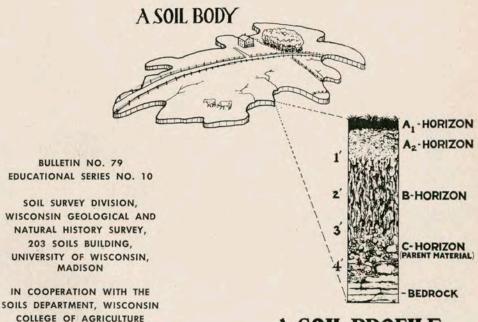
# Introduction to the

# SOILS OF WISCONSIN

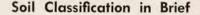
A General Scheme of Classification of the Principal Soils of Wisconsin



A SOIL PROFILE



1955



- There are usually several kinds of soils on a Wisconsin farm, and sometimes half a dozen in a single field. All told, there are hundreds of kinds of soils in the state of Wisconsin.
- Each kind of soil is different . . . in appearance, in mode of formation, in native fertility, in waterholding capacity, in ability to respond to management, and so on.
- 3. Each kind of soil is given a place name . . . the name of the city or village or lake near which the soil was first studied. Like the name of a person, a soil name stands for a complex of characteristics and conditions. The cross-section of a soil, called the soil profile, shows soil differences to a depth of 3 to 5 feet.
- 4. By means of simplified groupings, the hundreds of soils in our state can be arranged in orderly fashion. Publications like this one are issued to report the latest findings in soil classification. This bulletin is an introductory report on soil classification in Wisconsin. Farmers, teachers, students, county agents, farm appraisers, highway engineers, and many others who are dealing with the soils of the state will find that information on soil classification is both useful and interesting.

#### Soil Textural Classes

Soil texture refers to the proportions of clay, silt and sand in a soil. A loam is a soil which is a mixture or blend of all three . . . about 20% clay, 40% silt, and the rest sand. Soils which contain somewhat more clay are called clay loams; those made up predominantly of silt are silt loams; those higher in content of sand are sandy loams. Sands and clays are soils which do not contain enough of the other constituents to merit the use of the term "loam."

#### INTRODUCTION TO THE SOILS OF WISCONSIN

Ву

FRANCIS D. HOLE and GERHARD B. LEE
Soil Survey Division, Wisconsin Geological
and Natural History Survey,
203 Soils Building,
University of Wisconsin
at Madison

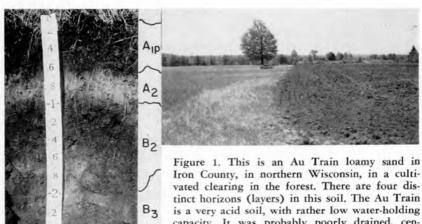
1955

In cooperation with the Soils Department,
Wisconsin College of Agriculture

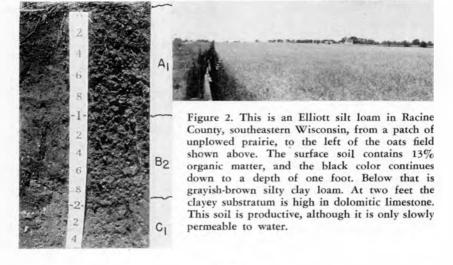
#### **CONTENTS**

	Pa	ge
I.	SOIL CLASSIFICATION IN BRIEF	2
II.	THERE ARE MANY KINDS OF SOILS IN WISCONSIN	5
III.	SOME IMPORTANT SOIL CONSTITUENTS	7
IV.	HOW TO CLASSIFY THE SOILS WHERE YOU ARE	8
V.	WISCONSIN SOILS MAY BE CLASSIFIED UNDER A FEW HEADINGS	10
VI.	MAJOR SOIL REGIONS OF WISCONSIN, AND SOIL KEYS11, 13-	27
VII.	APPENDIX12,	28
	A. List of some common soil series of Wisconsin, with brief characterizations12,	28
	B. Definitions of some terms used in describing soil profiles	44
	C. Definitions of some useful soil sequences	46
	D. Sample detailed soil profile description	
	E. Bedrock map of Wisconsin	<b>40</b>
	F. Glacial deposits map of Wisconsin	41
	G. Wind-blown deposits map of Wisconsin	<b>4</b> 2
	H. Native vegetation map of Wisconsin	<b>4</b> 3
	I. Climatic influences on soils: Frost date maps of Wisconsin	

Each kind of soil has a characteristic profile (cross-section) and landscape, as illustrated by the two examples below, taken from extreme northern and southern points in Wisconsin.



Iron County, in northern Wisconsin, in a cultivated clearing in the forest. There are four distinct horizons (layers) in this soil. The Au Train is a very acid soil, with rather low water-holding capacity. It was probably poorly drained, centuries ago, but is now naturally well-drained. It is not extensive, but is shown here because of its striking profile. It has a relatively low native fertility.



# Introduction to the SOILS OF WISCONSIN

SOIL extends as an almost continuous blanket over the land surface of the earth. We recognize that there are many kinds of soils in this blanket, which is made up of millions of distinct patches. Figure 3 shows a Wisconsin landscape in which two kinds of soils are prominent, one of which plows up light colored and one which plows up dark. Under the cover of crops, these differences were not immediately evident. And it is only by studying soils to a depth of at least three or four feet, as a soil surveyor does, that the significant contrasts between them can be discovered. Soil variations are great not only in a single field (Fig. 3), but also from one part of the state to another (Figs. 1 and 2). Some of these differences are reflected in quality and quantity of crops and of animals feeding on the crops.

#### There Are Many Kinds of Soils in Wisconsin

Now that soil scientists have been mapping and studying soils intensively for about 50 years in Wisconsin, we have a list of several hundred kinds of soils, and dozens of maps. The list of soils continues



Figure 3. A field of Elba (dark) and Clyman (light colored) silt loams in Dodge County, Wisconsin.

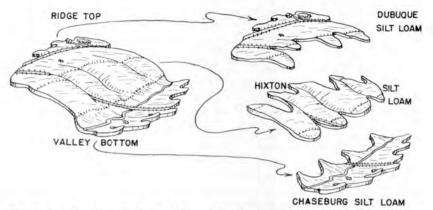


Figure 4. This diagram shows, left, a segment of a landscape extending from a ridge top to a valley bottom. Sketches, right, are of the three soil bodies which constitute this landscape segment.

to grow, as more careful study is made of soil variations. This is inevitable, because natural soil conditions differ so much from place to place. Soil materials have been moved by oceans, lavas, ice-sheets, winds, rivers, and lakes. Plants and animals, and climatic influences have changed these materials to soils. Because conditions varied so greatly, many different kinds of soils were formed, and soil scientists are only now beginning to record the pattern in detail.

The diagram on the front of this bulletin shows that an individual body of soil has a characteristic cross-section or soil profile several feet



Figure 5. Profile of a soil in Dodge County, Wisconsin, showing a wavy A<sub>2</sub> horizon (light colored) over a wavy B horizon (dark colored) over light colored dolomitic loam till.

thick. Figure 4 indicates how soil bodies fit together like pieces of a jig-saw puzzle to form a landscape. Each soil body may have an area of about 5 to 500 acres, and may be said to have an irregular border like that of a leaf, but with notable variations in slope of surface, and in smoothness or roughness of both the upper and lower surfaces. The soil shown in Figure 5 has a fairly smooth upper surface, but a rather rough under surface.

#### Some Important Soil Constituents

Soils may be considered to be combinations of rock materials, water, air, and organic matter. Rock materials are commonly referred to in soils studies as parent materials, because soils are derived from them. In Wisconsin, parent materials range from red clays to light brown loams to white and even green sands. These materials may be dry or wet. In general, the wetter they are the more organic matter they contain. Black soils occur in wet lowlands, and lighter colored soils on highlands. However, dark gray soils have formed even on highlands under some types of vegetation, such as the prairie. Topography, or the lay of the land, influences the distribution of water, organic matter, and parent material. Figure 6 shows the major topographic features of the state.

Soil texture, which means fineness or coarseness of the soil, is probably the most important characteristic in a general scheme of classification. Figure 7 shows the four chief textural separations in soils. Gravel particles are larger than 8 hundredths of an inch in diameter, sand particles measure from 2 thousandths to eight hundredths of an inch across, silt particles are 8 hundred-thousandths to 2 thousandths of an inch in diameter, and clay particles are still smaller. By rubbing moist soil between the fingers, one can feel about how much of each of these sticky, floury, and gritty materials is present. In this way soils can be recognized as clays, sands, sandy loams, loams, and silt loams.



Figure 6. View of a relief map of Wisconsin.

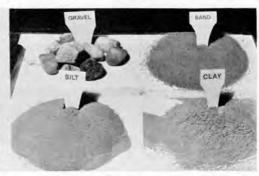


Figure 7. All soils, except peats and mucks, consist of mineral particles of one or more of these four sizes.

#### How to Classify the Soils Where You Are

To classify the soils where you are, find on the soil map, page 11, the region in which you live. Then look at the general soil classification keys as listed on pages 10 and 12. Consult the alphabetical list of soil names near the back of the bulletin for brief soil characterizations. Your agricultural leader can help set up additional soil keys, as needed in your area.

The name of a soil, such as Almena, is called the series name. It is like Acer, the genus name for maple trees. The texture of the surface soil, such as silt loam, is the type designation of a soil. It is like saccharum, the species name of sugar maple. Acer saccharum is the full name of the sugar maple; Almena silt loam is the complete soil type name for the "yellow clay" of north central Wisconsin.

A soil association is a grouping of two or more soils which occur together in a particular landscape. The Almena-Freer association is an example which is illustrated on page 21. There are, of course, many other soils in this part of Wisconsin, but the Almena and Freer soils are the most extensive ones. The table below lists over 50 important soils of Wisconsin in 22 soil associations.

TABLE OF MAJOR SOIL ASSOCIATIONS IN WISCONSIN

	Approxin	g.:i	
Soil Association	Thousands of Acres	% of Land Area of State	Soil Key page
1. Fayette-Dubuque 2. Almena-Freer 3. Plainfield-Sparta-Nekoosa 4. Omega-Hiawatha 5. Dodge-McHenry-Elba 6. Milaca-Cloquet-Peat 7. Hixton-Gale-Arland 8. Kewaunee-Poygan 9. Onaway-Emmet 10. Kennan-Elderon 11. Iron River-Elderon 12. Wakefield-Gogebic 13. Coloma-Wyocena 14. Parr-Corwin-Warsaw 15. Tama-Dodgeville 16. Oshkosh-Poygan 17. Blount-Elliott-Ashkum 18. Ontonagon-Bergland 19. Antigo-Onamia 20. Vesper-Hixton-Peat 21. Rozellville-Rudolph-Mara-	3,600 3,540 3,540 2,800 2,780 2,000 1,800 1,400 1,200 1,140 700 740 700 700	12.2 10.5 9.9 9.2 8.2 7.8 5.6 5.1 3.9 3.7 2.7 2.1 1.9 1.8 1.8 1.5	26 21 17 16 23 19 17 14 15 18 18 17 25 27 14 22 13 20 17
thon22. Fox-Rodman	400 300	$\begin{smallmatrix}1.2\\0.9\end{smallmatrix}$	$\mathbf{\bar{24}}^{-1}$

The profile of a soil is the vertical cross-section showing the various horizons or layers (see front cover). The  $A_0$  horizon is the humus layer on a forest floor. This is gone in cultivated fields. The  $A_1$  is a mixture of humus and mineral soil. Some soils, like the Hiawatha, have no  $A_1$  horizon, but have an  $A_2$  horizon. The  $A_2$  horizon is a lighter-colored layer. Below the A horizons or surface soil layers is the B horizon. This is usually a dark brown layer. In the Plainfield and Omega soils it is quite sandy, but in many soils the B is rather clayey.

