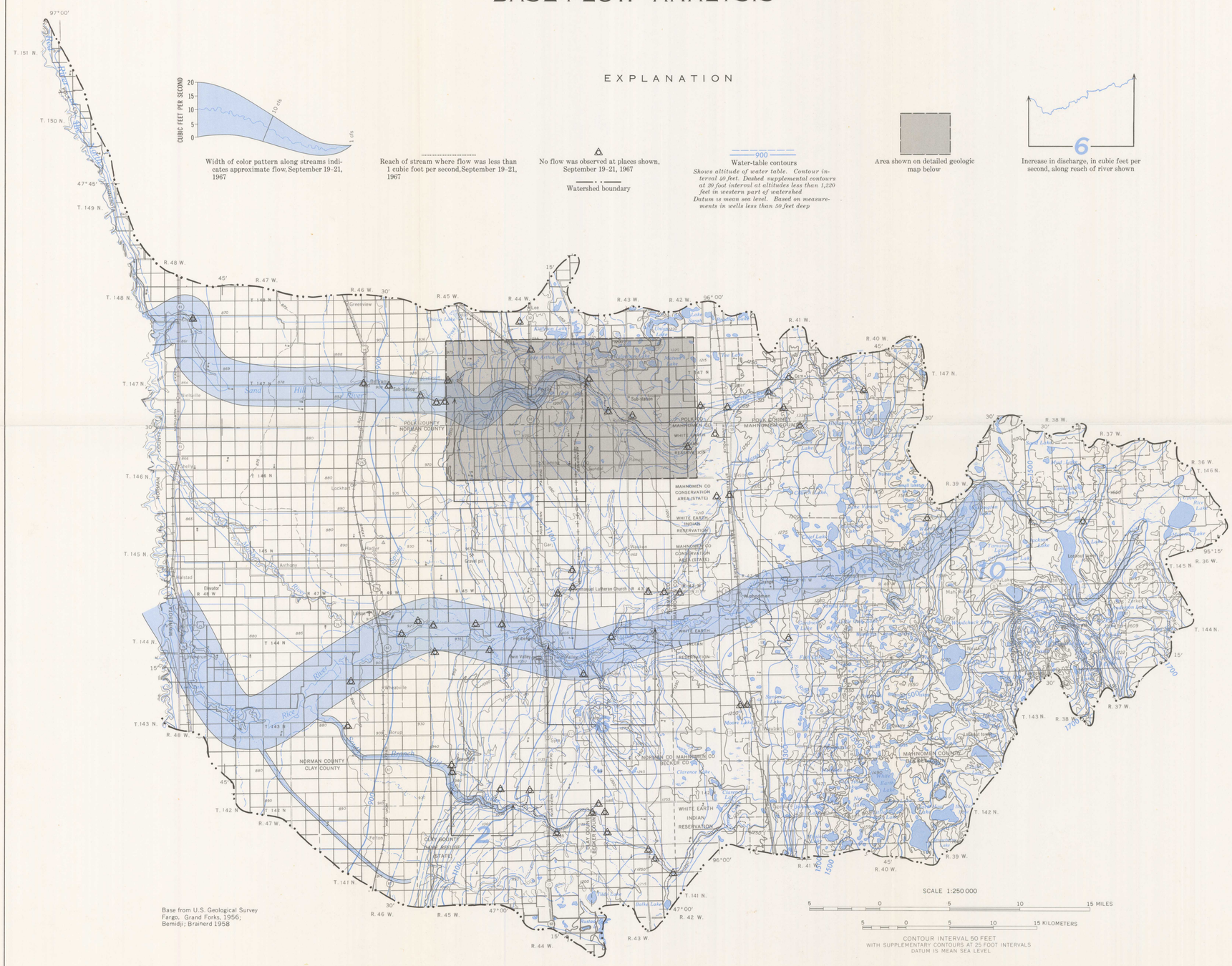
PREPARED IN COOPERATION WITH
THE MINNESOTA DEPARTMENT OF CONSERVATION
DIVISION OF WATERS, SOILS, AND MINERALS



