STATE OF SOUTH DAKOTA
Richard Kneip, Governor

SOUTH DAKOTA GEOLOGICAL SURVEY
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Information Pamphlet No. 3

MAJOR AQUIFERS AND SAND AND GRAVEL RESOURCES IN DAY COUNTY, SOUTH DAKOTA

by

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and the Oahe Conservancy Sub-District

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CONTENTS

INTRODUCTION

This publication is designed to acquaint the reader with: (1) the general distribution, quality, and physical characteristics of the major aquifers in Day County, and (2) the general distribution of sand and gravel resources in Day 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 Day 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 is available are shown on Figures 1 and 2. The number beside each test hole on Figure 2 refers to the depth to and thickness of sand and gravel, if present, and depth to water table.

WATER RESOURCES

GLACIAL OUTWASH AQUIFERS

Day County contains three distinctly different major outwash aquifers--the Lynn, Lonesome Lake, and Eastern Lakes system (fig. 3).

The Lynn aquifer is located in the northwest quarter of the County and extends north into Marshall County where it is known as the James aquifer (Koch, Water Information Pamphlet No. 1, 1972). The Lynn aquifer rests on shale bedrock and trends generally northeast to southwest in a broad shallow trough, bounded on the west by a shale ridge and on the east by the edge of an early drift sheet. The aquifer is confined at the top by the drift of the latest glacier. Thickness of the aquifer ranges from 12 to 65 feet. Depth from land surface to the top of the aquifer runs from 180 to 320 feet. Because of its buried and confined nature, the aquifer is artesian; the head or water level has been measured at 170 feet above the top of the aquifer.

The aquifer becomes cleaner toward the center; i.e., the percentage of clay and silt becomes less. Production from a properly designed, gravel-packed well in the aquifer could probably be expected to run around 500 gallons per minute.

The quality of the water in the Lynn aquifer reflects the hydraulic connection with the shale beneath it and therefore is quite high in sulfate, calcium, and bicarbonate. More complete chemical data will be presented in a future report.

Drillers historically have usually avoided this aquifer when drilling wells for a customer. Usually they finish the well in a small lense of sand and gravel above the Lynn, or in the fractured shale beneath it. Such practice is probably the result of tradition more than anything else. The Lynn aquifer should be considered for future development and greater exploitation.

The Lonesome Lake aquifer is located in the southeast quarter of Day County and extends into Roberts, Grant, and Codington Counties. This aquifer is also buried and is composed of outwash ranging in thickness from 12 to 26 feet. Depth to the top of the aquifer ranges from 220 to 290 feet in the low areas and to nearly 400 feet beneath the high ridge along the eastern border of Day County. The aquifer is artesian; the head in an observation well has been measured at 188 feet above the top of the aquifer.

As far as can be determined, there are no wells in this aquifer. Therefore, it was not possible to get a water sample from it. However, comparison of the chemistry of deeply buried aquifers with that of shallow ones would indicate that the hardness and amount of total dissolved solids in this aquifer would be greater than that of the Eastern Lakes aquifers described below.

The yield of the Lonesome Lake aquifer is difficult to predict accurately, but production of 150 gallons per minute should be possible with a properly designed well.

The Eastern Lakes aquifer system is located in the area of the large lakes in eastern Day County. This is a complex system of several aquifers of varying thicknesses and elevations. The aquifers in this system are best developed and thickest around the edges of the lakes. The aquifers are essentially surface aquifers, but in places they connect with sand and gravel bodies which are buried beneath glacial drift. Depth to water ranges from land surface to around 80 feet. Most of the aquifers around the edges of the lakes are connected to each other by surface deposits of sand

and gravel. However, the surface deposits are, for the most part, high and dry; only in the connecting surface gravels between Blue Dog and Bitter Lakes can one expect to find water. The other surface deposits of outwash, although devoid of water, help to supply the aquifers to which they are connected with water from rain and melting snow; they are shown on the map (fig. 3) by dashed lines.

