WATER USE

WITHDRAWAL USE OF WATER IN 1968
IN MILLION GALLONS PER DAY

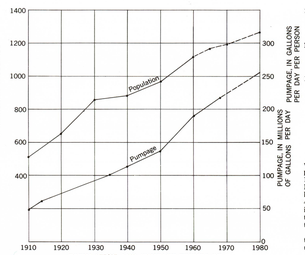
Use	Source and type of supply						Total
	Ground water			Surface water			
	Public supply		Private supply	Public supply		Private supply	
	Municipal	Other		Municipal	Other		
Domestic	7.2	1.1	8.2	59.5	0	0	76.0
Industrial and commercial, excluding fuel-electric cooling	14.1	0	13.3	108	0	.2	135.6
Fuel-electric cooling	0	0	0	0	0	1,262	1,262
Irrigation	.5	0	.3	2.5	0	.2	3.5
Stock	0	0	3.1	0	0	.8	3.9
Other	2.8	.9	.6	46.1	0	0	50.4
Subtotal	24.6	2.0	25.5	216.1	0	1,263.2	
Total		52.1			1,479.3		1,531.4

About 560 billion gallons of water were withdrawn for use within the Lake Michigan basin in 1968. About 97 percent (1,479.3 mgd) of this water came from Lake Michigan, and about 3 percent (52.1 mgd) was withdrawn from ground-water sources. However, ground water was the source of supply over 90 percent of the basin. Because water is usually discharged into a lake or stream after use, an undetermined amount of the total water use is actually reuse of the same water.

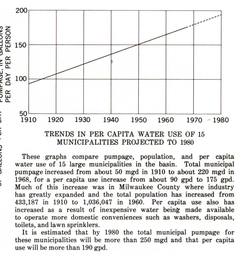
In the table above, public-supply use is that of municipalities, subdivisions, sanitary districts, and self-supplied schools and institutions. Private supply includes all other uses, such as for farms, non-farm rural, industrial, and commercial. In the use column, "other" includes losses from distribution systems, street washing, main flushing, and use in public buildings.

All surface water used for public supply in the basin is from Lake Michigan and is about eight times greater than the total amount taken from the ground (see Withdrawal Use table).

About 86 percent of the surface water withdrawn in the basin, 1,262 mgd, was for cooling condensers in steam-powered generating plants located at Oak Creek, Milwaukee, Port Washington, Sheboygan, and Manitowoc. In this use the only important change is quality or quantity of the water is an increase in temperature.



POPULATION AND PUMPAGE TRENDS OF
15 MUNICIPALITIES PROJECTED TO 1980



TRENDS IN PER CAPITA WATER USE OF 15
MUNICIPALITIES PROJECTED TO 1980

These graphs compare pumpage, population, and per capita water use of 15 large municipalities in the basin. Total municipal pumpage increased from about 50 mgd in 1910 to about 220 mgd in 1968, for a per capita use increase from about 90 gpd to 175 gpd. Much of this increase was in Milwaukee County where industry has greatly expanded and the total population has increased from 433,187 in 1910 to 1,036,047 in 1960. Per capita use also has increased as a result of inexpensive water being made available to operate more domestic conveniences such as washers, disposals, toilets, and lawn sprinklers.

It is estimated that by 1980 the total municipal pumpage for these municipalities will be more than 250 mgd and that per capita use will be more than 190 gpd.

NONWITHDRAWAL USE

The most important nonwithdrawal water uses in the Lake Michigan basin are fish and wildlife habitat, recreation, navigation and transportation, and waste transport and disposal.

In Wisconsin the management of fish and wildlife habitat and recreation are important because the State derives considerable economic gain from tourism.

Shipping in Lake Michigan via the St. Lawrence Seaway is an asset to Wisconsin. Food stuffs and manufactured goods enter and leave through several ports in the basin.

Many streams in the basin are used to transport treated wastes from many sources. Lake Michigan receives these effluents from several municipalities along the shore.