# BASE-FLOW ANALYSIS

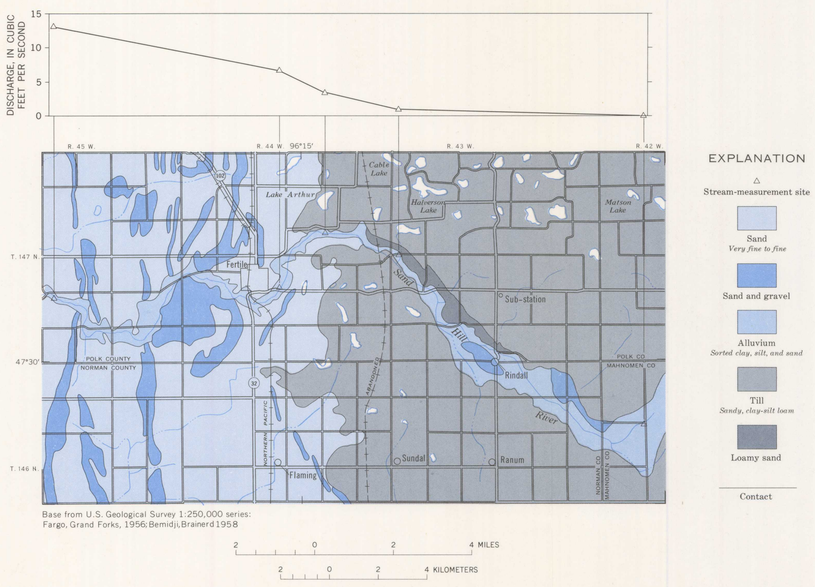



WATER-TABLE CONTOURS AND BASE FLOW OF THE SANDHILL AND WILD RICE RIVERS ARE DIRECTLY RELATED TO SURFICIAL GEOLOGY AND TOPOGRAPHY.

*The sharp increase in streamflow in the Wild Rice River northwest of Lower Rice Lake from less than 1 cubic foot per second to more than 10 cubic feet per second occurs where the stream flows across outwash and ice-contact sand and gravel (see sheet 1). The stream continues to pick up ground-water discharge through the higher part of the morainal area and then remains fairly constant in flow throughout the western half of the morainal area. The next large increase in base flow occurs near the east edge of the lake plain where the Wild Rice River is fairly deeply incised and the water-table contours are closely spaced and bend far upstream. Little ground water is contributed to the stream in the area of lake silt and clay.*

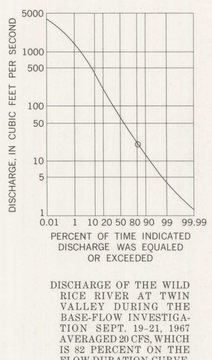
*The largest influx of ground water to South Branch Wild Rice River also occurs near the edge of the lake plain in the area of the sand and gravel beach ridges.*

*A detailed examination of the ground-water contribution to the Sandhill River is shown below.*

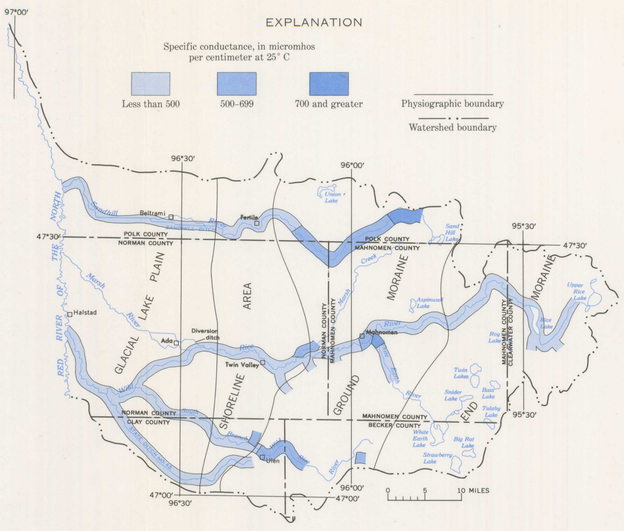



GROUND-WATER OUTFLOW FROM SANDY AREAS IS THE PRINCIPAL SOURCE OF BASE FLOW IN THE SANDHILL RIVER.

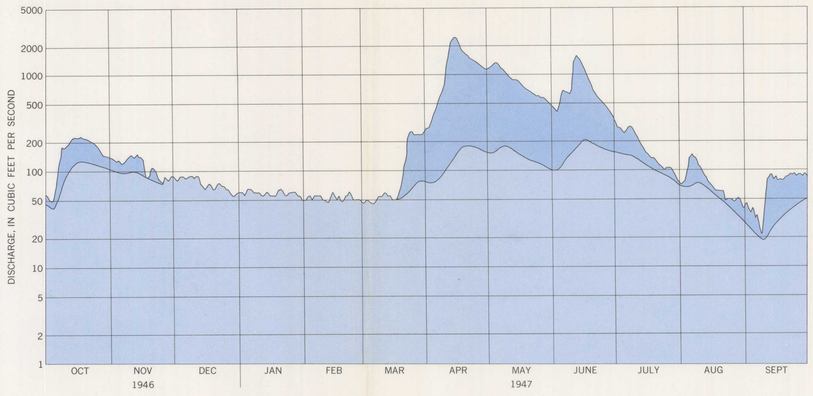
*Base flow first begins to appear in the Sandhill Channel where the stream flows through deposits of sand and sand and gravel. The first large increase in base flow occurs where the stream enters the sandy edge of the lake plain northeast of Fertile. A similar increase occurs where the stream flows through the area of beach ridges.*




DISCHARGE OF THE WILD RICE RIVER AT TWIN VALLEY DURING THE BASE-FLOW INVESTIGATION SEPT. 19–21, 1967 AVERAGED 20 CFS, WHICH IS 82 PERCENT ON THE FLOW DURATION CURVE.



