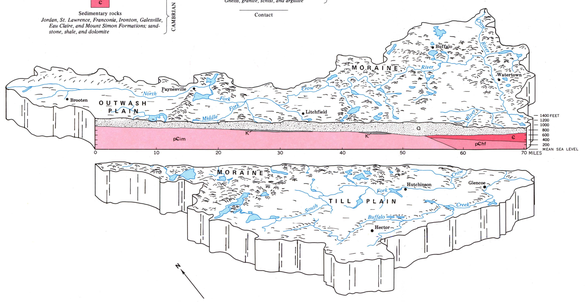
PREPARED IN COOPERATION WITH THE
MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS, SOILS, AND MINERALS

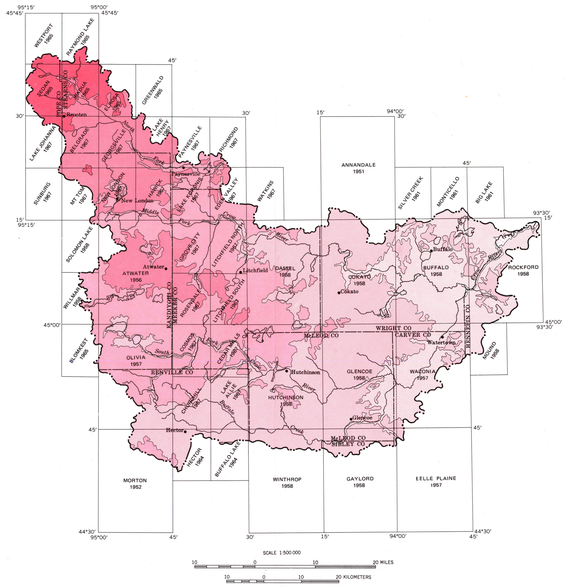
INTRODUCTION



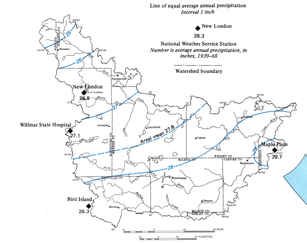
THE CROW RIVER WATERSHED, AN AREA OF ABOUT 2,760 SQUARE MILES, IS COVERED ENTIRELY BY GLACIAL DEPOSITS.— *A topographically high, east-west-trending end moraine divides most of the watershed into two drainage areas of approximately equal size. The North Fork Crow River drains a mixture of glacial outwash and till deposits, whereas the South Fork Crow River drains chiefly till deposits. Local relief is greatest in morainal areas and least in surficial outwash areas. Details of topography are shown on the land surface map (sheet 2) and the bedrock topography map (sheet 3).*

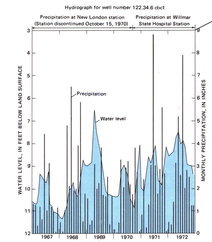
Cambrian and Precambrian sedimentary rocks underlie the glacial drift in the eastern part of the watershed. Cretaceous sedimentary rocks, though discontinuous, are present in part of the western two-thirds of the watershed. Where sedimentary bedrock is absent, the glacial drift is directly underlain by Precambrian igneous or metamorphic rocks.

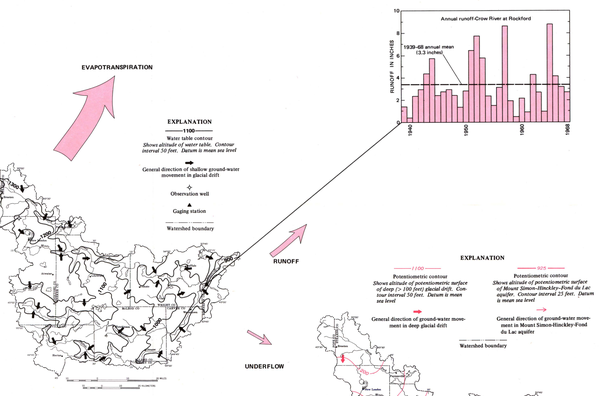
Forested areas are sparse and occur mainly in steeply sloping morainal areas. Most land is used for agriculture, and slightly more than half the total population is rural.



