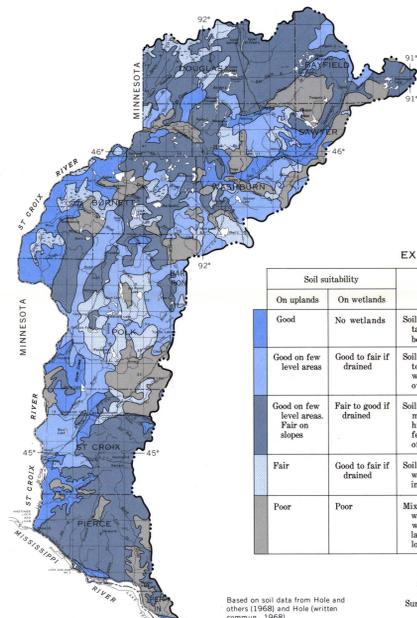


IRRIGATION

Although rainfall is plentiful in the basin, irrigation can provide timely application of moisture for optimum production of row and truck crops. Water is applied through sprinkler systems at 5- to 14-day intervals as needed. Application per season averages about 3 inches but the amount varies considerably, depending on weather conditions and crop type. The area irrigated in 1968 was small, less than 1,000 acres. Most of the irrigated field crop was potatoes and the rest was green beans.

Ground water is used for all irrigation of row and truck crops in the basin. Wells in surficial sand and gravel are used in Washburn County, and wells in the Prairie du Chien Group and Jordan Sandstone are used in St. Croix County.

In addition to row and truck crops, about 410 acres of cranberry bogs were irrigated with surface water in 1968, 60 percent by flooding and 40 percent by a combination of flooding and sprinkling (Wisconsin Statistical Reporting Service, 1969).



EXPLANATION

Soil suitability	Characteristics		Parent material
	On uplands	On wetlands	
Good	No wetlands	Soil is level and permeable; water table is more than 4 feet below land surface	Sand and gravel, sand, and silt
Good on low level areas	Good to fair if drained	Soil is highly permeable but hilly to undulating; water table within 4 feet of land surface over much of the low land	Outwash sand and gravel, till, and organic material
Good on low level areas, Fair on slopes	Fair to good if drained	Soil is moderately to highly permeable but undulating to hilly; water table within 4 feet of land surface over much of the low land	Outwash sand and gravel, till, organic material, and loess
Fair	Good to fair if drained	Soil is level and permeable; water table generally is within 4 feet of land surface	Wetland vegetation with minor amount of loess
Poor	Poor	Mixed soil types, hilly to level, with low to high permeability; water table within 1 foot of land surface over much of the low land	Sandy loam, till, loess, and sandstone

Based on soil data from Hole and others (1968) and Hole (written commun., 1968)

SOIL SUITABILITY FOR IRRIGATION

Soils are suitable for irrigation of row and truck crops over one-third to one-half of the basin. Many soils derived from outwash or other sandy deposits have good potential for irrigation in the basin. The suitability of soil for irrigation depends upon the flatness of the land, the permeability of the soil, and the depth to the water table. The best conditions are 1) level land, which allows use of sprinkler irrigation and reduces surface runoff; 2) permeable soil, which allows water to infiltrate; and 3) depth to the water table of 4 feet or more, which allows plant roots to remain in the zone of aeration for good assimilation of oxygen and nutrients.

Based on topography, soil type, and depth to water, soils in the basin are arranged in five irrigation suitability groups according to a classification by F. D. Hole (written commun., 1968). Water availability, soil fertility, and air temperature were not included in this classification and must be considered locally. In general, the soils suitable for irrigation are underlain by fairly productive aquifers (see Ground-Water Availability, sheet 2).

