Estimated Use of Water in the Tennessee River Watershed in 2000 and Projections of Water Use to 2030

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ABSTRACT

Estimates indicate that after increases in water withdrawals from 1965 to 1980 in the Tennessee River watershed, withdrawals declined from 1980 to 1985 and remained steady from 1985 to 1995. Water withdrawals in the Tennessee River watershed during 2000 averaged about 12,211 million gallons per day (Mgal/d) of freshwater for offstream uses—22 percent more than the 1995 estimate. The 2000 estimate is nearly the same as the estimate for 1980, the highest year of record, with 12,260 Mgal/d. The reuse potential of water from the Tennessee River is high because most of the water withdrawn for offstream use is returned to the river system. Besides water quality, reuse potential reflects the quantity of water available for subsequent uses and is gaged by consumptive use, which is the difference between water withdrawals and return flow. For the Tennessee River watershed, return flow was estimated to be 11,562 Mgal/d, or 95 percent of the water withdrawn during 2000. Total consumptive use accounts for the remaining 5 percent, or 649 Mgal/d.

Estimates of water withdrawals by source indicate that during 2000, withdrawals from surface water accounted for 98 percent of the total withdrawals, or 11,996 Mgal/d, 23 percent more than during 1995. Total ground-water withdrawals during 2000 were 215 Mgal/d, or 17 percent less than during 1995.

During 2000, thermoelectric power withdrawals were estimated to be 10,276 Mgal/d; industrial, 1,205 Mgal/d; public supply, 662 Mgal/d; and irrigation, 68.9 Mgal/d. Return flows were estimated to be: thermoelectric power, 10,244 Mgal/d; industrial, 942 Mgal/d; and public supply, 377 Mgal/d. Consumptive use was estimated to be: thermoelectric power, 32.2 Mgal/d; industrial, 263 Mgal/d; public supply, 285 Mgal/d; and irrigation, 68.9 Mgal/d. Each category of use affects the reuse potential of the return flows differently. The consumptive use in the river is comparatively small because most of the water withdrawn from the Tennessee River watershed is used for once-through cooling for the thermoelectric power and industrial sectors.

Average per capita use for all offstream uses was 2,710 gallons per day per person in 2000, compared to the record high of 3,200 in 1975 and 1980. The intensity of use for the Tennessee River watershed as measured as a function of area was 298,489 gallons per day per square mile in 2000.

In 2030, water withdrawals are projected to increase by about 15 percent to 13,990 Mgal/d. By category, water withdrawals are projected to increase as follows: thermoelectric power, 11 percent or 1,152 Mgal/d; industry, 31 percent or 368 Mgal/d; public supply, 35 percent or 232 Mgal/d; and irrigation, 37 percent or 25.2 Mgal/d. Total consumptive use is projected to increase about 51 percent or 334 Mgal/d to 980 Mgal/d. Per capita use in 2030 is calculated to be about 2,370 gallons per day, about 26 percent less than in 1980. Water transfers to the Tennessee-Tombigbee waterway for navigation lockages were estimated as 200 Mgal/d for 2000 and 800 Mgal/d for 2030. Water transfers for hydropower commitments through Barkley Canal averaged 3,361 Mgal/d for 2000 and are estimated to be an average of 4,524 Mgal/d in 2030.

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INTRODUCTION

The Tennessee River system is the Nation's fifth largest river system with a 40,910 mi^2 drainage area. The Tennessee water-resources region (WRR), which corresponds to the Tennessee River watershed, ranked tenth among the 21 nationally designated WRRs in the United States in the volume of average daily withdrawals of freshwater in 1995. These withdrawals account for less than 3 percent, or 10,000 Mgal/d, of the overall total freshwater use of 341,000 Mgal/d in 1995. Of the 10,000 Mgal/d, about 80 percent was used for once-through cooling in the generation of electricity. In 1995, the Tennessee WRR produced 8 percent of the Nation's total power from thermoelectric and hydroelectric plants and ranked fourth in overall power production. The Tennessee WRR ranked twelfth in thermoelectric-power production and fifth in hydroelectric-power production (Solley and others, 1998).

As measured by intensity of freshwater withdrawals in gallons per day per square mile (gal/d/mi^2), the Tennessee WRR was the most intensively used watershed among the 18 WRRs in the conterminous United States, averaging 244,439 gal/d/mi^2 in 1995. Measured as a ratio of consumptive use to water withdrawals, the reuse potential of the Tennessee WRR is high. The consumptive use in 1995 was about 3 percent of the water withdrawals (289 of the 10,000 Mgal/d) (fig. 1). The California WRR was the second most intensively used watershed averaging 226,978 gal/d/mi^2. The reuse potential of the Tennessee River watershed is high compared to the California WRR. In the California WRR, nearly 80 percent of the 36,500 Mgal/d of water withdrawals was for irrigation and about 70 percent of the applied irrigation water was consumptively used. In 1995, the California WRR had the greatest consumptive use, and the Tennessee WRR ranked eighteenth (or fourth lowest). As a percentage of the total water withdrawals, consumptive use in the Tennessee WRR was the smallest at 3 percent in 1995 (fig. 1).

About 4.5 million people resided in the Tennessee River watershed in 2000, an increase of about 15 percent since 1990. The watershed includes parts of Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia (fig. 2). A series of 49 dams and reservoirs regulates flow on the Tennessee River system. Reservoirs in the watershed developed by the Tennessee Valley Authority (TVA) and the United States Army Corps of Engineers (USACE) add more than 643,749 surface acres to the water resources of the area and contribute substantially to public supplies, navigation, flood damage reduction, power production, water quality, and fisheries and wildlife management. The reservoirs also provide recreational and aesthetic benefits. The reservoirs offer a broad range of water-resource benefits on which much of the economic progress in the watershed has been built. The abundance of water in the watershed supports the sport and commercial fisheries and the tourist industry and helps attract industry and commercial activity to the region (Hutson and others, 1990). The TVA has federal responsibility for operating the reservoirs in the Tennessee River watershed.

Wisely managing the water resources in the Tennessee River watershed and preserving and enhancing the diverse and rich aquatic ecosystems are dependent on accurate and complete information on the availability and use of the water resources. Reliable water-use information about where water is used, how water is used, how much water is used, and how that use has changed over time is required by regulatory and resource agencies.

The U.S. Geological Survey (USGS), in cooperation with the TVA, conducted an investigation to collect and analyze water-use information for 2000 and to project water demand to 2030 for the Tennessee River watershed. These data will be used by TVA as part of the water-supply analysis for the TVA reservoir operations study. Reservoir system operating policies affect reservoir levels, when changes in reservoir levels occur, and the amount of water flowing through the reservoir system at different times of the year. The reservoir operations study being conducted by TVA is a formal evaluation of TVA policies for operating the reservoirs in the Tennessee River system. The purpose of the study is to determine if changes in the TVA reservoir operating policies would produce greater overall public value. Water supply, of which water use is a component, is one of the criteria being used to evaluate reservoir policy.

