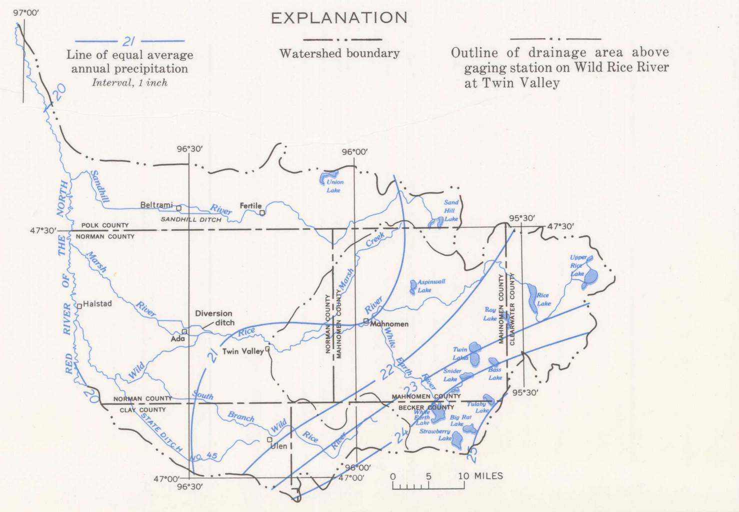
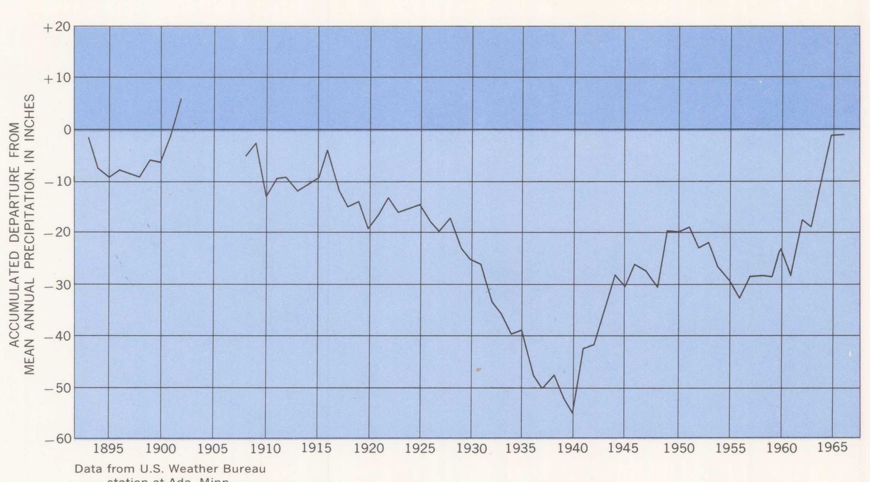
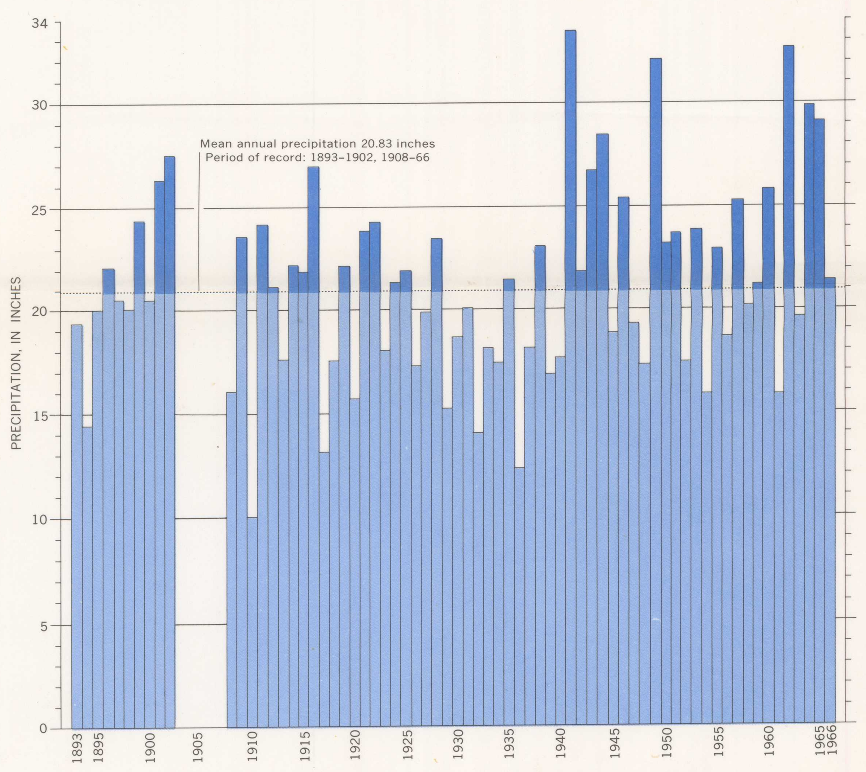
CLIMATE AND WATER USE

