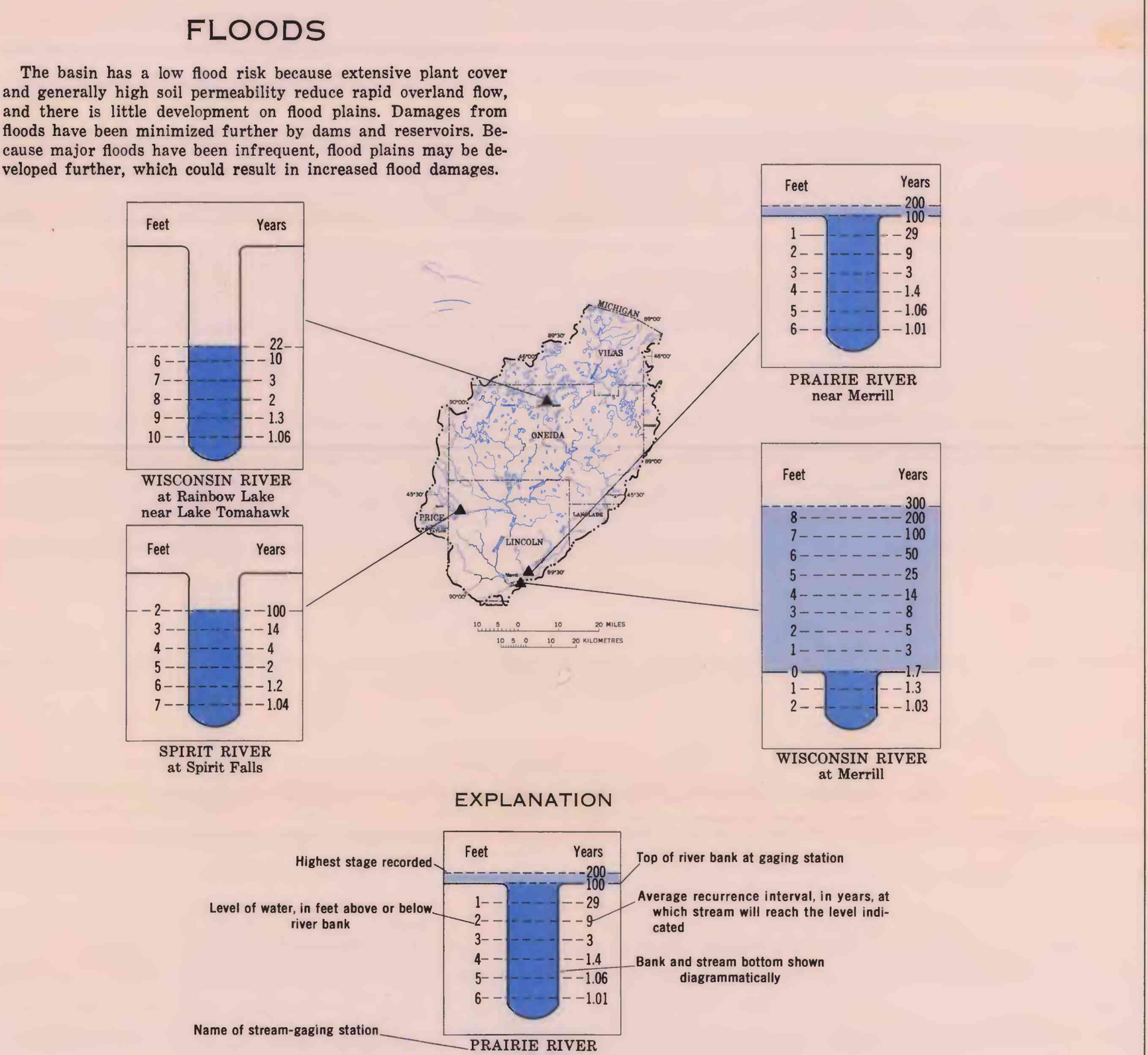
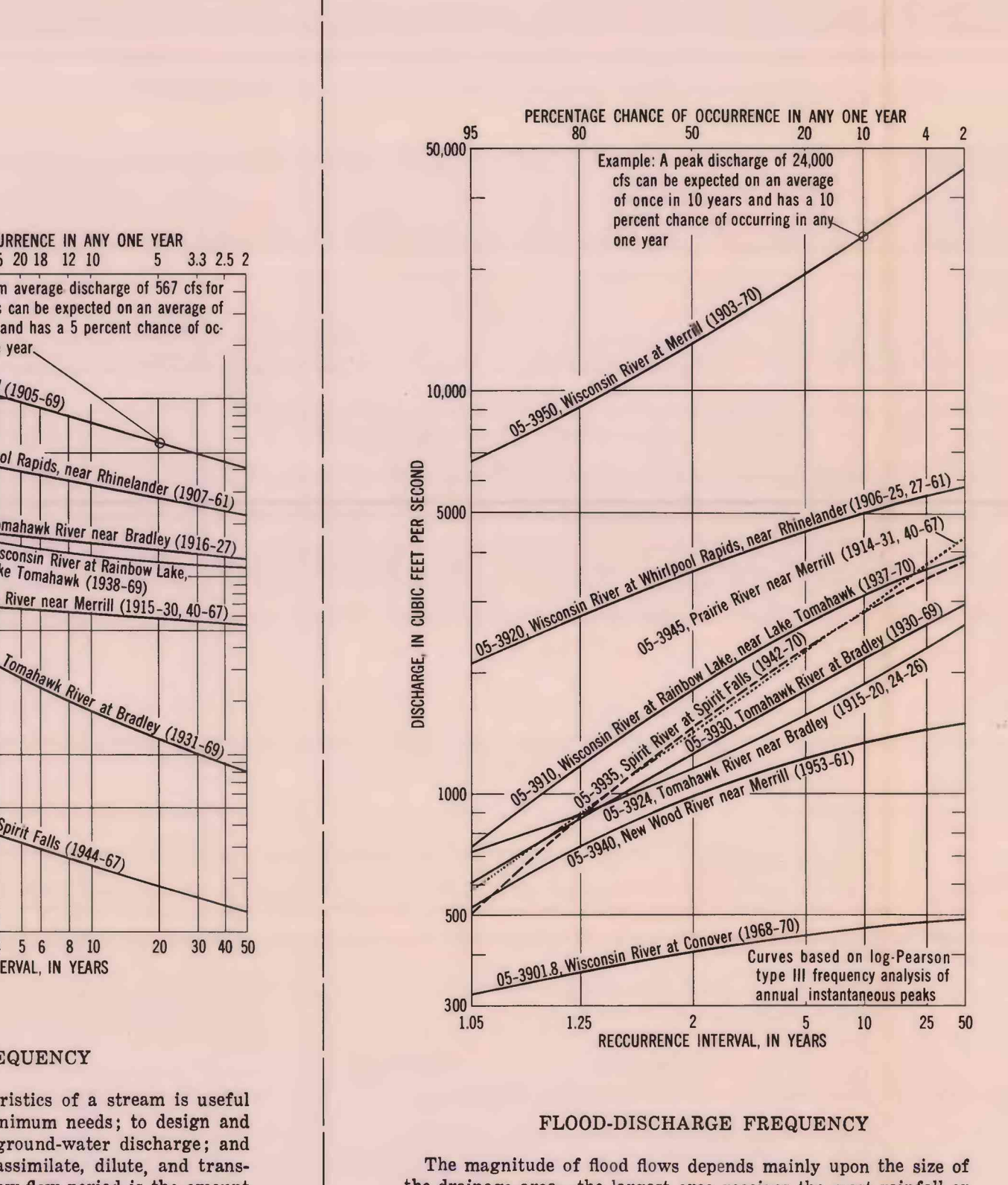
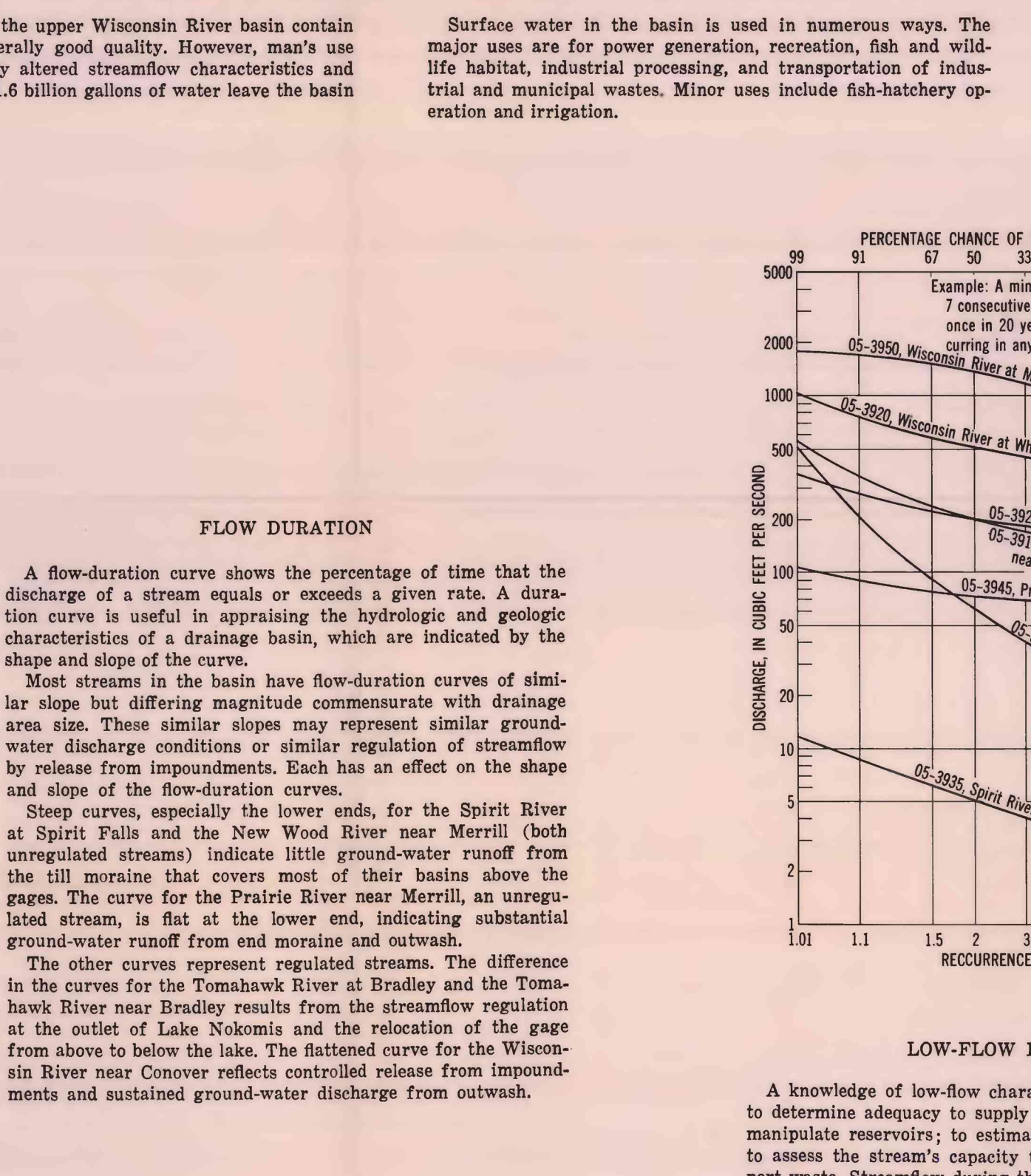
