

STATE OF SOUTH DAKOTA
William J. Janklow, Governor

DEPARTMENT OF WATER AND NATURAL RESOURCES
Warren R. Neufeld, Secretary

GEOLOGICAL SURVEY
Merlin J. Tipton, State Geologist

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MAJOR AQUIFERS IN HANSON AND DAVISON
COUNTIES, SOUTH DAKOTA

by

Donald S. Hansen
United States Geological Survey
United States Department of the Interior

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ABSTRACT

Five glacial and three bedrock aquifers underlie much of Hanson and Davison Counties, South Dakota. The Floyd and Plum Creek glacial aquifers range in thickness from 5 to 87 feet and may yield as much as 1,000 gallons per minute to wells. The Ethan, Warren, and Alexandria glacial aquifers range in thickness from 5 to 37 feet and well yields may be as much as 400 gallons per minute. Water in the Floyd and Ethan aquifers is of the sodium calcium sulfate type; in the Plum Creek and Warren aquifers, water is of the calcium magnesium sulfate type; and in the Alexandria aquifer, water is of the calcium magnesium bicarbonate type. In all the glacial aquifers, dissolved-solids concentrations range from 210 to 2,740 milligrams per liter.

The Niobrara Chalk, Codell Sandstone, and Dakota Sandstone of Cretaceous age are the major sources of water from bedrock aquifers. Yields from these aquifers range from 2 to 1,000 gallons per minute. Water from the Niobrara aquifer is of the sodium calcium sulfate type; in the Codell aquifer, water is of the sodium sulfate type; and in the Dakota aquifer, water is of the calcium magnesium sulfate type. Water from all three aquifers is used for stock watering and domestic purposes. Water from the Niobrara also is used for irrigation.

INTRODUCTION

This information pamphlet is one of a series of reports on water-resources studies of South Dakota counties. It is designed to acquaint the reader with the general distribution, quantity, and quality of ground water available from the major aquifers in Hanson and Davison Counties. A comprehensive report to be published later will contain some of the geohydrologic data collected during the study and much additional information on the hydrology and geology of the area. Information in this pamphlet is based on data (fig. 1) collected by the U.S. Geological Survey and the South Dakota Geological Survey during 1978-80.

Copies of this publication and other county reports may be obtained from the South Dakota Geological Survey as they become available. Persons wishing additional information about the hydrology and geology may contact the U.S. Geological Survey in Huron or the South Dakota Geological Survey in Vermillion.

The inch-pound units used in this report may be converted to metric (SI) units by the following conversion factors:

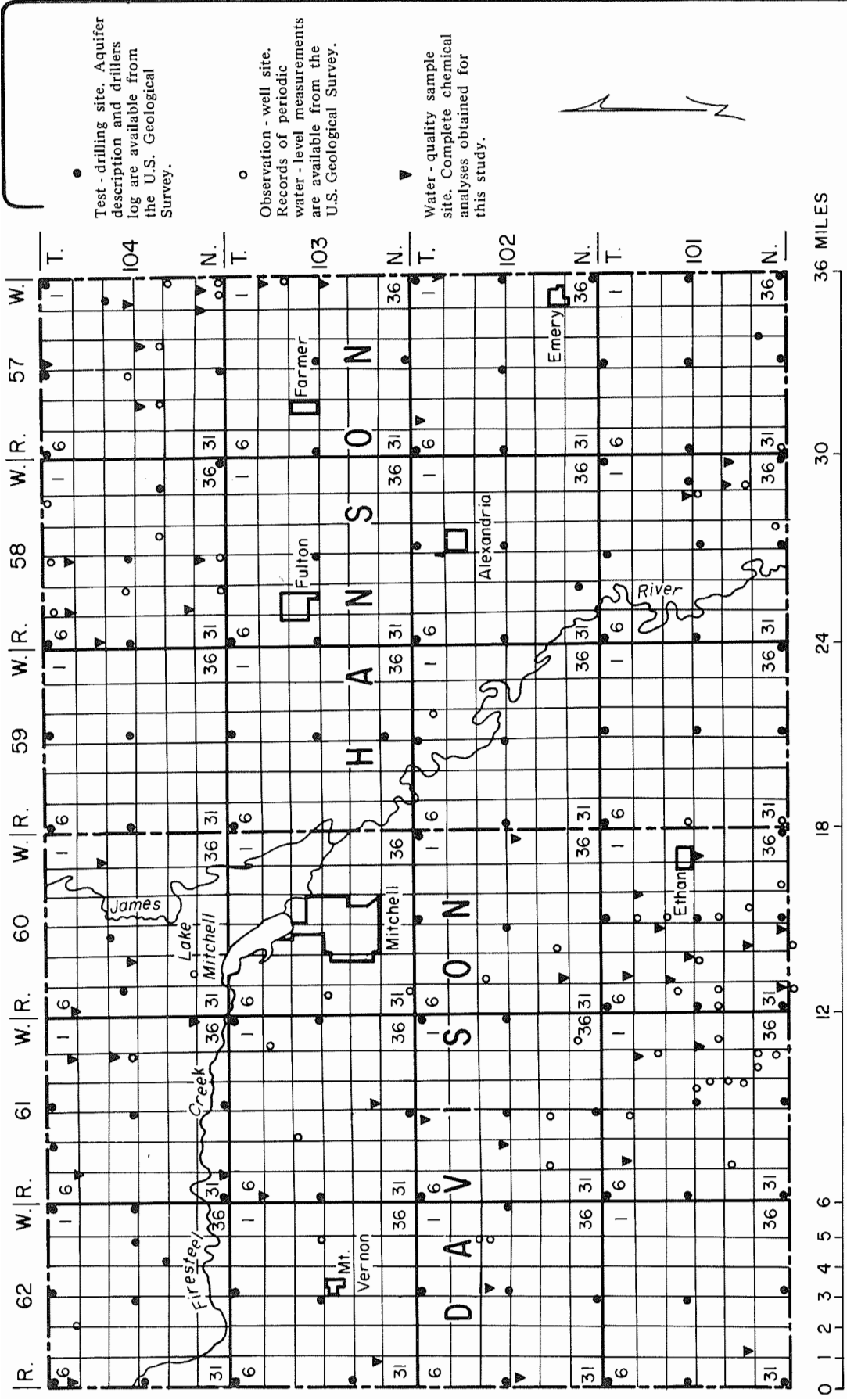


Figure 1. Locations of data sites in Hanson and Davison Counties.

| Multiply inch-pound unit | By | To obtain metric unit |
|--------------------------|--------|-----------------------|
| foot | 0.3048 | meter |
| gallons per minute | 0.063 | liter per second |
| mile | 1.609 | kilometer |
| square mile | 2.590 | square kilometer |

DEFINITIONS OF TERMS

AQUIFER -- A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

ARTESIAN AQUIFER -- A confined aquifer in which the water in a tightly cased well completed in the aquifer rises above the top of the aquifer.

BEDROCK -- A general term for the rock, usually solid, that underlies soil, sand, clay, or other unconsolidated material. In Hanson and Davison Counties the uppermost bedrock deposit is shale.

DISSOLVED SOLIDS -- Term that expresses the quantity of dissolved material in a sample of water.

GLACIAL AQUIFER -- An aquifer composed of materials derived from a glacier. In Hanson and Davison Counties, aquifers consist mainly of unconsolidated sand and gravel deposited as glacial outwash.

GLACIAL DRIFT -- A general term applied to all rock material (clay, sand, gravel, boulders) transported by glaciers and deposited directly on land or in the sea.

GLACIAL OUTWASH -- Sand, gravel, silt, and clay that was deposited by water from melting ice. For the purpose of this report, the term is restricted to sand and gravel.

HARDNESS -- Dissolved calcium and magnesium salts that decrease the lathering ability of soap and form scale in boilers and pipes. Hardness is reported as calcium carbonate and is classified by the U.S. Geological Survey as follows:

| Classifi- cation | Milligrams per liter | Grain per gallon |
|---------------------|-------------------------|---------------------|
| Soft | 0- 60 | 0- 3.4 |
| Moderately hard | 61-120 | 3.5- 7.0 |
| Hard | 121-180 | 7.1-10.5 |
| Very hard | More than 180 | More than 10.5 |

PROPERLY-CONSTRUCTED WELL -- A well constructed to admit a maximum amount of water from an aquifer without excessive loss of hydraulic head at the well. This generally requires either installing a well screen or perforating the casing and installing a gravel pack around the casing opposite the depth interval of the aquifer. It also requires pumping the well in such a manner as to remove drilling mud and other fine-grained material from the aquifer adjacent to the well.

