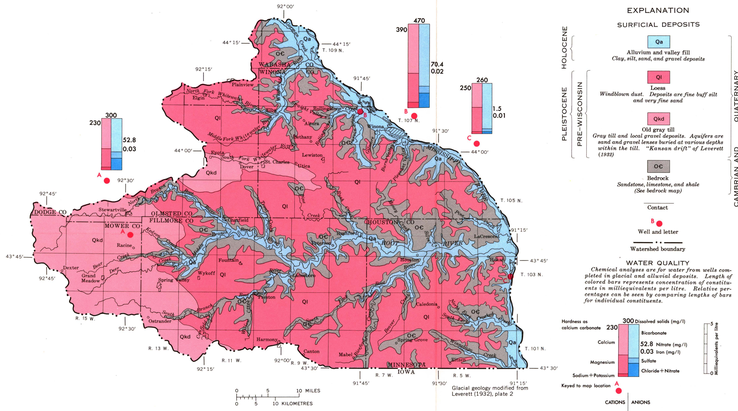
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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

HYDROLOGIC INVESTIGATIONS
ATLAS HA-548 (SHEET 2 OF 3)

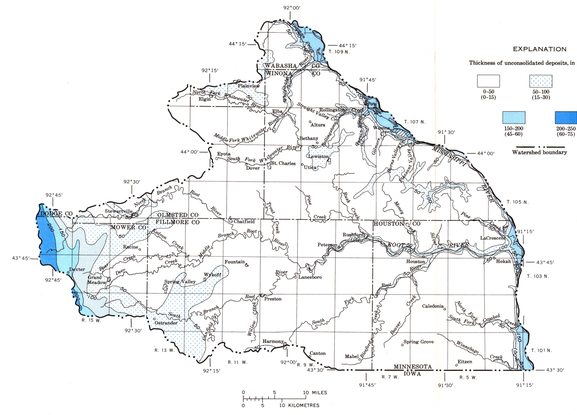
GLACIAL DEPOSITS



GLACIAL DEPOSITS COVER MOST OF THE WATERSHED, BUT THERE ENOUGH SATURATED SANDS AND GRAVELS TO PERMIT LARGE GROUND-WATER WITHDRAWALS ONLY IN THE WESTERN PART AND IN THE MISSISSIPPI AND ROOT RIVER VALLEYS

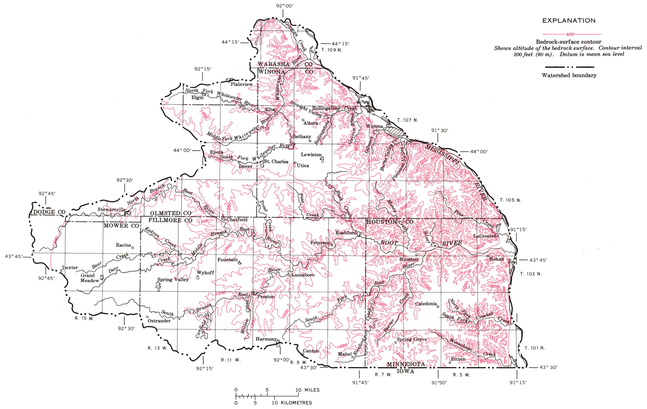
Municipal, industrial, and private domestic water supplies are obtained from unconsolidated deposits along the Mississippi and Root Rivers. Loess, covering more than half the watershed, is generally thin and does not yield water to wells. Some private domestic water supplies are obtained from sand lenses in glacial moraines in the western part of the watershed.

Water obtained from aquifers in unconsolidated deposits is generally of acceptable quality for domestic use; however, it may contain high nitrate concentrations, reflecting the general susceptibility of these aquifers to pollution. Dissolved-solids and sulfate concentrations are generally higher where these aquifers are overlain by glacial till.



UNCONSOLIDATED DEPOSITS OUTSIDE THE RIVER VALLEY ARE GENERALLY THICK ENOUGH TO PROVIDE WATER ONLY IN THE WESTERN PART OF THE WATERSHED

In the western part of the watershed the unconsolidated deposits are more than 200 feet (60 m) thick. The greater the thickness, the greater the likelihood of penetrating a saturated sand deposit capable of providing a satisfactory water supply. The alluvial and valley-fill deposits are more than 150 feet (45 m) thick in parts of the Mississippi River flood plain and adjacent lowlands along the eastern margin of the watershed. As these deposits are largely composed of sand and gravel, high yields are commonly obtainable from them.

