DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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TENNESSEE DEPARTMENT OF HEALTH AND ENVIRONMENT,
OFFICE OF WATER MANAGEMENT

OPEN-FILE REPORT 88-348

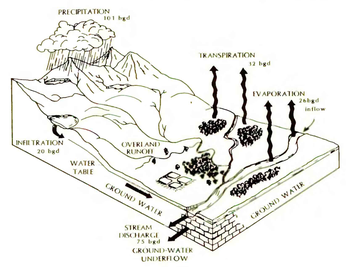
ESTIMATED USE OF WATER IN TENNESSEE, 1985

by SUSAN S. HUTSON

Supply

Introduction

Tennessee is water rich with abundant surface- and ground-water resources. The actual availability and quality of water are determined, to a large degree, by the way in which these resources are developed and managed in the face of changing demands. Typically the demand for water in Tennessee increases gradually with time. If the storage and distribution facilities that provide this developed supply do not keep pace with these increases, the result is a decline in the reliability of the supply – that is, supplies become more vulnerable to rapid population or economic growth or to drought. This vulnerability can be diminished by building surface-water reservoirs, drilling wells, improving water-supply forecasting, and improving overall management of existing facilities. This report describes some of the characteristics of the supply and the nature and the extent of the demand on the water resources in Tennessee during 1985. The data collected provide an information base for making water-use management decisions which effect water availability in Tennessee. Further, the data increase our understanding of the effect of man's activities on the hydrologic cycle and of his behavior in the allocation and use of water in Tennessee.



Water Budget.

Water Budget

Tennessee's water-supply characteristics can best be understood by an analysis of the hydrologic cycle. This cycle represents the constant circulation of nearly all water (liquid and vapor) near the surface of the earth: precipitation, runoff to streams and lakes, infiltration (recharge) to the ground-water regime, evaporation, transpiration, and consumption (water not immediately available for re-use).

- The water-supply components include an average of 101 bgd (billion gallons per day) (50 inches annually) of precipitation and 26 bgd as streamflow from adjacent states.
- Evapotranspiration and consumption losses are 32 bgd.
- Infiltration to aquifers averages 20 bgd.
- Streamflow leaving the State is 75 bgd.

Major rivers and tributaries in Tennessee and relative discharge.

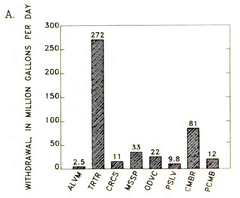
Surface-Water Supply

- The Cumberland, Tennessee, and Mississippi Rivers are Tennessee's principal rivers.
- Of the 42,301 mi^2 (square miles) in Tennessee, the Tennessee River drains approximately 22,545 mi^2; the Cumberland River drains approximately 10,160 mi^2.
- The Mississippi River, which forms the western boundary, drains approximately 8,907 mi^2 of the western part of the State.
- Normal storage in reservoirs is 8.12 million acre-feet (2,650 billion gallons).
- Most streams and lakes contain relatively good quality water. However, some are experiencing problems. Causes of these water-quality problems include discharges from surface mines, agricultural runoff, and low oxygen concentrations in water released from dams.

Ground-Water Supply

- An estimated 200 trillion gallons of freshwater are stored in Tennessee; 98 percent of this is underground in 9 principal aquifers.
- More than one-half of the population in Tennessee depends on ground water for drinking-water supplies.
- Yields from wells vary geographically and range from less than 1 gal/min (gallon per minute) to thousands of gal/min.
- Water quality is generally good, except in areas where concentrations of dissolved solids exceed drinking-water standards. Contamination is often localized at hazardous-waste sites, landfills, and spills. Statewide, about 100 wells are contaminated.

A.

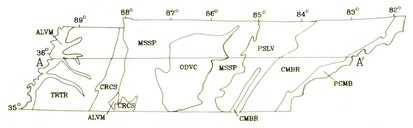


EXPLANATION

ALVM	Alluvial aquifer
TRTR	Tertiary sand aquifer
CRCS	Cretaceous sand aquifer
PSLV	Pennsylvanian sandstone aquifer
MSSP	Mississippian carbonate aquifer
ODVC	Ordovician carbonate aquifer
KNOX	Knox aquifer
CMBR	Cambrian–Ordovician carbonate aquifer
PCMB	Crystalline rock aquifer

A–A' Trace of cross section

B.



