some short, coarse buffalo grasses in places.

Agricultural Development.—Plainfield sand in common with some of the other soils in the area, has been farmed only to a very limited extent. Less than two dozen cultivated fields of any consequence were noted on the areas mapped with this soil. In most cases, the cultivator of this soil derives part at least of his income from other sources than the land, such as conducting a summer resort. In several cases, the farms on this soil were conducted in connection with the summer home of some man from the city. In other cases, as that of Chas. Ahlburn Sec. 25 (T39-R5) the soil is cultivated in connection with land of better quality.

The crops now grown consist mainly of potatoes, rye, buckwheat and corn. Yields are fair in those seasons when rainfall conditions are most favorable. Rather thin crops of clover have been made to grow in some cases on new land. Potatoes are reported to give from 100-150 bushels in good years. Corn 20-30 bushels. Rye 10 to 12 bushels. Hay is a light crop and a sod is very difficult to maintain on the soil.

Agricultural Value.—The type as a whole is of low value for general settlement because of its sandy character. The soil requires a system of farming which will increase its content of organic matter and improve its water holding capacity. The inauguration of such a system would mean that for the first few years, the settler must put much into the soil as well as taking crops off. This, the average settler is not prepared to do. Taken in conjunction with heavier and better adjoining soils, farms can in part be developed on Plainfield sand. An extensive system of farming such as a potato farm on a large scale where expensive machinery could be used for clearing and cultivation, might be practicable. But the opening of small farms with limited amounts of capital is not recommended on this soil because of the prevalence of much better types of soil where better yields may be obtained immediately and for a number of years continuously without artificial fertilization. The lack of firewood, and the liability of the soil to drought are serious impediments to the average settler.

When the better soils have been taken up and the general price of land has risen in the locality due to its development, cheap land of this kind can be more easily and profitably utilized for general farming. A further discussion of the agricultural value of this type of soil will be found in Chapter on Summary and Conclusions.

The following table shows the results of a chemical analysis of typical samples of this soil.

TABLE 3.

Chemical Composition of Plainfield Sand in Per Cent.

Soil Number.	Total Phosphorus.	Total Potassium.	Total Nitrogen.
861	%	%	%
Surface A	0.042	1.11	0.057
Subsoil B	0.027	0.87	0.056
873			
Surface A	0.051	0.76	0.095
Subsoil B	0.031	0.95	0.027
919			
Surface A	0.052	1.24	0.096
Subsoil B	0.035	1.36	0.045
743			
Surface A	0.042	1.19	0.047
Subsoil B	0.029	1.01	0.025

PLAINFIELD FINE SAND

Extent and Distribution.—The Plainfield fine sand is an important and extensive soil in the area. Approximately 195 square miles of this soil were mapped in the area. It occurs in extensive areas in the vicinity of Eagle River in (T40–R10) (T40–R9) and Clearwater Lake (T39–R10) and Three Lakes (T38–R11). Extensive areas occur also in the vicinity of Minocqua, Woodruff, Arbor Vitae and about Lac Du Flambeau. (T39–R6) (T40–R6) (T40–5) T41–R4) (T38–R4). Areas of smaller size are mapped in nearly every township in the area.

Topography and Drainage.—The surface of the type is generally level with some slight irregularities in topography bordering streams, lakes or marshes, due to erosion of the plain and giving a slightly undulating topography in such places. Other small irregularities consist of small bowl-shaped depresssions or pits which occur singly or in groups and break the evenness of the topography to a greater or less extent. Generally, the groups of pits are small and do not affect the topography over more than one or two forties where they occur.

This soil, like Plainfield Sand, has good drainage because of its open texture and loose, sandy subsoil, but excessive drainage or drought does not so easily occur because of the greater amount of fine material, silt and clay, in the surface eight to twelve inches. This greater amount of fine material perceptibly increases the water-holding capacity and drought resisting ability of the soil as compared with the Plainfield sand. The difference can be noted in a greater compactness of the surface of the former soil and the numerous pools of rainwater which remain in the roads often for several days after a hard shower. The difference in these two soils is again noted in the vegetation and tree growth reproduced when the original pine timber was removed and in the difference in the original timber growth itself which is described hereafter under Native Vegetation.

The Plainfield loamy fine sand is an alluvial soil; the material was deposited in stratified layers by water from the glacier as was the Plainfield sand, the only difference being, that, due to a slower movement of the water, a greater amount of silt and clay or fine sand was deposited on the surface where this loamy fine sand is mapped.

Texture and Composition.—Beneath two inches of grayish loamy fine sand to sandy loam the surface soil is a compact brown to reddish brown loamy fine sand or sandy loam becoming yellowish sand or fine sand at 10–16 inches. In some cases, the fine sand subsoil is deep, containing no coarser material; in others, the subsoil contains small gravel stones becoming quite gravelly at 20 to 24 inches. Where gravel is present, the sand grains are generally of medium to coarse texture.

The type contains material of two somewhat different combinations, one being that of a fine sand containing slightly more clay and silt particles in the surface soil than the Plainfield sand; the other, while having still more silt and clay particles, also has a larger number of sand grains of coarser texture, giving the soil a light sandy loam texture. These two textures were found so intimately associated that no attempt was made to separate them. The two are, however, of relatively the same consistency and both have better water-holding capacity than has the Plainfield sand.

The following mechanical analyses of typical samples show the percentages of different sized particles composing this soil.

TABLE 4.

Mechanical Analysis or Texture of the Plainfield Fine Sand.

	Gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
A Surface 8 in	7.23	20.05	20.62	14.49	8.22	20.98	8.80
A Surface 8 in	.85	11.07	19.04	27.93	27.06	11.26	3.20
B Subsoil 24 in	.80	9.44	18.33	28.51	32.98	7.47	2.64
C Subsoil 36 in	1.29	11.81	20.14	28.64	33.00	4.14	1.31
A Surface 8 in	1.25	4.33	8.40	46.17	21.18	12.37	6.30
B Subsoil 8-36 in	2.00	4.14	9.20	51.01	21.62	7.91	4.17

Native Vegetation.—The original timber growth consisted of pine, the majority of it being large White pine with occasionally a smaller amount of Norway or large Jack pine mixed in. An exception to this rule occurs in (T38–R4) where the level fine sandy soil is not as well drained. Here numerous cedar, hemlock and tamarack swamps occur, and the general water table is near the surface, so that the timber of the fine sand is hemlock and birch with much cedar and tamarack and a few maples. Another such exception occurs in Sec. 35 and 36 (T44–R5) where birch, hemlock and maple with but a few large white pine grow on soil mapped with this type.

The second growth on this type where the original pine timber has been removed, is a thick stand of poplar and white birch 10–30 feet high, with a greater or less proportion of young White and Norway trees. In places the young pine growth predominates over the poplars.

The ground growth consists of ferns, brakes and sweet fern with some grass. A fair grass sod is often found established on the virgin soil where pastured and where moisture conditions are favorable.

Agricultural Development.—While but a comparatively small part of this soil has been farmed as yet, the Plainfield fine sand has more farmers on it than any other soil in the area. About 250 clearings and farms were noted on this soil. The clearings range from small patches of three to five acres, to large well-developed farms, with forty to one one hundred acres of cleared land.

The settlements about Eagle River and Clear Water Lake, comprising about one hundred and forty clearings or farms, with 2,000 acres of cleared land, are largely on this kind of soil. The settlements about Woodruff and Minocqua including about seventy-five clearings and farms with 1,500 acres cleared, are in large part on this soil. While some of the farms are owned and conducted by people in other lines of work in the towns, most of the farmers are making a comfortable income from their farms alone.

The kind of farming followed is a general one. In some cases, several cows are kept and the cash income is derived from the sale of milk, cream or butter. In other cases the sale of hay, potatoes, grain or garden truck furnishes the income. Potatoes are often the main cash crop on this soil.

Mr. Hans Sherve near Minocqua (T39–R6) has farmed seven years on this soil. He keeps four cows, sells clover seed and hay, oats, potatoes and barley. He manures his land and turns under the second-crop of clover. He reports yields of oats of fifty-six bushels; potatoes two hundred bushels; hay two tons, corn fifty bushels, barley twenty-six bushels.

Mr. Steven Schaefer north of Woodruff (T40–R6) reports flint corn yielding forty to forty-five baskels of ears per acre, potatoes one hundred and twenty-five to one hundred and fifty bushels, rye eighteen bushels, oats forty bushels, hay one ton, rutabagas three hundred and fifty bushels. Mr. Morgan at Eagle River reported yields of potatoes of one

VIEW OF FARM ON PLAINFIELD FINE SAND NEAR WOODRUFF.
Shows crops of clover and corn obtainable on this soil.

hundred and fifty to two hundred bushels per acre, oats thirty to forty bushels, good corn, clover, and garden truck.

Similar reports from many other farms on this soil indicate that the following crops and yields are quite generally produced. Potatoes one hundred and fifty to two hundred bushels. Oats thirty to forty bushels. Barley twenty to thirty bushels, rye twenty bushels, peas twenty bushels, clover two tons in two cuttings, corn forty bushels. Larger yields than the above are often obtained and smaller ones also, depending much upon the season and the quality of the farming done. Potatoes are well adapted to the soil and good yields are obtained. Oats also give good yields. Early varieties of corn, while often retarded by a dry spell or a frost, mature well in most seasons if seeded early enough. Clover does well and no great trouble in getting a good stand was noted.

Agricultural Value.—Chemical analysis shows that the supply of mineral plant food elements in this type is larger than that in similar soils of the central part of the state where they are underlaid by sandstone.

The following table gives in percentage the amounts of the most important plant food elements as found by chemical analysis of typical samples of this soil.

TABLE 5.

Chemical Composition of Plainfield Fine Sand.

Soil number.	Total Phosphorus.	Total Potassium.	Total Nitrogen.
	%	%	%
741			
Surface A	0.063	0.87	0.068
Subsoil B	0.030	1.08	0.026
764			
Surface A	0.049	1.00	0.073
Subsoil B	0.043	1.06	0.027
780			
Surface A	0.058	1.12	0.078
Subsoil B	0.039	1.31	0.037
785			
Surface A	0.068	1.21	0.094
Subsoil B	0.042	1.15	0.028
849			
Surface A	0.047	1.21	0.087
Subsoil B	0.037	1.17	0.049
862			
Surface A	0.041	0.97	0.079
Subsoil B	0.032	0.97	0.032
863			
Surface A	0.059	1.06	0.099
Subsoil B	0.033	1.18	0.049

In common with most of the soils here, the total amounts of phosphorus and potassium are high as compared with soils of the same class in the southern part of the state. The amounts of these elements in the surface 8 inches of this soil are equal to those found in very good sandy loam soils in the southern part of the state. The nitrogen content, however, is low when compared with these soils and it will be noted that the phosphorus percentage in this soil drops very quickly in the subsoil in most cases.

The nitrogen can be maintained by the growth of clover or other legumes to be used as feed where stock is kept, or turned under as a green manuring crop when the farm is extensively devoted to potatoes or other special crop.

PLAINFIELD SANDY LOAM.

Extent and Distribution.—The Plainfield sandy loam is one of the least extensive soil types in the area, covering a total of about 12-15 square miles. The soil is confined to a small area in (T40-R10) NE of Eagle River called the Saltenberger district, and to more extensive areas near Rest, Harris and Clear Lakes in (T43-R5) (T42-R6) and in (T41-R3) near the Springstead Lakes. Small patches occur also in Section 31 (T40-R7) and Section 26 (T40-R11) and Section 12 (T39-R10).

Topography and Drainage.—The topography of the Plainfield sandy loam is level. The only variation is where gentle undulations occur bordering marshes, lakes or streams. This variation is of small occurrence. The drainage is good due to the open, loamy sand to fine sand character of the subsoil. The soil has greater water-holding capacity than the Plainfield find sand and does not yield to the effects of of drought so soon.