WATER TABLE -- That water surface in an unconfined aquifer at which the pressure is atmospheric. Generally this is the upper surface of the zone of saturation, except where the surface is within a relatively impermeable rock type.

GLACIAL AQUIFERS

The location and saturated thickness of the glacial aquifers in Hanson and Davison Counties are shown in figure 2. The aquifers are composed primarily of coarse sand and gravel deposited by meltwater from glaciers.

Floyd Aquifer

The Floyd aquifer underlies about 84 square miles of northeastern Hanson County. Its thickness ranges from about 5 to 90 feet and averages about 40 feet. Depth to the top of the aquifer ranges from 45 to 275 feet and averages about 175 feet. The aquifer is under artesian conditions and the depth to water in wells generally is less than 25 feet below land surface, except in the easternmost part of Hanson County where water levels range from about 45 to 65 feet below land surface. Yield from properly-constructed wells may be as much as 1,000 gallons per minute in areas where the aquifer is greater than 40 feet thick. In areas where the aquifer is less than 40 feet thick, well yields generally are less than 300 gallons per minute.

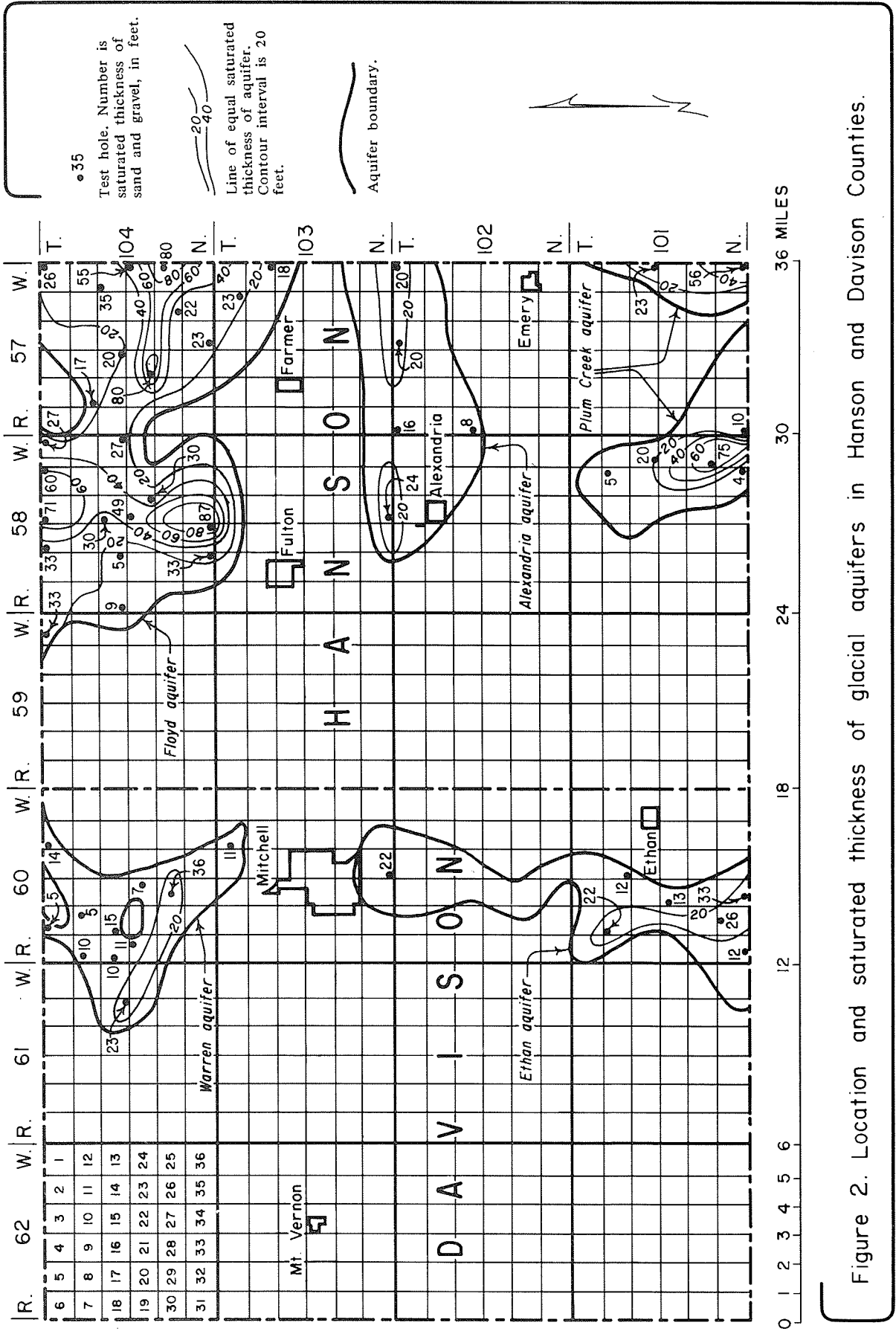


Figure 2. Location and saturated thickness of glacial aquifers in Hanson and Davison Counties.