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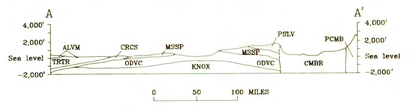
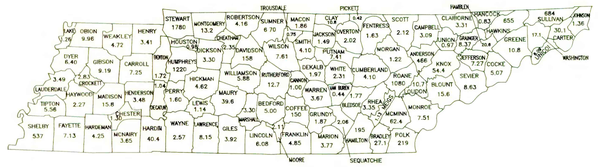


Principal aquifers in Tennessee. A, Total water withdrawals by aquifer. B, Geographic distribution. C, Generalized cross section A–A'.

Demand

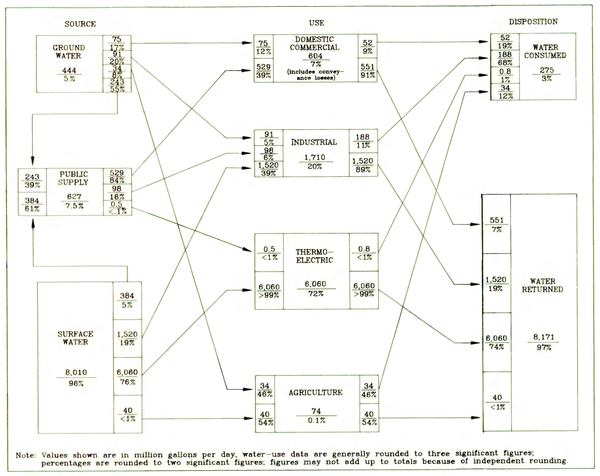
Total Water Withdrawals for Offstream Use, in Million Gallons Per Day



Source, Use, and Disposition of Water

Precipitation and streamflow from adjacent states supply 127 bgd of water to Tennessee's water resources. That renewable supply was about 16 times the rate of water withdrawal (8.45 bgd) and about 500 times the amount of water consumption (0.275 bgd) during 1985. This demand reflects a 16 percent decrease in total water withdrawals since 1980. The following "octopus" diagram illustrates the relation between the source, use, and disposition components of water demand. Water is withdrawn from surface- and ground-water sources directly by the user, or withdrawn by a public supply and then distributed to several categories of users. The water is used for various purposes and then, either returned to a stream or consumed.

- Surface water provided about 8,010 Mgal/d (million gallons per day) (95 percent) of all water withdrawals.
- Ground water provided about 444 Mgal/d (5 percent).
- Public-supply facilities delivered about 7.5 percent of the water supplied to major users.
- Cooling for thermoelectric powerplants was the largest offstream use of water.
- Industry was the largest consumer of water accounting for 68 percent of all water consumed.
- Thermoelectric returned more than 99 percent of the water it withdrew.



Note: Values shown are in million gallons per day, water-use data are generally rounded to three significant figures; percentages are rounded to two significant figures; figures may not add up to totals because of independent rounding.