The origin of the Plainfield sandy loam was the same as that of the other Plainfield types previously described but the surface 6-8 inches has received a greater amount of the silt and clay particles than did the other Plainfield soils.

Texture and Composition.—Beneath 8-10 inches of dark brown to brown sandy loam, the soil is a grayish loamy brown sand to sandy loam, containing some small gravel stones. This generally extends to 40 inches or more. In places, as about Springstead Lakes, (T41-R3) the surface soil contains numerous small stones 2-4 inches in diameter. Locally, these stones are very numerous both in the surface and subsoil. In connection with these stony patches, a surface layer, heavier than above described, and a coarser sand subsoil at 18 to 20 inches is often found. No boulders or large stones are present.

Native Vegetation.—The soil is partly a hardwood soil and in part white pine was the predominant timber. The hardwood timber consists of hemlock, birch, maple and basswood with an occasional white pine as in (T41-R3). In places the birch and hemlock predominate. In the area of the soil mapped in (T40-R10) the timber was mainly white pine and has grown up to a thick cover of poplar and white birch and white pine 10 to 25 feet high. This is also true of the other small areas mentioned in Section 31 (T40-R7) and in Section 12 (T39-R10). The area in (T43-R5) also was mainly white pine timber which has been cut and the second growth consists of poplar, birch and pine with an occasional larger oak, maple or birch tree.

On most of the soil except that in (T41-R3) the original timber has all been removed and where pine was the original timber, the present growth is poplar and birch and where heavy hardwood was removed, small birch, cherry, poplar, maple and hemlock slashings are now found.

Agricultural Development.—This soil is only partly developed, there having been only 12-15 attempts at farming made on the type. The best example of farming on the soil is in (T42-R10) north east of Eagle River, called the Saltenberger district, where a group of 6-7 farms have been started. Here about 250 acres have been cleared and cropped. Excellent crops of clover, oats, corn, barley and potatoes were seen.

Clover generally makes a catch with very little trouble and produces two crops. Potatoes yield 150 to 200 bushels per acre. Barley 25 bushels, oats 30 to 50 bushels. Corn, while often injured by a late spring or early fall frost, generally ripens if seeded early enough in the spring.

Being of such small extent, no chemical analyses of this type of soil were made.

CHAPTER III.

VILAS SOILS.

VILAS SAND.

Extent and Distribution.—The Vilas sand is one of the less extensive types of soil in this area, covering in all about 75 or 80 square miles.

The largest areas covering 3-5 square miles each, occur in (T42-R7) (T42-R8) (T40-R5). Much of the soil occurs as small irregular areas, 1-2 square miles or less in extent, of rolling sandy soil usually bordering a marsh or stream.

Topography and Drainage.—The surface of the Vilas sand varies from undulating to gently and moderately rolling. On account of the generally loose, open structure of the soil, the drainage is excessive on this type and droughty conditions are indicated by its bare appearance and general lack of timber or other vegetation.

The soil of this type consists of glacial debris which was ground from the rock underlying the district or from sandstone rocks further north. The small amount of silt and clay particles is due to its origin from sandstone rocks or to the sorting and removal of the fine material by water before the ice finally worked it into its present form.

Texture and Composition.—The surface of the Vilas sand is generally a brownish medium to fine sand with a top one-inch layer of grayish color. The surface 6-8 inches are underlaid by light yellowish brown medium to coarse sand containing some gravel. Not much gravel and very few boulders are exposed on the surface.

The following table shows the percent of different sized particles found by a mechanical analysis of typical samples of this soil.

TABLE 6.

Giving the Mechanical Analysis of Vilas Sand in Per Cent.

	Gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
A Soil	5.0	13.52	20.89	36.87	8.61	9.31	5.88
B Subsoil	7.80	12.83	17.61	41.61	9.52	6.19	4.27
A Soil	2.92	9.88	26.50	38.29	8.92	8.35	4.91
B Subsoil	4.00	9.71	28.75	39.60	8.38	5.65	3.82
C Subsoil	3.65	4.77	21.83	51.64	11.97	3.67	2.50

Native Vegetation.—Most of the surface area of the Vilas sand has a rather bare, open aspect. Most of the soil has very little timber on it. Where timber occurs, it consists of small clumps of Norway and Jack pine, or a stunted growth of poplar, scrub-oaks and birch 3–5 feet high. Sweet-fern and blueberry grow plentifully on this soil type. Not much grass or sod are found. Fires have frequently run over much of this type in dry years, burning the dry sweet-fern and oak brush and destroying any small trees that have attempted to grow.

Present Agricultural Development.—Very little, if any, of the soil has been farmed. Some attempts have been made, but in many cases an abandoned clearing has been the result. The lack of fire wood, the liability of crops to suffer from drought in summer, and the poor yields, due to the quick dissipation of the small amount of organic matter under cultivation all tend to discourage any permanent settlement on this type of soil.

The following table gives in per cent the amounts of the most important plant food elements in typical samples of this soil.

TABLE 7.

Chemical Composition of Vilas Sand in Per Cent.

Soil number.	Total Phosphorus.	Total Potassium.	Total Nitrogen.
740	%	%	%
Surface A	0.052	0.79	0.047
Subsoil B	0.032	1.21	0.026
850			
Surface A	0.025	0.92	0.080
Subsoil B	0.022	1.01	0.036
869			
Surface A	0.053	1.02	0.076
Subsoil B	0.045	1.09	0.032

VILAS STONY SAND.

Distribution and Extent.—The Vilas stony sand is an extensive type of soil in the area. The largest areas of it occur in Forest County (T39-R12) (T40-R12) and in (T38-R8) (T42-R8) (T41-R7) (T41-R8) (T42-R9) (T39-R7) (T40-R7) (T40-R4) Smaller areas of 1 to 2 square miles occur in several other townships. This type of soil occupies a total of approximately one hundred and forty square miles in the area surveyed.

Topography and Drainage.—The topography of the Vilas stony sand is very uneven, rolling, rough and broken. It consists of a series of sharp pointed, choppy knobs or ridges interspersed with numerous pot-hole marshes and small ponds. These rough morainic belts represent the margins or terminals of lobes of the glacier where excessive movement of the soil-forming debris took place. The pot-hole swamps, ponds and marshes in these rough areas have no outlets.

The material forming the soil of this type is largely derived from the granitic rock on which it lies and from sandstone rocks to the north. This material was ground off from the rocks, and reworked and mixed with the soil previously on the ground by the advancing or retreating ice sheet.

The soil was not laid down by water, nor sorted by it, as were the level Plainfield and Antigo types, except in cases where the fine material was carried away by swift-flowing water leaving the gravel "hog-backs" or ridges called eskers. None of the material is laid down in horizontal layers or stratified.

Texture and Composition.—The texture of this soil type varies somewhat. Rough topography and stoniness are the chief characteristics of the type. A typical boring of much of the soil gives eight to ten inches of brown medium sand to loamy sand containing much gravel which increases in amount with depth. At 18 to 20 inches a medium yellowish-brown sand is found which continues to a depth of 40 inches or more. Most of the area of this soil bears mainly pine and sweet fern. Other portions of the soil, while the original timber was largely pine, include small clumps of birch, oak, maple, timber and slightly better soil, the surface of which approaches a medium sandy loam with a medium to coarse sandy-gravelly subsoil. Boulders, large and small, are scattered over the surface,—in places very thickly and through the soil section. This soil bears the most boulders of any type mapped in the area and portions are exceedingly stony. Much gravel is in evidence.

Native Vegetation.—Much of the Vilas stony sand is nearly bare, cut-over Norway and White pine soil. It bears sweet-fern, some scattered Norway, Jack or White pine, or a sparse second growth of poplar and white birch. In the portions of slightly less sandy soil, a heavier growth of poplar and birch is found and scattered clumps of hardwood, one to ten acres in extent, covering some of the knolls.

Agricultural Development.—Very little farming has been attempted upon any area mapped as stony sand and little or no crop data is available. In most cases where the land is cropped at all, merely garden spots have been started or portions fenced off for pasture. No extensive attempt at cultivation has been made on this soil.

The Agricultural Value.—This soil, while often having better texture and water holding capacity in places than the Vilas Sand, is deemed to be low in value because of its rough, choppy topography, and the great number of boulders generally found upon it. These boulders range in size from 6 inches to 10 feet in diameter and in places are so numerous that they would confine any attempted cultivation strictly to hand work as machines could not be operated there.

Small patches of ground might be selected where the texture of this soil is much better than a sand and where the number of stones and the rough topography are not excessive, but where such better texture is found, the value of the soil is generally much reduced by its excessive stoniness or very rough topography or both.

A chemical analysis of a sample of this soil, showing in per cent the amount of the most important plant food elements is given in the following table.

TABLE 8.

Chemical Composition of Vilas Stony Sand in Per Cent.

Soil number.	Total Phosphorus.	Total Potassium.	Total Nitrogen.
872	%	%	%
Surface A	0.065	0.98	0.123
Subsoil B	0.039	1.11	0.037

VILAS SANDY LOAM.

Extent and Distribution.—This is the most extensive type of soil mapped in the area covering about 450 square miles. This soil is pretty generally distributed over the whole area and at least small portions of it were mapped in nearly every township in the area surveyed. Some townships are comprised mainly of this soil. Large areas occur in Townships (40-R14) (41-R13) (38-R11) (39-R11) (41-R10) (39-R5) (39-R4). It occurs in connection with the hardwood areas of Forest County in the east part of Vilas and with those bordering the state line to the north as well as in connection with the pineries of the rest of the area.

Topography and Drainage.—The topography of the Vilas sandy loam is gently undulating to gently rolling. While somewhat broken near marshes, lakes or streams, the topography on practically the whole of the soil area is not sufficiently uneven to interfere with agricultural operations.

It generally consists of gently undulating country or of a series of gently rolling ridges and knolls. Wherever the topography of this soil became particularly rolling or broken, the soil was put into the rolling phase, described later.

This soil is ground moraine material, deposited beneath the ice sheet. It comprises the bulk of the gently undulating to rolling white pineries of the area.

The drainage of this soil is good, due to the open character of soil and subsoil. In lighter portions of the type, drainage may be excessive and crops are likely to be subject to drought during the dry spells. This is not at all a general condition over the type, however, and most of the soil has sufficient water-holding capacity so that crops are not likely to feel the lack of moisture except during extensive dry seasons. Most of the soil is not elevated more than 40 to 60 feet above the marshes, streams and lakes, and much of it not more than 10 to 15 feet. Good well water is found at 40 to 50 feet or less and springs are frequently found on the lower portions, indicating that the general ground-water level is sufficiently near the surface to aid most of the soil in resisting drought. The most sandy and coarser textured and most elevated portions of the soil would be those to feel the effects of drought first.

Texture and Composition.—Beneath one to two inches of dark brown fine sand or medium sandy loam, the surface ten to twelve inches of soil is a light brownish, fine to medium loamy sand or light sandy loam. Medium yellow sand, often containing much coarse sand and gravel is found at sixteen to twenty inches and extends to a depth of forty inches or more. Boulders are scattered more or less freely over the surface and through the body of the soil, but generally are not numerous enough to interfere with agricultural development. Gravel and small stones are found in the subsoil at sixteen to thirty inches.

The organic matter in the soil is found chiefly in the surface three to six inches, giving the surface a somewhat darker color. While there is a fair amount of organic matter in these few surface inches, this soil is apt to lose its virgin productiveness after the first two or three season's cultivation unless the content of organic matter is supplemented by the growth and plowing under of clover or the addition of

VIEW OF VILAS SANDY LOAM.

Shows undulating to gently rolling topography and character of present timber growth. Pine stumps in the foreground and poplar, white birch and pine second growth in the background.

manure to the soil. The texture of this soil favors the swift oxidation of the organic matter under cultivation, and additions must be made to keep up its fertility.

TABLE 9.

Mechanical Analysis of the Vilas Sandy Loam in Per Cent.

	Gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
	%	%	%	%	%	%	%
Surface 8 inches	5.75	12.59	13.84	25.64	16.04	19.30	6.60
Subsoil 8 to 40 in.	11.73	11.74	13.91	26.54	15.25	15.08	5.75

Native Vegetation.—This type of soil is essentially a pinery soil. The original timber was mostly large White pine with some Norway. This has all been cut and the pine stumps with scattered birch stubs are all that remain of the virgin timber. In some cases, patches of hardwood timber are found on soil mapped with this type. The hardwood consists generally of birch, hemlock, black oak and a few small maples. These grow in clumps in the pinery upon knolls of slightly heavier soil, or on low areas where the water table is nearer the surface than usual. The areas mapped with this type in Forest County include some slightly heavier soil and more hardwood timber than is to be found on the soil in Vilas County. This soil in Forest County includes pinery as well as extensive areas of mixed pine, hemlock, birch, maple and some elm and basswood.

The cut-over pinery has grown up to poplar and birches ten to thirty feet highwith much cherry, alder or scrub oak brush and small pines. White pine and birch stubs generally stand up above this second growth. Sweet-fern and brakes grow thickly in places.

Agricultural Development.—But a small proportion of the soil is under cultivation. A few farms are developed on this soil in the vicinity of the larger settlements, as near Minocqua and Hazelhurst in (T38–R6) (T39–R6) or near Eagle River and Three Lakes in (T40–R10) (T39–R10)

(T39–R11). Not over 40 to 50 clearings or farms were noted on this type of soil. Yields, as far as reported, are fair.

Brown Brothers (T38–R9) have about eighty acres cleared on this soil. They have concrete silos, large house and barns. They report yields of oats 40 to 50 bushels, potatoes 150 to 250 bushels, hay one and one-half tons. They have no trouble with clover and 40 to 50 bushels of ripe corn are produced in favorable seasons. Forty head of stock, twenty of which are milk cows are kept on the place.

Mr. Denton, Section 34 (T42–R10) has a ten-acre clearing. He has a good house and barns, milks two or three cows, keeps ten head of young stock and three horses. He raises potatoes, hay, oats, corn and garden truck.

Jacob Huber, Section 8 (T39–R7) has a clearing of 70 acres largely on this soil. He reports yields of oats 35 to 45 bushels, hay one and one-half tons, potatoes one hundred and fifty to two hundred bushels. Clover is grown without difficulty.

Peter Nysted, Section 9 (T38–R6) has farmed eight years and has thirty acres cleared. He reports yields of one to one and one-half tons of hay, one hundred and fifty bushels of potatoes and forty bushels of oats. Good corn has been grown and he has not had much trouble with clover.

Agricultural Value.—The Vilas sandy loam type of soil may be described as being of fair value agriculturally. The soil type is one of the most extensive in the area and includes some variations in texture so that portions which are rather light and sandy and approach the Vilas sand in texture, may be subject to drought in dry seasons. Other portions of the soil have a good sandy loam texture and the soil as a whole has enough fine material in it to give it a fair water-holding capacity.

Clover can be grown and sod for pasture maintained on most of the soil. Potatoes are well adapted to it and corn and oats give fair returns so that potatoe farming with a rotation in which a second crop of clover is turned under once in three years, or general dairy farming are adapted to this soil.

Clover must be grown and turned under and barnyard manure applied to keep up the fertility of this soil.

The following table gives in per cent the amounts of the most important plant-food elements found in samples of this soil.

TABLE 10.

Chemical Composition of Vilas Sandy Loam in Per Cent.

Soil number.	Total Phosphorus.	Total Potassium.	Total Nitrogen
765	%	%	%
Surface A	0.059	1.55	0.063
Subsoil B	0.041	1.56	0.030
784			
Surface A	0.063	1.20	0.052
Subsoil B	0.056	1.21	0.025
866			
Surface A	0.069	1.44	0.079
Subsoil B	0.052	1.46	0.050
870			
Surface A	0.057	1.57	0.103
Subsoil B	0.052	1.52	0.052
871			
Surface A	0.061	----------	0.093
Subsoil B	0.057	----------	0.071
921			
Surface A	0.064	----------	0.080
Subsoil B	0.045	----------	0.044

This soil is fairly well supplied with phosphorus and potassium when compared with other soils of the same class farther south in the state. The nitrogen, however, is slightly low. The above analyses show 30 to 50 per cent more phosphorus than do the Plainfield or Vilas sandy soils.

VILAS SANDY LOAM (Rolling Phase).

Distribution and Extent.—The rolling phase of the Vilas sandy loam covers approximately one hundred and forty square miles of territory in the area. The largest tracts of it occur in (T39–R9), (R41–R9) west and northwest of Eagle River, in (T38–R7), (R40–R7) south of Wind Pudding Lake and north of Arbor Vitae Lake in (T40–R6) and south of Crab Lake in (T43–R6).

This type of soil is quite generally distributed over the Vilas and Oneida County portions of the area. The largest tracts occur in connection with the rough, terminal-moraine soil of the Vilas stony sand.

Topography and Drainage.—The topography of the rolling phase is generally very broken and choppy or uneven, consisting of a series of sharp knolls and ridges with deep depressions intervening. Small marshes are common in the depressions. On the tops of the highest ridges, areas of five to thirty acres of more gentle and often nearly level topography are included in the type. The difference in topography between this soil and the Vilas stony sand is one only of degree. While but slightly less rolling than the latter soil, this rolling phase is not so stony and the soil is of better texture, making it of somewhat greater value agriculturally.

Excepting in the pot-holes and deep depressions, the drainage on this soil is good, due to its irregular topography and open, gravelly subsoil. The water-holding capacity is fair, so that the soil resists drought better than the Vilas stony sand does. Rolling topography is the characteristic of this phase of the soil.

The material making up the soil of this type was largely ground from granitic and sandstone rocks and deposited by glacial ice. The rough topography is due to the fact that it was deposited near the edges of the glacier where greater amounts of debris were accumulated and where more movement of it took place.

Texture and Composition.—Beneath 1 to 2 inches, colored dark brown by organic matter, the surface of this soil consists of 8 to 10 inches of brown medium to fine loamy sand or sandy loam. Beneath this is a subsoil of loamy sand which is generally gravelly and stony at sixteen to twenty inches.

The surface soil of the type varies in texture from a loamy sand to sandy loam. While much of the soil is light and much gravel is often evident, patches and areas of heavier sandy loam soil where the topography is rolling to rough are included in the type—as east of Arbor Vitae Lake where the soil is a good sandy loam in places but very rolling.

Stones and boulders are generally more numerous on this phase of the soil than on the more gently rolling main type. The following table shows a mechanical analysis of this soil.

Native Vegetation.—The timber of this soil was mainly large White pine with a few Norway in places. On other places, maples, black oaks, and birches are found scattered as individual trees among the pine stumps or in clumps upon small knolls or ridge tops of more level and heavier soil.

Poplar, birch, cherry, maple, oak, pine, and hazel brush-trees 8 to 30 feet high are found among the second growth.

Agricultural Development.—But very little of this soil has ever been cultivated and little or no crop data are available. The topography makes the laying out and cultivation of fields difficult and no large farms or extensive settlements are found upon this kind of soil.

Agricultural Value.—On the whole, this soil must be placed with the soils of rather low agricultural value. This is because of its rough and uneven topography. While the soil texture and water-holding capacity are generally sufficient to place it with the fair agricultural types, the rough, choppy, and hilly topography make this soil undesirable farming land, while much equally good and better soil with better topography remains undeveloped. Small patches of five acres to thirty acres or more of undulating to gently rolling topography can be picked out but such patches are not numerous. The type is adapted to grazing for sheep or cattle.

The following table shows the percentage of important plant food elements found by chemical analysis of typical samples of this rolling phase.

TABLE 11.

Chemical Composition of Rolling Phase of Vilas Sandy Loam in Per Cent.

Soil number.	Total Phosphorus.	Total Potassium.	Total Nitrogen
782	%	%	%
Surface A	0.062	1.15	0.047
Subsoil B	0.063	1.21	0.030
864			
Surface A	0.063	1.45	0.064
Subsoil B	0.056	1.44	0.050
867			
Surface A	0.072	1.32	0.068
Subsoil B	0.054	1.50	0.038

CHAPTER IV.

THE ANTIGO AND KENNAN SOILS.

ANTIGO FINE SANDY LOAM.

Extent and Distribution.—The Antigo fine sandy loam is one of the less extensive soils in the area, occupying somewhat less than 20 square miles of territory.

One area of two square miles occurs about the town of Three Lakes in (T38-R11). Another area similar in size occurs in parts of Sections 7-17-18 in (T40-R10) northwest of Eagle River. Two areas of about one square mile each south of Phelps in (T41-R11) and (T41-R12) an area of five square miles mainly in (T40-R7) north of Abror Vitae; one of four square miles in (T43-R4) north of Manitowish, and smaller areas occur in (T43-R6) and (T38-R6).

Topography and Drainage.—The topography of the Antigo fine sandy loam is level due to the fact that it is of alluvial origin, having been deposited by streams issuing from the glacial ice. The area in (T40-R7) is described as being slightly undulating in places. This is also true to a slight degree of the small area southwest of Hazelhurst. In the Three Lakes area, bowl-shaped depressions 50 to 100 feet in diameter and 10 to 25 feet deep in the center occur singly or in groups. These depressions, called pits, were formed by action of the ice or water during deposition of the soil material, and form the only other variation in topography on this soil. They do not affect an area of any considerable extent.

The drainage of the soil is generally good. It is not excessive and the soil contains sufficient fine material so that it resists drought well.

Texture and Composition.—The Antigo fine sandy loam, under a surface one to two inches of grayish fine sandy loam, has 8 to 10 inches of grayish-brown to dark brown fine sandy loam though there is some variation. Below this soil it merges into a gray-brown sandy loam containing more or less gravel stone. Brown sandy loam, containing much medium to coarse sand as well as gravel, is generally found at 18 to 20 inches. This extends to forty inches or more in depth. In the Three Lakes area the surface soil varies greatly in texture within short distances. From a sandy loam or a fine sandy loam, it merges into heavier soil in spots, which is nearly a silt loam in texture. Gravelly spots occur at the surface in a few places.

The area in Section 17 (T41-R11) also is a very fine sandy loam to silt loam in places, with often a thin, compact silty-clay layer above the usual medium to coarse sandy loam at 18 to 24 inches. Small cobble stones two to six inches in diameter often occur on the surface.

Native Vegetation.—The Antigo fine sandy loam is a hardwood type of soil. The original growth consisted of large maple, basswood, hemlock, and birch with a sprinkling of large white pine.

Agricultural Development.—This type of soil is farmed only in part. The most farming upon the soil is found in the vicinity of Three Lakes, where about 20 to 25 farms have been started. Excellent crops of oats, barley, clover, hay, corn and potatoes were seen there during the past two seasons.

Potatoes produce 150 to 250 bushels, barley 30 bushels, oats 40 to 50 bushels, clover 2 tons, etc. Fifty bushels of corn have been produced per acre, although the maturity of this crop depends much upon the non-occurrence of frost during the early part of the season.

Mr. August Widelow in Section 36 (T42-R12) has a 25-acre clearing on this soil. He has good buildings and a herd of jersey cows. He sells butter and milk and potatoes at Phelps.

On the Tooley farm, Section 17 (T40-R10) there are 80 acres of this soil cleared. Yields of potatoes are reported at 200 bushels per acre, oats 40 bushels, and corn 40 bushels, This place has been farmed for 13 years.

Mr. Michaelson, Section 10 (T38-R6) has 65 acres clear on this soil. He had 16 acres in potatoes, 12 acres in oats, and the rest in clover and pasture. Oats yielded 45 bushels

VIEW OF A FARM ON ANTIGO FINE SANDY LOAM, SOUTH OF HAZELHURST.
Shows crops and level topography of this soil. Hardwood timber in the background.

per acre, potatoes 150 to 250 bushels, clover 1½ to 2½ tons. A three-year rotation is practiced and clover is plowed under. Potatoes are the cash crop and a 4000-bushel warehouse is located on the place.