The substratum of a soil is the material lying below the A and B horizons, ordinarily at a depth of about 3 feet. This material is usually thought of as the parent material of the soil, or the material from which the A and B horizons formed. In some cases, however, it is quite different from the original A and B materials. In Wisconsin, a soil may be formed from a thin blanket of sediment, overlying a substratum which is a deposit made by an ice-sheet, or an ancient river, lake, or a dust-storm thousands of years ago, or is bedrock. A few soils, like the one pictured in Figure 8, are young river-laid soils, still in the making. The maps on pages 40 to 45 show the distribution of bedrocks, glacial deposits, wind-blown materials, native vegetation and climatic influences in Wisconsin which determined the soil pattern.

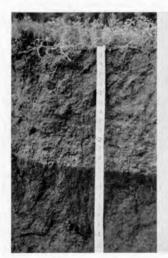




Figure 8. The Ray silt loam is an alluvial soil in southwestern Wisconsin consisting of light colored silt loam 1 to 4 feet thick which buries the original dark alluvium. In some places this soil is now being covered by gravel, and in others it is being completely washed away by storm waters. Valley slopes above have Boone, Hixton, Gale and Sogn soils. On the ridgetops, Dubuque, Fayette, Dodgeville and Tama soils occur.

#### Wisconsin Soils May Be Classified Under a Few Headings

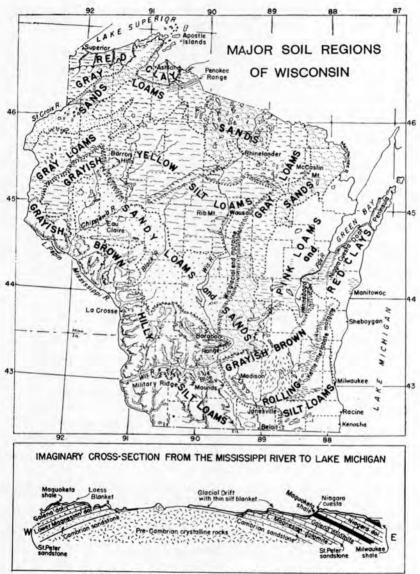
The generalized state map on page 11 groups the major soils of Wisconsin under eight headings, which in a general way indicate colors, textures, and topographic conditions, as follows:

	Page Numbers
Soil Regions	Major Soil Associations of Soil Keys
1. Red clay	Ontonagon-Bergland13
2. Pink loams and red clays	Solution (Control of the Control of
3. Sands	Omega-Hiawatha16
4. Sandy loams and sands	Plainfield–Sparta–Nekoosa Coloma–Wyocena Hixton–Gale–Arland Vesper–Hixton–Peat
5. Gray loams	Kennan-Elderon Iron River-Elderon Wakefield-Gogebic Milaca-Cloquet-Peat Antigo-Onamia
6. Grayish-yellow silt loams	Almena-Freer21
7. Grayish-brown rolling silt loams	Blount-Elliott-Ashkum Dodge-McHenry-Elba Fox-Rodman Parr-Corwin-Warsaw
8. Grayish-brown hilly silt loams	- Fayette-Dubuque Tama-Dodgeville

A ninth general soil grouping is organic soils, called peats and mucks (Carlisle-Greenwood-Spalding) which occur in bodies scattered throughout the state.

#### LIST OF COUNTIES AND PAGE NUMBERS FOR RELEVANT SOIL KEYS

Page	Page
Adams 17	Columbia 17, 23, 25
Ashland 13, 18	Crawford 26, 27
Barron 16, 17, 21	Dane 23, 25, 26, 27
Bayfield 13, 16, 19, 20	Dodge 17, 23,25
Brown 14, 15	Door 14, 15
Buffalo 17, 26	Douglas 13, 16, 19, 20
Burnett 16, 19, 20	Dunn 16, 17
Calumet 14, 23	Eau Claire16, 17, 26
Chippewa 16, 17, 18, 19, 20	Florence 15, 18
Clark 17, 21	Fond du Lac 14, 23, 24, 25



THE SOIL SURVEY DIVISION, WISCONSIN GEOLOGICAL AND NATURAL, HISTORY SURVEY

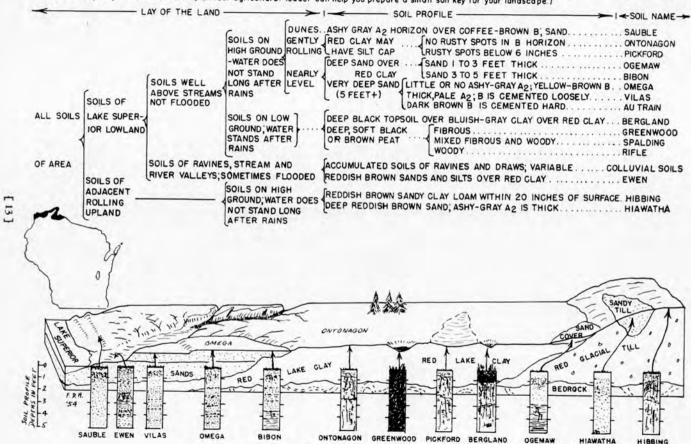
Page	Page
Forest 18	Pierce 26, 27
Grant 26, 27	Polk 16, 19, 20, 21
Green 26, 27	Portage 17, 20, 21
Green Lake 14, 17, 23, 25	Price 18, 19, 20, 21
Iowa 26, 27	Racine 22, 23, 24
Iron 13, 18	Richland 26, 27
Jackson 17, 26	Rock 23, 25, 26
Jefferson 23, 24	Rusk 19, 20, 21
Juneau 14, 17, 26	St. Croix 19, 20, 21, 26, 27
Kenosha 22, 23, 24	Sauk 17, 23, 26
Kewaunee 14, 15	Sawyer 16, 19, 20, 21
La Crosse 26	Shawano 14, 15, 16, 20
Lafayette 26, 27	Sheboygan 14, 22, 23, 24
Langlade 16, 20, 21	Taylor 18, 19, 21
Lincoln 16, 21	Trempealeau 17, 26
Manitowoc 14, 15, 23, 24	Vernon 26, 27
Marathon 20, 21	Vilas 16, 18
Marinette 15, 16, 18	Walworth 23, 24, 25
Marquette 17	Washburn 16, 19, 20
Milwaukee 14, 22	Washington 22, 23, 24
Monroe 14, 17, 26	Waukesha 22, 23, 24
Oconto 14, 15, 16, 18, 20	Waupaca 14, 17, 20
Oneida 16	Waushara 14, 17
Outagamie 14, 15	Winnebago 14, 23, 25
Ozaukee 14, 22	Wood 21
Pepin 16, 26	

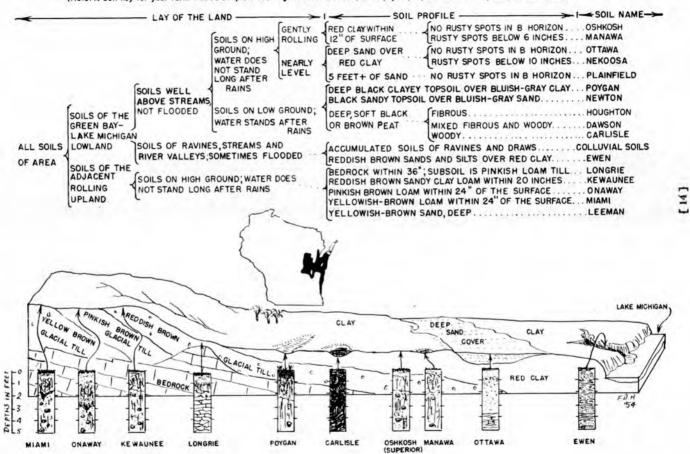
#### **APPENDIX**

#### A. LIST OF SOME COMMON SOIL SERIES IN WISCONSIN

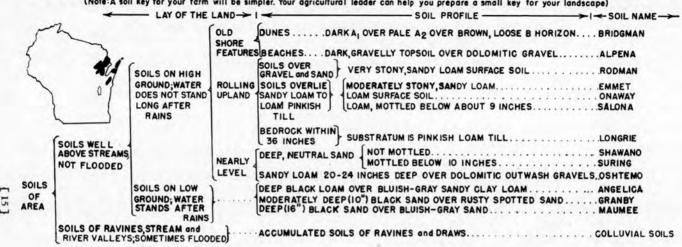
	Page in this Bulletin	General Characterization
Abington	24	Very poorly drained silt loams underlain at 4 to 5'feet by dolomitic gravel and sand. A <sub>0</sub> -A <sub>1</sub> -G-D. Humic-Gley. Fox associated.
Adolph	19, 20, 21	Very poorly drained silt loams and loams. A <sub>0</sub> -A <sub>1</sub> -G-C. A <sub>1</sub> is 8 to 12 inches thick. Humic-Gley.
Ahmeek	18	Moderately well drained silt loams, loams, and sandy loams, shallow over dark crystalline rocks. A <sub>0</sub> -A <sub>1</sub> -B-C. Acid Brown Forest.
		Imperfectly drained silt loams underlain at $30-42''$ by reddish brown sandy clay loam glacial till. $A_0$ - $A_1$ - $A_2$ -B-C-D, mottled below $A_1$ . Planosolic, weak Podzol.
Alpena	15	Excessively drained old beach gravels and gravelly loams. A <sub>0</sub> -A <sub>1</sub> -D. Regosol.
Alvin	26	Well drained, light colored loams and sandy loams 2 or 3 feet deep over sandy outwash. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Gray-Brown Podzolic.

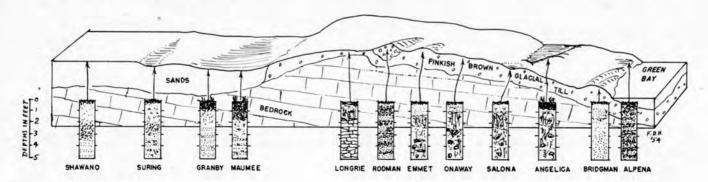
GENERALIZED SOIL KEY FOR USE IN THE FIELD IN THE RED CLAY SOIL REGION(ONTONAGON-BERGLAND SOIL ASSOCIATION) OF NORTHERN WISCONSIN (Note: A soil key for your farm will be simpler. Your agricultural leader can help you prepare a small soil key for your landscape.)

