

Water-Use Program

The North Carolina Water-Use Program is part of the National Water-Use Information Program operated by the U.S. Geological Survey (USGS). The National Water-Use Information Program is a cooperative program with State and local governments designed to collect and disseminate water-use information to a wide variety of government agencies and private organizations.

The program was initiated in 1978 to address the need for a single source of uniform information on water use and to serve as a focal point for water-use information. The Water-Use Program is financed through the Federal-State Cooperative Program of the USGS with matching funds to support water-use information activities throughout the 50 States and Puerto Rico.

The North Carolina Water-Use Program was developed in 1979 in cooperation with the North Carolina Department of Environment, Health, and Natural Resources (DEHNR). Through this program, a computerized data base of principal water users in the State has been maintained and updated periodically since 1980. Since 1950, the USGS has compiled and published water-use estimates every 5 years. For example, 1990 data are in the USGS Circular 1081, "Estimated Use of Water in the United States in 1990," which summarizes State water-use estimates.

Estimated Water Use

Estimated water use for North Carolina for 1995 is presented in this report. Data were compiled from a combination of Federal, State, local, and private sources. Where metered data were not available, estimated values were used. Water-use values are expressed in the text as whole numbers and percentages appear as integers. These values may not add to totals because of rounding. Compilation methods and standards can be found in the document titled "Guidelines for Preparing U.S. Geological Survey Water-

Use Estimates for the United States for 1995" (Crompton and Solley, 1995). The categories include public supply, domestic and commercial, industrial and mining, thermo- and hydroelectric power generation, and irrigation and livestock.

Physiographic Setting

North Carolina has a mild, humid climate and ranks sixth in the Nation in average annual precipitation (49.3 inches). In 1995, the State experienced higher-than-normal precipitation totaling 54.9 inches (National Atmospheric and Oceanic Administration, 1996). A water-budget study in eastern North Carolina indicated that as much as 61 percent of the annual precipitation is returned to the atmosphere by evapotranspiration, and about 39 percent recharges the ground- and surface-water systems (Winner and Simmons, 1977).

The physiography of North Carolina is diverse. The State has three physiographic provinces—the Blue Ridge in the west, the Piedmont in the central part of the State, and the Coastal Plain in the east (fig. 1). The Blue Ridge consists of mountainous terrain giving way to the gently sloping, hilly terrain of the Piedmont. The Coastal Plain is flat and low-lying with little topographic relief. Streams and rivers along the eastern slope of the Blue Ridge flow to the Atlantic Ocean, and streams and rivers along the western slope flow to the Ohio and

Tennessee River Basins in adjacent States. The division between the western and eastern watersheds of the Blue Ridge is known as the Tennessee Valley Divide (fig. 1).

Water Supply and Use

North Carolina has abundant water resources. However in some areas, water supplies are not always adequate during certain times to meet local demand. In recent years, rapid growth in population, urbanization, and industry has resulted in an increasing demand for North Carolina's water resources. In 1995, the population of North Carolina was about 7.2 million (U.S. Bureau of the Census, 1996), an increase of 8 percent since 1990. Demands for water are increasing from domestic, commercial, industrial, mining, irrigation, and other sectors. Surface water is the primary source of water for the Blue Ridge and Piedmont Provinces, whereas ground water is the primary source of water for the Coastal Plain Province.

In 1995, about 7,730 million gallons per day (Mgal/d) of freshwater was withdrawn from rivers, streams, and aquifers (fig. 2). Of that quantity, 6,912 Mgal/d (89 percent) was returned to the hydrologic system, 105 Mgal/d was lost or unaccounted for by public supply systems, and the remaining 713 Mgal/d (9 percent) was consumed. Consumptive use is defined as the water that is



Figure 1.--Major cities and physiographic provinces of North Carolina.

evaporated, transpired, incorporated into products or crops, consumed by people or livestock, or otherwise removed from the immediate water environment. Consumptive use is shown for each category in figure 2. Of the total withdrawals, 93 percent (7,197 Mgal/d) was from surface water, and the remaining 7 percent (533 Mgal/d) was withdrawn from ground water.