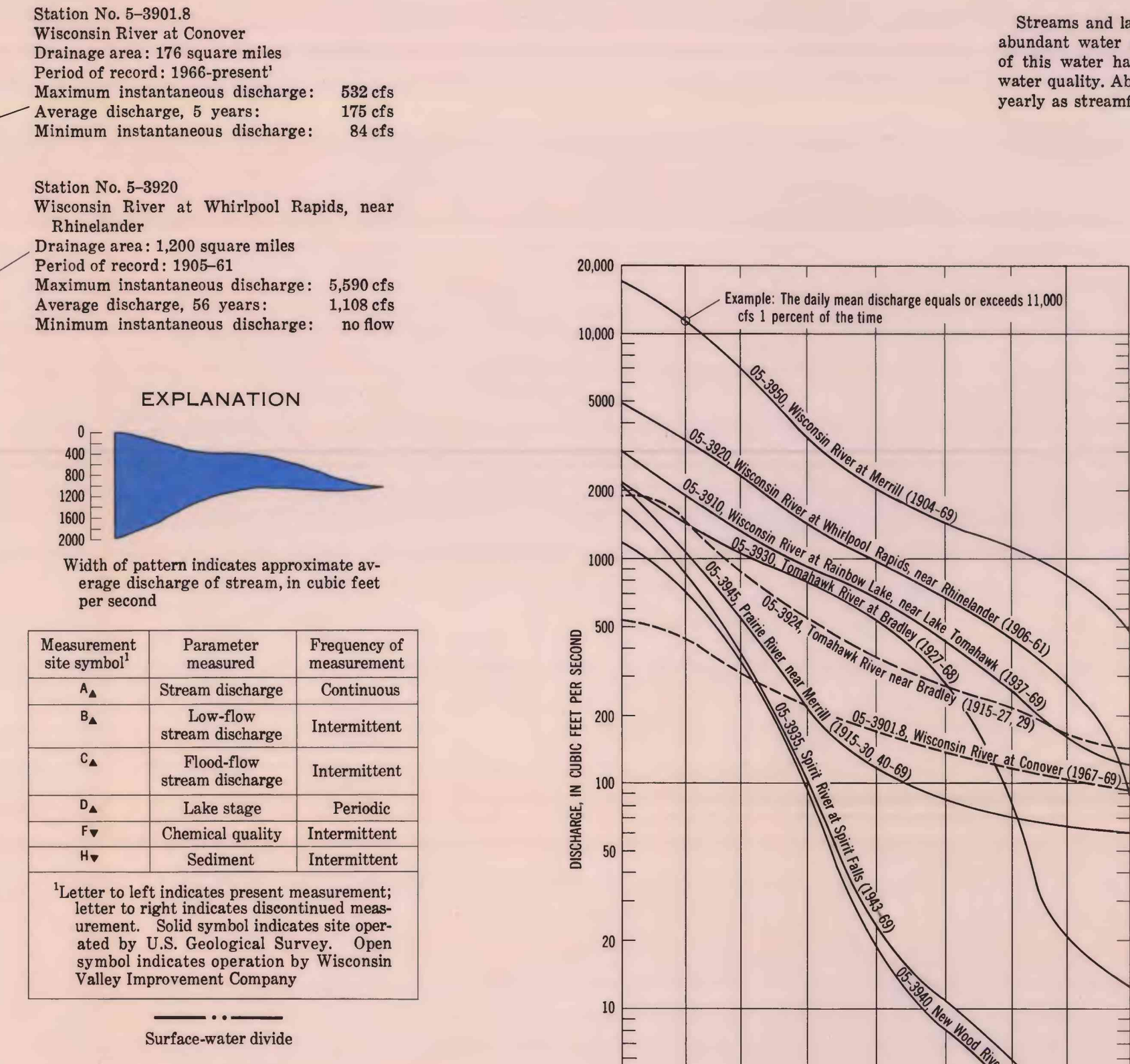
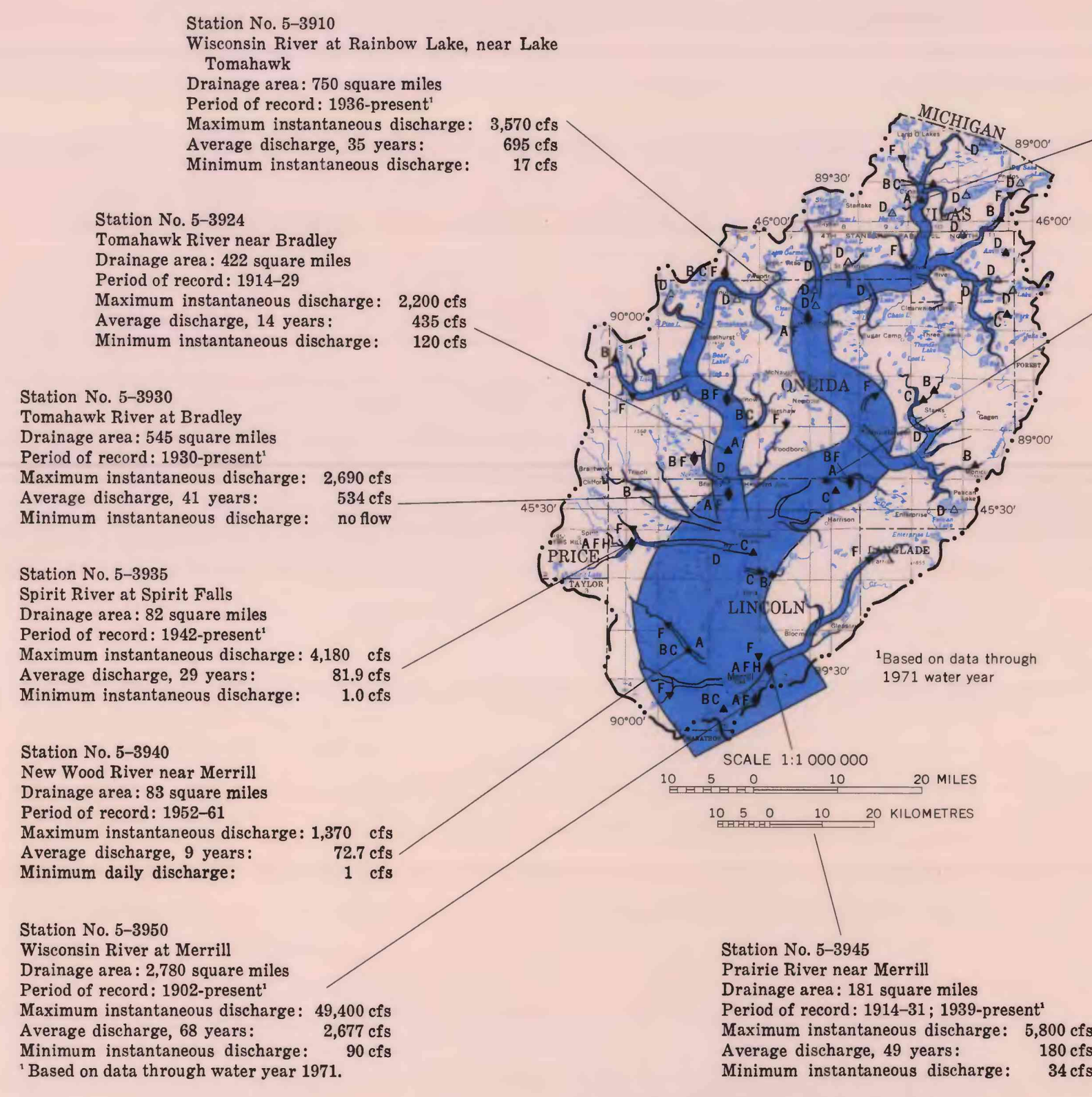