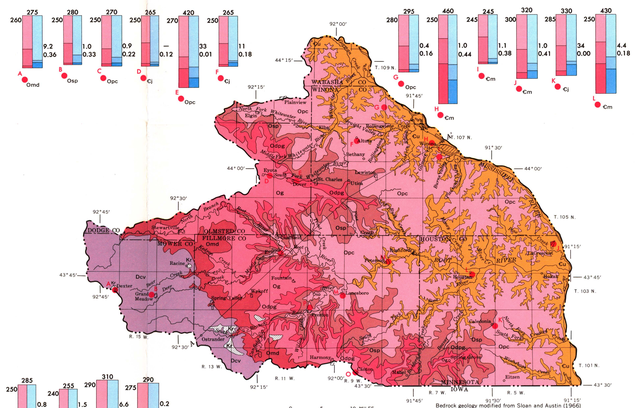


THE BEDROCK-SURFACE CONFIGURATION REFLECTS TOPOGRAPHY OVER MOST OF THE WATERSHED

Preglacial drainage patterns were not significantly altered by glaciation. Buried bedrock valleys that contain saturated sand and gravel are found in the adjacent watershed to the west but are not known in this watershed.

GROUND WATER

The ground-water system involves the interrelationships of water with the thickness, hydrologic characteristics, and areal extent of the geologic units. The system is continuously recharged in some places and discharged in others and is always tending to adjust, sometimes in minor degrees, to climatic variations and activities of man.



THE DISTRIBUTION OF BEDROCK FORMATIONS SHOWS THE AERIAL EXTENT OF BEDROCK AQUIFERS

In the southwestern part of the watershed, most bedrock wells obtain water from the Cedar Valley—Maquoketa—Dubuque—Galena aquifer, and others obtain water from the St. Peter aquifer. Large water supplies are available from the Jordan aquifer, except near its valley outcrops, where it may be dry. The Ironton—Galesville and Mount Simon—Red clastics aquifers can supply water everywhere in the watershed. For general purposes, the depth to a particular bedrock aquifer can be estimated by adding the thickness of the surficial deposits and the average thickness of the bedrock formations overlying the aquifer at the point of interest.

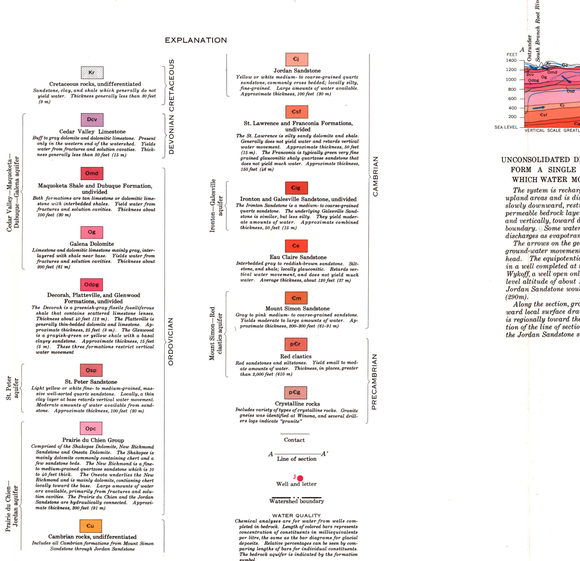
Water in bedrock aquifers is generally of acceptable quality for domestic use but has a wide range of suitabilities for other uses. The principal objections are excessive hardness and resultant carbonate encrustation in water heaters.

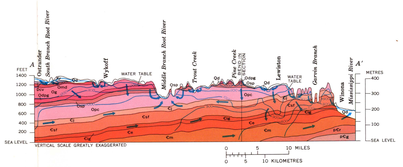
The quality of water obtainable at a specific location and depth is related to type and thickness of overlying surficial deposits and to the aquifer penetrated. Water in Cambrian and Ordovician aquifers generally contains about 300 mg/l (milligrams per litre) dissolved solids. The dominant ions in water from these aquifers are calcium, magnesium, and bicarbonate. Water in shallow bedrock overlain by thin surficial deposits is highly susceptible to bacteria and nitrate pollution from surface sources. (See E, K.)

Water from some wells that penetrate the Mount Simon—Red clastics aquifer is relatively high in dissolved-solids concentration and contains a high percentage of sodium and chloride ions. (See H, L.) Water in the Mount Simon—Red clastics aquifer increases in salinity with depth (data from a specific-conductance survey) and locally may be too saline to drink.

Iron may exceed U.S. Public Health Service (1962) recommended limits (0.3 mg/l) in all aquifers. (See A, B, H, I, J, M, and N.)