WITHDRAWAL USE OF WATER IN 1968

Use	Source and type of supply						Total
	Ground water			Surface water			
	Public supply	Private supply	Other	Public supply	Private supply	Other	
Domestic	1.6	<0.1	5.3	0	0	0	6.9
Industrial and commercial	2.5	0	2.1	0	0	0	4.6
Irrigation	<.1	0	.2	0	0	3.1	3.3
Stock	0.4	<.1	0	0	0	.8	1.1
Other	1.0	<.1	0	0	0	0	1.4
Subtotal	5.5	<.1	10.9	0	0	3.9	20.3
Total	16.4						20.3

About 20.3 million gallons of water per day were withdrawn for use in the St. Croix River basin in 1968. Of this water, almost 80 percent was from wells, and the rest was diverted from streams, natural lakes, and manmade impoundments. The 20.3 mgd (million gallons per day) is equivalent to only 31 cfs, which is about 1 percent of the average runoff from the basin. Most of the water withdrawn was discharged to streams and was available for reuse downstream.

Water for domestic purposes, the largest use, was supplied entirely by ground water and accounted for about 42 percent of the ground water used. Privately supplied water was more than three times the amount publicly supplied, emphasizing the rural character of the basin. Consumption in domestic water use is low, and most of the water withdrawn was discharged into streams through sewage-treatment plants or to the ground through septic tanks.

Industry and commerce also were supplied by ground water and accounted for 26 percent of the ground water used. Much of the water was used for cooling. Consumption of water was very low in industrial and commercial use, and most of the water withdrawn was discharged to streams through storm drains or waste-treatment plants, or to the ground through settling basins.

Stock watering was the third largest withdrawal use, and about 80 percent was ground water. Consumption probably is high in this use.

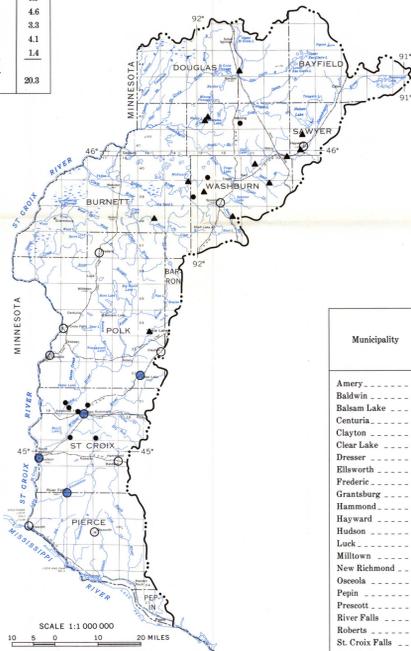
Cranberry culture used the 3.1 mgd of surface water shown as irrigation use. Most of this water was used for frost protection and harvesting and not for irrigation, but quantitative separation is not practical. Consumption of water is low in this use because most of the water drains from the bogs into streams or reservoirs or seeps into the ground. Evapotranspiration is high, however, from the reservoirs and the small areas of the bogs.

A very small amount of ground water was used for irrigation. It was largely the 0.2 mgd used for irrigation of row and truck crops from private wells. This use has a very high consumption rate because most water applied is consumed in plant growth or is evaporated from the soil.

In the use column, "other" includes losses from distribution systems, street washing, main flushing, and use by schools and other public buildings. Consumption of water is low in this use because most of the water discharges to streams through storm drains or returns to the ground.

WITHDRAWAL USE

Withdrawal use of water in the basin is small; it is greatest in the southern one-third where the major population centers are located. Of the 27 municipal supplies in the basin in 1968, only the 13 shown on the map withdrew an average of 0.1 mgd or more.



EXPLANATION

- 0.1-0.5 Municipal ground-water pumpage in million gallons per day
- 0.5-1.0 Municipal ground-water pumpage in million gallons per day
- ▲ Surface-water supply for cranberry culture
- Irrigation well
- Surface-water divide