Agricultural Value.—This soil is adapted to potato or grain raising and a combination of general and dairy farming will make it one of the best agricultural soils of the area. Its level topography and excellent water-holding capacity make it very desirable farming land.

The following table gives the chemical analyses of typical samples of this soil.

TABLE 12.

Chemical Composition of Antigo Fine Sandy Loam in Per Cent.

Soil number.	Total Phosphorus.	Total Potassium.	Total Nitrogen.
739	%	%	%
Surface A	0.045	1.45	0.113
Subsoil B	0.033	1.08	0.041
742			
Surface A	0.064	1.51	0.146
Subsoil B	0.041	1.17	0.048
846			
Surface A	0.053	1.18	0.103
Subsoil B	0.047	1.37	0.049

KENNAN FINE SANDY LOAM.

This type of soil occurs in several extensive areas comprising in all about 150 square miles of territory. The largest areas occur in the vicinity of Phelps in (T41-R11) (T41-R10) (T42-R11) in the vicinity of Sugar Camp and Thunder Lakes in (T38-R9) (T38-R10); in (T42-R9) (T43-R9) (T43-R8) and about Winchester in (T43-R5) (T44-R5).

The soil material is produced from weathering of glacial debris, deposited largely as ground moraine by the last glacial ice sheet. It is derived mainly from the granitic rocks which underlie it and in part from sandstone.

Topography and Drainage.—The topography of the Kennan fine sandy loam varies from gently undulating to gently rolling. The topography is somewhat more rolling bordering large marshes, streams or lakes. This is true in Sections 20-10-15-16 (T41-R11) south of Phelps, where elevated but rather broadly sloping ridges occur. Here the topography approaches that of the rolling phase of this soil.

Drainage is fair to good on nearly all of the soil. Flat, wet areas occur in the vicinity of smaller streams and marshes, but the soil as a whole is well drained.

Texture and Composition.—The surface 8 to 10 inches of soil is a greyish-brown to brown, compact fine sandy loam becoming a lighter brown fine sandy loam to sandy loam at 16 to 24 inches. The subsoil generally contains a few small angular gravel stones and becomes somewhat coarser textured with increasing depth. Some stones and boulders are found on the surface and in the soil section. The boulders are often more thickly scattered in the depressions and in some cases also on the upland as east of Phelps, but the great majority of the soil bears only scattered boulders and stones.

The soil texture varies somewhat in different areas. In Sections 25, 26, 35 and 36 (T41-R10) the soil is very variable. The heaviest sandy loam to loam soil is found on the wooded ridge tops, while the lower slopes and valleys often have lighter soil. In places south of Tenderfoot Lake (T43-R8) and in places south and east of Phelps, the soil becomes a very fine sandy loam or loam. The depth of heavy surface soil above the general sandy and gravelly loam subsoil is often greater than typical in these places too, the heavy surface material being 30 to 40 inches deep in some places.

In the vicinity of Winchester, a red clay layer was found in places in the subsoil of this type. The red clay did not appear to be in any large body but occurs as layers of local extent only. The red clay layer varied from a few inches to five or six feet in thickness and lay at or near the surface and sometimes at a depth of four or five feet. The clay layer is to be seen in some of the railroad cuts and indicates its presence on the surface by an undrained and springy condition of the soil of the long slopes where it is found. Small areas with this clay subsoil were noted in Section 27 and 28 and Section 5 in (T43-R5). Mr. Brandeis in Section 5 has about twenty acres where this clay layer lies at the surface. In every case the clay layer was found to be underlaid by the sandy gravelly loam subsoil generally found beneath the Kennan fine sandy loam soil.

Native Vegetation.—The Kennan fine sandy loam is almost exclusively a hardwood type of soil. In the larger areas where typically developed, the timber consists of a heavy growth of large maple, basswood, birch and hemlock, with a few white pine mixed in. On the more sandy portions of the soil, hemlock and birch predominate, and in the heavier portions, large basswood and maple predominate. In a few outlying or smaller, isolated areas as (T41-R10) the soil bore for the most part, large white pine which have been cut and only scattered oaks, and hemlock, maple and birch clumps remain among the heavy poplar and birch second growth. The virgin hardwood remains in places, but large amounts of it have been cut over, especially around Phelps, Winegar and Winchester, and also around Sugar Camp Lakes.

Agricultural Development.—The Kennan fine sandy loam promises to be one of the best and most permanently valuable farm soils of the area. Quite a little has already been accomplished in developing this soil. The most extensive clearing has been done south and west of Sugar Camp Lake (T38-R9), (T38-R10). East and south of Conover in (T41-R10) a number of farms have been developed on the soil, and south and east of Phelps, an important settlement—in large part of Finlanders—has been developed by the lumber company there.

In the Sugar Camp Lake area, about 70 farms have been started with a total cleared area of about 1,500 acres. A good indication of what can be done on this soil is shown by the Robbins Lumber Company's farm in NE NE Section 14 (T38-R9), where yields of potatoes were reported at from 200 to 250 bushels, oats 60 bushels and clover $2\frac{1}{2}$ tons. Excellent corn was reported. This settlement has been developing for the last 15 years. Each farm has 10 to 40 or more acres cleared. Corn, clover, oats, peas, turnips, potatoes, barley and garden truck are grown. Several farmers keep a number of cows and sell cream and butter.

Several farmers reported yields of oats of 50 to 60 bushels, potatoes 150 to 250 bushels, clover $2\frac{1}{2}$ to $3\frac{1}{2}$ tons (two cuttings). Excellent corn of early varieties was seen the past two seasons, and the ears ripened. Yields of 50 to 60 bushels per acre have been reported.

In the Conover area about 15 farms have been started on this type of soil. This is a newer community. Potatoes are grown, corn, clover and oats also. Stock raising is included in the system of farming. As mentioned above, the soil here is slightly lighter than the average of the type about Sugar Camp Lake.

In the Phelps area, about 90 clearings have been started, about half of which are on the Kennan fine sandy loam. There is a total of about 1,047 acres cleared or under cultivation. Potatoes yield about 200 bushels per acre, cabbage 15 tons, clover and timothy 1½ tons, oats 40 to 50 bushels, barley 30 to 40 bushels, and corn is raised. Most of the farmers here raise sufficient crops for their own use besides some products for sale. Many of them keep one or two horses, a cow or two and pigs or chickens. This also, is a new settlement and the Finnish farmers depend upon the Lumber Company largely for work in the winter time and for marketing such products as they have for sale.

A few scattered farms or clearings are located on this soil in the vicinity of Winchester and Winegar, but no extensive settlement has yet been developed there. This is one of the best soils in the area and as good farm communities as any in northern Wisconsin should develop where this soil exists.

The following table gives in per cent the amount of the important plant food elements found by chemical analysis of typical samples of this soil.

VIEW OF FARM ON KENNAN FINE SANDY LOAM, SOUTHEAST OF MERCER.
Shows gently undulating topography and characteristic crops, with hardwood timber in the background.

TABLE 13.

Chemical Composition of Kennan Fine Sandy Loam in Per Cent.

Soil number.	Total Phosphorus.	Total Potassium.	Total Nitrogen.
766	%	%	%
Surface A	0.051	1.32	0.120
Subsoil B	0.036	1.23	0.040
781			
Surface A	0.067	1.26	0.092
Subsoil B	0.060	1.31	0.045
847			
Surface A	0.074	1.32	0.135
Subsoil B	0.042	1.43	0.076

Compared with other productive soils of the state, these analyses indicate a good supply of the chemical plant food elements in this soil. All the samples gave an acid reaction with litmus paper.

KENNAN FINE SANDY LOAM (Rough Phase).

The rolling or rough phase of the Kennan fine sandy loam covers about 60 square miles of territory, largely in the vicinity of Winchester and Winegar. The largest area occurs in Townships (43-R7), (43-R6), (43-R5), and (43-R4).

Topography and Drainage.—The topography varies from rolling to hilly, consisting of a succession of narrow rolling ridges or bumpy knolls and hills with narrow and often wet and marshy gullies or pot-holes between.

Much wet land consisting of the small gully or pot-hole marshes in the depressions, is included. Springy slopes and pockets also are common in places. This lack of drainage in places about Winchester is in part due to thin layers of impervious red clay or compact reddish sandy clay loam in the subsoil which are described in another portion of the report.

While small pieces of from one to ten acres in extent may be found which are neither excessively rough nor wet, the majority of the soil area is too rough and uneven to permit the use of farm machinery.

Texture and Composition.—Typical borings of this phase of soil show much the same soil section as found on the more gentle topography of the main type. About 8 to 10 inches of dark brown fine sandy loam with a surface two inches of grayish-brown to black color, overlies a heavy brown sandy loam with a brown loamy sand at 20 to 24 inches containing much coarse sand and some gravel. In the vicinity of Winchester, layers or lenses of reddish sandy clay loam or red clay 2 to 4 inches thick may be found in places in the subsoil. Deeper layers of red clay also are found in the vicinity, but generally not on this phase of the soil. The texture of this soil is generally excellent.

The texture, compared with that of the other soils is one of the best in the area but the topography is so uneven that its value for farming is greatly reduced and the roughest portions were classed with the soils of low value solely on this account.

Native Vegetation.—Like the less rolling main type, the soil bears a heavy covering of hardwood consisting of maple, basswood, birch, including a few scattered balsam, hemlock and white pine. In a few places where the soil is somewhat more sandy than typical, hemlocks and birch predominate, but in most cases, the maple and basswood predominate.

Much of this timber near Winchester and Winegar has been removed, leaving the land covered only with brush and young growth, familiarly known as "cut-over" land.

Agricultural Development and Value.—Little or no farming has been done on this soil. While the texture of the soil and its timber growth invite settlement, the roughness of its topography discourage any attempts at farming. The soil will produce good pasturage, and portions of it could be used for stock raising where it occurs in connection with lands of better topography and for that reason, could be classed as soil of fair agricultural value, but where such topography occurs in extensive areas much of this soil has been classed with the soils of low agricultural value.

No chemical analyses of this phase of the soil were made but the amounts of plant food given in the analyses of the main type are undoubtedly typical of the amounts to be found in this rough phase.

KENNAN SILT LOAM.

The Kennan silt loam occurs largely in the townships in the southeast corner of the area which lie in Forest County and in (T41-R12) and (T42-R12) east of Phelps in Vilas County. The soil is an extensive one in the eastern end of the area, occupying several of the townships almost exclusively and covering a total of 175 square miles. Associated with the Kennan silt loam are small areas of the deep phase of the soil which has nearly level topography, bears some boulders, and has a deeper silt covering above the sandy-gravelly subsoil.

Topography and Drainage.—The surface of the Kennan silt loam varies from gently rolling to rolling. The topography is often formed by a series of parallel ridges, extending in a northeasterly and southwesterly direction, which are from 50 to 150 feet above the intervening valleys, but the slopes are seldom too steep to farm. Often the slopes are long and gentle and it is from 1-2 to 1 mile or more from ridge-top to ridge-top.

Swamps and lakes are often found in the depressions. Because of the uneven topography and the open character of the deeper subsoil, the surface and subsoil drainage are good. Erosion will be a problem requiring attention in many places when the steeper slopes are cleared.

The material forming the Kennan silt loam is glacial drift which covers the entire region from a few feet to over 100 feet deep. It appears that the original surface before the ice invasion must have been rolling as now and that the drift was deposited as a veneer of ground moraine over the underlying rocks or in places over a previous drift deposit in the form of ridges and drumlins.

The mass of the deposit consists of a mixture of unassorted gravel, sand and some finer material, over which a thin layer of silt has been placed. This silt may have been deposited by wind in part and in part produced by weathering since the glacial period. The boulders are from the underlying rock and have probably not been moved a great distance from their place of origin.

