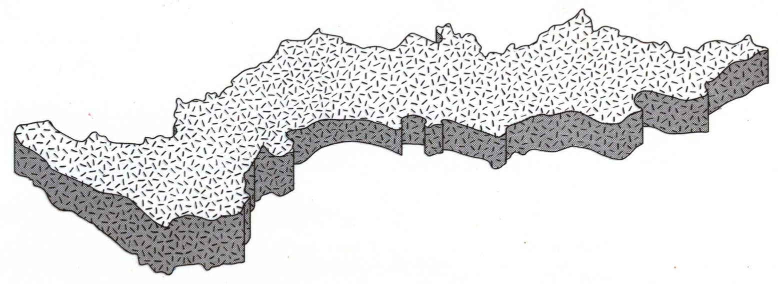
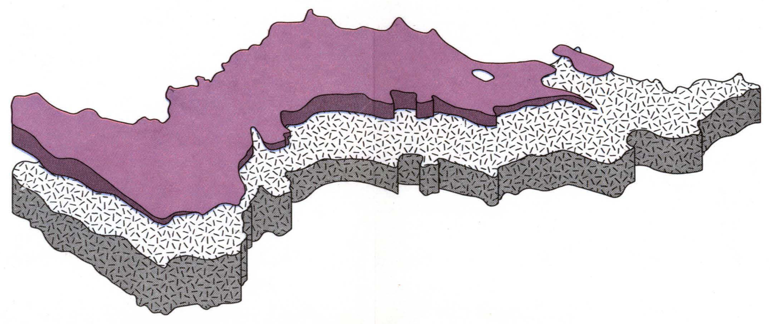
PREPARED IN COOPERATION WITH
THE MINNESOTA DEPARTMENT OF CONSERVATION
DIVISION OF WATERS, SOILS, AND MINERALS

GROUND WATER

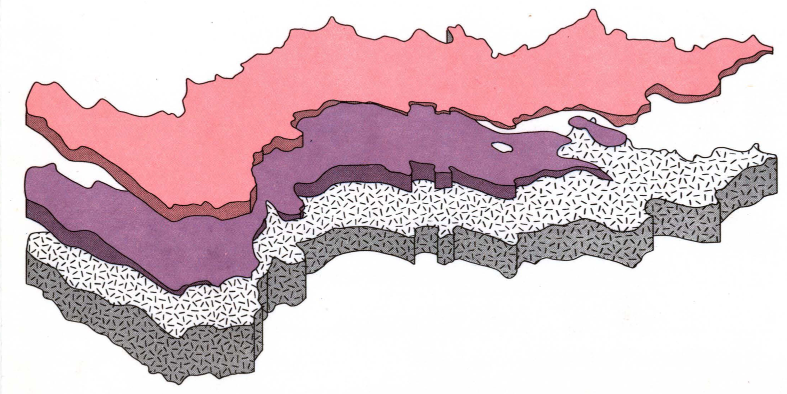
The ground-water system is defined by the interrelationships of thickness, hydrologic characteristics, and areal extent of each geologic unit. The system is dynamic and perpetual, continually recharging in some places and discharging in others, but always maintaining a balance and adjusting to changes in climate and activities of man.



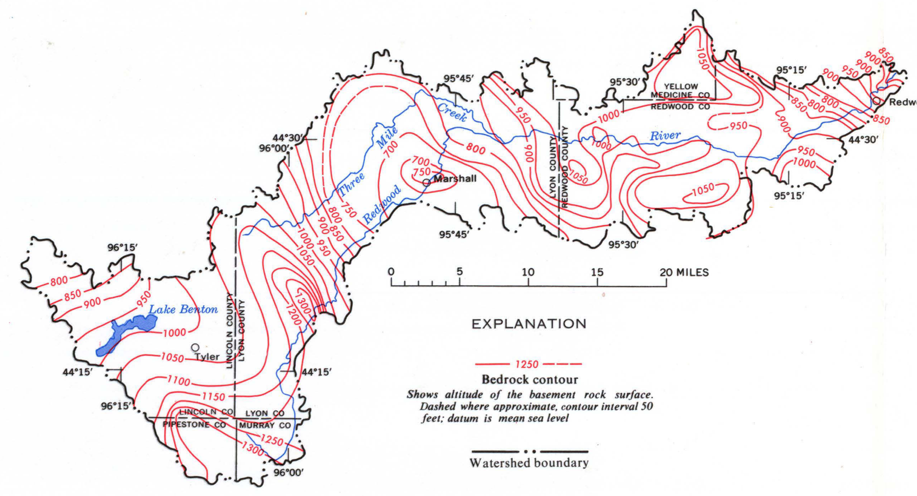
THE OLDEST AND LOWERMOST ROCKS IN THE AREA ARE THE CRYSTALLINE ROCKS OF THE BASEMENT COMPLEX.—*These massive Precambrian rocks underlie the entire watershed.*