Thicknesses of the aquifers around the edges of the Lakes range from about 10 to 20 feet and are quite variable in thickness and in percentage of clay. Production from this system is difficult to predict due to the complex and varied nature of the deposits. The aquifers which are in direct hydraulic connection with the lakes will probably yield 500 gallons per minute to properly constructed gravel-packed wells.

Caution should be taken in pumping large amounts of water from the aquifer around the edge of Bitter Lake. The water is highly saline in the Lake, and any potential high-yield well in this aquifer should be carefully pump-tested in order to determine what rate of pumpage can be maintained without drawing the saline lake water into the aquifer.

The chemistry of the Eastern Lakes system is also quite variable; total dissolved solids range from 200 to 2000 parts per million, sulfates from 35 to 1000 parts per million, and hardness runs from 10 to 70 grains per gallon.

BEDROCK AQUIFERS

Bedrock aquifers in Day County are of two types: shale and Dakota sandstone.

In the northwest quarter of the County many wells tap the fractured Pierre shale bedrock, known locally as "slate." The wells are small pumpjack types with a narrow sand point screen or a perforated casing at the bottom of the well; production will seldom exceed 10 gallons per minute. Drillers report that larger diameter wells with large screens and submersible pumps will produce 40 gallons per minute. Water from the shale is usually quite hard and quite high in sulfates. Shale water actually comes from the Lynn aquifer above the shale.

The Dakota sandstone is pumped along the western edge of the County in the areas of low elevation. This is the well-known "artesian" formation and is found at depths in excess of 1,000 feet. Up on the high part of the County to the east the aquifer is not used because the head of the aquifer is too low, and the aquifer becomes rather poor in quality toward the east (production in gallons per minute is less toward the east). In the area where the Dakota aquifer is used, a few of the wells flow, but most have to be pumped. The water is usually soft and of a sodium sulfate type.

HIGH PRODUCTION WELLS

The domestic wells in Day County are nearly all low production types, seldom producing more than 8 to 10 gallons per minute. Adequate aquifers exist for the use of high-production wells. Before a high-yield well is installed, careful test drilling should first be employed. The test well should be tested by pumping for several hours in order to determine what rate of production can be maintained. The aquifer materials should be examined in order to determine the proper slot size of screen to be employed. In addition, chemical analyses of the water should be made in order to determine if the water is suitable for the use intended; this is especially true if the water is to be used for irrigation.

Finally, it should be noted that the most successful and productive wells are those which have a gravel pack between the aquifer and the well screen. Wells so constructed will not only yield more water per unit time, but will give less trouble and will last longer because a properly constructed gravel pack will filter out the fine sand and clay which can damage pumps. Persons who anticipate installing high-yield wells should bear in mind that the extra cost of such a properly developed well will be offset by longer pump life and better production over a longer period of time.

SAND AND GRAVEL RESOURCES

DISTRIBUTION OF SAND AND GRAVEL

Figure 4 shows the general distribution of sand and gravel deposits and the locations of gravel pits in Day County. In addition, location of test holes drilled by the South Dakota Geological Survey for this study are shown.

INTERPRETATION AND USE OF THE SAND AND GRAVEL MAP

PROBABILITY OF FINDING SAND AND GRAVEL

Probability of finding sand and gravel has been classified into four groups and are shown in Figure 4. The classifications are high, fair, poor, and none. The areas of high probability have been explored and are known to contain sand and gravel. Areas of fair probability are predominately areas of glacial till. Poor probability areas are those covered with a considerable thickness of lake silt. Areas where there is no probability of finding sand and gravel are shale bedrock outcrops.

TOPOGRAPHIC CLASSIFICATION

Most of the areas which are known to contain sand and gravel have been classified into five 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 fairly 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 table is not usually a problem except in some cases where the foot of the deposit reaches the bottom of a wet valley or depression.

Type III: Deposits of this type are found in large hills with steep sides and fairly flat to gently sloping tops. Many of these forms actually look like buttes or mesas and the material normally decreases in average size toward the interior of the hill. The water table is generally no problem except in areas where the foot of the hill reaches a wet area.