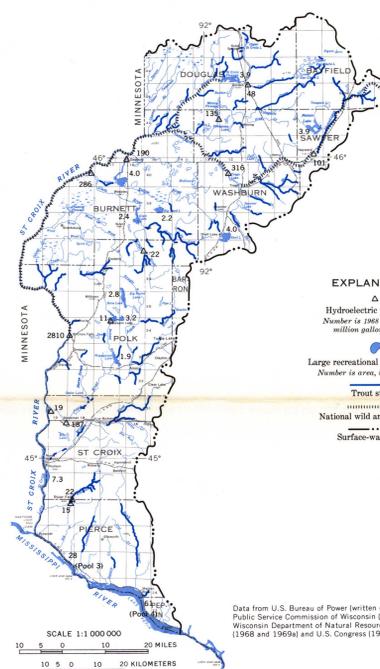
MUNICIPAL WATER USE IN 1968

Municipality	County	Population 1960	Average daily pumpage (mgd)	Maximum daily pumpage (mgd)	Use (million gallons per year)	Source of water			
					Domestic	Industrial and commercial	Public	Other	
Amery	Polk	1,769	0.239	0.476	25.8	41.5	12.9	43.7	S
Baldwin	St. Croix	1,184	1.156	4.88	14.8	30.0	1.82	10.2	D, S
Balsam Lake	Polk	641	0.54	2.06	9.53	1.77	15.9	6.95	G
Centuria	Polk	551	0.84	1.30	15.2	15.0	.45	—	S
Clayton	Polk	224	2.12	419	3.63	72.4	1.28	10	D, S
Clear Lake	Polk	724	2.06	8.40	93.6	9.86	—	—	S
Dresser	Polk	498	0.98	1.28	4.99	14.0	.16	5.66	S
Ellsworth	Pierce	1,701	1.67	2.88	26.0	16.8	3.65	14.6	D, S
Frederic	Polk	807	2.32	1.14	12.2	57.9	7.73	6.88	G
Granbury	Burnett	900	0.78	174	8.00	12.4	5.15	2.84	G
Hammond	St. Croix	645	0.40	0.54	7.89	3.34	2.18	1.17	D, S
Hayward	Sawyer	1,540	2.02	5.32	17.5	23.2	5.01	27.9	S
Hudson	St. Croix	4,225	6.60	1.28	120	82.2	20.0	18.2	S
Laek	Polk	833	0.98	1.57	11.6	13.0	1.92	9.40	G
Milltown	Polk	698	0.67	1.10	10.8	7.46	1.52	4.86	G
New Richmond	St. Croix	3,316	3.67	1.84	51.9	241	23.5	—	S
Oceola	Polk	942	1.18	2.38	10.5	5.20	2.20	25.0	S
Pepin	Pepin	825	0.82	263	7.92	2.28	2.33	6.98	G
Prescott	Pierce	1,536	1.62	409	30.5	17.4	1.82	39.9	S
River Falls	Pierce	4,857	7.21	1.22	83.2	44.9	55.9	79.0	D, S
Roberts	St. Croix	308	0.26	0.38	6.22	5.15	1.15	1.51	D
St. Croix Falls	Polk	1,249	1.70	3.88	21.1	33.1	1.50	6.40	S
Shell Lake	Washburn	1,016	0.89	11.1	17.2	11.6	1.92	9.40	G
Somerset	St. Croix	729	0.54	—	11.8	6.76	1.11	—	S
Spooner	Washburn	2,398	3.36	3.67	33.4	36.2	1.76	4.4	G
Turtle Lake	Barron	691	0.86	268	7.92	18.1	1.85	37.6	S
Weber	Polk	514	0.83	0.64	5.82	2.56	1.28	2.48	G
Total		35,401	5.478		382.45	904.16	175.88	236.52	

G, sand and gravel aquifer; S, Cambrian sandstone or sandstone aquifer; D, Prairie du Chien Group of sandstone aquifer

DISTRIBUTION OF WITHDRAWAL USE

NONWITHDRAWAL USE



EXPLANATION

- ▲ Hydroelectric power plant
- Large recreational lake or reservoir
- Trout stream
- ... National wild and scenic river
- Surface-water divide

All municipal water supplies in the basin are from ground water. Of the 27 municipal supplies in 1968, 8 are from the sand and gravel aquifer and 19 are from the sandstone aquifer. The largest withdrawal, although moderate, were by New Richmond, River Falls, and Hudson. Industrial and commercial use accounted for 45 percent of municipal pumpage. Domestic use was 29 percent, and the remaining 26 percent was used for public buildings, street washing, and main flushing, or was lost in distribution.

Public water supplies in unincorporated places are not included in the table and accounted for about 0.1 mgd of pumpage in 1968. A new municipal supply has been installed since 1968 in the village of Siren.