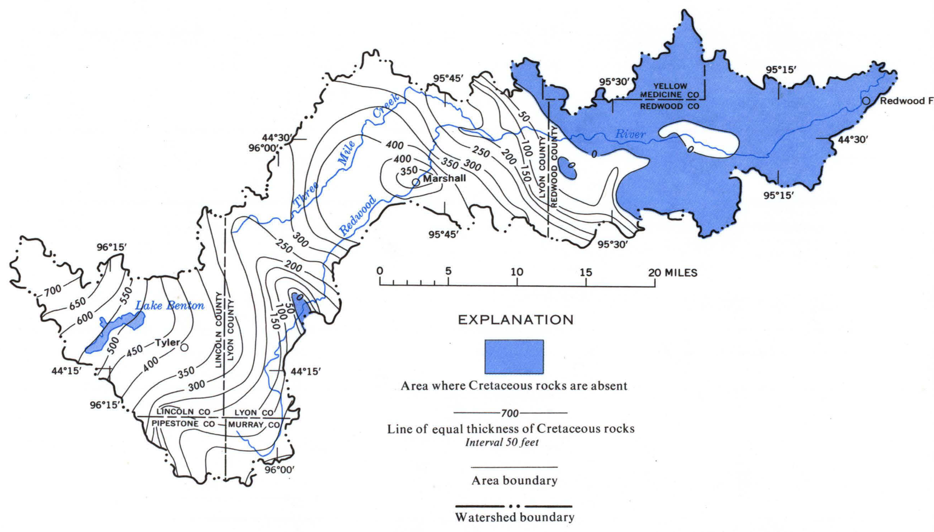
SEDIMENTARY ROCKS OF CRETACEOUS AGE DIRECTLY OVERLIE THE BASEMENT COMPLEX IN MOST OF THE WATERSHED.—*They consist mostly of shale and fairly continuous beds of poorly cemented siltstone and sandstone.*

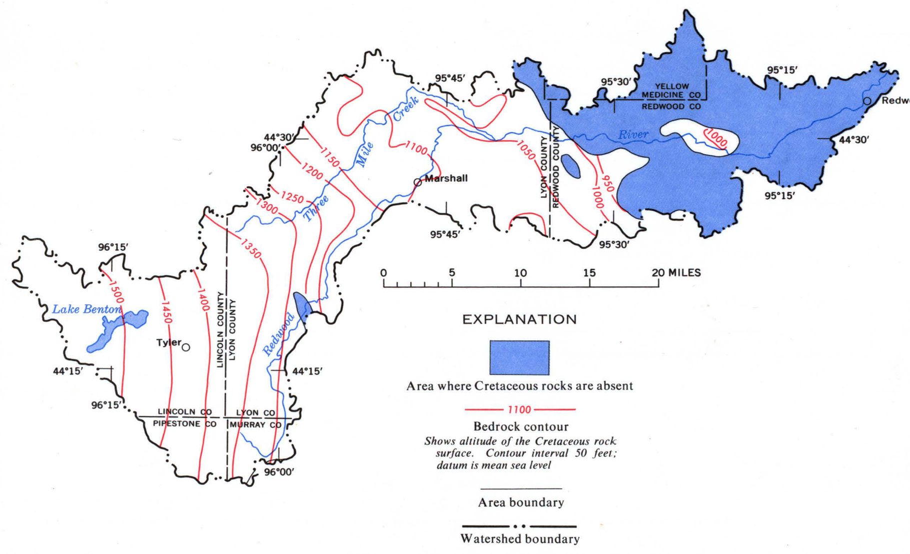


QUATERNARY GLACIAL DRIFT COVERS THE ENTIRE WATERSHED AND FORMS THE PRESENT LAND SURFACE.—*The drift overlies the Cretaceous rocks in all but the easternmost part of the watershed where it is in direct contact with the underlying basement rocks. The drift is mostly clayey till, although locally continuous deposits of sand and gravel are common within the drift and at its surface.*