# SURFACE WATER



**DATA NETWORK AND AVERAGE STREAMFLOW**

The surface-water monitoring system in the basin consists of 68 sites. Of these, 38 are U.S. Geological Survey sites, and the remainder are sites of the Wisconsin Valley Improvement Company.

Streamflow (including flood and low flows) and reservoir and lake-stage fluctuations are or have been monitored at 47 sites. Streamflow is continuously monitored at six sites. Continuous records also are available for three sites where streamflow measurements have been discontinued. Intermittent low-flow and flood-flow measurements are made at 14 and nine sites, respectively. The stages of 21 lakes and reservoirs are measured periodically.

**EXPLANATION**

Width of pattern indicates approximate average discharge of stream, in cubic feet per second.

Measurement symbol	Parameter measured	Frequency of measurement
A	Stream discharge	Continuous
B	Low-flow stream discharge	Intermittent
C	Flood-flow stream discharge	Intermittent
D	Lake stage	Periodic
F	Chemical quality	Intermittent
W	Sediment	Intermittent

**FLOW DURATION**

A flow-duration curve shows the percentage of time that the discharge of a stream equals or exceeds a given rate. A duration curve is useful in appraising the hydrologic and geologic characteristics of a drainage basin, which are indicated by the shape and slope of the curve.

Most streams in the basin have flow-duration curves of similar slope but differing magnitude commensurate with drainage area size. These similar slopes may represent similar ground-water discharge conditions or similar regulation of streamflow by release from impoundments. Each has an effect on the shape and slope of the flow-duration curve.

**LOW-FLOW FREQUENCY**

A knowledge of low-flow characteristics of a stream is useful to determine adequacy to supply minimum needs; to design and maintain reservoirs; to estimate ground-water discharge; and to assess the stream's capacity to assimilate dilute, and transport waste. Streamflow during the low-flow period is the amount of water released from underground and surface storage.

**FLOOD-DISCHARGE FREQUENCY**

The magnitude of flood flows depends mainly upon the size of the drainage area—the largest area receives the most rainfall or snowmelt and has the most runoff. However, intensity and duration of rainfall, rate of snowmelt, land slope, soil permeability, plant cover, and frost effects also influence the magnitude of flood flows. In general, curves on the graph above are in descending order with decreasing drainage area. An exception is the transposed curves for the New Wood River near Merrill and the Wisconsin River at Conover, which is attributed to the dissimilar periods of record for these sites.

**WATER QUALITY**

Chemical quality of streams is monitored intermittently at 20 sites. These data and chemical-quality data on lakes are presented in the "Water Quality" section.

The average discharge pattern represents amounts that hypothetically would yield continuous, unvarying flow through the period of record.

**EXPLANATION**

Highest stage recorded.

Level of water, in feet above or below river bank.

Back and stream bottom shows diagrammatically.

