Minnesota Department of Natural Resources
Division of Lands and Minerals
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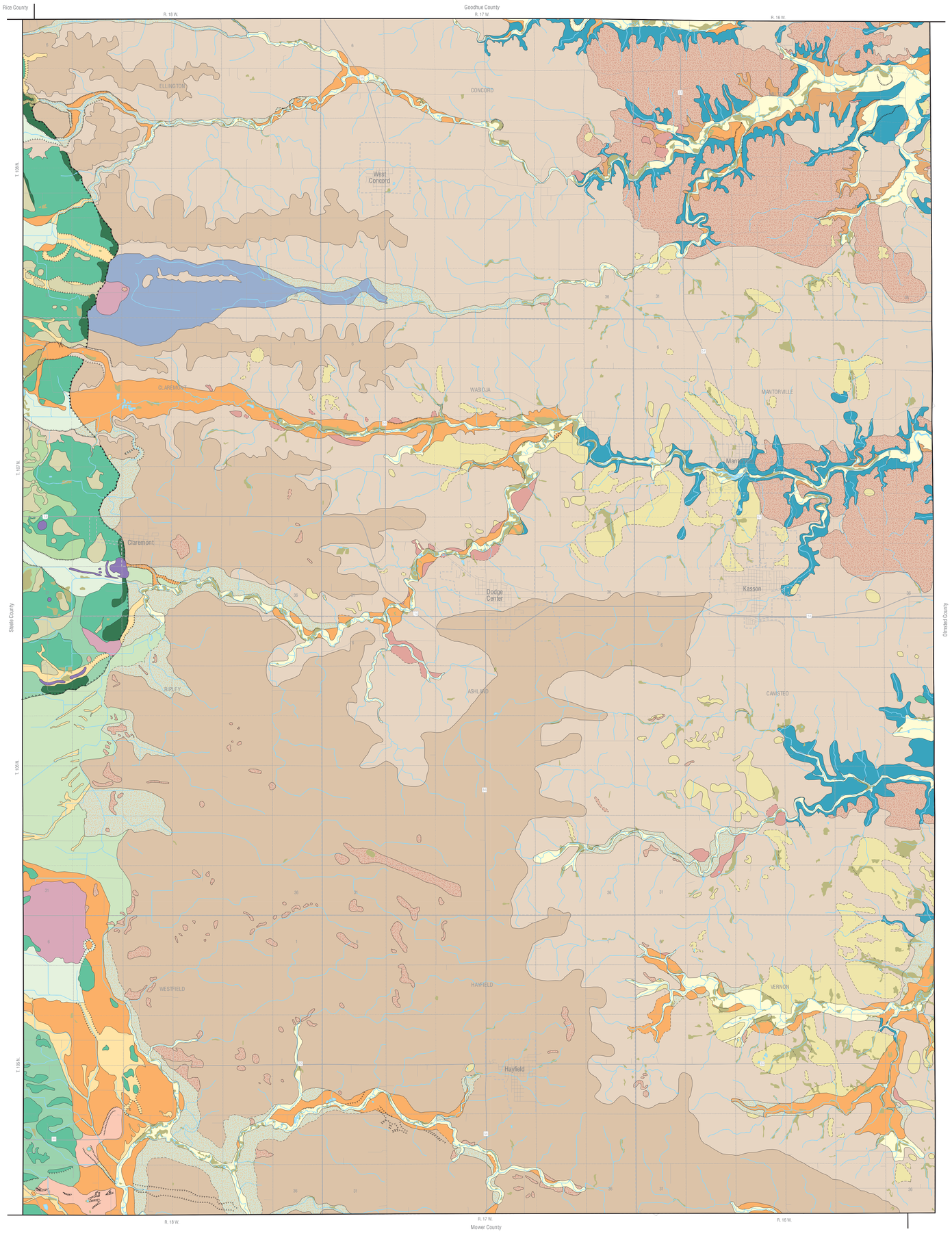

SURFICIAL GEOLOGY
DODGE COUNTY, MINNESOTA

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MODERN SEDIMENTS, WATER, AND WETLANDS: Includes features where recent geologic processes related to erosion and transportation of sediment have been occurring. These map units are Holocene (10,000 years ago until Present) in age and include lakes, streams, wetlands, alluvium, and colluvium.

