ESTIMATED USE OF WATER IN NORTH DAKOTA IN 1985 AND TRENDS DURING 1960–85

By Edwin A. Wesolowski

U.S. GEOLOGICAL SURVEY
WATER-RESOURCES INVESTIGATIONS REPORT 89–4003
Prepared by
U.S. Department of the Interior
U.S. Geological Survey
In cooperation with
North Dakota State Water Commission

INTRODUCTION

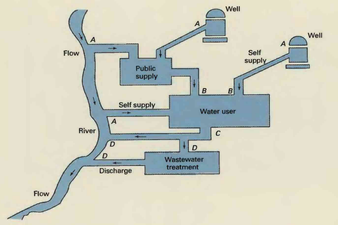
Estimates of water use in North Dakota have been compiled by the U.S. Geological Survey every 5 years since 1950. These estimates have been published in national summaries of water use (MacKichan, 1951, 1957; MacKichan and Kammerer, 1961; Murray, 1968; Murray and Reeves, 1972, 1977; and Solley and others, 1983, 1987). In this report, estimates of offstream water use for 1985 and trends in water use in 5-year increments from 1960 through 1985 are presented for the following categories of use:

- Public supply
- Domestic and commercial
- Industrial and mining
- Thermoelectric power
- Agricultural (irrigation and nonirrigation)

Estimates for instream water uses such as recreation and hydroelectric power generation, which used about 12,700 Mgal/d (million gallons per day) in 1985, are not included in this report.

Offstream water use is water that is withdrawn or diverted from a ground- or surface-water source for use by public supply, domestic and commercial, agricultural, industrial and mining, and thermoelectric power generation. To determine the amount of water used, three factors are involved as explained below and shown in the diagram.

1. Withdrawals—the amount of water withdrawn or diverted from a ground- or surface-water source ("*A*" in diagram).
2. Delivery/release—the amount of water delivered at the point of use ("*B*") (self supply or public supply) and the amount released after use ("*C*"). The difference between these amounts is consumptive water use.
3. Return flow—the amount of water that reaches a ground- or surface-water source ("*D*") after release from the point of use or treatment and thus becomes available for immediate reuse.



Withdrawal estimates for 1985 as presented here are summarized as average daily quantities withdrawn. The average is derived from annual withdrawal estimates and is reported in million gallons per day.

The North Dakota State Water Commission (NDSWC) began collecting water-use information in 1965 to better manage and develop the State's water resources. Water-use information is obtained from water-permit applications and from annual inventories of water withdrawals. In 1977 the NDSWC joined in a cooperative program with the U.S. Geological Survey (USGS) to establish a National Water-Use Information Program (NWUIP) to complement the USGS's data on the availability and quality of the nation's water resources. To help meet NWUIP's goals, a computer program, the State Water Use Data System (SWUDS), was developed. The purpose of SWUDS is to store locally collected, site-specific data, and aggregate the data to produce county and river basin summaries of water use to meet national needs. These data are the basis for the water-use information presented in this report.

WATER SUPPLY

North Dakota is a rural and agricultural State. Almost one-third of the population—total 1985 population was 688 thousand people (R.W. Rathage, Department of Agricultural Economics, North Dakota State University, written commun., 1986)—lives on farms or ranches, and more than 80 percent of the communities have populations of less than 1,000.

North Dakota has an abundant supply of water, both in surface-water sources and ground-water sources. Distribution systems to move the water from its source to potential users are not fully developed in all parts of the State.

The Missouri River is the most substantial source of surface water in the State; flowing diagonally across the southwestern one-third of the State, its mean annual flow accounts for more than 80 percent of the total measured mean annual streamflow in the State (Winter and others, 1984). Lake Sakakawea, on the Missouri River, stores more than 97 percent [18.3 million acre-feet (acre-ft)] of the total usable reservoir storage of all the larger reservoirs (larger than 5,000 acre-ft) in the State (U.S. Army Corps of Engineers, 1981). The Red River of the North, which flows northward into Canada and forms the North Dakota-Minnesota boundary, is the next most substantial source of surface water in the State.