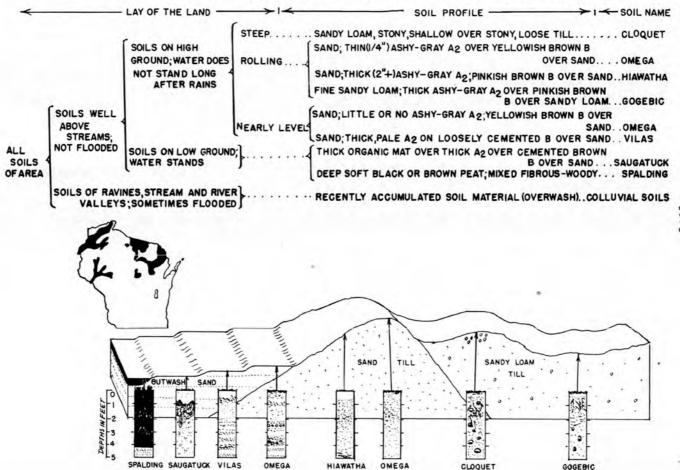




SENERALIZED SOIL KEY FOR USE IN THE FIELD IN THE PINK LOAM REGION (ONAWAY-EMMET SOIL ASSOCIATION), EASTERN WISCONSIN (Note: A soil key for your farm will be simpler. Your agricultural leader can help you prepare a small key for your landscape)







SPARTA-NEKOOSA: HIXTON-GALE: VESPER-HIXTON SOIL ASSOCIATIONS). WISCONSIN (Note: The soil key for your farm will be simpler. Your garicultural leader can help you prepare a soil key for your landscape) LAY OF THE LAND - SOIL PROFILE -> I+ SOIL NAME → BOONE STEEP DEEP LOAMY SAND OVER SANDSTONE ..... SANDSTONE DEEPSANDY LOAM; SOME CLAY IN B; ON SANDSTONE... HIXTON HILL COUNTRY ROLLING DEEP GREEN (GLAUCONITIC) SANDY LOAM; B HAS CLAY. . NORDEN 24"-30" OF SILTY MATERIAL OVER SANDSTONE . GALE NOT MOTTLED: WELL DRAINED SHAWANO DEEP SAND. | NOT ACID MOTTLED BELOW 9 INCHES . . . YELLOWISH SOILS ON HIGH NOT MOTTLED; WELL DRAINED .. PLAINFIELD OUTWASH AND BROWN ACID. MOTTLED BELOW 9 INCHES ... NEKOOSA GROUND: WATER NEARLY LACUSTRINE DOES NOT STAND LEVEL 2-5 FEET OF SAND NOT MOTTLED; WELL DRAINED .. OTTAWA PLAINS LONG AFTER OVER RED CLAY MOTTLED BELOW 9 INCHES. . BERRIEN RAINS DEEP DARK LOAMY SAND A OVER YELLOWISH BROWN SD. SPARTA SOIL FORMED FROM NOT MOTTLED; WELL DRAINED ... TUSCOLA SOILS WELL ABOVE MOTTLED BELOW 9 INCHES. . . . SHIOCTON & V. FINE SANDS STREAMS: DEEP SAND SOME SILT IN B ; LOAMY SAND TILL . . . . COLOMA NOT SANDY TILL HILLY FLOODED COUNTRY SANDY LOAM WITH SANDY CLAY LOAM B ON SANDY TILL . . WYOCENA TO ROLLING SANDY LOAM ON SILTY LOAM B OVER LOAM TILL . . . . . RIO ALL SOILS SOILS ON LOW 17 IN SANDSTONE DEEP BLACK A OVER 30"+ OF SILT OR FINE SANDY GROUND: WATER OF AREA ABLUISH GRAY SUBSOIL COUNTRY LOAM OVER SANDSTONE STANDS AFTER RAINS VESPER DEEP SANDS . . . . . . . . . NEWTON IN OUTWASH AND (DEEP BLACK A OVER DEEP SANDY LOAM: LIMEY BELOW. GRANBY LACUSTRINE PLAINS BLUISH GRAY SUBSOIL STRATIFIED SILTS AND F.SANDS .. KEOWNS SOILS OF RAVINES, STREAM AND RIVER VALLEYS: SOMETIMES FLOODED...... RECENTLY ACCUMULATED SOIL MATERIALS..... COLLUVIAL SOILS GLAUGONITIC SANO SANDY SANDSTONE TILL LOAM TILL CLAY VA: OUTWASH SAND 40 DEPTHSIN DYK. VESPER BOONE GALE HIXTON NORDEN

COLOMA

WYOCENA

KEOWNS

TUSCOLA

OTTAWA

NEWTON

NEKOOSA

PLAINFIELD

GENERALIZED SOIL KEY FOR USE IN THE FIELD IN THE CENTRAL REGION OF SANDY LOAMS AND SANDS (COLOMA-WYOCENA; PLAINFIELD-

(Note:A soil key of your farm will be simpler. Your agricultural leader can help you prepare a small soil key for your landscape.) LAY OF THE LAND-- SOIL PROFILE -> I +SOIL NAME -> SHALLOW STONY SANDY LOAM; SOME DOLOMITE IN TILL.... ELDERON STEEP NO DOLOMITE THICK(2") ASHY-GRAY A OVER BROWN B ... CLOQUET THIN (1/2") ASHY-GRAY A OVER YELL-BR. B . . SCANDIA IN TILL SOILS ON HIGH SAND: THICK ASHY-GRAY A OVER PINKISH-BROWN B ... HIAWATHA GROUND: WATER DOES SAND; THIN ASHY-GRAY A OVER YELLOWISH-BROWN B. . . OMEGA NOT STAND LONG FINE SANDY LOAM: TOVER LOAMY SAND TILL . . . . MARENISCO AFTER RAINS ROLLING THICK ASHY-GRAY A OVER SANDY LOAM TILL . . . . GOGEBIC OVER PINKISH-BR. B OVER LOAM TILL . . . . . . . . WAKEFIELD SOILS WELL ABOVE OVER PINK - BR. SDY. LOAM TILL . . IRON RIVER STREAMS: NOT 0-36" OF SILTY SOIL OVER YELL-BR. SDY. L.TILL THIN AZ KENNAN FLOODED 0-36" OF LOAM OVER TILL HIGH IN CONTENT OF DARK IGNEOUS ROCKS OF WHICH ACTUAL OUTCROPS ARE COMMON. ALL DEEP DARK AL : NO A2 . . . AHMEEK SOILS THIN PEAT OVER BLACK A JA, IS 8-12" THICK OF ADOLPH OVER BLUISH-GRAY LOAM A, IS 3-6" THICK . . . . . . CABLE AREA SOILS ON LOW GROUND; WATER ORGANIC SOILS; BROWN FIBROUS AND WOODY PEAT. .... SPALDING STANDS AFTER RAINS SOILS OF RAVINES. STREAM AND RIVER VALLEYS: RECENTLY ACCUMULATED SOILS OF RAVINES AND DRAWS SOMETIMES FLOODED DEEP OVERWASH DEPOSITS . . . . COLLUVIAL SOILS VERY TSTONY 0 SANDY STONY LOAM SAND TILL SANDY 0:0 LOAMY LOAM SANDY DARK ' IGNE OUS SAND TILL LOAM TIL BEDROCK

CLOQUET

OMEGA

MARENISCO

COGEBIC

ELDERON

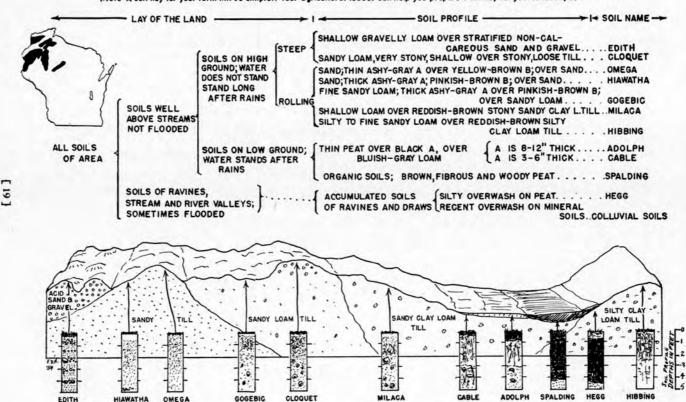
IRON RIVER WAKEFIELD

AHMEEK

HEGG

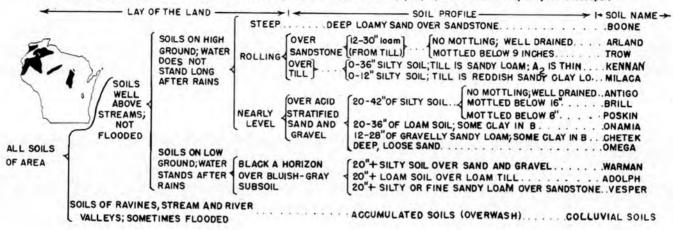
SPALDING

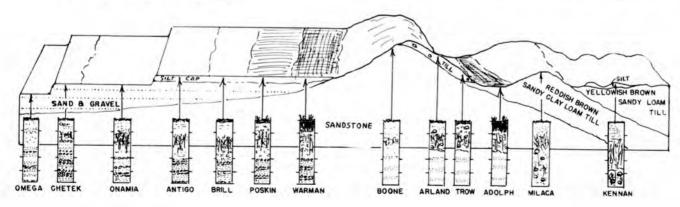
18



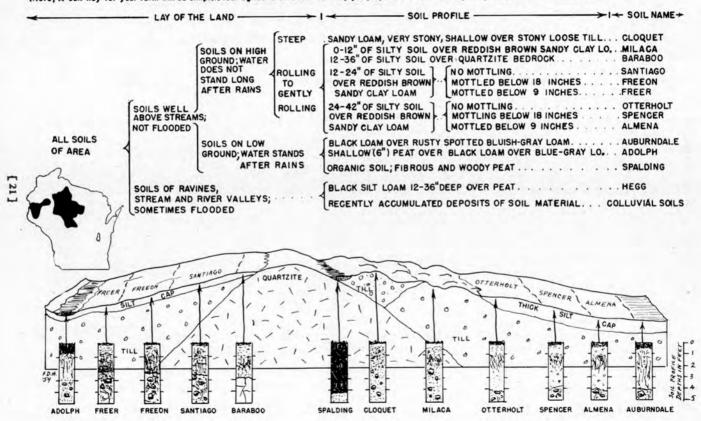
20 ]

GENERALIZED SOIL KEY FOR USE IN THE GRAY LOAMS REGION (MILACA-CLOQUET; KENNAN-ELDERON; ANTIGO-ONAMIA), NO.WISCONSIN (Note: The soil key for your farm will be simpler. Your agricultural leader can help you prepare a small soil key for your landscape.)





GENERALIZED SOIL KEY FOR USE IN THE GRAYISH YELLOW SILT LOAM REGION (ALMENA-FREER SOIL ASSOCIATION) OF NORTHERN WISCONSIN (Note; A soil key for your farm will be simpler. Your agricultural leader can help you prepare a small soil key for your particular landscape.)

