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SOUTH DAKOTA GEOLOGICAL SURVEY
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MAJOR AQUIFERS AND SAND AND GRAVEL RESOURCES IN BROWN COUNTY, SOUTH DAKOTA

by

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CONTENTS

ILLUSTRATIONS

FIGURES

TABLE

INTRODUCTION

This publication is designed to acquaint the reader with: (1) the general distribution, quality, and physical characteristics of the major aquifers in Brown County, and (2) the general distribution of sand and gravel resources in Brown County, and to show the optimum areas in the County to explore for further development of sand and gravel resources. A more detailed and comprehensive report will be published later and will describe the finer technical aspects of ground-water supplies in the County. This report and other forthcoming reports of Brown County may be obtained from the South Dakota Geological Survey in Vermillion. Personnel of this office are also available for further consultation should the need arise.

DEFINITION OF TERMS

Alluvium: This is a material deposited in stream valleys by running water and is usually high in silt. Very seldom does alluvium contain significant amounts of sand and gravel.

Aquifer: An aquifer is defined as a body of earth material (sand, gravel, fractured rocks) from which water may be obtained in significant quantities.

Artesian aquifer: An artesian aquifer is one in which the hydraulic head rises above the top of the aquifer.

Bedrock: Solid rock underlying unconsolidated rock material such as shale, limestone, quartzite, etc.

Glacial drift: A collective term applied to all material in transport by glacial ice and deposited by glacial ice. It includes till.

Glacial outwash: This is sand, gravel silt, and clay which is deposited by water from melting ice. For the purposes of this report, outwash is restricted to sand and gravel.

Head: The hydraulic head of an aquifer is the level to which water in the aquifer rises in a well which taps the aquifer.

Till: Till is a mixture of clay, sand, gravel, and boulders laid down directly by the glacial ice itself. It does not show layering of the sediments.

TEST HOLE INFORMATION

Test holes which were drilled for this study and for which data are available are shown on Figures 1 and 4.

WATER RESOURCES

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Aquifers

Glacial aquifers are composed mostly of sand and gravel. Where the glacial aquifers are confined by overlying material, this overlying material generally consists of clay containing some sand, gravel, and stones of all sizes. When an aquifer is confined by an overlying, relatively impermeable material such as clay, and the water in wells rises above the top of the aquifer, the water is said to be under artesian pressure. Some aquifers are under sufficient pressure that water flows from the well at the land surface. In an unconfined aquifer the surface of the saturated zone is called the water table. In the saturated zone all openings between rock particles are filled with water.

Glacial Aquifers

Three major glacial aquifers--the **Deep James, Middle James,** and **Elm**--are present in the County. The **Deep James aquifer** underlies an area of about 250 square miles in Brown County. The aquifer consists of an interconnected system of channels extending from southwestern Brown County in a north and northeast direction across the County (fig. 2). The channels are filled with clay, silt, sand, and gravel, with sand and gravel thickness ranging from 1 to 160 feet.

The Deep James aquifer may yield as much as 1,000 gpm (gallons per minute) to properly constructed wells at depths ranging from 150 to 380 feet. Water in the aquifer occurs under artesian conditions, and water levels in wells tapping the aquifer range from 5 to 35 feet below land surface.

The few available quality of water data indicate that there are considerable differences from one area to another. In some areas water is suitable for irrigation but in others it is unsuitable because of a high salt content.

The **Middle James aquifer** underlies an area of about 530 square miles in Brown County. It extends from north to south through the central part of the County and ranges in width from 2 miles between Aberdeen and Columbia to more than 10 miles in the southern and northern parts of the County (fig. 3). The aquifer may yield as much as 1,000 gpm to properly constructed wells at depths ranging from 60 to 200 feet. Water in the aquifer occurs under artesian conditions and water levels in wells tapping the aquifer range from flowing to 32 feet below land surface. Aquifer thickness ranges from 2 to 70 feet.