Dependable water supply from surface water without storage is available only from the mainstream of the Missouri River and from the lower Red River of the North below the confluence of the Red Lake River, which is located in Minnesota. Due to the State's semiarid climate and variable runoff, a dependable water supply is not available from the remaining smaller rivers in the State unless storage is provided. Surface water is an important source of supply for all categories of water use, especially public supply for most larger cities; however, thermoelectric power generation is the primary user. For a more detailed discussion of the State's surface-water resource, see Winter and others, 1984.

North Dakota has ground water available from unconsolidated and consolidated aquifers. Unconsolidated aquifers are associated with the glacial drift, which overlies the bedrock throughout most of the State north and east of the Missouri River. The consolidated aquifers are associated with several layers of extensive deposits of water-bearing sedimentary bedrock, which underlies the State.

Major unconsolidated aquifers in parts of central, northern, and eastern North Dakota are the most substantial sources of shallow ground water; together these aquifers contain about 60 million acre-ft of water (North Dakota State Water Commission, 1982). Unconsolidated aquifers are an important supply of water for all categories of water use; however, irrigation is the primary user. Away from the major aquifer areas, water is available from minor unconsolidated aquifers but in small quantities. These minor aquifers consist of thin isolated beds of sand and gravel that seem to have a random distribution. Although these minor aquifers are not very productive, they are an important source of supply for domestic and livestock use.

Wells developed in the consolidated aquifers as a source of water supply are scattered through the State, but the majority of them are located in the southwestern corner of the State. The southwestern corner of the State was not glaciated and, excluding surface water, water from consolidated aquifers is the only supply available. Collectively, these aquifers have the potential as a major source of water; however, the quality is not desirable for domestic use and the more prolific aquifers are far below the land surface.

Unconsolidated aquifers and shallower consolidated aquifers are an important source of water for farms, ranches, and smaller cities. Almost 63 percent of the population uses ground water as their source of supply for domestic use. For a more detailed discussion of the State's ground-water resources see Winter and others, 1984.

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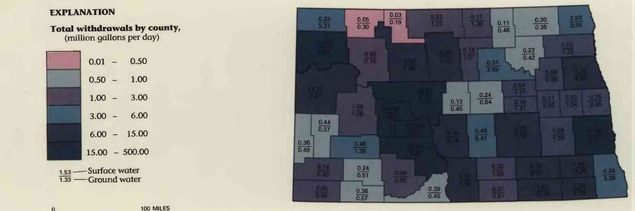
ESTIMATED USE OF WATER, 1985

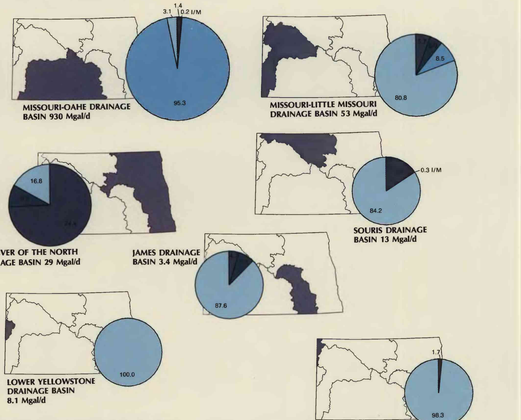
All numbers have been rounded and values may not add to totals because of this rounding. Percentages are rounded to the nearest tenth of a percent (0.1 percent) in the interval between 0.1 and 99.9 percent. [Source: Data from U.S. Geological Survey National Water-Data Storage And Retrieval System (WATSTORE).]