Purpose and Scope

This report presents water-use estimates for 2000 and water-use projections to 2030 for the Tennessee River watershed. The TVA uses a number of computer-based mathematical models to coordinate and optimize reservoir operation in the Tennessee River watershed. The data from this report aggregated

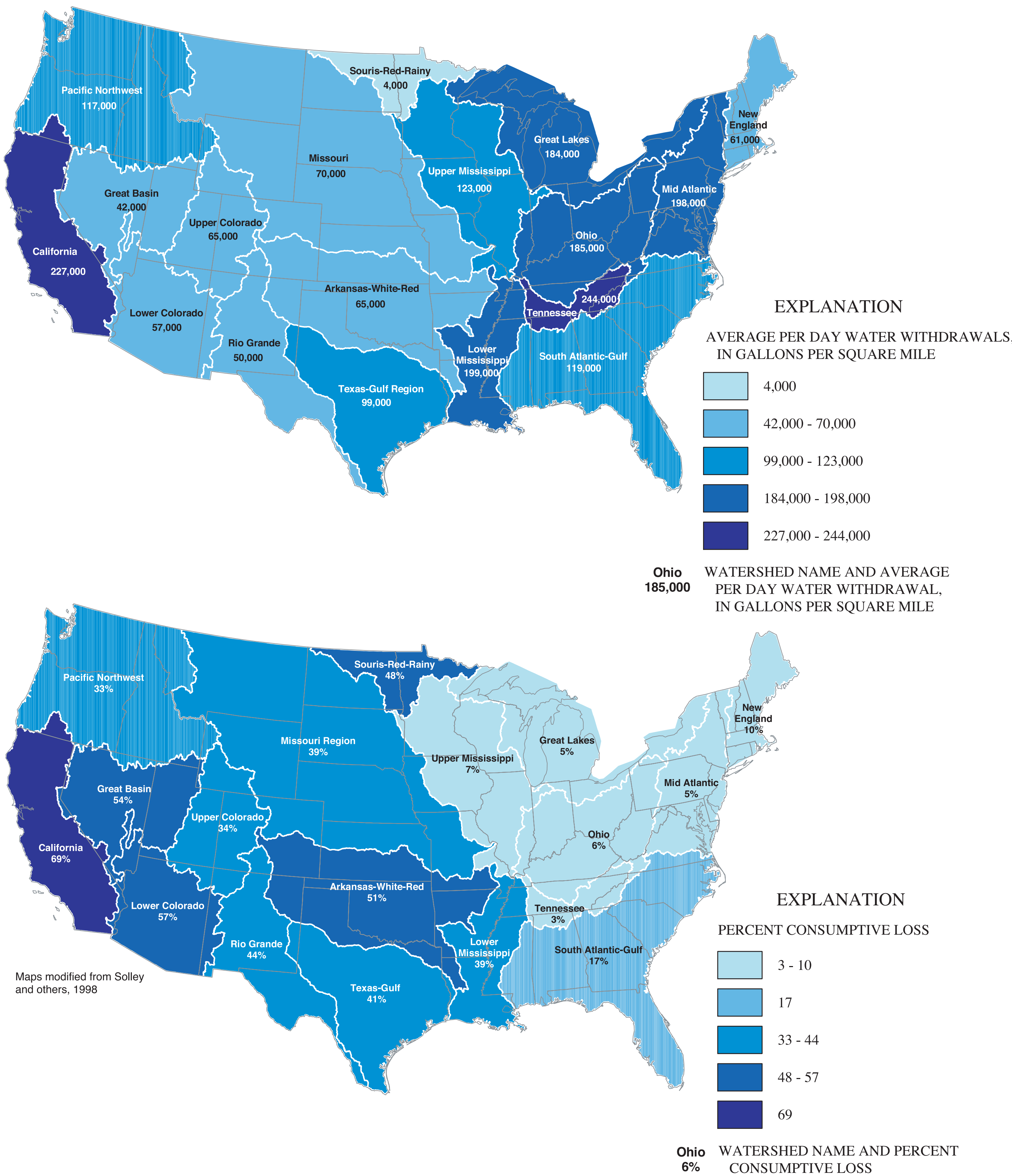


Figure 1. Total freshwater withdrawals per square mile and percent consumptive loss in the conterminous United States by watershed region in 1995.

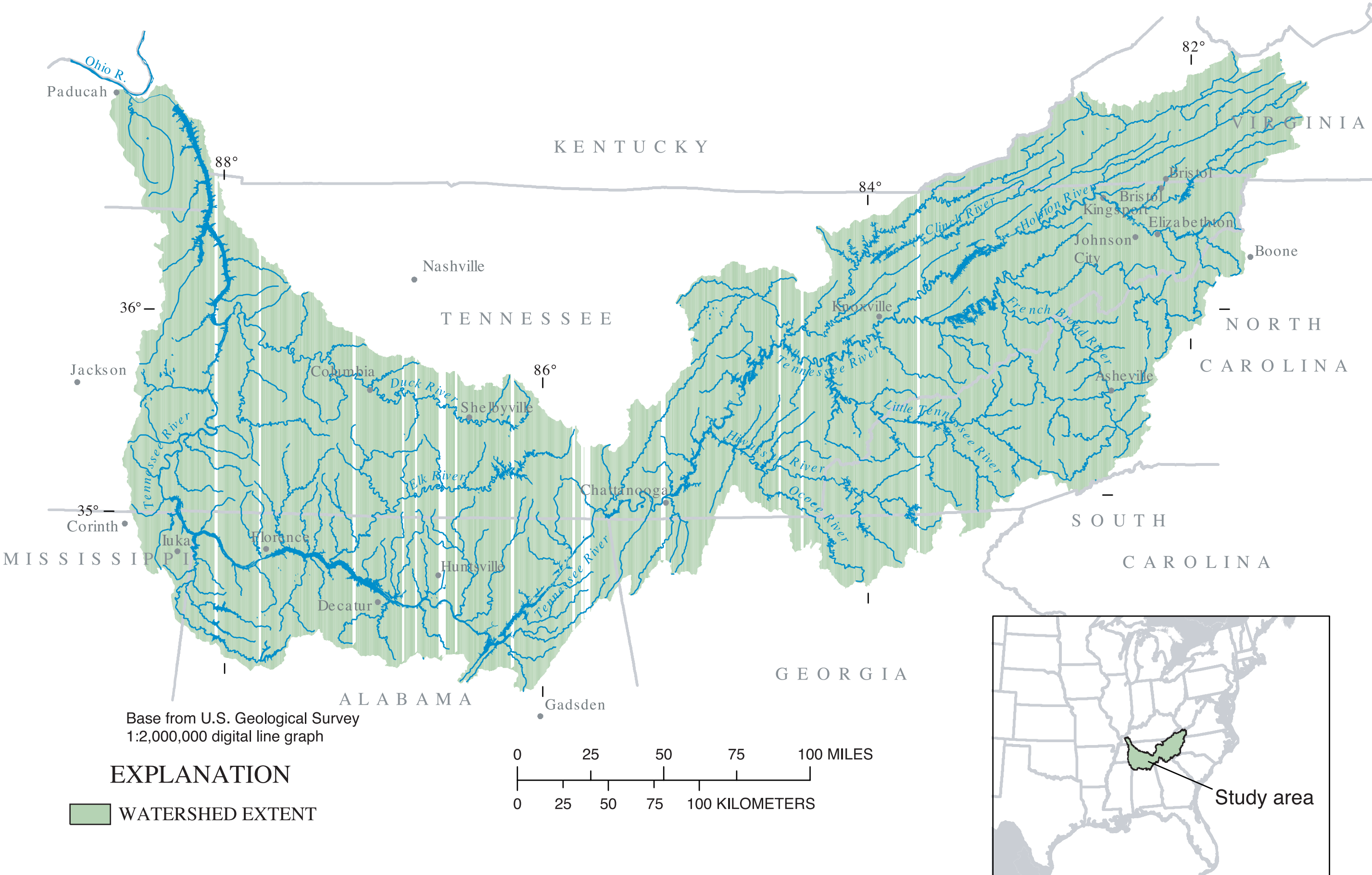


Figure 2. The Tennessee River watershed and major tributaries.

to the reservoir catchment area (RCA) were input to the TVA reservoir-management models to evaluate alternative water-supply scenarios for determining future multi-purpose reservoir-management practices.

