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DEPARTMENT OF NATURAL RESOURCE DEVELOPMENT
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GEOLOGICAL SURVEY
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Information Pamphlet No. 16

MAJOR AQUIFERS IN CLARK COUNTY, SOUTH DAKOTA

by

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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 Clark County. A comprehensive report to be published later will contain much additional information on the hydrology and geology of the area.

Information in this report is based on data (fig. 1) collected by the U.S. Geological Survey and the South Dakota Geological Survey during the period 1973-76.

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 English units used in this report may be converted to metric units by the following conversion factors:[1]

DEFINITION 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.--An artesian aquifer is one in which the water in a well rises above the top of the aquifer.

Basement rock.--A general term for granite, quartzite, and other dense, impermeable rocks that are the base of the hydrologic system.

Bedrock.--A general term for the rock, usually solid, that underlies soil, sand, clay or other unconsolidated material. In Clark County the uppermost bedrock is shale.

Dissolved solids.--Includes all material in water that is in solution.

Glacial aquifer.--A water-bearing formation composed of materials derived from a glacier. In this report it is mainly unconsolidated sand and gravel deposited as outwash from a glacier.

Hardness.--Dissolved calcium and magnesium salts that reduce 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:[2]

Prairie Coteau.--A high plateau of rolling to hilly topography in eastern South Dakota. The Coteau comprises the eastern part of Clark County.

Properly-constructed well.--One constructed to admit a maximum amount of water from an aquifer without excessive loss of head at the well. This generally requires either installing a well screen or perforating the casing opposite 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.

Saline water.--For the purpose of this report, saline water is classified as that which contains more than 1,000 mg/L of dissolved solids.

Till.--An unsorted, unstratified mixture of clay, silt, sand, gravel, and boulders deposited by a glacier.

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[1]

Multiply English Unit	By	To Obtain Metric Unit
feet (ft)	0.3048	meters (m)
gallons (gal)	3.785	liters (L)
gallons per minute (gal/min)	0.063	liters per second (L/s)
miles (mi)	1.609	kilometers (km)
square miles (mi^2)	2.590	square kilometers (km^2)

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[2]

Description	Milligrams per liter (mg/L)	Grains per gallon (gpg)
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