**LOW-FLOW FREQUENCY**

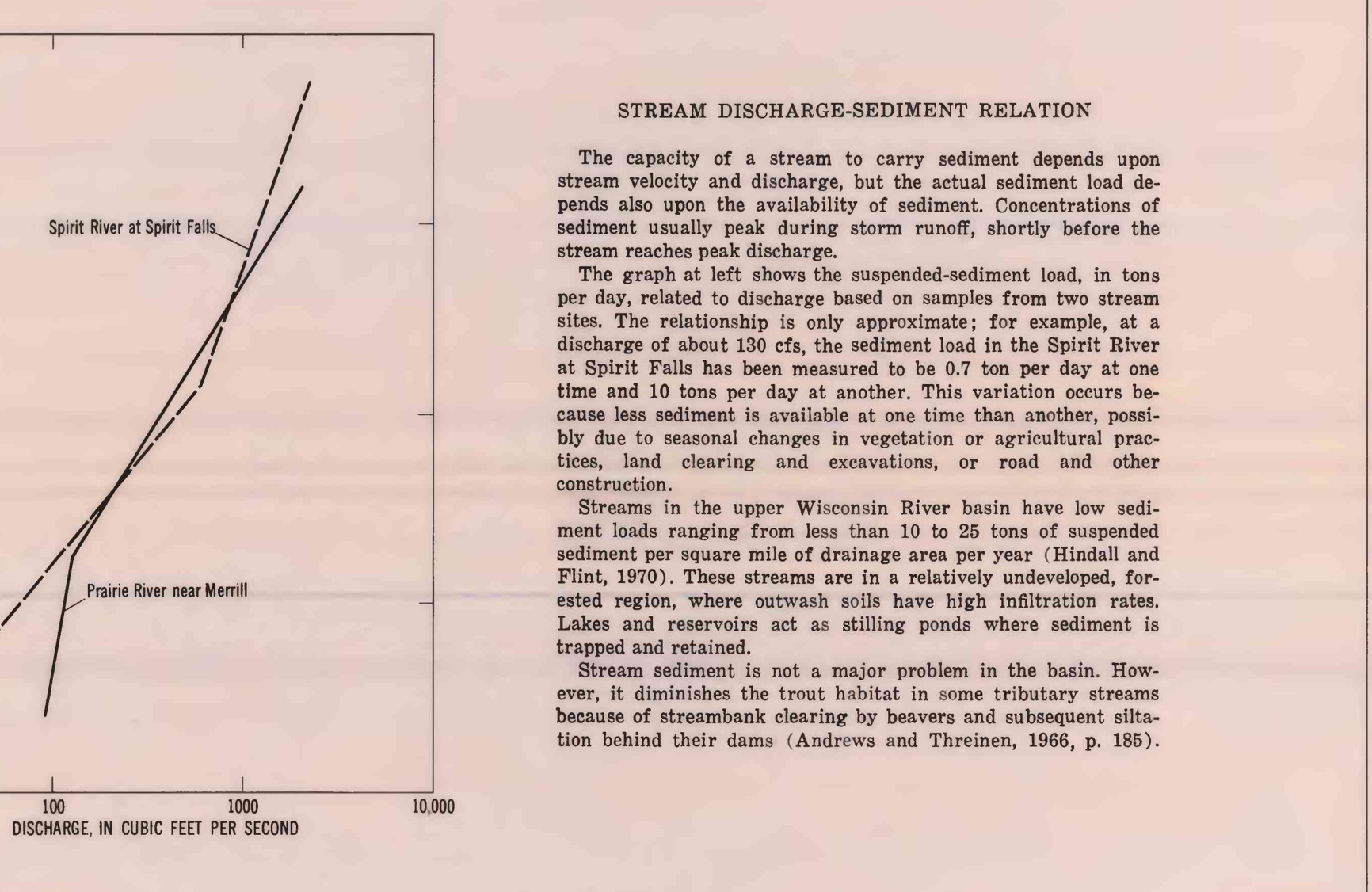
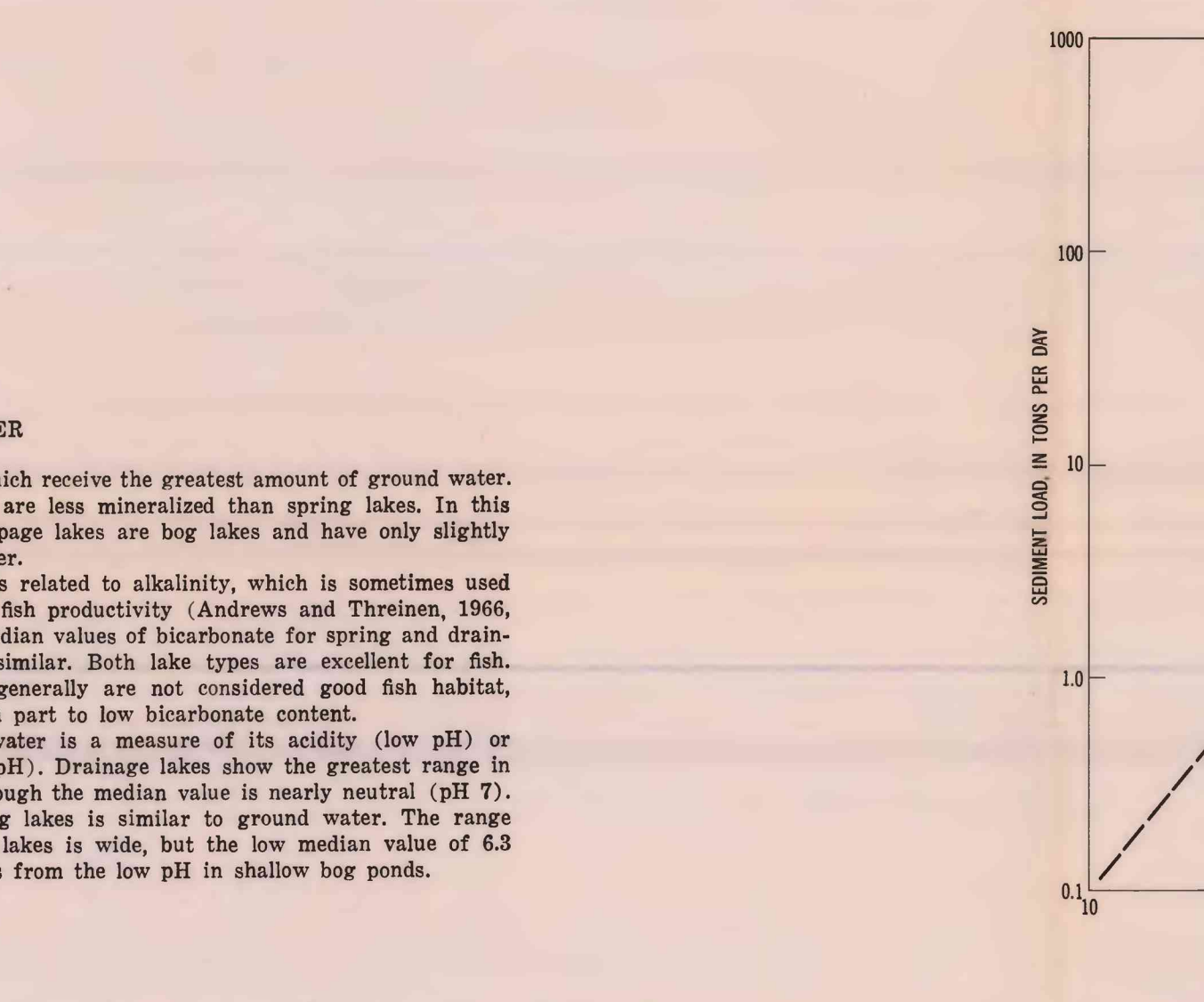