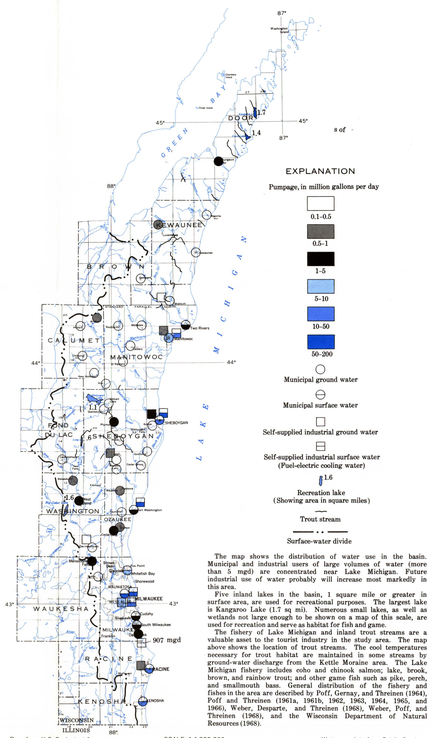
MUNICIPAL WATER USE IN 1968 AND SOURCE OF WATER

Municipality	County	Population 1960	Average pumpage, in million gallons per day (mgd)	Maximum pumpage mgd	Source of water
Adell	Sheboygan	398	0.03	0.06	Niagara aquifer
Algoma	Kewaunee	3,855	.39	.68	Niagara aquifer and sandstone aquifer
Brillion	Calumet	1,783	.53	1.0	Niagara aquifer and sandstone aquifer
Brown Deer	Milwaukee	11,290	*1.0	2.0	City Milwaukee
Butler	Waukesha	2,274	.24	.66	Sandstone aquifer
Campbellsport	Fond du Lac	1,472	.21	.44	Niagara aquifer and sandstone aquifer
Cedarburg	Ozaukee	5,191	1.5	2.6	Niagara aquifer and sandstone aquifer
Cedar Grove	Sheboygan	1,175	.14	.34	Niagara aquifer
Chilton	Calumet	2,578	.43	.81	Niagara aquifer
Cudahy	Milwaukee	17,975	2.8	5.0	Lake Michigan
Denmark	Brown	1,106	.14	.46	Niagara aquifer
Elkhart Lake	Sheboygan	651	.19	.54	Niagara aquifer
Fox Point	Milwaukee	7,315	.91	—	Lake Michigan
Fredonia	Ozaukee	710	.98	.24	Niagara aquifer
Germantown	Washington	622	.06	.15	Niagara aquifer and sandstone aquifer
Glenbeulah	Sheboygan	428	.03	.10	Niagara aquifer
Glendale	Milwaukee	9,537	2.5	17.1	Lake Michigan
Grafton	Ozaukee	3,748	.84	1.7	Niagara aquifer and sandstone aquifer
Greendale	Milwaukee	6,943	*1.0	2.8	City Milwaukee
Hilbert	Calumet	736	.05	.07	Niagara aquifer
Kenosha	Kenosha	67,899	12.2	21.2	Lake Michigan
Kewaskum	Washington	1,272	.55	.73	Niagara aquifer
Kewaunee	Kewaunee	2,772	.26	.41	Niagara aquifer
Kiel	Manitowoc	2,524	.18	.24	Niagara aquifer
Kohler	Sheboygan	1,524	.21	.71	Niagara aquifer
Luxemburg	Kewaunee	700	.07	1.2	Niagara aquifer
Manitowoc	Manitowoc	32,275	8.2	14.3	Sand and gravel aquifer
Menomonee Falls	Waukesha	18,276	1.8	3.2	Sand and gravel aquifer, Niagara aquifer, and sandstone aquifer
Milwaukee	Milwaukee	741,324	156	265	Lake Michigan
Mishicot	Manitowoc	762	.07	.26	Niagara aquifer
New Holstein	Calumet	2,401	.41	.71	Niagara aquifer and sandstone aquifer
Oak Creek	Milwaukee	9,372	1.0	1.5	Niagara aquifer and sandstone aquifer
Oostburg	Sheboygan	1,065	.10	.20	Niagara aquifer
Plymouth	Sheboygan	5,128	1.4	2.7	Sand and gravel aquifer and Niagara aquifer
Port Washington	Ozaukee	5,984	1.1	1.6	Lake Michigan
Racine	Racine	89,144	20.2	34.6	Lake Michigan
Random Lake	Sheboygan	858	.28	.71	Niagara aquifer
Reedsville	Manitowoc	830	.07	.12	Niagara aquifer
Saint Nazianz	Manitowoc	669	.05	.10	Niagara aquifer
Sankville	Ozaukee	1,938	.36	.64	Niagara aquifer
Sheboygan	Sheboygan	45,747	11.6	20.8	Lake Michigan
Sheboygan Falls	Sheboygan	4,061	*1.3	1.9	City Sheboygan
Shorewood	Milwaukee	15,990	*1.6	—	City Milwaukee
South Milwaukee	Milwaukee	20,307	4.5	6.5	Lake Michigan
Sturgeon Bay	Door	7,353	1.1	2.1	Niagara aquifer and sandstone aquifer
Sturtevant	Racine	1,488	* .24	.40	City Racine
Two Rivers	Manitowoc	12,393	2.3	3.5	Lake Michigan
Valders	Manitowoc	622	.12	.20	Niagara aquifer
Waldo	Sheboygan	403	.03	.08	Niagara aquifer
Wauwatosa	Milwaukee	56,923	*6.5	9.5	City Milwaukee
West Allis	Milwaukee	68,157	*10.2	16.2	City Milwaukee
West Bend	Washington	9,969	2.5	5.1	Sand and gravel aquifer and Niagara aquifer
Whitefish Bay	Milwaukee	18,290	2.0	—	Lake Michigan
Whitelaw	Manitowoc	420	.04	.08	Niagara aquifer
	Total	1,328,017	240.67		