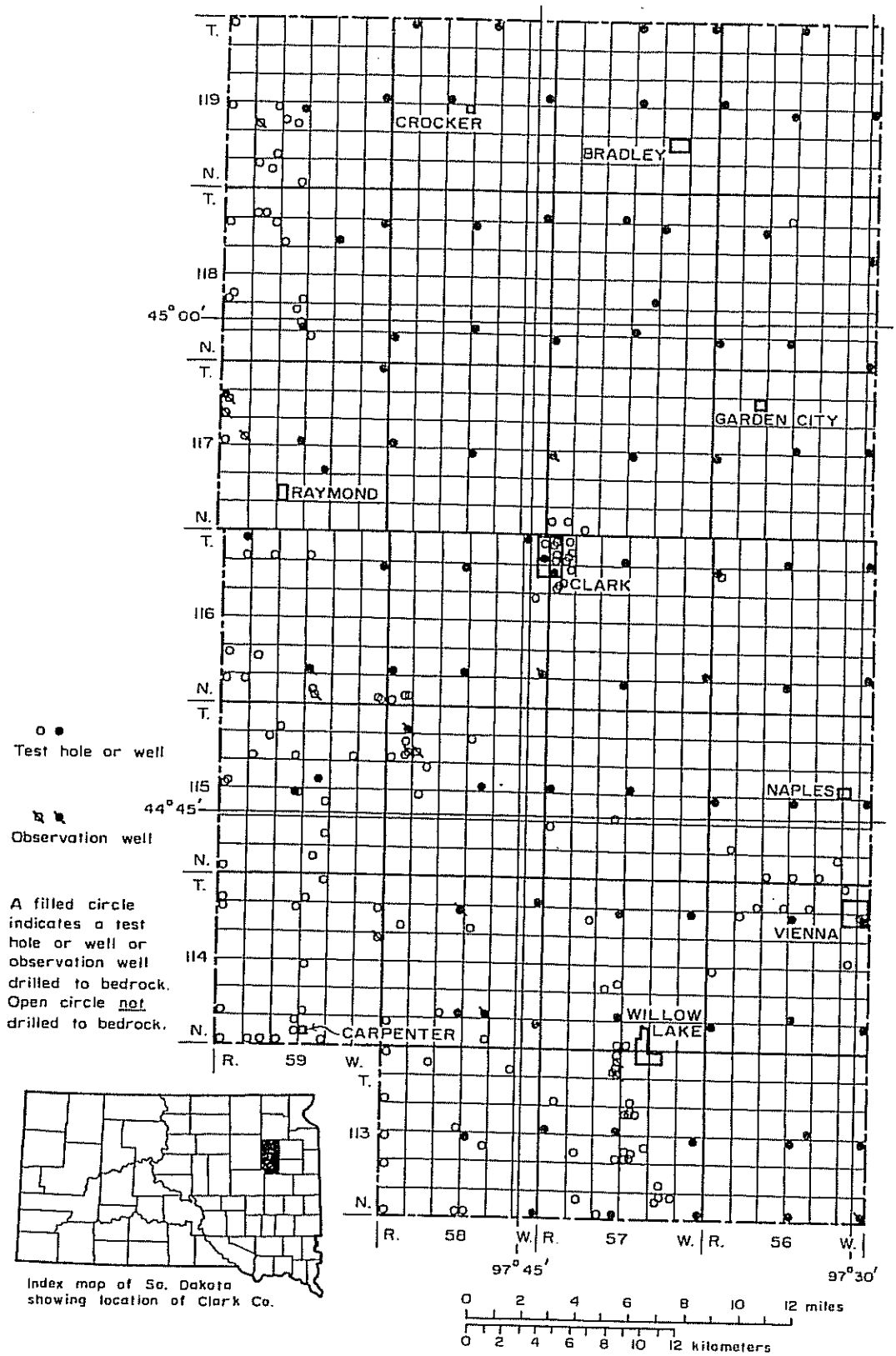

Figure 1. Map showing location of test holes and wells for which geologic, electric, or driller's logs are available.

Water table.--That surface in an unconfined water body at which the pressure is atmospheric. Generally this is the upper surface of the zone of saturation, except where the surface is formed by a poorly permeable body.

GLACIAL AQUIFERS

Table 1 summarizes some of the physical and hydrochemical properties of six major glacial aquifers. Three of the aquifers are grouped as the Prairie Coteau aquifers and the other three are grouped as the Altamont aquifers which occur at lower altitudes than the former.

Prairie Coteau Aquifers

The Prairie Coteau aquifers (fig. 2), numbered 1, 2, and 3, in order of increasing depth, underlie an area of nearly 200 mi^2. They are shown in a single figure (fig. 2) because the area of overlapping is small and easily discerned. However, they are not hydraulically connected, being separated from one another and the Altamont aquifers by 30 to 150 ft of poorly permeable till. Altitudes of the tops of the Prairie Coteau aquifers range from 1,520 to 1,790 ft. Depths to the tops of the aquifers range from 5 to 330 ft below land surface.

Although most of the water in the Prairie Coteau aquifers is saline it has been a satisfactory supply for human and livestock consumption. The water may require treatment for other uses in order to reduce high concentrations of iron, manganese, and hardness. Some of the water in aquifers 2 and 3 may be unsuitable for irrigating poorly drained soil because of the high concentrations of dissolved solids in the water.

Prairie Coteau Aquifer 1

The aquifer extends over an area of about 80 mi^2. The depth to its top ranges from 5 to 30 ft below land surface (table 1). The aquifer is mostly silty, fine to coarse sand and gravel which has an average thickness of about 20 ft. Where it is thicker than average it can yield as much as 800 gal/min of water to a properly-constructed well. The water occurs under water-table conditions and water levels range from 6 to 40 ft below land surface.