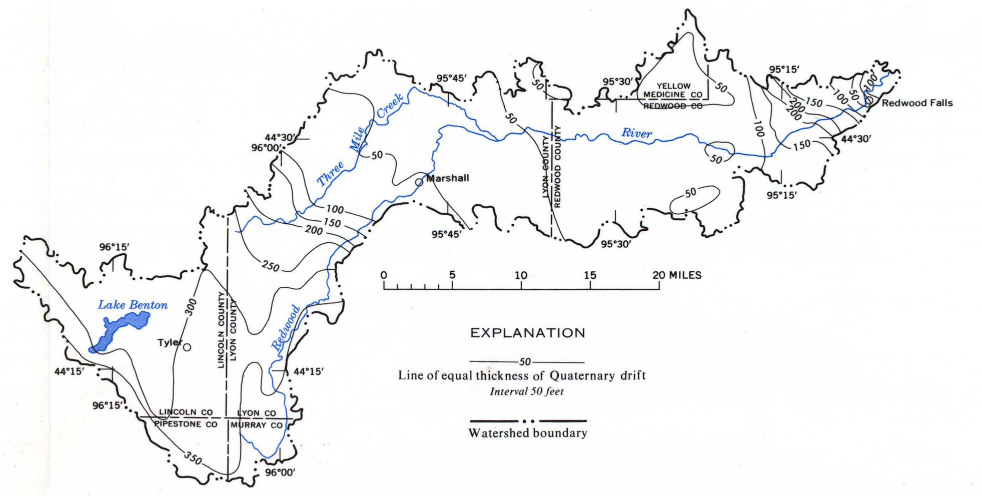
PRECAMBRIAN ROCKS YIELD WATER FROM WEATHERED OR FRACTURED ZONES AT THEIR SURFACE.—*This weathered surface is the lowermost water-bearing zone in the area. Relief of over 600 feet results in a wide variation in the thicknesses of the younger, overlying Cretaceous rocks and Quaternary drift.*