Each section of this report consists of text, illustrations, and tables showing data for each water-use tabulation area (WUTA) and associated reservoir catchment area (RCA), hydrologic unit (referred to by hydrologic unit code, HUC), and states and counties within the Tennessee River watershed. This report contains information on total water use by category and source of water, water projections to the year 2030, and trends in water use for 1965 to 2000. Information and data on four categories of offstream water use—thermoelectric power, industrial, public supply, and irrigation—are presented for 2000 and projected to 2030. Estimates of water withdrawn from surface- and ground-water sources, estimates of consumptive use, and estimates of wastewater releases and thermoelectric-power and industrial return flows are presented for 2000.

Hydrologic Setting

The headwaters of the Tennessee River watershed are in the mountains of western Virginia and North Carolina, eastern Tennessee, and northern Georgia (Tennessee Valley Authority, 1990) (fig. 2). The Tennessee River is formed by the confluence of the Holston and the French Broad Rivers near Knoxville, Tennessee. The river flows to the southwest and is fed by three principal tributaries—the Little Tennessee, the Clinch, and the Hiwassee Rivers. As the Tennessee River flows south, west, and then north, two other major tributaries, the Elk and Duck Rivers, contribute to the flow that eventually joins the Ohio River at Paducah, Kentucky.

The Tennessee River watershed drainage area is 40,910 mi^2. The drainage area to Chattanooga, Tennessee is 21,400 mi^2; west of Chattanooga to the Ohio River, the drainage area is 19,500 mi^2. The drainage area lies mostly in Tennessee (55 percent or 22,545 mi^2) with parts in Alabama (17 percent or

6,780 mi^2), Georgia (4 percent or 1,475 mi^2), Kentucky (2 percent or 966 mi^2), Mississippi (1 percent or 414 mi^2), North Carolina (13 percent or 5,480 mi^2), and Virginia (8 percent or 3,250 mi^2). Forty-nine dams constitute the Tennessee River water-control system. The reservoirs are operated year round for the purposes of navigation, flood damage reduction, power generation, water supply, water quality, and recreation. The operation of the reservoirs is linked to rainfall and runoff patterns in the watershed.

The rainfall varies seasonally, annually, and geographically. The mean-annual rainfall in the drainage area is about 52 inches, ranging from a low of 36 inches in 1985 to a high of 65 inches in 1973 (Tennessee Valley Authority, 1990). The heaviest concentrations of rainfall occur in mountainous areas along the headwaters of the tributaries where mean-annual rainfall is more than 90 inches. In parts of the French Broad, Clinch, and Holston River watersheds, the mean-annual rainfall is as low as 40 inches.

The mean-annual runoff is about 22 inches, about 42 percent of the mean-annual rainfall over the drainage area. Considerable natural storage, provided by the deep soils and extensive underground storage in many tributary areas, stabilizes runoff to some extent. During most of the year, dense ground cover on the steep slopes also limits rapid runoff from intense rainfall. In winter, however, when plants are dormant, runoff increases and the ground becomes wetter, reducing natural storage and thereby increasing runoff.

Sources of Data and Methods of Analysis

The data for this report are stored in the Tennessee Valley Authority Water-Use Data System (TVA-WUDS), which is a site-specific relational database. Each record in the database is labeled as a withdrawal or return flow water-use transaction. A water-use site may have either a withdrawal transaction or a return-flow transaction, or both. Each water-use transaction for a site in the database is assigned to a WUTA, RCA, HUC, State, and county. For some water-use sites, the intake for the water withdrawal is located in one RCA, and the outfall for the return flow is downstream of the dam in the next RCA. In such a case, the data records for the site indicate the different locations of the intake and outfall.

The database contains preliminary water-withdrawal data for 2000 collected by the States of Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia and the USGS National Water-Use Information Program (NWUIP) as of December 2001 (appendix A). A supplementary inventory by TVA and USGS of industrial and thermoelectric power facilities in the watershed provided additional water-withdrawal and return-flow data. The U.S. Department of Energy, Energy Information Administration (DOE, EIA) electricity database was a secondary source of information on water withdrawal, return flow, and power generation for the thermoelectric plants in the watershed (U.S. Department of Energy, Energy Information Administration, 2000a and 2000b). The municipal wastewater, the industrial sanitary, process, and cooling water, and the mining return-flow data are from the U.S. Environmental Protection Agency, National Pollutant Discharge Elimination System program, Permit Compliance System (USEPA, NPDES, PCS). Stormwater-runoff discharge was excluded from the return-flow totals. The USGS NWUIP provided estimates of population data for the HUCs based on the U.S. Bureau of the Census data for 2000 (U.S. Bureau of the Census, 2001). The population estimates were generated by applying geographic information system (GIS) computer techniques to the population and associated boundary and centroid of each census tract in the watershed (Kristin S. Linsey, USGS, written commun., 2001).

To assure the quality of the data, the preliminary 2000 water-withdrawal and municipal wastewater return-flow site data were aggregated to the county level and compared to the 1995 USGS county water-use data (U.S. Geological Survey, 2002). Gaps in the 2000 county water-withdrawal data by category were adjusted using a projection factor based on the Woods and Poole economic data (Woods and Poole Economics, Inc., 2001). Missing record for wastewater releases and industrial return flows was estimated using ratios derived from the collected site-specific data for 2000 from TVA-WUDS. For wastewater releases, a coefficient of 0.57 was applied to public-supply withdrawals. For industrial return flows, a coefficient of 0.79 was applied to industrial withdrawals.

Water-use numerical data are the average daily quantities used. Irrigation water is applied during only a part of the year and at variable rates; therefore, the actual rate of application is greater than the average rate given in the tables in this report. Numerical data in the text generally are rounded to three significant figures for values less than 100 and presented as integers for values of 100 and greater. The tables show these values to two decimal places in million gallons per day. Per capita use data in gallons per day are shown as an integer. In the illustrations, values are generally expressed as integers or to 1-decimal place if the value is less than 1.0. All numbers were rounded independently; thus the sums of independently rounded numbers may not equal the totals in the report. The percentage changes discussed in the text were calculated from the unrounded data and appear as integers. Cumulative consumptive-use values are expressed as integers.

Water-use data are aggregated to one of the 30 RCA units in the watershed because the data in this report were input to the TVA reservoir-management models that use similar units. The water-use data are aggregated by HUCs because these units are often used as a geographical framework for detailed water-resources planning and for evaluating interbasin transfer of water or wastewater. Because the HUCs are widely recognized and used, a spatial analysis of the water use is included by HUC. The type and availability of the water-use data varies by State and is determined by State law, the presence of a water-permitting or water-use program, and funding. The State and county data are important data-analysis units used in formulating policy and making water-management decisions; therefore, these data are included in the report.