Water from the aquifer is of the calcium bicarbonate or the calcium bicarbonate sulfate type. Concentrations of dissolved solids range from 270 to 2,000 mg/L. The hardness of the water ranges from 190 to 1,400 mg/L.

Prairie Coteau Aquifer 2

The aquifer has an areal extent of about 110 mi^2. The depth to its top ranges from 50 to 170 ft below land surface. The aquifer is mostly fine to very coarse sand and gravel which has an average thickness of about 20 ft. Where it is thicker than average it can yield as much as 800 gal/min of water to a properly-constructed well. The water occurs under artesian conditions. Water levels range from 1 to 100 ft below land surface.

Water from the aquifer is of the sodium calcium sulfate type. Concentrations of dissolved solids range from 750 to 2,200 mg/L, and the hardness of the water ranges from 620 to 1,800 mg/L.

Prairie Coteau Aquifer 3

The aquifer has an areal extent of about 50 mi^2. The depth to its top ranges from 200 to 330 ft below land surface. The aquifer is mostly clayey, fine to very coarse sand and gravel which has an average thickness of 20 ft. A properly-constructed well can produce as much as 200 gal/min of water where the aquifer is thickest. The water occurs under artesian conditions and water levels range from 140 to 180 ft below land surface.

Water from the aquifer is of the calcium sulfate type; concentrations of dissolved solids range from 1,400 to 2,300 mg/L and hardness ranges from 770 to 1,800 mg/L.

Altamont Aquifers

The Altamont aquifers, numbered 1, 2, and 3, in order of increasing depth, underlie an area of 700 mi^2, about 70 percent of Clark County (table 1). The aquifers are separated vertically from each other by as much as 140 ft of poorly-permeable till in the eastern part of the County, but are hydraulically connected west of the Coteau.

Altitudes of the tops of the aquifers range from 1,260 to 1,500 ft; depths to their tops tend to increase from west to east as the land surface slopes upward onto the Prairie Coteau.

Although most of the water in the Altamont aquifers is saline it has been a satisfactory supply for human and livestock consumption. The water may require treatment for other uses in order to reduce high concentrations of iron, manganese, and hardness. Some of the water may be unsuitable for irrigating poorly-drained soil because of its high concentrations of dissolved solids.

Altamont Aquifer 1

This uppermost of the Altamont aquifers extends over an area of 180 mi^2, shown in fig. 3. The depth to the top of the aquifer is only 70 ft at its southwest

TABLE 1. Some physical and hydrochemical properites of major glacial aquifers

Aquifer name	Range in altitude of top (feet above mean sea level)	Range in depth to top (feet)	Range in water level (feet), + indicates above land surface	Average thickness (feet)	Maximum well yield (gal/min)	Range in concentrations of dissolved solids (mg/L)	Range in hardness (mg/L)
Prairie Coteau aquifers							
1	1,760-1,790	5- 30	6- 40	20	800	270-2,000	190-1,400
2	1,650-1,770	50-170	1-100	20	800	750-2,200	620-1,800
3	1,520-1,590	200-330	140-180	20	200	1,400-2,300	770-1,800
Altamont aquifers							
1	1,450-1,500	70-372	+25-260	30	800	1,500-2,500	850-1,800
2	1,360-1,500	10-480	+25-326	40	800	780-3,380	400-1,600
3	1,260-1,360	70-585	8-260	30	300	600-2,500	250-1,100