Type IIIa: This is a subgroup of Type III in which the deposits are found in groups of small hills or knobs. In this type the quality and size of materials are quite variable. The water table may or may not be a problem depending upon the particular situation.

Type IV: Sand and gravel deposits in this group are found in low areas around lakes and are often interspersed with lake silts which often cover the sand and gravel. The water table is generally near the surface--a condition which may require drag-line operations for extraction.

Type V: This type of deposit is 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 the ridge in wet areas.

SIZE-CHANGE DIRECTION

In many of the larger deposits of sand and gravel it was possible to determine the direction in which the average size of materials decreases. These directions are shown on the map by large black arrows. If one is exploring for sand and gravel in the vicinity of these arrows and finds the general size of material too large, one can follow the direction of the arrow to areas of smaller size material and vice-versa. Areas for which arrows are not given contain material with a wide variation in size from place to place.

LOCATIONS OF TESTED SAND AND GRAVEL PITS

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

THE PRESENCE OF SHALE

Many persons have inquired about the possibility of finding shale-free gravel, or at least gravel containing less than 2 percent shale. It must be emphasized that shale is ubiquitous in Day County gravels. Therefore, in exploring for gravel and sand careful tests should be made to determine the quality of the gravel and its suitability for the intended use.

REFERENCE CITED

Koch, Neil, C., 1972, Major aquifers and sand and gravel resources in Marshall County, South Dakota: S. Dak. Geol. Survey Water Inf. Pamph. no. 1, 9 p., 3 figs., 1 table.

Table 1. List of sand and gravel pits in Day 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.	Mrs. Merle Ahern	NW¼16-121-59	Gravel	119,000
2.	Marvin Buhler	NW¼11-121-56	Gravel	150,000
3.	John Bury	N½31-122-57	Sand & Gravel	100,000 *
4.	Albert & Vera Buss	SW¼32-124-58	Clay	9,000
5.	Ellen E. Denholm	SE¼33-122-59	Gravel	200,000
6.	John Fischer	SE¼9-124-55	Gravel	80,000
7.	John Fischer	NE¼NE¼16-124-55	Gravel	80,000
8.	F. A. & Dolores Gallnick	SE¼22-122-56	Gravel	125,000 *
9.	William Good	SE¼25-121-53	Gravel	140,000
10.	Helen Gruba	NW¼13-124-53	Gravel	138,000
11.	Clarence Gustafson	SE¼20-122-57	Gravel	48,000 *
12.	Hansmeier & Son Corp.	SE¼2-121-59	Gravel & Sand	Unknown
13.	Hansmeier & Son Corp.	NW¼2-121-59	Gravel	80,000 *
14.	James Helwig	NW¼18-123-55	Gravel	30,000
15.	Frank Kozlowski	SW¼17-123-54	Gravel	70,000
16.	Ivan & Caroline Morehouse	NW¼26-122-59	Clay	6,000
17.	Harry D. Witt	E½NE¼7-120-58	Gravel	130,000