Fourteen WUTAs and 30 RCAs constitute the Tennessee River watershed. The WUTA groups RCAs to account for the complete site-specific water-use transactions between adjoining RCAs and is used to determine consumptive use at a large scale. An RCA (fig. 3) is a natural drainage area truncated by a dam. Within this topographically distinct area, precipitation, runoff, evapotranspiration, shallow and deep infiltration to and discharge from the soil, and subsurface storage contribute to the water impounded in the reservoir by the dam. The reservoir is a functional unit operated to meet specific objectives ranging from power generation to recreation. The guidelines under

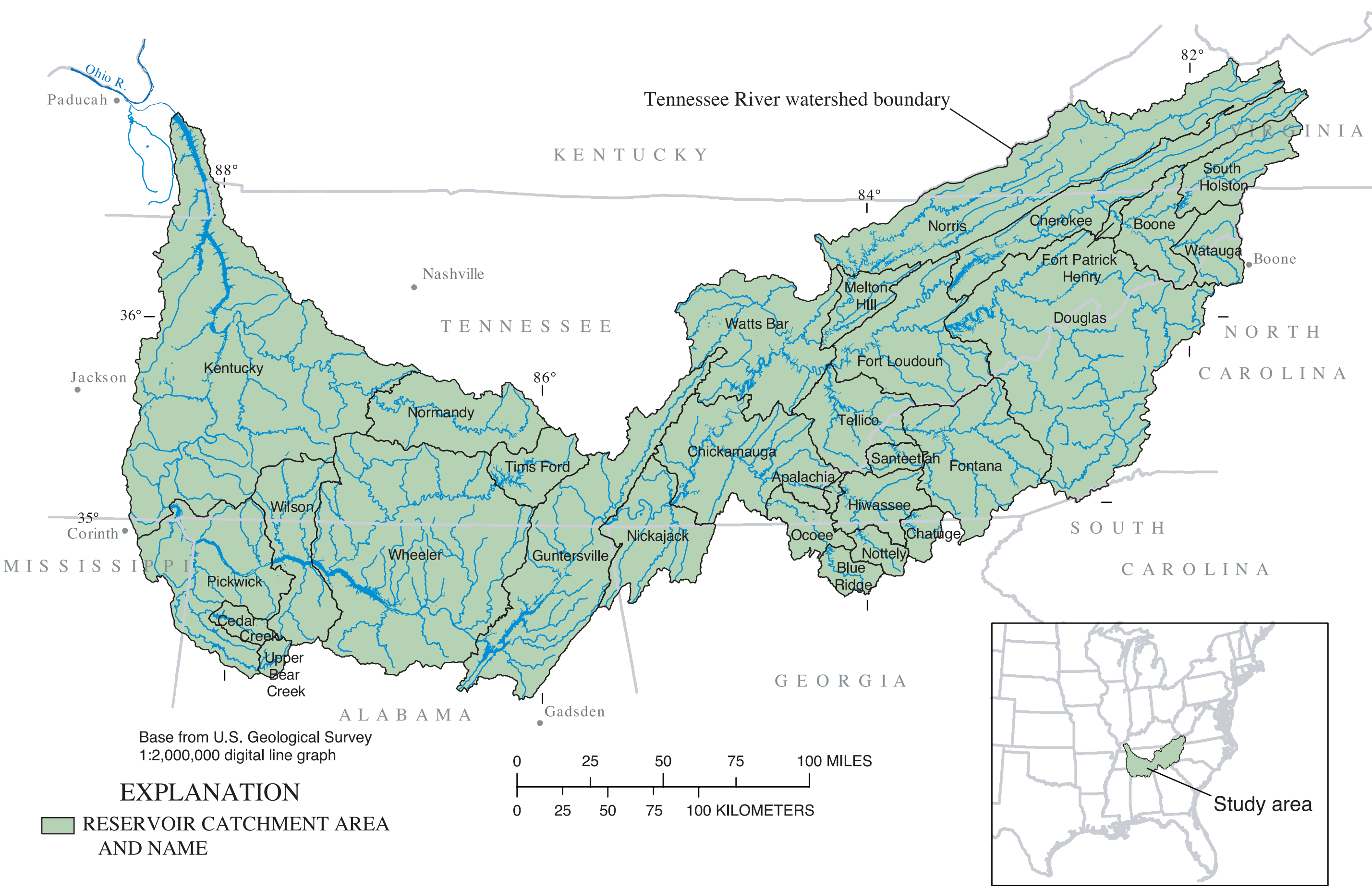


Figure 3. Reservoir catchment areas in the Tennessee River watershed.

which a reservoir is operated are part of an integrated management plan of the entire reservoir system, thus linking water availability throughout the watershed.

Net water demand was calculated by subtracting return flow from withdrawals and was determined for each RCA. The net water demand is accumulated at the downstream boundary of the WUTA to calculate a consumptive use. Cumulative consumptive use was calculated at key junctures of the WUTAs (Fort Loudoun, Watts Bar-Chickamauga, Nickajack, Guntersville, Wheeler-Wilson, Pickwick, and Kentucky) in the river system and indicates a sum of consumptive use in the watershed to that juncture. Cumulative consumptive use for the Tennessee River watershed was calculated at Kentucky Dam. The diversion of water to the Tennessee-Tombigbee waterway for lockages for navigation and the diversion of flow from Kentucky Reservoir to Barkley Reservoir for generating hydroelectric power also are losses to the river system.

The Kentucky and Normandy RCAs function with a unique operational water-supply requirement for Normandy Reservoir. The other RCAs exclude areas downstream of the reservoir; however, Normandy Dam is operated to meet downstream flow requirements mandated by the Tennessee Department of Environment and Conservation, Division of Water Pollution Control, at Shelbyville, Tennessee. Net water demand for Normandy was calculated using the withdrawals and return flows in the Normandy Reservoir and in the area downstream of the dam to the City of Columbia, Tennessee.

Thirty-two watershed areas designated by HUC constitute the Tennessee River watershed (Seaber and others, 1984) (appendix B) (fig. 4). Several counties in the Tennessee River watershed are only partially located within the basin (fig. 5). For each of these counties, only the water-use transactions occurring within the basin were compiled for this study. In Virginia, the water-use data for an embedded political unit such as Bristol City were aggregated to the neighboring county unit.