*Pumpage also included under vendor's pumpage

Pumpage data, water source, and the population of municipalities having public water supplies are listed in the table above. Subdivisions and sanitary districts having separate water supplies are not listed, but their total use has been estimated and included in the table on withdrawal use.

Ground water is the source of supply for 36 municipalities in the basin, 22 of which use the Niagara aquifer, one uses the sand and gravel, one uses the sandstone, and 12 use a combination of two or more aquifers. Eighteen municipalities along Lake Michigan use the lake as a source. Among these are Kenosha, Racine, Milwaukee, Port Washington, and Sheboygan. A few of the suburban areas along the lake purchase water from cooperatives, municipalities, or other community systems that use the lake as a source. Sheboygan supplies Lake Michigan water to Sheboygan Falls, and Racine supplies Sturtevant. The city of Milwaukee furnishes water to five suburban communities, as indicated in the table.



Base from U.S. Geological Survey
1:500,000, 1968

SCALE 1:1 000 000
10 5 0 10 20 MILES
10 5 0 10 20 KILOMETERS

DISTRIBUTION OF USE

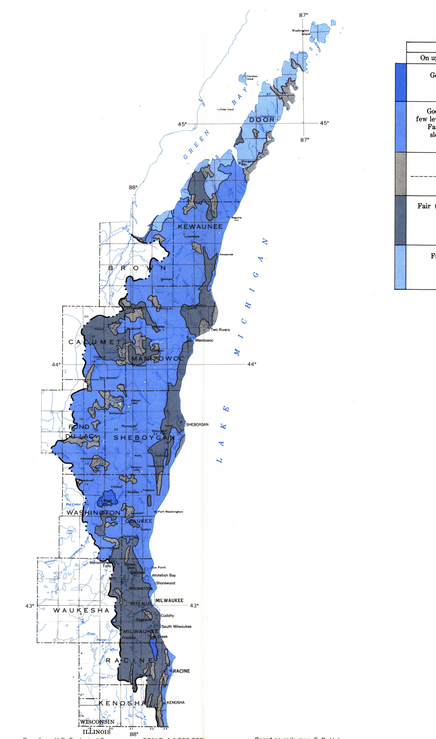
The map shows the distribution of water use in the basin. Municipal and industrial users of large volumes of water (more than 5 mgd) are concentrated near Lake Michigan. Future industrial use of water probably will increase most markedly in this area.