WATER BUDGET





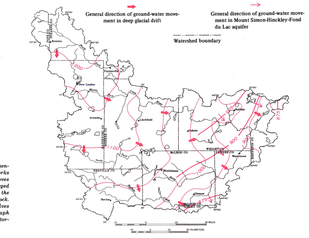


PRECIPITATION	=	RUNOFF	+	UNDERFLOW	±	CHANGE IN STORAGE	+	EVAPOTRANSPIRATION
27.6 inches (measured)		3.3 inches (measured)		0.1 inch (calculated)		0 (assumed)		24.2 inches (remainder)

The average annual water budget is for 1939–68, and is illustrated schematically above (blue arrows—inflow; red arrows—outflow). About 1,300 billion gallons move through the system annually.

Average annual precipitation, about one-third of which is snow, increases from west to east. Almost 10 percent of this inflow is returned to the atmosphere by evapotranspiration. More than 10 percent becomes stream runoff; however, this quantity varies widely from year to year because of variations in annual precipitation. Some precipitation percolates downward to become ground water, most of which then moves laterally in local flow systems (map above) before being discharged to streams or lakes or by evapotranspiration. Shallow ground-water movement is generally from the higher morainal areas toward the North and South Forks of the Crow River. A relatively small amount of ground water moves deeper as part of a more regional flow system. This water is discharged as underflow across the southeastern and southern boundaries of the watershed through deep glacial drift and underlying sedimentary bedrock.

For any given year, the water budget of the watershed likely involves a change in storage, as shown by observation wells (sample hydrograph at left). Over the 30-year period considered here, however, change in storage is assumed to be zero, and inflow and outflow are equal.



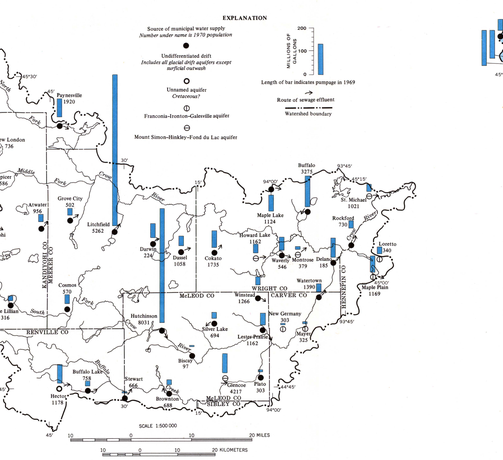
WATER USE

WATER USE IN 1969 (MILLIONS OF GALLONS)

Type of use	Ground water	Surface water
Municipal	2,540	----------
Industrial (private supply)	700	----------
Irrigation	430	60
Rural domestic	1,600 (est.)	----------
Livestock	3,100 (est.)	
Total	8,430	

WATER USE EXCEEDED 8 BILLION GALLONS IN THE WATERSHED IN 1969.— *Nearly all water is obtained from ground-water sources. Figures in the table are based on reported and estimated data and are considered minimal.*

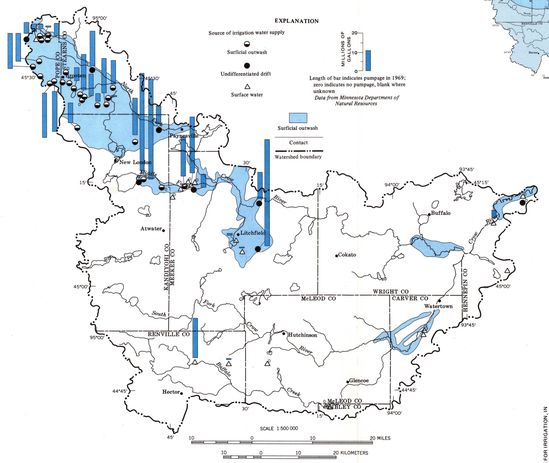
Although irrigation, by ground water accounted for only 5 percent of the total usage in 1969, it is expected to become a major use in the near future.

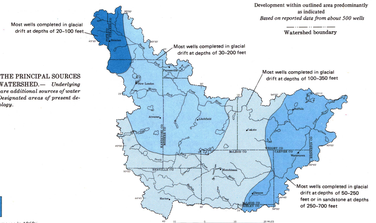


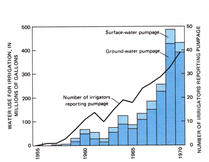
ABOUT 90 PERCENT OF WATER WITHDRAWN BY MUNICIPALITIES IN 1969 WAS OBTAINED FROM GLACIAL-DRIFT AQUIFERS.— *Most of the remainder was withdrawn from the two major sedimentary bedrock aquifers in the eastern part of the watershed.*

Of the 31 municipalities with a public water supply, 30 have sewer systems. All of these except Atwater, Brownton, and Buffalo Lake have sewage-treatment facilities. All treatment is secondary except at New London, where primary treatment is used.