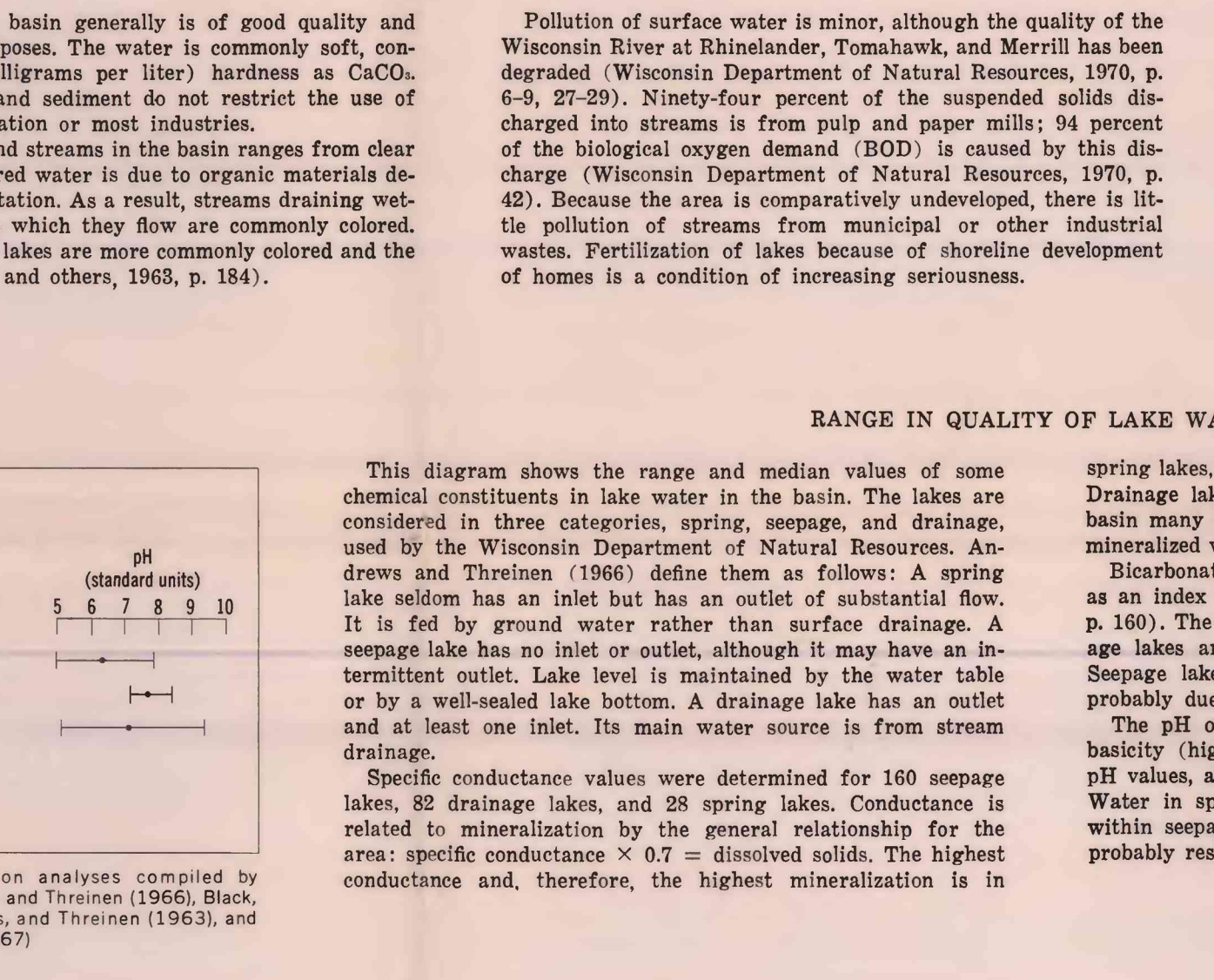
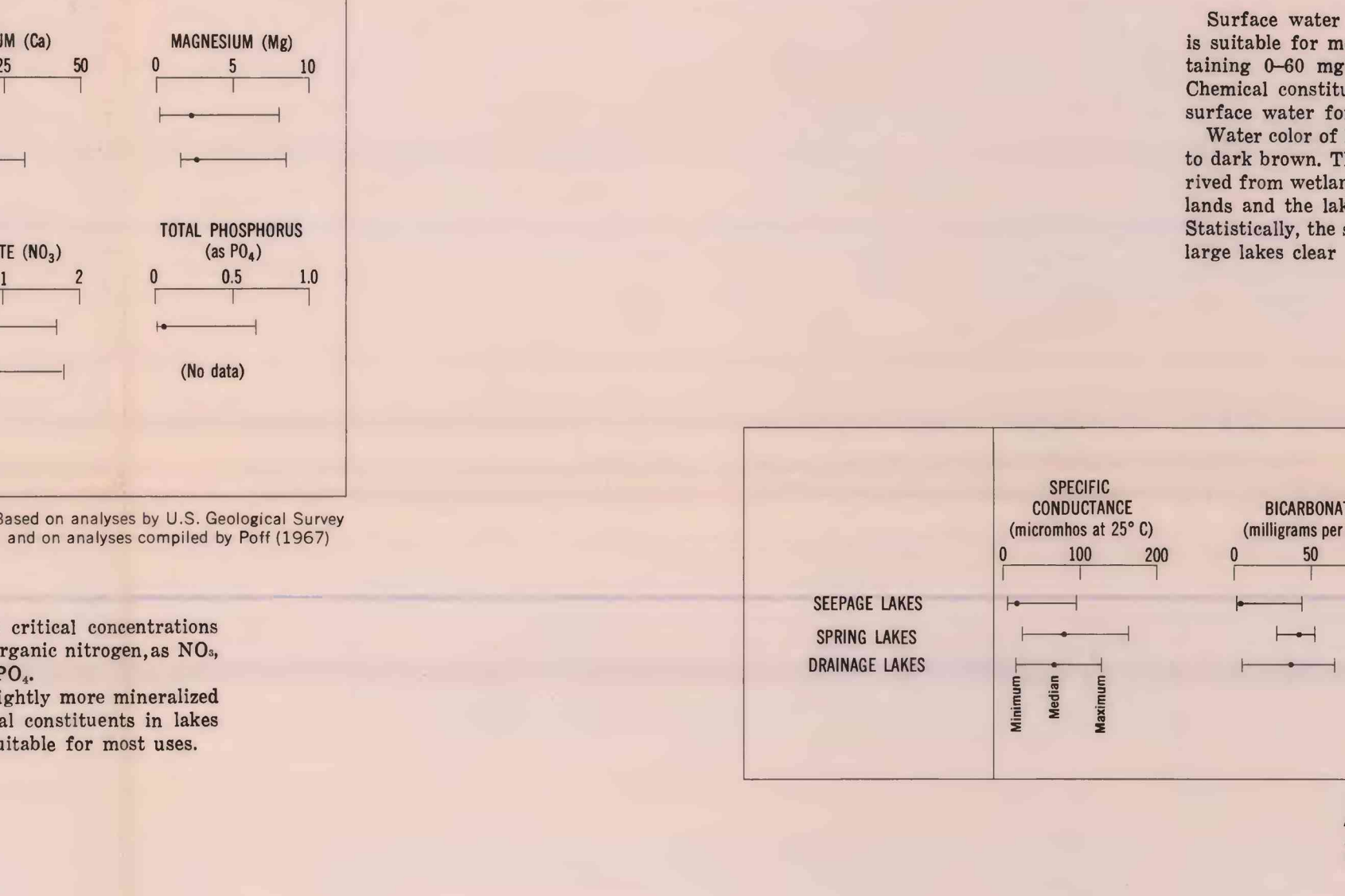
