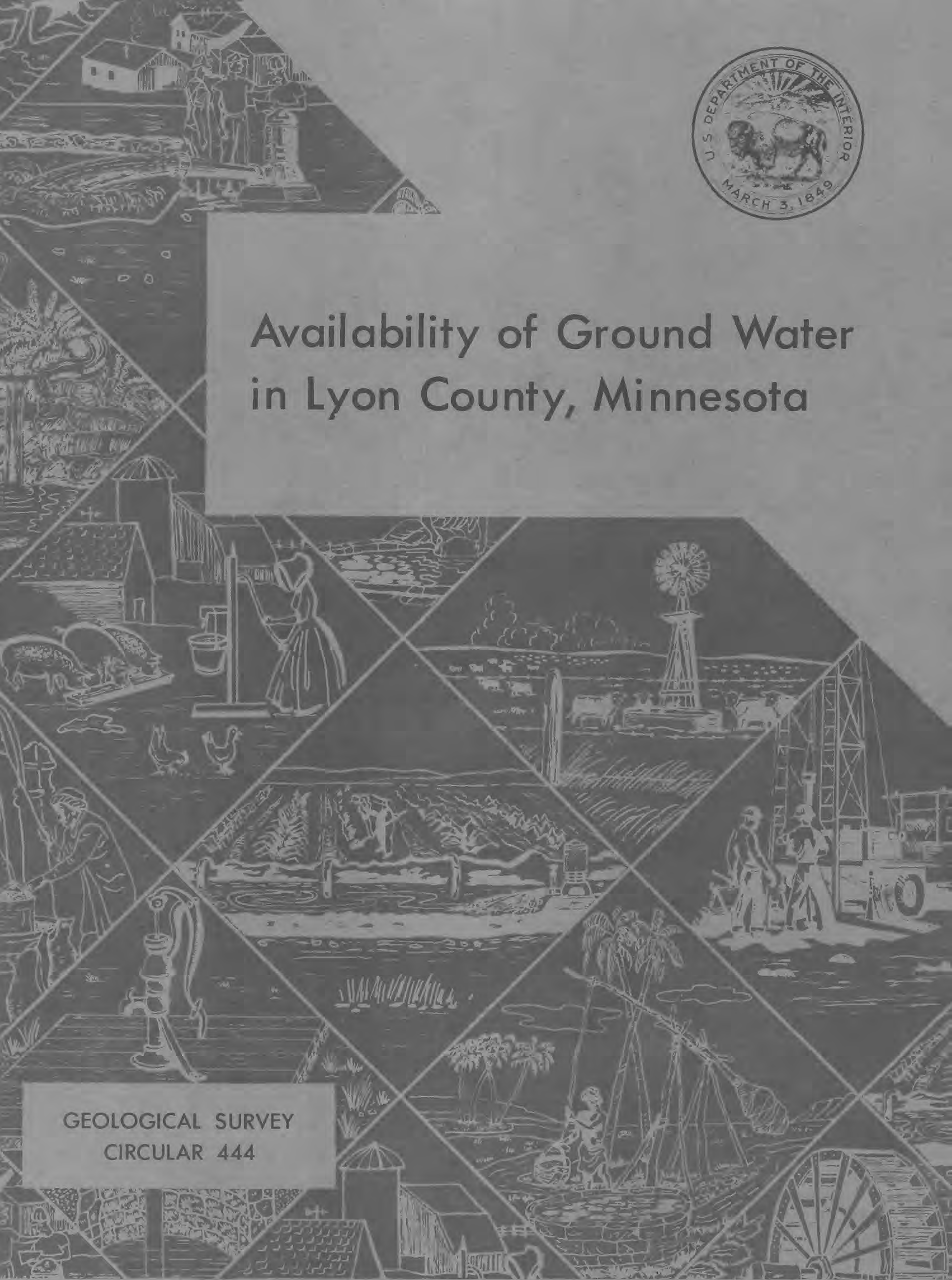
Availability of Ground Water in Lyon County, Minnesota



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Prepared in cooperation with the Division of Waters, Minnesota Department of Conservation and the Marshall Municipal Utilities, Marshall, Minn.

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ABSTRACT

Lyon County is in southwestern Minnesota, about 150 miles southwest of Minneapolis and St. Paul. The basement rocks in the area consist of granite and quartzite of Precambrian age. These materials are in turn overlain by shale and sandstone of Cretaceous age, glacial drift of Pleistocene age, and alluvium of Recent age. Ground water is available primarily from aquifers in Pleistocene and Cretaceous strata from depths ranging from 15 to 500 feet below the land surface.

