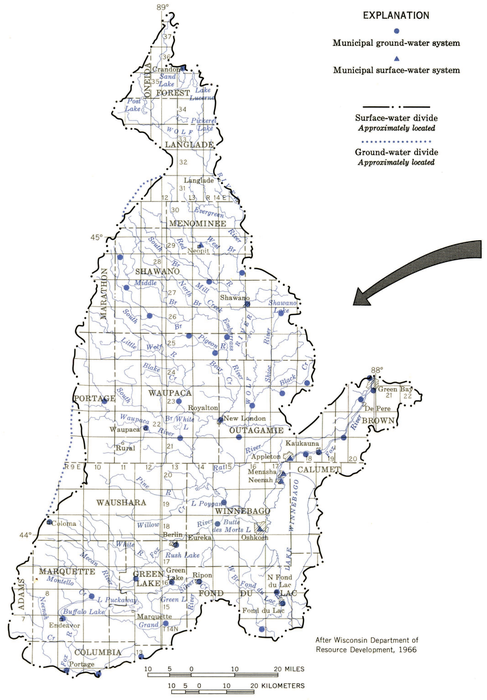
WATER USE



After Wisconsin Department of Resource Development, 1966

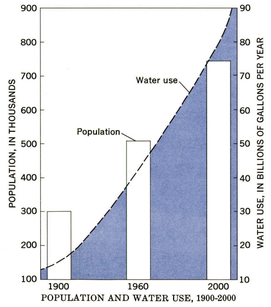
MUNICIPAL WITHDRAWAL USE OF WATER

WITHDRAWAL USE OF WATER

Withdrawal use of water includes water that is removed from a stream or aquifer to satisfy a need. Water withdrawn for all uses except irrigation and stock watering generally returns to streams or to aquifers with only a small loss. Water used for irrigation and stock watering is largely consumed. Approximately 1 percent of water used for industrial and commercial purposes is consumed, and about 10 percent of the water for municipal use is consumed (Wirth, 1959). Rural-domestic use is nonconsumptive.

Estimated withdrawal use and consumption of water in the Fox-Wolf basin is summarized in the table below. Industry and commerce, both self supplied and municipally supplied, withdraw about 65 percent of the total water used. Municipalities withdraw about 20 percent of the total for domestic and miscellaneous puposes. Approximate percentages of total water withdrawn in the basin for the other uses include: stock watering, 5 percent; rural-domestic, 5 percent; and irrigation, 5 percent.

Aquifers are a source of water throughout the basin except along Lake Winnebago and the lower Fox River valley. Municipal water systems are shown on the accompanying illustration and are coded to show the source of water. Oshkosh, Neenah, Menasha, Appleton, and Green Bay use surface water for municipal water. Except for Neopit in Menominee County, all other municipal systems use ground water. Industrial use of surface water is concentrated along Lake Winnebago and the lower Fox valley.



POPULATION AND WATER USE, 1900-2000

ESTIMATED TOTAL WITHDRAWAL OF WATER IN 1964

(Million gallons per day)

Use	Ground water		Surface water		Total	
	Withdrawn	Consumed	Withdrawn	Consumed	Withdrawn	Consumed
Municipal supply: domestic and miscellaneous	9.9	1.0	17.4	1.7	27.3	2.7
industrial and commercial	7.2	.1	12.8	.1	20.0	.2
Industrial and commercial, self-supplied	24.2	.2	34.2	.3	58.4	.5
Irrigation	5.9	5.9	.4	.4	6.3	6.3
Rural domestic	7.5	0	0	0	7.5	0
Stock	5.7	5.7	2.5	2.5	8.2	8.2
TOTAL	60.4	12.9	67.3	5.0	127.7	17.9

NONWITHDRAWAL USE OF WATER

Nonwithdrawal use of water, or "in place" use of lakes, streams, and wetlands, does not physically remove or consume surface water, but it may affect the quality of the water. These uses include recreation, such as boating, fishing, and swimming; waste disposal; and the generation of electric power.

Water-related recreation provides an important economic resource in the Fox-Wolf basin. The basin contains numerous lakes, including 5 of the 18 largest lakes in the State (Wis. Conservation Dept., pub. 218-58). Excellent canoe trails are formed by many streams in the basin, ranging from white-water canoe trails in the upper Wolf River to lake trails in the Waupaca County Chain-O-Lakes. Wetlands provide habitat for many game animals.

