

UNITED STATES DEPARTMENT OF AGRICULTURE



FROM THE  
**GROUND  
DOWN**

An Introduction to Iowa Soil Surveys

NATURAL RESOURCES CONSERVATION SERVICE



# An Introduction to Iowa Soil Surveys

FROM THE  
GROUND  
DOWN



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*Helping People Help the Land  
in Iowa*



# Just a bunch of dirt?

You couldn't be more wrong.

Like snowflakes, no two soils are exactly the same. Each different kind of soil is called a series. These soil series are named for towns or local landmarks. For example, Clarion soils are named for the town of the same name located in north-central Iowa. More than 10,000 soil series have been named and described in the United States, and more are defined each year. There are about 479 soil series in Iowa.

Much of our life's activities and pursuits are influenced by the soil beneath our houses, roads, sewage systems, airports, parks, recreational sites, farms, forests, schools and shopping centers. What is put on the land should be guided by the soil that is beneath it. A soil's behavior, once known, is true for that type of soil no matter where the soil is located. Different soils, with great differences in properties, can occur within the same subdivision or field.

The mission of the Iowa Cooperative Soil Survey is to continue developing science-based soil system information, customized to meet users' needs for natural resources management.

A soil survey has text, tables and soil maps that help land users identify the potentials and limitations of soils. Soil surveys are prepared by soil scientists, who recognize and record the





properties of the soil and predict soil behavior for a host of uses. These predictions, called soil interpretations, are developed to help users of soils manage the resource. Soil surveys of each Iowa county are available in three formats: as publications, on CDs, and online.

The publications represent a snapshot in time. They contain information that was current at the time of printing. But the text, tables and soil maps may have been updated since publication. The most current information about the soil survey program in Iowa is available at [www.ia.nrcs.usda.gov/soils.html](http://www.ia.nrcs.usda.gov/soils.html).

The Natural Resources Conservation Service (NRCS) also has several web sites devoted to the soil survey program on a national basis. The primary one is <http://websoilsurvey.nrcs.usda.gov/app/>.

To gather information for a soil survey, soil scientists walk the landscapes, dig holes with soil augers, shovels and probes, and examine cross-sections of soil profiles. They observe soil textures (the ratio of sand, silt and clay), soil color, structure and thickness of the different soil horizons. These and many other soil properties are studied in the field, while others are deter-

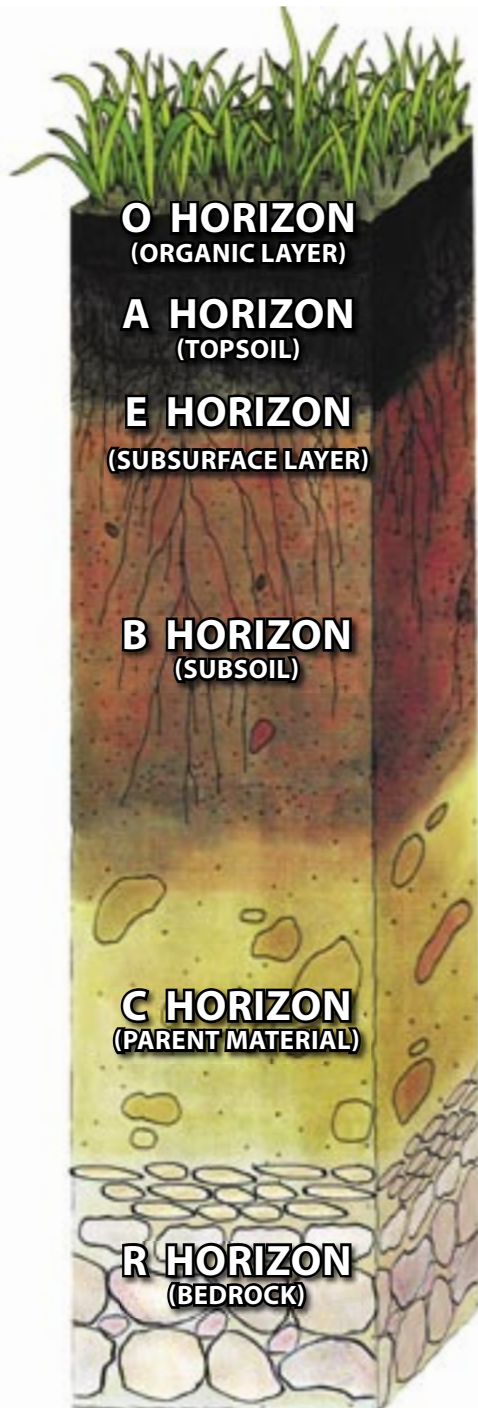
mined through laboratory tests. The intent of this publication is to acquaint users and potential users of soil survey reports with the content of those reports, and to help them extract useful soils data. To be proficient in using soil survey data, it is imperative that users have a basic understanding of the concepts of soil development and of soil-landscape relationships. These topics are covered briefly in the next two sections of this guide.

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*Photo: NRCS soil scientist Rick Bednarek (right) evaluates a soil probe drawn from a continuous no-till field in Adair County with former District Conservationist Marvin Lundstedt.*

# Soil Horizons

Soils develop in layers. These layers, called horizons, can be seen where roads have been cut through hills and other areas where the soil is exposed. The presence and thickness of each horizon varies with location. Under disturbed conditions, such as intensive agriculture, building sites, or where there is severe erosion, some horizons may not be present. The photos on Page 6 are profiles of Iowa soils with visible horizons labeled.



## O Horizon

O horizons are present in soils that have significant amounts of decomposed plant and animal materials at the soil surface. The layer is black in color, and is most commonly present in shallow, depressional areas of north-central Iowa. Because of the high levels of organic content, O horizons feel much lighter than mineral horizons.