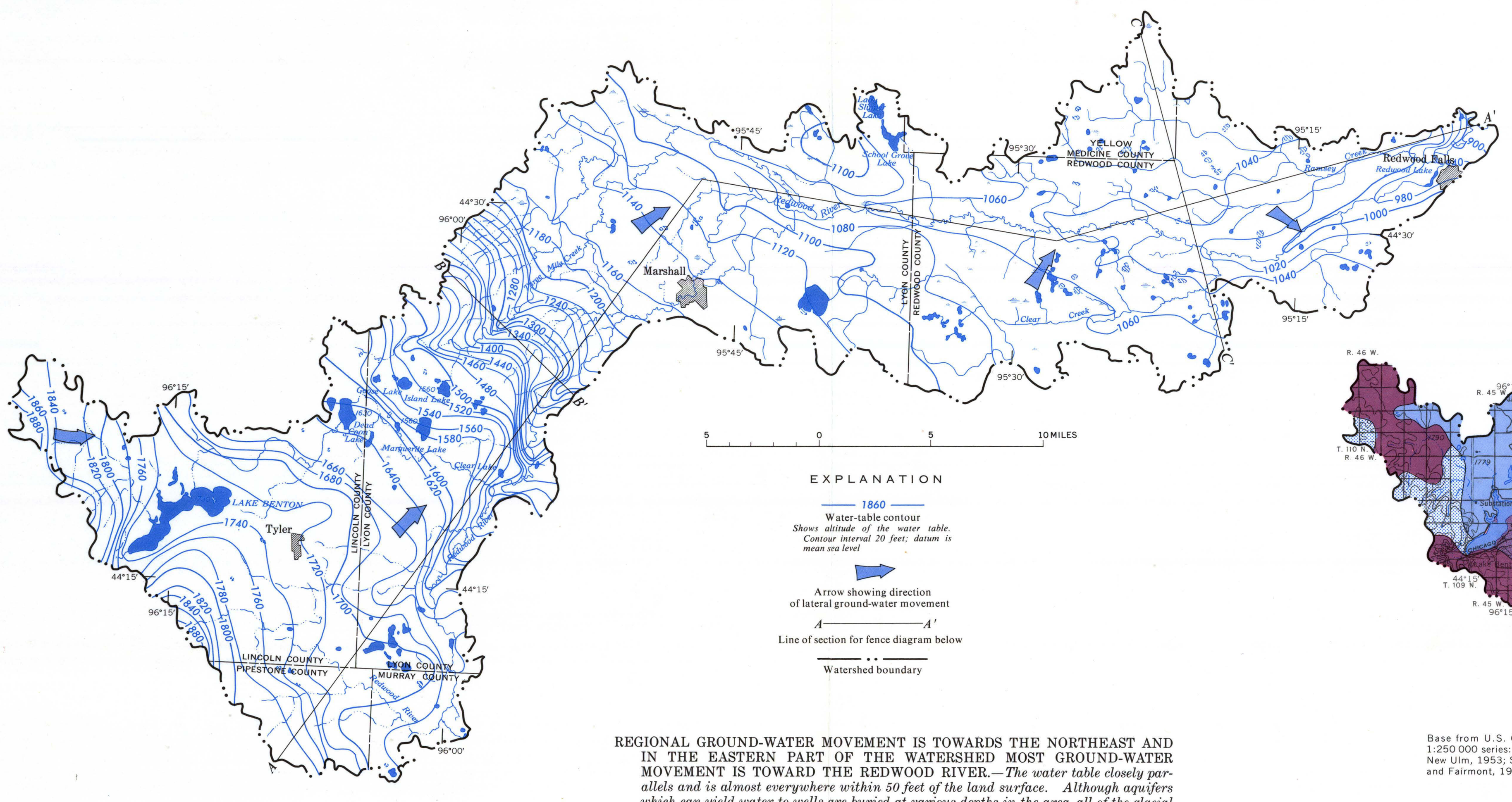


SANDSTONE BEDS IN THE CRETACEOUS ROCKS, PARTICULARLY AT THEIR BASE, YIELD SUBSTANTIAL WATER SUPPLIES TO WELLS IN THE CENTRAL PART OF THE AREA

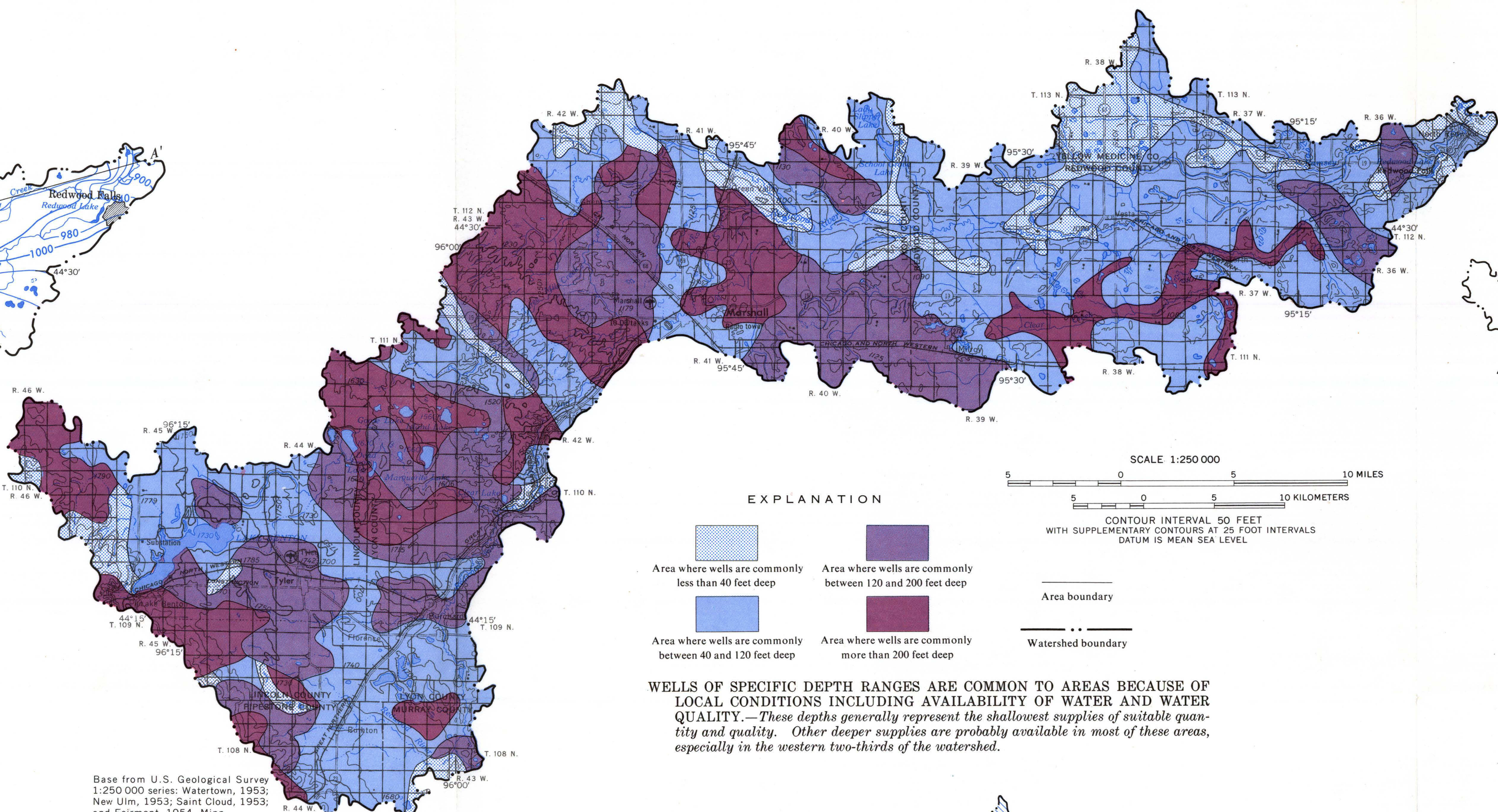
In most of the eastern part of the watershed, Cretaceous rocks are absent. In the western part of the basin, water is generally available from overlying aquifers and few wells have yet been drilled into the Cretaceous strata. In that area, sedimentary rocks are as much as 700 feet thick and probably contain aquifers of potential value.



