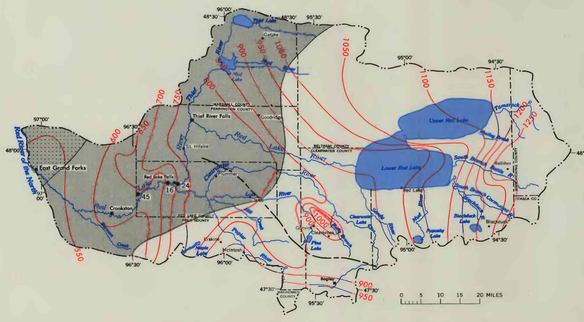
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

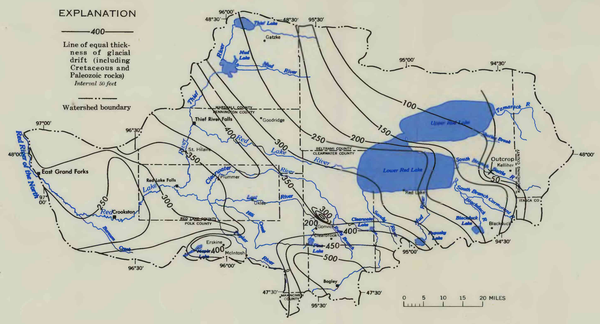
PREPARED IN COOPERATION WITH
THE MINNESOTA DEPARTMENT OF CONSERVATION
DIVISION OF WATERS, SOILS, AND MINERALS

HYDROLOGIC INVESTIGATIONS
ATLAS HA-346 (SHEET 2 OF 4)

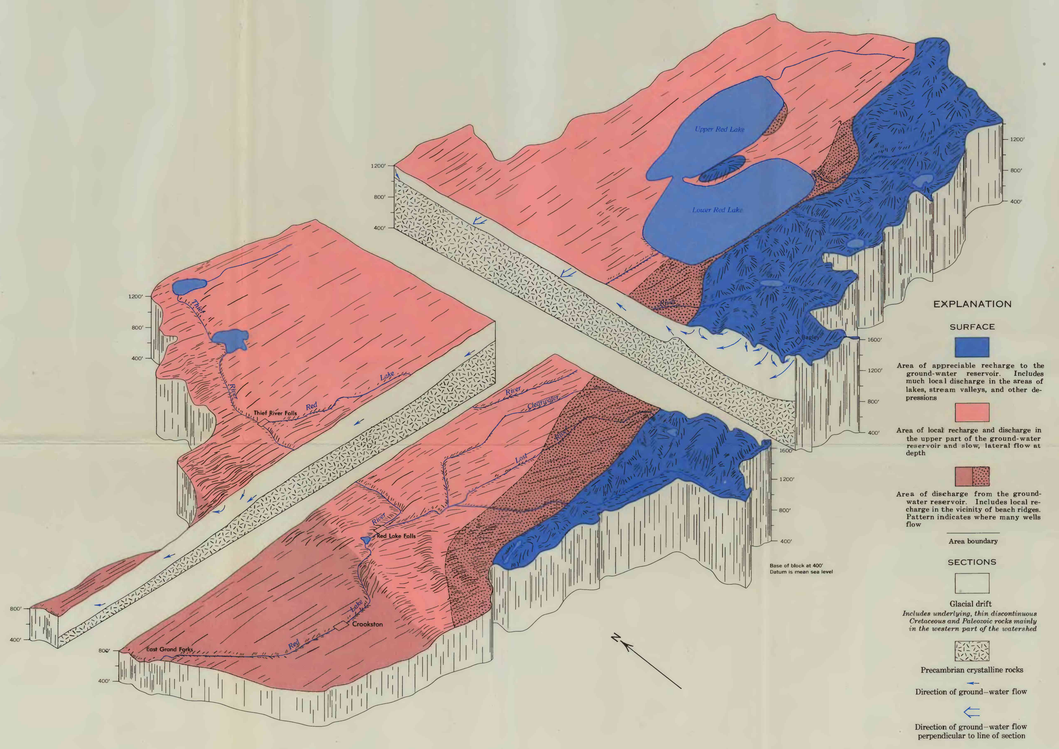
GROUND WATER



CRETACEOUS SEDIMENTS, WHICH ARE FAIRLY CONTINUOUS IN THE WESTERN PART OF THE WATERSHED, CONSIST MAINLY OF SHALE.—*However, where thin layers of fine to coarse sand are a part of the Cretaceous sediments, wells yielding less than 50 gallons per minute can be developed. Paleozoic limestone and sandstone occur in the extreme western tip of the watershed. Although wells yielding large quantities of water can usually be developed in rocks of this type, they are quite thin and probably discontinuous in this watershed in addition to containing highly saline water. The Precambrian crystalline rocks form the base of the ground-water reservoir. Contours on the surface of the basement rock show a large broad valley trending northwest-southeast in the central part of the watershed.*