The county is divided into areas of ground-water availability based on the quality and quantity of ground water available from the different geologic units. The glacial drift which covers all of the area, yields very hard water from sands and gravels occurring in melt-water channel deposits or as small, isolated melt-water bodies. Wells in the drift commonly yield from 2 to 30 gpm (gallons per minute), but sustained yields of as much as 500 gpm are obtained in areas where thick melt-water channel deposits occur. Cretaceous strata underlie about two-thirds of the county and yield water from poorly consolidated sandstone. The water ranges in hardness from soft to very hard and is sometimes high in chloride content. Wells in Cretaceous strata commonly yield from 2 to 7 gpm; however, in areas where the sandstone is in contact with the underlying weathered granite, sustained yields of as much as 75 gpm are obtained. The geographic and stratigraphic distribution of the geologic units suggests that additional water supplies may be available from Pleistocene and Cretaceous strata in areas not yet fully explored.

INTRODUCTION

Ground water in Lyon County, Minn., is available in widely varying quantities from several geologic units. This circular summarizes the availability of ground water and briefly describes the geologic source and quality; its purpose is to present this information to residents and drillers of the area. The study was made by the U.S. Geological Survey as part of an investigation of the ground-water resources of Lyon County in cooperation with the Division of Waters, Minnesota Department of Conservation. The investigation was made under the direct supervision of Robert Schneider, district geologist of the Ground Water Branch of the U.S. Geological Survey.

Much of the information in this report is based on records of more than 2,500 wells collected from well owners and drillers during the summer field seasons of 1956–58. Detailed information on individual aquifers in the area was obtained from drillers' logs, by mapping of surficial glacial deposits, and by test drilling supervised by the Geological Survey. Determinations of hardness and chloride content of water samples were made in the field, and some were verified later by laboratory analysis.

Lyon County is in southwestern Minnesota, about 150 miles southwest of Minneapolis and St. Paul in the drainage basin of the Minnesota River. The county is approximately rectangular, about 30 miles from north to south and 24 miles from east to west. It may be divided into two distinct topographic units: the southwestern part which lies on the northeast slope of the Coteau des Prairies, an elongate highland extending northwestward through South Dakota, Minnesota, and Iowa (Fenneman, 1938, p. 573); and the northeastern part, which is a gently rolling prairie. The southwestern part is well drained and is characterized by a moderately dissected drift topography, whereas the northeastern part is a flat, poorly drained drift plain.

GEOLOGIC CONDITIONS

The geographic and stratigraphic distribution of the major geologic units in Lyon County is illustrated on the accompanying map (fig. 1) and are described briefly in table 1. The basement rocks consist largely of Precambrian granite and quartzite, the quartzite occurring only in the extreme southwestern part of the area. In most places the granite is deeply weathered and is covered by a thin

Table 1.—*Description of geologic units and their water-bering characteristics*

System	Series	Approximate thickness (feet)	Description	Water-bearing characteristics
Quaternary	Recent	0–20(?)	Alluvium made up mostly of silt, sand, and gravel, generally restricted to stream valleys.	Not an important aquifer because of its limited thickness and areal extent.
	Pleistocene	10–550+	Glacial drift, mostly till made up of unsorted mixture of clay, silt, sand, gravel, and boulders; contains sorted and bedded outwash deposits of sand and gravel deposited in channels and lake basins; till contains small lenses and irregularly shaped bodies of silt, sand, and gravel.	Outwash sand and gravel yields small to large supplies of water, the amount depending on the thickness, extent, and permeability of the deposits. Till is relatively impermeable; small to moderate amounts of very hard water are obtained from small bodies of silt, sand, or gravel in the till.
Cretaceous	Upper Cretaceous	0–450+	Shale, soft, dark-bluish-gray contains thin zones of interbedded sandstone, siltstone, and lignite; sandstone is fine grained and loosely consolidated and generally occurs in beds less than 2 ft thick.	Sandstone usually yields small amounts of water. Shale, siltstone, and lignite are virtually impermeable.
Precambrian	(?)	(?)	Quartzite, hard, compact, pink, fractured.	Virtually impermeable; may yield a little water from creviced zones.
			Granite, pink, red, and gray, coarse-grained, biotitics; weathered and creviced at the top.	Virtually impermeable; may yield a little water from weathered and creviced zone.

regolith, consisting in part of weathered materials transported and reworked during Cretaceous time.