Water in the Floyd aquifer is predominantly a sodium calcium sulfate type. Dissolved-solids concentrations ranged from 742 to 2,830 milligrams per liter and hardness concentrations ranged from 210 to 1,300 milligrams per liter. The average concentrations were 1,590 milligrams per liter for dissolved solids and 705 milligrams per liter for hardness. Water from the Floyd aquifer is used for domestic purposes, stock watering, and irrigation.

Plum Creek Aquifer

The Plum Creek aquifer underlies about 27 square miles of southeastern Hanson County. Thickness of the aquifer ranges from 5 to 73 feet and averages about 18 feet. The depth to the top of the aquifer ranges from 120 to 195 feet and averages about 150 feet. The aquifer occurs under artesian conditions. The depth to water in wells ranges from about 65 to 110 feet below land surface but generally is between 70 and 80 feet below land surface. Yield from properly-constructed wells may be as much as 1,000 gallons per minute in areas where the aquifer thickness exceeds 40 feet.

Water in the Plum Creek aquifer is predominantly a calcium sulfate type. Dissolved-solids concentrations ranged from 1,640 to 2,324 milligrams per liter and hardness concentrations ranged from 570 to 1,680 milligrams per liter. The average concentrations were 1,911 milligrams per liter for dissolved solids and 1,481 milligrams per liter for hardness. The water is used primarily for stock watering due to the excessive dissolved-solids concentrations; however, in the southwest part of T. 101 N., R. 58 W., dissolved-solids concentrations decrease and aquifer thickness increases. Use of the water for irrigation may be possible in this area.

Ethan Aquifer

The Ethan aquifer underlies 33 square miles of southeastern Davison County, ranges in thickness from 5 to 37 feet, and averages about 20 feet. The aquifer is at or near land surface 1 mile south of Mitchell but increases in depth southward to 95 feet below land surface at the county line. The aquifer is under artesian conditions in the southern part of the county and becomes a water-table aquifer 3 miles south of Mitchell. Depth to water in wells usually is less than 35 feet below land surface. Yield from properly-constructed wells in the southern part of the aquifer may be as much as 400 gallons per minute. Yield in the northern part of the aquifer are considerably less because of its shallow depth and decreased thickness. Wells in this area may go dry during a drought.

Water in the aquifer is a sodium calcium sulfate type. Dissolved-solids concentrations ranged from 1,470 to 3,120 milli-

grams per liter and averaged 1,998 milligrams per liter. Hardness concentrations ranged from 514 to 1,500 milligrams per liter and averaged 880 milligrams per liter. Water from the Ethan aquifer is used primarily for stock watering and domestic purposes; however, there are several irrigation wells that produce from both the Ethan and the Niobrara aquifers.

Warren and Alexandria Aquifers

The Warren and Alexandria aquifers are classified as minor glacial aquifers because both are limited in areal extent and thickness. Combined areal extent is approximately 45 square miles and thickness averages about 15 feet. Depth to the top of the aquifers ranges from 40 to 80 feet and averages about 50 feet. Water occurs under artesian conditions and water levels in wells generally are less than 45 feet below land surface. Well yields seldom exceed 10 to 15 gallons per minute.

Water in the Warren aquifer is a calcium magnesium sulfate type and water in the Alexandria aquifer is a calcium magnesium bicarbonate type. Two water samples from the Warren aquifer have dissolved-solids concentrations of 1,950 and 1,403 milligrams per liter, and hardness concentrations of 1,300 and 864 milligrams per liter. Dissolved-solids concentrations in water from the Alexandria aquifer ranged from 1,470 to 3,770 milligrams per liter and hardness concentrations ranged from 1,131 to 2,741 milligrams per liter. Average concentrations were 2,485 milligrams per liter for dissolved solids and 1,852 milligrams per liter for hardness. The water from the aquifers is used for stock watering and domestic purposes.