## A Horizon

All soils have an A horizon. It is the layer of mineral soil at the soil surface or immediately below the O horizon. Commonly referred to as topsoil, the A horizon is typically darker and more fertile than lower horizons.

## E Horizon

Soils in eastern Iowa that formed under forest vegetation commonly have a subsurface layer called an E horizon. Soil in the E horizon is silty and light colored. As water moves through this horizon, soluble minerals, such as iron, are leached to lower horizons. This horizon will usually have less clay than the horizons above and below.

## B Horizon

Most soils have a B horizon, where soil development has taken place since the original soil parent

material was formed. B horizons are lighter colored than the organically enriched A and O horizons and have developed good soil structure. The B horizon typically has more clay and different soil pH than the layers directly above and below.

## C Horizon

The C horizon is the undeveloped material from which the soil is formed. It is also called soil parent material. Common parent materials in Iowa include **glacial till**, which is the material left by glaciers that passed through the state tens of thousands of years ago; wind blown material called **loess**; and water deposited material from flooding events called **alluvium**. The C horizon is usually deep in the soil profile, but can also be near the soil surface where soils have not been able to develop, such as on the Missouri or Mississippi River bluffs.

## R Horizon

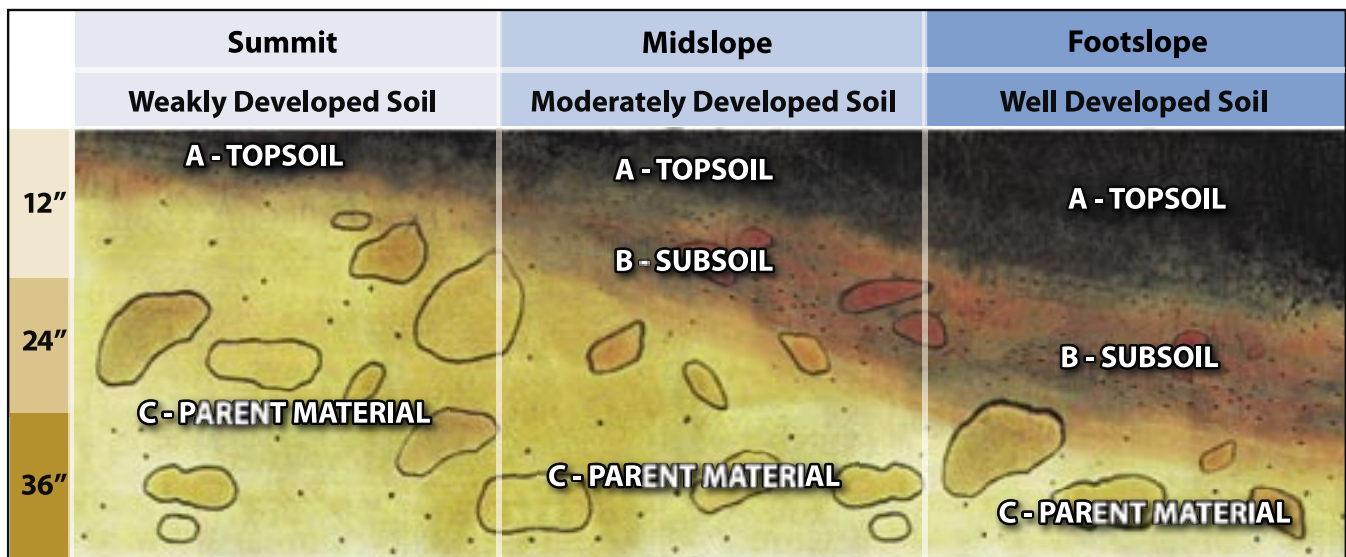
The lowest horizon, R horizon, is bedrock. In Iowa, this horizon is typically very deep. However, there are areas in northeast Iowa where the bedrock plateau was so high that the glaciers could not pass over the bedrock, and in central Iowa where bedrock is exposed due to geologic erosion.



# Iowa Soil Horizons



- A. Colo soil is found in bottomlands throughout Iowa. The topsoil (A Horizon) is one meter or more thick due to the low lying landscape position.
- B. Sperry soil is found in southern Iowa. The subsurface layer (E Horizon) in this model has been stripped of organic coatings through frequent wetting and drying, and appears bleached.
- C. Clarion soil occurs in north-central Iowa. Soils in this region of the state were formed from glacial deposits where stones and rocks are common in the parent material (C Horizon).
- D. Tama soil occurs in eastern Iowa and has been designated as Iowa's State Soil. It formed under prairie vegetation that resulted in a thick topsoil (A Horizon) and a well-developed subsoil (B Horizon). The parent material (C Horizon) has wind deposited sediments, called loess.
- E. Racine soil occurs in northeast Iowa. It formed under oak-savannah vegetation. The parent material (C Horizon) was the result of significant geologic erosion.
- F. Allamakee soil formed in eastern Iowa under forest vegetation. The surface layer (A Horizon) is much thinner in forested soils than in prairie soils. Most of the organic matter is stored in trees, as opposed to being stored in many fine roots of grasses.



# How Soil Develops

The three boxes in the diagram represent either a soil in the same spot at different times in history or a soil at three different points on a hill slope. During that time, climate, living organisms and topography changed the soil. Notice in this example how the parent material is broken down, and the soil's structure changes from weakly developed to well-developed. Not all soils undergo this exact type of change, and the time for change differs with location. These differences occur because the climate differs from one location to another, as do the number and types of organisms living in the soil.

## Parent Material

Parent material (C Horizon) consists of the loosely arranged mineral and organic matter from which soils are developed. Parent material can be ash from volcanoes, sediments moved and

deposited by wind and water, or sand and rock deposited by glaciers. Broken down bedrock is another example of parent material. In Iowa, Alluvial soils deposited by water are the youngest and least developed.