Total withdrawals by county



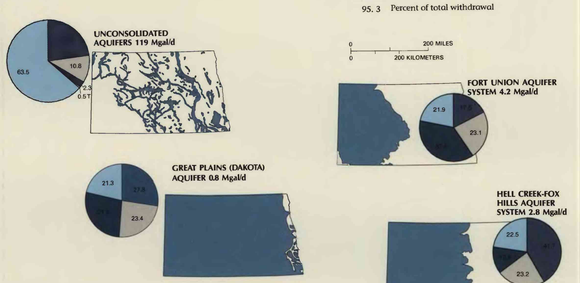
- Surface-water withdrawals exceeded ground-water withdrawals in 19 counties.
- Ground-water withdrawals exceeded surface-water withdrawals in 33 counties.
- Surface- and ground-water withdrawals were equal in one county.
- Withdrawals by Mercer and Oliver Counties by far exceeded withdrawals in other counties—459 and 398 Mgal/d, respectively, in 1985.
- Withdrawals by Morton, Williams, and Cass Counties are the next largest withdrawals—52, 43, and 18 Mgal/d, respectively, in 1985.
- Withdrawals by county ranged from 0.22 Mgal/d to 459 Mgal/d.
- Withdrawals by county averaged about 22 Mgal/d.

Surface-water withdrawals by water-resources subregion



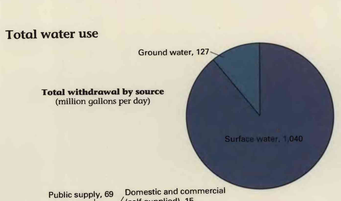
- North Dakota has parts of seven water-resources subregions (major natural drainage basins) within its State boundaries.
- The largest withdrawals were in the Missouri-Oahe River basin, of which 95.3 percent of the water was used for thermoelectric power generation.
- The second largest withdrawals were in the Missouri-Little Missouri River basin, of which 80.8 percent of the water was used for agricultural use.
- The third largest withdrawals were in the Red River of the North basin where 43.5 percent of the State's population is concentrated; 74.4 percent of the water was used for public-water supplies.
- The largest withdrawals for the four remaining river basins were for agricultural use.

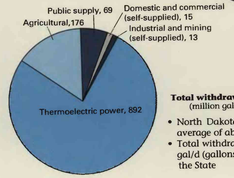
Ground-water withdrawals by aquifer



- Unconsolidated aquifers provided almost 94 percent of the total ground-water withdrawals, of which the primary user is agricultural.
- Consolidated aquifers generally are developed in the southwestern one-quarter of the State and are used almost equally for agricultural, public-water supply, domestic, and industrial and mining purposes.

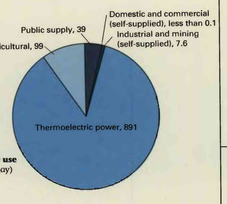
Total water use

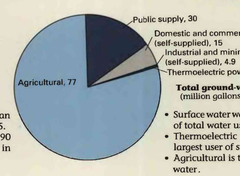




Total withdrawal by category (million gallons per day)

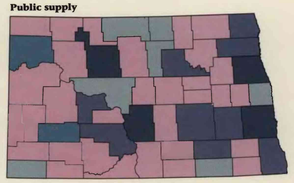
- North Dakota water users withdrew an average of about 1,170 Mgal/d in 1985.
- Total withdrawals averaged about 1,690 gal/d (gallons per day) for each person in the State

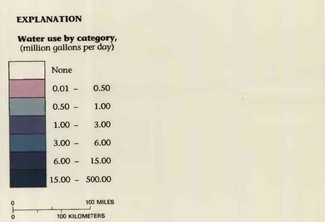




- Surface water was the source of 89 percent of total water used.
- Thermoelectric power generation is the largest user of surface water.
- Agricultural is the largest user of ground water.

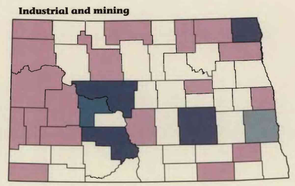
Water use by category





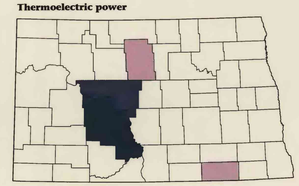
Public supply is treated as a source and user of water. Public supply serves to transfer water from a surface- or ground-water source for domestic and commercial and industrial and mining users. Public supply includes 19 rural water systems that serve 10 percent of the population.