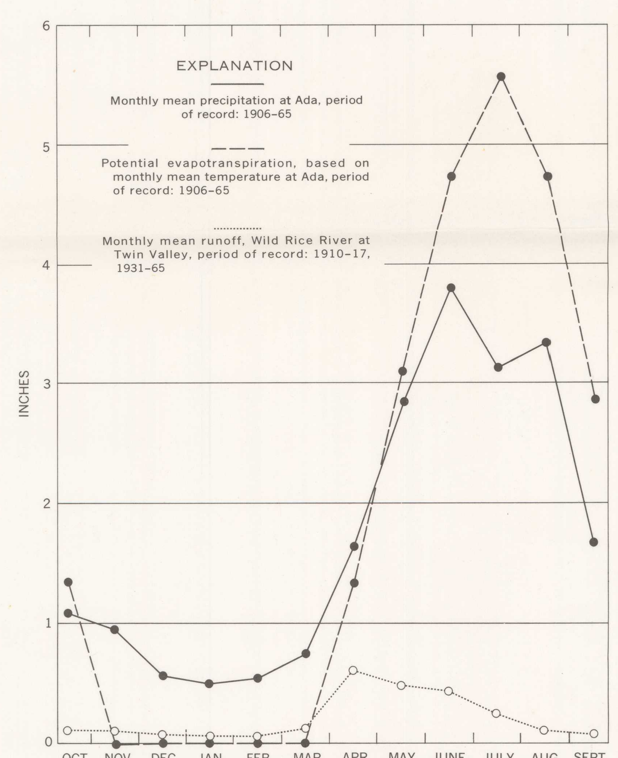


AVERAGE ANNUAL PRECIPITATION IS FAIRLY UNIFORM IN THE LAKE PLAIN BUT INCREASES TOWARD THE HIGHER PART OF THE MORAINAL AREA.—*The Wild Rice River basin above Twin Valley was used in the estimation of water yield (see Water Yield, this sheet). This drainage basin is largely within the glacial moraine that receives the higher average annual precipitation.*



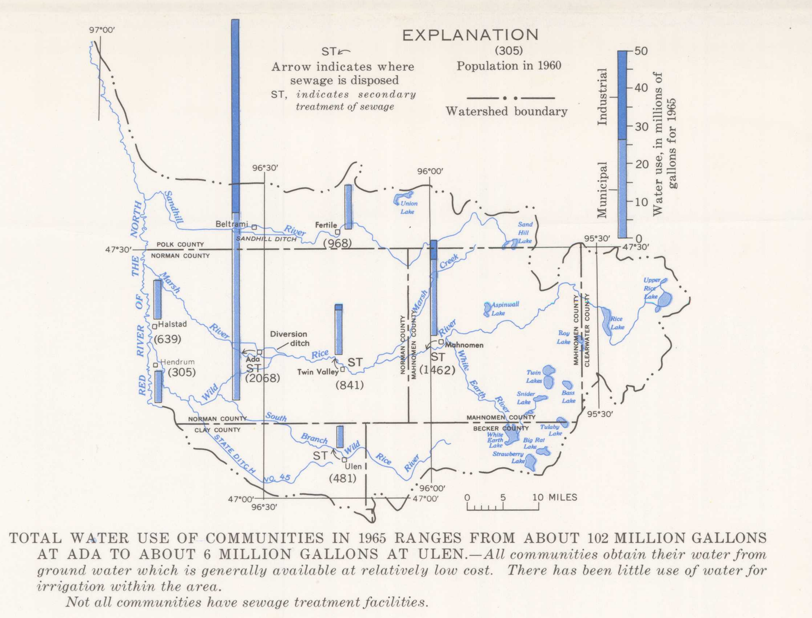


THE GREATEST RATE OF ACCUMULATED DEFICIENCY OF PRECIPITATION OCCURRED IN 1929–40.—*This period is characterized by extreme climatic conditions of long but unknown recurrence. The annual precipitation ranges from 10.07 in 1910 to 33.39 in 1941. The greatest deficit in accumulative departure from mean annual precipitation was about 55 inches in 1940.*