## Climate

Climate helps change parent material into subsoil, subsurface soil and topsoil. Freezing, thawing, wetting and drying breaks parent material apart. Rain dissolves some minerals and transports them deeper into the soil. Soils in northwest Iowa develop slower because it is drier and cooler than other parts of the state.

## Living Organisms

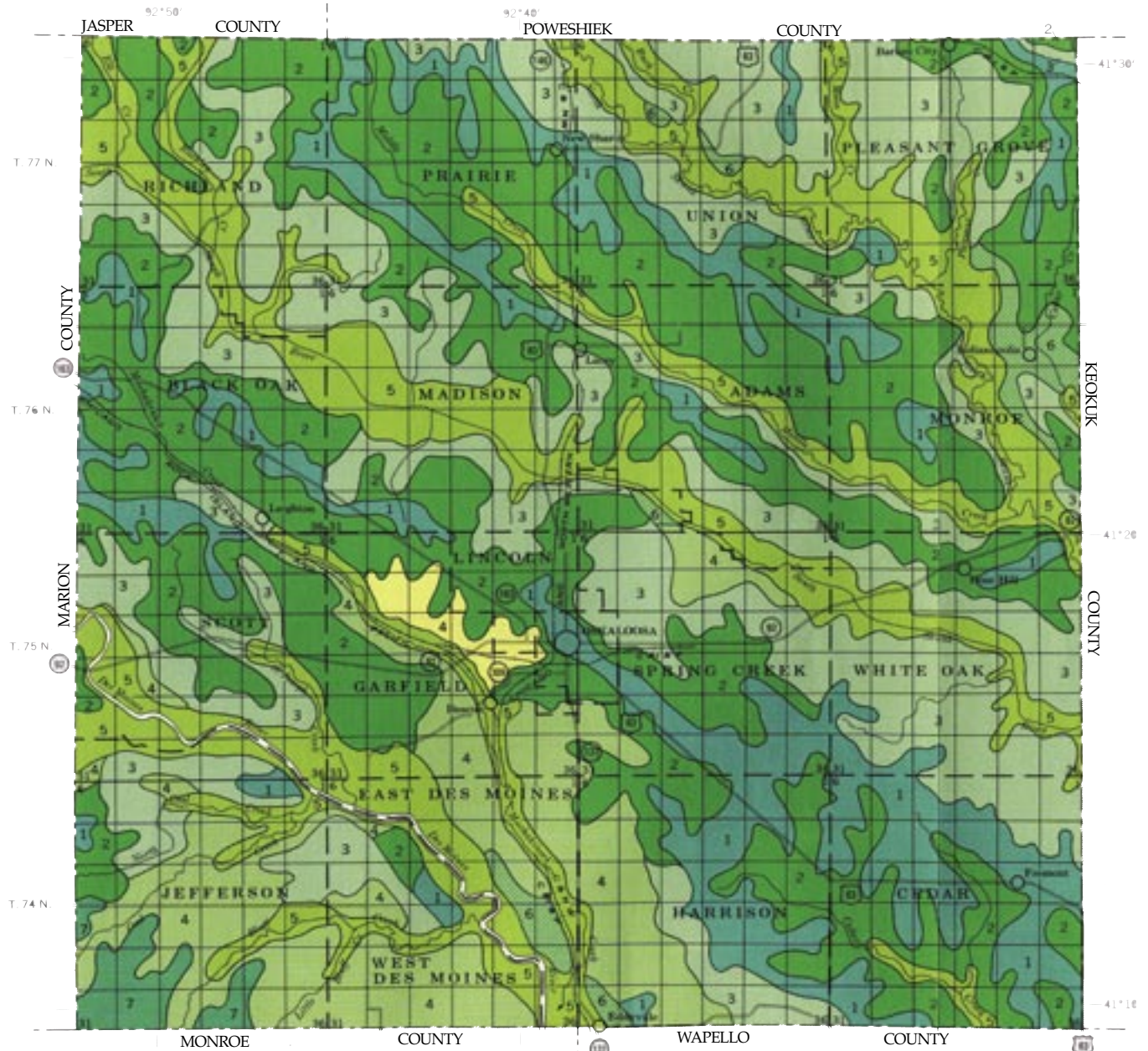
Plants and animals change the weathered parent material into subsoil and topsoil. Leaves, twigs, stems and bark from plants fall onto the soil, and are broken down by fungi, bacteria, insects and other animals that live in

the soil. Insects and earthworms burrowing through the soil eat and break down organic matter and minerals into simpler compounds. Plants and animals help make the soil rich in nutrients as they die and decay. Living organisms are directly related to the amount of vegetation produced, which is directly related to soil moisture.

## Topography

Topography refers to the lay of the land. Steeper slopes may have eroded topsoil, exposing subsoil or parent material. This makes the soil look like the weakly developed soil in the diagram (above). Steeper slopes take longer to develop because moisture runs off the slope instead of infiltrating the soil. Soils in low areas and depressions tend to be wetter and more developed. In contrast, soils in more sloping areas tend to be drier and less developed.