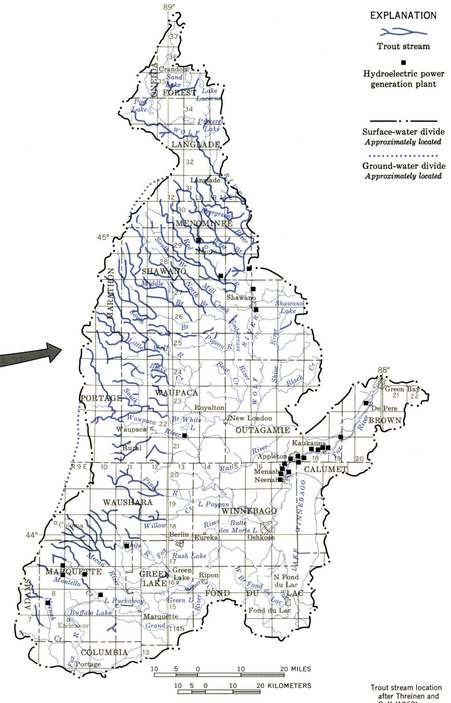
Trout streams in the Fox-Wolf basin, as mapped by the Wisconsin Conservation Department, are shown on the accompanying map taken from Wisconsin Conservation Department publication 213-51. The trout streams, with a few exceptions, are in the northern and western parts of the basin where ground-water discharge from highly permeable outwash sand and gravel deposits provides the necessary cool water and steady stream flows.

The use of streams and lakes for the disposal of municipal and industrial wastes is one of the most important nonwithdrawal uses of water in the basin. Proper disposal of treated sewage in streams depends on adequate streamflow. Overloading a stream with inadequately treated wastes causes pollution and results in fish kill, unesthetic appearance and odor, and a depreciation in the value of the resource. With the exception of Friesland, Coloma, and Endeavor, all municipalities with public water supplies have sewage plants that discharge treated wastes to streams (Wis. Dept. of Resource Development, 1966). In addition, many industries, especially along Lake Winnebago and the lower Fox River, discharge wastes to the Fox River.

Hydroelectric power generation is another nonwithdrawal use of water in the Fox-Wolf basin. There are 27 existing hydroelectric plants in the basin, according to the Federal Power Commission, Bureau of Power (see map at right). Power generation has only a small effect on streamflow because most of the reservoirs are small and control small amounts of water. Dams may regulate low flows and high flows somewhat and cause warming of the water in the reservoirs. Reservoirs are shown on the stream profiles on sheet 1.

AVERAGE WATER USE IN MILLIONS OF GALLONS PER DAY IN 1964

County or part of county in basin	Ground water			Surface water		
	Municipal	Industrial self-supplied	Irrigation	Municipal	Industrial self-supplied	Irrigation
Adams	----	0.07	0.2	----	----	----
Brown	1.91	2.62	----	10.62	----	----
Columbia	.9	.07	.05	----	----	----
Fond du Lac	4.98	9.70	----	----	----	----
Forest	.11	----	----	----	----	----
Green Lake	.8	.4	.03	----	----	----
Langlade	----	.0	.03	----	----	0.0005
Marathon	----	----	.49	----	----	----
Marquette	.08	.4	.2	----	----	----
Menominee	.05	----	----	.16	----	----
Outagamie	2.84	1.97	.01	6.55	----	----
Portage	.06	.29	2.74	----	----	----
Shawano	1.39	.45	----	----	----	.0005
Waupaca	2.90	.004	.31	----	----	----
Waushara	.02	.03	1.84	----	----	----
Winnebago	.71	9.04	----	12.90	34.24	----



NONWITHDRAWAL USE OF WATER

Trout stream location after Threinen and Poff (1963)

WATER PROBLEMS

Water problems in the Fox-Wolf basin arise from both manmade and natural causes. Manmade problems occur mostly in the industrial and population center around Lake Winnebago and the lower Fox River. The natural problems occur throughout the basin and generally are minor. Water problems are listed below with suggestions that may aid in further understanding of the problems and their possible solutions.