* Nearly exhausted

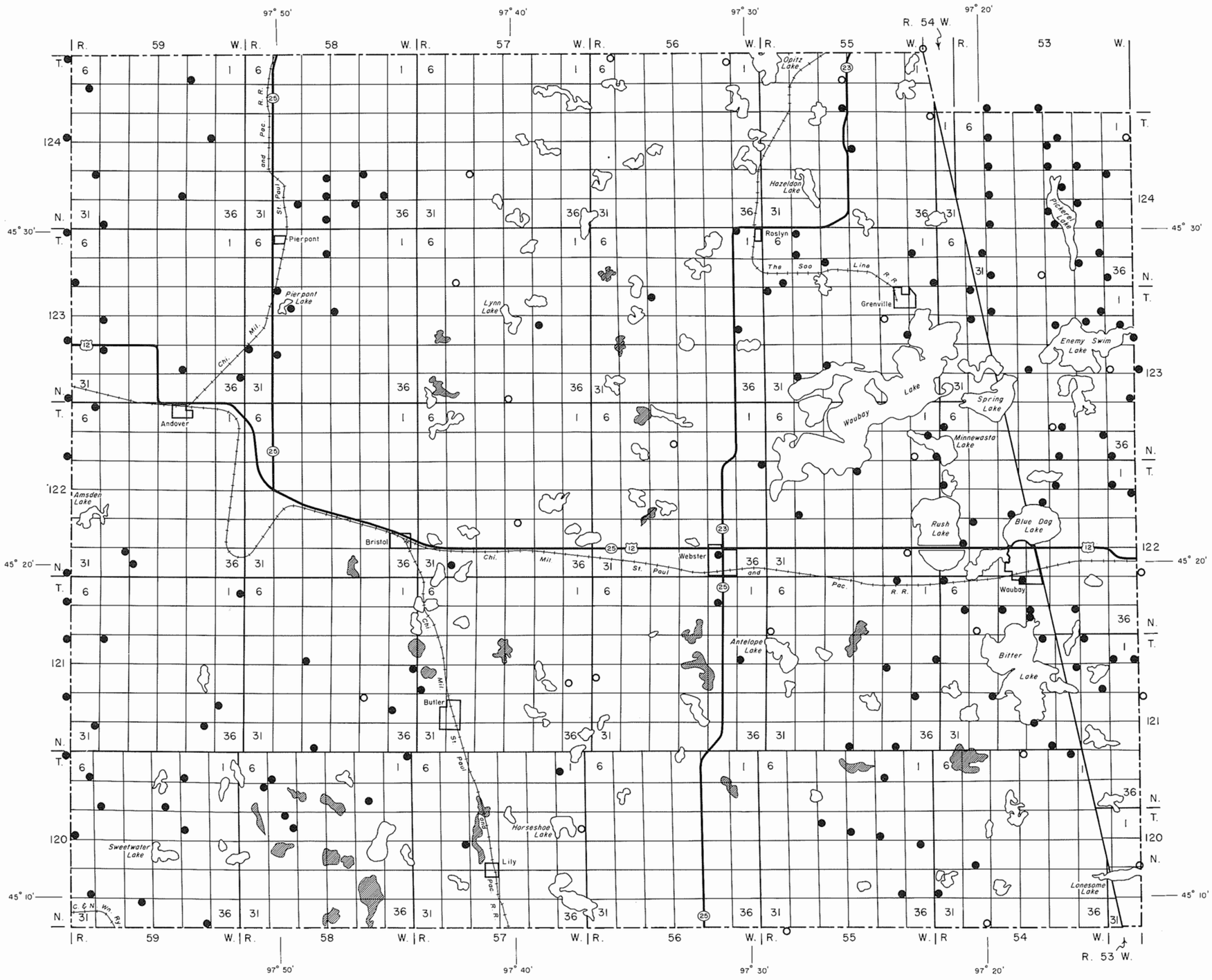

Figure 1. Map showing locations of test holes in Day County for which logs are available.

EXPLANATION

● Test holes for which descriptive logs are available.

○ Test holes for which descriptive and electric logs are available.