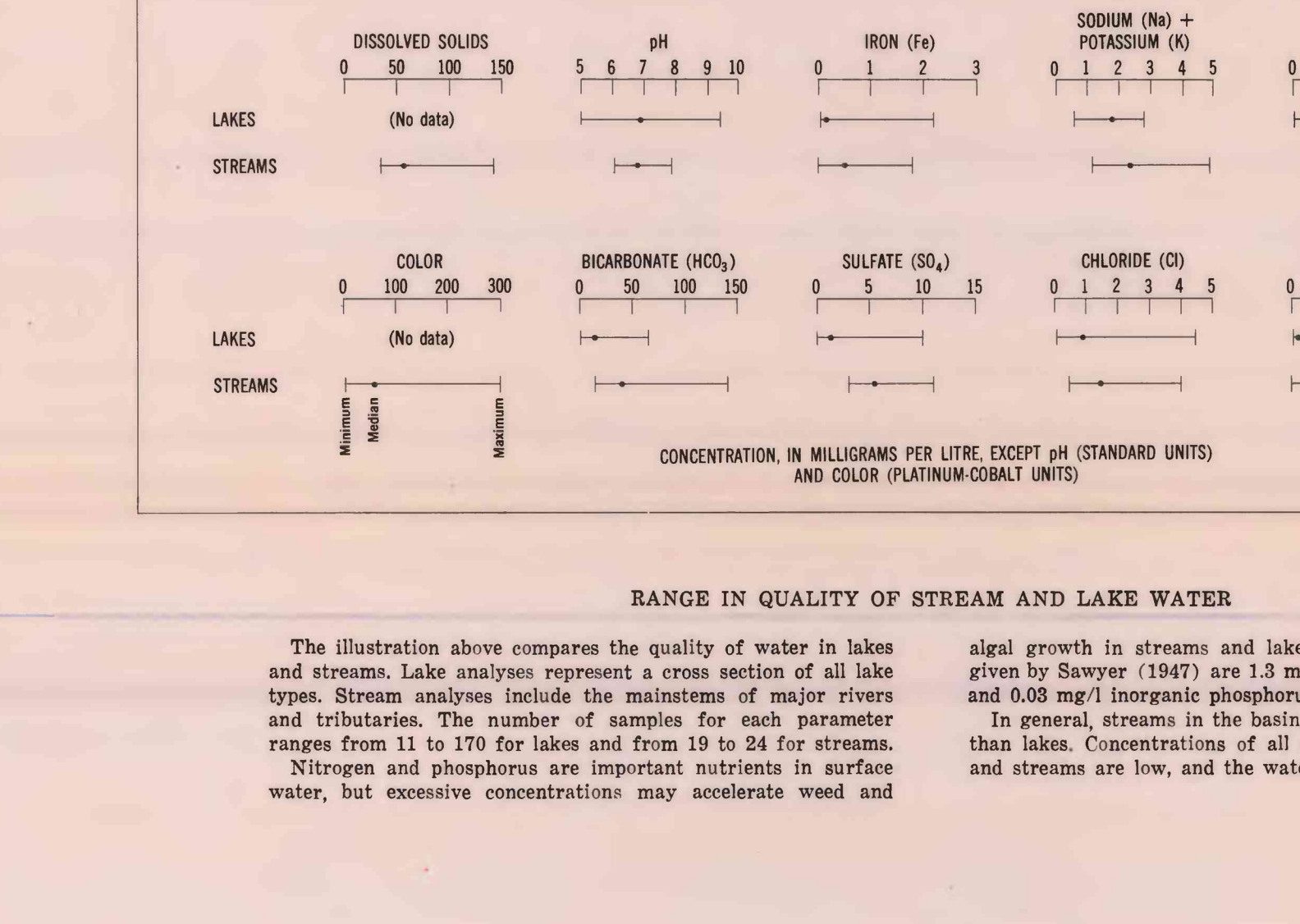
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**FLOOD-STAGE FREQUENCY**