BEDROCK AQUIFERS

The bedrock aquifers in Hanson and Davison Counties include the Niobrara, Codell, and Dakota aquifers. The aquifers in Hanson County are found in the northeast, north-central, and southwestern parts. The rest of Hanson County is underlain by the Precambrian Sioux Quartzite. A water-bearing zone of weathered quartzite lying on the Sioux Quartzite in Hanson County probably is part of the Dakota aquifer. All the bedrock aquifers are present throughout Davison County.

Niobrara Aquifer

The Niobrara aquifer underlies approximately 425 square miles in Davison County and is composed of a densely fractured, calcareous chalk that contains numerous solution cavities. These fractures and openings have developed enough to allow adequate quantities of water to be pumped for irrigation in T. 101 N., R. 60 and 61 W. (fig. 3). Thickness of the aquifer ranges from 30 to

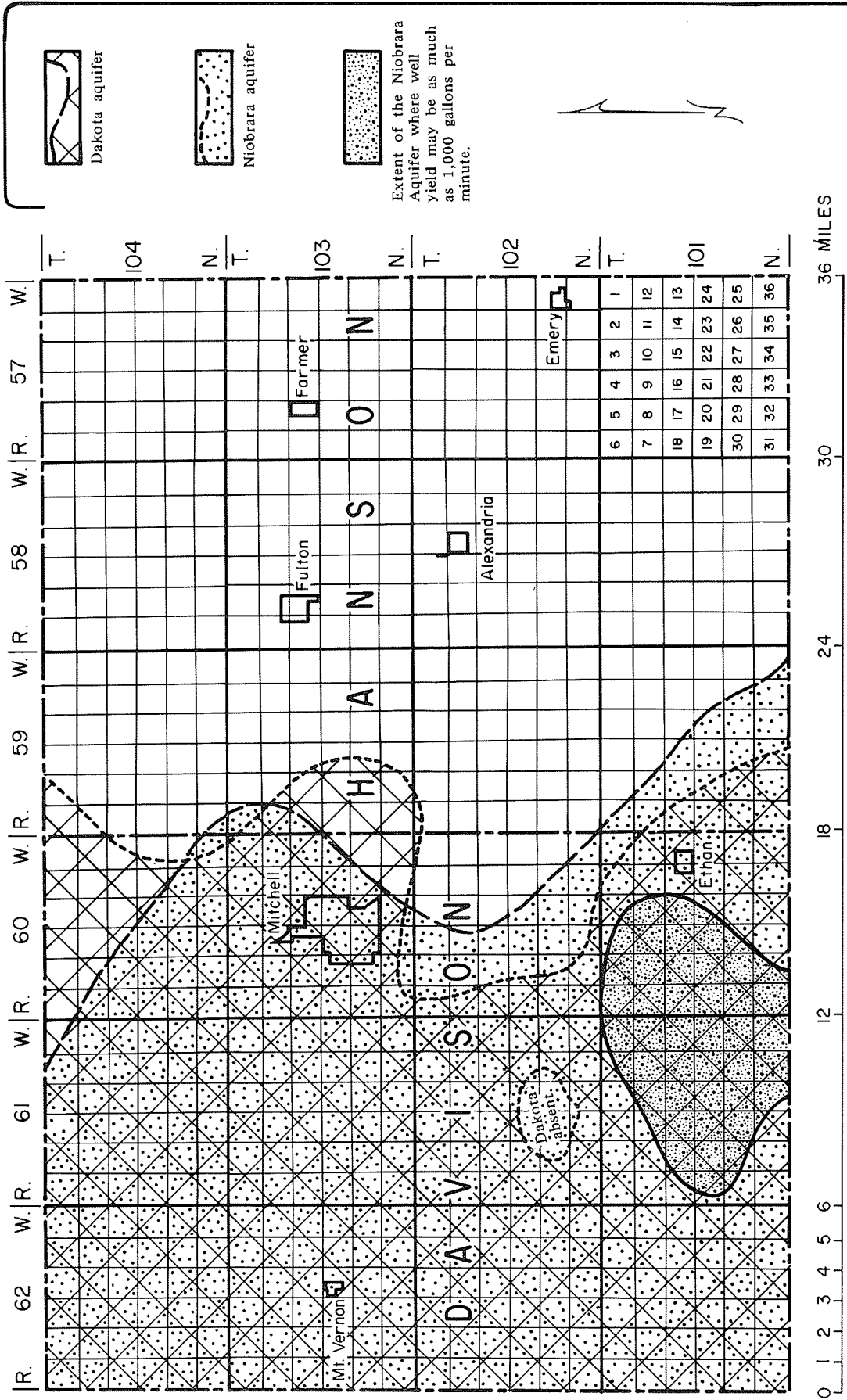


Figure 3. Extent of the Niobrara and Dakota aquifers in Hanson and Davison Counties.