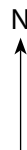
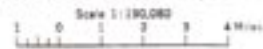
**SOIL ASSOCIATIONS**

- 1** Mahaska-Tainter association: Nearly level and gently sloping, somewhat poorly drained and poorly drained soils that have a subsoil of silty clay loam or silty clay; on uplands
- 2** Otley-Ladega-Nira association: Gently sloping to strongly sloping, moderately well drained soils that have a subsoil of silty clay loam; on uplands
- 3** Clinton-Linley-Gara association: Gently sloping to steep, well drained and moderately well drained soils that have a subsoil of silty clay loam or clay loam; on uplands
- 4** Ladega-Clinton-Gaspert association: Gently sloping to steep, moderately well drained soils that have a subsoil of silty clay loam or silty clay; on uplands
- 5** Cole-Nodaway-Zeak association: Nearly level and gently sloping, poorly drained to moderately well drained soils that are dominantly silty clay loam and silt loam throughout or that have a subsoil of silty clay loam or silty clay; on bottom lands
- 6** Clinton-Chelsea association: Moderately sloping to steep, moderately well drained and excessively drained soils that have a subsoil of silty clay loam or that are leamy fine sand and fine sand throughout; on uplands
- 7** Pershing-Grundy-Haig association: Moderately sloping to nearly level, moderately well drained to poorly drained soils that have a subsoil of silty clay and silty clay loam; on uplands

Compiled 1975

U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE  
IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION  
COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY  
DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

**GENERAL SOIL MAP  
MAHASKA COUNTY, IOWA**



**SECTIONALIZED  
TOWNSHIP**

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



# General Soil Maps

A General Soil Map is a small-scale map of the survey area. It is color-coded to show major soil associations. Descriptions of each of the soil associations are near the front of the soil survey report. This section of the report is labeled **General Soil Map Units** in the Table of Contents of a Soil Survey. A map of Iowa Soil Regions is also available online at [www.ia.nrcs.usda.gov/soils.html](http://www.ia.nrcs.usda.gov/soils.html).

Each color-coded area on the General Soil Map has a corresponding description. In the example General Soil Map of Mahaska County (Page 8), the area coded 7 and shaded

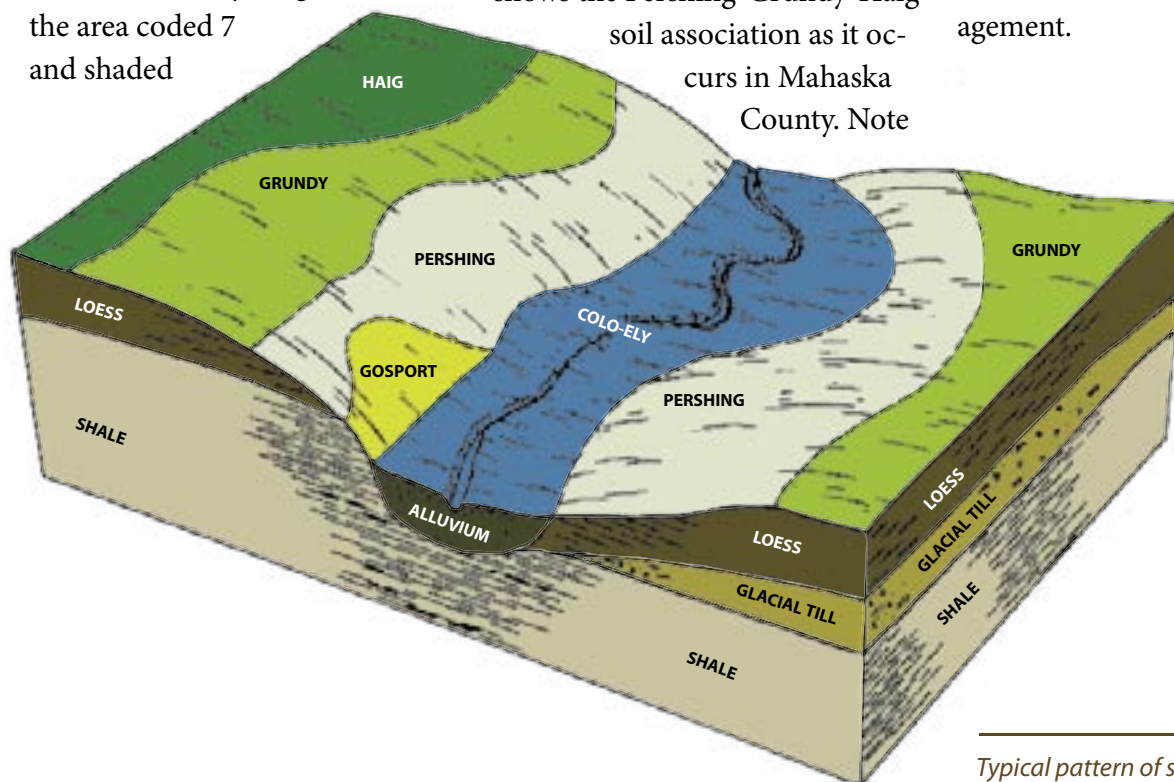
green designates the Pershing-Grundy-Haig soil association. As the name of the map implies, Pershing, Grundy and Haig are the major soils that occupy the landscapes of this section of Mahaska County. Likewise, the description of soil association 7 gives general information about this section of the county.

Iowa soil survey reports contain a number of three-dimensional drawings, called block diagrams, depicting the relationships of soils, parent material and topography for the major soil associations. The illustration below shows the Pershing-Grundy-Haig soil association as it occurs in Mahaska County. Note