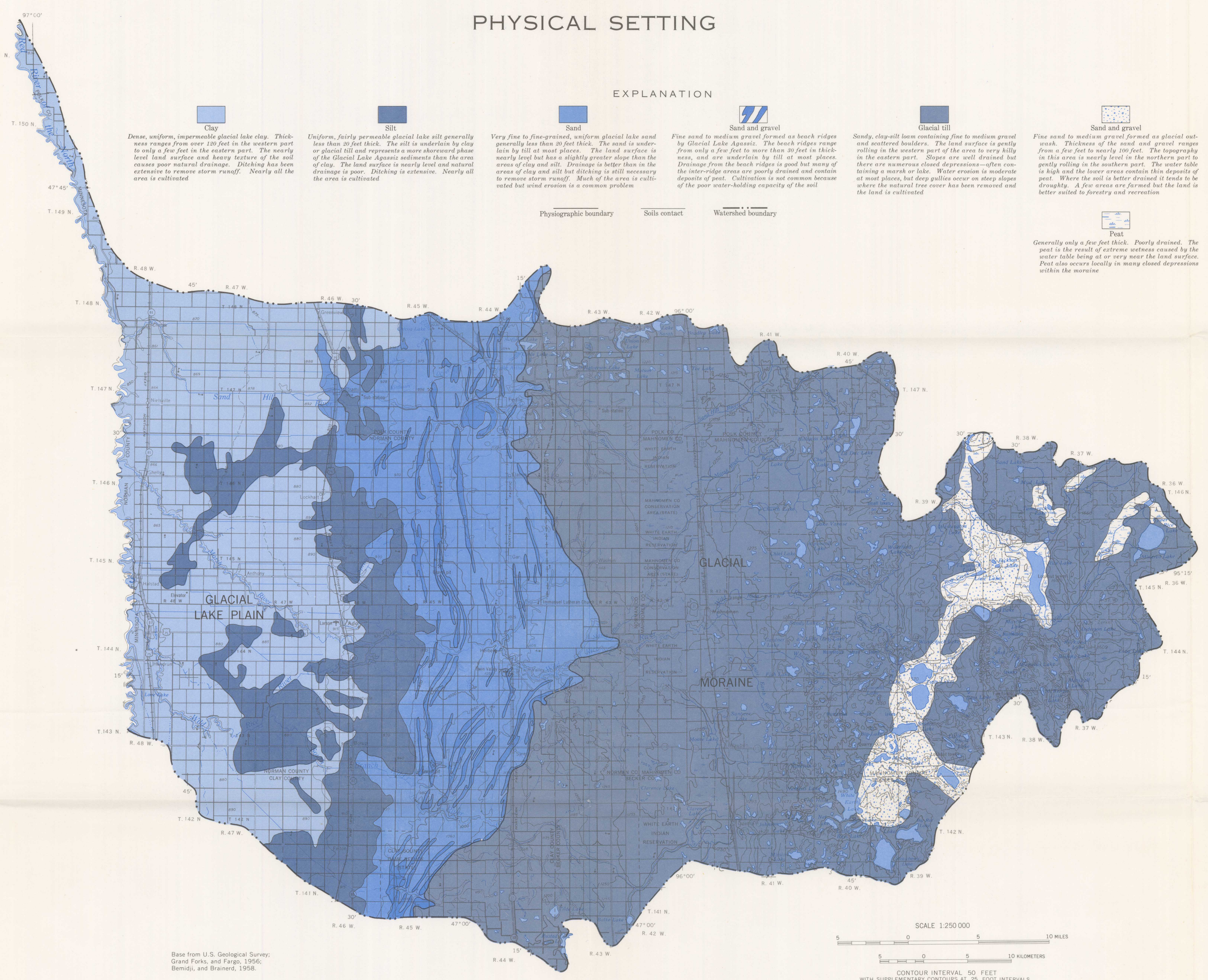
THE MONTHLY AND SEASONAL VARIATIONS AND RELATIONSHIPS BETWEEN PRECIPITATION, RUNOFF, AND EVAPOTRANSPIRATION CAN BE DETERMINED FROM THE GRAPH.—*Precipitation surplus occurs during the period from November to April resulting in delayed runoff during March, April, and May. Potential evapotranspiration exceeds precipitation during the growing season and plant growth less than optimum occurs during the late summer months when storage of soil moisture is depleted. Although potential evapotranspiration exceeds precipitation during the growing season part of the runoff occurs because the intensity of thunderstorms commonly exceeds the soil infiltration rate. The remainder of the runoff is released from ground-water storage.*

The estimation of potential evapotranspiration was computed by the method described by Thornthwaite and Mather (1957). It is based on the monthly precipitation and mean temperature for the month.