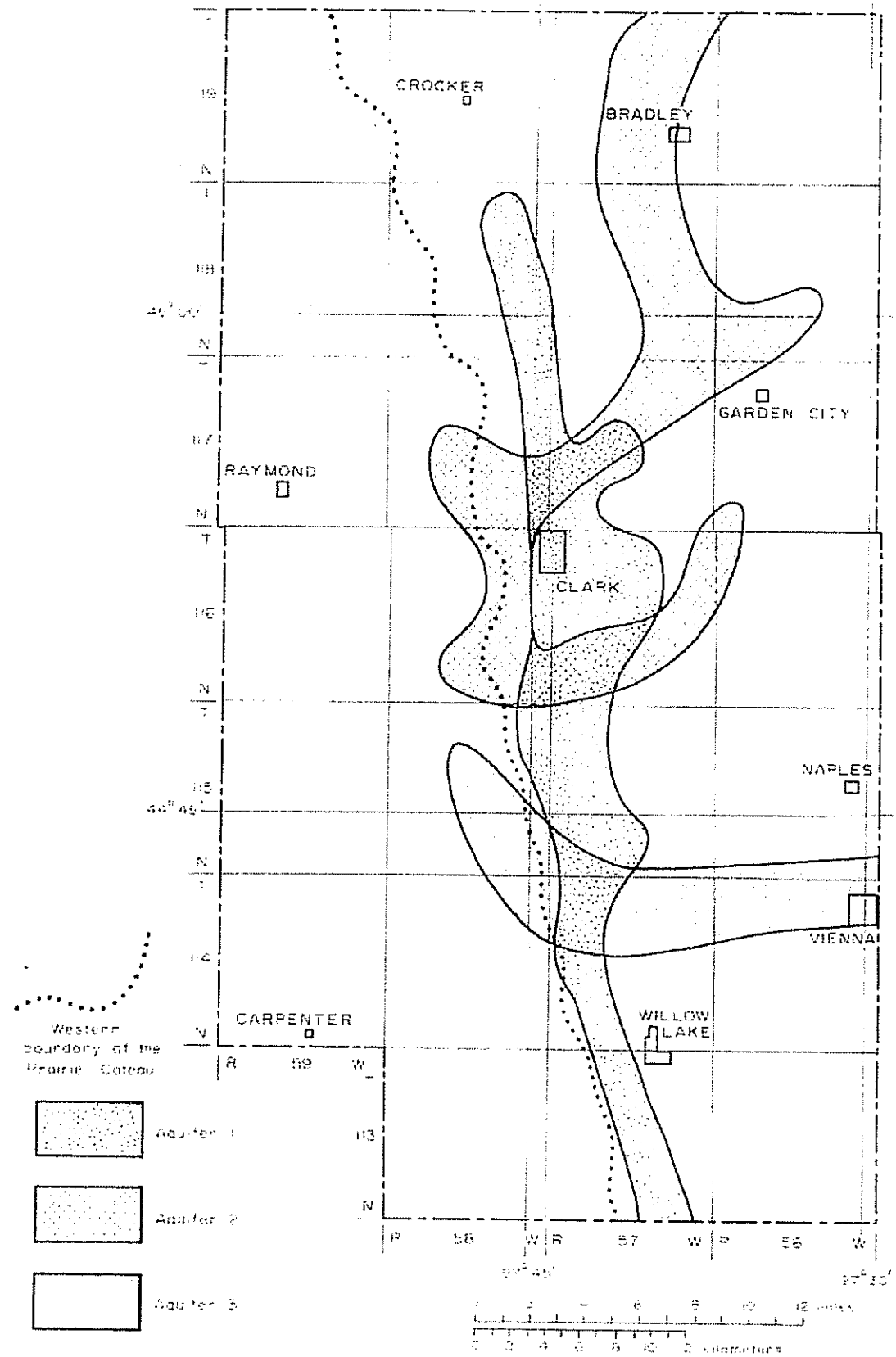

Figure 2. Map showing areal extent of the Prairie Coteau aquifers

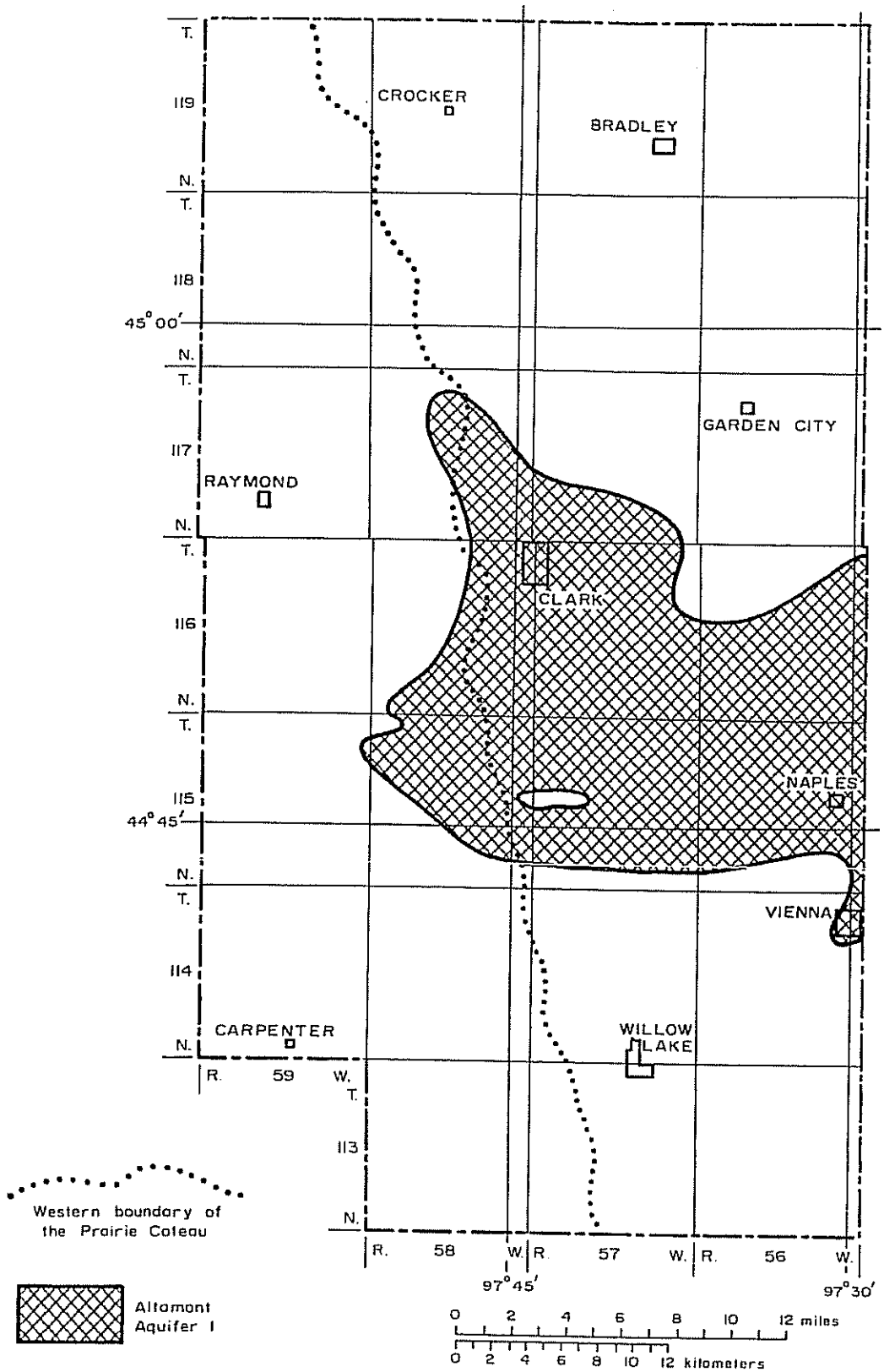

Figure 3. Map showing areal extent of the Altamont aquifer I.

end. However, depths increase greatly in a few miles to the north and east and range from 300 to 372 ft on the Coteau. The aquifer is mostly fine to very coarse sand and gravel which has an average thickness of about 30 ft. It can yield as much as 800 gal/min of water to a properly-constructed well where its thickness exceeds 20 ft. The water occurs under artesian conditions. Water levels range from 25 ft above land surface at a flowing well at the southwest edge of the aquifer, to 260 ft below land surface on the Coteau, 4 mi to the east of the flowing well.