Five inland lakes in the basin, 1 square mile or greater in surface area, are used for recreational purposes. The largest lake is Kangaroo Lake (1.7 sq mi). Numerous small lakes, as well as wetlands not large enough to be shown on a map of this scale, are used for recreation and serve as habitat for fish and game.

The fishery of Lake Michigan and inland trout streams are a valuable asset to the tourist industry in the study area. The map above shows the location of trout streams. The cool temperatures necessary for trout habitat are maintained in some streams by ground-water discharge from the Kettle Moraine area. The Lake Michigan fishery includes coho and chinook salmon; lake, brook, brown, and rainbow trout; and other game fish such as pike, perch, and smallmouth bass. General distribution of the fishery and fishes in the area are described by Poff, Gernay, and Threinen (1964), Poff and Threinen (1961a, 1961b, 1962, 1963, 1964, 1965, and 1966), Weber, Desparte, and Threinen (1968), Weber, Poff, and Threinen (1968), and the Wisconsin Department of Natural Resources (1968).

Water use data from Public Service Commission of Wisconsin and individual users, and recreational lakes and trout streams from Department of Natural Resources

POTENTIAL AREAS FOR IRRIGATION



Base from U.S. Geological Survey
1:500,000, 1968

SCALE 1:1 000 000
10 5 0 10 20 MILES
10 5 0 10 20 KILOMETERS

Based on soils map, F. D. Hole and others (1968)

SOIL SUITABILITY FOR IRRIGATION

Although water for irrigation is available nearly everywhere in the basin, soils over most of the basin do not have "good" suitability for irrigation, either because they are not level or because they require drainage.

The suitability of soils for irrigation depends upon topography, soil permeability, and depth to the water table. Soil suitability, as shown on the map and in the explanation, does not take into account water availability or soil fertility.

Under the best conditions (good suitability in the table), the topography is level to allow uniform distribution of water and to prevent excessive water runoff, the soil is permeable so that water can infiltrate and percolate to the root zone, and the depth to the water table is 4 feet or more so that plants' roots remain in the zone of aerated soil for proper assimilation of oxygen and nutrients.

Soils in the study area are grouped into five categories (Hole and others, 1968) and generalized. Many local conditions contrary to the suitability depicted in the map are not shown.

SUMMARY

Large amounts of good quality water are available in the Lake Michigan basin. Of the 29 inches of average annual precipitation that falls on the basin, about 7.7 inches or 1,750 mgd leaves the basin as streamflow. This represents the amount of water available for use, although water can be borrowed from a much larger quantity stored beneath the ground. Also in proximity to almost any part of the basin is approximately 1,180 cubic miles of high quality water stored in Lake Michigan.

The quantity of surface water used in the basin is much greater than ground water. Of the 560 billion gallons of water withdrawn for use in the basin in 1968, about 97 percent (1,479.3 mgd) of this water came from Lake Michigan. Most of the municipalities along Lake Michigan use the lake as a public supply source.

Ground water is more widespread in the basin than surface water. It is available from three aquifers: the sand and gravel aquifer, the Niagara aquifer, and the sandstone aquifer. Any of these aquifers is capable of yielding domestic and stock supplies. All are capable of yielding more than 1,000 gpm of water to wells in some areas.

The principal water problems in the basin are related to water quality. Both ground and surface water have high natural hardness; high iron content is a local problem in ground water. Some reaches of streams are polluted by industrial, municipal, or domestic wastes, rendering them less useful as wildlife habitat and for recreational purposes. Shallow aquifers, whether dolomite, sandstone, or glacial drift, are locally polluted by man's wastes from surface sources. Also, the sandstone aquifer is saline in some local areas and, therefore, is not usable for water supplies.

Another problem is the conflict of interest in the use of water and land. An example is the draining of wetlands to increase agricultural production in conflict with the use of wetlands for fish and wildlife habitat.