Data from U.S. Bureau of Power (written commun., 1967), Public Service Commission of Wisconsin (1969), Wisconsin Department of Natural Resources (1968 and 1969a) and U.S. Congress (1968)

DISTRIBUTION OF NONWITHDRAWAL USE

Nonwithdrawal uses of water in the basin are hydroelectric power generation, waste transport and disposal, fish and wildlife habitat, recreation, and transportation. Although water is not consumed in nonwithdrawal use, its physical and chemical quality may be affected. Hydroelectric power generation in 1968 used and reused about 42 bpd (billion gallons per day), twice the average runoff from the basin. Almost 170,000 megawatt-hours of electricity were generated at 15 hydroelectric plants (Public Service Commission of Wisconsin, 1969), which have at their disposal about 110,000 acre-feet of usable reservoir storage capacity (U.S. Bureau of Power, 1964). Although this use does not consume water, quality and temperature changes occur in reservoirs.

Many streams in the basin transport treated wastes from municipalities and industries. Pollution occurs locally in reaches of streams where waste disposal is concentrated (see Surface-Water Quality, sheet 3).

Fish and wildlife habitat and recreation are important in this basin because the area derives great economic gain from tourism. The resource "outdoors," of which water is a major part, draws many people into the St. Croix basin for swimming, boating, fishing, hunting, sightseeing, water and snow skiing, snowmobiling, camping, hiking, and picnicking. These uses sometimes conflict with the preservation of fish and wildlife habitat and other uses such as irrigation and reservoir regulation for hydroelectric power generation and flood control.

The large number of lakes and streams indicate the amount of water recreation available in the basin. Many of the large lakes shown are reservoirs or "flowages" constructed to store water for or provide operating head for hydroelectric power generation. Power companies commonly provide recreational facilities along streams and reservoirs. The lakes, wetlands, and streams are utilized extensively for recreation and serve as fish and wildlife habitat. Streams in the basin provide consistent conditions ranging from quick-running water to white-water rapids.

Public Law 90-342, called the "Wild and Scenic Rivers Act" (U.S. Congress, 1968), established a National wild and scenic rivers system. This system is intended to preserve the natural environment and free-flowing conditions of designated streams, which include the segments shown of the St. Croix and Namakagon Rivers.

Both waterborne commerce and recreational boating are important activities on the Mississippi River, as shown by the following data from the U.S. Corps of Engineers (written commun., 1969):

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SUMMARY

Large amounts of good quality water are available in much of the St. Croix River basin. Ground water is more widespread than surface water and is used more extensively. It is available from the sand and gravel aquifer and the sandstone aquifer, which commonly yield 500 to 1,000 gpm to wells in some areas. Most municipalities and industries have adequate supplies of ground water available for growth and development. The main exception is the poor availability of ground water in scattered areas of this drift over Precambrian bed-

rock in the northern part of the basin, where domestic supplies range from 5 to 15 gpm.

Streamflow is dependable generally, but low flows are small in much of the extreme southern part. A large number of lakes and reservoirs can supply adequate quantities of water for industrial and municipal uses, but they are located mainly in the sparsely populated northern half of the basin.

The quality of both ground and surface water in the basin is generally good except for hardness. About 73 percent of the ground water sampled has a hardness greater than 120 mg/l, and surface water ranges from soft in the north to very hard in the southwest. Ground water may be high in iron, and surface water commonly is colored. There is very little contamination of either the surface water or the ground-water reservoir.

Very little of the available water in the basin is withdrawn for man's use. Of the 20.3 inches of average annual precipitation on the basin, 8.0 inches or 735 billion gallons leaves the basin as streamflow. This runoff represents the yield of the basin that is theoretically available for use. Present withdrawal use is equivalent to only 1 percent of runoff; therefore, the area has great potential for future increases in water use.