The diagrams above illustrate the recurrence frequency of stage of water, in feet above or below river bank, shortly before the stream reaches peak discharge.



## SUMMARY

Large amounts of good quality water are available in the upper Wisconsin River basin. Most areas have adequate supplies of water for future growth. The amount of surface water withdrawn in the basin is three times that of ground water, although the total withdrawal use is only about 2 percent of the streamflow leaving the basin. Ninety-one percent of the surface water used in the basin is for pulp and paper processing.

Nonwithdrawal uses of surface water are power generation, recreation, fish and wildlife habitat, cranberry culture, and fish hatcheries. Ground water is used for all community and most rural supplies and for some irrigation.

Ground water, which is more widespread than surface water, is available principally from crystalline sand and gravel deposits, although a few wells tap fractured bedrock. Domestic and stock supplies are available everywhere in the basin. The sand and gravel commonly yields several hundred gallons per minute to wells in many places.

Controlled release from a network of 20 reservoirs regulates streamflow for power generation on the Wisconsin and Tomahawk Rivers. Supplemental benefits of the network are flood control and the development of recreational areas.

## SUMMARY

Water quality in the basin generally is of good quality and is suitable for most purposes. The water is commonly soft, containing 0-60 mg/l (milligrams per liter) hardness as CaCO<sub>3</sub>. Chemical constituents and sediment do not restrict the use of surface water for recreation or most industries.

Water color of lakes and streams in the basin ranges from clear to dark brown. The colored water is due to organic materials derived from wetland vegetation. As a result, streams draining wetlands and the lakes into which they flow are commonly colored. Statistically, the smaller lakes are more commonly colored and the larger lakes clear (Black and others, 1963, p. 184).

Pollution of surface water is minor, although the quality of the Wisconsin River at Rhinelander, Tomahawk, and Merrill has been degraded (Wisconsin Department of Natural Resources, 1970, p. 6-3, 27-29). Ninety-four percent of the suspended solids discharged into streams is from pulp and paper mills; 94 percent of the biological oxygen demand (BOD) is caused by this discharge (Wisconsin Department of Natural Resources, 1970, p. 42). Because the area is comparatively undeveloped, there is little pollution of streams from municipal or other industrial wastes. Fertilization of lakes because of shoreline development of homes is a condition of increasing seriousness.