The Middle James aquifer yields water that is predominantly of sodium bicarbonate and sodium sulfate types, with specific conductances ranging from 679 to 5,690 and averaging 2,407 μ mhos/cm (micromhos per centimeter). The specific conductance of water is a measure of its capacity to conduct an electrical current and is dependent upon the amount and kind of dissolved mineral matter. An estimate of the total dissolved solids in milligrams per liter can be obtained by multiplying specific

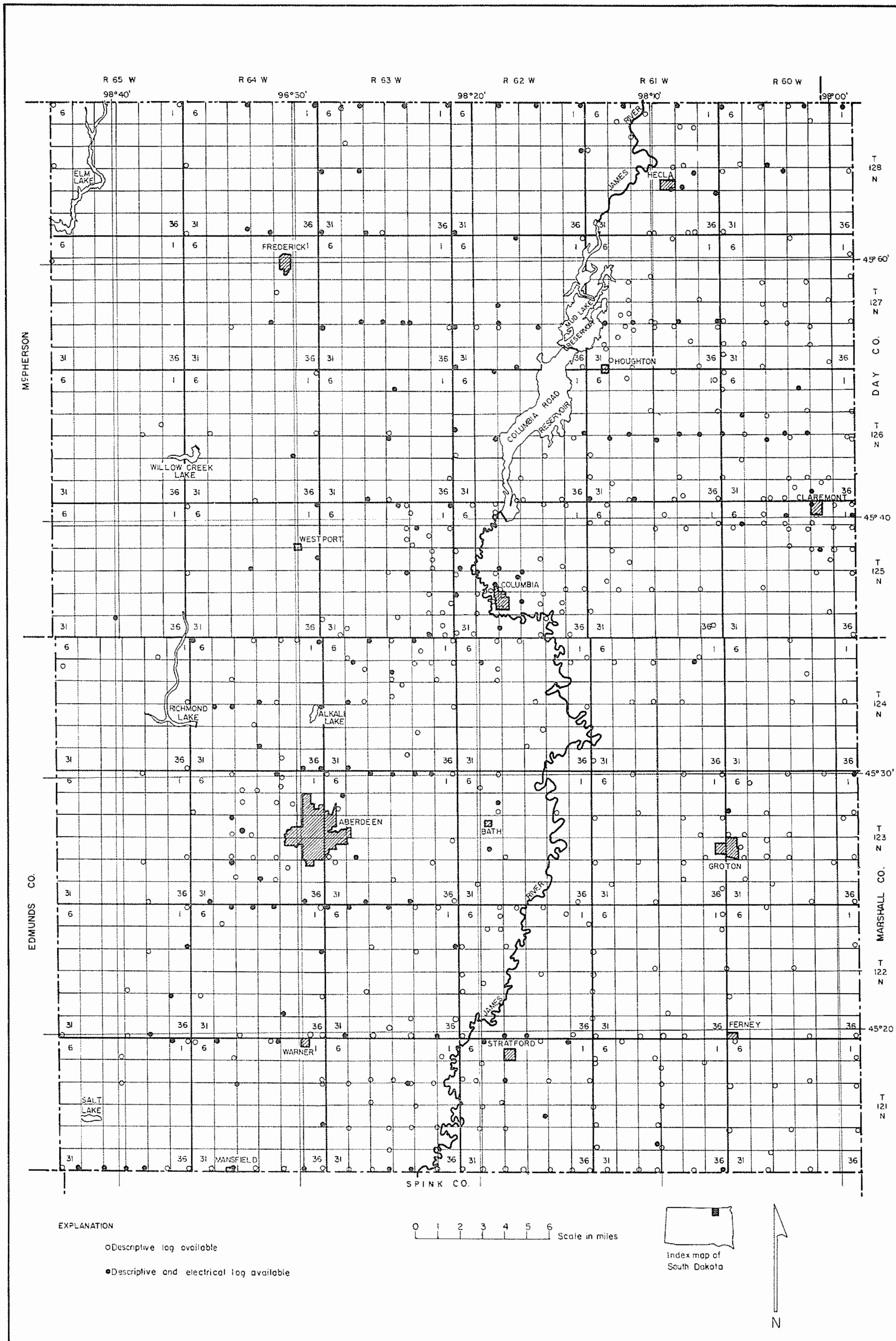


Figure 1. Map showing locations of wells and test holes in Brown County for which data are available.