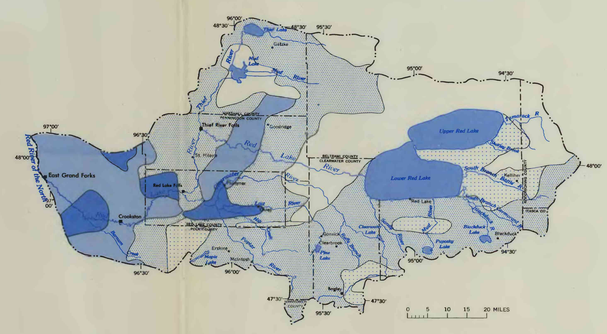


THICKNESS OF THE GLACIAL DRIFT RANGES FROM LESS THAN ONE FOOT NEAR KELLIHER, WHERE THE PRECAMBRIAN CRYSTALLINE ROCKS CROP OUT AT THE SURFACE, TO MORE THAN 500 FEET IN THE SOUTH-CENTRAL PART OF THE WATERSHED.—*Knowledge of the thickness of glacial drift is an important factor in analyzing ground-water supplies (see availability map this sheet). The Cretaceous and Paleozoic rocks are included in the estimation of drift thickness because of the lack of geologic information to separate them from the drift. However, the available information indicates that the thickness of these rocks is extremely variable and is probably less than 50 feet.*



WATER ENTERS THE GROUND-WATER SYSTEM MOSTLY IN THE ROLLING UPLANDS IN THE SOUTHEASTERN PART OF THE WATERSHED

Within this morainal area much water becomes part of local flow systems; that is, the water enters the ground-water system in the higher areas and moves to adjacent lowlands, commonly occupied by lakes and swamps, where it is discharged by evapotranspiration or runoff. The water that moves deeper into the ground-water reservoir becomes part of the regional flow system. This water moves northward to the lake plain where it moves upward and is discharged by evapotranspiration or runoff or moves laterally westward toward the Red River lowland. This lateral flow is very slow to nearly stagnant. Precipitation that enters the ground-water reservoir in the lake-washed till plain again either moves to adjacent lowlands as part of local flow systems or moves deeper into the ground-water reservoir and moves westward. The lake plain is generally an area of regional ground-water discharge. However, within this area, local recharge occurs in the beach ridge area. Where the Cretaceous and Paleozoic rocks are continuous with those in North Dakota (see bedrock geology map), the hydraulic head is generally greater than that in the overlying glacial drift. This results in water moving upward and mixing with water in the drift.



GROUND WATER FOR DOMESTIC AND STOCK SUPPLIES CAN USUALLY BE OBTAINED FROM A WELL LESS THAN 150 FEET DEEP IN THE EASTERN TWO-THIRDS OF THE WATERSHED.—*In the western part of the watershed, wells are generally deeper because 50 to 100 feet of glacial lake sediments must be penetrated before reaching the glacial till which contains sand lenses of sufficient permeability for water supply.*

COMMUNITY WATER SUPPLIES

Community	Well characteristics					Water quality (mg/l)				Remarks
	Depth (feet)	Diameter (inches)	Operating rate (gpm)	Depth to static water level (feet)	Specific capacity (gpm per ft)	Total dissolved solids	Hardness	Iron	Sulfate	
Bagley										
Well 1	180	8	250	30		409	360	1.3	0.5	Well 1 now being used as observation well.
Well 2	170	12	300	30	12					Well 2 will yield 660 gpm.
Blackduck										
Well 1	110	8	55	30	7					Well 1 has been pumped at 150 gpm for 8 hours.
Well 2	124	8	75	35	10		370	0.36	0	
Well 3	130	12					350	3.4	1.3	Well 3 tested at 400 gpm.
Clearbrook	135	8	150	18						
	135	8	150	18						Each well will yield 300 gpm.
Erskine	75	10	250				240	1.9	2.4	
	94	10	230	8	19	310	275	1.7	9.0	
Fisher	140	12	125	12			210	1.3	150	
Fosston	236	8	150	27	7					
	125	12	250	23	19		380	1.4	42	
	270	12	300	29	10					
Gonvick	119	8	70	34	4					
Kelliher	202	6	60							
	184	6	35	20		340	284	0.4	10	
McIntosh	212	8	50	65						
	82	10		16	3					
Northome	90	10	300	12						
	95	10	400							
Oklee	268	10	500	8			260	4.0	95	
Plummer	220	6	150	18			370	1.1	200	
Red Lake Falls	157	12	185	85						
	146	12	110				490	1.7	130	
	303	8	300	48	4.5					
St. Hilaire	129	8	200	2		694	440	0.31	196	