SUMMARY OF WATER AVAILABILITY AND SUITABILITY FOR VARIOUS USES

Source	Surface water							Ground water					
	Mississippi River	Lower St. Croix River	Namakegon and upper St. Croix Rivers	Apple River	Yellow, Clam, and Wood Rivers	Kinnickinnic, Bush, and Willow Rivers	Lakes and reservoirs	Sand and gravel aquifer	Sandstone aquifer				
Use and criteria								Surficial deposits	Isolated buried deposits	Cambrian sandstones	Prairie du Chien Group	Prairie du Chien Group and Jordan Sandstone	St. Peter Sandstone
Municipal and industrial supplies Quantity—100,000 gpd (gallons per day) (about 1,000 population or a small industry) Quality—meet drinking water standards of U.S. Public Health Service (1962, p. 7). Special industrial criteria may exist. (Federal Water Pollution Control Administration, 1968)	Adequate discharge Good quality Water hard to very hard Pollution reported Treatment necessary	Adequate discharge Good quality Very little pollution Discharge regulated Colored Treatment required for domestic use	Adequate discharge Good quality Very little pollution Discharge regulated Colored Treatment required for domestic use	Adequate discharge Good quality Discharge regulated Colored Treatment required for domestic use	Good quality Very little pollution Discharge regulated Colored Treatment required for domestic use	Good quality Very little pollution Discharge regulated Colored Treatment required for domestic use	Adequate quantity in large lakes and reservoirs Good quality Easily polluted Colored water in drainage lakes and reservoirs Treatment required for domestic use	Large well yields Good quality Easily polluted Commonly high in iron	Good quality Not generally subject to pollution Adequate for small supplies Limited areal extent Commonly high in iron	Large well yields Not subject to pollution Locally artesian Limited to southern one-half of basin Deep wells necessary for large supplies Commonly high in iron	Good quality Adequate for small supplies Subject to pollution	Large well yields Good quality Very hard water Locally subject to pollution	Good quality Inadequate quantity Limited areal extent Very hard water
Rural domestic and stock supplies Quantity—5 gpm (gallons per minute) Quality—meet drinking water standards of U.S. Public Health Service (1962, p. 7)	Available only to riparian land Treatment necessary	Available only to riparian land Treatment required for domestic use	Available only to riparian land Treatment required for domestic use	Available only to riparian land Treatment required for domestic use	Available only to riparian land Treatment required for domestic use	Available only to riparian land Treatment required for domestic use	Limited to lake frontage Treatment required for domestic use	Good quality Easily polluted Commonly high in iron	Good quality Not generally subject to pollution Limited to southern one-half of basin Commonly high in iron	Good quality Locally subject to pollution	Good quality Deep water table Locally subject to pollution	Limited areal extent Locally subject to pollution	
Irrigation Quantity—1 ft (cubic feet per second) or 450 gpm per 40 to 60 acres	Adequate discharge Available only to riparian land	Adequate discharge Available only to riparian land	Adequate discharge Available only to riparian land	Adequate discharge Available only to riparian land	Adequate discharge Available only to riparian land	Adequate discharge Available only to riparian land	Adequate quantity in large lakes and reservoirs Available only to riparian land	Large well yields Adequate for small supplies Limited areal extent	Large well yields Limited to southern one-half of basin	Inadequate quantity Limited areal extent	Large well yields	Inadequate quantity Limited areal extent	
Recreation Attractive appearance Oder-free water Lack of pollution Reasonable access Adequate depth	Suitable for fishing, hunting, boating Public access at many sites Nearby constant pool levels behind dams	Suitable for fishing, hunting, boating Public access at many sites Very little pollution	Suitable for fishing, hunting, boating Public access at many sites Very little pollution	Suitable for fishing, hunting, boating Public access at many sites Very little pollution	Suitable for fishing, hunting, boating Public access at many sites Very little pollution	Suitable for fishing, hunting, boating Public access at many sites Very little pollution	Limited canoeing Shallow depths in summer Limited boating, hunting Fur fishing in Wood River	Shallow depths in summer Limited boating, hunting Fur fishing in Wood River	Shallow depths in summer Limited boating, hunting Fur fishing in Wood River	Shallow depths in summer Limited boating, hunting Fur fishing in Wood River	Shallow depths in summer Limited boating, hunting Fur fishing in Wood River	Shallow depths in summer Limited boating, hunting Fur fishing in Wood River	
Fish and wildlife habitat Adequate depth Permeability Less than 1,000 mg/l (milligrams per liter) dissolved solids Lack of pollution	Excellent wildlife habitat in marshes and sloughs Extensive variety of game fish Occasional floods Pollution reported	Excellent wildlife habitat in marshes and sloughs Extensive variety of game fish Very little pollution Occasional floods	Excellent wildlife habitat in associated wetlands and lakes Extensive variety of game fish Several reaches of trout streams Very little pollution Occasional floods	Excellent wildlife habitat in associated wetlands and lakes Extensive variety of game fish Several reaches of trout streams Very little pollution Occasional floods	Excellent wildlife habitat in associated wetlands and lakes Extensive variety of game fish Several reaches of trout streams Very little pollution Occasional floods	Excellent wildlife habitat in associated wetlands and lakes Extensive variety of game fish Several reaches of trout streams Very little pollution Occasional floods	Good wildlife habitat in associated wetlands and lakes Wetlands in Wood River basin Several reaches of trout streams Very little pollution Shallow depths	Excellent wildlife habitat in associated wetlands and lakes Easily polluted	Excellent wildlife habitat in associated wetlands and lakes Easily polluted	Excellent wildlife habitat in associated wetlands and lakes Easily polluted	Excellent wildlife habitat in associated wetlands and lakes Easily polluted	Excellent wildlife habitat in associated wetlands and lakes Easily polluted	