130 feet and averages about 100 feet. Depth to the top of the aquifer ranges from 2 to 80 feet below land surface. The aquifer generally occurs under artesian conditions; water levels in wells range from about 10 to 70 feet below land surface. Properly-constructed wells in the Niobrara can yield 500 to 1,000 gallons per minute.

Water in the aquifer is predominantly a sodium calcium sulfate type. Dissolved-solids concentrations in water from the Niobrara aquifer ranged from 1,400 to 2,210 milligrams per liter and hardness concentrations ranged from 370 to 1,000 milligrams per liter. Average concentrations were 1,986 milligrams per liter for dissolved solids and 817 milligrams per liter for hardness. Water is used for stock watering, irrigation, and domestic purposes.

Codell Aquifer

The Codell aquifer is a fine-grained sandstone and is the most widespread and most used bedrock aquifer in Hanson and Davison Counties. The aquifer, shown in figure 4, underlies about 547 square miles of both counties. Thickness of the aquifer ranges from 5 to 88 feet and averages about 40 feet. The top of the aquifer is at a depth of 45 feet in eastern Davison County increasing to a depth of 350 feet in the southwestern part. The aquifer occurs under artesian conditions and water levels in wells range from about 10 to 90 feet below land surface. Properly-constructed wells in the Codell aquifer may yield as much as 50 gallons per minute.

Water in the aquifer is predominantly a sodium sulfate type. Dissolved-solids concentrations ranged from 1,200 to 2,100 milligrams per liter and averaged 1,640 milligrams per liter. Hardness concentrations ranged from 51 to 325 milligrams per liter and averaged 205 milligrams per liter. The Codell aquifer is used extensively for domestic and stock wells. Wells have no irrigation potential due to the relatively small yields and excessive sodium concentration of the water.

Dakota Aquifer

The Dakota aquifer is composed of a brown, fine-grained sandstone interbedded with thin shale beds and underlies about 340 square miles of Davison County (fig. 3). The average thickness of the Dakota aquifer is 110 feet. The aquifer ranges from 110 to 400 feet thick in western Davison County and gradually thins to the east where it pinches out against the Sioux Quartzite ridge. Depth to the top of the aquifer ranges from about 500 to 700 feet below land surface in western Davison County, decreasing toward the east to about 250 to 350 feet. In southern Davison County, the aquifer occurs under artesian conditions and water levels in wells range from 5 to 10 feet below land surface. Most wells flow