EXPLANATION

Till

Lithologic characteristics: *An unsorted mixture consisting mainly of silt and clay, but containing sand, gravel, and boulders. The till at depth in the eastern part of the morainal area is generally sandier than in the remainder of the watershed. Lenses of stratified silt, sand, and gravel, from a few inches to several feet in thickness, occur at many places within the till. Till extends from the surface to the Precambrian crystalline rocks except in the lake plain where it is overlain by glacial lake deposits and underlain by Cretaceous sediments. The upper part of the till, where it is exposed at the surface, is oxidized and leached to a depth of 15 to 30 feet.*

Water-bearing characteristics: *Yields to individual wells are commonly less than 10 gallons per minute; however, a few wells yield up to several hundred gallons per minute. The oxidized portion of the till is slightly more permeable than the underlying unweathered till. However, yields of deeper wells are generally greater than shallower wells because of more available head for drawdown. Test drilling is usually necessary in till areas to locate aquifers that will yield large amounts of water to wells*

Fine-grained lake deposits

Lithologic characteristics: *Stratified lacustrine silts and clays occur in the western part of the area and fine sand occurs in the eastern. Thickness of the lake sediments ranges from more than 120 feet of silt and clay in the west to only a few feet of sand in the east.*

Water-bearing characteristics: *The lake sediments generally are not a source of water. However, large diameter dug wells or cattle ponds in the clay and silt intercept enough permeable stringers of silt to maintain watering ponds for livestock*

Beach ridge aquifers

Lithologic characteristics: *Predominantly fine to coarse sand containing gravel at many places. The deposits vary in shape and size—some beach deposits are ridges of sand that essentially lie on top of clay, silt, or till; whereas, a more complex and less common type of deposit is sand that interfingers laterally with adjoining lake clay and silt. Section A–A' below, shows an example of the type of aquifers found in the shoreline area of Glacial Lake Agassiz.*

Water-bearing characteristics: *Beach ridges are usually saturated in their lower half to two-thirds. Yields of more than 20 gallons per minute to individual wells can usually be obtained from the larger sand deposits. The deeper sands that occur on the lakeward side of the ridges are usually saturated except for the upper 1–3 feet. The smaller ridges are unreliable as a source of ground water because wells would commonly go dry in late summer and fall*

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Outwash and ice-contact aquifers and area number

Lithologic characteristics: *Medium to coarse sand and fine gravel. Medium gravel occurs locally. Thickness of the aquifers varies considerably. Section B–B' below, shows the thickness of sand and gravel in area 1 to range from about 30 to 75 feet. Area 2 does not have drill hole information but gravel pits in this area show thicknesses greater than 50 feet. The fence diagram of area 3 below, shows a maximum thickness of this deposit of more than 90 feet. The thickest saturated sand, in the valley bottom, within area 3 has a very high water table.*

Water-bearing characteristics: *The aquifers have not been test pumped, but the permeability and available head suggest that wells yielding several hundred gallons per minute could be developed in them. A yield of nearly 1,000 gallons per minute was reported from area 1. Water-table contours indicate much ground-water movement to area 3 and some movement to the lower parts of areas 1 and 2*

Contact

Watershed boundary

1060

Water-table contour

Shows altitude of water table. Contour interval 40 feet. Supplemental contours (dashed) at 20 foot intervals, at altitudes less than 1080. Datum is mean sea level. Based on information on wells less than 50 feet deep

Test hole

AVAILABILITY MAP SHOWS KNOWN AREAS WHERE GROUND WATER CAN BE OBTAINED FROM THE GLACIAL DRIFT.

Ground water for domestic and stock use can be obtained at most places in the area. For larger yield wells the best potential is in the outwash and ice-contact areas. Large yield wells may be obtained in other parts of the area but test drilling is required to locate the sand and gravel bodies.

The general direction of ground-water movement is indicated by the water-table contours. The close spacing of the contours near the streams, at the eastern edge of the lake plain, indicates the low permeability of the glacial till through which water moves toward a major discharge zone along the deeply incised stream channels.

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WATER RESOURCES OF THE RED LAKE RIVER WATERSHED, NORTHWESTERN MINNESOTA

By
L. E. Bidwell, T. C. Winter, R. W. Maclay

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