Total freshwater withdrawals in 1995, by county, are shown in figure 3. The counties with the largest total withdrawals (fig. 3A) generally have thermoelectric power plants or large populations. The largest thermoelectric withdrawals occur in Mecklenburg, Stokes, Catawba, and Person Counties, where the demand for water for cooling is greatest. Excluding freshwater withdrawals for thermoelectric power, surface-water withdrawals accounted for 72 percent of the total withdrawals. Large withdrawals in Charlotte, Greensboro, Winston-Salem, and in the Raleigh-Durham area accounted for 22 percent of the total withdrawals, excluding thermoelectric water use, and reflect the larger populations and concentrations of industrial activity in the State.

Saline water is not extensively used to meet potable water demands because of the cost of desalinization. However, about 1,553 Mgal/d was withdrawn from North Carolina's coastal waters for cooling.

Public Supply

In 1995, public suppliers delivered water to 4.7 million people in North Carolina. Public-supply systems withdraw, treat, and deliver water to customers. The 1995 per capita use for public supply, including domestic, commercial, and industrial deliveries is estimated to be 70 gallons per day (gal/d). Of the 767 Mgal/d of water withdrawn for public supply, about 82 percent (633 Mgal/d) was surface water and 18 percent (134 Mgal/d) was ground water (fig. 2). About 2 Mgal/d of saline water was withdrawn from aquifers in Dare and Hyde Counties and treated by reverse osmosis.

Public-supply systems delivered water to three major water-use categories: Domestic deliveries accounted for 43 percent (332 Mgal/d), commercial deliveries accounted for 18 percent (138 Mgal/d), and industrial facilities accounted for 25 percent (193 Mgal/d).

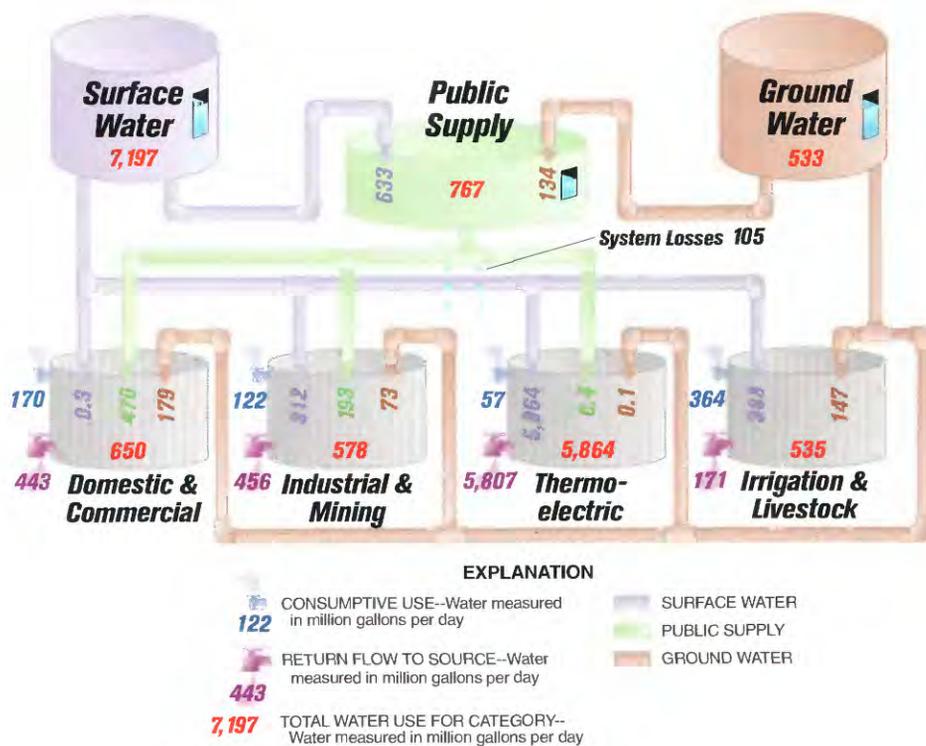


Figure 2.--Source, use, and disposition of an estimated 7,730 million gallons per day of freshwater in North Carolina, 1995.

Water lost by leaky pipes in the distribution system (conveyance losses), system maintenance, and unbilled water accounted for 14 percent (105 Mgal/d) of the withdrawals. This quantity is calculated as the difference between total water withdrawals and actual deliveries to users.