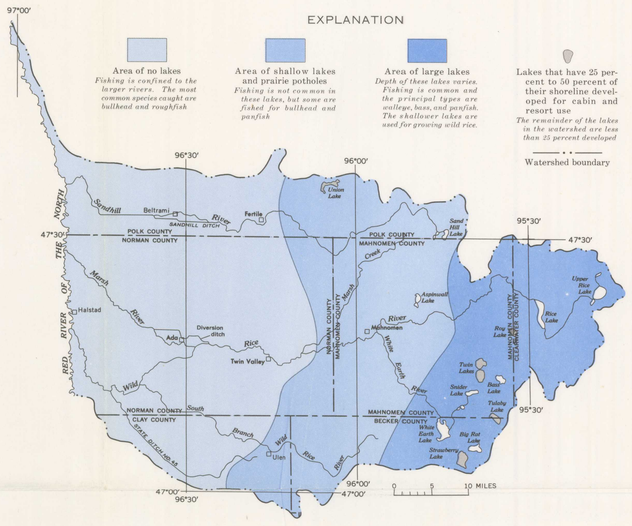

QUALITY OF SURFACE WATER IN THE WATERSHED AT A TIME OF LOW FLOW (SEPTEMBER 19–21, 1967) SHOWS THE STRONG INFLUENCE OF GROUND WATER ON BASE FLOW.—*Conductivity of water flowing from a lake region, such as the headwaters of the Wild Rice River, is low (less than 500 micromhos). In areas of glacial till, where there is little increase in ground-water discharge, the water that does enter the stream is more mineralized because of longer time in contact with finer-grained materials than in sand and gravel areas. Therefore, streams that do not drain large lake areas, such as the Sandhill and South Branch Wild Rice River, show directly the effect of the more highly mineralized ground water on the quality of the stream's low flow. Conductivity decreases where streams get large amounts of ground-water discharge from the sandy deposits of the shoreline area. Conductivity continues to be low in the lake plain because of the negligible contribution of ground water to the streams in this area.*




THE RELATION OF BASE FLOW AND SURFACE RUNOFF TO THE TOTAL FLOW OF THE WILD RICE RIVER AT TWIN VALLEY IS SHOWN BY THE SEPARATION OF THE COMPONENTS ON THE DISCHARGE HYDROGRAPHS.

*Years of low (1937) and high (1947) runoff were selected to show the characteristics of this relationship over a wide range of stream discharge. The striking difference between the two hydrographs is the slight increase in base flow over the winter in 1937 compared to the more typical recession for this same period in 1947. The slight rise in runoff over the winter of 1937 is probably caused by the heaviest snow cover in over 40 years. Excess snow prevented freezeup of ground-water inflow and increased discharge from the many morainal lakes. The gradual melting of snow during March resulted in much moisture going into the ground-water reservoir, and little surface runoff occurred. Base flow was slow to increase after the spring breakup of 1937 because the ground-water reservoir had been severely depleted during the previous drought.*

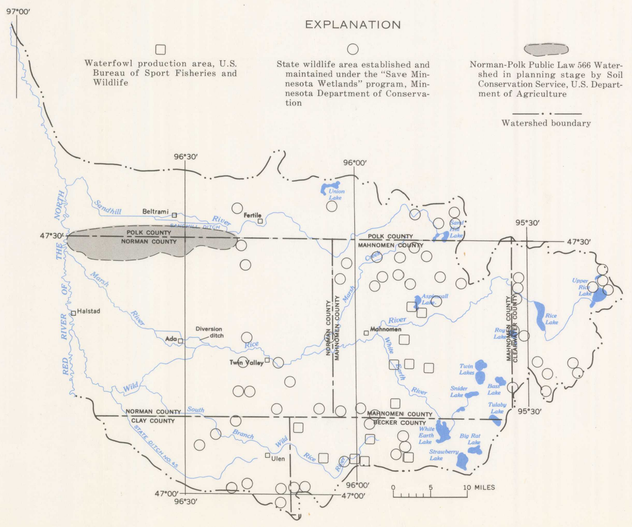
# WATER RECREATION




THE DEEPER COLD-WATER LAKES, WHICH ARE MOST COMMON IN THE MORAINAL AREA, ARE EXCELLENT FOR WALLEYE AND NORTHERN PIKE FISHING.