Texture and Composition.—The surface soil of the Kennan silt loam to an average depth of 10 to 12 inches consists of a brown or grayish-brown friable silt loam practically free from coarse sand grains and which contains a fair amount of organic matter. The surface 6 inches is usually somewhat darker due to the organic matter than the soil beneath.

The subsoil consists of a yellowish-brown or grayish brown silt loam which becomes heavier with depth, grading into a silty-clay loam at 16 to 20 inches beneath which the subsoil contains increasing amounts of sand and fine gravel. The lower subsoil is an unstratified mixture of light yellowish or brown fine and medium sand with much gravel.

Stones and boulders, ranging in size from a few inches to several feet in diameter, are scattered over the surface. In places the stones are very few, in others they are very numerous. They are often numerous in low flats or bordering marshes or streams. In general, the stones are not numerous enough to detract materially from the agricultural value of the soil.

On the tops of most of the hills and ridges, the silty covering over the sandy gravelly subsoil is thinner than typical and on some of the sharpest ridges, gravelly material outcrops and gravel is found upon the surface. Going down the slopes, the silt covering becomes deeper and frequently along the lower slopes and across the valley to the next rise, no gravel is found within three feet of the surface. Where slopes are gentle and ridges broad, the silty covering frequently continues of uniform depth. In other places quite a little fine sandy loam which in a detailed map would be separated, is included in the type.

Native Vegetation.—The timber growth on the Kennan silt loam consisted chiefly of hardwood and hemlock with some pine mixed in. The townships in Forest County are largely virgin timber. The hardwood consists of maple, birch, hemlock and basswood, with some oak and elm. Maple is always most plentiful on the heavier portions of the soil but where the soil is lighter textured, a greater percentage of hemlock is found.

Agricultural Development.—Only a small proportion of this soil has been put under cultivation, but sufficient has been done to demonstrate that the soil is well adapted to all the general farm crops suitable to the climate. It is a naturally strong and productive soil. General farming is followed at present with a tendency toward potato raising and dairying.

The chief crops grown at present are potatoes, hay, oats, and some corn. Potatoes yield 150 to 200 bushels per acre or higher. Oats yield 50 bushels and hay 2 to 3 tons per acre. Clover and all kinds of grasses suited to the climate do remarkably well on this soil.

About forty settlers have started clearings on cut-over land of this kind of soil east of Phelps and about Sand Lake in (T41-R12) and (T42-R12).

The majority of the settlers are Finlanders, many with but 40 acres of land and 2 to 5 acres of clearing, but some larger farms with 20 to 40 acres of clearing were seen Clover, oats, hay, potatoes, and root crops are grown. A few scattered farms are found on this soil in the townships along the east and north boundaries of Forest County (T38-R18), (T39-R14), T39-R13), (T40-R14), and (T41-R13). As most of the cultivated region on this soil is still new, no definite system of crop rotation or methods of cultivation are yet in general use. The question of maintaining soil fertility has not been paid much attention, the greatest problem being to get the land cleared and ready for the plow.

Cut-over land of this character ranges in price from 12 to 25 dollars per acre. Partly improved farms are valued at 35 to 50 dollars, depending upon location and amount of improvements.

Agricultural Value.—This kind of soil is one of the best farming soils mapped in the area. While some portions of it will be found to be quite stony and other portions in the southeastern part of the area will be found to be quite rolling in topography, yet all things considered, this soil can be expected to develop into one of the best farming and dairy soils of this part of the state.

The following table indicates the per cent of plant food elements found by chemical analysis of typical samples of this soil.

TABLE 14.

Chemical Composition of Kennan Silt Loam in Per Cent.

Soil number.	Total Phosphorus.	Total Potassium.	Total Nitrogen.
848	%	%	%
Surface A	0.072	1.28	0.236
Subsoil B	0.042	1.30	0.073
841			
Surface A	0.069	incomplete	0.113
Subsoil B	0.057	incomplete	0.053

KENNAN SILT LOAM (Deep Phase).

The deep phase of the Kennan silt loam occurs almost entirely in the Forest County portion of the area. It is closely associated with the typical soil there. The area of the type covers about 10 square miles of territory principally in (T41-R14), (T40-R14), (T41-R13), (T40-R13), (T41-R12).

Topography and Drainage.—The surface of the deep phase is level to very gently rolling, while the typical soil ranges from gently rolling to rolling. In most cases, the natural drainage is thorough but where the topography is level and the silt three feet or more in depth, the internal drainage is somewhat slow. The soil, as a whole, retains moisture very well and because of its even topography, erosion will probably never be a factor in the management of this soil.

Texture and Composition.—The texture of the surface of this phase is the same as that of the typical Kennan silt loam, except that the percentage of silt is higher and the percentage of sand grains is lower in the former. The subsoil consists of a light yellow or yellowish-brown, silt loam, becoming somewhat heavier with depth till silty clay loam or heavy clay loam is reached at 18 to 20 inches. This heavy subsoil layer usually extends on an average, to 30 inches, the lower portion of it frequently containing some sand and gritty material. Below 30 inches, the subsoil grades into unassorted glacial till consisting of fine and medium sand and gravel with but little silt or clay.

Stones and boulders are present on the surface, though not so plentifully as to interfere seriously with cultivation. The chief differences between this phase and the typical soil are that the silty surface is generally deeper on the phase, the soil contains a larger per cent of silt, more of it is free from stone, and the topography is more nearly level or gently rolling than that of the typical soil.

Native Vegetation.—The timber growth consists chiefly of maple, birch and hemlock, though the hemlock is not as plentiful as on the main type. Basswood, elm and white pine are found in smaller amounts. Most of the pine has been cut but the greater part of the hardwood and hemlock is still standing.

Agricultural Development and Value.—But a small part of this phase has been cleared and farmed. Only six or eight clearings have been started on this soil but sufficient has been done to show that this type will become one of the most productive and valuable soils in the area.

Potatoes, grains, clover and hay are the chief crops grown and yields are excellent.

The chemical plant-food supply in this deep phase is sufficiently indicated in the analyses given under the main type.

CHAPTER V.

DESCRIPTION OF MARSH AND SWAMP SOILS.

PEAT.

Distribution and Extent.—Under this classification is included all varieties of swamp and marsh land which covers about 450 square miles in the area mapped. Both wooded swamps and open peat grass marshes are included. More or less of the peat soil occurs in every township mapped. It occurs on low-lying areas bordering streams and lakes, in depressions having no outlet between the rolling ridges or hills of the upland, or as wide extensive areas of low lying land which is wet the greater part of the year and has accumulated a surface covering of peat in varying stages of decomposition, derived from the remains of generations of water-loving plants which have grown there.

The wooded type of swamp peat occurs along the streams and the smaller depressions of most every township, but the extensive open grass marsh occurs chiefly in three or four localities. These latter are known as the Thunder Lake or Three Lakes marsh on (T38-R10), (T39-R10); the Swamp Lake marsh in (T38-R8), (T39-R8); the Flambeau marsh three miles north of Lac du Flambeau station in (T41-R5), (T42-R5), and the Manitowish marshes which cover extensive tracts bordering the Manitowish River and its tributaries in (T41-R4), (T41-R3), (T42-R4), (T43-R4).

Each of these marsh districts comprises from 15 to 25 square miles of low wet peat lands. Smaller but important areas of peat land occur in (T38-R4), (T39-R4), (T38-R7), and in Forest County in (T38-R12), (T38-R13), (T39-R12), (T39-R13).

Topography and Drainage.—All the marsh and swamp lands are necessarily nearly level. The drainage is poor due to the lack of a surface outlet or because of a dense subsoil layer, commonly called a hard-pan, which prevents the water from seeping away through the porous subsoil. Some of the larger marshes have indications of once having been large lakes since glacial times, which have found outlets more recently and have been partially or completely drained of their surface water. The Flambeau and Three Lakes marshes appear to be of this origin, the lower lying portions of these marshes still containing large shallow lakes.

Texture and Composition.—This kind of soil consists of the remains of water loving vegetation in varying stages of decomposition. Moss, ferns, blueberry vines, sedges, grasses and woody parts of swamp trees have contributed to this material. The peat of the open grass marsh areas is generally of a finer texture, more compact and of a black or darker brown color than that of the wooded or moss cranberry and blueberry marshes. The soil is generally a dark brown to yellowish-brown spongy peat usually from one to three and often even ten feet deep. The surface is often finer and more decomposed than the subsoil on the grass marshes. The peat is generally underlaid by sand with a compact hard-pan layer several inches thick, between the peat and the sand.

Many of the grass marshes have been burned repeatedly in dry years; others have been flooded by rising water from adjacent stream and more or less mineral matter mixed with the peat. The burning or addition of mineral matter have produced a finer, denser, more decomposed surface soil which approaches a muck in texture.

This sort of soil is found on the Haymeadow Creek marshes near Conover in (T41-R10). This is also true of parts of the marsh bordering Mud Creek just west of Powell in (T42-R4) where a good heavy compact muck is found in places. The best marsh soil was generally found on the grassy marshes, being best where blue-joint grass was found growing, with somewhat less mineral matter and less depth where wire grass grew.

The wooded and blueberry marshes which have not been burned over, have a covering of sphagnum moss and the peat derived from this source is coarse and stringy like excelsior and very raw and acid.

Native Vegetation.—Where protected from fire, partially due to their being lower and less often dry even in dry years, the open marshes bear sphagnum moss and patches of blueberry and cranberry bushes. Such marshes are generally partly wooded. Scattered clumps of stunted black spruce six to ten feet high may be found with a dense growth of tamarack, cedar and spruce around the edges of the swamp. Other swamps are entirely covered with the dense tamarack and cedar timber twenty to fifty feet high.

The open marshes, where the peat is not too deep and there is no moss, have grown up to wire grass which has a small round stem sixteen to twenty-four inches high. Where the marsh soil is heavier and approaches a muck in texture, blue-joint grass is apt to be found. This is a taller grass two to three feet high with a feathery tassel and makes much better hay than wire grass for feeding purposes.

Agricultural Development.—Very little of the peat soil has been drained and put into farm crops. Mr. Denton, Section 34 (T42-R10) near Conover, says that a large portion of his marsh was ditched, plowed and seeded to timothy during a series of dry years and yielded fine crops of timothy hay for several years. This marsh has gone back to wire grass and blue-joint due to a return of wet conditions. Buckwheat has been grown on a part of the Three Lakes marsh. The Three Lakes marsh and Swamp Lake marsh contribute large quantities of wire grass. Farmers cut it for hay and much is baled and shipped to grass rug and carpet concerns in Green Bay and Oshkosh. Large amounts are obtained for this purpose from the Flambeau marsh also.

Where blue-joint grows, an excellent hay is obtained from the marshes. The blue-joint marshes also furnish good pasture for cattle during the summer and fall. Mr. Sherman at Powell has fattened as high as one hundred head on his blue-joint marsh along Mud Creek.

The Flambeau and Three Lakes marshes seem to offer good opportunities for drainage with ample fall in most cases. Such a proposition, however, requires much capital and generally must await the development of the surrounding upland and the general rise in land values.

The following table gives the chemical analysis of samples of marsh soil taken in Vilas and Oneida Counties.

TABLE 15.

Chemical Composition of Peat in Per Cent.

Soil number.	Total Phosphorus.	Total Potassium.	Total Nitrogen.	Loss on Ignition.	Note
738	%	%	%	%	
Surface A	0.086	0.79	1.347	46.07	Muck
Subsoil B	0.039	1.24	0.444	16.78	
845					
Surface A	0.086	0.20	1.829	90.70	
Subsoil B	0.065	0.23	1.504	90.00	
865					
Surface A	0.074	0.19	1.289	95.43	
Subsoil B	0.064	0.36	1.391	95.53	
868					
Surface A	0.084	0.17	1.895	86.33	
Subsoil B	0.057	0.14	1.806	88.50	

CHAPTER VI.