Water from the aquifer is of the calcium sulfate type. Concentrations of dissolved solids range from 1,500 to 2,500 mg/L and the hardness ranges from 850 to 1,800 mg/L.

Altamont Aquifer 2

The areal extent of this aquifer, shown in fig. 4, is about 630 mi^2. Depths to aquifer 2 range from 10 to 480 ft but are between 300 and 480 ft in the northeastern part and between 350 and 400 ft in the southeastern part of the County. In the northeastern part the aquifer is mostly sandy silt which has an average thickness of 80 ft and can yield as much as 200 gal/min of water to a properly-constructed well. Elsewhere in the County the aquifer is fine to very coarse sand and gravel which is about 30 ft thick. The sand and gravel can yield as much as 800 gal/min to a properly-constructed well. Water in the aquifer occurs under artesian conditions. Water levels range from 25 ft above land surface for flowing wells at the southwest end of the aquifer to as much as 326 ft below land surface on the western edge of the Coteau. On the Coteau, depths to water in wells generally range from 100 to 200 ft below land surface.

Water from the aquifer is of the calcium magnesium sulfate or sodium sulfate type. Concentrations of dissolved solids range from 780 to 3,380 mg/L and the hardness of the water ranges from 400 to 1,600 mg/L.

Altamont Aquifer 3

This lowermost of the Altamont aquifers extends over an area of 210 mi^2 (fig. 5). It occurs as a series of narrow, braided channels within a branching valley 1- to 6-mi wide, which was cut into shale bedrock by streams. One of the channels is beneath the city of Clark (section 6, T. 116 N., R. 57 W.) where the top of the aquifer is at a depth of from 474 to 585 ft. The depth decreases westward, from the Coteau to a minimum of 70 ft.

The aquifer is mostly silty, clayey, fine to very coarse sand and gravel which has an average thickness of 30 ft. The aquifer can yield as much as 300 gal/min of water to a properly-constructed well. The water occurs under artesian conditions. Water levels range from 8 ft below land surface in the western end of the aquifer to 260 ft below land surface near the city of Clark.

Water from the aquifer is of the sodium sulfate or calcium sulfate type. Concentrations of dissolved solids range from 600 to 2,500 mg/L and the hardness ranges from 250 to 1,100 mg/L.

BEDROCK AQUIFER

The Dakota Formation of Cretaceous age is the only known bedrock aquifer in Clark County. It is composed of fine-grained, silty sandstone and sandy shale. The aquifer underlies the entire County except possibly at a few places where wells have penetrated only hard, dense rock. This rock may be either cemented sandstone or basement rock, both of which probably are impermeable in this area.

The depths to the top of the formation range from about 900 ft in the south to about 1,100 ft in the north along the western end of the County. The corresponding depths to the east, on the Prairie Coteau, range from 1,200 ft in the south to 1,400 ft in the northern part of the County.

The formation, which ranges in thickness from 0 to 200 ft, can yield as much as 50 gal/min to a properly-constructed well.

Although the water from the Dakota Formation is saline it has been a satisfactory supply for human and livestock consumption. The water is softer than that from shallower aquifers but is unsuitable for irrigation because of its high concentration of dissolved solids and high percentage of sodium. The water is of the sodium sulfate type. Concentrations of dissolved solids range from 2,200 to 3,300 mg/L and hardness ranges from 15 to 200 mg/L.

POSSIBILITIES FOR OBTAINING WATER FOR IRRIGATION WELLS

The best possibilities for obtaining wells capable of supplying yields sufficient for irrigation are in the areas where the aquifers are more than 20 ft thick. Before irrigation wells are constructed, a test hole should be drilled at the selected location to determine the thickness of the aquifer and to 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 in the construction of the test well. Controlled pumping of the test well can show the yield of the aquifer at that locality and provide a water sample for chemical analysis. A knowledge of 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.