0 1 2 3 4 5 6 miles

Scale

Index map of South Dakota showing location of Day County

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drafted by D. Johnson

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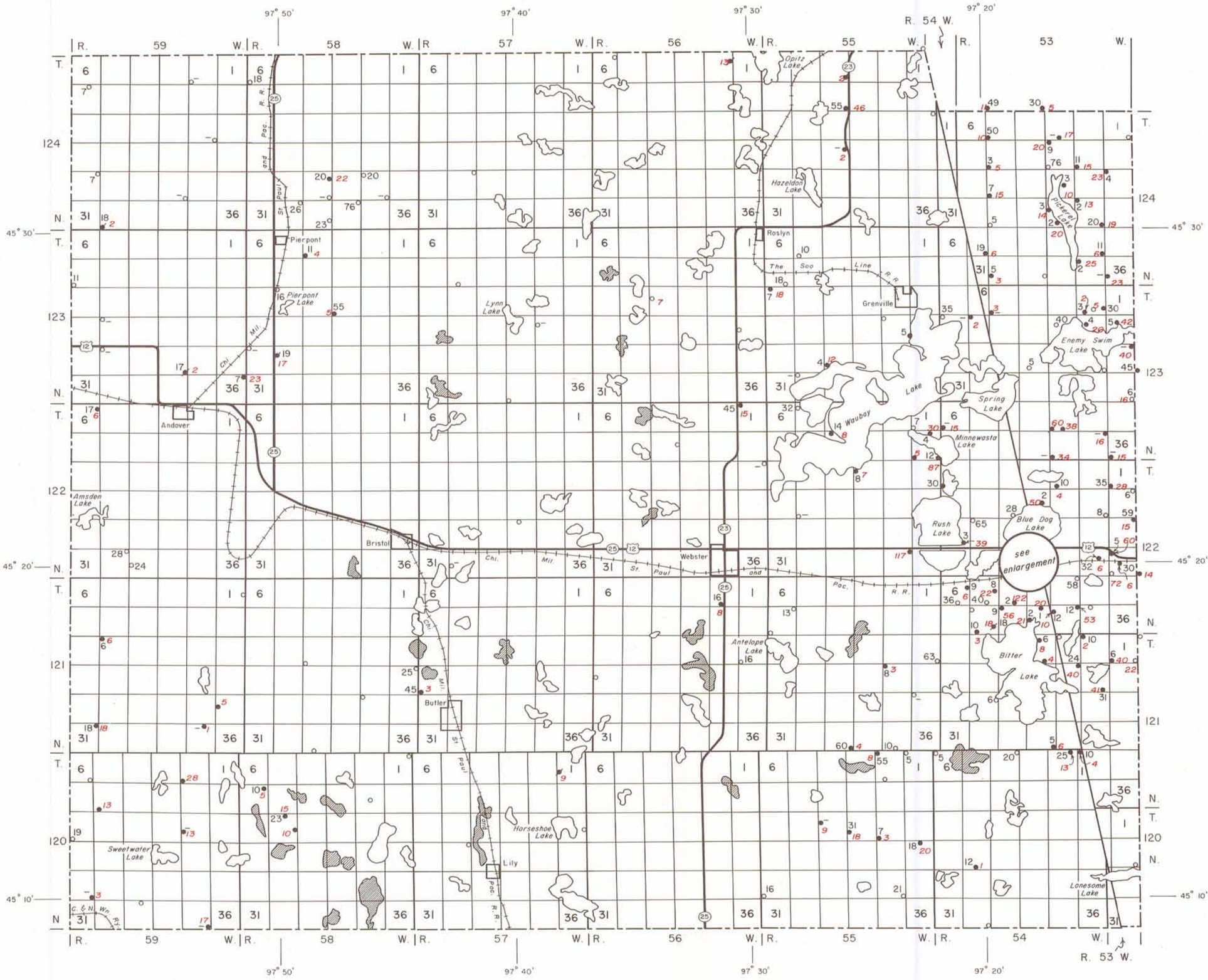
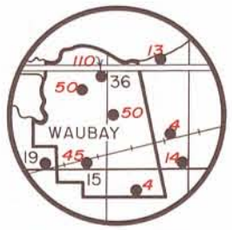


EXPLANATION

- • Test hole showing sand and/or gravel within 10 feet of land surface.
- ⸗ Test hole showing sand and/or gravel within 20 feet of land surface.
- ◦ Test hole showing no sand and/or gravel within 20 feet of land surface.
- 60 Number indicates thickness of sand and/or gravel in feet.
- 15 Number indicates depth to water table in feet. Number absent where depth to water table could not be determined. A dash indicates water table was not reached.