- **Water:** Open water including lakes and streams.
- **Wetlands - Organic Sediments:** Partially decomposed plant material, silt, and clay, found in or around shallow lakes, marshes, and peatlands. Wetlands overlie other mapped units.
- **Alluvial Sediments:** Stratified fine sand, coarse sand, and gravel, with layers of silt, clay, and organics. The sediment is well to very well-sorted. Alluvium is deposited in streambed and overbank deposits to form features like floodplains, fans, and terraces.

GLACIAL SEDIMENTS: Includes all material (clay, silt, sand, gravel, and boulders) that was transported by glaciers and subsequently deposited directly by the glacier, from the ice as the glacier retreated, or by running water associated with the melting of glacial ice. The glacial sediments, which cover the majority of Dodge County, are Pleistocene (2.5 million to 10,000 years ago) in age.

Des Moines Lobe Sediments: Consists of sediments transported by the Des Moines Lobe glacial ice, meltwater, or wind during the Last Glacial Maximum. This glacial lobe flowed out of Canada through northwestern Minnesota, across southcentral Minnesota, and into Iowa. The easternmost margin of glacial ice deposited sediments along the western edge of Dodge County. The rock types typically associated with Des Moines Lobe sediments include carbonates, granites, and shales.

- **Loess:** Massive silt, clay, and very fine sand that is greater than 5 feet thick. The sediment is very well sorted and was transported and deposited by wind erosion. The majority of loess is found in the northeastern corner and east-central portion of the county. Loess also occurs as dunes in the central part of Dodge County. Loess dunes may contain more sand than silt.
- **Colluvial Sediments:** Poorly sorted clay, silt, and angular fragments of sand, gravel, cobbles, and boulders. The sediment may contain thinly bedded sand lenses and is moderately to poorly sorted. Colluvium is deposited by slopewash or bedrock freeze/thaw processes. Most of the mapped colluvium is sediment formed by the weathering and mechanical breakdown of bedrock due to freeze/thaw processes associated with the last glaciation. Modern colluvium is deposited as sediment is washed down slopes and hillsides by alluvial processes and gravity.
- **Fluvial Sediments:** Stratified fine and coarse sand, gravel with layers of silt and clay, and pockets of coarse gravel. The sediment is generally moderately sorted to well sorted sand, with gravel scattered throughout. The sediment was deposited from fluvial processes related primarily to meltwater drainages and secondarily to climate fluctuation associated with the last glaciation. Sediment consists of typical rock lithologies associated with the Des Moines Lobe and sediment gradually becomes more dominated by local rock lithologies going east.
- **Collapsed Outwash Sediments:** Stratified silt, fine sand, coarse sand, and gravel. The sediment is moderately sorted and at one time contained blocks of buried ice. The surface collapsed when the buried ice blocks melted. This caused depressions and small undulations. These sediments were deposited as the Des Moines Lobe meltwater flowed south to the Cedar River. This unit is found in the southwestern portion of the county.
- **Glaciofluvial Fan Sediments:** Silt, fine sand, coarse sand, and some gravel. The sediment found within most of these fans consists of fine sand and silt. Sediment is moderately to well sorted and is deposited into ponded water on the western side of the Des Moines Lobe moraines. The feature is coarser and thicker on the western portion and becomes finer and thinner to the east.
- **Coalesced Outwash Fan Sediments:** Stratified silt, fine sand, coarse sand, and gravel over till. The sediment is moderately sorted and discontinuous in some places. The sediment was deposited in pools of water that may have been dammed in the south.
- **Scoured Outwash Channel Sediments:** Stratified silt, fine sand, coarse sand, and some gravel, thinly layered over outwash modified till. Where present, the sediment is moderately to well sorted. These sediments are remnants of larger, surrounding outwash features and/or channels that have been eroded by glacial meltwater.
- **Glaciolacustrine Sediments:** Silt, clay and fine sand typically deposited in thin layers. The sediment is moderately well to very well sorted. The interpretation of the sediment is that it is derived from suspended material brought by meltwater streams into a basin in western Dodge County. This deposit of lacustrine sediment thinly covers undifferentiated till.
- **Ice Contact Sediments:** Stratified and non-stratified silt, fine sand, coarse sand, and gravel, with layers of clay and washed till mixed throughout. The sediment is found in discontinuous ridges, collapsed lake sediments, and fans. The sediment is poorly to very well sorted. Landforms are created by water flowing on or in stagnant ice, with the sediments deposited as the surrounding ice melts.
- **Ice Contact Outwash Channel Sediments:** Stratified and unstratified silt, clay, fine sand, coarse sand, and cobbles over Des Moines Lobe till. The interpretation of the sediment is that a valley carved into, on top of, below, or in between glacial ice and formed an outwash channel. The channel may contain some outwash sediments as well as scoured till.
- **Outwash Modified Sediments (Till):** Unsorted clay, silt, sand, gravel, cobbles, and boulders deposited by glacial ice that has been scoured and modified by glacial meltwater. Till is poorly sorted and may be overlain by lenses of moderately to well sorted stratified silts, sands and gravel. Both outwash and till are associated with the Des Moines Lobe.
- **Supraglacial Sediments (Meltout Till):** Slightly sorted clay, silt, sand, gravel, cobbles, and boulders. This material was deposited from till located on top of and within stagnant glacial ice. As the ice melted, the till became slightly sorted, leaving behind discontinuous patches of sediment.
- **Stagnant Moraine Sediments (Till):** Unsorted and sorted clay, silt, sand, gravel, cobbles, and boulders deposited as the glacier stagnated and melted. This unit may contain stringers of sorted sand and gravel. This sediment is associated with a moraine landform. Due to incorporation of ice blocks within the sediment during deposition, the resulting landform is hilly and undulating.
- **Ground Moraine Sediments (Till):** Unsorted clay, silt, sand, gravel, cobbles and boulders deposited during the advance and retreat of the glacier. The till is discontinuous and patchy in some places and thinly (~20 feet thick) drapes over older, undifferentiated till. There is little relief associated with the deposition of this till.
- **Moraine Ridge Sediments (Till):** Unsorted clay, silt, sand, gravel, cobbles, and boulders deposited at the margin of a glacier. These ridges are mainly composed of discontinuous till ridges and may contain stringers of sorted silt and sand. The ridges represent the easternmost margin of the Des Moines Lobe during the Last Glacial Maximum.