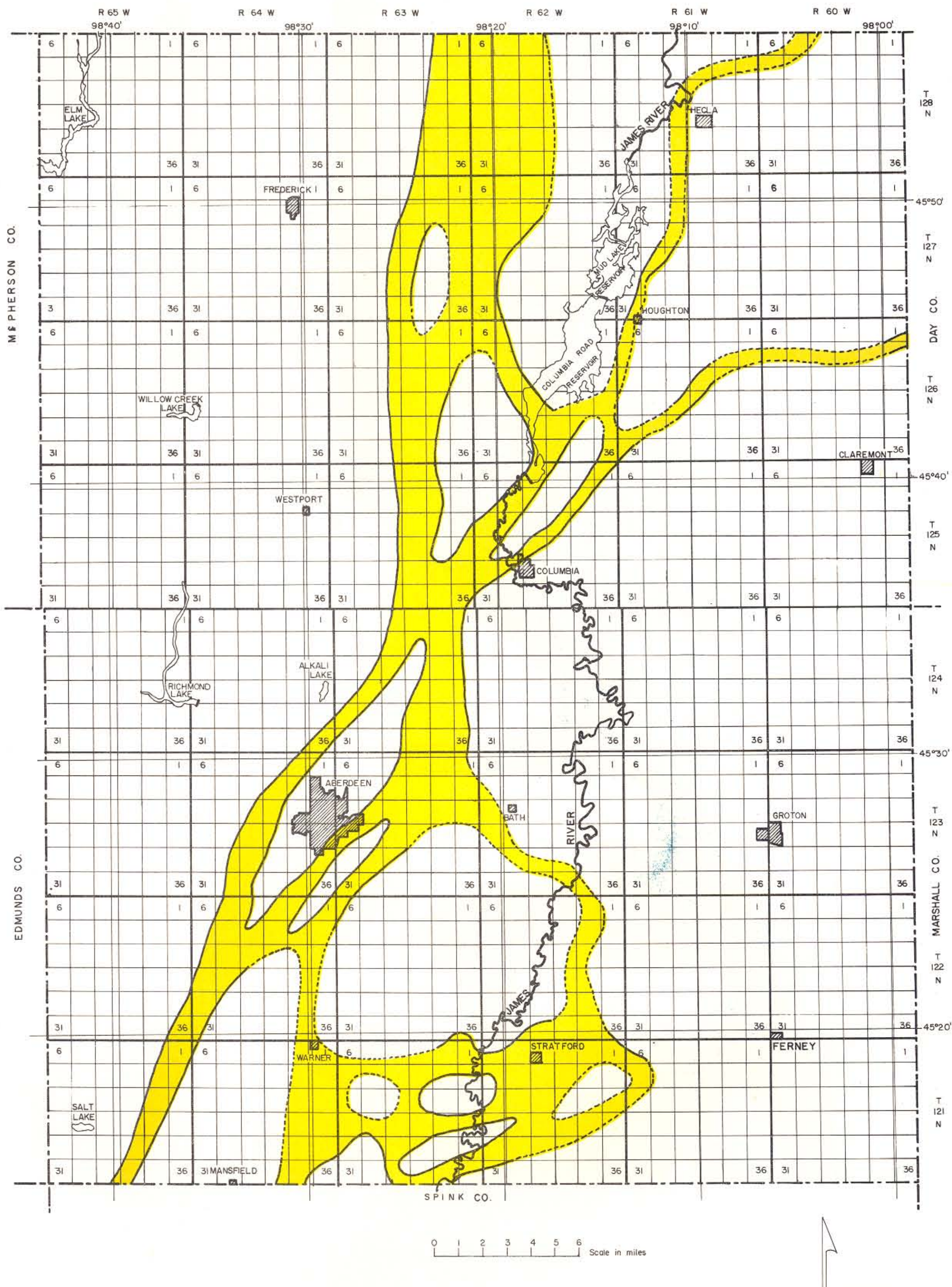


Figure 2. Map showing locations of the Deep James aquifer.