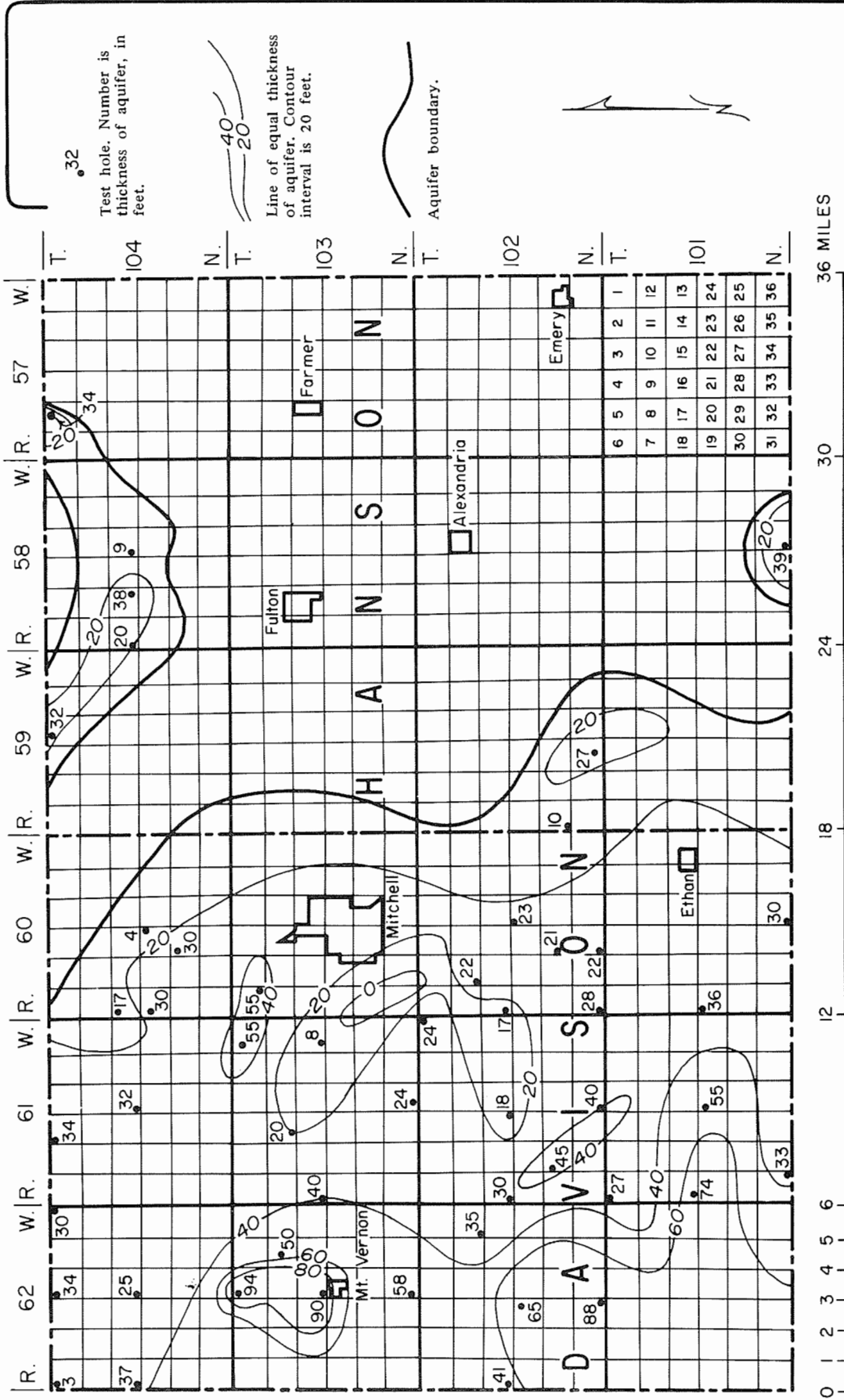


Figure 4. Extent and thickness of the Codell aquifer in Hanson and Davison Counties.

at land surface in northern Davison County. The average yield from flowing wells is about 2 to 5 gallons per minute; however, in some instances yields may be as much as 50 gallons per minute.

Water in the Dakota aquifer is a calcium magnesium sulfate type with the exception of the extreme northern part of Davison County where it is a sodium sulfate type water. Dissolved-solids concentrations averaged 2,055 milligrams per liter and hardness values averaged 1,230 milligrams per liter. Water from the Dakota aquifer is used for stock watering and domestic purposes.

A water-bearing zone of weathered quartzite, known locally as the "quartzite wash," lies directly on the Sioux Quartzite in the northeast and southwest quarter of Hanson County, and probably is in hydraulic connection with the Dakota aquifer. The thickness of the wash ranges from 10 to 105 feet and the depth to the top of the aquifer averages 500 feet. Depth to water in wells ranges from 5 to 30 feet. Water quality and use is similar to that of the Dakota aquifer.

LARGE-CAPACITY WELLS

The best possibilities for developing large-capacity wells capable of supplying more than 500 gallons per minute are in the areas where glacial aquifers are more than 40 feet thick. The Floyd, Plum Creek, and Ethan aquifers all have limited irrigation potential. The Ethan and Niobrara aquifers are interconnected and individual wells completed in both aquifers can provide sufficient water for irrigation even though the Ethan aquifer is less than 30 feet thick. Before production wells are constructed, test holes commonly are drilled to determine the thickness of the aquifer and to provide samples for determining the grain size of the aquifer material. This information helps in the selection of the proper slot size and length of screen to be used in the construction of a well. Controlled pumping of the well for at least several hours indicates the yield of the aquifer at that locality and provides a representative water sample for chemical analysis. Measurement of the recovery of water level in the well provides information that is used for estimating the yield of a well during longer pumping periods. If the well is to be used for irrigation, knowledge of the type of soil, subsoil, and topography are also important in selecting the most suitable irrigation system.