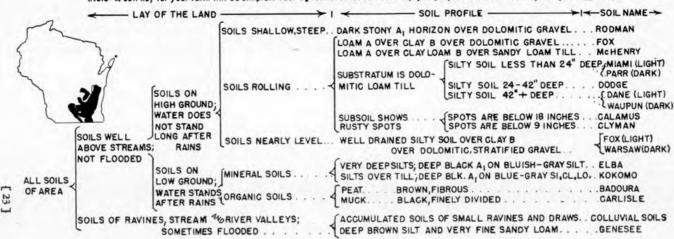


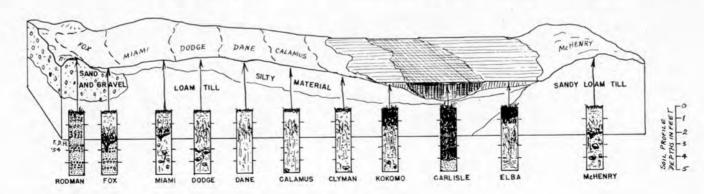
## GENERALIZED SOIL KEY FOR USE IN THE CLAY PRAIRIE OF THE GRAYISH BROWN ROLLING SILT LOAMS REGION (BLOUNT-ELLIOTT-ASHKUM SOIL ASSOCIATION), SOUTHEASTERN WISCONSIN

(NOTE: A soil key for your farm will be simpler. Your agricultural leader can help you prepare a small soil key for your landscape.) LAY OF THE LAND -SOIL PROFILE - SOIL NAME -SOILS ON HIGH BLACK A, SILTY CLAY LOAM, DEEP(8"), MODERATELY GROUND; WATER WELL DRAINED .... ELLIOTT GENTLY DOES NOT STAND DARK BROWN A, SILTY CLAY LOAM, DEEP. ROLLING LONG AFTER RAINS MODERATELY WELL DRAINED . . . . . BEECHER SOILS WELL ABOVE STREAMS; LIGHT BROWN A, SHALLOW. MODERATELY WELL DRAINED . MORLEY MOTTLED BELOW 10 INCHES . BLOUNT NOT FLOODED DEPRESSIONS DEEP (8") BLACK ALOVER BLUISH-GRAY CLAY. . . . . . . . ASHKUM L VERY DEEP (16") BLACK A, OVER BLUISH-GRAY CLAY . . . PEOTONE IN TILL ALL SOILS ON LOW SOILS GROUND; WATER OF ON LEVEL ANCIENT STANDS AFTER DEEP BLACK A, OVER BLUISH-GRAY CLAY. . . . . . AREA RAINS LAKE PLAINS SOILS OF RAVINES. STREAM AND RIVER .RECENT ACCUMULATIONS IN RAVINES AND DRAWS . . . . COLLUVIAL SOILS VALLEYS; SOMETIMES FLOODED ELLIOTT BEECHER GRAY BROWN SILTY CLAY LOAM GRAY SILTY CLAY (GLACIO-LACUSTRINE) MORLEY BEECHER BLOUNT ASHKUN ELLIOTT PEOTONE BRYCE

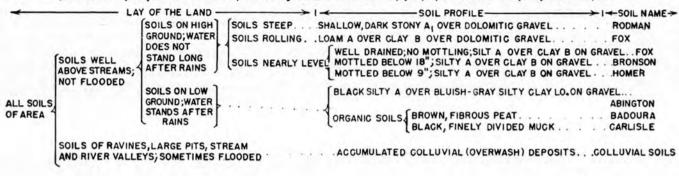
## GENERALIZED SOIL KEY FOR USE IN THE GRAYISH-BROWN ROLLING SILT LOAMS REGION (DODGE-MCHENRY-ELBA; FOX-RODMAN SOIL

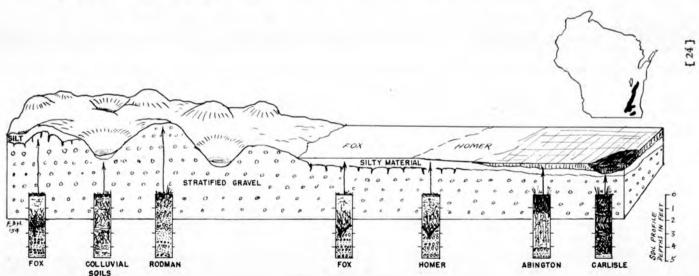
(Note: A soil key for your farm will be simpler. Your agricultural leader can help you prepare a small soil key for your landscape.)



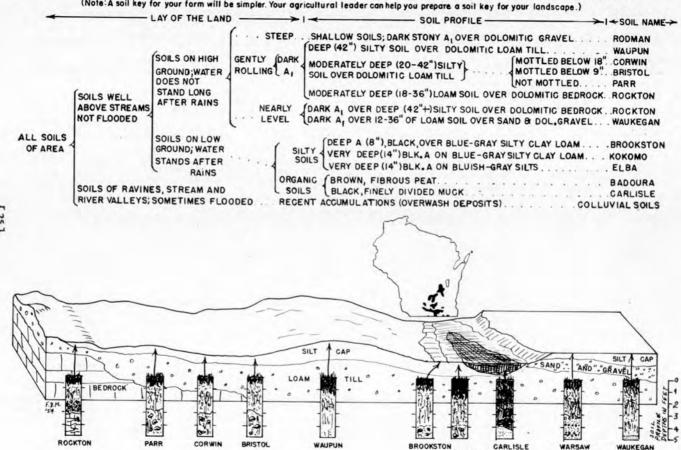


GENERALIZED SOIL KEY FOR USE ON THE GRAYISH BROWN SOILS OF THE KETTLE MORAINE (FOX-RODMAN SOIL ASSOCIATION), WISCONSIN (Note: A soil key for your farm will be simpler. Your agricultural leader can help you prepare a small soil key for your landscape)





GENERALIZED SOIL KEY FOR USE IN THE SILTY PRAIRIES (PARR-CORWIN-WARSAW SOIL ASSOCIATION), IN SOUTHEASTERN WISCONSIN (Note: A soil key for your form will be simpler. Your agricultural leader can help you prepare a soil key for your landscape.)



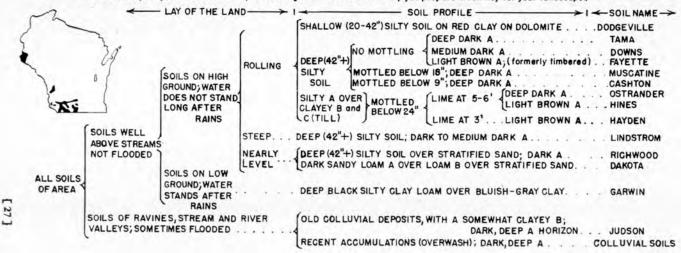
[ 26 ]

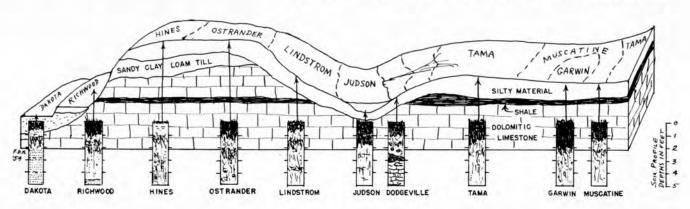
GENERALIZED SOIL KEY FOR USE IN THE GRAYISH BROWN HILLY SILT LOAMS REGION (FAYETTE-DUBUQUE SOIL ASSOCIATION), S.W. WISCONSIN (Note: A soll key for your farm will be simpler. Your agricultural leader can help you prepare a small soil key for your landscape.) >1 - SOIL NAME -> LAY OF THE LAND-SOIL PROFILE-STEEP STONY LAND MODERATELY STEEP ... SILTY & GLAYEY SOIL 0-20" THICK OVER DOLOMITE .... SOILS WELL SOILS ON HIGH MEDIUM DEEP (20-42") SILTY SOIL OVER RED CLAY ON DOLOMITE .. DUBUQUE ABOVE STREAM GROUND; WATER ROLLING TO -LEVEL; NOT DOES NOT GENTLY DEEP (42"+) NO MOTTLING MODERATELY DARK BROWN A . . . DOWNS FLOODED STAND LONG ROLLING AFTER RAINS SILTY SOIL MOTTLED BELOW 12 INCHES . . . . . . . . . STRONGHURST ALL SOILS DEEP (42"+) SILTY SOIL, LIGHT BROWN A; SUBSTRATUM IS SAND BERTRAND NEARLY OF AREA SANDY LOAM A OVER LOAM B OVER DEEP STRATIFIED SAND. . . . . ALVIN LEVEL ACCUMULATED | RECENT OVERWASH IN RAVINES AND DRAWS. . . COLLUVIAL SOILS OLD ACCUMULATED SOILS (WITH SOMEWHAT CLAYEY SOILS SOILS OF RAVINES, STREAM AND RIVER B HORIZONS) IN RAVINES AND DRAWS . . CHASEBURG VALLEYS; SOMETIMES FLOODED BOTTOM SOILS: (WELL DRAINED (NO MOTTLING) . . . . ARENZVILLE SERIOUSLY FLOODED MOTTLED BELOW 9 INCHES . . . ORION NEARLY EVERY YEAR DUBUQUE DOWNS FAYETTE DUBUQUE ! THAT WALL THE PARTY PARTY PARTY THE WHEN ALVIN SILTY MATERIAL DUBUQUE DOWNS DUBUQUE FAYETTE STRONGHURST STEEP ARENZVILLE CHASE-BERTRAND

RURG

STONY LAND

## GENERALIZED SOIL KEY FOR USE IN THE FIELD IN THE PRAIRIE AREAS (TAMA-DODGEVILLE SOIL ASSOCIATION) OF WESTERN WISCONSIN. (Note: A soil key for your farm will be simpler Your agricultural leader can help you prepare a soil key for your landscape.)