The Precambrian rocks are overlain in places by flat-lying Upper Cretaceous strata composed largely of thick sections of soft dark-bluish-gray shale but including thin beds of loosely consolidated sandstone. The strata were deposited in a basin whose axis bisects the county from northwest to southeast. They are more than 450 feet thick near the center of the basin and gradually pinch out against its flanks.

Glacial drift, deposited during successive advances and retreats of the Pleistocene ice sheets, overlies the Precambrian and Cretaceous rocks. The drift, which consists largely of till, ranges in thickness from about 10 feet in the north and northeast to about 550 feet in the southwest.

The most prominent surficial glacial deposits in the county are 5 northwestward-trending end moraines, 2 of which are associated with, and parallel to, relatively extensive belts of outwash. The intervening areas are flat to slightly rolling ground moraine. In the

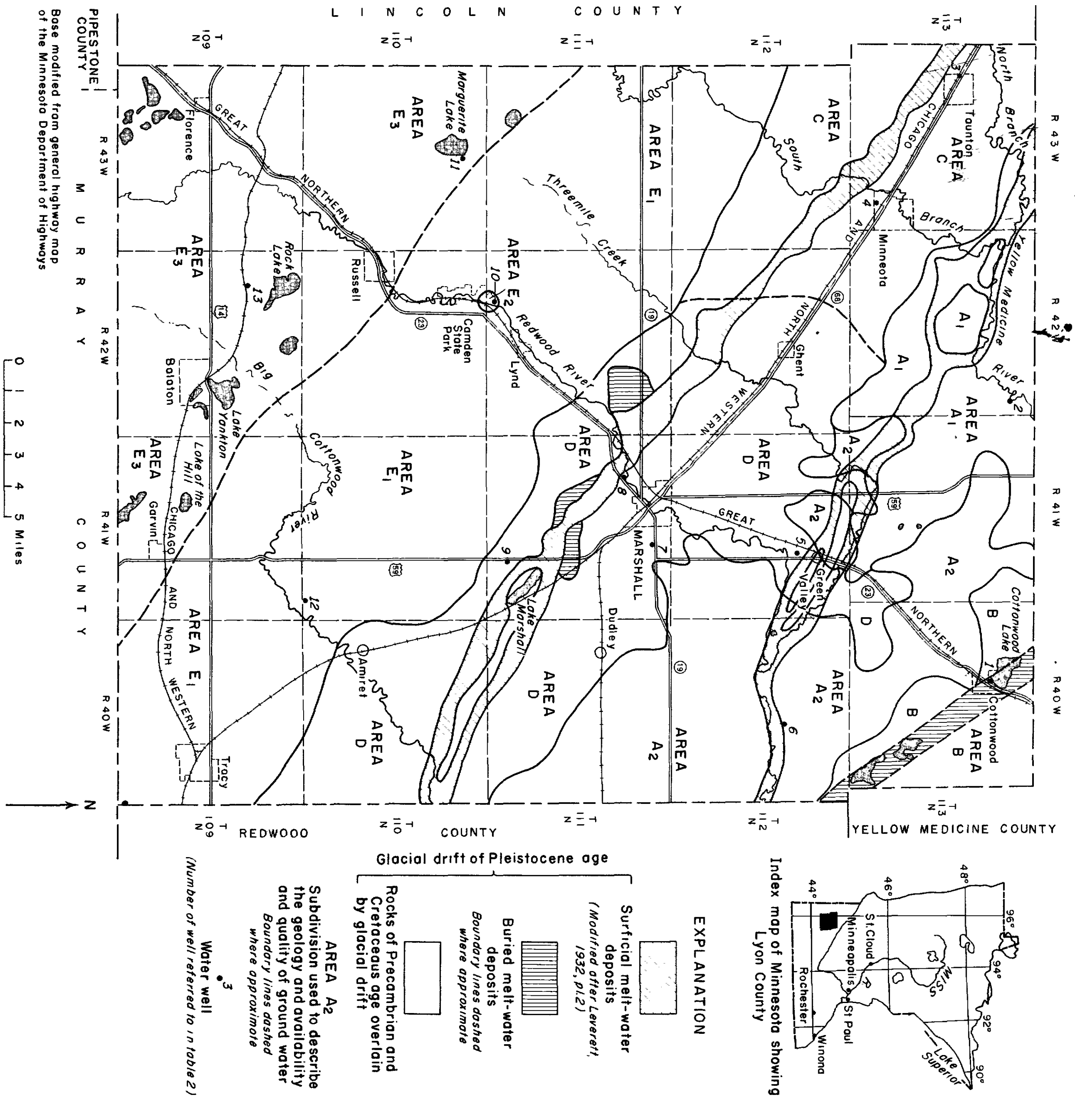

Figure 1.—Map of Lyon County, Minn., showing the availability and quality of ground water and the distribution of major geologic units.

southwest, where the drift is very thick as a result of multiple glaciation, buried melt-water channel deposits having no obvious topographic expression probably occur at depth (Schneider and Rodis, 1959, p. 1671).

GROUND-WATER CONDITIONS

The principal sources of ground water in Lyon County are the permeable deposits of sand and gravel in the glacial drift and the sandstones of Cretaceous age (table 1). Although water is locally obtained from Recent alluvium and Precambrian rocks, these materials are not dependable sources of water.

Water in the glacial drift may occur under artesian or water-table conditions. The water is usually very hard and low in chloride, and contains large amounts, 2 to 6 ppm (parts per million) of iron. In most places wells in the drift yield 2 to 30 gpm (gallons per minute); however, where melt-water channel deposits occur, sustained yields of as much as 500 gpm are obtained. In the northern and northeastern parts of the county where the drift is thin, static water levels in the drift range from 5 to 20 feet below the land surface. Where the drift is thicker, as in the southwest, static water levels generally range from 30 to 150 feet below the land surface.

Water in the Cretaceous sandstone occurs under artesian conditions and is commonly softer, lower in iron (0 to 2 ppm), but higher in chloride content, than the water in the glacial drift. Because the Cretaceous aquifers have low coefficients of permeability and are relatively thin, they commonly yield only 2 to 7 gpm to wells. However, where they are in contact with the underlying regolith and the weathered granite, yields as high as 75 gpm are sometimes obtained. Static water levels of wells in Cretaceous strata generally range from 20 to 70 feet below the land surface. There are some flowing wells in the central part of the county, however.