A potential problem is flooding. With a continued increase in occupation of flood plains, flood damages will increase.

SUMMARY OF WATER RESOURCES

Water resources	Surface water						Ground water				
	Milwaukee and Sheboygan Rivers	Manitowoc River	East Twin, West Twin, Kewaunee, and Ahnapee Rivers	Root River, Pike River, and Oak Creek	Menomonee River and Cedar Creek	Lake Michigan	Sand and gravel aquifer		Niagara aquifer	Sandstone aquifer	
							Surficial deposits	Buried deposits	Dolomite	Sandstone and dolomite	
Quantity	Average discharge of Milwaukee River at Milwaukee, 384 cfs (cubic feet per second); exceeds 52 cfs 90 percent of time Average discharge of Sheboygan River at Sheboygan 232 cfs; exceeds 30 cfs 90 percent of time Low flow may be affected by fifteen dams on the Milwaukee and nine on the Sheboygan River	Discharge magnitude comparable to, but less than the Sheboygan River Low flow may be affected by five dams	Average discharge of Kewaunee River near Kewaunee, 47 cfs, no flow data available for other three streams but flows are probably less than the flow of Kewaunee River East Twin, West Twin, and Ahnapee Rivers may be affected by one dam each in the lower parts of their watersheds; the Kewaunee River is unregulated	Average discharge of Root River at Racine, 104 cfs; exceeds 4 cfs 90 percent of time Average flows of Pike River and Oak Creek are less than 50 cfs; Oak Creek exceeds 3 cfs 90 percent of the time Periods of no measurable flow in parts of the streams Root River maybe affected by one dam about 1 mile upstream from mouth No dams on Pike River or Oak Creek	Average discharge of Menomonee River at Wauwatosa, 64.6 cfs; exceeds 11 cfs 90 percent of time Average discharge of Cedar Creek near Cedarburg, 62.7 cfs; exceeds 6 cfs 90 percent of the time May be affected by three dams on the Menomonee River and twelve dams on Cedar Creek	Very large storage (Approximately 1,180 cubic miles)	Large yields as much as 1,200 gpm from conventional wells Specific capacities as much as 50 gpm per foot of drawdown Well depths commonly from 30 to 120 feet Limited areal extent Not used extensively	Small to moderate yields, generally not greater than 125 gpm Well depths commonly from 50 to 480 feet Limited areal extent Not used extensively	Small to large yields, as much as 1,200 gpm Specific capacity for wells ranges from 0.2 gpm per foot to 400 gpm per foot of drawdown Well depths commonly from 75 to 300 feet. Underlies most of the basin Used extensively over most of the basin	Large yields are as much as 1,500 gpm Specific capacity of high-capacity wells are as much as 14 gpm per foot of drawdown Well depths commonly from 1,000 to 1,500 feet Underlies entire basin Used extensively for high-capacity wells in the lower one-third of the basin
Quality	Quality ranges from fair to poor Very hard water Significant sewage effluent Milwaukee River also receives water from a number of industries Water temperatures ranges from freezing to about 28° C (83° F) Dissolved oxygen variable Generally moderate turbidity Color increases during spring floods	Quality ranges from good to fair Generally very hard water, but extremely high flows produce hard water Water temperatures ranges from freezing to about 22° C (71° F) Dissolved oxygen generally abundant Generally moderate turbidity Color increases during spring floods	Generally good quality Hardness ranges from hard to very hard Degradation evident locally near some small communities and industries(Schraufnagle and others, 1965) Water temperature ranges from freezing to about 25° C (77° F) Dissolved oxygen is abundant Moderate turbidity Colored	Generally poor quality Very hard water Local degradation of quality by municipal sewage wastes and agricultural runoff Water temperature ranges from freezing to about 28° C (83° F) Dissolved oxygen fluctuates widely	Fair quality Very hard water Both streams receive significant sewage effluent of municipal and industrial origin Degradation downstream from pollution sources, but the streams have reasonable recovery capacities Water temperature ranges from freezing to near 30° C (86° F) Dissolved oxygen fluctuates widely	Good quality Hard water (averages about 125 milligrams per liter) Water temperature at surface ranges from freezing to 21° C (70° F) Dissolved oxygen is abundant, generally at or near saturation	Good quality Generally very hard (greater than 180 mg/l hardness) water, but locally hard (about 140 mg/l)	Good quality Generally very hard water, but locally hard	Good quality Generally very hard water but locally soft to moderately hard Highly mineralized locally	Quality varies by area Water hard to very hard Saline in some areas
Special considerations	Moderate flooding in the Milwaukee River Moderate pollution, especially of the Milwaukee River	Flooding is moderate and damage is slight because the watershed is largely Water only slightly polluted but receives waste from small cities and villages scattered throughout the watershed	Flooding is minor Local pollution below small communities and industries Overloading of sewage treatment plants below some communities has caused fish kills	Flooding is minor Pollution is a major concern (indicated by dissolved oxygen, chloride, and nitrate concentrations During summer months sewage effluent exceeds entire discharge of the streams	Flooding is minor Local pollution where biochemical oxygen demand and overloading are prevalent and dissolved oxygen is depleted	Receives polluted water from some streams Beaches occasionally littered with dead alewives Shoreline and bank erosion occurs especially along Kenosha and Racine County shorelines	Water table generally shallow Easily polluted by surface wastes	Water table generally shallow; locally artesian Deposits are often thin Generally not subject to pollution except locally	Water table generally from 50 to 100 feet deep; locally artesian Subject to pollution	Artesian Regional decline in water levels due to pumping in lower one-third of basin Not easily polluted
Suitability	Flow adequate for most uses Quality adequate except in lower reaches, but treatment may be required Suitable for limited fishing, hunting and boating, but pollution in lower reaches limits body-contact activity Generally only rough fish Poor to fair wildlife habitat	Flow adequate for most uses Quality generally adequate, but treatment may be required Suitable for fishing, hunting and boating Rough fish abundant Some game fish; one trout stream and one coho release site Good wildlife habitat	Flow adequate for most uses Quality adequate, but treatment may be required Suitable for fishing, hunting, and boating Game and rough fish Several tributaries are trout streams; in some, trout migrate inland from Lake Michigan Good wildlife habitat in upper stream reaches	Flow adequate for most uses except during low flow Quality generally inadequate Suitable for limited fishing and hunting Unsuitable for body-contact activity Rough fish abundant Poor wildlife habitat	Flow adequate for most uses Quality adequate, but treatment may be required Suitable for hunting, fishing, and boating Rough fish generally abundant Poor wildlife habitat	Adequate for most uses Quality adequate, but treatment may be required Suitable for swimming, boating, and fishing Trout, bass, perch, and salmon fishery Poor wildlife habitat	Yields locally adequate for municipal, industrial, and other uses Quality adequate	Yields locally adequate for domestic and small municipal and industrial uses Quality adequate	Yields range from adequate for municipal and industrial uses to adequate for only small domestic uses Quality adequate	Yields adequate for municipal, industrial; and other uses Quality adequate except in local areas having saline water