TOTAL WATER USE OF COMMUNITIES IN 1965 RANGES FROM ABOUT 102 MILLION GALLONS AT ADA TO ABOUT 6 MILLION GALLONS AT ULEN.—*All communities obtain their water from ground water which is generally available at relatively low cost. There has been little use of water for irrigation within the area.*
Not all communities have sewage treatment facilities.

PHYSICAL SETTING



THE WILD RICE WATERSHED INCLUDES TWO GENERAL PHYSIOGRAPHIC AREAS—THE GLACIAL LAKE AGASSIZ PLAIN AND A GLACIAL MORAINE

The lake plain is extremely flat in the western part, sloping only a few feet per mile, but in the eastern part the plain is traversed in a north-south direction by long, narrow beach ridges up to 20 feet high. The moraine is an area of hills and depressions. The local relief is low in the western part of the moraine but increases to more than 200 feet in the east. Altitude of the land surface ranges from 800 feet above mean sea level where the Red River flows north out of the area to 2,040 feet near the southeastern edge of the watershed (one of the highest points in Minnesota).

The area of the watershed is about 2,600 square miles and includes most of Mahnomen and Norman Counties and parts of Becker, Clay, Clearwater, and Polk Counties. The population of the area is about 37,000 people of which about 70 percent live on farms. The economy is based principally on farming. The area of lake clay and silt is used mostly for raising sugar beets and wheat; and potatoes are grown largely on the sandy soils. In the western part of the morainal area small grain, dairy, and cattle farming is the most common. The eastern part of the morainal area is important for forest products and recreation. Industries in the area are small and are based on agricultural processing and service.