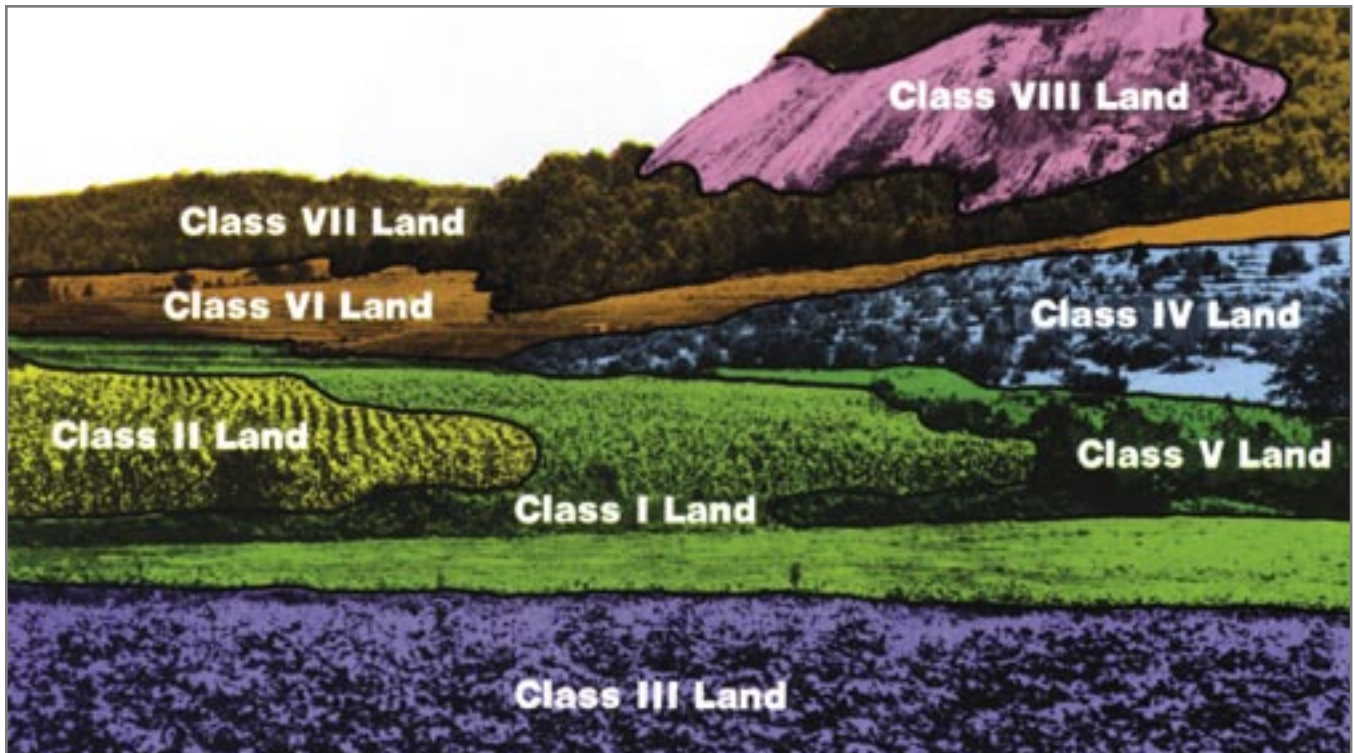
the relationship of parent material (loess, glacial till, shale and alluvium) and the topography to the different soils. Refer to the **How Soil Develops** section of this guide (Page 7) for additional insights on these relationships.

The General Soil Map can be used to compare the suitability of large areas for general land uses. Because of the small scale, it is not intended to be used to make management decisions on specific sites. Soils within a soil association may vary greatly in slope, depth, drainage and other characteristics that affect management.

soil association as it occurs in Mahaska County. Note



*Typical pattern of soils and parent material in the Pershing-Grundy-Haig soil association.*



Natural Resources Conservation Service photo illustration

## Soil Capability Classes

Each soil is grouped by capability class, and in most cases by subclass. These groupings reveal the suitability of soils for field crops and pasture, and indicate associated risks and responses to conservation treatment and management.

There are eight capability classes, which represent progressively greater limitations and narrower choices for practical land use. These classes are designated by Roman numerals I through VIII.

### Classes:

- I** - have few limitations that restrict their use. Class I has no subclasses because these soils have few limitations.
- II** - have moderate limitations that restrict the choice of plants or that require moderate conservation practices.
- III** - have severe limitations that reduce the choices of plants or

- that require special conservation practices, or both.
- IV** - have very severe limitations that reduce the choice of plants or that require very careful management, or both.
- V** - are not likely to erode but have other limitations, impractical to remove, that limit their use.

- VI** - have severe limitations that make them generally unsuitable for cultivation.
- VII** - have very severe limitations that make them unsuitable for cultivation.
- VIII** - soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are noted with an “e,” “w” or “s” following the capability class numbers. For example, in 2e, the “e” indicates the soil is erosive. A “w” would signify a wetness limitation. An “s” would denote a shallow, droughty or stony soil.



## How To Use Soil Capability Classes

On the whole, producers make rational use of their farmland. Almost all United States land in Capability Class I—with soils that are level, deep, well-drained and easy to work—is used to grow crops. The more extensive capability classes of II and III comprise the majority of cultivated cropland, although that land generally requires conservation measures.

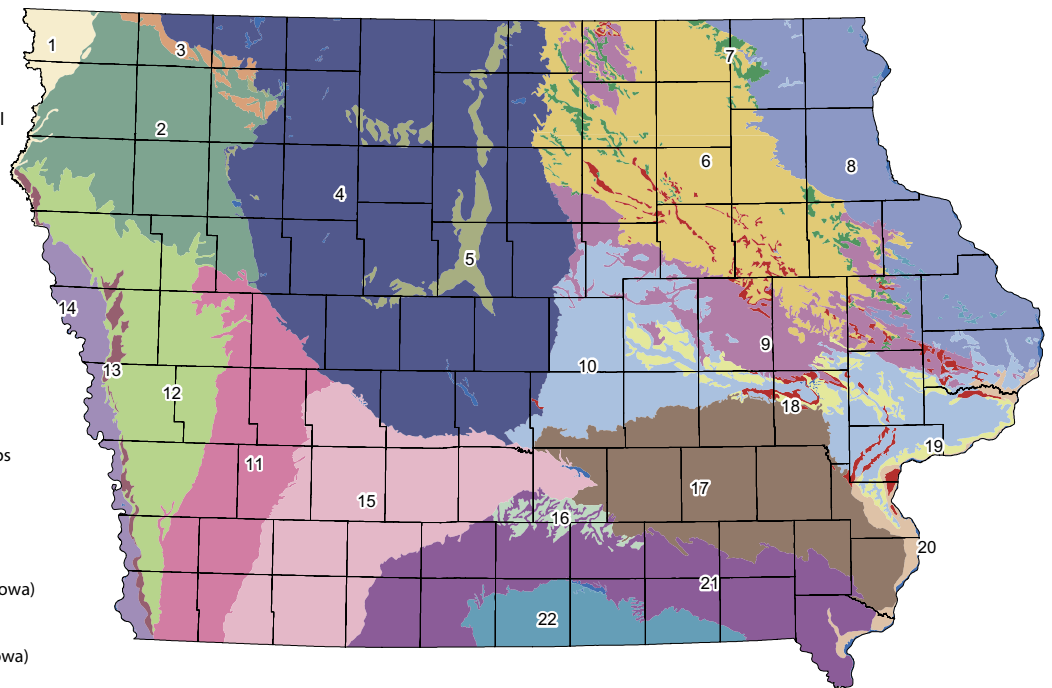
Most of Iowa’s land is very well suited to cropland. More than 84 percent of the state’s 36 million acres are in Class I, II or III, and only 8 percent is in Class VI, VII or VIII.

