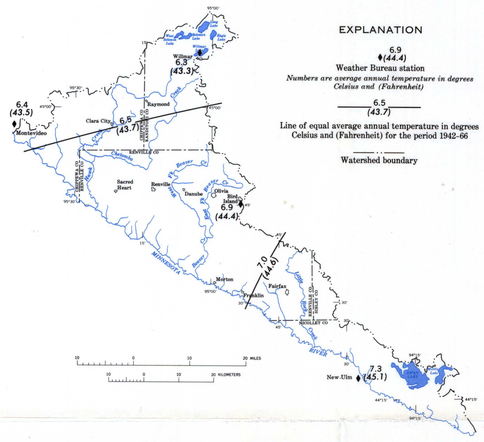
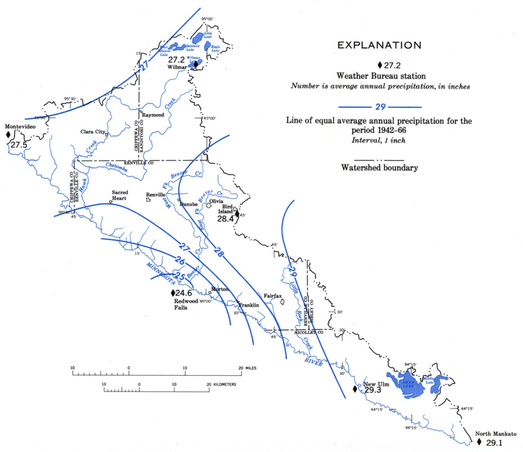
PREPARED IN COOPERATION WITH THE
MINNESOTA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATERS, SOILS, AND MINERALS