SUMMARY

SUMMARY OF WATER RESOURCES

Purpose	Considerations	Surface water: Red River of the North	Surface water: Tributaries	Surface water: Lakes and potholes	Ground water: Sand lenses within till	Ground water: Beach ridges	Ground water: Outwash and ice-contact sand and gravel
Municipal and industrial supply	For a moderate supply, principal needs are: QUANTITY 1. Minimum sustained supply of 2 cubic feet per second (cfs) or 900 gallons per minute (gpm). QUALITY 1. Total dissolved-solids content less than 500 milligrams per liter (mg/l). 2. Hardness less than 180 mg/l.	Adequate flow. Additional storage possible in headwaters of major tributaries. Total dissolved solids less than 500 mg/l at Halstad. — At low flow hardness is generally more than 180 mg/l at Halstad. Treatment necessary.	Adequate flow in main stems except during extreme droughts. Storage possible in headwaters of Sandhill and Wild Rice Rivers. Total dissolved solids mostly less than 500 mg/l. — Inadequate flow in Marsh River and minor tributaries. At low flow hardness is greater than 180 mg/l. Treatment necessary.	Large lakes adequate for limited use. Additional storage possible in lakes with adequate inflow. Total dissolved solids mostly less than 500 mg/l. — Hardness is greater than 180 mg/l. Treatment necessary. High evaporation loss.	Some sand lenses within till are sources of adequate water supply for small municipalities and industries. Suitable quality at most places. — Test drilling is usually necessary to locate aquifers adequate to supply amounts needed. Aquifer may be located at considerable distance from the place of water use. Hardness is generally greater than 180 mg/l.	Generally not an adequate supply. Limited areal extent.	Potential yield to individual wells is several hundred gpm at many places. Suitable quality, but hardness and iron content might be high. Fairly large areal extent. — Hardness is generally greater than 180 mg/l. Iron content might be high.
Rural domestic and stock supply	For an adequate farm supply, needs are: QUANTITY 1. About 5 gpm or more. QUALITY 1. Total dissolved-solids content less than 1,000 mg/l.	Adequate flow. — Available only to riparian lands. Treatment necessary for domestic use.	Adequate flow in major streams. Suitable quality. — Available only to riparian lands. Inadequate flow in Marsh River and most minor streams. Treatment necessary for domestic use.	Most are adequate for stock. Additional storage possible in lakes with adequate inflow. Suitable quality. — Available only to riparian lands. Many small lakes and potholes dry up during droughts. Limited inflow in most small lakes and potholes. Treatment necessary for domestic use.	Sand lenses that yield 5 gpm or more to individual wells can be found at most places in the area. Suitable quality at most places. — Hardness is generally greater than 180 mg/l.	Most beach ridges contain sufficient water for yields of 5 gpm or more to individual wells. Suitable quality. — Lower beach ridges are unreliable sources of water. Hardness is generally greater than 180 mg/l.	Adequate yields. Suitable quality. — Hardness and iron content might be high.
Irrigation supply	For an average farm, needs are: QUANTITY 1. Minimum flow of 2 cfs during growing season or wells yielding 250 gpm or more. QUALITY 1. Total dissolved-solids content less than 1,000 mg/l. 2. Suitability of water quality for irrigation as indicated by classification of U.S. Dept. of Agriculture.	Adequate flow using water released from storage. Additional storage possible in headwaters of major tributaries. Suitable quality. — Restricted to riparian lands.	Adequate flow in major streams for small acreage during years of normal wetness. Additional storage possible in headwaters of Sandhill and Wild Rice Rivers. Suitable quality. — Restricted to riparian lands.	Large lakes would be adequate for small acreage during years of normal wetness. Additional storage possible in lakes with adequate inflow. Suitable quality. — Restricted to riparian lands. Limited inflow in most small lakes and potholes. High evaporation loss.	Quality of water is generally suitable outside of lake plain. — Test drilling is usually required to locate sand lenses that will yield 250 gpm to individual wells. Quality of water may not be suitable for irrigation at some places in the lake plain.	Suitable quality. — Generally not an adequate supply. Limited areal extent.	Potential yield to individual wells is more than 250 gpm at many places. Fairly large areal extent. Suitable quality. — Part of area might not be available for agriculture because of swamplands.
Hunting, fishing, and other recreation	Adequate cover for wildlife habitat is provided by: 1. Wetlands—potholes or lakes surrounded by marsh areas. 2. Streams which have woodland marsh areas along banks. Adequate depths and quality of water for fish in lakes and streams. Adequate availability and access to areas suitable for hunting, fishing, and other water sports. Available resorts and lake cottages. Aesthetic considerations: 1. Absence of odors. 2. Sightliness. 3. Attractive physical setting. 4. Absence of pollution.	Some waterfowl loafing and feeding areas along rivers. Fair to poor fishing conditions. Public access at some sites. Good habitat along banks. Favorable location with respect to population. Boating in pool above Grand Forks, N. Dak. — Occasional high water. Aesthetic considerations generally poor to fair. Severe pollution by wastes from municipalities and industry; remedial measures have been instigated.	Some waterfowl loafing and feeding areas along rivers. Fair to poor fishing conditions. Public access at some sites. Good habitat along banks. Favorable location with respect to population. Suitable water quality. — Occasional high water. Aesthetic considerations generally fair.	Excellent migratory waterfowl nesting, loafing, and feeding areas. Many wetland game management and hunting areas. Large deep lakes good for fishing and water sports. Shallow lakes good for wild-rice production and fur-bearing-animal habitat. Favorable location with respect to population. Suitable water quality. Aesthetic conditions generally good. — Some potholes dry up during droughts. Occasional high stages. High evaporation loss.			

EXPLANATION

Good — Fair — Poor: Overall evaluation for purposes and considerations indicated

Sand lenses that yield 5 gpm or more to individual wells can be found at most places in the area. Suitable quality at most places. — Advantages