AVAILABILITY OF GROUND WATER

Division of the county into areas of ground-water availability (fig. 1) is based on the amount and the quality of ground water available at various depths from the different geologic units. These areas are described as follows:

AREA *A*

[Glacial drift is underlain by Cretaceous strata]

Most wells obtain water from Cretaceous sandstone at depths of about 100 to 300 feet; some tap the overlying glacial drift at depths of 15 to 75 feet. A few wells obtain small amounts of water from the underlying weathered granite. Yields from Cretaceous sandstone generally range from 2 to 7 gpm.

Where water is obtained from the drift, wells yield from 2 to 30 gpm; higher yields, as much as 500 gpm, can be obtained where the drift contains melt-water channel deposits. Known melt-water deposits are outlined on the map. The water from the glacial drift usually is very hard (>500 ppm) but is low in chloride content (< 50 ppm).

AREA A_1

Water from the Cretaceous sandstone is hard (120 to 500 ppm) and is high in chloride content (500 to >2,000 ppm).

AREA A_2

Water from the Cretaceous sandstone ranges from soft (< 60 ppm) to hard, and its chloride content commonly is moderately high (50 to 500 ppm).

AREA *B*

[Glacial drift is underlain by Cretaceous strata or Precambrian granite]

Most wells obtain water from the glacial drift at depths of about 15 to 125 feet. In some places, however, water is obtained from Cretaceous sandstone at depths of 100 to 180 feet, and from the weathered granite at depths of 40 to 250 feet.

Wells in the drift may yield 2 to 30 gpm. Sustained yields of 75 gpm have been obtained where the drift contains melt-water deposits. The water is commonly very hard but is low in chloride content.

Wells in the Cretaceous sandstone and in the weathered granite normally yield 2 to 7 gpm. The water ranges from moderately hard (60 to 120 ppm) to very hard and, in places, is moderately high in chloride content.

AREA *C*

[Glacial drift is underlain by Cretaceous strata]

Very hard water is obtained from the glacial drift at depths of about 15 to 80 feet and from Cretaceous sandstone at depths of about 40 to 120 feet. In places, moderately hard or hard water in smaller quantities is obtained from Cretaceous sandstone at depths of 220 to 280 feet. The weathered granite is of little importance as a water source.