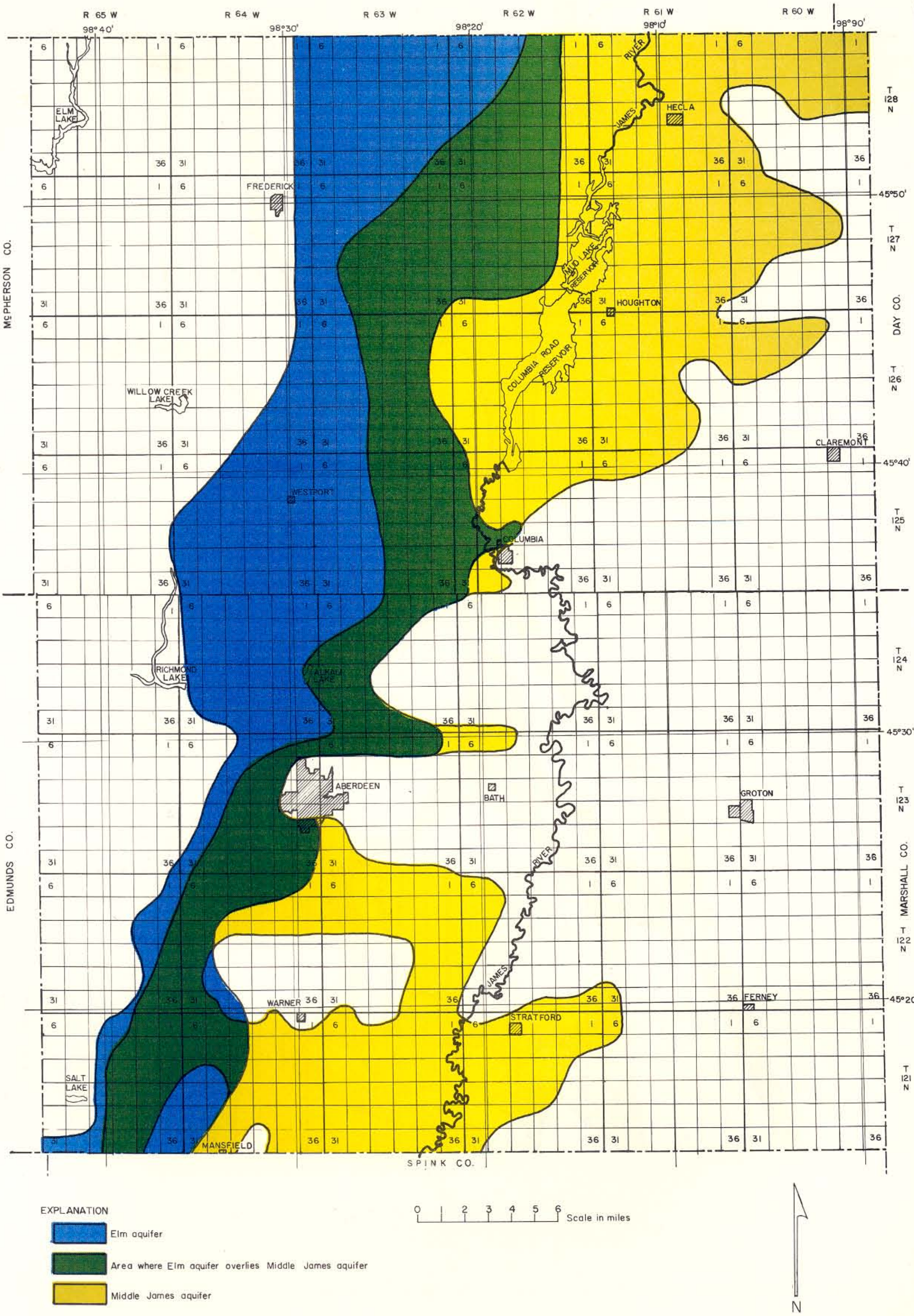


Figure 3. Map showing locations of the Middle James and Elm aquifer.

conductance of 0.65.