EXPLANATION

- ▲ Adequate discharge
- Water hard to very hard
- Treatment necessary
- Advantages for use
- Limitations for use
- General suitability for use
- ▲ Good
- Fair
- Poor

AGENCIES HAVING ADDITIONAL INFORMATION

Agency	Geology	Soils	Topography and drainage	Land use	Water budget	Ground-surface-water relationships	Surface water	Surface-water quality	Pollution	Ground water	Ground-water quality	Water use	Recreation and fish and wildlife
The Geological and Natural History Survey, University of Wisconsin—Extension 1815 University Avenue, Madison, Wis. 53706	x	x	x	x	x	x	x	x	x	x	x	x	x
U.S. Department of the Interior, Geological Survey, Water Resources Division 1815 University Avenue, Madison, Wis. 53706	x	x	x	x	x	x	x	x	x	x	x	x	x
Wisconsin Department of Natural Resources 4601 Hamersley Road, P.O. Box 4248, Madison, Wis. 53711	x	x	x	x	x	x	x	x	x	x	x	x	x
U.S. Department of the Army, Corps of Engineers, St. Paul District 1217 U.S. Post Office and Custom House, St. Paul, Minn. 55101	x	x	x	x	x	x	x	x	x	x	x	x	x
U.S. Environmental Protection Agency, Water Quality Office, (formerly Federal Water Quality Administration) 7401 Lyndale Avenue South, Minneapolis, Minn. 55423	x	x	x	x	x	x	x	x	x	x	x	x	x
Minnesota-St. Paul Sanitary District 3400 Chaska Road, St. Paul, Minn. 55106	x	x	x	x	x	x	x	x	x	x	x	x	x
Minnesota Pollution Control Agency 717 Delaware Street, St. Paul, Minn. 55440	x	x	x	x	x	x	x	x	x	x	x	x	x
Public Service Commission of Wisconsin 432 Hill Farm Station Office Building, Madison, Wis. 53702	x	x	x	x	x	x	x	x	x	x	x	x	x
Minnesota Department of Natural Resources Centennial Office Building, St. Paul, Minn. 55101	x	x	x	x	x	x	x	x	x	x	x	x	x
U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife 824 State Capitol, St. Paul, Minn. 55101	x	x	x	x	x	x	x	x	x	x	x	x	x
U.S. Department of the Interior, Bureau of Outdoor Recreation, Lake Central Region 2853 Research Park Drive, Ann Arbor, Mich. 48104	x	x	x	x	x	x	x	x	x	x	x	x	x
U.S. Department of the Interior, U.S. Fish and Wildlife Service 3600 Federal Building, Fort Snelling, Minn. 55111	x	x	x	x	x	x	x	x	x	x	x	x	x

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