BEDROCK





UNCONSOLIDATED DEPOSITS AND SEDIMENTARY BEDROCK FORM A SINGLE REGIONAL HYDROLOGIC SYSTEM IN WHICH WATER MOVES VERTICALLY AND LATERALLY

The system is recharged primarily by infiltrating precipitation in upland areas and is discharged in valleys. Regionally, water moves slowly downward, restricted by beds of low permeability. Through permeable bedrock layers, water can move more rapidly, horizontally and vertically, toward discharge areas. The Root River is a discharge boundary. Some water discharges as seepage into the river and some discharges as evapotranspiration.

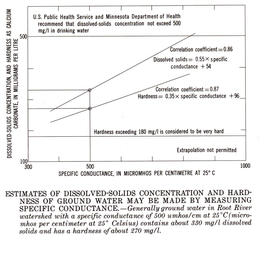
The arrows on the geohydrologic section A–A' indicate direction of ground-water movement—from areas of high to areas of low hydraulic head. The equipotential lines show the level to which water will rise in a well completed at the depth shown by the line. For example, at Wykoff, a well open only to the Galena Dolomite would have a water-level altitude of about 1,200 feet (366 m), and a well open only to the Jordan Sandstone would have a water-level altitude of about 950 feet (290m).

Along the section, ground-water movement near land surface is toward local surface drains. In the deeper aquifers, water movement is regionally toward the northeast and the Mississippi River. (Location of the line of section is shown on the bedrock geology map and on the Jordan Sandstone structure map)

EXPLANATION
Qd
Surficial deposits
Till, sand and gravel, and loess
Contact
Water table
Approximately located
Potentiometric contour
Show altitude of the static water level (potentiometric surface). Interval 100 feet (30 m). Datum is mean sea level
General direction of ground-water movement
NOTE
Refer to bedrock-geology map for explanation of symbols

AQUIFER AND WATER QUALITY DATA FROM MUNICIPAL RECORDS

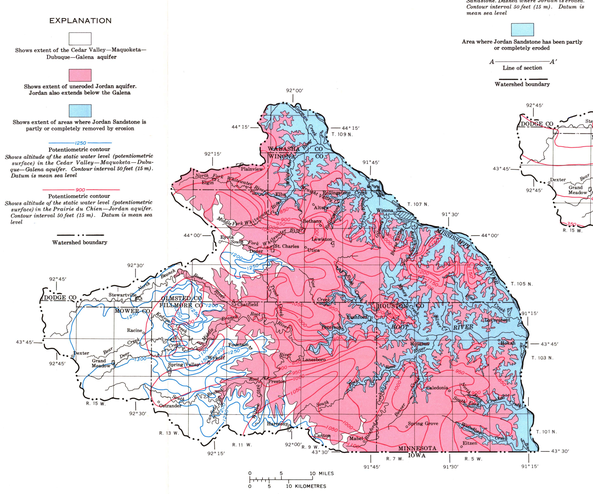
Aquifer	Average thickness open to wells (feet)	Towns using aquifer	Municipal wells in aquifer	Well depth (feet)		Usual pumping rate (gpm)		Specific capacity (4 wells (gpm/ft))		Iron (mg/l)		Sulfate (mg/l)		Chloride (mg/l)		Dissolved solids, residue (mg/l)		Hardness as CaCO$_3$ (mg/l)	
				Range	Mean	Range	Mean	Range	Mean	Range	Median	Range	Median	Range	Median	Range	Median	Range	Median
Outwash sand and gravel	40	1	5	149–159	152	495–1025	842	11–62	35	0.44	---	47	---	35	---	410	---	180	---
Cedar Valley to Galena	53	3	3	232–338	273	50–125	83	4.4	---	.05–.92	.36	11–60	25	3–22	21	230	---	240–340	260
St. Peter	60	2	2	512–619	566	80–200	140	3.6–6.7	5.2	.06–.33	.20	44–50	47	<1–7	4	140–270	205	240–250	240
St. Peter to Jordan	376	4	4	450–931	704	80–360	250	3.8–28	12	<.02–.20	.06	11–36	26	<1–15	7.2	270–390	285	200–230	220
Prairie du Chien	132	5	6	150–404	243	50–360	152	1–1.7	1.3	<.02–.78	.16	12–56	19	2.0–21	13	320–650	360	260–590	290
Prairie du Chien-Jordan	296	8	10	220–1035	627	100–430	212	3.3–108	30	<.02–.25	.15	8.8–42	25	.5–30	7.8	220–380	285	190–390	230
Jordan	79	12	16	309–834	464	15–450	238	.6–36	11	<.02–.72	.05	1.3–20	15	.05–14	1.8	190–370	280	180–270	250
Franconia	208	2	3	245–375	310	170–248	209	8.1–19	14	.26	---	13	---	1.0–3.7	2.4	300	---	250	---
Ironton-Galesville to Mount Simon	259	5	6	295–720	484	100–400	220	2.4–5.6	4.1	.04–4.2	.24	13–26	17	<1	---	260–300	270	250–270	260
Mount Simon	286	5	14	259–910	524	195–1200	591	3.6–27	13	.18–1.80	.44	25–76	42	1.5–86	26	280–550	360	180–250	220