Hardness of water from the Middle James aquifer ranges from 260 to 1,500 and averages 495 mg/l (milligrams per liter) or 29 grains per gallon.

The **Elm aquifer** underlies an area of about 390 square miles in Brown County. It extends from north to south across the west central part of the County and overlies the western part of the Middle James aquifer (fig. 3). In some of the areas where both aquifers occur they are hydraulically connected. The aquifer may yield as much as 1,000 gpm to properly constructed wells at depths ranging from 15 to 100 feet. Aquifer thickness ranges from 2 to 80 feet. Water in the aquifer may be under water-table or artesian conditions, and water levels in wells tapping the aquifer range from 4 to 50 feet below land surface.

Water in the Elm aquifer is predominantly of sodium, calcium, sulfate, bicarbonate types with specific conductances ranging from 246 to 5,900 μ mhos/cm and averaging 2,017 μ mhos/cm. Hardness ranges from about 80 to 3,300 and averages about 860 mg/l or 50 grains per gallon.

Bedrock Aquifers

The major bedrock aquifers in Brown County are the **Dakota Sandstone,** and the **Fall River** and **Sundance Formations**. These three formations occur in the northwest half of the County. The Sundance pinches out southeastward, and is absent in the southeast half of the County. The Fall River pinches out in the extreme eastern part of Brown County. Water from the Sundance aquifer recharges the Fall River aquifer which in turn recharges the Dakota aquifer. Many wells obtain water from both the Dakota and Fall River aquifers which results in a mixed water quality and a water pressure more nearly representing the aquifer with the lower pressure.

The Dakota aquifer has in the past been divided into an upper sandstone aquifer locally called the "first flow," and a lower sandstone aquifer called the "second flow." As the result of considerable development, the waters from the second flow have mixed with those of the first flow to the extent that water from the two flows cannot be distinguished. The water pressures are also the same in each aquifer. The interconnection between the first and second flows is such that they are hydraulically one aquifer. Well depths to the Dakota and Fall River aquifers range from 850 to 1,100 feet below land surface in the southeast half of the County and from 900 to 1,200 feet in the northwest half.

Wells in the Sundance aquifer range in depth from 1,150 to 1,450 feet below land surface.

Water in the bedrock aquifers occurs under artesian conditions. Wells in the Dakota aquifer flow in topographically low areas of Brown County. Wells in the Fall River aquifer have higher pressures and those in the Sundance aquifer have still higher pressures and both flow at the higher elevations in the western part of the County.

The Dakota water is of a sodium chloride type; Fall River water is of a sodium sulfate type and Sundance water is of a calcium sodium sulfate type. Hardness ranges from soft in the Dakota water to very hard in the Sundance water. Water from the bedrock aquifers is not suitable for irrigation.

High-Yield Wells

Before high-yield wells such as those generally needed for irrigation are constructed, it is desirable that a test well be drilled at the selected location to determine the thickness of the aquifer and provide samples for determining the grain size of the aquifer material. This information will help in the selection of the proper slot size and length of screen to be used. Pumping the test well shows the yield of the aquifer at that locality and provides a water sample for chemical-quality analysis. A water sample from the Deep James aquifer should be obtained from every test well for chemical-quality analysis because of the considerable variation in water quality in that aquifer. The type of soil and subsoil and the topography are also important in determining the suitability of the land for irrigation, and in selecting the most suitable irrigation system.

SAND AND GRAVEL RESOURCES

Darrell I. Leap

Distribution of Sand and Gravel

Figure 4 shows the general distribution of sand and gravel deposits and the locations of sand and gravel pits in Brown County. In addition, test hole locations for this study are shown.

Interpretation and use of the Sand and Gravel Maps

Probability of Finding Sand and Gravel

Probability of finding sand and gravel has been classified into five groups and are shown in Figure 4. The classifications are known occurrences, high probability, good probability, fair probability, and poor probability. Areas of known occurrences have been explored and mapped. Fair-probability areas are predominantly those of glacial till. Poor-probability areas are areas of deep lake silt.