P	age in this	
Soil Series Name	Bulletin	General Characterization
		Very poorly drained silt loams underlain at 3 to 5 feet by sandy loam to sandy clay loam glacial till. A <sub>0</sub> -A <sub>1</sub> -G-D. Humic-Gley. Associated with Onaway.
-		Well drained silt loams underlain at 2 to 4 feet by coarse sand and gravel outwash containing little or no carbonates. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-(C)-D. Gray-Brown Podzolic to weak Podzol.
Arenzville	26	<ul> <li>Well drained, deep, light colored silt loam alluvium, recent. A<sub>11</sub>-A<sub>126</sub>-A<sub>136</sub> Alluvial.</li> </ul>
Arland	., 20	Let Well drained silt loams and loams under- lain at 2 to 3 feet by Cambrian sandstone. Formed from both loess and till. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> - BD <sub>1</sub> -BD <sub>2</sub> -D <sub>3</sub> . Gray-Brown Podzolic.
		Poorly drained clayey soil underlain at 2 to 4 feet by dolomitic silty clay loam glacial till. A₀-A₁-G-C. Humic-Gley. Associated with Elliott and Morley.
(Auburn)		Now called Boone.
Auburndale	<b>21                                </b>	- Poorly drained silt loams, wetter than Almena and better drained than Adolph. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -G-C-D. A <sub>2</sub> is mottled. Planosolic Humic-Gley.
Au Train		Well drained sands on level outwash plains. A <sub>0</sub> -A <sub>2</sub> -B <sub>2</sub> -C. The A <sub>2</sub> is about 1 foot thick and the B <sub>2</sub> is 1 to 2 feet thick and is cemented. Podzol.
		Fibrous mucky peat. 1-2-3-4. Bog.
(Baldwin)		Now called Hines.
		Well drained silt loams underlain at 2 to 4 feet by quartzite bedrock. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B <sub>1</sub> (C)-D. Gray-Brown Podzolic.
(Baxter)		Now called Dubuque.
		Imperfectly drained silty clay loam over dolomitic silty clay till. A <sub>0</sub> -A <sub>1</sub> (deep)-A <sub>2</sub> -B-C. Mottled below A <sub>2</sub> . Gray-Brown Podzolic-Prairie (Brunizem). Associated with Morley and Elliott.
(Bellefontaine)		Now called Casco and Fox.
		Very poorly drained black clay underlain at about 2 feet by pink clay. A <sub>0</sub> -A <sub>1</sub> -G-C. Humic-Gley. Associated with Ontonagon.
Berrien		sandy loams 3 to 5 feet deep over lacustrine clays. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-(C)-D. Mottled in B. Gray–Brown Podzolic,
Bertrand	26	Well drained silt loams underlain at 5 feet or so by outwash sand. A₀-A₁-A₂-B-C-D. Gray-Brown Podzolic.

Soil Series Name	Page in this Bulletin	General Characterization	
		Well drained sands 3 to 5 feet	deep over
3.50h	<b>2</b>	lacustrine red clay. Northern V A <sub>0</sub> -A <sub>2</sub> -B-(C)-D. Podzol.	
Blount	22	Imperfectly drained silty clay dolomitic clayey till. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-solic-Gray-Brown Podzolic. Mott.	C. Plano-
Boone	17, 20	A <sub>1</sub> . Associated with Morley.  Excessively drained sands to loa without textural profile, develo	my sands
n · i		sandstone. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Weak Gr. Podzolic.	ay–Brown
		Excessively drained dune san A <sub>0</sub> -A <sub>2</sub> -B-C. Weak Podzol.	
Brill	20	Moderately well drained silt loan feet deep over outwash gravel	
		A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-(C)-D. Mottled in Brown Podzolic-weak Podzol,	B. Gray-
		with Antigo.	
Bristol	25	Imperfectly drained silt loams 3 deep over dolomitic loam till. A <sub>0</sub> -	
		Prairie (Brunizem). Mottled b	elow A1.
D		Associated with Waupun and Pari	
bronson		Moderately well drained silt loa 3 feet deep over limestone gra	
		wash). A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-D. Mottled in	B. Gray-
Brookston	25	Brown Podzolic. Associated with Very poorly drained silt loams	
Dioonston		clay loams 2 to 3 feet deep over	dolomitic
		loam till. A <sub>0</sub> -A <sub>1</sub> -G-(C)-D. Hu	mic-Gley.
Bryce	22	Associated with Miami.  Very poorly drained silt loams to	silty clay
, ••		loams, underlain at about 4 feet	by dolo-
	ě	mitic silty clay glacial till. Hu Associated with Elliott. Till is mo	mic–Gley. ore clavey
		than under Ashkum.	
		Very poorly drained silt loams a A₀-A₁-G-C. 3 to 6-in. A₁. Humic-	Gley.
Calamus	23	Moderately well drained silt loan	ns 3 to 5
		feet deep over dolomitic loam till. B-(C)-D. Mottling in B. Gray-Br zolic. Associated with Dane and	own Pod-
Carlisle	14, 23, 24, 25	Muck formed from woody and file	rous peat
(Carrington)		in southeastern Wisconsin. 1-2-3- Now called Waupun, Elliott and	-G. dog. Parr.
Casco		Excessively drained silt loams a	nd loams
		12 to 18 inches deep over dolomi and coarse sand, A <sub>0</sub> -A <sub>1</sub> -B <sub>2</sub> -D. Gr. Podzolic.	
Cashton		Imperfectly drained silt loam for	ormed on
	•	deep silt in a prairie border A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Prairie-Gray-Brown transition. Mottled below A <sub>1</sub> . A	Podzolic
		with Downs.	

	Page in this	
Soil Series Name	Bulletin	General Characterization
Chaseburg	26	Well drained silt loams in small ravines and valleys. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Gray-Brown Podzolic. Fayette-Dubuque landscape.
Chelsea	`	This name was once used for soils on granitic glacial till, later called Kennan soils. Chelsea is now used for soils formed from wind-blown and colluvial sand terraces in Grant and Richland counties. A <sub>0</sub> -A <sub>2</sub> -C. Regosol.
Chetek		Well drained sandy loams and loams with loam to sandy clay loam B horizons and underlain at 10 to 15 inches by outwash gravel and sand, A <sub>0</sub> -A <sub>1</sub> -A <sub>9</sub> -B-C. Weak Podzol. Associated with Antigo and Onamia.
Cloquet	16, 18, 19, 21	Well drained sandy loams and loams in hilly morainic country. Similar to Chetek except for topography. Very stony in places.
		A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Weak Podzol. Associated with Milaca.
(Clyde)		This soil is now called Kokomo.
Clyman	23	Imperfectly drained silt loam 3 to 5 feet deep over dolomitic loam till, associated with Dodge and Dane. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C-D profile. Planosolic soil, a transition between Gray-Brown Podzolic and Humic-Gley.
(Colby)		This soil is now called Spencer (moderately well drained) and Almena (imperfectly drained). The Almena is the more extensive of the two.
Colluvial soils	All keys	This term includes the many unnamed soils being formed of deposits of materials eroded from hillsides into lowlands be- tween the hills. Chaseburg and Judson are
·	17	soils with slight textural B horizons. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Weak Gray-Brown Podzolic. Associated with Plainfield and Wyocena.
(Cornucopia)	- <b></b>	This soil is now called Hiawatha.
Corwin	25	Moderately well drained dark silt loam 3 to 5 feet deep over dolomitic loam till, associated with Waupun and Parr. A <sub>0</sub> -A <sub>1</sub> -B-C-D. Mottled in B. Prairie (Brunizem).
Dakota	<b>27</b>	This soil is now called Hayden.  Well drained sandy loam and loam soils formed over deep outwash sand. A₀-A₁-B-C profile. Prairie analogue of Alvin.
Dane	23	Well drained silt loam underlain by dolomitic loam till at 3 to 5 feet. Solum resembles that of Fayette. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C-D. Gray-Brown Podzolic.
		F 2A T

Soil Series Name	Page in this Bulletin	General Characterization
		Mixed fibrous and woody peat of Eastern Wisconsin. 1-2-3-4-G. Bog.
Dodge	23	Well drained silt loam underlain by dolomitic loam till at 2 to 3 feet. Solum resembles that of Dubuque. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B <sub>2</sub> -D. Gray-Brown Podzolic.
Dodgeville	27	Well drained silt loam with dark deep A <sub>1</sub> , underlain at 2 or 3 feet by cherty red clay over dolomite. A <sub>0</sub> -A <sub>1</sub> -B-D <sub>1</sub> -D <sub>2</sub> . Prairie (Brunizem) analogue of Dubuque.
Downs	26	Well drained silt loam with a moderately dark A <sub>1</sub> about 7 inches thick underlain by a weak A <sub>2</sub> . On uplands or terrace benches. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C-D. Prairie (Brunizem)-Gray-Brown Podzolic transition, between Tama and Fayette.
-		Well drained silt loam similar to Dodgeville, except that it has a shallow A <sub>1</sub> and a well developed A <sub>2</sub> . A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-D <sub>1</sub> -D <sub>2</sub> . Gray-Brown Podzolic.
(Dunning)		This soil is now called Newton.
Edith	19	Excessively drained soil formed from acid gravel and coarse sand on kames and eskers.  More acid than Rodman. A-C. Regosol.
Elba	23	Very poorly drained black silt loam or silty clay loam on old lake-laid silts, lying between drumlins, A <sub>0</sub> -A <sub>1</sub> -G-C. Humic-Gley.
Elderon	18	Excessively drained stony sand loam soil over sandy loam glacial till containing some dolomite. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. May have a surficial layer of very fine sand or silt. Weak podzol. Till is more acid than below Cloquet.
Elliott	22	Moderately well drained black silty clay loams with dolomitic silty clay loam till at 2 feet. A <sub>0</sub> -A <sub>1</sub> -B-C. Prairie (Brunizem).
Emmet	15	Excessively drained sandy loams over pink sandy loam to loam glacial till. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. A weak podzol. Associated with Onaway.
Ewen	13, 14	Red alluvial soil, redeposited red clay or till material. A <sub>11</sub> -A <sub>120</sub> -A <sub>130</sub> . Alluvial. Asso- ciated with Ontonagon and Oshkosh (Superior).
Fayette	26	Well drained silt loam formed from calcareous loess 4 or more feet deep, overlying bedrock and residuum. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Gray-Brown Podzolic.
		۲ 31 ٦

Soil Series Name	Page in this Bulletin	General Characterization
Fenwood		Well drained silt loam underlain at 1 to 3 feet by fine grained crystalline rock. Marathon County. Associated with Stettin and Rietbrock. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B <sub>-</sub> (C)-D. Gray-Brown Podzolic-Podzol transition.
		Well drained silt loam and loams under- lain at 2 to 5 feet by dolomitic gravel and coarse sand. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B <sub>2</sub> -D. Gray-Brown Podzolic.
Freeon	21	Moderately well drained silt loam 1 to 2 feet deep over reddish brown sandy clay loam till. Associated with Santiago and Freer. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-D. Mottling in B. Transitional between Gray-Brown Podzolic and Podzol.
		Imperfectly drained silt loam one to two feet deep over reddish sandy clay loam till. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-D. Mottled below A <sub>1</sub> . Planosolic weak Podzol.
Gale	17	Well drained silt loam underlain at 2 to 3 feet by sandstone. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-(C)-D. Gray-Brown Podzolic.
Garwin	27	Very poorly drained silt loams and silty clay loams, associated with Downs, and
Genesee		Tama. A <sub>0</sub> -A <sub>1</sub> -G-C. Humic-Gley.  Well drained light colored silt loam bottom soil of southeastern glaciated Wiscon-
		sin. A <sub>11</sub> -A <sub>12b</sub> -A <sub>18b</sub> Alluvial.  Well drained very fine sandy loam soils over sandy loam acid till at 30 inches. Heavier in texture than Hiawatha. A coarse textured associate of Iron River. A <sub>0</sub> -A <sub>2</sub> -B-C. Podzol.
		Very poorly drained sand, with pH above 6.0, on old lake plains. Associated with the better drained Shawano and the more poorly drained Maumee. A <sub>0</sub> -A <sub>1</sub> -G-C. Humic-Gley.
		Acid fibrous peat of northern Wisconsin. 1-2-3-G. Bog.
Hayden	<b>-</b>	Well drained fine sandy loam formed on calcareous loam till of Mankato age, leached about 4 feet. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C <sub>1</sub> -C <sub>2</sub> . Gray-Brown Podzolic.
		<ul> <li>Silty overwash, more than one foot deep, on peat. A<sub>2</sub>-1<sub>b</sub>-2<sub>b</sub>-G. Colluvial (local Alluvial).</li> </ul>
		<ul> <li>Excessively drained sand formed from deep sandy glacial drift, all acid. A<sub>0</sub>-A<sub>2</sub>-B-C. Podzol (medial).</li> </ul>
Hibbing	13, 19	Well drained sandy loams developed over reddish brown sandy clay till south of the Lake Superior Iowland. Calcareous at 3 to 4 feet. A <sub>0</sub> -A <sub>2</sub> -B-C. Weak Podzol.