Hardness is generally greater than 180 mg/l. — Disadvantages

CONCLUSIONS

1. The annual mean runoff of the entire Wild Rice River watershed is about 1.8 inches or 250,000 acre-feet. Runoff is not equally distributed throughout the watershed—ranging from slightly more than 1 inch along the Red River of the North to over 3½ inches in the upper reaches of the Wild Rice River.
2. Runoff is greatest during spring and early summer when water is released from surface storage and the soils are commonly saturated. High runoff may occur during July following periods of thunderstorm activity. Runoff recedes during late summer and fall to low values during winter. Generally, the smallest range in daily discharge occurs just prior to spring breakup, whereas, the largest occurs during the summer.
3. Flooding along the lower Wild Rice, Marsh, and Sandhill Rivers is caused by flat land surface, small capacity channels, and low gradient of the channels in the lake plain. Moderately steep channel gradients and faster runoff in the eastern part of the watershed contribute to the severity of the flooding in the lake plain.
4. The natural streamflow of the Red River of the North is inadequate for a dependable water supply and pollution abatement in the river. Streamflow is supplemented by release of stored water from Orwell Reservoir on the Ottertail River and from Lake Ashtabula on the Sheyenne River in North Dakota.
5. Evaporation of about 1.9 cubic feet per second per square mile (26 inches per year) of lake or reservoir surface must be considered in design of storage reservoirs.
6. The frequency of recurrence of the long periods of low flow during the severe drought of the 1930's cannot be adequately defined by the short length of streamflow records in the watershed.
7. Streamflow in the Sandhill and Wild Rice Rivers, which drain the morainal area, is sustained by lake storage and effluent from ground-water reservoirs. Ground-water contribution to streamflow is most significant in the outwash sand and gravel in the morainal area and the beach ridges and sand hills in the eastern part of the glacial lake plain. Marsh and South Branch Wild Rice Rivers, go dry many summers because they have little natural storage and little ground-water contribution.
8. Specific conductance of surface water at periods of low flow show a strong relation to ground-water discharge. Conductivity is low in water flowing from lakes, increases in areas of ground-water inflow, and decreases where little ground water moves into the stream channel.
9. Baseflow is slow to increase in a spring of normal wetness if the ground-water reservoir has been severely depleted the previous year.
10. Lakes and streams in the morainal area provide excellent recreational opportunities both for fishing and for waterfowl hunting.
11. Regional movement of ground water in the glacial drift is westward from the rolling uplands of the morainal area to the lake plain and the Red River of the North. Locally, ground water moves toward depressions and valleys within the uplands.
12. Water for domestic and farms use can usually be obtained with a well less than 150 feet deep in all but the western quarter of the watershed.
13. The area with best potential for large yield wells is the outwash and ice-contact sand and gravel in the eastern part of the watershed.
14. Calcium magnesium bicarbonate, the most common water type in the area, occurs mainly in the central and eastern part of the watershed. Sodium chloride type water is commonly associated with the Cretaceous sediments.
15. Most surface and ground water has a low sodium hazard but medium to high salinity hazard for irrigation use.

ACKNOWLEDGMENTS

We express our appreciation to the well owners and well drillers in the area for their cooperation in providing basic data for this study.

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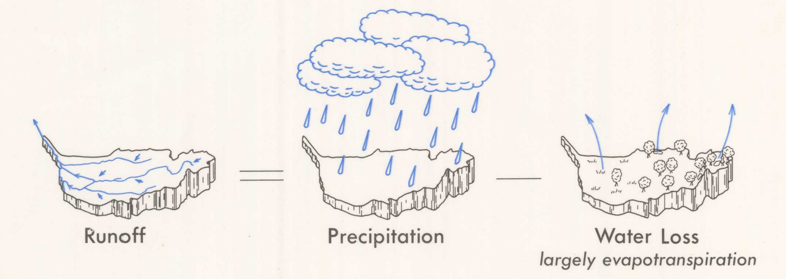
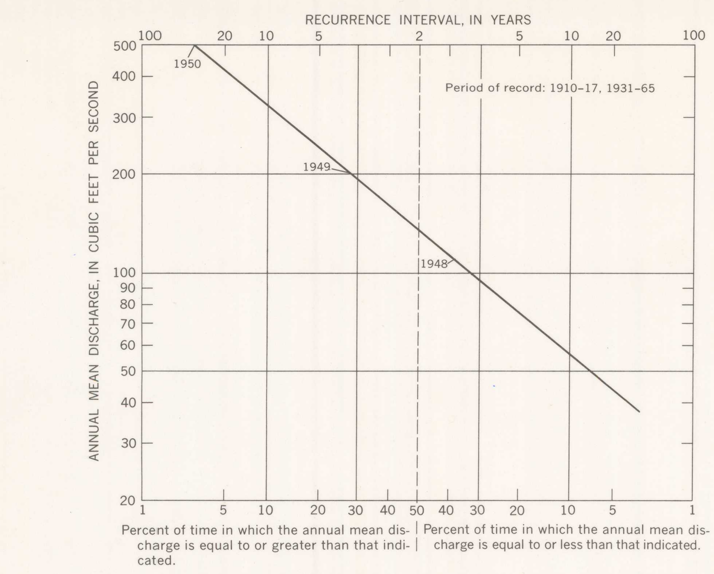
WATER YIELD



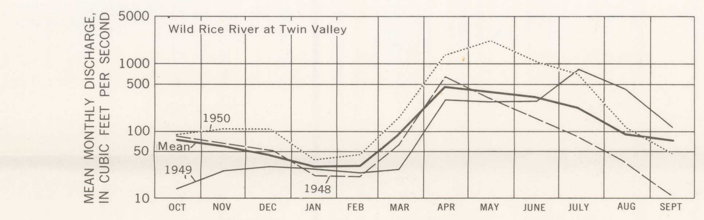
	Runoff	Precipitation	Water Loss
Entire watershed	1.8 inches	21.2 inches	19.4 inches
Wild Rice River above Twin Valley	2.5 inches	22.6 inches	20.1 inches