More than two-thirds of Iowa is cultivated cropland, and there is an additional 1 million acres that is in non-cultivated hay or horticultural crops. About 3.5 million acres are grazed pastures and a little more than 2 million acres in Iowa are forested.

# Iowa Soil Regions Map

### Legend

-  Iowa Counties
- Soil Regions**
-  1 Semi Arid Loess over Glacial Till
-  2 Loess (NW Iowa)
-  3 Tazewell Glacial Till
-  4 Loamy Wisconsin Glacial Till
-  5 Clayey Lacustrine Deposits
-  6 Loamy Glacial Till
-  7 Shallow to Bedrock
-  8 Loess with Bedrock Outcrops
-  9 Shallow Loess over Glacial Till
-  10 Loess Ridges and Sideslopes
-  11 Loess with Glacial Till Outcrops
-  12 Deep Loess
-  13 Missouri River Bluffs
-  14 Missouri River Alluvium
-  15 Loess Ridges/Glacial Till (SW Iowa)
-  16 Loess, Shale, and Glacial Till
-  17 Loess Ridges/Glacial Till (SE Iowa)
-  18 Eolian Sand
-  19 Loess (Timbered)
-  20 Alluvium
-  21 Loess Ridges/Glacial Till Sideslopes
-  22 Loess Ridges/Clay Paleosol
-  23 Water



The 479 soil types that are currently used in Iowa can be subdivided into 22 unique geologic regions that were formed thousands of years ago as geologic processes shaped the Iowa we recognize today. For more information about Iowa’s soil regions, visit [www.ia.nrcs.usda.gov/soils.html](http://www.ia.nrcs.usda.gov/soils.html).

# Soil Properties

All soils possess properties that impact their suitability for specific uses. Although some properties, such as slope, may be altered to some extent to make a site more suitable, it is usually impractical to modify these properties extensively. Following is a list of major soil properties that affect the suitability of soils for a number of specific uses. The table on Page 15 provides examples of various land uses that are affected by specific soil properties.

## Texture

Soil particles vary in size. From coarsest to finest, they are sand, silt or clay. The percentage of each in any given soil determines its texture.

Texture is an important soil property because it is closely related to many aspects of soil behavior. It influences ease of tillage and root development. It also affects the availability of nutrients in the soil, the amount of water that a soil will hold and how water moves through the soil.

Sand causes little restriction of air, water and root movement through the soil, whereas clay often reduces movement.



*Relative sizes of sand, silt and clay*

## Structure

Two soils with the same texture may have distinctly different physical properties because of the arrangement of soil particles. This arrangement is called soil structure. Soil structure forms when individual grains of sand, silt and clay are bound together physically or chemically. Plant roots, organic matter and clay particles all provide physical and chemical binding agents. These bound particles form larger units called peds. A ped is a single unit of soil structure. The shapes of peds, which range in size, determine the structure type

(granular, platy, blocky or prismatic).

Soil structure is constantly changing. Although the process is too slow for you to notice, a soil's structure becomes stronger and more distinct over time.

## Color

Color is one of the most noticeable soil properties. Color is affected by organic matter content, climate, soil drainage and minerals. Most soil minerals are naturally white or light gray. However, humus and iron compounds change the outer color of the soil particles much like a coat of paint.

Soil color gives clues about the nature of the root zone, which is the normal depth that roots penetrate into the soil. Dark colors reflect favorable amounts of humus. Gray colors suggest wetness. Brown and red colors indicate favorable air-water relationships.

## Depth to High Water Table

A saturated soil layer, or water table, will fluctuate throughout the year. How high the water table rises, and how long it stays at that



level, will affect the use of the soil.

## Depth to Bedrock

Bedrock is the solid rock under the soil and parent material. Sometimes it is exposed at the surface. The depth from the soil surface to bedrock influences the soil's potential and limitations.

### Depth Classes

#### Very Shallow:

less than 10 inches to bedrock

#### Shallow:

10 to 20 inches to bedrock

#### Moderately Deep:

20 to 40 inches to bedrock

#### Deep:

40 to 60 inches to bedrock

#### Very Deep:

More than 60 inches to bedrock

## Permeability and Saturated Hydraulic Conductivity

Permeability and Saturated Hydraulic Conductivity both refer to how easily water moves through soil. Water movement is influenced by texture, structure, compaction and the presence or absence of cementing agents.



*Iowa NRCS Soil Scientist Dale Ceolla examines Tama soil, Iowa's state soil.*

Permeability is measured as the inches per hour that water moves downward and laterally through saturated soil. (See the illustration at the bottom of this page.)

Saturated hydraulic conductivity is the measurement of this movement of water through the soil. It is measured in micrometers per second.