	Page in this	
Soil Series Name	Bulletin	General Characterization
Hines	27	Well drained silt loam formed from 1 to 2 feet of loess over clay loam till, calcareous at 6 feet. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -BD-CD-D. Gray-Brown Podzolic.
Hixton	17	Well drained sandy loams formed from Cambrian sandstone, siltstone and shale. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Gray-Brown Podzolic.
Homer	24	Imperfectly drained silt loam, underlain at 2 to 5 feet by dolomitic gravel and sand. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-(C)-D. Mottling below A <sub>3</sub> . Planosolic soil transitional between Gray-Brown Podzolic and Humic-Gley.
Houghton	<del>-</del>	Fibrous peat of eastern Wisconsin. 1-2-3-G. Bog.
Iron River	18	Well drained fine sandy loam or silt loam underlain at 30 inches by purplish-reddish brown sandy loam till, acid. A <sub>0</sub> -A <sub>2</sub> -B-C-D. Podzol.
Judson	27	Well drained, dark colluvial soil of south- western Wisconsin associated with Tama and Downs. A <sub>0</sub> -A <sub>2</sub> -B-C. Prairie (Brunizem).
Kennan	18, 20	Well drained fine sandy loam or silt loam underlain at 2 to 3 feet by brown sandy loam till. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-D. Weak Podzol to Gray-Brown Podzolic.
Keowns	17	Poorly drained silt loam formed on lake-laid silts and very fine sands, associated with Elba and Shiocton. A <sub>0</sub> -A <sub>1</sub> -G-C. Humic-Gley.
	1 <b>4</b> -	developed from dolomitic till of the same texture. Dolomitic at 2 feet. May have a sandy cap, with dolomitic till at 4 feet. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Weak Gray-Brown Podzolic.
		This soil is now called Seaton, Fayette, and Dubuque.
Kokomo	23, 25 ,	Levery poorly drained black silt loam or silty clay loam formed over dolomitic loam till. Associated with Miami, McHenry, and Parr. A₀·A₁·G·C-D. Humic-Gley.
Lawson		
Leeman	·	

Soil Series Name	Page in this Bulletin	General Characterization
(Lindley)		This soil is now called Pecatonica and Hines.
Lindstrom		
		This soil is now called Bertrand.
		Well drained shallow silt loam or loam underlain at 1 to 3 feet by dolomite bedrock, A <sub>0</sub> -A <sub>1</sub> -B-D or A <sub>0</sub> -A <sub>2</sub> -B-D. Brown Forest and Podzol soils.
		Imperfectly drained loams and silty clay loams associated with Kewanee and Oshkosh (Superior). A <sub>0</sub> -A <sub>1</sub> -A- <sub>2</sub> B-C. Mottled below A <sub>1</sub> . Planosolic, transitional between Gray-Brown Podzolic and Humic-Gley.
Marathon	·	Well drained shallow silt loams underlain at 18-36 inches by shattered and weathered gneiss. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-D. Gray-Brown Pod- zolic.
Marenisco	18	. Well drained sandy loam over loamy sand till at 30 inches, acid. A <sub>0</sub> -A <sub>2</sub> -B-D. Only slightly heavier in texture than Hiawatha. Podzol.
		This soil is now called Tama.
(Mason)	<u>-</u>	This soil is now called Ogemaw.
		Very poorly drained sandy loams, calcareous at 20 to 36 inches. Associated with Shawano, Suring and Granby. A <sub>0</sub> -A <sub>1</sub> -G-C. Humic-Gley.
McHenry	23	Well drained silt loams and fine sandy loams over dolomitic sandy loam till at
Medary	·	2 to 3 feet. Associated with Dodge and Dane. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B <sub>2</sub> -C. Gray-Brown Podzolic. Moderately well drained silt loams and silty clay loams formed on terraces of reddish calcareous silts and clays in the valleys of the Wisconsin and Mississippi Rivers.
		A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Gray-Brown Podzolic. This soil is now called Gogebic, Marenisco. Wakefield.
(Meridean)		This is now called Meridian.
Meridian		Well drained loam or sandy loam formed from water reworked Cambrian sandstone. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. B is more clayey than that
Miami	14, 23	of Alvin. Gray-Brown Podzolic.  Well drained silt loams formed in less than 2 feet of silty or loamy material over calcareous loam dolomitic till. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B <sub>2</sub> -C. or D. Gray-Brown Podzolic.

Page in this	
Soil Series Name Bulletin Milaca 19, 20, 21	General Characterization Well drained loams and silt loams over red sandy clay loam till. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Surface texture is finer than in Wakefield. Weak Podzol to Gray-Brown Podzolic.
(Milltown)	This soil is now called Antigo.
Morley 22	Moderately well drained silty clay loam, somewhat better drained than Blount. Dolomitic clayey till occurs at a depth of about 2 feet. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Weak Gray-Brown Podzolic.
Muscatine 27	Moderately well drained silt loam developed from deep calcareous loess. Associated with Tama. $A_0$ - $A_1$ -B-C. Mottled in B. Prairie (Brunizem).
	Imperfectly drained sands formed from deep outwash. Associated with Plainfield. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Mottled below A <sub>1</sub> . Planosolic, transitional between Gray-Brown Podzolic and Humic-Gley.
	Poorly drained acid black sands, associated with Plainfield and Nekoosa. $A_1$ is about 18 inches thick. $A_0$ - $A_1$ - $G$ - $C$ . Humic-Gley.
Norden 17	Well drained silt loams and loams formed from Cambrian greensand and greensilt. Associated with Hixton, A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Gray-Brown Podzolic.
Ogemaw 13	Imperfectly drained sandy soils formed from 1 to 3 feet of sand over red dolomitic lake clays. A <sub>0</sub> -A <sub>2</sub> -B-D. Mottled in B. Groundwater Podzol.
Omega 13, 16, 18, 19, 20	Excessively drained sands formed over deep outwash. A <sub>0</sub> -A <sub>1</sub> -B-C. Brown Podzolic.
Onamia 20	Associated with Antigo and Chetek. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Weak Podzol.
Onaway 14, 15	Well drained sandy loam over sandy loam dolomitic till, which lies at a depth of 2 to 3 feet. A variety of profiles: Brown Forest (A <sub>0</sub> -A <sub>1</sub> -B-C), Gray-Brown Podzolic (A <sub>0</sub> -A <sub>2</sub> -B-C), Podzol (A <sub>0</sub> -A <sub>2</sub> -B-C), and double (A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-A <sub>2</sub> -B-C), meaning a weak Podzol in a Gray-Brown Podzolic.
	Moderately well drained silty clay formed from red lake clays, dolomitic at 2 feet, in the Lake Superior Lowland. A <sub>0</sub> -A <sub>2</sub> -B-C. Weak Gray-Wooded or Podzol.
(Orienta)	This soil resembles Saugatuck but is under- lain by red clays at 40 to 72 inches.
	[35]

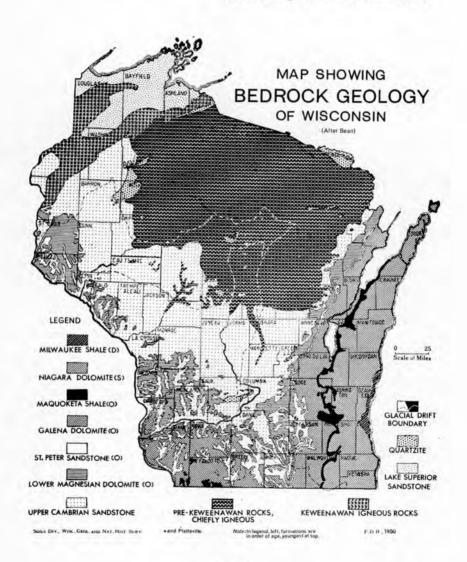
Soil Series Name	Page in this Bulletin	General Characterization
Orion		Imperfectly to moderately well drained
		silt loams, bottom soils, associated with Arenzville in southwestern Wisconsin. A <sub>11</sub> -A <sub>12b</sub> -A <sub>18b</sub> Alluvial.
Oshkosh (Superior) 14		sandy loams and silty clay loams formed over dolomitic red lacustrine clays. Dolo- mite occurs at a depth of about 2 feet. Found in the Lake-Winnebago-Green Bay
Oshtemo		outwash plains. Transitional between Plainfield and Fox as to texture. The
Ostrander	27	Prairie analogue is Warsaw. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Gray-Brown Podzolic.  Well drained silt loam formed over dolo-
Ostrander		mitic clay loam till. Leached 4 feet. A <sub>0</sub> -A <sub>1</sub> -BD-C <sub>1</sub> D-D. Prairie (Brunizem).
Ottawa	14, 17	<ul> <li>Well drained sand overlying dolomitic red clay at 2 to 5 feet. Solum resembles that of Plainfield. A<sub>0</sub>-A<sub>1</sub>-A<sub>2</sub>-B-C-D. Gray-Brown</li> </ul>
Otterholt	21 ,	Podzolic. Some Podzols.  Well drained silt loams formed from 3 to 4 feet of silty material over reddish sandy clay loam till. Associated with Santiago,
Parr	25	Spencer, and Almena. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C-D. Weak Podzol to Gray-Brown Podzolic.  Well drained Prairie (Brunizem) analogues of Miami and Dodge, developed from 1 to 3 feet of loess on dolomitic loam till.
Pecatonica	<u>-</u>	loam till, leached 4 to 10 feet. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -
Peotone	22	line, developed on Lake laid clays. Elliott
Pickford	13	landscape. A <sub>0</sub> -A <sub>1</sub> -G-C. Humic-Gley.  Imperfectly to poorly drained silty clay loams associated with Ontonagon and Bergland, between which Pickford soils are transitional. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -G-C. Mottled below A <sub>1</sub> . Planosolic, an intergrade between
Plainfield	17	Gray-Wooded and Humic-Gley.  Excessively drained sands and loamy sands developed from deep outwash. A <sub>0</sub> -A <sub>1</sub> -
Poskin	20	A <sub>2</sub> -B-C. Gray-Brown Podzolic.  Imperfectly drained silt loam underlain at 2 to 4 feet by gravel and sand outwash. Associated with Antigo. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-(C)-D. Mottled below A <sub>1</sub> . Planosolic, an intergrade between Gray-Brown Podzolic and Humic-Gley.