CLIMATE.

The chief climatic factors influencing crop production may be grouped under two heads—those of temperature and precipitation.

Temperature.—The growth of agricultural crops is affected by the temperature of the region in two ways, first by the length of the growing season, and second by the amount of heat available after growth begins. This second factor may be called "effective heat."

Growing Season.—By the term "growing season" we ordinarily mean the length of time between the last killing frost in the spring and the first killing frost in the fall. This period determines the time which crops subject to frost will have in which to mature and affects particularly the staple crops such as corn and potatoes. The length of time during which frost records have been kept in that section is too brief to determine with certainty the average length of the growing season. Moreover, in some cases the observations have been made with instruments placed in situations unusually subject to local frosts and in others in situations unusually free from local frost, so that our knowledge of the actual length of the growing season is less exact than could be wished. The best data available indicates that practically all of the region under consideration has a length of growing season between killing frosts somewhat under 100 days, though observations taken at points quite free from local frosts indicate a length of growing season of about 130 days. The length of the growing season is affected chiefly by the latitude and altitude. A comparison of the length of the growing season of this section with other portions of the state is shown in the accompanying map. In this it will be seen that a large area in the central part of the state has a length of growing season from 120 to 130 days or on the average about 25 days longer than that indicated for the region under consideration. This difference is due in part to the difference in latitude, but probably to a greater degree to a difference in altitude. The average altitude of Vilas County is approximately 1600 feet, while that of Clark and Wood Counties is about 1100 feet.

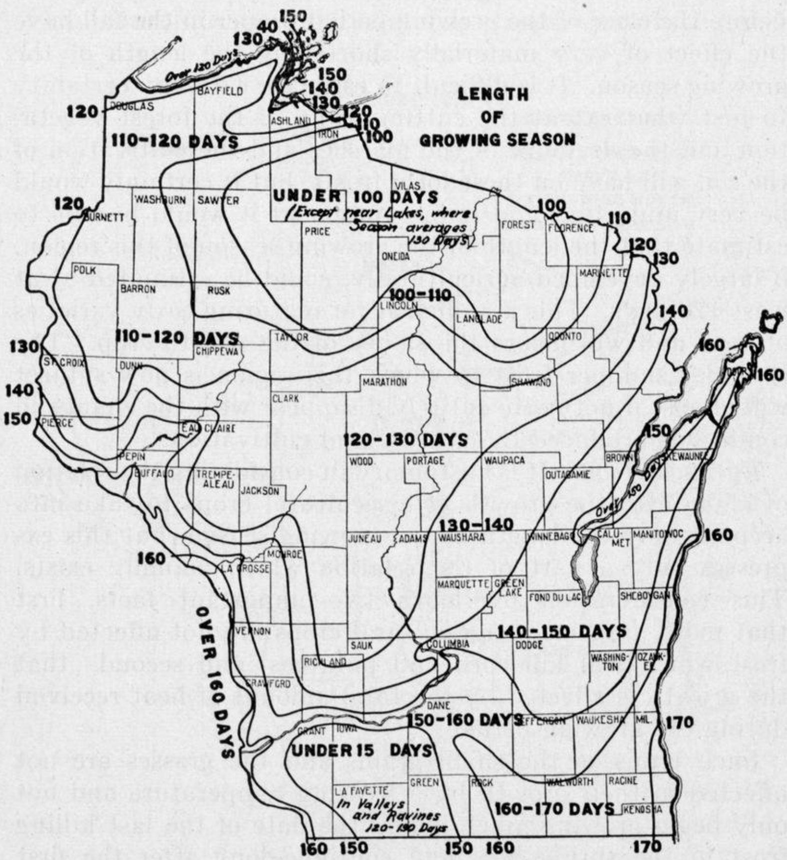


Figure I.—Comparative length of growing season. This map shows the average number of days between the last killing frost in the spring and the first in the fall for twelve years from 1899 to 1910, inclusive.

The upland of this region is still largely covered by trees and under-growth and the marshes by a dense covering of moss and grass, both of which forms of vegetation have the effect of preventing the sun's rays from reaching the soil so that the heat is radiated into the atmosphere during the day and the radiation continues during the night with the result that frosts are much more likely to occur during nights of relatively low temperature than is the case in sections which have been cleared. These local frosts coming after the season has reached a good stage of advancement in the spring and before the close of the growing period proper in the fall have the effect of very materially shortening the length of the growing season. It is difficult to estimate with any certainty to just what extent the cutting away of the forest vegetation and the drainage of the marshes and the cultivation of the soil will have on these local frosts, but it certainly would be very important and in our judgment it would be safe to estimate that the length of the growing season of this region, if largely developed agriculturally, could be estimated at at least 120 days. This is sufficient for maturing early varieties of corn and will insure the safety of the potato crop. The irregular summer frost to which this region is now subject will almost if not quite entirely disappear with the change in conditions produced by clearing and cultivation.

Effective Heat.—It is customary in considering the relation of climate to the growth of agricultural crops to take into account only the length of the growing season, but this expresses only a part of the relation which actually exists. This consideration overlooks two important facts, first that many important agricultural crops are not affected by frost which will kill corn and potatoes; and second that the growth is affected by the total amount of heat received during the growing period.

Such crops as the small grains and the grasses are not affected in their growth by a freezing temperature and not only begin growing much before the date of the last killing frost in the spring but may continue long after the first killing frost in the fall, so that the length of the growing season as ordinarily expressed is a very unsatisfactory means of stating the relation between temperature and the growth of these crops.

The growth of practically all staple crops, especially corn and potatoes, depends on the amount of heat received during their growth when the temperature is above that at which growth begins. These crops make relatively little growth when the temperature is below 45 and their rate of growth is very much greater at 70 than at 60 degrees, but this influence of temperature is not expressed in the length of the growing season. Regions immediately adjoining large bodies of water, such as Lake Superior, are given a long growing period by the influence of the water in retarding changes from low to high temperatures and vice versa. They therefore have a relatively longer growing season

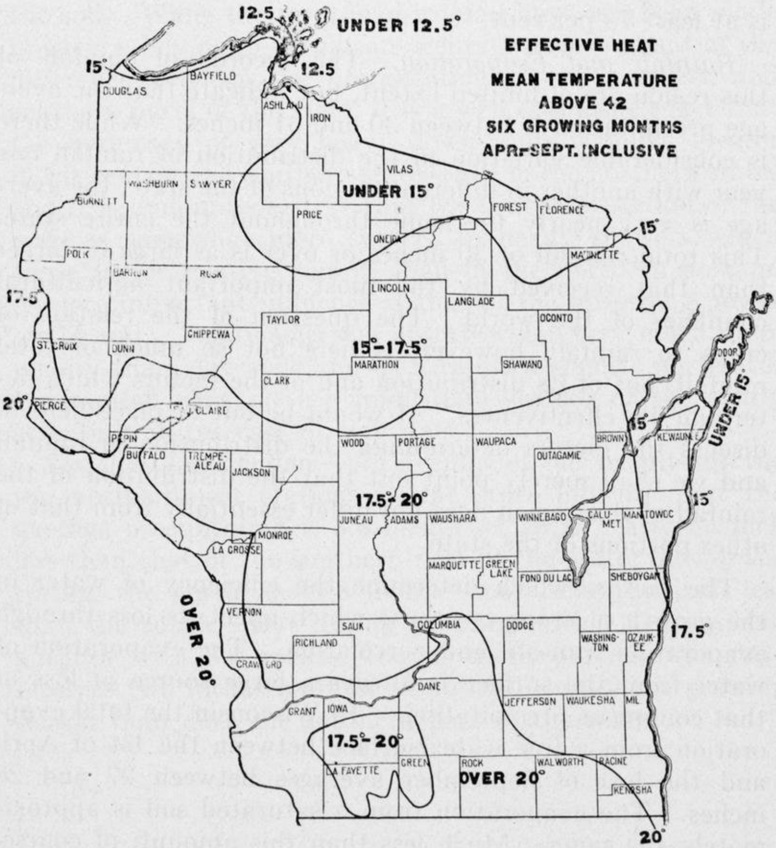


Figure II.—Comparative effective heat.

between frosts than the regions farther inland, but at the same time less heat is available during the period of growth. The region of Vilas County, while having a relatively short growing period for the reasons stated, has a larger amount of heat available for the growth of corn and potatoes than has the region nearer Lake Superior. These relations are expressed in the accompanying map. An examination of this map in comparison with that showing the length of the growing season will demonstrate that while under present conditions the length of the growing season of the Vilas County region is only 58 per cent of that of the southeastern portion of the state—the amount of effective heat it receives is at least 75 per cent.

Rainfall and Evaporation.—The records of rainfall of this region are of limited extent, but indicate that the average precipitation is between 30 and 31 inches. While there is considerable variation in the distribution of rainfall one year with another in different sections of the state, the average is very nearly the same throughout the entire state. This total rainfall of 30 inches or over is as large or larger than that received by the most important agricultural countries of the world. The question of the relation of crops to rainfall, however, is here not so much of total rainfall, but of its distribution and of the factors which determine its effectiveness. It would be out of place here to discuss the factors determining the distribution of rainfall and we shall merely point out that the distribution of the rainfall of this region does not differ essentially from that of other portions of the state.

The factors which determine the efficiency of water in the growth of crops are those which affect its loss through evaporation, run-off, and percolation. The evaporation of water from the surface is always a large source of loss of that coming as precipitation. In Wisconsin the total evaporation from a free water surface between the 1st of April and the last of September averages between 27 and 28 inches. The evaporation from a saturated soil is approximately the same. Much less than this amount, of course, evaporates from the surface of our land as a whole, since when the immediate surface has become dry, the rise of water to the surface becomes very slow. The evaporation of water here, however, is much less than that in the South West. In western Kansas and Texas the evaporation is between 55 and 60 inches or approximately twice that of central and northern Wisconsin. In other words the loss in this way is distinctly less in the Vilas County region than in the central or southern part of the state and it is probably safe to estimate that the rainfall of this region is equivalent to one of at least 2 inches greater in the southern portion of the state.

Run-off.—The run-off of water coming as rain depends on the rate of precipitation and on the absorbing power of the soil. While the records of rainfall have not been made in such a way as to permit an accurate measurement of the difference between the precipitation of the northern and southern parts of the state, it is a well established fact that the frequency of very heavy down-pours is much greater in the central and southern states than in the northern states and it is undoubtedly true that the southern portion of the state is somewhat more subject to heavy showers which cause larger relative run-off than in the northern portion. A more important influence is that of the absorbing power of the soil. Sandy soils will absorb water very much more readily than clay soils and as a result a smaller portion of the rainfall runs off the immediate surface of the sandy soils than in the case of clay soils.

Seasonal Distribution.—An average of the records of the ten northernmost stations in the state indicate that the average precipitation is 3.4 inches which is nearly an inch less than that of the southern part of the state; during the spring, the north has 7.8 inches—more than an inch less than the south. But during summer, with 12 inches and autumn with 8.4 inches, the northern part of the state receives two inches more of its rainfall during the growing season than does the southern part of the state.

CHAPTER VII.

SUMMARY AND CONCLUSIONS.

A consideration of the description of the soil types as given in the foregoing pages leads to the conclusion that on the basis of their agricultural value they may be classified as follows:

Good.—Kennan fine sandy loam, Kennan silt loam, Antigo fine sandy loam.

Fair.—Plainfield fine sand, Plainfield sandy loam, Vilas sandy loam.

Low.—Plainfield sand, Vilas sand, Vilas stony sand, rough phase of Vilas sandy loam, rough phase of Kennan fine sandy loam, Peat.

This classification is expressed in Map No. 2.

The Kennan fine sandy loam, Kennan silt loam, and Antigo fine sandy loam are of high agricultural value because their texture adapts them to nearly all staple crops which the climate permits, and because of their fertility.