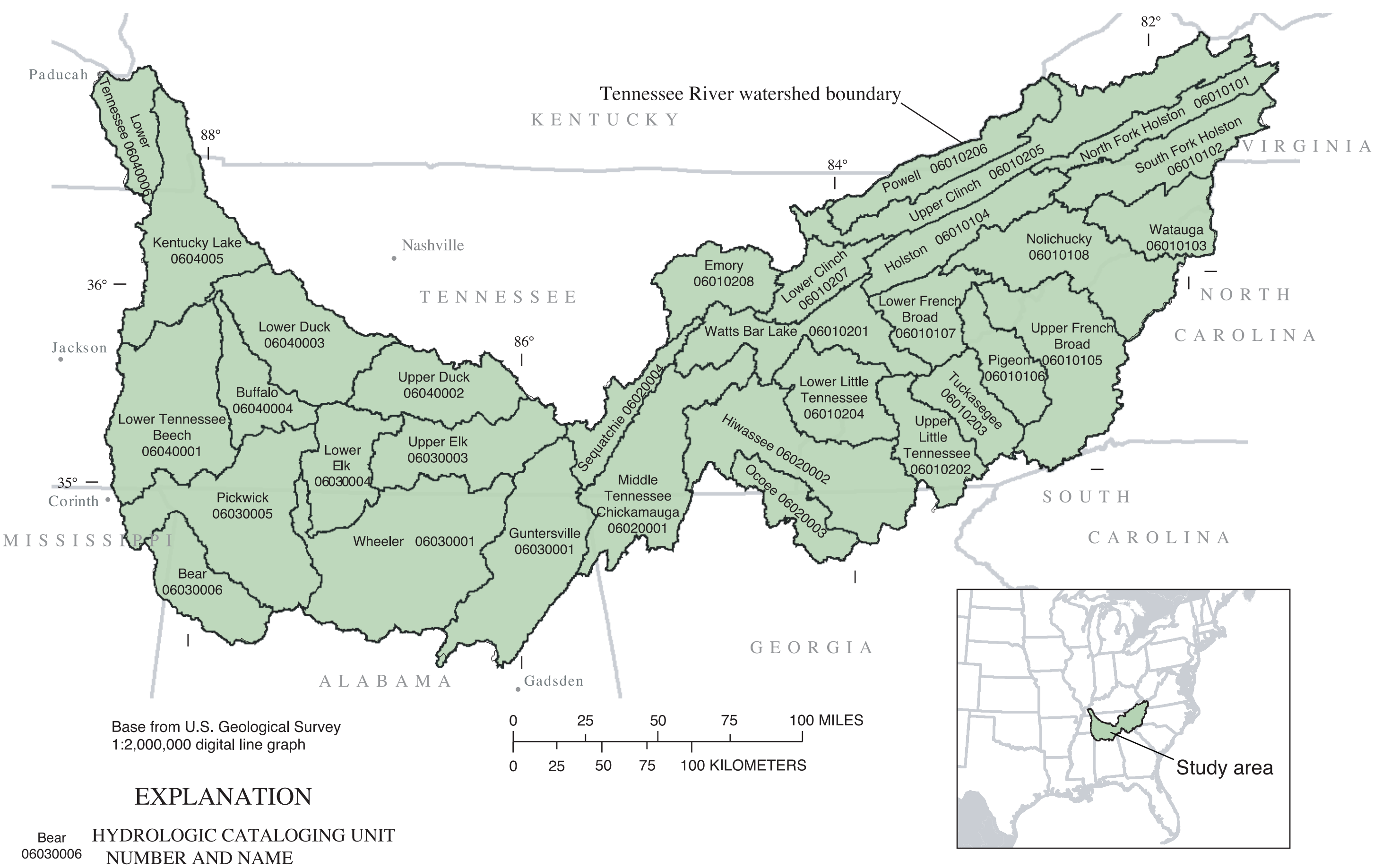


Figure 4. The 8-digit hydrologic unit codes of the Tennessee River watershed.

Acknowledgments

The authors thank the personnel from the many State and local agencies in Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia who assisted with the compilation of data for 2000, and the USGS water-use specialists from Alabama, Georgia, Kentucky, Mississippi, North Carolina, and Virginia who assisted with the collection and compilation of the data for this report. The authors also appreciate the assistance provided by George E. Welch, TVA, in coordinating the industrial and thermoelectric power water-use survey and by Melissa Alverson, TVA, in producing the cover and several graphics for the report.

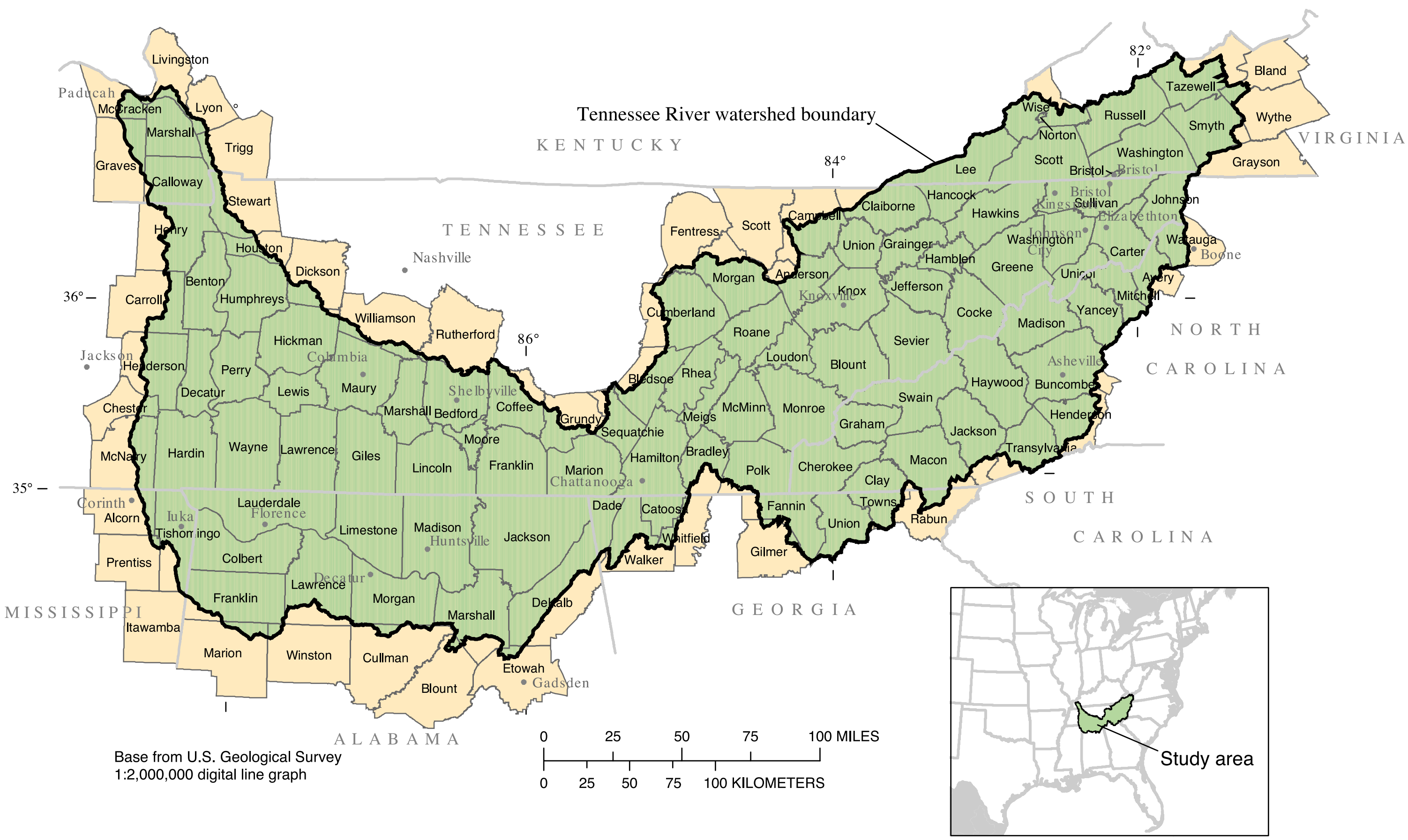


Figure 5. States and counties in the Tennessee River watershed.