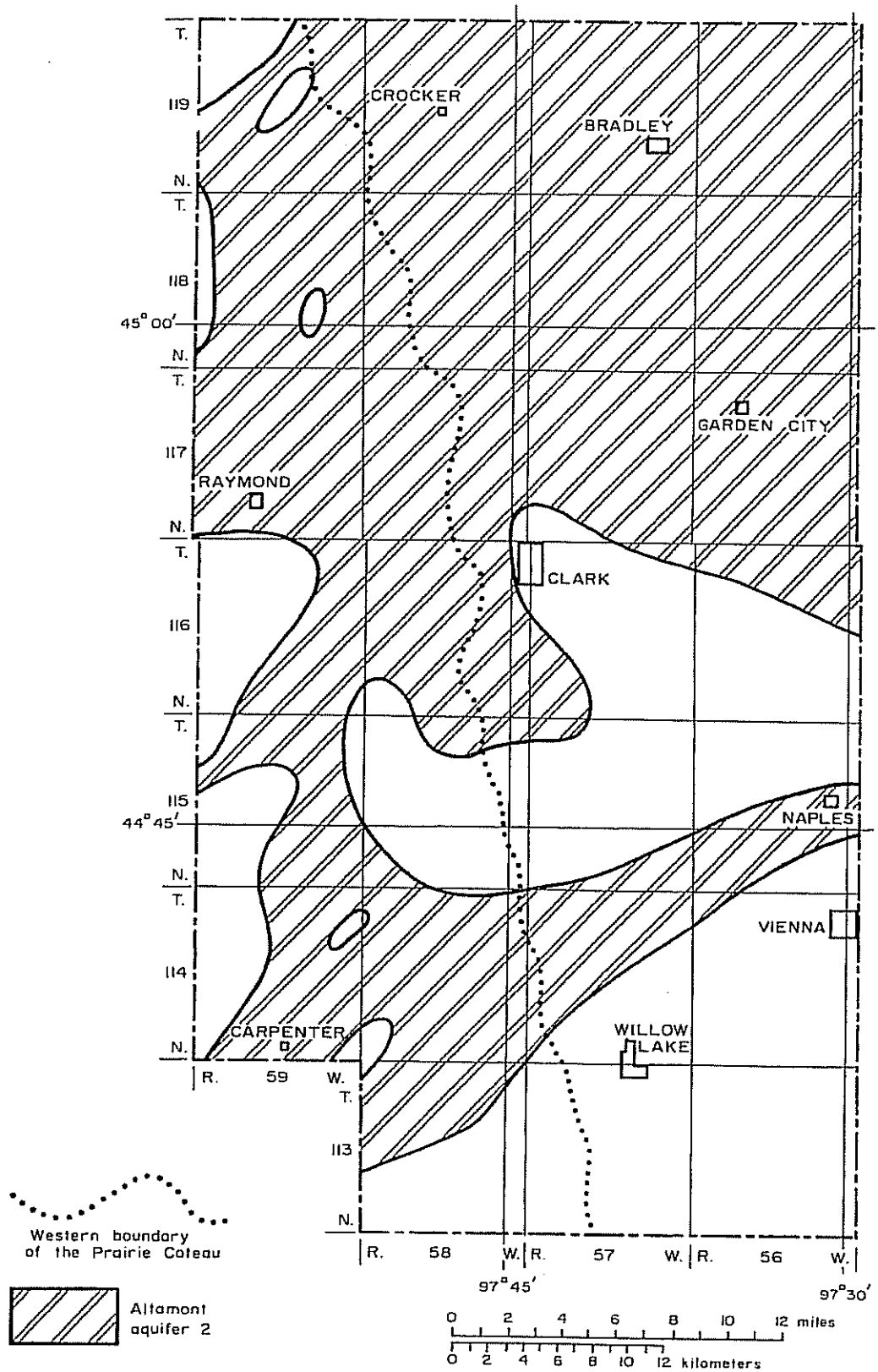

Figure 4. Map showing areal extent of the Altamont aquifer 2.