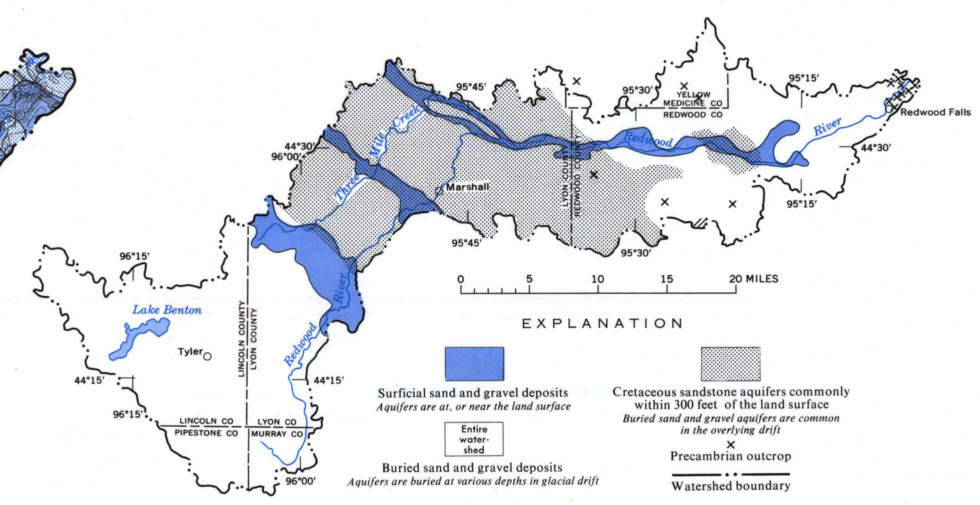
SAND AND GRAVEL DEPOSITS AT DIFFERENT DEPTHS IN THE GLACIAL DRIFT ARE THE MOST ACCESSIBLE AND WIDELY USED AQUIFERS OF THE WATERSHED.—*The aquifers are generally thin and discontinuous but provide supplies adequate for most uses. Glacial drift thicknesses vary from less than 50 feet to more than 350 feet. Thicker sections of the drift commonly contain more aquifers so chances of development of good water supplies are better in those areas.*



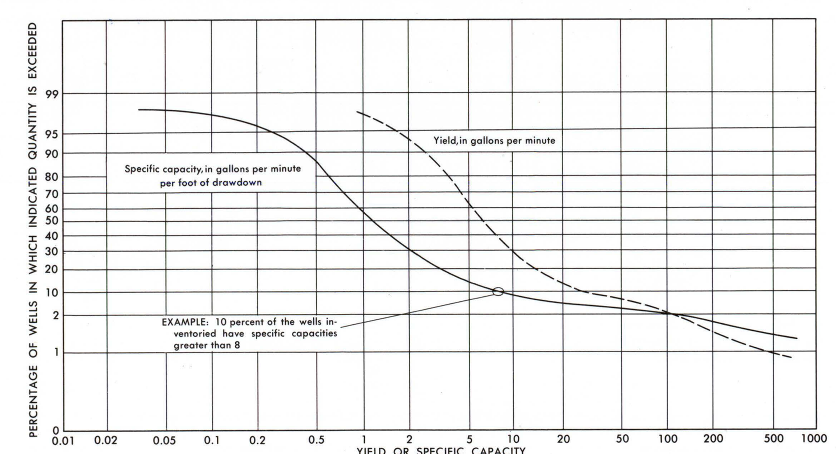
REGIONAL GROUND-WATER MOVEMENT IS TOWARDS THE NORTHEAST AND IN THE EASTERN PART OF THE WATERSHED MOST GROUND-WATER MOVEMENT IS TOWARD THE REDWOOD RIVER.—*The water table closely parallels and is almost everywhere within 50 feet of the land surface. Although aquifers which can yield water to wells are buried at various depths in the area, all of the glacial and sedimentary deposits are saturated beneath the water table.*