WATER USE

Water in river and reservoir systems can be used instream for hydroelectric power generation, for navigation, for maintaining minimum streamflows to support fish and wildlife habitat, and for the assimilation of wastewater. Water also can be withdrawn from the river and reservoir systems to meet offstream needs for thermoelectric power, industry, public supply, and irrigation. Water use in this report is limited primarily to the offstream transactions of water withdrawal, return flow, and consumptive use in the Tennessee River watershed (fig. 6). Water delivered to a user from a public supplier or water released from a user to a wastewater treatment plant is not accounted for in this report; however, these transactions are shown as B and C in figure 6.

Surface- and ground-water withdrawals and consumptive-use estimates are reported for thermoelectric power, industry, public supply, and irrigation. Wastewater releases are reported as return flows in the public-supply category. Wastewater releases refer to water released from private and public wastewater-treatment facilities as designated by the USEPA as publicly owned treatment works (POTW). The reported wastewater releases include the quantity of water released to a stream and exclude the quantity of water reclaimed for beneficial uses, such as irrigation of golf courses and parks. Return flow also is reported for the thermoelectric power and industrial categories. The diversion of flow to the Tennessee-Tombigbee Waterway in the Mobile River watershed for lockages for navigation and to the Barkley Reservoir in the Cumberland River watershed for generating hydroelectric power are identified as interbasin transfers.

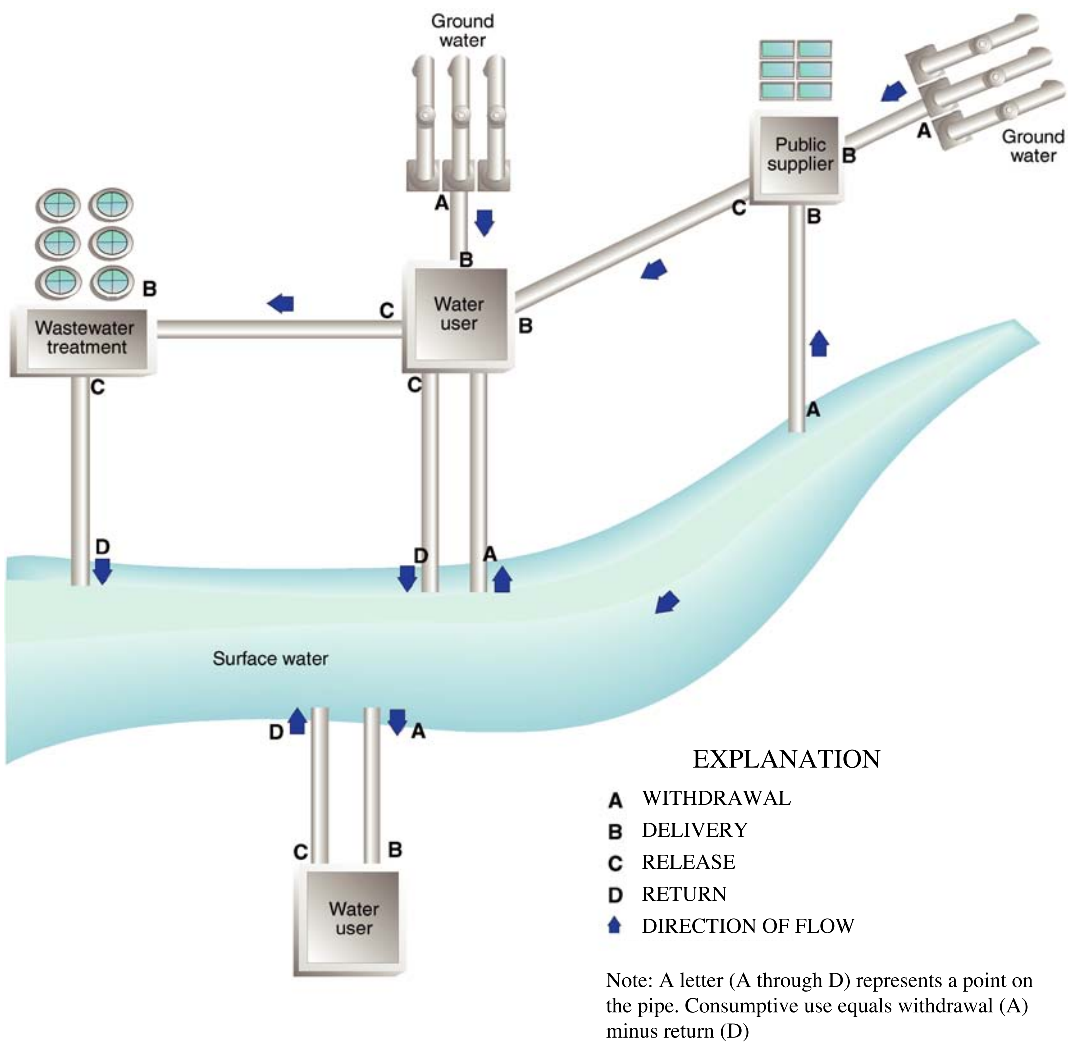


Figure 6. The interrelation of water-using entities and water-use transactions to sources of supply.

Instream use

Instream use occurs without diverting or withdrawing water from surface- or ground-water sources. Examples of instream use are hydroelectric power generation, navigation, maintenance of minimum streamflows to support fish and wildlife habitat, and for wastewater assimilation. Quantitative estimates for most instream uses are difficult to compile for a large-scale regional watershed, and assessing the instream water use in the Tennessee River watershed was beyond the scope of this report. However, because instream uses compete with offstream uses and affect the quality and quantity of water resources for all uses, effective water-resources management requires that methods and procedures be devised to enable instream uses to be assessed quantitatively.

Knowledge about the processes and functions of instream flow can be integrated with engineering designs sensitive to the environment to meet the biological and commercial water-use needs for instream use. TVA is developing the science and technology to increase the efficiency and capacity of its 30 hydroelectric plants without degrading water quality (appendix C). Nine main river and 19 tributary hydroelectric projects within the Tennessee River watershed have the potential to generate 3,700 megawatt hours of electricity. This capacity represents about 13 percent of TVA's generating capacity and is important to meet peak power demands and maintain power system reliability within the watershed, particularly during the summer months. State-of-the-art hydroturbines, control systems, system optimization models, and water-quality technologies are used to balance regional needs for energy and power. Minimum instream flows typically are provided by multiple techniques, including re-regulation weirs at Norris, Chatuge, South Holston, small minimum flow turbines at Tims Ford, Nottely, Blue Ridge, and turbine pulsing units at Apalachia, Boone, Cherokee, Douglas, Ft. Patrick Henry, Watauga, and Wilbur.

Navigation on the Tennessee River system is important for commercial shipping and recreational boating. Cargo transported on the Tennessee River system averages 50 million tons per year. The Tennessee River system also provides passage for 20,000 recreational vessels each year and supports the boat building, marina, and sports fishing industries. Fourteen locks at 10 dams in the river system are operated to support navigation. Jointly, the USACE, U.S. Coast Guard, and TVA maintain a year-round 11-foot deep navigation channel on 800 miles of main stem and tributary rivers. Passage also is maintained on many more miles of secondary channels for recreational use. The instream use for hydroelectric power and navigation of the Tennessee River system does not affect the consumptive use because the water remains in the river system.