Topographic Classification

All of the areas which are known to contain sand and gravel have been classified into four major topographic groups in order to give the reader a general idea of the terrain to be encountered and some idea of the relative ease or difficulty in mining the areas.

Type I: Deposits of this category usually occur in small to large sheets of level to gently sloping to gently rolling terrain. The water table may be near the surface in some places and quite deep in others.

Type II: Sand and gravel deposits of this category are found on the sides of valleys and lake depressions. They are steep sided for the most part and access to the sand and gravel can often be made by digging into the side of the deposits. The water is not usually a problem except in some cases where the foot of the deposit reaches the bottom of a wet valley or depression. Often these deposits spill out onto the high ground above the valley and merge into Type I deposits.

Type III: Deposits of this type are found in small hills or knolls, or ingroups of small hills or knolls. The water table is generally no problem except in areas where the foot of the hill reaches a wet area. The quality of material found in these deposits may be quite variable in size and in silt and clay content.

Type IV: Sand and gravel deposits of this type are found in ridges of a few hundred feet to a few miles in length. The quality and size of material may be variable from place to place along the ridge. Water table conditions present no problems except along the foot of such ridges in wet areas.

Grain Size of Materials

Most of the sand and gravel deposits in Brown County contain materials with a wide range in grain size and silt and clay content. The deposits were not categorized according to grain size and quality.

Locations of Tested Sand and Gravel Pits

Table 1 lists the locations and sizes of sand and gravel pits which have been tested by the South Dakota Department of Highways.

Many persons have inquired about the possibility of finding shale-free gravel and sand, or at least gravel and sand containing less than 2 percent shale. It must be emphasized that shale is ubiquitous in Brown County sands and gravels. The percentage of shale is especially high in those deposits which occur in deep bedrock valleys such as Snake Creek along the southwestern border of the County and the Elm River (fig. 4). Therefore, in exploring for gravel and sand, careful tests should be made to determine the quality of the material found and its suitability for the intended use.

TABLE 1. List of sand and gravel pits in Brown County described by the South Dakota Department of Highways.

(Courtesy of Mr. Don Crampton, District Materials Engineer, South Dakota Department of Highways, Aberdeen, South Dakota)

Pit No.	Owner	Location	Type	Approximate Size (Cubic Yards)
1	Irene Gunderson	SW¼19-125-63	Gravel	64,000
2	Jacob and Mathilda Jenner	SE¼34-123-64	Sand & Gravel	92,000
3	Frank Rathert	NW¼6-124-62	Filler (Sandy)	10,000
4	Harold Schlosser	NW¼14-127-64	Gravel	100,000
5	A. W. Schnuerle	NW¼ & SW¼9-124-63	Sand	Unknown
6	Virgil and Emery Stucke	E½ & NW¼16-124-63	Gravel	30,000
7	Edwin Wiedebush	SW¼18-121-64	Sand & Gravel	140,000
8	Benjamin Witte	SE¼24-128-64	Gravel	59,000

NOTE: Pits in Townships 121 through 128 are shown on Figure 4.

EXPLANATION

Area of known occurrence of sand and gravel.

Areas having high probability of sand and gravel occurrence.

Areas having good probability of sand and gravel occurrence.

Areas having fair probability of sand and gravel occurrence.

Areas having poor probability of sand and gravel occurrence.

10●6 Sand and/or gravel within 10 feet of surface.

10ø5 Sand and/or gravel within 20 feet of surface.

10○ No sand or gravel within 20 feet of surface.

Test holes. Numbers at left of symbol indicate water depth. Numbers at right of symbol indicates thickness of sand and/or gravel. (Dashed if dry hole. No number or dash if water depth uncertain.