	Page in this Bulletin	General Characterization
0012 012-10 1 11		Very poorly drained black silty clay soils associated with Kewaunee and Oshkosh (Superior). A <sub>0</sub> -A <sub>1</sub> -G-C. Humic-Gley.
Proctor		See Tuscola.
Ray	9	Well drained silt loams in small valley bottoms, showing 1 to 3 feet of recent alluvium overlying darker silt loam alluvium. A <sub>11</sub> -A <sub>12b</sub> -A <sub>18b</sub> Alluvial.
(Rice Lake)		This soil is now called Onamia.
Richwood	<b>2</b> 7	Well drained silt loams formed from deep silt overlying outwash sand. A <sub>0</sub> -A <sub>2</sub> -B-C-D. Tama on a terrace bench. Prairie (Bruni- zem) analogue of Bertrand. See Downs.
Rifle	. <b></b>	. Slightly acid to alkaline woody peat of northern Wisconsin. 1-2-3-G. Bog.
Rio	17	Well drained loamy fine stands and fine sandy loams formed from about 2 feet of sandy material overlying 2 feet of silty material on dolomitic gravelly loam till. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -BD <sub>1</sub> -D <sub>2</sub> . Gray-Brown Podzolic.
Rockton	25	Well drained dark silt loams and loams underlain by dolomitic bedrock at 2 to 3 feet. Prairie (Brunizem) analogue of Whalen. A <sub>0</sub> -A <sub>1</sub> -B-D. Prairie (Brunizem).
Rodman	. 15, 23, 24	Excessively drained gravelly loam, formed on gravel and coarse sand of eskers and kames. Kettle moraine. A-C. Rendzina, Brown Forest, and weak Gray-Brown Pod- zolic.
Rozellville		Well drained silt loams formed from silty material overlying micaceous glacial till on schist and phyllite bedrock. Marathon County. Associated with Rozell and Zel. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-D. Intergrade between Gray-Brown Podzolic and Podzol.
Rudolph		Well drained silt loams developed over micaceous loam and underlain at about 3 feet by reddish brown sandy clay, probably disturbed by the glacier, Marathon County. Associated with Rudo, Dolph and Altdorph. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-D. Intergrade between Gray-Brown Podzolic and Podzol.
Salona		Imperfectly drained silt loams and loams overlying dolomitic loam to sandy loam glacial till. Associated with Onaway. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Mottled below A <sub>1</sub> . Planosolic, and intergrade between Gray-Brown Podzolic and Humic-Gley.

Page in this Soil Series Name Bulletin	General Characterization
Santiago 21	Well drained silt loam one to 2 feet thick over reddish brown sandy clay loam till. Associated with Freer. Shallower than Otterholt. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-BD-D. Weak Podzol.
Sauble 13	Excessively drained fine sands developed on dunes. Color profile. A pinkish Bridgman-like profile. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Weak Podzol.
Saugatuck 16	Imperfectly drained sands formed near bogs on deep outwash sand. A <sub>0</sub> -A <sub>2</sub> -B-C. Ground-water Podzol, extremely developed.
Scandia	Gravelly sandy loams developed on pinkish gravelly sandy loam till, in association with Milaca. Acid. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Intergrade, Gray-Brown Podzolic to Podzol.
Shawano 15	Excessively drained sands and sandy loams on neutral to alkaline outwash sand. Omega is on acid outwash. A <sub>0</sub> -A <sub>1</sub> -B-C. Weak Podzol.
Shiocton	Imperfectly drained silts and very fine sands, on lake-laid fine sands, silts, and calcareous pink clays. Associated with Tuscola, Keowns, and Elba. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Mottled below A <sub>1</sub> . Intergrade between Gray-Brown Podzolic and Humic-Gley.
Sogn 26	Well to excessively drained silt loams and stony clay loams formed from thin silt over cherty red clay over dolomitic bed- rock in southwestern Wisconsin. A-C. Regosol, Rendzina, Prairie, Gray-Brown Podzolic.
	Acid, mixed fibrous to woody peat, northern Wisconsin. 1-2-3-4-G. Bog.
	Excessively drained dark sands and loamy sands on outwash sand. A <sub>0</sub> -A <sub>1</sub> -B-C. Prairie (Brunizem) analogue of Plainfield.
Spencer 21	Silt loam, moderately well drained, formed from 2 to 4 feet of loess over acid red sandy clay loam till. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C-D. Mottled in B. Associated with Otterholt and Almena. Weak Podzol to Gray-Brown Podzolic.
Steep stony land 26	A miscellaneous land unit including steep undifferentiated soils and rock outcrops or very stony areas.
Stronghurst 26	

Soil Series Name	Page in this Bulletin	General Characterization
Superior		Well drained sandy loams and loams un-
		derlain at 10 to 42 inches by calcareous red lake clay. Associated with Ontonagon. A <sub>0</sub> -A <sub>2</sub> -B-(C)-D. Podzol.
Suring	15	Moderately well to imperfectly drained sandy loams associated with Shawano and Granby. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Mottled below A <sub>1</sub> . Planosolic intergrade between Gray-Brown Podzolic and Humic-Gley.
Tama	27	Well drained deep dark acid silt loams developed from deep calcareous loess. A <sub>0</sub> -A <sub>1</sub> -B-C <sub>1</sub> -C <sub>2</sub> . Prairie (Brunizem).
Tell		Well drained, moderately deep silt loams underlain at 24–30 inches by outwash sand. Shallower than Betrand. Resembles but is over outwash. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-D. Gray-Brown Podzolic.
(Thornapple)		This soil is now called Omega, rolling phase.
(Thurston)		This soil was mapped in Columbia County as a Prairie analogue of what is now called McHenry, a Gray-Brown Podzolic.
Trenary		Sandy loams on loam till which is less dolomitic and more sandy than Onaway till, but more dolomitic and less sandy than Munising and Kennan. A <sub>0</sub> -A <sub>2</sub> -B-C. Podzol.
Trow	20	Imperfectly drained silt loams and loams 1 to 3 feet deep to Cambrian sandstone bedrock. Associated with Arland. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-D. Mottled below A <sub>1</sub> . Planosolic intergrade between Gray-Brown Podzolic, weak Podzol, and Humic-Gley.
Tuscola	17	Well drained silt loams and very fine sands formed on lake-laid fine sands, silts and calcareous pink clays. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C. Gray-Brown Podzolic.
Vesper	17	Very poorly drained acid fine sandy loams with thick A <sub>0</sub> and A <sub>1</sub> over Cambrian sandstone and shale. A <sub>0</sub> -A <sub>1</sub> -G-C. Humic-Gley.
Vilas	13, 16	Excessively drained sands developed from deep sandy outwash, level or hilly. A <sub>0</sub> -A <sub>2</sub> -B-C. Podzol.
(Wabash)		This soil is now called Lawson.
		Well drained loams over loam to sandy clay loam reddish brown acid till, which is intermediate in texture between the till of the Iron River and Hibbing soils. A <sub>0</sub> -A <sub>2</sub> -B-C. Podzol.

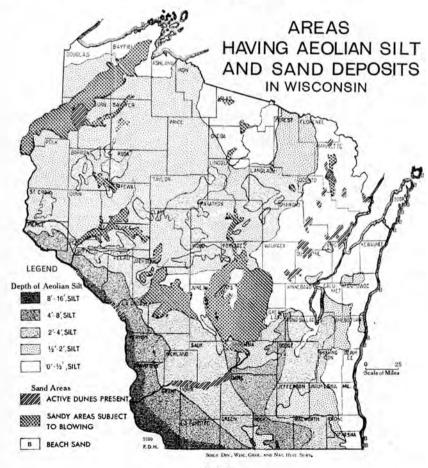
Soil Series Name	Bulletin	General Characterization
Wallace		Sands with thick ashy gray $A_2$ and cemented B formed on old dunes. $A_0$ - $A_2$ -B-C. Podzol, extremely developed.
Warman 20		Dark poorly drained silt loam, underlain at 2 to 4 feet by outwash gravel and sand. Associated with Antigo, Profile resembles that of Adolph. $A_0$ - $A_1$ - $G$ - $D$ . Humic-Gley.



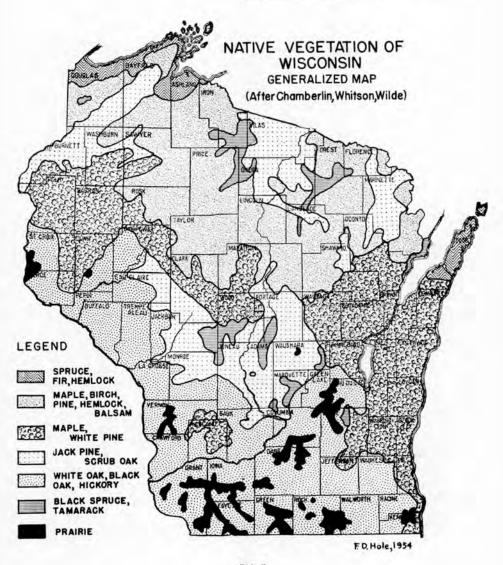
Soil Series Name	Page in this Bulletin	General Characterization
Warsaw	25	Well drained dark silt loam or loam, underlain at 1 to 3 feet by dolomitic outwash gravel. There is no " $B_3$ " as in the Fox. $A_0$ - $A_1$ -B-D profile. Brunizem.
Waukegan	25	Well drained dark silt loam underlain at 4 to 6 feet by dolomitic outwash sand. A <sub>0</sub> -A <sub>1</sub> -B-C profile. Brunizem.
(Waukesha)		This soil is now called Waukegan.



Soil Series Name Bulletin	General Characterization
Waupun 25	- Well drained dark silt loam developed from 3 to 4 feet of loess overlying dolo- mitic loam till, A <sub>0</sub> -A <sub>1</sub> -B-C profile. Brunizem analogue of Dane.
Wauseon	<ul> <li>Poorly drained sand underlain at 2 to 3 feet by lacustrine clays. Associated with Ottawa. A<sub>0</sub>-A<sub>1</sub>-G-D profile. Humic-Gley.</li> </ul>
Weare	Sands with moderately developed ashy-gray A <sub>2</sub> , and with slightly cemented B, formed on stable dunes. Intermediate between Bridgman and Wallace as to degree of profile development, A <sub>0</sub> -A <sub>2</sub> -B-C. Moderately developed Podzol.
(Webster)	This soil is now called Antigo.



Soil Series Name Page in this Bulletin	General Characterization
(Whitman)	This soil is now called alluvial soils, undifferentiated, poorly drained, in the Almena-Freer landscape.
Wyocena 17	Well drained acid sandy loam with sandy clay loam B over deep sandy till. Associated with Coloma. A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C profile. Gray-Brown Podzolic.