## SUMMARY

Public access at many points. State and county parks. Trout streams. Very little pollution. Large low flows. Little sediment. County park.

Good boating on lower reaches. Good fishing for pan fish and game fish. Strong flow maintained by release from reservoirs. Little sediment.

Fishing degraded by pollution in some reaches of the Wisconsin River.

Good cover in adjacent wetlands and forest.

Depth inadequate in headwaters. Small low flows.

Depth commonly adequate. Good cover in adjacent wetlands and forest.

Depth commonly adequate. Good cover in wetlands and forest adjacent to lakes.

Excessive fertilization from nearshore sewage disposal may contribute to a local algae and winterkill problem. Low fish productivity common.

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## SUMMARY OF WATER AVAILABILITY AND SUITABILITY FOR VARIOUS USES

Source	SURFACE WATER					GROUND WATER			
	Wisconsin, Tomahawk, Pelican, and Eagle Rivers	Prairie River	Spirit, New Wood, Copper, and, Somo Rivers	Headwaters and small tributary streams	Large lakes and reservoirs	Small lakes and wetlands	Ground and end moraine	Outwash and ice-contact sand and gravel	Bedrock
Municipal and industrial supply	Adequate discharge. Soft water. Strong flow maintained by release from reservoirs. Some reaches polluted by municipal and paper mill wastes. Sanitary treatment necessary.	Adequate discharge. Good chemical quality; mostly soft water. Very little pollution.	Good chemical quality; mostly soft water. Very little pollution.	Good chemical quality; mostly soft water. Very little pollution.	Adequate quantity. Good chemical quality; mostly soft water. Very little pollution.	Lakes have good chemical quality; mostly soft water. Very little pollution.	Good chemical quality; mostly moderately hard water. Not commonly subject to pollution.	Adequate well yields. Good chemical quality; mostly soft to moderately hard water. May be high in iron.	Good chemical quality; mostly soft to moderately hard water. Not commonly subject to pollution.
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## AGENCIES HAVING ADDITIONAL INFORMATION

Information category	Information source
Geology	U.S. Environmental Protection Agency (formerly Federal Water Quality Administration), 86th St. and 40th Ave. South, Minneapolis, Minn. 55440
Topography and drainage	U.S. Army Corps of Engineers, Chicago District, 219 South Dearborn St., Chicago, Ill. 60607
Land use	U.S. Department of Agriculture, Soil Conservation Service, 4601 Hamersley Rd., Box 4248, Madison, Wis. 53711
Water budget	U.S. Department of the Interior, Bureau of Outdoor Recreation, 3825 Research Park Dr., Ann Arbor, Mich. 48104
Ground- and surface-water quality	U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Room 403, Federal Building, Fort Snelling, Minneapolis, Minn. 55111
Surface-water quality	U.S. Forest Service, 632 West Wisconsin Avenue, Milwaukee, Wis. 53403
Pollution	U.S. Geological Survey, Water Resources Division, 1815 University Ave., Madison, Wis. 53706
Ground-water quality	Wisconsin Department of Natural Resources, 4610 University Ave., Box 450, Madison, Wis. 53701
Water use	Wisconsin Geological and Natural History Survey, 1815 University Ave., Madison, Wis. 53706
Water quality	Wisconsin Public Service Commission, 432 Hill Farms State Office Bldg., Madison, Wis. 53702
Water quality	Wisconsin Valley Improvement Company, 501 Jefferson St., Wausau, Wis. 54402
Water quality	University of Wisconsin Water Resources Center, Hydraulic and Sanitary Laboratory, Madison, Wis. 53706

## REFERENCES CITED

Andrews, L. M., and Threlson, C. W., 1966, Surface water resources of Oneida County, Madison, Wisconsin Conserv. Dept., 284 p.

Black, R. J., Andrews, L. M., and Threlson, C. W., 1963, Surface water resources of Vilas County, Madison, Wisconsin Conserv. Dept., 317 p.

Born, S. M., and others, 1973, Diffusional pumpage at Snake Lake, Wisconsin, Wisconsin Dept. Nat. Resources, Tech. Bull. 66, 39 p.

Carlson, R. F., Watts, D. G., Stadler, G. J., and MacCormick, A. J., 1968, Hydrology and reservoir control on the Wisconsin River basin, Madison, Univ. Wisconsin Water Resources Center, 211 p. [unpub.]

Devaul, R. W., 1967, Trends in ground-water levels in Wisconsin through 1966, Wisconsin Geol. and Nat. History Survey Inf. Circ. 9, 109 p.

Dutton, C. E., and Bradley, R. E., 1970, Lithologic, geographical, and mineral commodity maps of Precambrian rocks in Wisconsin: U.S. Geol. Survey Misc. Geol. Inv. Map I-531.

Erickson, R. M., 1972, Trends in ground-water levels in Wisconsin, 1967-71, Wisconsin Geol. and Nat. History Survey Inf. Circ. 21, 40 p.

Hindall, R. M., and Pflint, R. F., 1970, Sediment yields of Wisconsin streams: U.S. Geol. Survey Hydro. Inv. Atlas HA-376.

Poff, R. J., 1967, A catalog of chemical analyses of lake water samples, 1925-1965, Wisconsin Conserv. Dept., Fish Management Rept. 41, p.

Sawyer, C. N., 1947, Fertilization of lakes by agricultural and urban drainage: New England Water Works Assoc. Jour., v. 61, p. 109-127.

Threlson, C. W., 1956, Glacial features of Wisconsin: Wisconsin Geol. and Nat. History Survey open-file map.

U.S. Public Health Service, 1962, Drinking water standards, 1962, U.S. Public Health Service Pub. 566, 61 p.

U.S. Soil Conservation Service, 1964, Engineering test data and interpretations for major soils of Wisconsin: Madison, Wis. p. Wisconsin Department of Natural Resources, 1968, Wisconsin stream streams: Madison, Wis. Conserv. Pub. 213-68, 75 p.

1970, Upper Wisconsin River pollution investigation survey: Madison, 108 p.

Wisconsin Valley Improvement Company [no data], The Wisconsin River—nonsense of a state: Wausau, 18 p.