In the last few decades many municipalities have expanded their service areas to keep up with increasing population growth, and many previously self-supplied rural areas have become connected to public water systems. Mecklenburg County, which includes the city of Charlotte, had the largest rate of withdrawal for public supply (nearly 10 percent of total public-supply withdrawals, or 73 Mgal/d). Public-supply systems delivered water to more than 467,000 people in Mecklenburg County, which accounts for 10 percent of all people served by public supply. Wake (Raleigh), Forsyth (Winston-Salem), and Guilford (Greensboro) Counties are the other largest users of publicly supplied water in the State, with average withdrawals of 43, 43, and 42 Mgal/d respectively. These counties account for 19 percent of all population served, as well as all deliveries by public suppliers in the State.

Domestic and Commercial

In North Carolina, about 2.4 million of the State's 7.2 million people rely on private wells or springs for their drinking water. In 1995, combined domestic and commercial water use from deliveries and withdrawals was about 8 percent (650 Mgal/d) of total withdrawals (fig. 2). Water delivered by public-supply facilities accounted for 72 percent (470 Mgal/d). Domestic and commercial water withdrawals totaled about 179 Mgal/d, primarily from ground water.

Water use for domestic purposes in 1995 was about 504 Mgal/d. Public suppliers delivered about 332 Mgal/d, or 66 percent of the total domestic water use. Domestic withdrawals accounted for about 34 percent (172 Mgal/d) of the total domestic use. Per capita use is estimated at 70 gal/d, which is equivalent to per capita use for people served by public suppliers.

Commercial water use was estimated as 146 Mgal/d of which 138 Mgal/d was delivered from public suppliers. Withdrawals were about 7.6 Mgal/d, of which 7.3 Mgal/d were from ground water.