AGENCIES HAVING ADDITIONAL INFORMATION

Agency	Geology	Soils	Topography and drainage	Land use	Water budget	Ground- and surface-water relationships	Surface water	Surface-water quality	Pollution	Ground water	Ground-water quality	Water use
Public Service Commission of Wisconsin 432 Hill Farms State Office Building, Madison, Wis. 53702												■
Southeastern Wisconsin Regional Planning Commission 916 North East Avenue, Waukesha, Wis. 53186				■								
The University of Wisconsin-Extension, Geological and Natural History Survey 1815 University Avenue, Madison, Wis. 53706	■	■	■	■	■	■	■	■	■	■	■	
University of Wisconsin, Soils Department Soils Building, University of Wisconsin, Madison, Wis. 53706		■										
U.S. Department of Agriculture, Soil Conservation Service 4601 Hammersley Road, P. O. Box 4248, Madison, Wis. 53711		■	■	■	■							■
U.S. Department of Defense, Army Corps of Engineers 219 South Dearborn Street, Chicago, Ill. 60604												■
U.S. Department of the Interior, Federal Water Quality Administration 1 North Wacker Drive, Chicago, Ill. 60605												■
U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, 5 Research Drive, Ann Arbor, Mich. 48103												■
U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Federal Bldg., Fort Snelling, Minn. 55111												■
U.S. Department of the Interior, Geological Survey, Water Resources Division, 1815 University Avenue, Madison, Wis. 53706	■	■	■	■	■	■	■	■	■	■	■	■
Wisconsin Department of Agriculture 103 B Hill Farms State Office Building, Madison, Wis. 53702				■								
Wisconsin Department of Local Affairs and Development 123 West Washington Avenue, Madison, Wisconsin 53702												
Wisconsin Department of Natural Resources 4610 University Avenue, Madison, Wis. 53701				■		■						■