# B. DEFINITIONS OF SOME TERMS USED IN DESCRIBING SOIL PROFILES

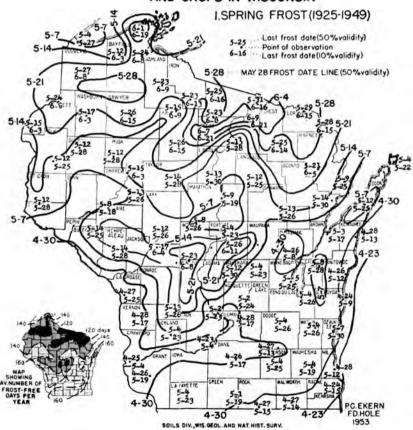
# (Quotations are from the Soil Survey Manual, U.S.D.A. Handbook #18)

1. Soil horizons defined briefly. "A soil horizon may be defined as a layer of soil, approximately parallel to the soil surface. . . ."

Ao\_\_\_\_\_\_\_"Organic debris partially decomposed or matted." Example:

Matted leaf litter on a forest floor.

# MAP SERIES SHOWING CLIMATIC INFLUENCES ON SOILS AND CROPS IN WISCONSIN



second layer of the A<sub>1</sub>. The A<sub>12b</sub> is an A<sub>12</sub> which has been buried by deposition of the layer above.

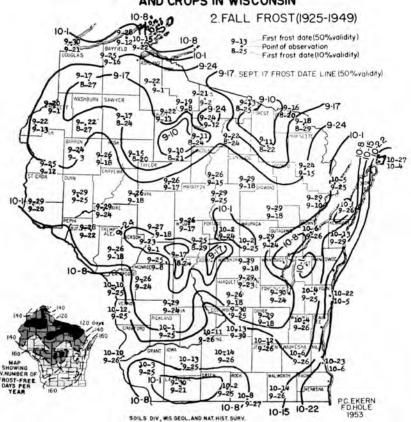
A2-----A "light-colored leached layer" above the B horizon.

B.\_\_\_\_Subsoil which is browner or more clayey or more blocky than the horizons above and below it. Example: Subsoil in a northern sandy forest soil, such as the Hiawatha. The B<sub>2</sub> is the central, most striking layer of the B horizon. The BD is a B horizon containing considerable material from the D.

C\_\_\_\_\_Unconsolidated soil material like that from which the overlying A and B horizons formed. Example: Sand below the B of the Hiawatha. The C<sub>1</sub> is the upper layer of the C, and the C<sub>2</sub> is a second, distinguishable layer of the C. The C<sub>ca</sub> is a C in which calicum carbonate has accumulated.

D\_\_\_\_\_Unconsolidated or solid rock or soil material which is different from that from which the overlying A and B horizons formed.

# MAP SERIES SHOWING CLIMATIC INFLUENCES ON SOILS AND CROPS IN WISCONSIN



- G-----Bluish-gray subsoil, splotched with yellow, in a water-logged soil or a recently drained soil. Example: Subsoil of a marsh-border soil like the Adolph.
- 1, 2, 3, 4\_\_\_Horizons in an organic soil. Example: Layers of muck and peat in the Carlisle muck.
- 2. Mottling defined. "The word 'mottled' means marked with spot of color." Example: Yellow spots of color in a bluish-gray G horizon.
- 3. Great Soil Groups briefly defined. Soils are classified into Great Soil Groups on the basis of general kinds of soil profiles and regional environments.

Examples:			Name of rep-
Horizons present	Important Features of original Environment	Name of Great Soil Group	resentative Soil Series
A <sub>00</sub> -A <sub>0</sub> -A <sub>2</sub> -B-C	Mixed coniferous and		
	deciduous forest on coarse textured material		
$A_{00}$ - $A_{0}$ - $A_{1}$ -B-C	_Same	Brown Podzolio	: Omega
$A_{00}$ - $A_{0}$ - $A_{2}$ - $B$ - $C_{ca}$ - $C_{}$	Mixed forest on medium		
	fine to fine textured -	Gray Wooded .	Ontonagon
	materials		
A <sub>00</sub> -A <sub>0</sub> -A <sub>1</sub> -A <sub>2</sub> -B-C	Deciduous forest	Gray-Brown Po	odzolicDane
$A_{00}$ - $A_{0}$ - $A_{11}$ - $A_{12}$ - $B$ - $C_{}$	Mixed forest on mate-		
	rial unusually high in		
	content of bases .	_Brown Forest -	Ahmeek
A <sub>11</sub> -A <sub>12</sub> -B-C	Prairie vegetation	Prairie (Bruniz	em) Parr
A <sub>11</sub> -A <sub>12</sub> -G-C	_Marsh border conditions	Humic-Gley	Elba
A <sub>11</sub> -A <sub>12b</sub> -A <sub>13b</sub>	_River flat, often flooded	Alluvial	Arenzville
A <sub>0</sub> -A <sub>1</sub> -C	_Steep, shallow soil	_Regosol	Rodman
	Level, imperfectly		
	drained upland	Planosol	

## C. DEFINITIONS OF SOME USEFUL SOIL SEQUENCES

Soil surveyors group soil series into sequences, several of which are described below briefly:

- 1. Textural sequence. A textural sequence consists of associated soil series arranged in order from coarse to fine textures. Examples are: Chetek-Omega-Onamia-Antigo; Rodman-Casco-Miami-Morley; Hiawatha-Marenisco-Gobebic-Wakefield-Hibbing; Plainfield-Alvin-Tell-Bertrand-Medary.
- 2. Natural drainage sequence. A natural drainage sequence or catena consists of associated soil series arranged in order from very well drained to very poorly drained conditions. Examples are: Otterholt-Spencer-Almena-Auburndale-Adolph; Antigo-Brill-Poskin-Warman; Dane-Calamus-Clyman-Elba; Waupun-Corwin-Bristol-Elba.
- 3. Developmental sequence. A developmental sequence consists of associated soil series arranged in order from those with minimal B development to those with maximal B development. Examples are: Omega-Vilas-Au Train; Bridgman-Weare-Wallace; Vilas-Hiawatha-Strongs; Arenzville-Chaseburg-Fayette.
- 4. Lithologic sequence. A lithologic sequence consists of associated soil series arranged in order of increasing content of a particular parent material. Increase in content of dolomite in the parent material is illustrated by the sequence: Kennan-Trenary-Onaway. Increase in content of red clay in the parent material is shown in the sequence: Dodge-Onaway-Kewaunee.

- 5. Depth sequence. A depth sequence consists of associated soil series arranged in order from those with minimum depth to a particular substratum, to those with maximum depth to the substratum. Examples are: Milaca-Santiago-Otterholt; Dubuque-Deep Dubuque-Fayette; Miami-Dodge-Dane; Alvin-Tell-Bertrand.
- 6. Great Soil Group sequence. A Great Soil Group sequence consists of associated soil series arranged in order from those of one Great Soil Group through a transition to another Great Soil Group. From Gray-Brown Podzolic to Brunizem (Prairie), representative sequences are: Fayette-Downs-Tama; Morley-Beecher-Elliott.

### D. SAMPLE DETAILED SOIL PROFILE DESCRIPTION

#### Au Train Series

This series includes maximal Podzols developed on glacial outwash sands in the Northern Lake States. These soils differ from the associated Vilas soil by having an ortstein instead of an orterde, and from the Saugatuck in being free from mottling.

Soil Profile. Au Train loamy sand. (SE 1/4, NE 1/4, Sec. 33, T.47 N., R. 1 W., Iron County, Wisconsin.)

A<sub>0</sub> 2-0" Very dark gray and dark brown (5YR 3/1 and 3/2 moist) forest litter and organic mat. pH 4.5. 1-4" thick.

A<sub>2</sub> 0- 6" Light reddish brown (5YR 6/3, moist), loose loamy sand; single grain structure; abrupt wavy lower boundary. pH 5.0. 3-9" thick.

B<sub>21</sub> 6-9" Dark reddish brown (5YR 3/3, moist) weakly cemented loamy sand; clear wavy lower boundary. pH. 5.0. 2-5" thick.

B<sub>22</sub> 9-16" Dark brown (7.5YR 4/4, moist) weakly cemented loamy sand; gradual wavy lower boundary. pH. 5.5. 4-10" thick.

B<sub>1</sub> 16-36" Strong brown (7.5YR 5/6, moist) weakly cemented loamy sand; clear wavy lower boundary. pH 5.5. 15-24" thick.

Ca 36-48" Reddish brown (5YR 4/4, moist) loose loamy sand; single grain; clear lower boundary. pH 5.5. 10-20" thick.

C<sub>2</sub> 48" + Light reddish brown (5YR 6/3, moist) loose, coarse sand; single grain, pH 5.0.

Range in Characteristics: There is considerable range, as indicated, in thickness of horizons. The degree of cementation of the B<sub>2</sub> horizon varies from weakly cemented to indurated.

Topography: Level to undulating glacial outwash plains and terraces.

Drainage: Well-drained. Runoff is slow and internal drainage is rapid.

Vegetation: The original forest of white and red pine, balsam fir, hard maple, yellow birch and other hardwoods has largely been removed. The invasion or introduction of grasses is producing an A<sub>1</sub> horizon in many bodies of Au Train.

Use: Most of the soil bodies are in cut-over timber land. Some bodies of Au Train are being used for pasture and crops.

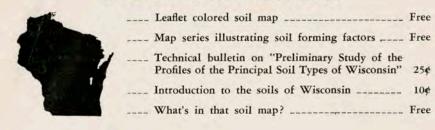
Distribution: Northern Wisconsin and Michigan.

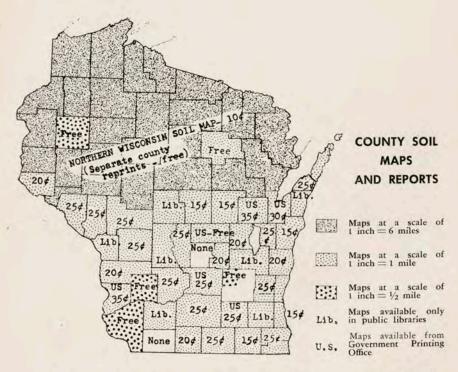
Type Location: Ontonagon County, Michigan. Series established: Alger County, Michigan, 1939. Source of name: Village in Alger County, Michigan.

Note: Soil color names according to Munsell notations.

Soil Survey Div., Wisconsin Geological and Natural History Survey

### WISCONSIN SOIL MAPS AND REPORTS





Requisitions and payments for soil survey publications are handled by: Secretary, Soils Department, University of Wisconsin, 203 Soils Building, Madison 6, Wisconsin.

\* \* \* \*

#### **ACKNOWLEDGEMENT**

Grateful acknowledgement is made to G. F. Hanson, R. J. Muckenhirn, O. J. Attoe, R. D. Sale, William DeYoung and W. H. Negley for their suggestions and encouragement, and to Margaret Stitgen for her assistance in preparing this bulletin.