Wells in the drift and in the shallow aquifers of Cretaceous age yield about 2 to 45 gpm, but yields from the deeper Cretaceous aquifers are generally less than 7 gpm. Higher yields may be obtained from melt-water channel deposits in the drift.

AREA *D*

[Glacial drift is underlain by Cretaceous strata]

Most wells obtain water from Cretaceous strata at 1 of 3 horizons: 40 to 120 feet, 240 to 280 feet, and 325 to 425 feet. Water is obtained also from the overlying glacial drift at depths of about 15 to 175 feet. A few wells obtain water from the weathered granite.

Wells tapping shallow aquifers of Cretaceous age (40 to 120 feet) generally yield 2 to 20 gpm. Commonly the water is hard to very hard, but it is low in chloride content. Wells in the deeper Cretaceous aquifers (240 to 280 feet and 325 to 425 feet) normally yield 2 to 7 gpm. The water is soft to hard and commonly is moderately high in chloride content. Where Cretaceous aquifers are in contact with the underlying regolith or the weathered granite, sustained yields of as much as 75 gpm have been obtained. Several flowing wells in the southwestern half of the area yield as much as about 2 gpm from the deeper Cretaceous aquifers.

Water in the drift is very hard but is low in chloride content. Yields commonly range from 2 to 30 gpm. Sustained yields of as much as 500 gpm have been obtained in places where the drift contains thick melt-water channel deposits.

AREA *E*

[Glacial drift is underlain by Cretaceous strata or by Precambrian quartzite or granite]

Most wells obtain water from the glacial drift at depths ranging from 15 to 450 feet, although the majority of the drift wells are less than 250 feet deep. Water in the glacial drift is very hard but low in chloride; yields of wells in drift commonly range from 2 to 30 gpm. A few wells obtain small amounts of water from the weathered granite or from quartzite at depths greater than 450 feet.

AREA E_1

[Glacial drift is underlain by Cretaceous strata]

Near the northeast border of this area, wells 200 to 500 feet deep yield 2 to 7 gpm from Cretaceous aquifers. The water from the Cretaceous strata is moderately hard to hard but is low in chloride content.

AREA E_2

[Glacial drift is underlain by Cretaceous strata]

In this area flowing wells yield about 30 to 150 gpm from Cretaceous strata at depths from 225 to 300 feet; the water is very hard but is low in chloride content.

AREA E_3

[Glacial drift is underlain by Precambrian quartzite or granite]

A few wells obtain small amounts of water from the quartzite.

DISCUSSION

The density of well information of which the map areas are based averages about 3 wells per square mile. Selected well information is shown on table 2; data on additional wells are on file at the U.S. Geological Survey, St. Paul, Minn.

Table 2.—*Description of selected water wells in Lyon County, Minn.*

[Geologic age of aquifer: p€, Precambrian; K, Cretaceous; P, Pleistocene. Use: D, domestic; S, stock; PS, public supply; I, industrial; M, municipal supply. Field chemical analyses: H, hardness; Cl, chloride. All wells are of the drilled type]