SELECTED REFERENCES

Bean, E. F., 1949, Geologic map of Wisconsin: Wisconsin Geol. and Nat. History Survey.

Comly, H. H., 1945, Cyanosis in infants caused by nitrates in well water: Am. Med. Assoc. Jour., v. 129, p. 112–116.

Drescher, W. J., 1953, Ground-water conditions in artesian aquifers in Brown County, Wisconsin: U.S. Geol. Survey Water-Supply Paper 1190, 49 p.

Foley, F. C., Walton, W. C., and Drescher, W. J., 1953, Ground-water conditions in the Milwaukee-Waukesha area, Wisconsin: U.S. Geol. Survey Water-Supply Paper 1129, 96 p.

Green, J. H., and Hutchinson, R. D., 1965, Ground-water pumpage and water-level changes in the Milwaukee-Waukesha area Wisconsin, 1950-61: U.S. Geol. Survey Water-Supply Paper 1809–I, 19 p.

Hindall, S. M., and Plitz, R. F., 19 , Sediment yields of Wisconsin streams: U.S. Geol. Survey Hydrol. Inv. Atlas HA–376.

Hole, F. D., Beatty, M. T., Lee, G. B., and Klingelhoets, A. J., 1968, Soils map of Wisconsin: University Extension, the Univ. of Wisconsin Geol. and Nat. History Survey.

Hutchinson, R. D., 1970, Water resources of Racine and Kenosha Counties, southeastern Wisconsin: U.S. Geol. Survey Water-Supply Paper 1878, 68 p.

Knowles, D. B., 1964, Ground-water conditions in the Green Bay area, Wisconsin, 1950-60: U.S. Geol. Survey Water-Supply Paper 1669–J, 27 p.

Knowles, D. B., Dreher, F. C., and Whetstone, G. W., 1964, Water resources of the Green Bay area Wisconsin: U.S. Geol. Survey Water-Supply Paper 1499–G, 67 p.

Newport, T. G., 1962, Geology and ground-water resources of Fond du Lac County, Wisconsin: U.S. Geol. Survey Water-Supply Paper 1604, 62 p.

Poff, R. J., Gernay, Ronald, and Threinen, C. W., 1964, Surface water resources of Ozaukee County: Wisconsin Conserv. Dept., 53 p.

Poff, R. J., and Threinen, C. W., 1961a, Surface water resources of Kenosha County: Wisconsin Conserv. Dept., 37 p.

_____1961b, Surface water resources of Racine County: Wisconsin Conserv. Dept., 37 p.

_____1962, Surface water resources of Washington County: Wisconsin Conserv. Dept., 63 p.

_____1963, Surface water resources of Waukesha County: Wisconsin Conserv. Dept., 69 p.

_____1964, Surface water resources of Milwaukee County: Wisconsin Conserv. Dept., 39 p.

_____1965, Surface water resources of Door County: Wisconsin Conserv. Dept., 66 p.

_____1966, Surface water resources of Kewaunee County: Wisconsin Conserv. Dept., 50 p.

Ryling, R. W., 1961, A preliminary study of the distribution of saline water in the bedrock aquifers of eastern Wisconsin: Wisconsin Geol. and Nat. History Survey Inf. Circ. 5, 23 p.