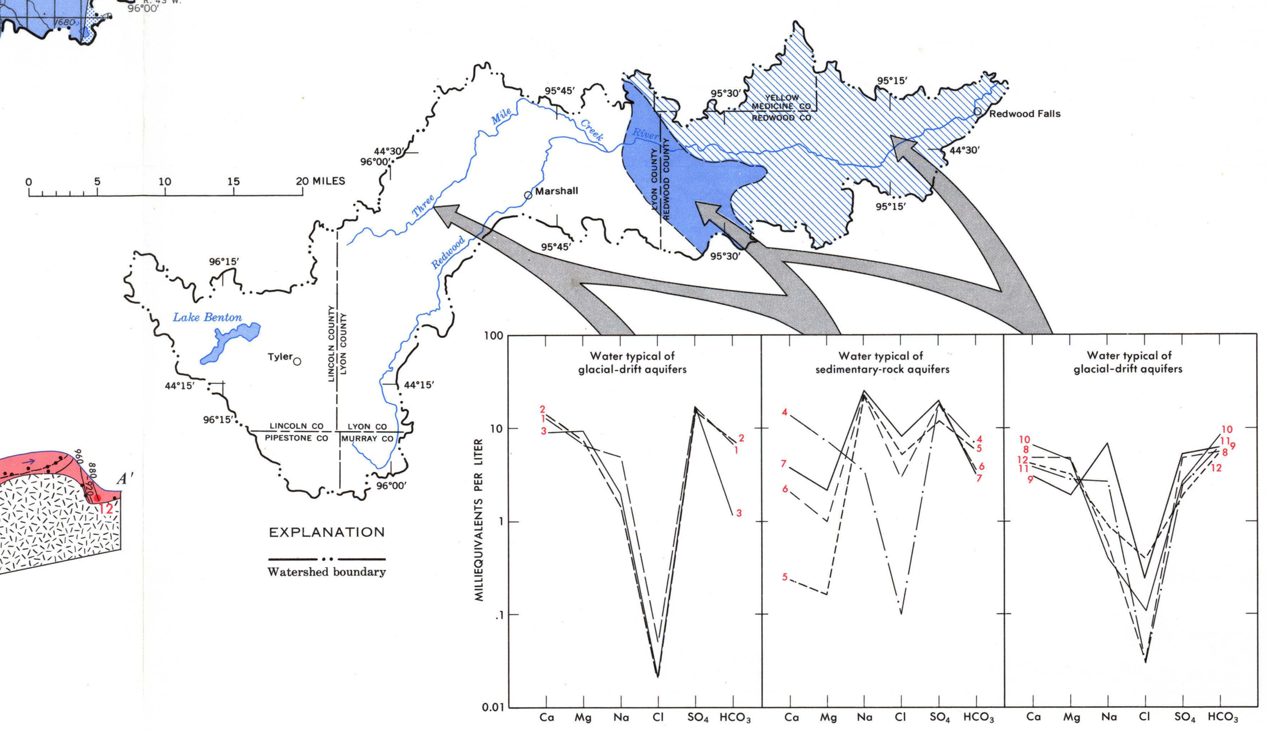
WELLS OF SPECIFIC DEPTH RANGES ARE COMMON TO AREAS BECAUSE OF LOCAL CONDITIONS INCLUDING AVAILABILITY OF WATER AND WATER QUALITY.—*These depths generally represent the shallowest supplies of suitable quantity and quality. Other deeper supplies are probably available in most of these areas, especially in the western two-thirds of the watershed.*