AQUIFERS IN GLACIAL DRIFT ARE THE PRINCIPAL SOURCES OF WATER OVER THE ENTIRE WATERSHED.— *Underlying Cambrian and Precambrian sandstones are additional sources of water in the eastern part of the watershed. Designated areas of present development reflect differences in hydrogeology.*







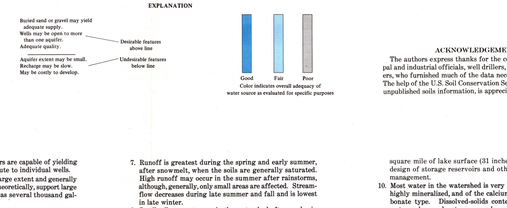
PUMPAGE FOR IRRIGATION IS CONCENTRATED ON SOILS OF LOW WATER-HOLDING CAPACITY DEVELOPED FROM SURFICIAL OUTWASH.— *Surficial outwash aquifers supplied more than half the water withdrawn in 1969 for irrigation in the watershed. The number of irrigators and the amount of water withdrawn for irrigation has increased considerably in recent years (graph).*

SUMMARY AND CONCLUSIONS

RELATIVE ADEQUACY OF WATER SOURCES

Purpose	Considerations	Surface water: Crow River (includes North and South Forks)	Surface water: Large lakes	Surface water: Small lakes and minor streams	Ground water[1]: Surficial outwash	Ground water[1]: Undifferentiated drift	Ground water[1]: Franconia-Ironton-Galesville aquifer	Ground water[1]: Mount Simon-Hinckley-Fond du Lac aquifer
Municipal or industrial supply	For a moderate supply, principal needs are: Quantity: Minimum available surface water supply of 1 cubic foot per second or wells yielding 250 gallons per minute. Quality: Dissolved-solids content less than 500 milligrams per liter. Hardness less than 180 milligrams per liter.	Adequate supply with development of storage facilities. Disinfection necessary for municipal use. Water may be very hard and high in dissolved solids.	Adequate supply from lakes for limited use. Disinfection necessary for municipal use.	Most are inadequate. Many dry up during droughts. Disinfection necessary for municipal use. Water may be very hard and high in dissolved solids in some streams.	Rapid recharge from precipitation. Generally adequate quality. Relatively inexpensive to develop. Much of aquifer too thin for adequate yield. Easily polluted. Treatment for hardness and iron may be necessary.	Buried sand or gravel may yield adequate supply. Wells may be open to more than one aquifer. Aquifer extent may be small. Recharge may be slow. Water high in dissolved solids and iron, very hard. May be costly to develop.	Adequate quantity, most probably from Ironton and Galesville Formations. Large areal extent. Depth of well required may be economically prohibitive. Water high in dissolved solids and iron, very hard.	Adequate quantity, most probably from Mount Simon Sandstone. Large areal extent. Depth of well required may be economically prohibitive. Water high in dissolved solids and iron, very hard.
Rural, domestic, or stock supply	For an adequate farm supply, needs are: Quantity: Minimum of 5 gallons per minute. Quality: Dissolved-solids content less than 1,000 milligrams per liter.	Adequate supply. Available only to riparian lands. Disinfection necessary for domestic use. Water may be very hard and high in dissolved solids.	Adequate supply. Available only to riparian lands. Disinfection necessary for domestic use.	Adequate for stock. Available only to riparian lands. Many dry up during droughts. Disinfection necessary for domestic use. Water may be very hard and high in dissolved solids in some streams.	Generally adequate quantity and quality. Relatively inexpensive to develop. Easily polluted. Treatment for hardness and iron may be necessary for domestic use.	Generally adequate quantity and quality. Water high in dissolved solids and iron, very hard. May be costly to develop.	Adequate quantity. Large areal extent. Depth of well required may be economically prohibitive. Water high in dissolved solids and iron, very hard.	Adequate quantity. Large areal extent. Depth of well required may be economically prohibitive. Water high in dissolved solids and iron, very hard.
Irrigation supply	For an average farm, needs are: Quantity: Minimum available surface-water supply 2 cubic feet per second during growing season or wells yielding 250 gallons per minute. Quality: Suitability of water supply for irrigation as indicated by classification of Wilcox (1955).	Adequate supply; some storage may be necessary. Available only to riparian lands.	Adequate supply from some lakes; limited use from others. Available only to riparian lands.	Adequate supply for limited use from some. Available only to riparian land. Most are inadequate. Many dry up during droughts.	Rapid recharge from precipitation. Adequate quality. Relatively inexpensive to develop. Much of aquifer too thin for adequate yield.	Buried sand or gravel may yield adequate supply. Wells may be open to more than one aquifer. Adequate quality. Aquifer extent may be small. Recharge may be slow. May be costly to develop.	Adequate quantity, most probably from Ironton and Galesville Formations. Large areal extent. Adequate quality. Depth of well required may be economically prohibitive.	Adequate quantity, most probably from Mount Simon Sandstone. Adequate quality. Large areal extent. Depth of well required may be economically prohibitive.
Fish and wildlife habitat	Adequate depth and quality of water for fish in lakes and streams. Adequate cover needed for wildlife habitat is provided by: Wetlands – lakes or potholes surrounded by marsh areas. Streams – marsh and woodland along banks.	Suitable for wildlife along banks. Suitable for fish. Occasional floods.	Excellent migratory waterfowl resting and feeding areas. Excellent wildlife habitats in marsh areas and along shores. Most suitable for fish. Occasional winter kill in some lakes.	Good resting and feeding areas for migratory water fowl. Excellent habitat along shores and banks. Low water stage.				
Recreation	Adequate access to lakes and streams. Availability of areas suitable for boating, fishing, and other water sports. Available resorts, lake cottages, and campgrounds. Esthetic values and absence of pollution.	Suitable for hunting and fishing. Occasional floods.	Suitable for hunting, fishing, and water sports. Widely distributed.	Many suitable for hunting and trapping. Widely distributed. Many dry up during droughts.				