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

Scalf, M. R., Hauser, V. L., McMillion, L. G., Dunlap, W. J., and Keeley, J. W., 1968, Fate of DDT and nitrate in ground water: U.S. Dept. Interior and U.S. Dept. Agriculture, 46 p.

Schraufnagel, F. H., 1962, Report on a field investigation of surface water quality in southeastern Wisconsin conducted in the summer of 1962: Wisconsin State Board Health and Comm. on Water Pollution mimeo. rept., 9 p.

Schraufnagel, F. H., Montie, L. A., Karl, G. W., and Lisnack, J. L., 1965, Report on an investigation of the pollution in the Twin and Kewaunee River drainage basins made during 1964 and early in 1965: Wisconsin State Board Health and Comm. on Water Pollution mimeo. rept., 14 p.

Schraufnagel, F. H., Montie, L. A., Loschcw, L. A., and Lisnack, J. L., 1965, Report on an investigation of the pollution in the Sheboygan River drainage basin made during 1962 and early 1963: Wisconsin State Board Health and Comm. on Water Pollution mimeo. rept., 20 p.

_____1965, Report on an investigation of the pollution in the Door drainage basin made during 1964 and 1965: Wisconsin State Board Health and Comm. on Water Pollution, mimeo. rept., 9 p.

Southeastern Wisconsin Regional Planning Commission, 1966, Soils of southeastern Wisconsin: Waukesha, Wis., Planning Rept. 8, 403 p.

Thwaites, F. T., 1956, Wisconsin glacial deposits (rev. 1964): Wisconsin Geol. and Nat. History Survey map.

_____1957, Buried Pre-Cambrian of Wisconsin: Wisconsin Geol. and Nat. History Survey map.

Thwaites, F. T., and Bertrand, Kenneth, 1957, Pleistocene geology of the Door Peninsula, Wisconsin: Geol. Soc. America Bull., v. 68, p. 831–880.

U.S. Department of Agriculture, Soil Conservation Service, 1964, Engineering test data and interpretations for major soils of Wisconsin: U.S. Dept. Agriculture Soil Conserv. Service, 70 p.

U.S. Department of Commerce, Weather Bureau, 1931–68, Climatological data: Washington, D.C., U.S. Govt. Printing Office. Published annually.

U.S. Department of the Interior, Federal Water Pollution Control Administration, 1968, Water pollution problems of Lake Michigan and tributaries: Chicago, 74 p.

U.S. Public Health Service, 1962, Drinking water standards, 1962: U.S. Public Health Service Pub. 956, 61 p.

Weber, J., Desparte, M., and Threinen, C. W., 1968, Surface water resources of Manitowoc County: Wisconsin Dept. Nat. Resources, 95 p.

Weber, J., Poff, R., and Threinen, C. W., 1968, Surface water resources of Sheboygan County: Wisconsin Dept. Nat. Resources, 77 p.

Wisconsin Committee on Water Pollution, 1965, Wisconsin surface water quality, 1961–1964: Madison, 96 p.

Wisconsin Department of Natural Resources [no date], State of Wisconsin surface water quality monitoring data 1965–68: Madison, 97 p.

_____1968, Wisconsin trout streams: Wisconsin Conserv. Div. Pub. 213–68, 75 p.

_____1969a, Report on an investigation of the pollution in the Manitowoc River drainage basin made during 1968: Wisconsin Div. Environmental Protection mimeo. rept., 29 p.

_____1969b, Report on an investigation of the pollution of the Milwaukee River, its tributaries, and Oak Creek made during 1968 and 1969: Wisconsin Div. Environmental Protection mimeo. rept., 43 p.

Wisconsin Natural Resources Committee of State Agencies, 1967, State of Wisconsin, State laws, policies, and programs pertaining to water and related land resources: Madison, 103 p.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1973—W71025

WATER RESOURCES OF WISCONSIN–LAKE MICHIGAN BASIN

By
Earl L. Skinner and Ronald G. Borman

1973