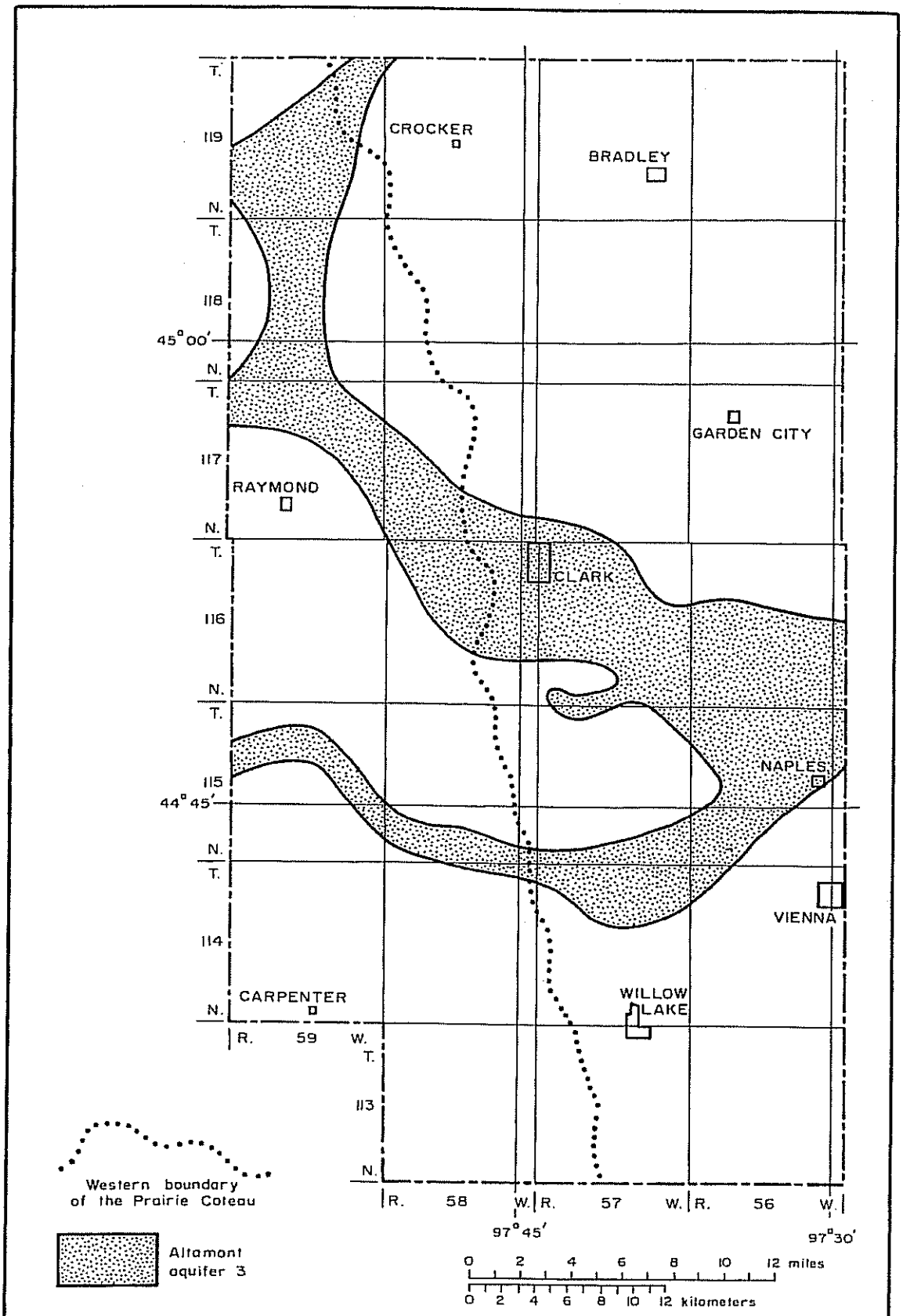

Figure 5. Map showing areal extent of the Altamont aquifer 3.