Distribution

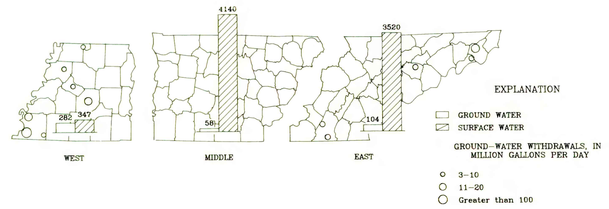
Water Withdrawals by Region

Middle and East Tennessee

- The Cumberland and Tennessee Rivers are the principal sources of supply for power, industry, and public supply in Middle and East Tennessee.
- Population centers and industrial developments are located along the principal rivers where ample water supplies and navigation routes are available.
- Nashville-Davidson County, the largest urban area in Middle Tennessee (population of 491,000), is supplied from the Cumberland and Stones Rivers through a number of public-supply systems, many of which are interconnected.
- Extensive reservoir systems provide significant storage for runoff, and thereby enhance the use of the surface-water supply.
- Ground-water supplies are limited in areas where yields to wells are low (1 to 10 gal/min). However, yields to wells may exceed 1,000 gal/min in some valleys overlying the Cambrian-Ordovician carbonate and crystalline rock aquifer systems.
- Eleven of the 34 ground-water pumping centers withdrawing at least 1 Mgal/d are in East Tennessee; 3 are in Middle Tennessee.
- Five of the 12 pumping centers withdrawing at least 3 Mgal/d are in East Tennessee; none are located in Middle Tennessee (see map below).

West Tennessee

- Several extensive and productive aquifers underlie West Tennessee, the most important being a Tertiary sand aquifer. Withdrawals from this aquifer were 272 Mgal/d, or 60 percent of the ground-water withdrawals in the State.
- Ground water supplies most of the public utilities and industries in West Tennessee; Memphis, the largest city in Tennessee (population 650,000), is completely supplied by ground water. Shelby County, which includes Memphis, withdrew 196 Mgal/d of ground water.
- Twenty of the 34 ground-water pumping centers that withdrew at least 1 Mgal/d are in West Tennessee.
- Of the 12 pumping centers statewide withdrawing at least 3 Mgal/d of ground water each, 7 are in West Tennessee (see map below).
- Withdrawals from the Mississippi River (338 Mgal/d) provided water for cooling at a thermoelectric plant in Shelby County.



Tennessee Water-Use Information Program

The Tennessee Water-Use Information Program is a cooperatively funded program with Tennessee's Office of Water Management, and the U.S. Geological Survey. The program is designed to collect data to meet water-management information needs for resolving water problems involving water quality, environmental impact, energy development, and resource allocation. Data are collected on where water is used, the amount of water used, how it is used, and how much is returned to the natural system.

Estimates of water use in Tennessee have been compiled by the Survey through the water-use program every 5 years since 1950 (MacKichan, 1951, 1957; MacKichan and Kammerer, 1961; Murray, 1968; Murray and Reeves, 1972, 1977; and Solley and others, 1983, 1988). The estimates of water use for the United States as detailed in the above references include the following categories of use: public supply, domestic self-supply, industrial self-supply, agriculture, irrigation, thermoelectric, and hydropower.

Hydrologic data are from the files of the Tennessee District, Water Resources Division, U.S. Geological Survey.

Water-use data are from the files of the Tennessee Water-Use Information Program.

For further information please write to:

Tennessee Water-Use Information Program
Tennessee Office of Water Management
150 Ninth Avenue
Nashville, Tennessee 37219-5404

Tennessee Water-Use Information Program
U.S. Geological Survey
A-413 Federal Building
Nashville, Tennessee 37203

Selected References

Alexander, F.M., Keck, L.A., Conn, L.G., and Wentz, S.J., 1984: Drought-related impacts on municipal and major self-supplied industrial water withdrawals in Tennessee: Part B: U.S. Geological Survey Water-Resources Investigations Report 84-4074, 398 p.

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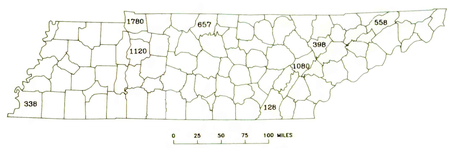
Categories of use

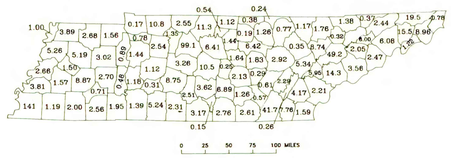


Thermoelectric

Thermoelectric plants in Tennessee are powered by gas, coal, or nuclear energy. Water is primarily used for cooling. There are eight fossil-fueled plants and two nuclear-fueled plants in Tennessee. In 1985, the nuclear-fueled plants were not operating commercially.