Undifferentiated Glacial Sediments: Consists of sediments transported by several older glaciers over a long period of time (130,000 to 300,000+ years before Present). Due to the age of these deposits, the landforms have undergone long periods of erosion and weathering; therefore there are no constructional features (e.g., moraines, eskers, or kames) associated with these glacial tills. In addition, the surface exposures of a single till, which may have been a continuous layer, is now patchy and discontinuous. Most surface exposures of till units indicate a northwestern source; however there are scattered remnants of northeastern-sourced till(s).

- **Fluvially Modified Undifferentiated Till:** Unsorted clay, silt, sand, gravel, cobbles, and boulders that have been modified by fluvial processes. The till is poorly sorted except for pebble, sand, and silt lags observed on exposed surfaces. Fluvial remnants are discontinuous throughout the unit and contain stratified silts, sands, and gravel. A majority of these deposits are observed where Des Moines Lobe meltwater flowed over older, pre-existing tills.
- **Quaternary Terrace Sediments:** Stratified fine and coarse sand, gravel with layers of silt and clay, and pockets of coarse gravel. The sediment is generally moderately to well sorted. These sediments were deposited as meltwater from older, northwestern-sourced glaciers utilized pre-existing valleys and deposited sand and gravel. Due to the age of the deposit, the upper 10 feet is very oxidized and has slight to strong cementation. These sediments are observed 10 to 20 feet higher on the sides of existing stream valleys.
- **Quaternary Outwash Sediments:** Stratified and unstratified fine and coarse sand, gravels with layers of silt and clay, and pockets of coarse gravel. The sediment is generally well sorted, very oxidized in the top 10 feet and can be slightly to moderately cemented with calcite or iron oxide. There are no associated landforms due to a long period of erosion. In addition, some outwash sediment is currently exposed along hill slopes where overlying till sediments are being eroded. Indicator pebbles vary between northeastern and northwestern rock types and can be a derivative of both.
- **Undifferentiated Tills - Upland:** Unsorted clay, silt, sand, gravel, cobbles, and boulders. Very poorly sorted sediment deposited by glacial ice. Where oxidized, the color is tan to brown, however, the unoxidized tills are mostly dark gray. Local lenses of sand and gravel can be observed within and between till units. Upland till units have been subjected to extensive wind erosion, but have not been dissected by stream cutting and therefore are topographically flat.
- **Undifferentiated Till - Stream Dissected:** Unsorted clay, silt, sand, gravel, cobbles, and boulders. Very poorly sorted sediment deposited by glacial ice. There are local lenses of sand and gravel within and between different till units. Oxidized tills are tan to brown in color, while the unoxidized tills are mostly dark gray and occasionally red. Stream dissected till units have been subjected to both wind and extensive stream erosion creating dendritic drainage systems. Due to headward stream erosion, the topography of this mapping unit is undulating (rolling).