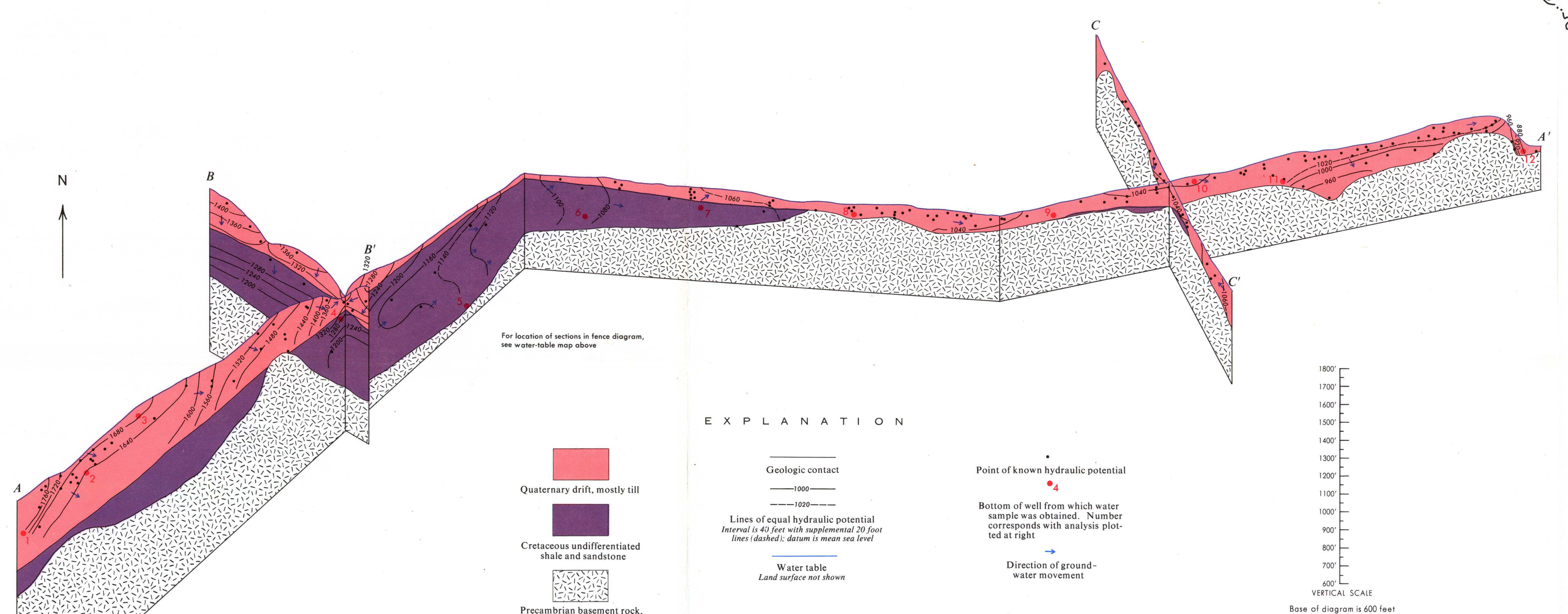
THREE FAIRLY CONTINUOUS SURFICIAL AQUIFERS TREND SOUTHEASTWARD ACROSS THE WATERSHED.—*They are more accessible and more rapidly recharged than deeper aquifers but are more susceptible to pollution. Deeper aquifers within the drift sheet occur in most of the watershed. Only locally, where glacial deposits are thin, do users have to rely on supplies from the underlying sedimentary and crystalline rocks. Sandstone aquifers are present at depths generally less than 300 feet in the central part of the area. They can be as much as 1000 feet below the surface in the west, and there, little is known about them. Locally in the eastern part of the watershed, where drift and sandstone aquifers are absent, Precambrian rocks are the only source of ground water.*



A STATISTICAL ANALYSIS OF 600 DRIFT WELLS INVENTORIED SHOWS A MEDIAN YIELD OF 6 GALLONS PER MINUTE AND A MEDIAN SPECIFIC CAPACITY OF 1.2 GALLONS PER MINUTE PER FOOT OF DRAWDOWN.—*About 8 percent of the wells yield over 50 gallons per minute. Most of these are municipal wells located by test drilling and constructed for maximum efficiency. Most of the lower 92 percent are domestic and stock wells not constructed for high efficiency and generally producing only a fraction of their potential yields.*



WATER QUALITY VARIES WITH POSITION IN THE FLOW SYSTEM.—*In the western part of the watershed, mainly a ground-water recharge area, water in the glacial drift contains primarily calcium, magnesium, sulfate, and bicarbonate ions. Water movement in the drift is principally downward to sedimentary-rock aquifers where the water is modified to a sodium-chloride-sulfate-bicarbonate type. The degree of change or softening effect on the water depends upon the thickness of sedimentary rock penetrated. Drift aquifers and thin sedimentary rocks located in the eastern part of the watershed are recharged by precipitation, streamflow, and the ground-water flow system to the west. Thus, ground water in this area may exhibit chemical properties of drift water, sedimentary-rock water, or a mixture of the two. Most water from wells in the eastern part of the watershed contains lower sulfates and higher bicarbonates. This change is accomplished by anaerobic decay of organic materials which are common to the area.*