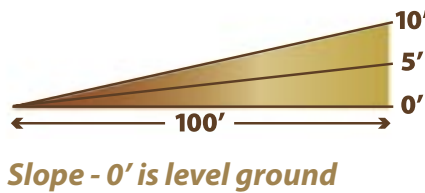
### Rock Fragments

The number of rock fragments on the surface and the percentage of fragments in the soil profile are important to land-use

planning. Excessive rock fragments reduce the available water capacity of the soil.

### Slope

Perfectly level land has a slope of 0 percent. All other land rises or falls to some degree. Slope is an important factor, and impacts water erosion and surface drainage.



### Available Water Capacity

Available Water Capacity is a measure of how much water a soil can store for use by plants. The Available Water Capacity is influenced by soil texture, organic matter content and pore space. It is measured in inches of water per inch of soil.

### Flooding and Ponding

Periodic floodwater from overflowing streams or runoff from nearby slopes makes sites risky for some uses. If floodwaters persist, they may delay planting and harvesting.

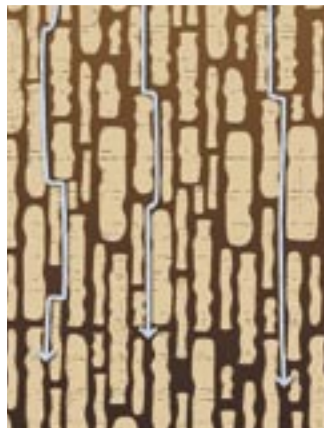
## Permeability and Saturated Hydraulic Conductivity- How Water Moves Through Soil



*Granular*



*Subangular Blocky*



*Columnar or Prismatic*



*Platy (closely resembles clay and compacted soils)*

(SOIL STRUCTURE TYPES)



# Soil Property – Land Use Table

**X** Indicates a particular land use that could be affected by a specific soil property.

		S O I L P R O P E R T Y								
		Wetness	Permeability	Depth to Bedrock	Slope	Surface Texture	Sub-surface Texture	Small Stones	Large Stones	Flooding
S E L E C T E D L A N D U S E	Tank Absorption Fields	X	X	X	X		X		X	X
	Sanitary Landfill (Trench)	X	X	X	X		X		X	X
	Sanitary Landfill (Area)	X	X		X					X
	Dwellings Without Basements	X		X	X	X	X		X	X
	Dwellings With Basements	X		X	X		X		X	X
	Small Commercial Buildings	X		X	X		X		X	X
	Local Roads and Streets	X		X	X	X	X		X	X
	Lawns and Landscaping	X		X	X	X		X	X	X
	Camp Areas	X	X		X	X		X	X	X
	Picnic Areas	X			X	X		X	X	X
	Playgrounds	X	X	X	X	X		X	X	X
	Paths and Trails	X			X	X		X	X	X
	Golf Fairways	X		X	X	X		X	X	X

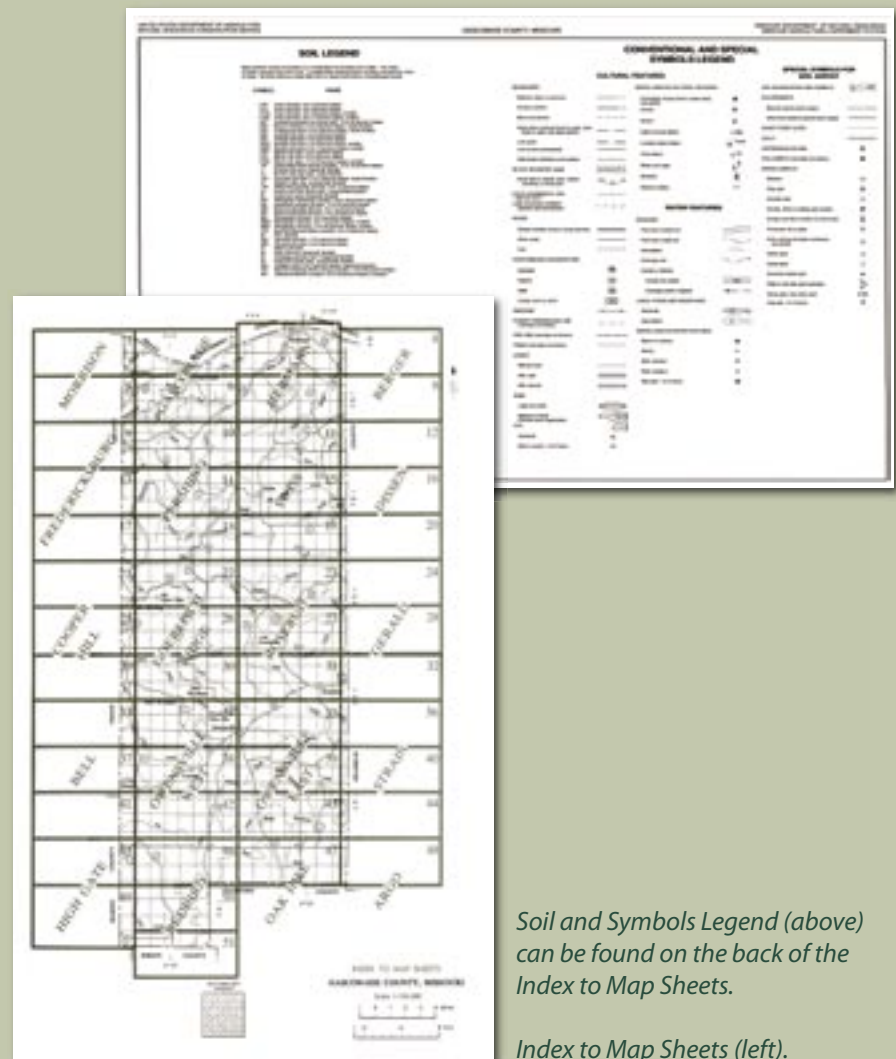
# Using Soil Maps

The General Soil Map, Index to Map Sheets and Detailed Soil Map Sheets are located at the back of the soil survey, or as separate maps in a folder. To obtain information about a particular plot of land, locate the area on the Index to Map Sheets, select the appropriate map sheet number, and locate the map sheet. Map sheets are in numerical order in the soil survey. Then locate a specific parcel of land on the map sheet by noting imagery or section numbers, roads, streams and towns.