Industrial and Mining

Industrial and mining water use was 578 Mgal/d, and accounted for 8 percent

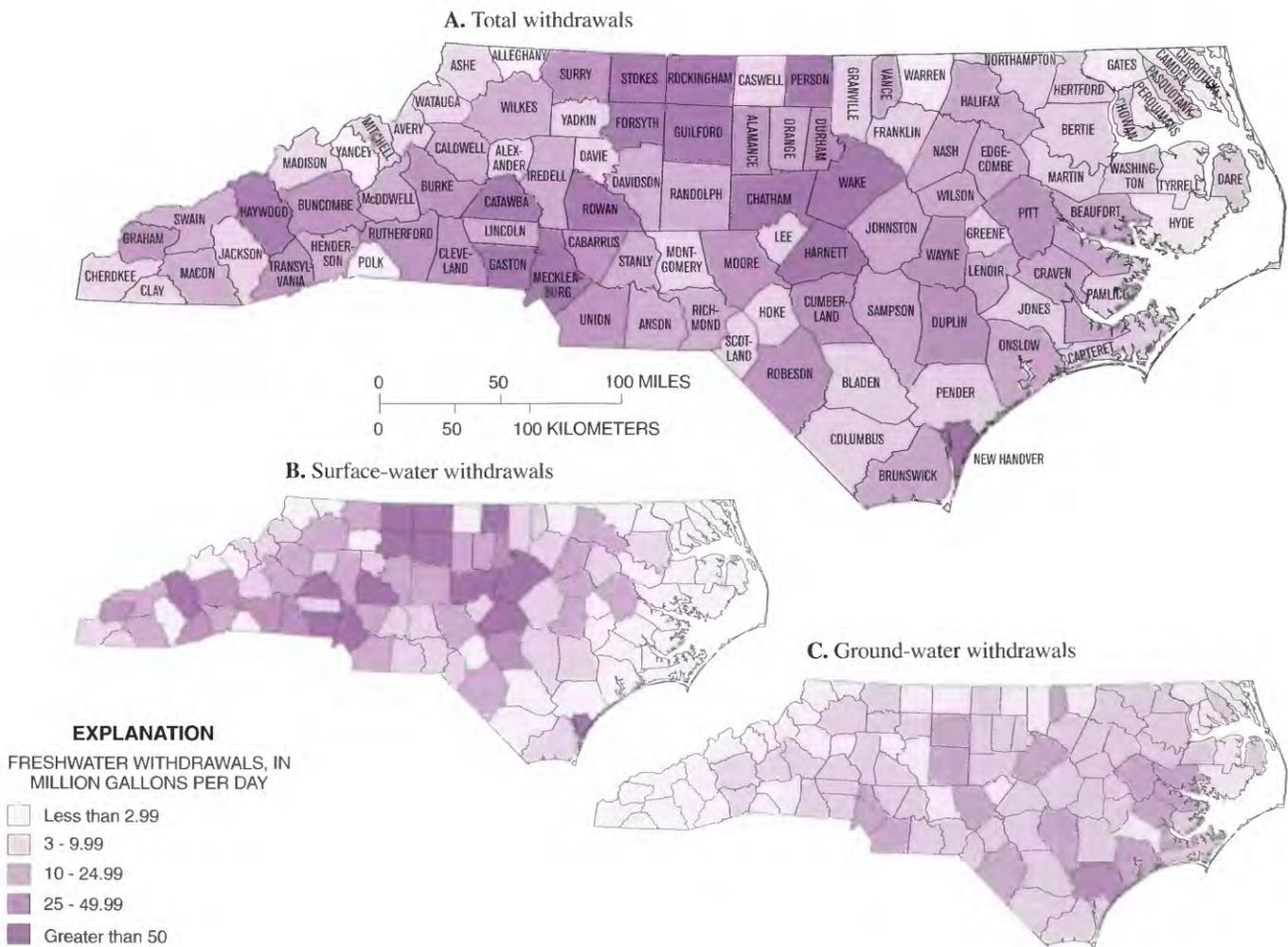


Figure 3.--Freshwater withdrawals by County in North Carolina, 1995. (Data from U.S. Geological Survey National Data Storage and Retrieval System.)

of the total use (fig. 2). Of that volume, 54 percent (312 Mgal/d) was from surface water, 13 percent (73 Mgal/d) was from ground water, and 33 percent (193 Mgal/d) was delivered by public suppliers. Industrial freshwater withdrawals were estimated as 369 Mgal/d, of which 83 percent was from surface water. Public suppliers delivered 193 Mgal/d to industries for manufacturing products and domestic purposes.

Mining operations are, for the most part, self supplied. Withdrawals for mining were 16 Mgal/d, of which 73 percent (12 Mgal/d) was from ground water. Of the ground water withdrawn, some was from wells, but most was from ground-water discharge into excavation pits from which the water is later withdrawn. Estimates are for beneficial use; therefore, these estimates do not include dewatering. However, it should be noted that the dewatering of mines discharges large amounts of ground and surface water to streams and rivers. In

Beaufort County, mining operations discharge nearly 22 Mgal/d from dewatering activities alone.

Thermoelectric Power

Thermoelectric-power generation facilities are the largest water users in the State. Thermoelectric-power plants produced about 93,433 million kilowatt hours (kWh) of electricity in 1995. These facilities withdrew 77 percent (5,864 Mgal/d) of the total freshwater withdrawals (fig. 2). North Carolina had 21 thermoelectric power plants operating in 1995; 18 fossil-fuel facilities accounted for about 55 percent (3,207 Mgal/d) of the total thermoelectric freshwater withdrawals. Two nuclear facilities accounted for the other 45 percent (2,656 Mgal/d). Of the water withdrawn, more than 99 percent was returned to the source (fig. 2). One other nuclear facility withdrew nearly 1,553 Mgal/d of saline water from the Cape Fear River estuary for cooling purposes.

Irrigation and Livestock

Withdrawals for irrigation and livestock were about 535 Mgal/d, which accounted for 7 percent of the total withdrawals in the State (fig. 2). Of this amount 73 percent (388 Mgal/d) was from surface water, and the remaining 27 percent (147 Mgal/d) was from ground water.

In North Carolina, withdrawals for irrigation are small in comparison to other water-use categories. Irrigation accounted for about 3 percent (239 Mgal/d) of the total freshwater withdrawals in 1995. Of this volume, 76 percent (181 Mgal/d) was from surface water. Irrigation can be subdivided into two subcategories--crop irrigation (including nurseries) and golf-course irrigation.