The fine texture of these soils gives them a good water holding capacity so that they are well adapted to grasses and small grains, as well as to most crops commonly grown on lighter soils. Dairying and other lines of live stock farming are therefore well suited to such land and since these permit the profitable use of the farmer's time in the winter they are likely always to be among the most profitable lines of agriculture in this section of the state. The chemical composition of these soils show that they compare favorably with the best soils of the state in the total amount of phosphorus and potassium. They are somewhat low in organic matter and nitrogen and are distinctly acid, but these defects can be corrected without seroius expense while they are being used for the lines of farming to which they are best adapted. Clovers and other legumes needed as stock feed will add nitrogen and organic matter to the soil, and lime to correct acidity can be purchased at moderate expense.

The Plainfield fine sand, Plainfield sandy loam, and Vilas sandy loam have only fair agricultural value, because their light character renders them more or less subject to drought, because they are not as well adapted to some of the staple crops, and because of their relatively low content of some of the essential elements of soil fertility. These soils, however, are well adapted to some of the most profitable special crops, chief of which is potatoes. Small grains, especially rye, may also be grown to good advantage. With proper attention to the necessary conditions, clover can be successfully grown so that a rotation of this crop together with the use of moderate amounts of fertilizers will maintain the fertility of these soils and permit profitable yields of potatoes and other special crops during most years. Early varieties of corn can also be successfully grown, especially for silage use, and this with clover makes dairying practicable, though not so highly profitable as on the heavier soils because the soil is not so well adapted to pasture grasses.

The Plainfield sand and Vilas sand have a low agricultural value because of their low water holding capacity and low fertility. Soils of this character have always been found to have relatively low agricultural value based on their yields of the staple farm crops. Even in older countries where agricultural development has reached a high stage, soils of this character are still, to a considerable extent, uncultivated. A large part of the northern portion of Holland is very sparsely inhabited and the land is in a very low stage of development because of its sandy character. The nearness of this large tract of sandy soil to the very highly developed southern portion of Holland brings out in striking contrast the valuation placed on land of different character by some of the most industrious and practical people of the world.

The low agricultural value of such soils is due primarily to the fact that they are subject to drought and to their low content of the essential elements and the difficulty of maintaining fertility.

The explanation of the fact that these soils are subject to drought is found in their low water holding capacity and in their low power of conducting soil moisture upward from greater depths. The insufficient water holding capacity is due to the fact that their coarseness makes the total surface area of the particles composing them relatively small in comparison with that of finer soils which have much larger surface area and hence can hold a much larger amount of moisture in the form of capillary films surrounding the individual grains. As an illustration of the difference commonly found in soils of varying degree of fineness the results of study by Buckingham may be cited. He found that at the height of forty inches above ground water, clear dune sand retained, after having been thoroughly saturated by rains, and standing a sufficient length of time to permit the actual drainage water to find its way downward, 3% of water, a coarse sandy loam 7%, and a light silt loam 17%. Still heavier soils such as clay will retain 30 to 40% or more than ten times that held by coarse clear sands and from six to eight times that held by coarse sandy soils.

Not all the water retained by soils after rains is available to crops, since some is lost by evaporation and some is retained by the soils when they have become so dry that crops are no longer able to draw water from them. After saturation by rains followed by twenty-four hours of drainage, the upper four feet of a coarse sandy soil will retain approximately five inches of water which would be available to growing crops if none were lost by evaporation. The fine sandy loam soils will retain eight inches of water under such conditions. When it is remembered that most crops grown in this section of the state will require for their actual use during their growth, only from nine to twelve inches of water it is evident that this difference of three inches between the water available in a coarse sandy loam and that in a fine sandy loam is a very important difference, since it may constitute from 25 to 33% of the total requirement for the season. Moreover, whatever difference there is in the amount of water which crops may secure from sandy loam soils in excess of that which can be secured from coarse sandy soils is repeated after every heavy rain during the season, so that if the crops on a sandy loam soil can secure only one inch more water than from a coarse sandy soil after a single heavy rain, this may be repeated four or five times during the season, so that crops growing on the fine loamy soil may actually receive four or five inches more water than those growing on the coarse sandy soil received during the growing season.

The low fertility of sand soils is due first, to their low total content of the essential elements; second, the fact that even this small amount of the essential elements is contained in relatively coarser soil grains which, therefore, offer less surface for solution and chemical action than is the case in soils of finer texture; third, since these sandy soils are largely derived from sandstone rocks devoid of carbonates, they are essentially free from carbonates and have an acid reaction; and fourth, to their small amount of organic matter.

A determination of the total calcium in the Plainfield sand shows on an average 0.82% of that element, while the Plainfield fine sand contains 1.16%. In other words, the fine sand contains 41% more of this element than does the medium sand. Here again the finer state of division as well as the larger content of this element means that it will more rapidly become available through chemical changes of weathering for growing crops and for acting as carrier of nitrogen into the growing plants.

The following table is calculated from the chemical analyses of several typical samples of each of the types of soil mapped in the area, and shows the number of pounds of the plant food elements in two million pounds of the soil of each type. Two million pounds is the weight of an acre of sandy loam soil eight inches deep.

TABLE 16.

Average Number of Pounds of Plant Food Elements Per Acre of Soil Eight Inches Deep.

Agricultural Value.	Total Phosphorus.	Total Potassium.	Total Nitrogen.
Low			
Surface A	895	20280	1391
Subsoil B	642	21653	685
Fair			
Surface A	1170	25000	1625
Subsoil B	870	25690	832
Good			
Surface A	1266	26400	3147
Subsoil B	855	25530	1151

The analyses of these soils arranged by classes as to their agricultural value show increased amounts of the elements with increased value of the soil as determined in the field. Thus, while the soils of low agricultural value average 895 pounds of phosphorus per two million pounds of the surface soil, those of fair value have 1170 pounds or over 30 per cent more of this element. Important differences are also found in the elements potassium and nitrogen.

The line between soils which can unquestionably be farmed with profit under present conditions and those concerning the farming of which there is doubt should be drawn between medium sand and fine sand. It is quite probable that with very skillful management and a full knowledge of their characteristics a considerable part of these medium sands can be farmed with profit. The experimental work done on soils of this type at Sparta is very encouraging. But the difficulties to be overcome on these soils are so great that with the knowledge now possessed by the average farmer the majority of attempts would lead to failure. We do not believe, therefore, that the state should encourage the development of farms on soil of this character at present.

Vilas sand is similar to the Plainfield sand in chemical composition and fertility, and is even more subject to drought because its rolling to rough topography has the effect of lowering the ground water level over much of the area.

The Vilas stony sand has the same low water holding capacity as the Vilas sand and is so rough and stony that it has very little agricultural value.

The Rough phase of the Kennan fine sandy loam is so rough as to make it largely unfit for cultivation. It might be used for pasture, but occurs in such large areas that it would be impossible to use it for pasture in connection with the cultivation of better soils used to produce winter feed.

Much of the peat swamp and marsh land of this region must be assigned a low agricultural value in its present condition because it is subject to frosts throughout the summer which would make the growing of several crops to which it is otherwise adapted very precarious. It is also difficult to cultivate and must be drained and in part cleared before it can be cultivated and made productive.

The distribution of land of the different classes is given in the Appendix-Table No. 17.

Agricultural Development.—As to the agriculture already developed, it may be said that considerable successful farming is already done in the area especially near the towns and where larger tracts of good farm land occur. The farms and cleared acreage have been approximately summarized under the description of each soil type and it will be seen that the better grades of soil have the most farmers.

Table 18 in the appendix summarizes by townships the number of farms or clearings noted and the number of acres cleared. A total of about 780 farms or clearings and 10,900 acres of land cleared in the entire area were noted during progress of the field work. In this summary all cleared land was included. As to the number of farms or clearings, if the buildings on a farm were vacant and in poor repair the place was not counted as a farm, although the cleared acreage on such a place was included. Summer resorts were counted as farms or clearings only where field as well as garden crops were grown.

Attention is called by the Soil Survey to the fact that there are other districts in the State which, because of the great preponderance of land of low value for farming purposes, would be well suited for re-forestation. To illustrate, an area in the north central part of Bayfield County may be mentioned, which includes the greater part of seven or eight townships.

TABLE 17.

Approximate Number of "Forties" or Lots, Private and State Owned on which the Major Part of the Soil is Low, Fair or Good in Agricultural Value by Townships in Vilas and Parts of Adjoining Counties.

T & R	Marsh		Low		Fair		Good	
	State	Private	State	Private	State	Private	State	Private
38– 3	30	71	0	0	19	165	9	265
–4	61	137	2	41	25	290	0	1
– 5	14	97	11	185	18	227	0	0
– 6	10	43	14	162	14	231	0	18
– 7	20	24	124	132	78	105	4	15
– 8	60	63	80	156	19	163	4	10
– 9	45	112	0	150	29	184	3	134
–10	54	52	0	64	2	137	1	133
–11	36	53	0	87	2	197	1	24
–12	159	176	1	19	2	70	6	121
–13	133	107	0	0	4	4	29	216
–14	37	165	0	0	0	31	5	317
39– 3	55	214	0	40	0	23	12	195
– 4	33	75	0	17	10	245	0	11
– 5	15	93	2	181	7	177	0	6
– 6	4	47	27	79	33	274	0	3
– 7	14	13	173	113	78	50	8	8
– 8	90	58	40	300	21	50	0	0
– 9	6	38	12	267	10	209	0	18
–10	52	108	1	29	14	303	0	3
–11	7	71	0	38	29	331	0	0
–12	25	233	1	164	2	61	2	78
–13	31	65	0	26	2	55	8	247

T & R	Marsh		Low		Fair		Good	
	State	Private	State	Private	State	Private	State	Private
–14	13	152	0	12	0	57	0	298
40– 3	11	159	2	234	1	80	0	17
– 4	19	43	22	217	35	155	0	20
– 5	5	31	1	110	15	256	0	4
– 6	41	23	58	129	43	226	2	19
– 7	14	17	219	142	58	40	45	3
– 8	2	11	52	246	19	173	4	22
– 9	4	35	50	150	30	275	0	2
–10	13	35	0	34	2	415	0	52
–11	7	30	0	10	42	370	1	44
–12	1	7	17	201	5	128	7	134
–13	17	110	0	100	6	140	9	167
–14	20	82	0	0	6	253	6	209
41– 2	23	275	1	36	5	214	5	6
– 3	81	179	6	44	3	53	6	118
– 4	183	74	7	34	90	32	8	78
– 5	158	37	11	45	7	115	0	33
– 6	85	39	79	50	128	60	19	4
– 7	20	0	294	38	67	61	11	1
– 8	12	4	156	25	133	70	24	4
– 9	2	15	34	332	17	150	0	17
–10	13	85	0	100	8	230	0	128
–11	15	28	11	51	10	127	2	261
–12	3	36	0	0	0	55	11	384
–13	7	48	0	0	1	218	4	98
–14	21	22	0	0	16	354	22	98
42– 4	242	67	92	45	35	51	6	34

T & R	Marsh		Low		Fair		Good	
	State	Private	State	Private	State	Private	State	Private
– 5	121	59	74	80	38	112	0	0
– 6	7	13	115	219	86	74	0	0
– 7	41	22	222	124	45	45	0	0
– 8	38	32	200	99	135	55	29	16
– 9	1	16	55	288	0	115	0	116
–10	15	101	23	320	3	112	0	0
–11	33	39	0	0	16	142	26	246
–12	2	14	0	0	0	300	2	158
43– 4	108	60	5	19	19	157	16	118
– 5	20	70	0	19	29	85	5	197
– 6	13	20	24	253	21	30	2	70
– 7	10	30	1	313	34	25	8	87
– 8	10	26	15	16	1	51	30	85
– 9	4	9	2	6	3	50	5	121
–10	0	4	0	18	0	20	1	8
44– 5	11	28	0	12	1	29	3	187
– 6	0	10	0	0	2	38	0	10

SUMMARY STATEMENT.