*In spite of the rugged nature of this area not all the lakes are deep. The shallow lakes are important for their large production of wild rice and habitat for waterfowl.*

*Union Lake, on the northern edge of the watershed, is the only lake in the central region that is fairly heavily used. This is probably because of its proximity to a major highway just north of the watershed.*




MOST OF THE WATERFOWL PRODUCTION AREAS ARE IN THE REGION OF PRAIRIE POTHOLES IN THE CENTRAL PART OF THE WATERSHED.

*Conditions for the production of waterfowl are almost ideal in a prairie pothole because of the abundant food and cover. This part of Minnesota has an additional advantage for waterfowl propagation because of the nearness of the more permanent lakes in the eastern part of the watershed which provide alternate sites for food and cover during periods when the potholes are dry.*

## SELECTED LAKES

| Name | Surface area (acres) | Length of shoreline (miles) | Depth (feet) | | Fish and game classification | Secchi disk transparency (feet) | Total alkalinity (mg/l) |
|---|---|---|---|---|---|---|---|
| | | | Maximum | Median | | | |
| Aspinwall | 378 | 4.2 | 9 | 6 | Semipermanent waterfowl and muskrat. | Average 3.5 | 192 |
| Big Rat | 1,106 | 10.0 | 6 | 4.5 | Semipermanent waterfowl. | Visible to bottom. | 122 |
| Lower Rice | 2,043 | 11.0 | 4 | 3 | Permanent waterfowl. | All of bottom is visible. | 228 |
| North Twin | 933 | 5.3 | 15 | 12 | Largemouthed bass. | 9 | 142 |
| Roy | 462 | ——— | 20 | 12 | Walleye—Some bass and panfish. | 6 | 162 |
| Sandhill | 488 | 5.4 | 17 | 6.8 | Waterfowl—marginal fish with occasional winter kill. | 7 | 207 |
| Snider | 610 | ——— | 25 | 14 | Walleye—largemouthed bass and panfish. | 14 | 178 |
| South Twin | 1,138 | About 6 | 30 | 17 | Bass—panfish—northern pike dominant predator. | 5 | 170 |
| Strawberry | 1,514 | ——— | 30 | ——— | Walleye—bass. | 10.5 | 165 |
| Upper Rice | 1,689 | 6.2 | 9.5 | ——— | Waterfowl and wild rice production. | 3.2 | ——— |
| Vanose | 119 | ——— | 20 | 8 | Waterfowl—fish. | 3 | ——— |
| White Earth | 2,005 | About 15 | 120 | ——— | Walleye—bass and panfish. | 8 | ——— |

| Name | Vegetation | Composition of bottom | Shoreline description | Remarks |
|---|---|---|---|---|
| Aspinwall | Submerged plants especially abundant. | Hard mud and sand. | Pasture, woods and wild hay. No erosion. | ——— |
| Big Rat | Seventy five percent of lake surface covered by emergents. | Soft mud. | About half marshland and half woods. No erosion. | Exceptional waterfowl area. |
| Lower Rice | Submergent generally abundant. Wild rice appears in June and July. | Organic ooze up to 6 ft. deep covered entire lake. | Entirely marsh. | Excellent for muskrats and migratory waterfowl, but limited for waterfowl breeding. Some rough fish and northern pike. |
| North Twin | Abundant aquatic plants. | Sand, gravel, and mud. | Sand, gravel, and mud. No erosion. | Cottages and resorts. |
| Roy | Vegetation covers 40 percent of that part of lake that is less than 10 ft. deep. | ——— | About half silty muck and half sand and gravel. No erosion. | Some cottages and resorts. |
| Sandhill | Six percent of lake covered by submergents. Twenty percent of lake covered by emergents. | About half sand and gravel along shore. Center about half muck. | Sandy loam and gravel. About seventy five percent woodland, remainder in pasture. Some bank erosion. | Small number of cottages. |
| Snider | Submerged aquatic plants moderately abundant along much of shoreline. | Mostly sand and clay. | Sand, gravel, and muck. No erosion. | Many cottages and a few resorts. |
| South Twin | Twenty five to thirty percent of lake covered by aquatic plants. | Sand along shore, mostly mud toward center. | All sand. Some ice erosion. | Cottages and resorts. |
| Strawberry | Adequate aquatic vegetation for fish shelter. | ——— | Sand, gravel and rocks. No erosion. | Many cottages and resorts. |
| Upper Rice | Wild rice abundant when managed. | Mostly muck. | Entirely marsh. | ——— |
| Vanose | Abundant aquatic plants. | Sand overlain with mud toward center. | Mostly sand—Muck in marshy fringe along southwest shore. | ——— |
| White Earth | Adequate aquatic vegetation for fish shelters. | ——— | Sand, gravel, boulders and rubble. No erosion. | Many cottages and a few resorts. |

Data obtained from Minnesota Department of Conservation

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1970—W69047

# WATER RESOURCES OF THE WILD RICE RIVER WATERSHED, NORTHWESTERN MINNESOTA

By
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1970