- Public supplies served about 512,000 people in 1985, about 74 percent of the population of the State.
- More than 100 small communities get all or part of their water supply from rural water systems.
- Withdrawals for public supply were estimated to be 69 Mgal/d.
- Surface water accounted for 56.7 percent of the withdrawals.
- Surface water and ground water served almost an equal percentage of the population.
- Burleigh, Cass, Grand Forks, and Ward Counties, the four most populated counties, withdrew most water for public supply.
- Ward County was the largest user of ground water for public supply.



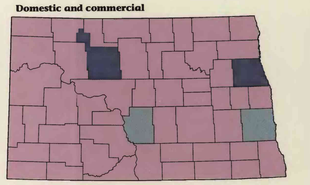
Industrial water users receive water from both public-supply and self-supplied facilities. Industry includes coal gasification, sugar refining, oil refining, and malt processing. Mining activities are coal and gravel excavation and oil and gas extraction.

- Industrial and mining water withdrawals amounted to 15 Mgal/d.
- Self-supplied systems provided about 13 Mgal/d or 84.6 percent.
- Surface-water sources provided 76 percent of the self-supplied water for industrial use.
- Ground-water sources provided 76 percent of the self-supplied water for mining use.
- Fifty-six percent of the withdrawals for mining were in two adjacent counties—McLean and Mercer—where coal mining is common.



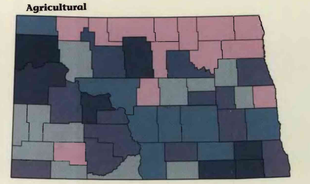
The State has 11 active thermoelectric power-generating plants. Five of these were built and became operational since 1979 in response to increased energy demands. Power production almost doubled from 1979 to 1985.

- Thermoelectric power-generating facilities used 892 Mgal/d for cooling purposes, which amounts to 76.6 percent of all withdrawals in North Dakota.
- Only 2.6 percent of the water withdrawn is consumed.
- Almost all of the water withdrawn is from surface-water sources, primarily the Missouri River and Lake Sakakawea.
- Mercer and Oliver Counties have the largest thermoelectric power withdrawals, followed by Morton and McLean Counties.



Domestic and commercial water users receive water from both public-supply and self-supplied facilities. Domestic withdrawals are used for normal household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. Commercial withdrawals are used by larger apartment buildings, motels, hotels, restaurants, office buildings, commercial facilities, and institutions, both civilian and military.

- Self-supplied domestic facilities (wells) served about 175,000 people in rural areas.
- Withdrawals by domestic and commercial water users from both public-supplied and self-supplied facilities were about 82 Mgal/d, which includes about 13 Mgal/d for public purposes such as street cleaning, etc., and delivery losses.
- Per capita use by domestic users was about 80 gal/d.
- Domestic use was about 54 Mgal/d, of which about 40 Mgal/d was from public-supply systems and about 15 Mgal/d was self supplied.
- Domestic consumptive use was about 18 Mgal/d.
- Commercial use was about 14 Mgal/d; almost entirely provided by public supply.
- Commercial consumptive use was about 2 Mgal/d.



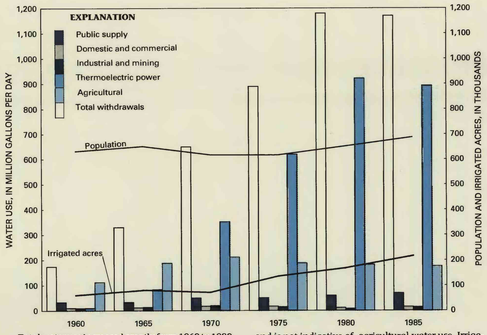
Agricultural water use consists of irrigation and nonirrigation withdrawals. Irrigation withdrawals are used to raise crops and to maintain recreational lands, such as parks and golf courses. About 204,000 acres were irrigated during 1985, of which corn was the most irrigated crop followed by pasture/hay crops. Conveyance losses for irrigation were more than 8 Mgal/d. Nonirrigation withdrawals are used for livestock watering and other farm purposes.