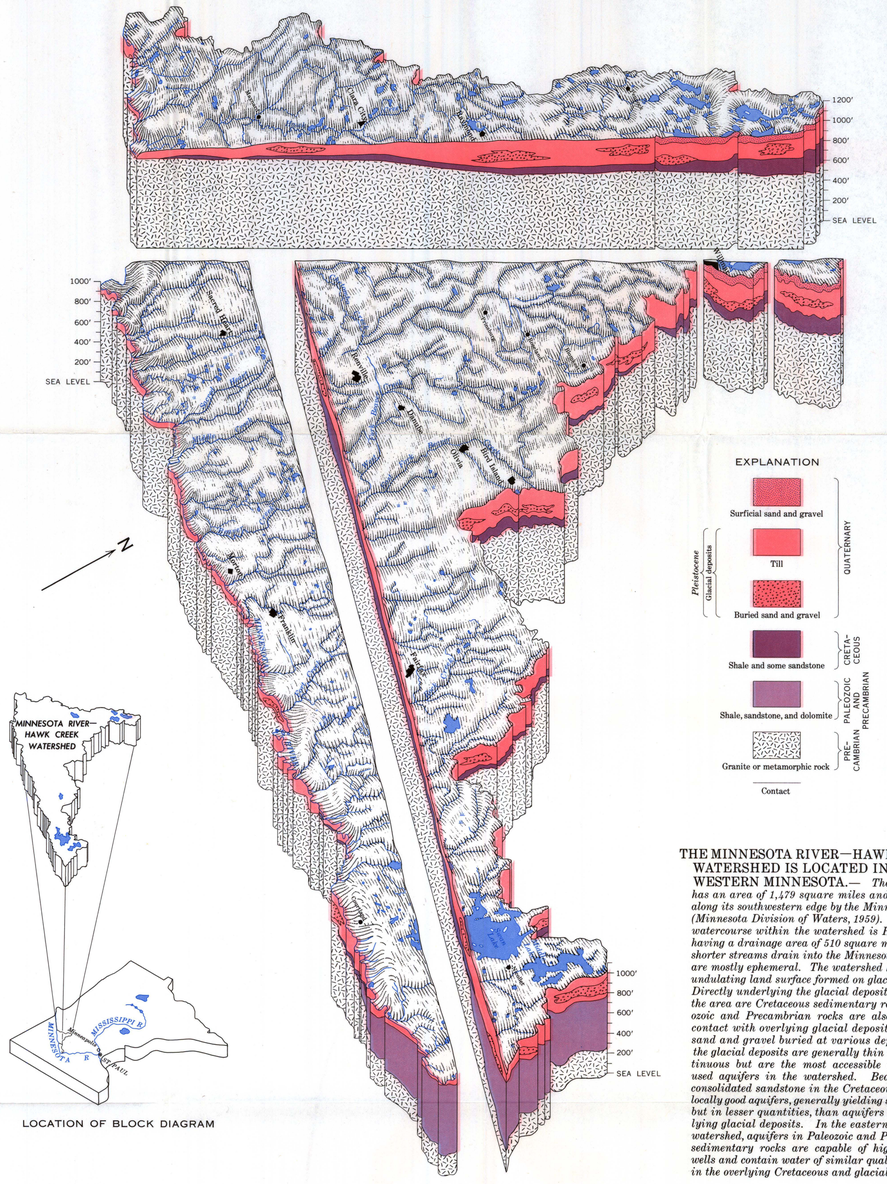
THE MINNESOTA RIVER—HAWK CREEK WATERSHED



AVERAGE ANNUAL TEMPERATURES ARE SLIGHTLY HIGHER IN THE SOUTHERN PART OF THE WATERSHED THAN IN THE NORTH.—*Temperatures range from about −40° C. (−40° F.) to about 43.3° C. (110° F.). Average January temperature is −11.2° C. (11.8° F.) and average July temperature is 22.5° C. (72.4° F.).*

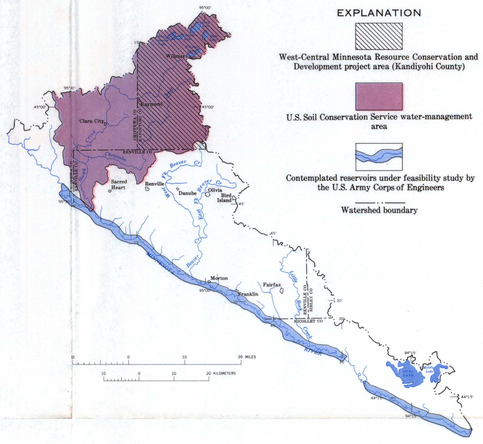


AVERAGE ANNUAL PRECIPITATION IS GREATEST IN THE EASTERN PART OF THE WATERSHED.—*More than three-fourths of the precipitation falls during the growing season (May through September). Average monthly precipitation varies from 0.62 inch in January to 4.53 inches in June.*

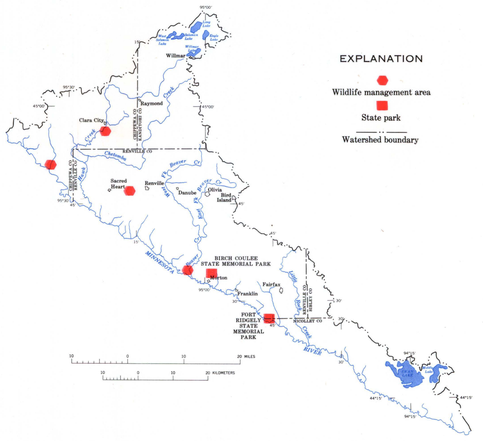


LOCATION OF BLOCK DIAGRAM

THE MINNESOTA RIVER—HAWK CREEK WATERSHED IS LOCATED IN SOUTHWESTERN MINNESOTA.— *The watershed has an area of 1,479 square miles and is drained along its southwestern edge by the Minnesota River (Minnesota Division of Waters, 1959). The major watercourse within the watershed is Hawk Creek, having a drainage area of 510 square miles. Other, shorter streams drain into the Minnesota River but are mostly ephemeral. The watershed has a gently undulating land surface formed on glacial deposits. Directly underlying the glacial deposits in most of the area are Cretaceous sedimentary rocks. Paleozoic and Precambrian rocks are also locally in contact with overlying glacial deposits. Beds of sand and gravel buried at various depths within the glacial deposits are generally thin and discontinuous but are the most accessible and widely used aquifers in the watershed. Beds of poorly consolidated sandstone in the Cretaceous rocks are locally good aquifers, generally yielding softer water, but in lesser quantities, than aquifers in the overlying glacial deposits. In the eastern part of the watershed, aquifers in Paleozoic and Precambrian sedimentary rocks are capable of high yields to wells and contain water of similar quality to water in the overlying Cretaceous and glacial deposits.*