[1]Cretaceous rocks, Jordan Sandstone, St. Lawrence Formation, Eau Claire Sandstone, and igneous and metamorphic rocks are relatively insignificant sources of water in this watershed and are not evaluated.



CONCLUSIONS

1. Average annual precipitation (1939–69) on the watershed is 27.6 inches. Of this amount, 24.2 inches is discharged as evapotranspiration, 3.3 inches as streamflow, and 0.1 inch as underflow.
2. Water use in the watershed exceeded 8 billion gallons in 1969. Nearly all water is obtained from ground-water sources, mainly glacial drift. All major aquifers can support additional development.
3. Thickness of glacial drift ranges from about 100 to 500 feet. Areas of thickest drift generally coincide with lows on the bedrock surface.
4. Parts of surficial outwash aquifers are capable of yielding several hundred gallons per minute to individual wells.
5. Two buried outwash aquifers of large extent and generally high hydraulic head could each, theoretically, support large short-term well yields, as much as several thousand gallons per minute.
6. The Franconia-Ironton-Galesville and Mount Simon-Hinckley-Fond du Lac sandstone aquifers can each, theoretically, support short-term well yields of as much as several thousand gallons per minute. The productivity, lateral continuity, and partly overlapping occurrence of these units in the eastern part of the watershed lend favorability to ground-water development in that area.
7. Runoff is greatest during the spring and early summer, after snowmelt, when the soils are generally saturated. High runoff may occur in the summer after rainstorms, although, generally, only small areas are affected. Streamflow decreases during late summer and fall and is lowest in late winter.
8. Small tributary streams in the watershed often go dry in the fall and winter because they have little natural storage and receive little ground-water contribution.
9. Sites for large storage reservoirs are limited to lower reaches of the North and South Forks of the Crow River. Annual evaporation of about 2.3 cubic feet per second per square mile of lake surface (31 inches) is a factor in the design of storage reservoirs and other aspects of water management.
10. Most water in the watershed is very hard, moderately to highly mineralized, and of the calcium magnesium bicarbonate type. Dissolved-solids content in both surface water and ground water commonly exceeds 500 milligrams per liter in the southern half of the watershed. Iron concentrations in ground water and manganese concentrations in both ground water and surface water are commonly excessive.

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WATER RESOURCES OF THE CROW RIVER WATERSHED, SOUTH-CENTRAL MINNESOTA

By
G. F. Lindholm, D. F. Farrell, and J. O. Helgesen

1974

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