ESTIMATES OF DISSOLVED-SOLIDS CONCENTRATION AND HARDNESS OF GROUND WATER MAY BE MADE BY MEASURING SPECIFIC CONDUCTANCE.—*Generally ground water in Root River watershed with a specific conductance of 500 umhos/cm at 25°C (micromhos per centimeter at 25° Celsius) contains about 330 mg/l dissolved solids and has a hardness of about 270 mg/l.*

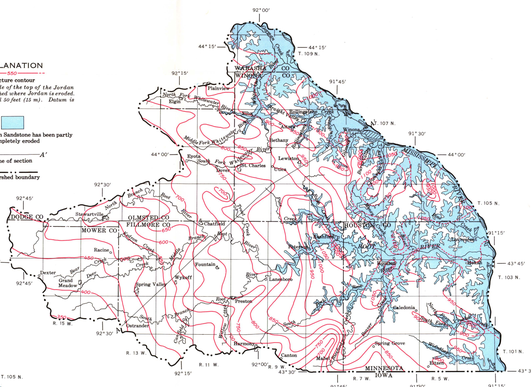
THE PRAIRIE DU CHIEN—JORDAN AQUIFER IS THE MOST WIDELY USED IN THE WATERSHED

About 60 percent of the municipalities obtain at least part of their water supply from the Prairie du Chien—Jordan aquifer. Although only three municipalities use the Cedar Valley—Maquoketa—Dubuque—Galena aquifer, a large number of private domestic wells are completed in it in the western part of the watershed.

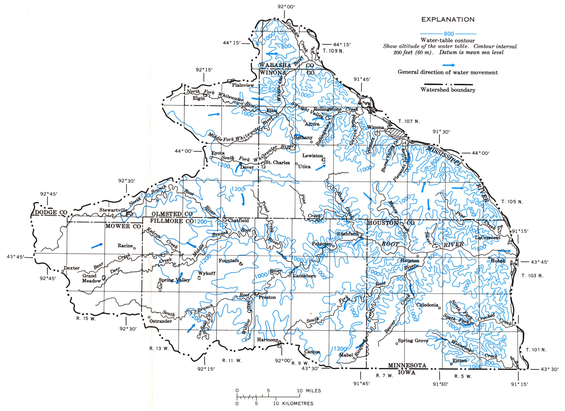


REGIONALLY, WATER MOVES TOWARD THE NORTHEAST IN BOTH THE PRAIRIE DU CHIEN—JORDAN AQUIFER AND THE CEDAR VALLEY—MAQUOKETA—DUBUQUE—GALENA AQUIFER

The hydraulic head in the Cedar Valley—Maquoketa—Dubuque—Galena aquifer is considerably higher than the head in the underlying Prairie du Chien—Jordan aquifer. Thus, in addition to regional movement toward the northeast and local movement toward streams, water moves downward from the upper aquifer and recharges the lower aquifer.



REGIONAL DIP OF THE JORDAN SANDSTONE IS SOUTHWESTWARD, AND THE STRUCTURE OF THE JORDAN REFLECTS THAT OF ALL THE OTHER BEDROCK FORMATIONS.—*Structural contours on top of the Jordan Sandstone in southeastern Minnesota indicate that the Root River watershed is on the northeast edge of a structural basin, which is centered in central Iowa. The approximate regional dip, 15 ft/mi (3 m/km), of this sandstone is disrupted by many smaller structures, especially in the southeastern part of the watershed. The depth to the Jordan Sandstone can be estimated by subtracting the altitude on the structure-contour map from the altitude of the land surface at any point. (Structure contours were projected across valleys where the Jordan Sandstone was eroded.)*



WATER-TABLE DIVIDES ARE APPROXIMATELY COINCIDENT WITH WATERSHED BOUNDARIES

General direction of lateral water movement in shallow aquifers is indicated by arrows on the water-table contour map. Water moves generally at right angles to the contour lines from upland areas to lowland areas (locally toward small surface drainage ways and regionally toward the Mississippi River).

Base from U.S. Geological Survey,
1:250,000: Eau Claire, 1953; La Crosse, 1958; Mason City, 1954; and St. Paul, 1953

WATER RESOURCES OF THE ROOT RIVER WATERSHED, SOUTHEASTERN MINNESOTA

By
W. L. Broussard, D. F. Farrell, H. W. Anderson, Jr., and P. E. Felsheim

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