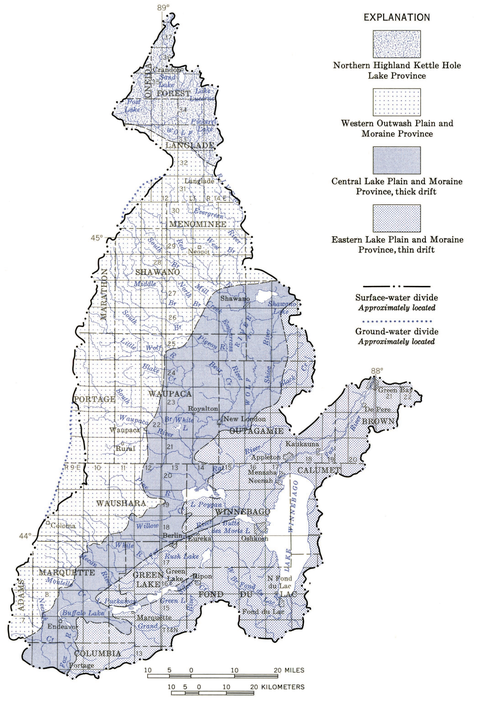
Manmade Water Problems

1. Surface-water pollution. The lower Fox River from Neenah-Menasha to Green Bay is polluted by industrial and municipal wastes. Identify sources of pollution and treat wastes adequately. Monitor water quality.
2. Availability of water. Municipal and industrial expansion is placing a greater demand on ground-water resources near Lake Winnebago and in the lower Fox River valley. Space wells properly in the heavily pumped areas. Monitor water-level trends.
3. Saline water migration. Saline ground water in the southeastern part of the basin may migrate toward centers of pumpage. Monitor water quality and note changes. If migration occurs, consider alternate sources of water supply.
4. Ground-water pollution. In areas where dolomite lies close to surface, ground water may be readily polluted from surface sources. Identify such areas and construct sewer systems and waste-disposal sites so that wastes will not seep into the ground water. Monitor water quality.

Natural Water Problems

1. Ground-water quality. Because water in the basin is hard, water softening may be advisable. High iron concentrations occur locally and may need removal. Saline water occurs in the deep aquifers in the southeastern part of the basin. Restrict fresh water development to shallow wells.
2. Ground-water availability. Most areas have adequate ground water for domestic supplies; however, the availability of ground water should be determined before developing an area.
3. Flooding. The lower Wolf and upper Fox Rivers frequently flood during spring thaws. Although there are plans to minimize flood damage, proper zoning and development of the flood plains offer the best protection.

SUMMARY AND CONCLUSION



GEOHYDROLOGIC PROVINCES

The Fox-Wolf basin is divided into 4 geohydrologic provinces based on differences in hydrology and geology. These provinces are shown on the accompanying map, and the table below describes the significant characteristics of the provinces.