The symbols on the map sheets are listed on the back of the Index to Map Sheets with the names of each soil that they represent. You can obtain detailed information about each soil area of interest by referring to the map unit description located in the text or interpretive tables located in the back of the soil survey publication. The map unit description or tables can be located easily by using the Table of Contents in the front of the publication.

Individual soil symbols on the soil maps may contain more than one soil. They generally include areas of similar soils, and possibly small areas of contrasting soils. The composition of soils is explained in each

map unit description. The soil maps provide sufficient information for developing resource plans, but an onsite investigation should be conducted to plan intensive uses in small areas.



*Soil and Symbols Legend (above) can be found on the back of the Index to Map Sheets.*

*Index to Map Sheets (left).*



# Locating Information

Every soil type has dozens of specific soil properties and interpretations that aid users in making decisions on the land. These properties and interpretations are listed by soil map unit number in various tables located throughout the soil survey report or online at: <http://soildatamart.nrcs.usda.gov/Survey.aspx?State=IA>.

Below is a list of tables and specific information they contain that are available in most soil survey reports.

## Tables

### Temperature and Precipitation

average daily minimum and maximum temperatures, growing degree days, snowfall, spring and fall freeze dates, length of growing season

### Cropland Management

#### Considerations

cropping considerations for each type such as 'acid soil', 'excessive permeability', or 'water erosion'

### Crop and Pasture Yield Tables

crop and pasture yields, land capability class, subsoil potassium and phosphorus levels

### Prime Farmland Lists

includes additional lands of state-wide and local importance

### Windbreaks and Environmental Plantings, Forestland

#### Productivity

specific trees that are suitable for each soil type and the height they will grow in 20 years, site index and volume of wood fiber is also available in areas where there are forests

### Recreational Development

soil suitability for camp areas, picnic areas, playgrounds, paths and trails, motorcycle trails, and golf fairways

### Wildlife Habitat

openland wildlife, woodland wildlife and wetland wildlife suitability

### Building Site Development

soil suitability for dwelling with or without basements, small commercial buildings, local roads and streets, shallow excavations and lawns and landscaping

### Sanitary Facilities

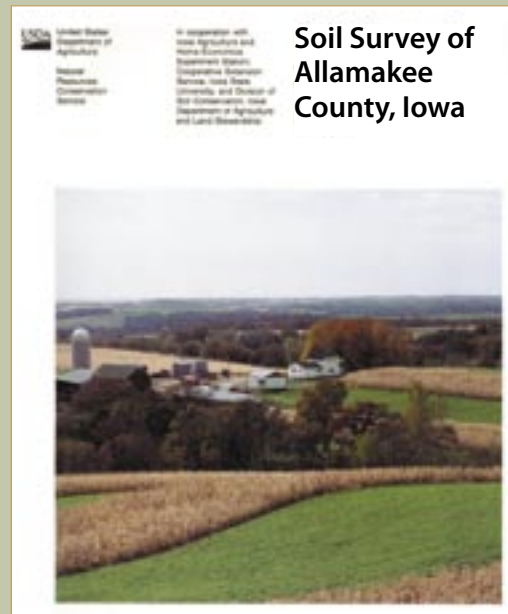
soil considerations for septic tank absorption fields, sewage lagoons and landfills

### Construction Materials

soils as a potential source of gravel, sand, topsoil, roadfill or reclamation material

### Water Management

soil suitability for ponds, embankments, dikes and levees



### Agricultural Waste Management

soil suitability for the application of manure or sewage sludge or for wastewater treatment

### Engineering Index Properties

Unified and AASHTO classifications, rock fragments, percent passing sieves, liquid limit and plasticity index

### Physical Properties of the Soil

soil bulk density, clay content, available water capacity, shrink-swell potential, organic matter content, erosion factors

### Chemical Properties of the Soil

cation exchange capacity, soil pH, calcium carbonate content

### Water Features

depth to saturated soil for each month, frequency and duration of ponding and flooding for each month for each soil type

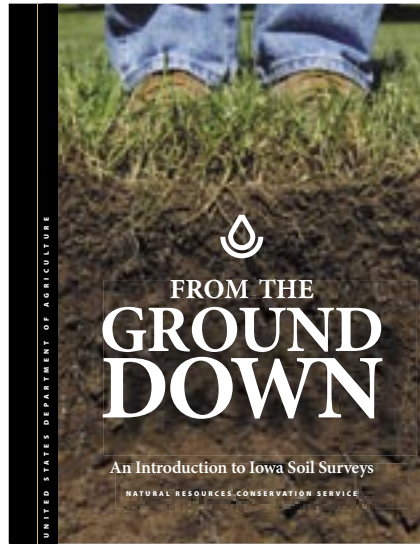
### Soil Features

depth to bedrock, potential for soil subsidence and frost heaving, risk of corrosion to steel and concrete

Soil interpretations are constantly being developed and tested. The Department of Homeland Security uses soil maps to determine suitable sites for animal burial and composting, or to identify soils that can sequester radioactive materials. The Department of Defense looks at soil surveys to determine areas vehicle trafficability, helicopter landing areas, and even strategic fighting positions.







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*For questions about information contained in this publication or in specific soil surveys,  
contact the Iowa NRCS Soils Staff at the above address, or phone (515) 284-4135.*

*For information about NRCS and its programs in Iowa,  
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