Index map of South Dakota showing location of Day County



Enlargement (2x)

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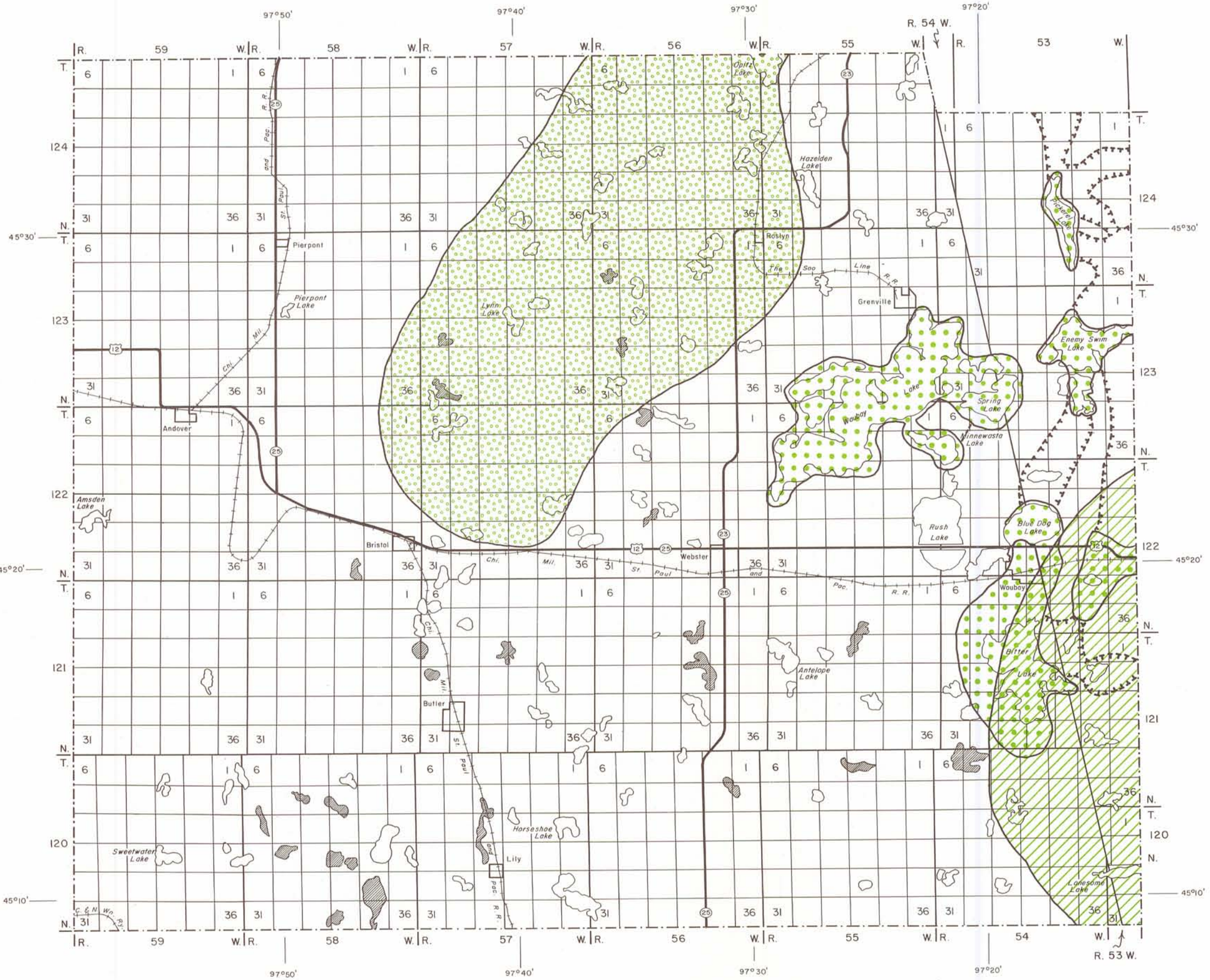
0 1 2 3 4 5 6 miles
Scale

Figure 2. Test hole map of Day County showing depth to and thickness of sand and gravel and depth to water table.



EXPLANATION

- Lynn Aquifer
- Eastern Lakes System Aquifers
- Connecting surface outwash between aquifers of the Eastern Lakes System
- Lonesome Lake Aquifer

0 1 2 3 4 5 6 miles
Scale

Index map of South Dakota showing location of Day County

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Figure 3. Map showing locations of major glacial aquifers in Day County.