In 1995 an estimated 121,000 acres were irrigated in North Carolina. Tobacco accounted for 34 percent of all irrigated acreage. Irrigation activities are influenced by the weather during the growing season. Because 1995 rainfall

amounts were higher than normal, irrigation activities were probably reduced. Crop irrigation accounted for about 40 percent (95.5 Mgal/d) of the total withdrawals for irrigation, of which, 76 percent (73 Mgal/d) was from surface water.

Golf is a popular recreational business in North Carolina. There are approximately 495 public, private, and military golf courses across the State. Golf-course irrigation accounted for about 60 percent (143 Mgal/d) of the total irrigation water withdrawals in 1995. About 76 percent (108 Mgal/d) of golf-course irrigation withdrawals was from surface water. Most irrigation is dependent upon on-site runoff collection ponds. During periods of below-normal rainfall, ground water is sometimes used to maintain pond water levels.

Approximately 46,080 acres were irrigated on golf courses across the State in 1995.

The livestock category is separated into stock and animal specialties. The stock subcategory includes water associated with the production of beef, dairy cows, cattle, sheep, milk, poultry, and eggs. The animal specialties subcategory includes water associated with the production of horses and the aquaculture of trout, bass, catfish, and crawfish. Livestock withdrawals were about 4 percent (297 Mgal/d) of the total freshwater withdrawals. Of the total withdrawals for livestock, 70 percent (207 Mgal/d) was from surface water. The stock subcategory represents about 41 percent (121 Mgal/d) of the total livestock withdrawals. About 71 percent (86 Mgal/d) of stock withdrawals was from ground water.

Animal specialties accounted for about 59 percent (175 Mgal/d) of the total livestock withdrawals. Of the total animal specialties withdrawals, about 98 percent (172 Mgal/d) was from surface water. Aquaculture accounted for more than 99 percent of these withdrawals. Aquaculture in the western part of the State is primarily trout farming. Water is diverted from and returned to the original source. This practice uses the most water, accounting for about 98 percent of the aquacultural water use. Aquaculture in the eastern part of the State is primarily for raising bass, catfish, and crawfish. Ground water is the source for about 92 percent (3.6 Mgal/d) of the water used for these operations.

Hydroelectric Power

Hydroelectric-power generation occurs in the Blue Ridge and Piedmont Provinces of the State where topographic relief

provides sufficient elevation drop essential for power generation. Water used for hydroelectric power is an instream water use. Even though no water is actually removed from the source, it is necessary to record the amount of water used by these facilities. North Carolina's water-budget planners must ensure that the amount of water needed to produce electricity for the State's ever-growing population is readily available to these facilities. In 1995, 38 hydroelectric facilities were in operation in North Carolina. The total amount of water that flowed through hydroelectric turbines in the State was about 56,400 Mgal/d. These facilities produced approximately 5,813 million kWh of electricity.

Water Management

Water supplies in North Carolina are managed by several local, State, and Federal agencies. Primary regulatory responsibilities are within the jurisdiction of the North Carolina DEHNR. Within DEHNR, the Division of Water Quality manages an integrated program to protect surface-water quality and is also responsible for ground-water management and regulatory programs. The Division of Water Resources (DWR) collects data on the use of surface and ground water and investigates regional or watershed resources. The emphasis of these regional investigations is to assess the availability of water to meet the State's needs for public supply, industry, and irrigation activities.

The DWR is responsible for developing a North Carolina State Water-Supply Plan mandated under North Carolina General Statute 143-355 (m). Local government water systems are required to develop local water-supply plans and submit them to the DWR. The process identifies local government water systems with current or potential water shortages, water-supply conflicts, and other problems that may limit future water-supply options. The primary sources of information for this analysis are the local water-supply plans and registrations of withdrawals and interbasin transfers of 1 Mgal/d or more (D.J. Rayno, Department of Environment, Health, and Natural Resources, Division of Water Resources, written commun., 1997). The Division of Environmental Health, Public Water Supply Section of DEHNR, monitors all public water supplies, enforces public water-supply rules, and assists in the planning and design of water-supply systems.

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