BEDROCK UNITS: Consisting of Ordovician age (458 million to 447 million years ago) exposures of sandstone, shale, and limestone. Both younger and older aged rocks are covered by hundreds of feet of glacial sediment. Rock units exposed in the county include the following (from oldest to youngest): St. Peter Sandstone, Glenwood Shale, Platteville Limestone, Decorah Shale, and the three formation members of the Galena Group: the Cummingsville Limestone, the Prosser Limestone, and the Stewartville Limestone.

- **Bedrock, Undivided:** Limestone, shale, and sandstone of Ordovician age. Bedrock was mapped in areas covered by less than 10 feet of Quaternary sediment (other than loess). Bedrock units were observed mostly in and near stream valleys in the eastern portion of the county. Most outcrops of exposed bedrock are limestone from the Galena Group.

GEOLOGIC CONTACTS AND LANDFORMS

- Geologic Contact - Well defined geologic contact.
- Geologic Contact - Inferred, gradational, or approximately located geologic contact.
- Channel Scarp - Well defined channel scarp or boundary of outwash channel.
- Channel Scarp - Inferred or approximate location of channel scarp or boundary of channel.
- Glacial Margin - Well defined glacial margin.
- Glacial Margin - Inferred or approximate location of glacial margin.

GEOLOGIC HISTORY

The geologic units exposed within Dodge County consist of bedrock formations, glacial drift, and modern sediments. There are seven sedimentary rock formations exposed in Dodge County: St. Peter Sandstone, Glenwood Shale, Platteville Limestone, Decorah Shale, and the Cummingsville, Prosser, and Stewartville Limestones which form the Galena Group. These rocks were deposited in the Ordovician Period (458 to 447 million years ago). During this time, southeastern Minnesota, including Dodge County, was submerged under a large continental sea. As the sea transgressed over the land, one unit to be deposited was the St. Peter Sandstone. This unit represents a marginal environment where large beaches and sand bars formed near the shore of an encroaching sea. As the sea level changed, becoming deeper (the sea transgressed) or shallower (the sea regressed) over millions of years, different sedimentary rocks were deposited. Shales represent a near shore depositional environment and limestones represent a calmer, deeper, off shore environment. From the time of deposition, these sediments have undergone an extensive history of deposition and erosion.

Much later in time, during the Quaternary Period (2.5 million years to Present), continental glaciers advanced over most of Minnesota. These continental ice sheets originated in Canada and slowly moved southward through Minnesota. Several different glacial advances originated from the northeast, flowing through the Lake Superior area. Many other glacial advances originated from the northwest, flowing through the Winnipeg area. As these glaciers advanced, they picked up (eroded) bedrock and other surface material along their path. These glaciers continued to advance, transporting some of this material into Dodge County and throughout Minnesota. The sediments contain indicator pebbles that were transported from a specific bedrock source area. As the glaciers melted (receded), they deposited sediments that had been eroded and transported from the northern areas.

Most of the county is covered in glacial material that was deposited from about 300,000+ to 130,000 years ago. The thickness of these deposits varies from several feet to several hundreds of feet. Generally, the glacial material is thicker in the west and thins to the east. Because the glacial material is thin to the east, the eastern landscape is most influenced by the pre-glacial landscape: stream dissected bedrock valleys. The dissection is dendritic or leaf-like in shape and primarily follows a west-east trend. For this reason, the eastern landscape is very rolling and the farm practice of terracing is observed along the sides of some hills. The western landscape has little topographic relief. Here the glacial material is very thick and underlying bedrock terrain has little to no expression on the surface.