Total Offstream Water Use

Total freshwater withdrawals during 2000 were estimated to be 12,211 Mgal/d for the offstream categories of thermoelectric power, industry, public supply, and irrigation (tables 1, 2, and 3). Per capita use for the offstream uses in 2000 was 2,710 gal/d of freshwater (table 2). Estimates of withdrawals by source indicate that during 2000, total surface-water withdrawals were 11,996 Mgal/d. Total ground-water withdrawals were 215 Mgal/d. Return flows to streams from thermoelectric power, industrial, and municipal wastewater facilities are estimated to have been 11,562 Mgal/d. Consumptive use was 649 Mgal/d. Water withdrawals that exclude thermoelectric power totals (nonpower withdrawals) are estimated as 1,935 Mgal/d, return flows as 1,319 Mgal/d, and consumptive use as 617 Mgal/d. Surface water supplied 98 percent of the total water, and ground water supplied the remaining 2 percent (fig. 7). The total consumptive use of water was 5 percent, and return flow was 95 percent of the disposition of the water.

A comparison of total water withdrawals by WUTA (table 1) indicates that Watts Bar-Chickamauga (3,187 Mgal/d) and Wheeler-Wilson (2,552 Mgal/d) account for 47 percent of the total water withdrawn in the Tennessee River watershed. A similar comparison of total withdrawals by HUC (table 2, appendix B) indicates that 06030002 Wheeler Lake (2,390 Mgal/d) and 06010207 Lower Clinch (1,848 Mgal/d) account for about 35 percent of the total withdrawals. The spatial distribution of total water withdrawals by HUC and by source is shown in figure 8. A comparison of total water withdrawals by State within the watershed is shown in table 3.

The two largest categories of withdrawals were thermoelectric power and industrial (tables 4, 5, and 6). During 2000, the most water (10,276 Mgal/d, 84 percent) was withdrawn for cooling at the thermoelectric plants (table 4). The largest thermoelectric-power water withdrawal (2,108 Mgal/d, 21 percent) was from the Wheeler Reservoir in the Wheeler-Wilson WUTA (table 4). Industrial withdrawals accounted for 10 percent (1,205 Mgal/d) of the total (table 4). The largest industrial withdrawal, 497 Mgal/d, was from the Fort Patrick Henry RCA and was 41 percent of the total industrial withdrawals (table 4). The return flow from thermoelectric power, industrial, and municipal wastewater facilities is 11,562 Mgal/d, or 95 percent of the water withdrawals (table 4). The largest return flow by category is thermoelectric power, 10,244 Mgal/d, or 89 percent of the total return flow (table 4). Overall, thermoelectric power has the smallest consumptive use; less than 1 percent, or 32.2 Mgal/d, of the thermoelectric power water withdrawals is consumptively used, compared to 263 Mgal/d (22 percent) for industry, 285 Mgal/d (43 percent) for public supply, and 68.9 Mgal/d (100 percent) for irrigation. Surface-water withdrawals by water-use category are shown by WUTA (table 7), by HUC (table 8), and by county (table 9). Ground-water withdrawals by water-use category are shown by WUTA (table 10), by HUC (table 11), and by county (table 12).

Consumptive use and interbasin transfers account for most of the water lost from the Tennessee River watershed. Consumptive use is reported as an increasing number at the junctures of the WUTAs to show the influence of the cumulative water withdrawals and return flows on water availability. The cumulative consumptive use at the juncture of Fort Loudoun WUTA is 176 Mgal/d; Watts Bar-Chickamauga, 288 Mgal/d; Nickajack, 300 Mgal/d; Guntersville, 317 Mgal/d; Wheeler-Wilson, 533 Mgal/d; Pickwick, 563 Mgal/d; and Kentucky, 649 Mgal/d for 2000 (fig. 9). The average daily lockage is 200 Mgal/d through the Jamie Whitten lock on the Tennessee-Tombigbee Waterway, and the average daily diversion of flow is 3,361 Mgal/d for hydroelectric power generation at Barkley Dam; the 200 and the 3,361 Mgal/d are interbasin transfers.

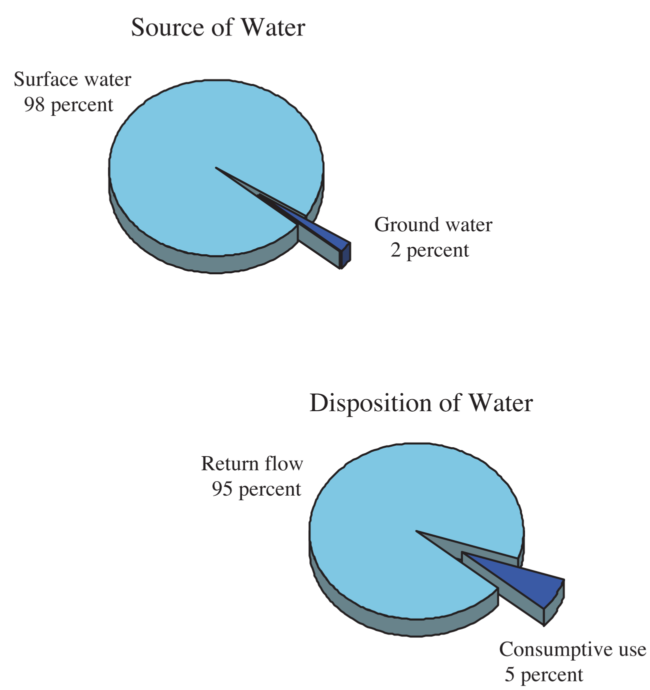


Figure 7. Source and disposition of total water use in the Tennessee River watershed in 2000.