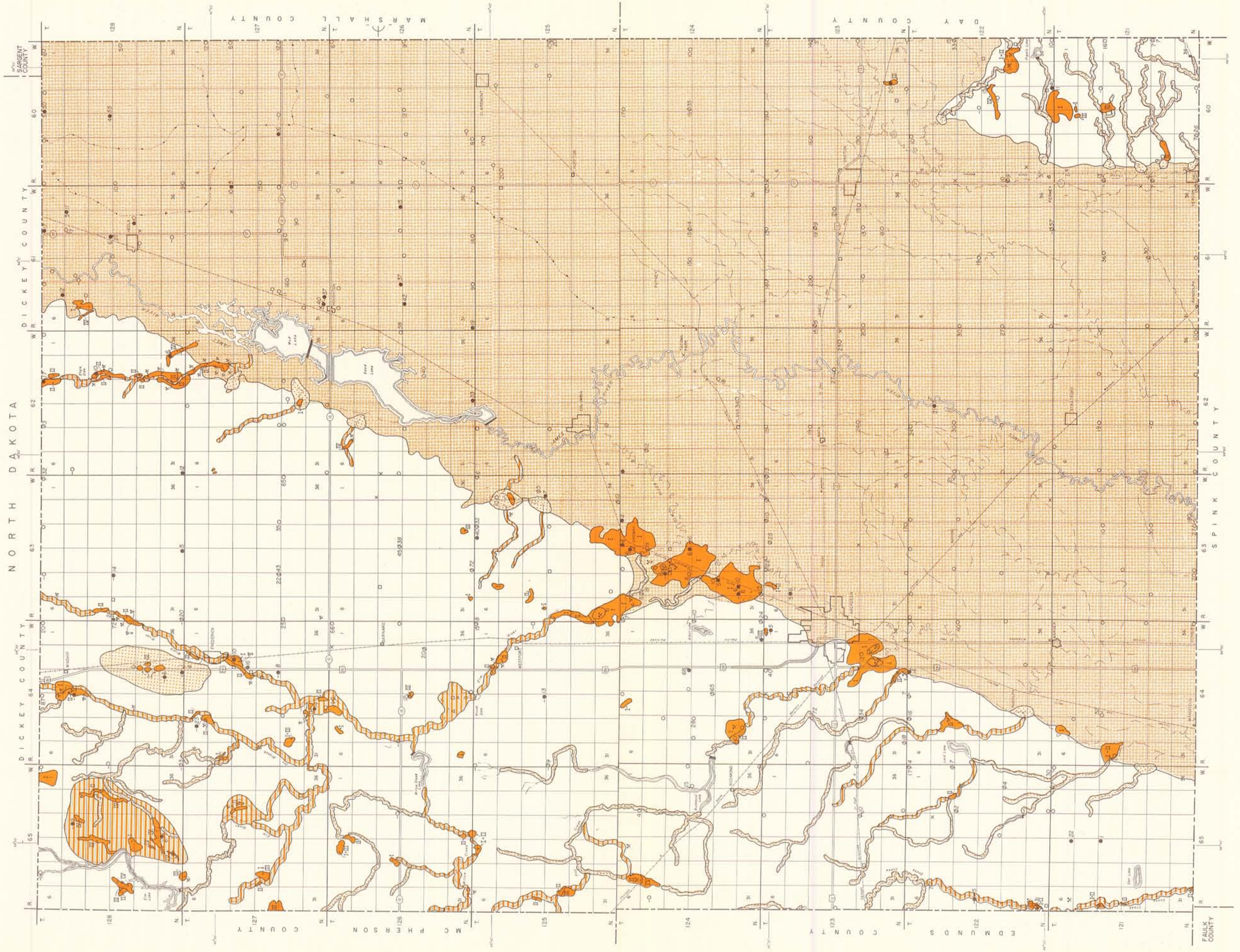
□ Gravel
× Sand

Special exploratory holes drilled by the South Dakota Department of Highways. Depth and thickness not given. (all are at or near ground surface).

I-IV Roman Numerals indicate topographic classifications of sand and gravel deposits, see text for description.

7× Sand and or gravel pits (no distinction between those abandoned and those presently in use). Numbers refer to those pits for which data are available (see table 1).

Figure 4. Map showing probability of sand and gravel occurrence in Brown County


MARSHALL COUNTY
DAY COUNTY
SARGENT COUNTY
DICKEY COUNTY
NORTH DAKOTA
SPINK COUNTY
MC PHERSON COUNTY
EDMUNDS COUNTY
FAULK COUNTY