Geohydrologic province	Geology, topography, and soils	Lithology of aquifers	Water-bearing characteristics of aquifers	Streamflow characteristics	Quality of water	
					Ground water	Surface water
Northern Highland Kettle Hole Lake	Glacial deposits, 50 to 150 feet thick, mainly outwash and unsorted ground moraine over crystalline bedrock. Hilly with many lakes and kettle holes. Altitudes range between 1,400 and 1,800 feet. Wetlands cover about 13 percent of the area Percentage of the province covered by soil types: 77 percent loams, sandy loams, and silty loams, moderate infiltration; 21 percent sand and sandy loams, rapid infiltration; 2 percent silty and clayey loams, slow infiltration	Outwash deposits, stratified sand and gravel containing lenses of clay and silt Ground moraine, unstratified, unsorted to sorted sand, silt, clay, gravel, and boulders	Glacial deposits yield moderate to large quantities of water, adequate for domestic and farm use, and adequate for irrigation in many areas. Yields exceeding 500 gpm may be obtained from properly constructed wells	About 0.4 to 0.6 cfs per square mile during low-flow period Generally consistent, relatively high low flows and little flooding	Hard to very hard water, of the calcium magnesium bicarbonate type. Locally high in iron. Total dissolved solids range from 175 to 300 ppm	Moderately hard to hard water, of calcium magnesium bicarbonate type. May be moderately high in iron. Dissolved solids range from 100 to 200 ppm
Western Outwash Plain and Moraine	Glacial deposits 75 to 200 feet thick consist mainly of outwash and end moraines Bedrock is sandstone in the south and crystalline rock in the north. Sandstone thickness ranges from 0 feet in the north to 600 feet in the south Topography is characterized by plains and morainal ridges trending from north to south. Altitudes range between 800 and 1,300 feet. Some lakes. Wetlands cover approximately 2 percent of the area Percentage of the province covered by soil types: 53 percent loams, sandy loams, and silty loams, moderate infiltration; 39 percent sand and sandy loam, rapid infiltration; and 8 percent silty and clayey soil types, slow infiltration	Outwash deposits, stratified sand and gravel containing lenses of clay and silt Moraines, unsorted and unstratified clay, silt, sand, gravel, and boulders and associated stratified and sorted ice-contact deposits of sand and gravel. Moraines in the northern two-thirds of the area generally have a high content of sand and gravel. Moraines in the southern one-third generally have a high content of clay and silt Sandstones, fine to coarse grained, interbedded with siltstone and shale	Glacial deposits yield moderate to large quantities of water, generally adequate for domestic and farm use, and adequate for irrigation in many areas. Yields exceeding 500 gpm may be obtained from properly constructed wells. Yields in the thin drift bedrock outcrop area generally are from 100 to 500 gpm Sandstones yield moderate to large quantities of water, depending on thickness. Yields generally range from 400 to 800 gpm, but higher yields are reported	From 0.2 to 0.7 cfs per square mile during low-flow period Generally consistent with relatively high low flows and little flooding. Embarrass and Little Wolf Rivers have less consistent flows	Hard to very hard, of the calcium magnesium bicarbonate type. Locally high in iron. Total dissolved solids from 175 to 300 ppm in both the glacial-drift and sandstone aquifers	Hard water of the calcium magnesium bicarbonate type. Moderately high in iron. Total dissolved solids from 150 to 215 ppm
Central Lake Plain and Moraine thick drift	Lake plain with a few end moraines and some ground moraine. Underlain by a preglacial drainage and glacial-drift fill ranging from 150 to 300 feet thick Bedrock is sandstone in south and crystalline rock in north. Sandstone thickness ranges from 0 in the north to 600 feet in the south Topography characterized by low plains, a few hills, and morainal ridges. Altitudes range between 725 and 850 feet. Several large lakes. Wetlands cover about 26 percent of the area Percentage of the province covered by soil types: 48 percent silty and clayey soil types, slow infiltration; 32 percent loams, sandy loams, and silty loams, moderate infiltration; and 20 percent sands and sandy loams, rapid infiltration	Glacial deposits largely are fine-grained sand, silt, and clay and some coarse to medium-grained sand. Continuous sand and gravel deposits overlie bedrock in parts of the buried valleys. These deposits are thickest in Outagamie and Shawano Counties Sandstones are fine to coarse grained containing some siltstone and shale layers	Glacial deposits in the southern half of the province yield from 10 to 100 gpm with larger yields locally. Water in sand and gravel lenses is often under artesian pressure, causing many flowing wells. Glacial deposits in northern half of basin yield 100 to 500 gpm with larger yields locally Sandstones yield as much as 500 gpm, depending on thickness. Higher yields are reported in the south edge of the province. The aquifer generally is artesian	About 0.10 to 0.14 cfs per square mile during low-flow period Generally inconsistent and variable. Streams subject to flash floods and may cease to flow during summer. However, many streams that originate in outwash areas are more stable	Hard to very hard and of the calcium magnesium bicarbonate type. Locally high in iron. Total dissolved solids from 200 to 400 ppm in both the glacial drift and sandstone aquifers	Moderately hard to hard and of the calcium magnesium bicarbonate type. May be moderately high in iron. Total dissolved solids from 200 to 400 ppm
Eastern Lake Plain and Moraine thin drift	Ground moraine and lake-plain sediments and a few morainal ridges. Glacial deposits are less than 100 feet thick Bedrock is sandstone and dolomite ranging between 600 and 1,000 feet thick Topography ranges from plains to rolling hills. Prominent escarpment and upland parallel to eastern border of province. Altitudes range between 740 and 1,050 feet. Wetlands cover about 13 percent of the area Percentage of the province covered by soil types: 54 percent silty and clayey soil types, slow infiltration; 43 percent loams, sandy loams, and silty loams, moderate infiltration; and 3 percent sand and sandy loams, rapid infiltration	Glacial deposits mainly are silt and clay and some sand and gravel Sandstones are fine to coarse grained with some interbedded siltstone and shale The Prairie du Chien Group is composed of dolomite and some sandstone layers. Unit varies in thickness with the overlying St. Peter Sandstone, one unit thickening as the other thins The St. Peter Sandstone is fine to coarse grained containing some shale at the base where the unit is thick The Platteville-Galena unit is dolomite The Maquoketa Shale is dolomitic shale The Niagara Dolomite is a dolomite	Glacial deposits generally are poorly permeable, thin, and form a poor aquifer Sandstone, the Prairie du Chien Group, and the St. Peter Sandstone collectively yield as much as 500 gpm. This aquifer is generally artesian The Platteville-Galena unit may yield as much as 50 gpm The Maquoketa Shale yields little water and is not considered an aquifer The Niagara Dolomite may yield as much as 50 gpm, but is not an important aquifer	From 0 to 0.3 cfs per square mile during low-flow period Generally inconsistent and highly variable. Streams subject to flash floods and may cease to flow during summer	Very hard, of the calcium magnesium bicarbonate type, may be high in iron, sulfate, and chloride. Locally high in iron. A saline-water zone is near Lake Winnebago. Dissolved solids from 300 to 500 ppm, but may be 2,000 to 3,000 ppm in the saline-water zone	Very hard water of the calcium magnesium bicarbonate type, may be high in iron, sulfate, and chloride. Total dissolved solids from 350 to 450 ppm

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Base from U.S. Geological Survey
State base map, 1911

WATER RESOURCES OF WISCONSIN—FOX-WOLF RIVER BASIN

By
Perry G. Olcott

1968

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