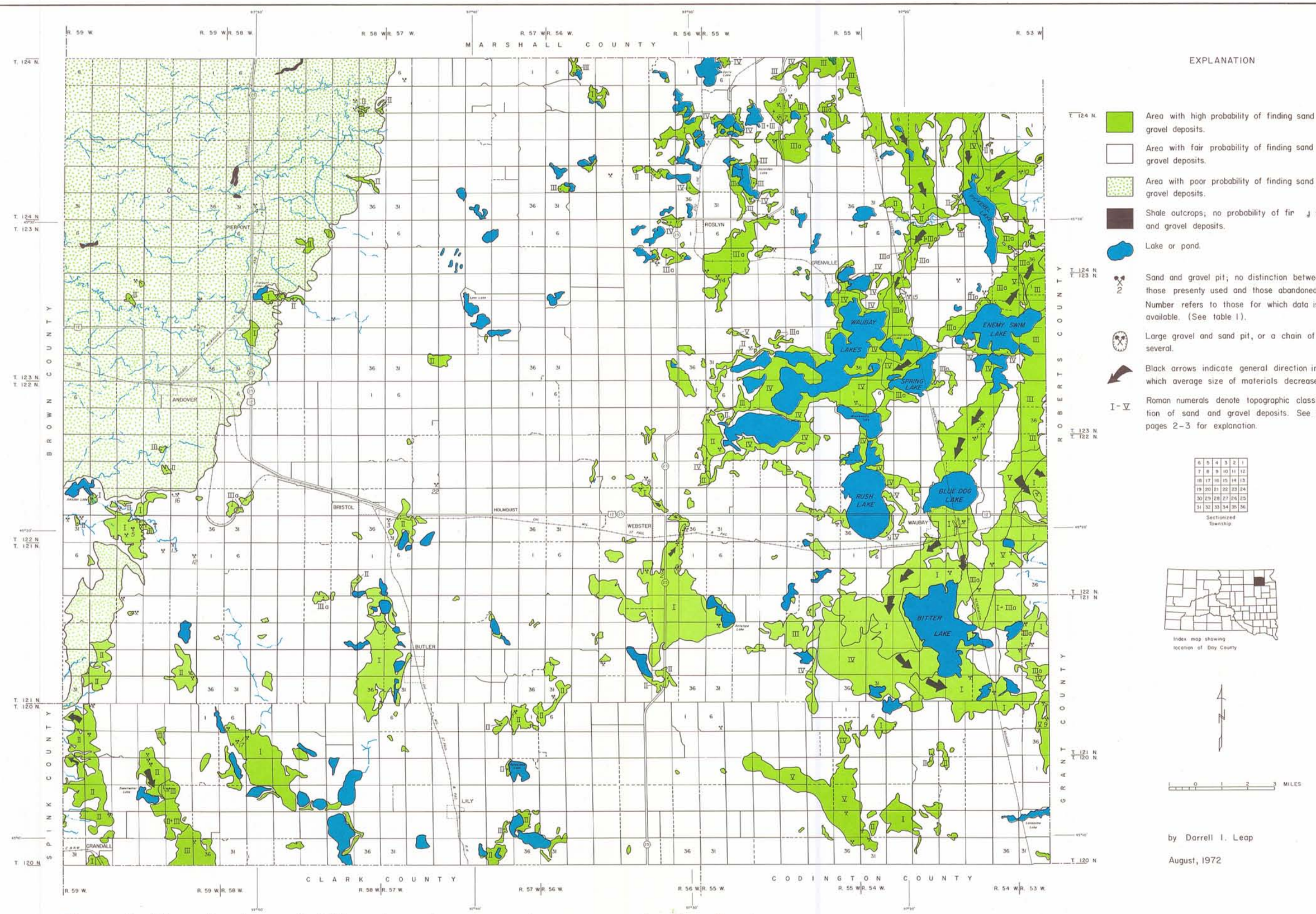

Figure 4. Map showing probability of sand and gravel occurrence in Day County.

by Darrell I. Leap

August, 1972