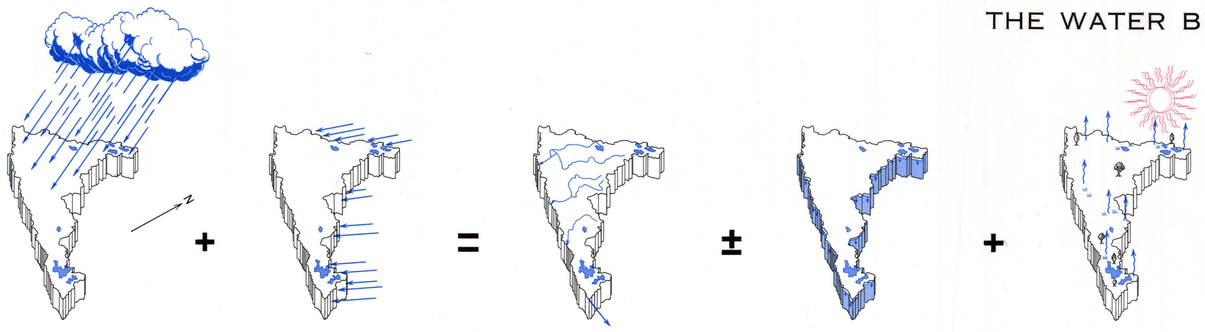


WATER MANAGEMENT PROJECT AND FEASIBILITY-STUDY AREAS INCLUDE KANDIYOHI COUNTY, THE HAWK CREEK DRAINAGE BASIN, AND THE VALLEY OF THE MINNESOTA RIVER.—*Research and construction projects in the watershed include the establishment of recreational areas utilizing water resources in Kandiyohi County, by the West-Central Minnesota Resource Conservation and Development Committee; channel straightening and diversion for flood control in the Hawk Creek drainage basin, by the U.S. Soil Conservation Service; and feasibility studies for flood control and recreation reservoirs along the Minnesota River, by the U.S. Army Corps of Engineers.*

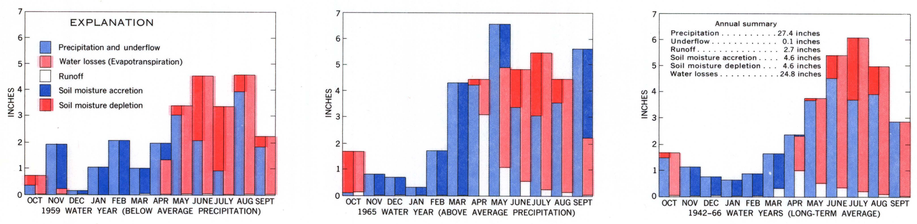


WATER RESOURCES ARE UTILIZED FOR RECREATIONAL PURPOSES IN LAKES, STATE PARKS, AND WILDLIFE MANAGEMENT AREAS.—*Most lakes have public access for fishing, boating, and swimming and provide habitat for waterfowl. State parks, located along watercourses, offer fishing for sportsmen and natural beauty for campers. Wildlife management areas are open to public hunting and serve as natural habitat for upland game, furbearers, and migrating waterfowl. The areas are generally marshy lowlands which act as storage for water which would otherwise be lost as runoff. Common improvements to lakes, state parks, and wildlife management areas include elimination of rough fish, stabilization of water levels, and encouragement of vegetal growth.*

THE WATER BUDGET



27.4″	0.1″	2.7″	0	24.8″
PRECIPITATION	UNDERFLOW	RUNOFF	CHANGE IN STORAGE	EVAPOTRANSPIRATION
Arithmetic mean using five Weather Bureau stations for 1942-66.	*Calculated using Darcy's Law and estimated values of hydraulic conductivity.*	*Average from gaging station records for 1942-66.*	*It is assumed that over the 25-year period, gains in ground-water, surface-water, and soil-moisture storage were balanced by losses.*	*Obtained by difference in the water budget.*



VARIATIONS IN RUNOFF AND SOIL MOISTURE ARE INFLUENCED BY VARIATIONS IN PRECIPITATION AND EVAPOTRANSPIRATION

Annual and long-term hydrologic budgets estimated by the Thornthwaite method (1957) are shown on the above graphs. In years of below average precipitation, such as 1959, below average runoff occurs and the demands of evapotranspiration deplete the soil moisture. In wet years, such as 1965, runoff is high and the demands of evapotranspiration are more nearly satisfied so an increase in soil moisture occurs. Over long periods of time, such as from 1942 to 1966, the hydrologic budget is assumed to balance so inflow is equal to outflow and there is no net change in soil moisture.