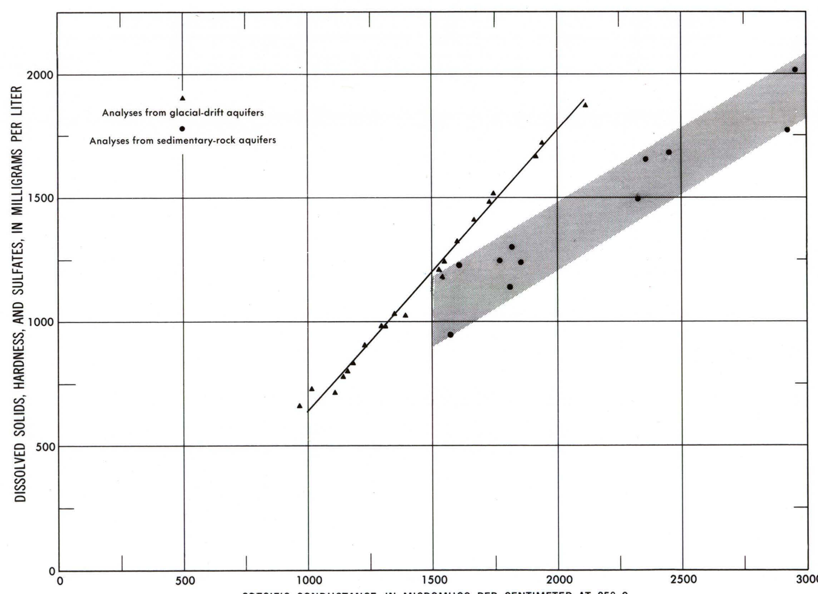


GROUND WATER MOVES FROM HIGH POTENTIAL TO LOW POTENTIAL

The glacial drift and sedimentary rocks are a single hydraulic system in which water moves vertically and laterally. The gradient of hydraulic potential indicates the direction of movement. The system is bounded at the surface by the water table and at the base by relatively impermeable crystalline basement rock. The ground-water flow patterns are related to the thickness of the system, the relative permeabilities of the drift and sedimentary rocks, and the configuration of the basement-rock surface. In the western part of the watershed, where the drift is thick, ground water has a steep downward gradient and is recharging the system. In the west-central area the drift is thin and water movement is mostly lateral within the relatively thick sedimentary rocks. In the center of the watershed, flow is upward toward the land surface where the system is constricted by the high basement rock surface. As the drift thickens farther east the cycle begins again and flow is ultimately directed toward the land surface at the mouth of the Redwood River. The steep downward gradient where the basement rock is lowest in the eastern part of the area indicates that flow there is not parallel to the line of section.

GROUND WATER THROUGHOUT THE BASIN IS USUALLY VERY HARD AND CONTAINS HIGH CONCENTRATIONS OF DISSOLVED SOLIDS.—*Soft water can be obtained from deep sandstone aquifers although sodium and chloride concentrations may be high. Water obtained from basement rocks generally has similar quality to that in the directly overlying sedimentary rocks or glacial drift.*

AGE OF AQUIFER (Number of analyses)		MAJOR CHEMICAL CONSTITUENTS, IN MILLIGRAMS PER LITER														
		Calcium	Magnesium	Sodium	Potassium	Chloride	Sulfate	Bicarbonate	Nitrate	Fluoride	Iron	Manganese	Boron	Silica	Hardness	Dissolved solids
QUATERNARY	Maximum	520	146	180	33	80	2,100	547	257	1.1	16	2.4	2.5	30	1,900	1,860
	Median	222	64	45	7.6	2.7	450	424	6.6	0.3	5.1	.43	.44	24	811	1,105
	Minimum	46	23	5	3.6	0.9	98	71	0.0	0.1	0.1	<.02	.21	8.0	249	488
CRETACEOUS	Maximum	262	108	615	14	514	985	496	17	4.4	7.1	1.3	4.4	20	1,100	2,010
	Median	82	20	207	7.1	84	589	328	0.9	0.8	.86	.11	3	8.7	226	1,300
	Minimum	4.6	4.9	89	4.3	5.0	275	181	0.0	0.2	.07	.03	.11	6.7	20	946
PRECAMBRIAN	Maximum	112	40	310	90	182	594	445	17	4.4	1.9	.51	3.3	25	444	1,490
	Median	78	22	146	7.0	28	205	367	3	1.2	.21	.08	.76	16	270	718
	Minimum	9.8	3.8	18	4.3	0.7	92	270	0.1	0.2	.09	.04	.06	8.0	20	483



THE RELATIONSHIP BETWEEN DISSOLVED SOLIDS AND SPECIFIC CONDUCTIVITY IN GROUND WATER DEPENDS UPON THE SOURCE AQUIFER, MIXING OF WATER TYPES, AND BASE EXCHANGE.—*For water in glacial drift aquifers, the relationship is linear and dissolved-solids content can be accurately predicted from specific conductance values. For water in sedimentary rock aquifers, where mixing and base exchange occur, the relationship is less definite, but the total dissolved-solids content can be approximated by using the patterned band.*

INTERIOR—GEOLOGICAL SURVEY WASHINGTON, D. C.—1970—W69170

WATER RESOURCES OF THE REDWOOD RIVER WATERSHED, SOUTHWESTERN MINNESOTA

By
W. A. Van Voast, L. A. Jerabek, and R. P. Novitzki
1970