MOST OF THE ANNUAL PRECIPITATION THAT FALLS ON THE WATERSHED IS RETURNED TO THE ATMOSPHERE BY EVAPOTRANSPIRATION AND ONLY A SMALL AMOUNT OF WATER IS RECOVERABLE BY MAN.—*Water yield or annual mean runoff for the Wild Rice River watershed (about 2,600 square miles) is 1.8 inches or 250,000 acre-feet for 1931 to 1964. The annual mean runoff is 2.5 inches or 118,000 acre-feet for the drainage area of the Wild Rice River at Twin Valley (888 square miles). The larger yield per unit area is a result of higher precipitation in the eastern part of the watershed. Part of this water is available for use by man through water management.*

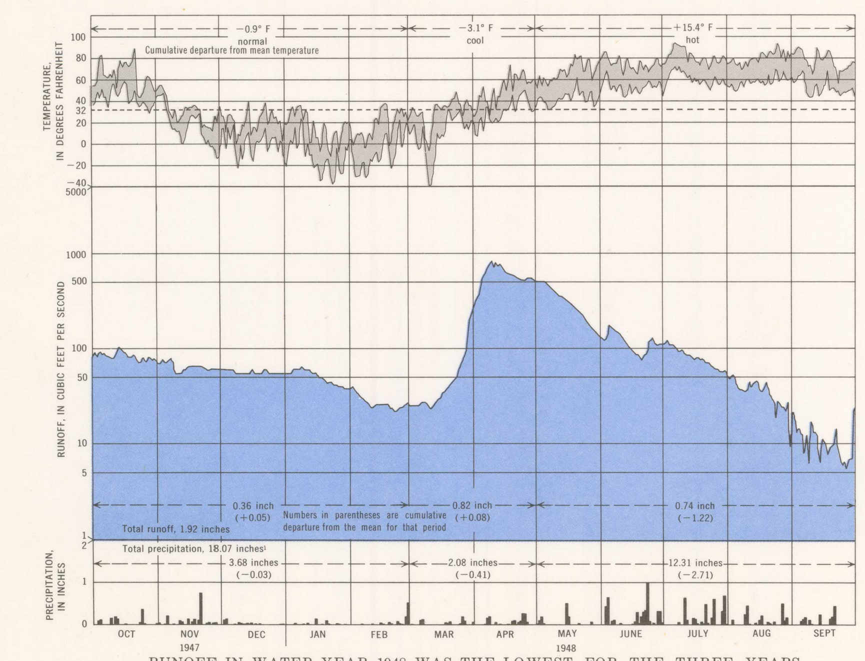


FREQUENCY DISTRIBUTION OF ANNUAL MEAN DISCHARGE OF THE WILD RICE RIVER AT TWIN VALLEY SHOWS THAT 135 CUBIC FEET PER SECOND MAY BE EXPECTED TO OCCUR ON AN AVERAGE OF ONCE IN 2 YEARS.—*A high annual mean discharge of about 400 cubic feet per second or more and a low annual mean discharge of 45 cubic feet per second or less may be expected to occur on an average of once in 20 years.*

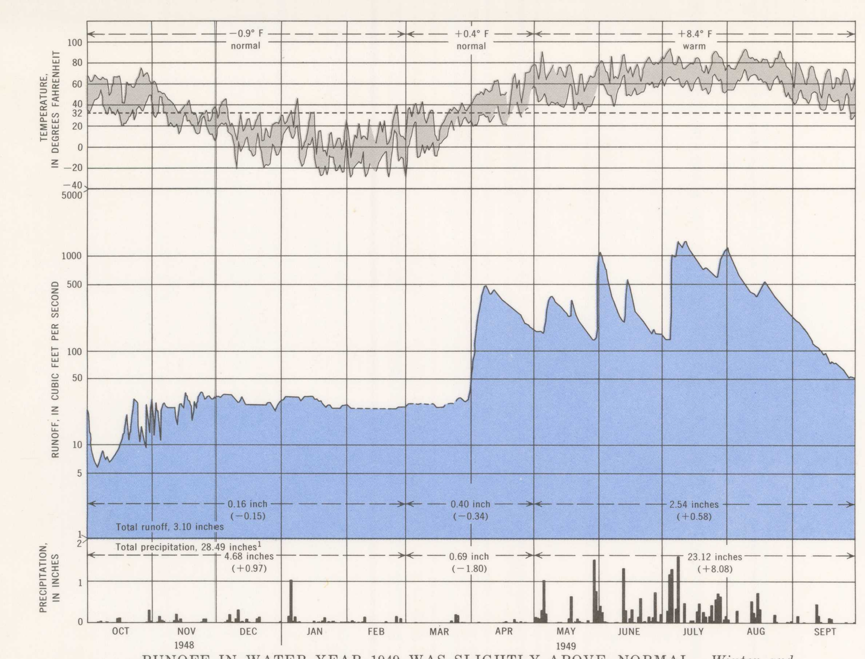
A period of three consecutive years that had available records was selected to analyze water yield for a wide range in yearly discharge.