SUMMARY

SUMMARY OF MUNICIPAL SUPPLIES

ALL MUNICIPAL SUPPLIES ARE FROM GROUND WATER.—*Most municipalities would have little trouble increasing supplies by drilling additional wells. Where relatively soft water is available in sufficient quantity in the Cretaceous sedimentary rocks, municipalities do not choose to utilize aquifers in the overlying glacial deposits. Waters used by almost all municipalities exceed the U.S. Public Health Service recommended limits for iron and manganese concentrations of 0.3 and 0.05 milligrams per liter, respectively.*

Municipality	Wells (1968) In use	Wells (1968) Standby	Depth (feet)	Diameter (inches)	Date drilled	Aquifer	Average withdrawal (gallons per day)	Usual pumping rate (gallons per minute)	Drawdown at usual pumping rate (feet)	Specific capacity (gallons per minute per foot of drawdown)	Available drawdown (feet from static water level to top of screen (feet))	Hardness (milligrams per liter)	Iron content (milligrams per liter)	Remarks	Potential additional supplies
Bird Island	3		354	10	1941	Buried sand and gravel.	100,000							Wells penetrate basement rock, but most water is from sand and gravel at base of glacial drift.	Withdrawals from the aquifer can be increased. Other buried sand and gravel aquifers are common in the area.
			498	16	1944	Buried sand and gravel.		75	52	1.4					
			278	8	1957	Buried sand and gravel.		150	45	3.3	120	390	2.4		
Blomkest	1		309	8	1968	Sandstone					220	290			Buried sand and gravel aquifers are common in the area.
Clara City	2		138	12	1951	Buried sand and gravel.	60,000	290	55	5.3	110	340	1.7	Main aquifer is near the base of the glacial drift.	Withdrawals from the aquifer can be increased. Other buried sand and gravel aquifers are common in the area.
			122	12	1957	Buried sand and gravel.		150	27	5.5	90	480	1.8		
		1	138	18	1961	Buried sand and gravel.		290	55	5.3	105	340	1.7		
Courtland	1						20,000	65				390	1.6		Potential for ground-water supplies is poor but surface water can be obtained from the Minnesota River, about 1 mile from Courtland.
Danube	1		260	8	1928	Sandstone	20,000	50	33	1.5	245	170	.38	Sandstone directly underlies the glacial drift.	Withdrawals from the sandstone aquifer can be increased. Shallower aquifers in the glacial drift are also common but contain harder water.
		1	220	4	1956	Sandstone						110	.29		
Fairfax	2		200	8			100,000	185	40	4.6	155	760	3.9	Aquifer is either sandstone or decomposed granite.	Withdrawals from the aquifer can be increased. Aquifers in the glacial drift are also common and may contain softer water.
			200	10				185	40	4.6	155	760	5.3		
Franklin	2		161	8	1953	Decomposed granite.		100	42	2.4	100	460	.52	Decomposed granite directly underlies the glacial drift.	Sand and gravel beds, 5 to 15 feet thick, are present at the base of the glacial drift. Surface water is available from the Minnesota River, about 1½ miles from Franklin.
			160	8	1961	Decomposed granite.		120	42	2.9	100	470	3.5		
Maynard	2		87	8	1948	Buried sand and gravel.		78	12	6.5	70	870	7.1		Withdrawals from the aquifer can be increased.
			78	8	1951	Buried sand and gravel.		65	16	4.0	50	870	4.0		