- Agricultural withdrawals amounted to 176 Mgal/d.
- Consumptive use was 146 Mgal/d.
- Irrigation withdrawals comprised 87.4 percent of the total agricultural withdrawals.
- Surface water was the source of 58 percent of the water used for irrigation.
- Ground water was the source of 60 percent of the water used for nonirrigation purposes.
- Seventy-five percent of irrigation using surface-water sources occurred in four counties—Williams, Mercer, McKenzie, and McHenry.
- Use of ground-water sources for irrigation is most common in the south-central and southeastern counties of the State.

TRENDS IN WATER USE, 1960–85 (5-YEAR INCREMENTS)

Year	1960	1965	1970	1975	1980	1985
Population (thousands)	632	652	618	617	652	688
	Estimated water use (million gallons per day)					
Withdrawal use:						
Total withdrawals	174	330	650	889	[1]1,180	1,170
Public supply	33	33	50	50	59	69
Domestic and commercial (self-supplied)	10	12	17	17	11	15
Industrial and mining (self-supplied)	9	13	19	14	7	13
Thermoelectric power	10	84	352	620	921	892
Agricultural	112	188	212	188	[1]182	176
Source of withdrawals:						
Surface water	133	276	558	782	[1]1,060	1,040
Ground water	42	54	92	107	119	127
Consumptive use:	110	171	198	241	334	201

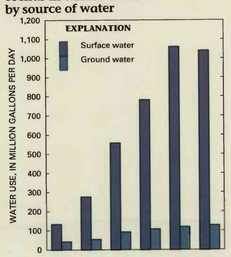
[1]Reduced from estimated use report by Solley and others (1983), which includes about 114 Mgal/d of surface water withdrawn from the Yellowstone River in Montana and delivered to North Dakota.



Total water use increased greatly from 1960 to 1980, but decreased slightly from 1980 to 1985. After 1965, thermoelectric power use increases parallel total withdrawal increases; public-supply use has increased steadily, but at a lower rate than population; domestic and commercial use and industrial and mining use have remained fairly constant.

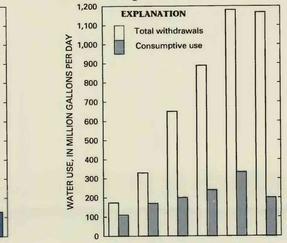
The agricultural trend is distorted by two surface-water irrigation projects in the western part of the State, and is not indicative of agricultural water use. Irrigation-water-use trend is more realistically represented by the irrigated-acres trend. The number of acres irrigated have increased more than two and one half times from 1970–85. Prior to 1970, most irrigation development used surface water and after 1970 ground water was the primary source.

Trends in withdrawals by source of water



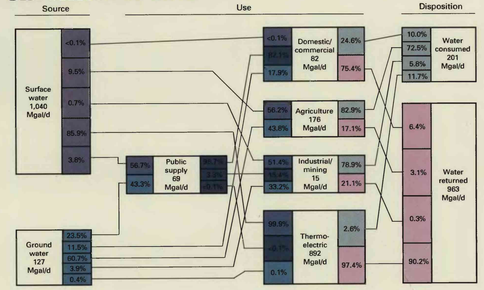
- Surface-water and ground-water withdrawals increased each 5th year except 1985 when surface-water withdrawals decreased.
- Surface-water withdrawals in 1985 are almost eight times greater than the withdrawals in 1960.
- Ground-water withdrawals in 1985 are more than two times greater than the withdrawals in 1960.

Trends in withdrawals and consumptive use



- Consumptive use of water has increased steadily from 1960 to 1980.
- Consumptive use as a percentage of total withdrawals has declined steadily for each 5th year from 1960 to 1985.

SUMMARY OF SOURCE AND USE OF WATER AND DISPOSITION OF WATER



Withdrawal, use, and disposition of an estimated 1,170 Mgal/d of freshwater occurred in North Dakota in 1985. Conveyance losses in public-supply distribution systems and some public-water uses, such as fire fighting, are included in the total shown for domestic and commercial use; losses in irrigation distribution systems are included in the total for agricultural water returned.