- Thermoelectric was the largest offstream water-use category, withdrawing 72 percent of the water used.
- Thermoelectric powerplants withdrew 6,060 Mgal/d.
- All the withdrawals were from surface water and reflect a 22 percent decrease in demand from 1980.
- A public-water system supplied less than 1 Mgal/d of ground water to a plant in Memphis.
- The largest withdrawals of water used to cool generators at thermoelectric plants occurred in Stewart, Roane, and Humphreys Counties.

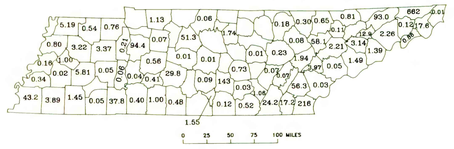
Note: All values shown are total water withdrawals in million gallons per day by county. No value indicates zero water use for category.



Public Supply

Public-supply refers to water withdrawn by public utilities for delivery to domestic, commercial, and industrial users and for municipal services such as fire fighting. Water lost by leaky pipes in the distribution system (conveyance losses) is also included in this category.

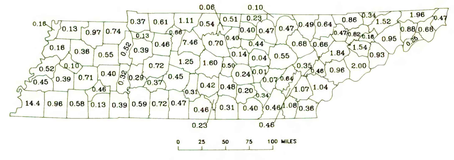
- Public suppliers served about 3.66 million people or about 77 percent of Tennessee's population.
- Withdrawals were estimated at 627 Mgal/d, with 10 percent of this total lost in the delivery system or distributed to municipal services.
- Withdrawals for public supply increased 23 percent since 1980 as many new users purchased water in preference to developing their own potable water source.
- Most of West Tennessee, where 26 percent of the population reside, relied on ground water for public-water supply.
- Shelby, Davidson, and Knox, the three most populated counties, accounted for 46 percent of the withdrawals for public supply.



Industry

The chemical and the pulp and paper industries were the largest self-supplied users of industrial water. Together, these industries use more water than all other industries combined. Other industries include, but are not limited to, mining, munitions, textiles, metal, petroleum and coal products, and food processing.

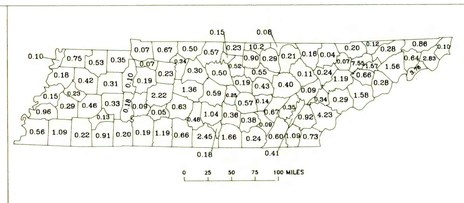
- Self-supplied industrial withdrawals were estimated to be 1,610 Mgal/d.
- Surface water was the source for about 98 percent of the 1,540 Mgal/d used by self-supplied industries in Middle and East Tennessee.
- Several surface-water users withdrew 100 Mgal/d or more. In contrast, individual industrial ground-water withdrawals throughout the State did not exceed 25 Mgal/d.
- Ground water was the principal source of the 65 Mgal/d withdrawn by self-supplied industries in West Tennessee.
- Some self-supplied industrial ground-water withdrawals have declined since 1980 as a result of increased water recycling and reduced economic activity.



Domestic and Commercial

Domestic water use includes water for household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns. Among commercial users are retail stores, restaurants, laundry services, and civilian and military institutions.

- Self-supplied domestic users withdrew 7.0 Mgal/d.
- About 1.1 million people withdrew their own water. The average use was 63 gallons per person per day.
- Self-supplied commercial users withdrew about 5 Mgal/d.
- Springs and wells supplied the water for domestic and commercial self-supplied users.
- Public-supply deliveries to domestic users averaged 302 Mgal/d, or 83 gallons per person per day. Commerical deliveries were about 163 Mgal/d.



Agriculture

Agricultural water use includes water withdrawn for irrigation of crops and recreational lands (golf courses) and non-irrigation uses such as aquaculture and livestock watering.

- Total withdrawals for agriculture were 74 Mgal/d.
- Non-irrigation uses accounted for most of this water (65 Mgal/d).
- Aquaculture used about one-half (37 Mgal/d) of the non-irrigation water. Most of that water was returned to streams.
- Nearly all of the water used for livestock watering was consumed.
- Approximately 29,000 acres were irrigated in 1985, a 53-percent increase from 1975 (19,000 acres).
- Irrigation water (9 Mgal/d) was mostly applied with sprinkler systems. More than 50 percent of these systems have been installed since 1980.