Morton	2		47	8	1964	Fractured granite.		75	13	5.8	30	570	3.7	Granite directly underlies the glacial drift.	Withdrawals from the aquifer can be increased. Surface water can be obtained from the Minnesota River, about ½ mile from Morton.
			48	10	1964	Fractured granite.		85	9	9.4	30	620	3.2		
Nicollet	2		410	8	1925	Sandstone						520	2.0	Sandstone is the Dresbach Formation. Glacial drift is about 260 feet thick.	Sandstone aquifers are thick and continuous in the area. Withdrawals from the glacial-drift aquifer can be increased.
			212	12	1967	Buried sand and gravel.		400	7	57.1	239				
Olivia	1		230	12	1964	Buried sand and gravel.									Buried sand and gravel aquifers are common near the base of the glacial drift.
Pennock	2		116	10	1949	Buried sand and gravel.	40,000	100				440	3.9		Buried sand and gravel aquifers are common. Sandstone aquifers reportedly yield soft water to farm wells in the area.
			75	10	1958	Buried sand and gravel.		100				380	1.6		
Prinsburg	2		324			Sandstone					216	34	.59	Sandstone aquifer is 23 feet thick. Nonpumping water levels have dropped about 33 feet in 11-year period (1957-68).	Additional supplies can probably be found in the glacial drift although the water may be very hard.
			318	10	1957	Sandstone		35			219	28	.15		
Raymond	1		204	8	1951	Buried sand and gravel.	75,000		95		160	190	2.4		Sandstone may be present at greater depth. Surface water can be obtained from nearby Lone Tree Lake.
Renville	2		260	10		Buried sand and gravel.		150				340	.66	Aquifer is at base of the glacial drift.	The basal aquifer has good areal extent. Sandstone aquifers are reportedly absent.
			259	12	1962	Buried sand and gravel.		150				350	.49		
Roseland	1		287			Buried sand and gravel.		30			250	92	.42		Additional supplies can probably be obtained from other buried sand and gravel aquifers.
Sacred Heart	2		173	10	1961	Buried sand and gravel.	40,000	100	14	7.1	80	490	.28		Withdrawals from the aquifer can be increased. Additional supplies can probably be obtained from buried sand and gravel aquifers.
			186	12	1965	Buried sand and gravel.		150	20	7.5	90				
Willmar	6		302	12	1948	Buried sand and gravel.	1,750,000	300	58	5.2	220	425	1.0	Deep wells (greater than 300 feet) are finished at base of the glacial drift.	Two buried sand and gravel aquifers were located near the NE corner of Willmar in 1968. One aquifer, 255-275 feet below land surface, has a transmissivity of 55,000 gpd per foot and a storage coefficient of 0.003; the other aquifer, 317-337 feet below land surface, has a transmissivity of 150,000 gpd per foot and a storage coefficient of 0.002. Surface water can be obtained from nearby Foot Lake and Willmar Lake.
			350	12	1957	Buried sand and gravel.		125	96	1.3	245	493	2.5		
			131	16	1957	Buried sand and gravel.		300	44	6.8	55	425	2.1		
			155	16	1958	Buried sand and gravel.		300	49	6.1	95	425	2.2		
			349	10	1961	Buried sand and gravel.		300	21	14.3	295	440	2.0		
			200	12	1966	Buried sand and gravel.		575	13	44.2	130	450	1.1		
		2	311	10	1924	Buried sand and gravel.					240				
			302	12	1936	Buried sand and gravel.		300			230	430	1.5		