	Marsh		Low		Fair		Good	
	State	Private	State	Private	State	Private	State	Private
No. 40's	2455	4312	2190	5946	1632	9512	404	5627
No. sq. mi.	153.4	269.5	136.9	371.6	102	594.5	25.3	351.7
Per cent of land area	7.65	13.47	6.82	18.53	5.08	29.65	1.25	17.54

SUMMARY STATEMENT.

TABLE 18.

Showing Number of Clearings or Farms and the Number of Acres Cleared in Each Township Vilas County and Portions of Adjoining Counties.

T. & R.	Clearings	Acres Clear.	T. & R.	Clearings	Acres
38– 4	0	0	41– 3	4	62
– 5	2	52	– 4	1	3
– 6	16	352	– 5	11	43
– 7	17	203	–36	2	72
– 8	28	320	– 7	2	13
– 9	60	1200	– 8	9	175
–10	21	340	– 9	4	10
–11	42	1135	–10	32	498
–12	0	0	–11	44	622
–13	0	0	–12	19	115
–14	5	120	–13	8	100
39– 4	1	1	–14	2	20
– 5	12	260	42– 4	6	163
– 6	32	657	– 5	5	31
– 7	7	150	– 6	4	33
– 8	5	50	– 7	6	50
– 9	16	95	– 8	1	3
–10	52	640	– 9	5	20
–11	15	200	–10	7	73
–12	0	0	–11	17	134
–13	1	12	–12	25	310
–14	1	40	43– 4	8	250
40 - 4	3	6	- 5	8	29

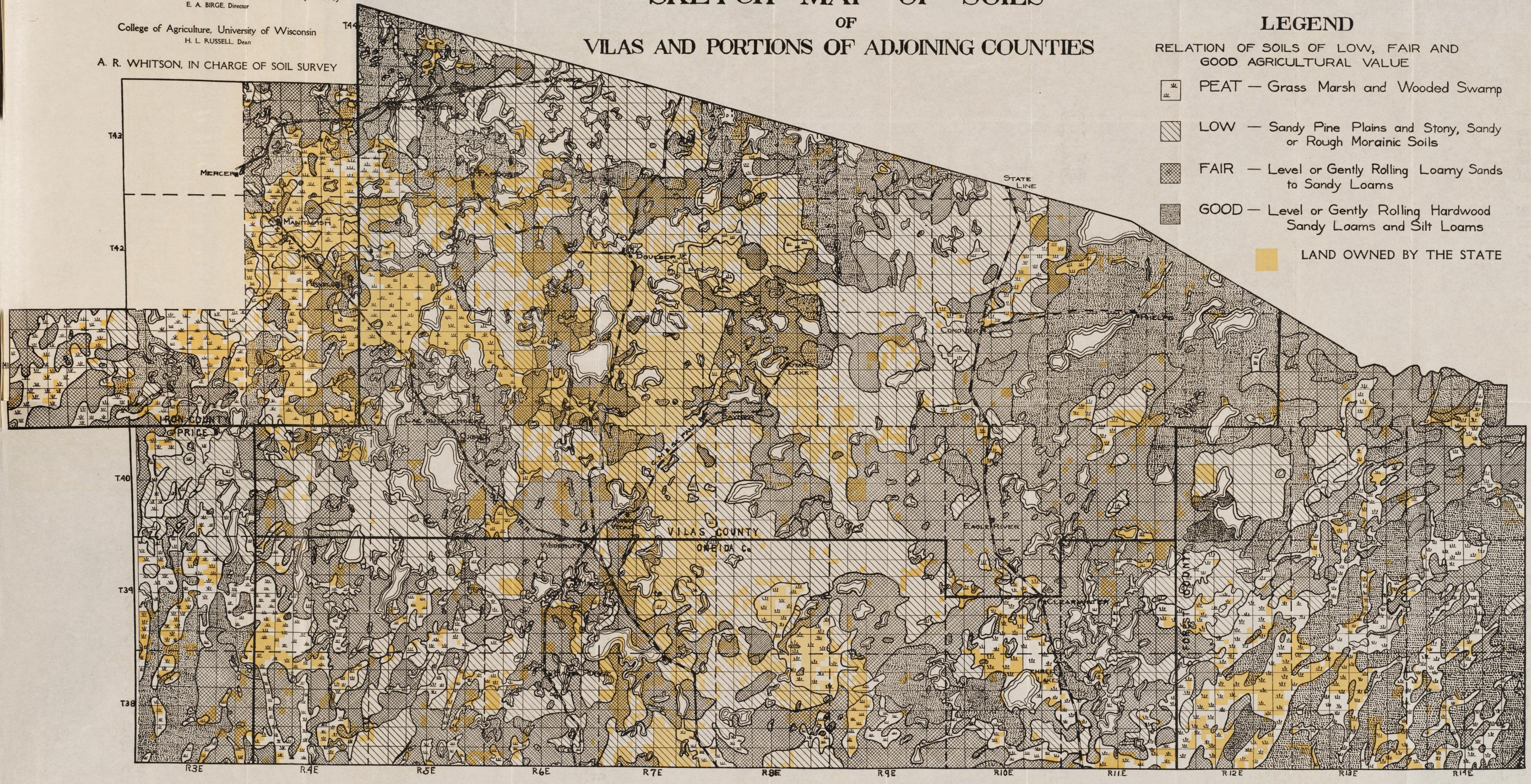
T. & R.	Clearings	Acres Clear.	T. & R.	Clearings	Acres
– 5	8	23	– 6	4	32
– 6	38	672	– 7	0	0
– 7	3	150	– 8	0	0
– 8	20	170	– 9	4	30
– 9	18	125	–10	2	15
–10	86	1200			
–11	8	42			
–12	2	2			
–13	7	25			
–14	10	75			

State of Wisconsin Geological and Natural History Survey
E. A. BIRGE, Director

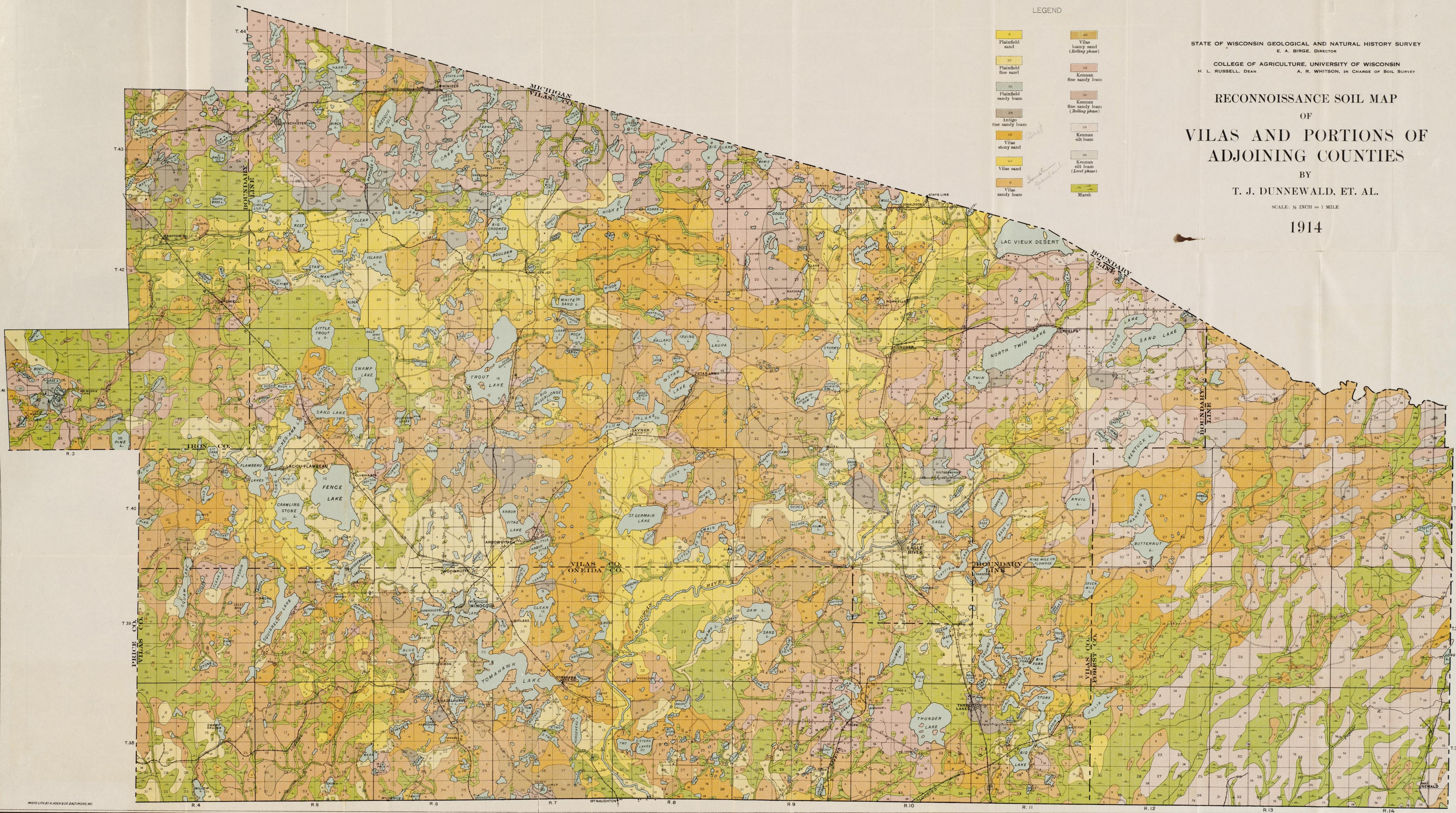
College of Agriculture, University of Wisconsin
H. L. RUSSELL, Dean

A. R. WHITSON, IN CHARGE OF SOIL SURVEY

SKETCH MAP OF SOILS
OF
VILAS AND PORTIONS OF ADJOINING COUNTIES



Note: Sec. 18 in T. 41, R4, should be indicated as Peat.


STATE OF WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY
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COLLEGE OF AGRICULTURE, UNIVERSITY OF WISCONSIN
H. L. RUSSELL, DEAN
A. R. WHITSON, IN CHARGE OF SOIL SURVEY
RECONNOISSANCE SOIL MAP
OF
VILAS AND PORTIONS OF
ADJOINING COUNTIES
BY
T. J. DUNNEWALD, ET. AL.
SCALE: ½ INCH = 1 MILE
1914
LEGEND
6 Plainfield sand
35 Plainfield fine sand
35 Plainfield sandy loam
29 Antigo fine sandy loam
28 Vilas stony sand
47 Vilas sand
9 Vilas sandy loam
20 Vilas loamy sand (Rolling phase)
56 Kennan fine sandy loam
56 Kennan fine sandy loam (Rolling phase)
58 Kennan silt loam
58 Kennan silt loam (Level phase)
Marsh
Best
Sometimes gravel sub.
LAC VIEUX DESERT
NORTH TWIN LAKE
TROUT LAKE
FENCE LAKE
TOMAHAWK LAKE
THUNDER LAKE
ST. GERMAIN LAKE
EAGLE RIVER
VILAS CO.
ONEIDA CO.
FOREST CO.
IRON CO.
PRICE CO.
MICHIGAN
STATE LINE
BOUNDARY LINE
R. 3
R. 4
R. 5
R. 6
R. 7
R. 8
R. 9
R. 10
R. 11
R. 12
R. 13
R. 14
T. 44
T. 43
T. 42
T. 41
T. 40
T. 39
T. 38
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Wisconsin Geological and Natural History Survey

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Soil Survey in Cooperation with the College of Agriculture

H. L. RUSSELL, Dean

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Special Report on the Reconnoissance

SOIL SURVEY

of

Vilas and Portions of Adjoining Counties

WISCONSIN

by

A. R. Whitson, T. J. Dunnewald

assisted by

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