Well (fig. 1)	U. S. G. S. well no.	Owner or user	Depth (feet below land surface)	Year drilled	Diameter (inches)	Water-bearing zones: Depth to top	Water-bearing zones: Thickness (feet)	Water-bearing zones: Material	Geologic age of aquifer	Water level: Feet below land surface	Water level: Date measured	Use	Source of information	Field chemical analyses (ppm)	Estimated yield (gpm)
1.....	113.40.9acc2	Village of Cottonwood.	105	1958	8	85	20	Sand and gravel.	P	20	May 1, 1958	M	Owner..................	H, 550	75
2.....	113.42.1dcb2	O. Thompson.........	165	1910	4	164	1+	Sandstone.........	K	45	Aug. 14, 1957	D	.....do..................	H, 630; Cl, 1,400	5
3.....	113.43.17bcc1	D. Dollershell.........	46	1958	5	45	1+	Sand..................	P	18	Aug. 5, 1958	D	Driller..................	H, 850; Cl, <50	15
4.....	113.43.36bbc1	Village of Minneota.	60	1955	8	34	26	Sandstone.........	K	20	May 2, 1958	M	Driller and owner.	H, 850	45
5.....	112.41.10ddd1	A. Grafenger.........	235	1938	5	234	1+	.....do..............	K	30	July 5, 1958	D	.....do..................	H, 100	5
6.....	112.40.15bda2	A. Lademan.........	175	1957	5	174	1+	.....do..............	K	30	Nov. 12, 1957	D	.....do..................	H, 100	7
7.....	111.41.3dbb1	Rund Co..............	74	1957	5	73	1	.....do..............	K	12	Sept. 26, 1957	D,I	.....do..................	H, 480	20
8.....	111.41.8caa2	J. Williams............	41	1957	5	25	16	Sand and gravel.	P	8	June 18, 1957	D	Driller..................	H, 700; Cl, <50	25
9.....	111.41.35bcb1	G. Verly................	423	1954	4	421	2+	Sandstone.........	K	10	Dec. 1, 1955	D	Driller and owner.	H, 50	7
10....	111.42.32dca2	Division of State Parks, Minnesota Department of Conservation.	238	1956	9	237	1+	.....do..............	K	Flowing	June 1, 1957	PS	.....do..................	H, 1,000; Cl, <50	100+
11....	110.43.3ccb1	Mrs. Grace Peterson.	448	1955	4	447	1+	Quartzite.........	p€	100	July 30, 1957	D,S	.....do..................	H, 1,200; Cl, <50	10
12....	110.41.36cdc1	W. Sabinske..........	90	1958	5	89	1+	Sand and gravel.	P	15	Aug. 2, 1958	D,S	.....do..................	H, 1,100	10
13....	109.42.8ccb1	F. Groeneweg.......	253	1957	5	250	3+	Sand.................	P	108	June 19, 1957	D,S	.....do..................	H, 1,200	15

Countywide differences in the geologic source of ground water are shown by areas *A, B, C, D,* and *E*; differences in the quality of water from a particular source are indicated by subscripts, as area A_1 and area A_2 (Rodis and Schneider, 1960). In areas *B* and *E* ground water is obtained from the glacial drift, whereas in areas *A* and *D* it is obtained primarily from the Cretaceous strata. In area *C* the glacial drift and Cretaceous strata are equally important as water sources. It should be noted, however, that where surficial melt-water channel deposits cross areas *A, C,* and *D*, these drift deposits may be the principal source of ground water.

The distribution of geologic units in the county suggests that additional water supplies may be available from strata not yet fully explored. Test drilling of surficial melt-water deposits near Marshall, in area *D*, has shown that they are not necessarily confined to the area beneath the surficial melt-water channel, but may extend 1 mile or more beyond its limits (Schneider and Rodis, 1959, p. 1671. Even though test drilling of these deposits was confined to a small area, it is probable that similar subsurface conditions exist in other parts of the same channel in areas *C* and *D* as well as in the melt-water channel that crosses area *A*. As was mentioned earlier, buried melt-water channel deposits probably occur in area *B*, but considerable drilling would be necessary to determine their extent.

Although Cretaceous rocks underlie much of area *E*, water supplies from these strata are obtained by only a few wells along the northeast margin and in area E_2. Inasmuch as multiple areally extensive aquifers are present in Cretaceous strata throughout areas *A*, *C*, and *D* and adjacent parts of E_1, it is likely that they occur also in the Cretaceous strata underlying area E_1.

CONCLUSIONS

Ground water in quantities adequate for domestic use and moderate-scale municipal and industrial use is available from deposits of sand and gravel associated with two surficial melt-water channels in northeastern Lyon County and in buried melt-water channels in the southwest. Because of the sinuous shape of these deposits, any large ground-water development should be preceded by an adequate program of test drilling and test pumping.

Supplies of ground water adequate for domestic and small municipal or industrial needs are available from small, isolated deposits of sand and gravel in the glacial till. These deposits are more numerous in the thick drift of the southwest than they are in the thin drift of the north and northeast.

Small quantities of ground water, adequate only for domestic supply, are available from the thin sandstone of Cretaceous age in the northern and northeastern parts of the county. It is likely that small supplies may be available also from Cretaceous aquifers at depth in the southeastern and south-central parts of the county.

Although water from Cretaceous aquifers is generally softer and lower in iron content than that from the glacial drift, supplies are small and adequate only for domestic use. Where larger supplies are needed, as for expanding municipal water systems and industrial developments, adequate amounts of water may locally be obtained from the thicker more permeable aquifers in the glacial drift.

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