SUMMARY OF WATER RESOURCES

THE SUITABILITY OF WATER FROM A PARTICULAR SOURCE DEPENDS UPON THE INTENDED USE.—*Factors contributing to the desirability of certain waters include the quantity available, the accessibility of the source, and the physical and chemical characteristics of the water.*

Use and criteria \ Source	SURFACE WATER: Minnesota River	SURFACE WATER: Minnesota River tributaries	SURFACE WATER: Lakes and sloughs	GROUND WATER: Quaternary sand and gravel	GROUND WATER: Cretaceous sandstone	GROUND WATER: Paleozoic and Precambrian sandstone	GROUND WATER: Weathered Precambrian crystalline rocks
Municipal and industrial supplies 1. 0.5 cubic foot per second or 225 gallons per minute per well 2. less than 1000 milligrams per liter total dissolved solids 3. less than 0.3 milligram per liter iron 4. less than 500 milligrams per liter total hardness	Adequate supply Storage sites available Location favorable for some communities ——— Not widely distributed Storage necessary Treatment necessary Low flows in some reaches	Adequate supply for limited use ——— Not widely distributed Treatment necessary Few storage sites available Shorter streams mostly ephemeral	Adequate supply from some lakes for limited use ——— Not widely distributed Treatment necessary Insufficient storage capacity Shallow lakes and sloughs dry up during drought years	Adequate yields can be obtained Widely distributed ——— Treatment is necessary Recharge may be limited Water is very hard Must be located by test drilling	Water may be soft, particularly in the western part of the watershed ——— Generally inadequate yields Treatment is generally necessary Recharge is limited	Adequate yields can be obtained ——— Not widely distributed Treatment may be necessary	——— Insufficient yields Inadequate recharge
Rural domestic and stock supply 1. 5 gallons per minute 2. less than 1000 milligrams per liter total dissolved solids	Suitable for stock ——— Treatment necessary for domestic use Not widely distributed	Suitable for stock ——— Not widely distributed Treatment necessary for domestic use	Suitable for stock ——— Not widely distributed Treatment necessary for domestic use Shallow lakes and sloughs dry up during drought years	Adequate yields can be obtained Widely distributed Recharge is sufficient ——— Water is very hard	Generally adequate yields Water may be soft ——— Depth to aquifer may be great	Adequate yields ——— Not widely distributed	——— Yields may be inadequate Recharge may be inadequate
Irrigation 1. 0.5 cubic foot per second or 225 gallons per minute per well 2. less than 700 milligrams per liter total dissolved solids 3. percent sodium less than 60 4. less than 0.5 milligram per liter boron	Adequate supply Quality suitable Storage sites available ——— Storage necessary during low flow periods Not widely distributed	Adequate supply for limited use Quality suitable ——— Not widely distributed Storage necessary	Adequate supply for limited use from some lakes Quality suitable ——— Not widely distributed Shallow lakes and sloughs dry up during drought years	Adequate yields can be obtained Widely distributed Generally suitable quality ——— Must be located by test drilling Recharge may be limited	——— Insufficient yields	Adequate yields can be obtained Generally suitable quality ——— Not widely distributed	——— Insufficient yields Inadequate recharge
Recreation 1. attractive appearance 2. odor-free water 3. lack of pollution	Suitable for hunting and fishing Location favorable Suitable quality ——— Wide variation in stage and discharge	Suitable for hunting and fishing Location favorable Suitable quality ——— Wide variation in stage and discharge	Some lakes suitable for water sports Suitable for hunting and trapping ——— Most are shallow Not widely distributed				
Fish and wildlife habitat 1. adequate depth 2. permanence 3. suitable quality	Suitable for wildlife along banks Suitable for fish ——— Wide variation in stage and discharge	Suitable for wildlife along banks ——— Wide variation in stage and discharge	Suitable for fur-bearing animals and waterfowl Some suitable for fish ——— Most are shallow Frequent winterkill Wide variation in levels				

EXPLANATION

Generally adequate yields
Water may be soft
———
Depth to aquifer may be great

Desirable features above the line
———
Undesirable features below the line

Good | Fair | Poor

Color denotes relative worth of water source over the entire watershed

CONCLUSIONS

1. The average annual precipitation is about 28 inches, of which about 25 inches returns to the atmosphere through evaporation and transpiration. Average annual runoff is about 3 inches, most of which occurs during the spring and early summer months.
2. The most accessible and widely used aquifers in the watershed are beds of sand and gravel buried in glacial deposits. The aquifers occur over almost the entire area and furnish adequate supplies for most stock and domestic uses. Sufficient yields for municipal and irrigation purposes can generally be found by test drilling.
3. Cretaceous sedimentary rocks beneath the glacial deposits include sandstone beds which supply water to many wells, particularly in the western part of the watershed. Yields are generally less than those available from the overlying glacial deposits.
4. Ground-water quality varies vertically and laterally. In the western part of the watershed, the softest, least mineralized water is obtained from the deepest wells. In the eastern part of the watershed, shallow wells obtain the most desirable water. Most ground water exceeds State and Federal recommended drinking water standards for iron and manganese and treatment is necessary for municipal use.
5. Streamflow in the watershed is intermittent. All tributaries of the Minnesota River in the watershed experience periods of no flow. Most of the increase in discharge in the Minnesota River between Montevideo and Mankato is from major tributaries south of the watershed.
6. Surface water presently is not used for public supply. Lakes and wetlands are not widely distributed but are excellent for wildlife propagation and public hunting.
7. Surface water is chemically suitable for most agricultural uses but may need treatment to meet municipal and industrial requirements.

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WATER RESOURCES OF THE MINNESOTA RIVER—HAWK CREEK WATERSHED, SOUTHWESTERN MINNESOTA

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