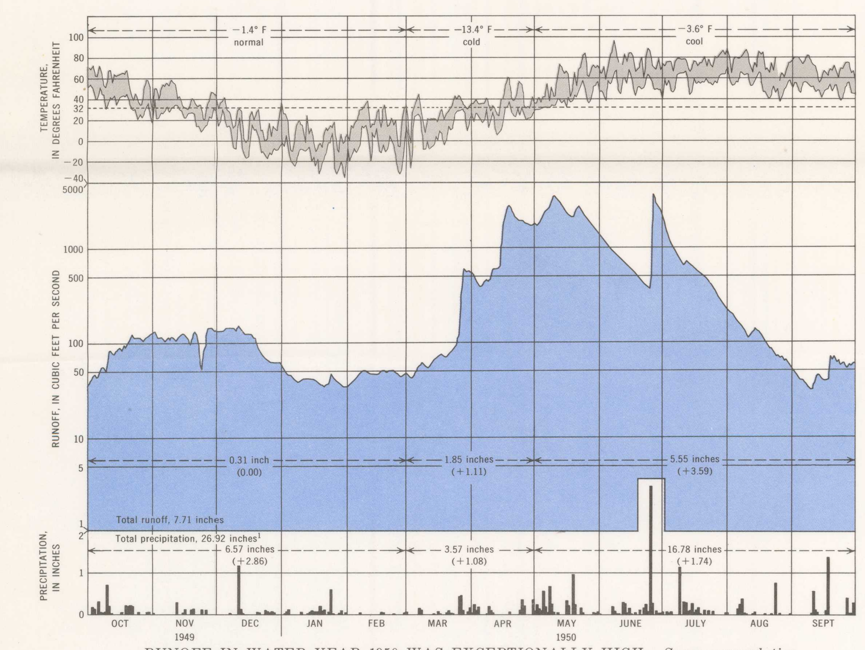
COMPARISON OF THE MEAN MONTHLY RUNOFF FOR THE PERIOD OF RECORD OF THE WILD RICE RIVER AT TWIN VALLEY, WITH THE MONTHLY RUNOFF FOR EACH OF THREE YEARS SELECTED FROM THE PERIOD, SHOWS A WIDE VARIATION OF RUNOFF DURING SPRING AND SUMMER AND RELATIVELY LITTLE VARIATION IN THE WINTER.



RUNOFF IN WATER YEAR 1948 WAS THE LOWEST FOR THE THREE YEARS SELECTED.—*Temperature and precipitation during the fall, winter, and early spring were about normal resulting in about normal runoff. The summer of 1948 was hot and dry, consequently streamflow receded to below normal discharge. During July, August, and September precipitation resulted in no significant runoff.*



RUNOFF IN WATER YEAR 1949 WAS SLIGHTLY ABOVE NORMAL.—*Winter and spring runoff was low resulting from the previous dry summer and less than normal precipitation during the winter and spring. The summer was wet and runoff increased to more than normal. Frequent thunderstorms caused several significant rises in daily runoff.*



RUNOFF IN WATER YEAR 1950 WAS EXCEPTIONALLY HIGH.—*Snow accumulation during the winter and early spring was above average resulting in much higher spring runoff. The late spring runoff was high because of the wetness of early spring. A storm during late June significantly increased the daily runoff. Runoff steadily declined during July, August, and September even though several storm periods of an inch or more precipitation occurred. Most precipitation during the late summer is discharged as evapotranspiration.*

*Daily precipitation for all three graphs was computed as a mean of two observation points located within or near the drainage area of the Wild Rice River above Twin Valley.

WATER RESOURCES OF THE WILD RICE RIVER WATERSHED, NORTHWESTERN MINNESOTA

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

1970

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