The older glacial deposits have been subjected to hundreds of thousand years of terrestrial erosion associated with glacial and non-glacial climate changes. Both wind and water have eroded the landscape to produce a wind-scoured surface that may be overlain by loess in some areas. Loess is wind blown silts and clays. Most of the loess can be observed in the northeastern portion of the county. Some of the loess was derived from wind blowing off of the glacial lobe called the Des Moines Lobe. This lobe flowed from Manitoba, down the Minnesota River valley, and south to Iowa. The very eastern margin of the lobe flowed onto the very western margin of Dodge County (~14,000 years ago). When the Des Moines Lobe retreated, the meltwater deposited outwash in the valleys of existing streams and rivers. Today, sediments are continually being eroded and deposited. These sediments form as the result of recent geological processes. Modern streams are creating fans, terraces, and bars that are constantly changing in size and shape.

RELATIONSHIP BETWEEN GEOLOGIC AGES AND MAPPING UNITS

QUATERNARY PERIOD: Representing 2.5 million years ago until Present.
HOLOCENE EPOCH: Representing ~10,000 years ago until Present.

- Water
- Wetlands - Organic Sediments
- Alluvial Sediments

PLEISTOCENE EPOCH: Representing 2.5 million to ~10,000 years ago.
Des Moines Lobe Sediments

- Loess
- Colluvial Sediments
- Fluvial Sediments
- Collapsed Outwash Sediments
- Glaciofluvial Fan Sediments
- Coalesced Outwash Fan Sediments
- Scoured Outwash Channel Sediments
- Glaciolacustrine Sediments
- Ice Contact Sediments
- Ice Contact Outwash Channel Sediments
- Outwash Modified Sediments (Till)
- Supraglacial Sediments (Meltout Till)
- Stagnant Moraine Sediments (Till)
- Ground Moraine Sediments (Till)
- Moraine Ridge Sediments (Till)

Undifferentiated Glacial Sediments

- Fluvially Modified Undifferentiated Till
- Quaternary Terrace Sediments
- Quaternary Outwash Sediments
- Undifferentiated Tills - Upland
- Undifferentiated Till - Stream Dissected

ORDOVICIAN AGE - Representing 458 million to 447 million years ago.

- Bedrock, Undivided

Scale 1:50,000

0 1 2 Miles
0 1 2 3 Kilometers

Surficial geology mapping units were delineated at 1:50,000

Base map data sources:
Lakes, wetlands, and rivers from National Wetland Inventory, U.S. Fish and Wildlife Service, compiled at 1:24,000 from aerial photography (1979-1988) and spot field checked.
Public Land Survey - PLS Project, 2001, Minnesota Department of Natural Resources, Division of Lands and Minerals.
Roads were obtained from Dodge County in September of 2002.
Civil Townships and Municipal Boundaries from MNDOT Basemap 2001 - Data layers Civiltwp and Muni, Minnesota Department of Transportation, BaseMap Development Group, Surveying and Mapping Section.

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GIS database design and cartography by Renee Johnson. Database assistance by Erika Rowe.
Field and drilling assistance by Rocco Rothbauma, Doug Rosnau, Al Dzuik, Mike Ellett, and Pat Geiselman.

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Projects are determined by a committee composed of Governor-appointed members from the public and private sectors.

Aggregate Resources and Surficial Geology:
Aerial photograph interpretation, field work, and delineation of mapping units by Heather E. Anderson, 2001-2002, County Aggregate Mapping Program, Division of Lands and Minerals, Minnesota Department of Natural Resources. Source information included aerial photographs from NAPP (National Aerial Photography Program), 1991-1992, 9"x9" color infrared photos at 1:40,000, DOQs (Digital Orthophoto Quadrangles) at 1:12,000 from USGS (United States Geological Survey), DRGs (Digital Raster Graphics) at 1:24,000 from USGS, 7.5-minute USGS topographic quadrangles at 1:24,000 (dating from 1982-1982), and a digital version of the Soil Survey of Dodge County, 1961, from the USDA-NRCS (United States Department of Agriculture - Natural Resources Conservation Service), captured into the Soil Survey Information System (SSIS) format by the University of Minnesota, Department of Soil, Water, and Climate.

This project includes a CD-ROM of maps, data, and metadata in a digital format and the following plates:
Plate I, Report 357, Significant Aggregate Resource Deposits.
Plate II, Report 357, Aggregate Resources.
Plate III, Report 357, Surficial Geology.
Plate IV, Report 357, Data Sources and Mapping Methodology.