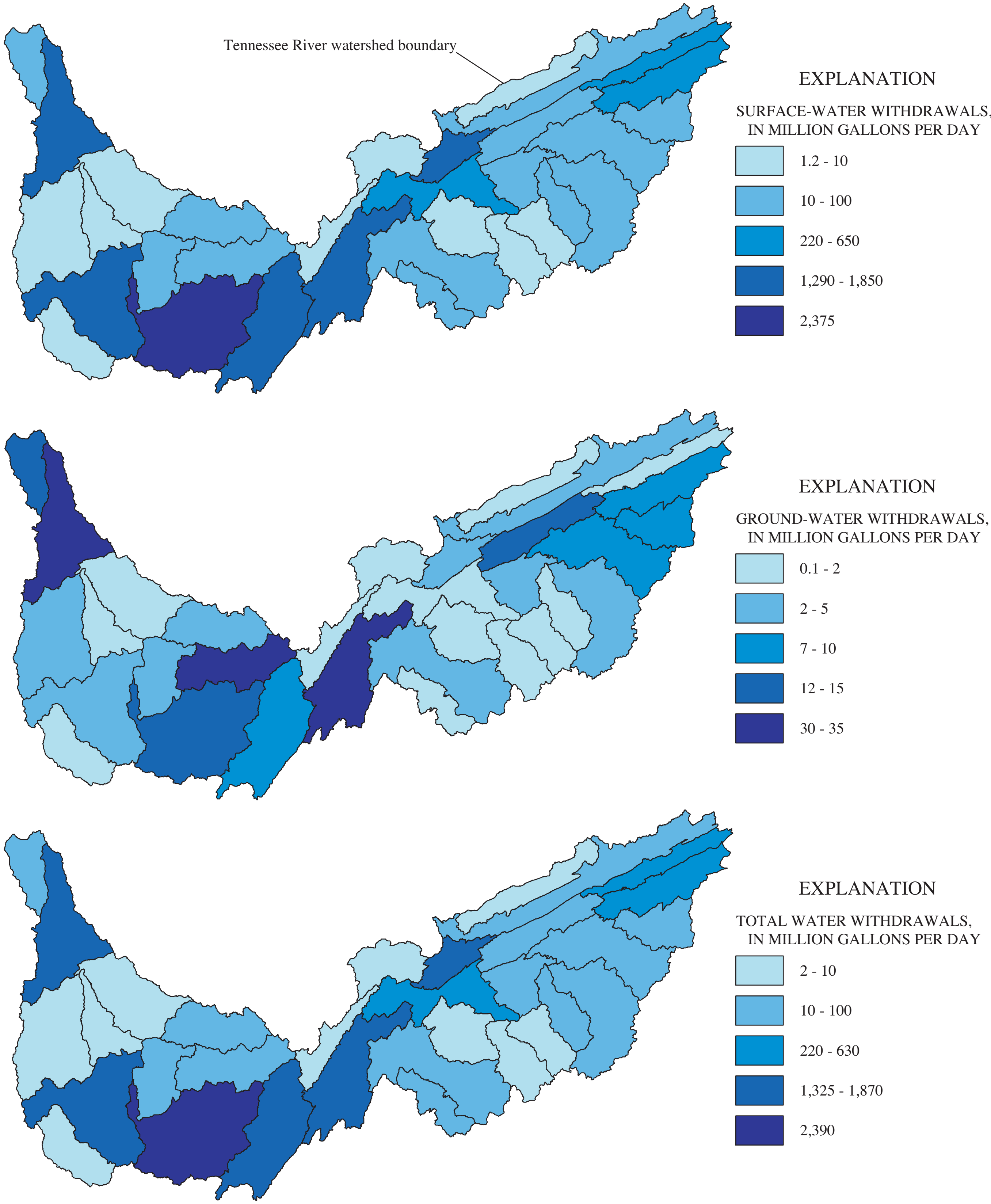


Figure 8. Total water withdrawals by source and by hydrologic unit in the Tennessee River watershed in 2000.

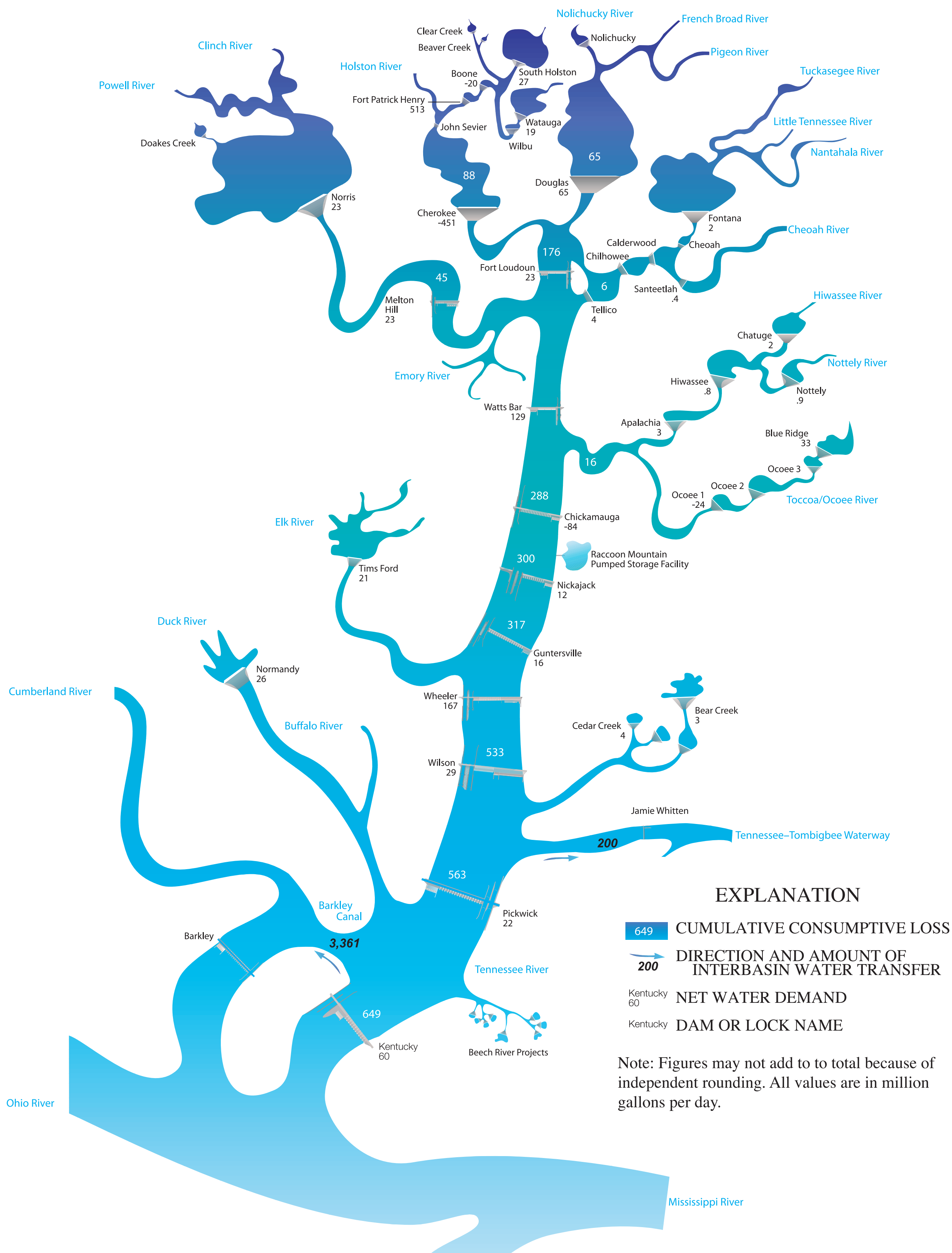


Figure 9. Cumulative consumptive use at major water-use tabulation area junctures and net water demand for reservoir catchment areas in the Tennessee River watershed in 2000.

The intensity of use for the Tennessee River watershed measured as a function of area was 298,489 gal/d/mi^2 in 2000. Gross per capita use also is a measure of intensity of use. High per capita use values in the Tennessee River watershed generally correspond to sparsely populated watersheds with large thermoelectric power water withdrawals. Gross per capita use (fig. 10 and table 2) ranges from 19,782 gal/d (Kentucky Lake, 0604005) to 39 gal/d (Lower Duck, 06040003).

The source, use, and disposition of the 12,211 Mgal/d of water withdrawn in the Tennessee watershed during 2000 is summarized in figure 11. Surface water was the source of 11,996 Mgal/d, and ground water was the source of the remaining 215 Mgal/d. Industry withdrew 1,134 Mgal/d of surface water and 71 Mgal/d of ground water; consumed 263 Mgal/d; and returned the remaining 942 Mgal/d as flow to the river (fig. 11).

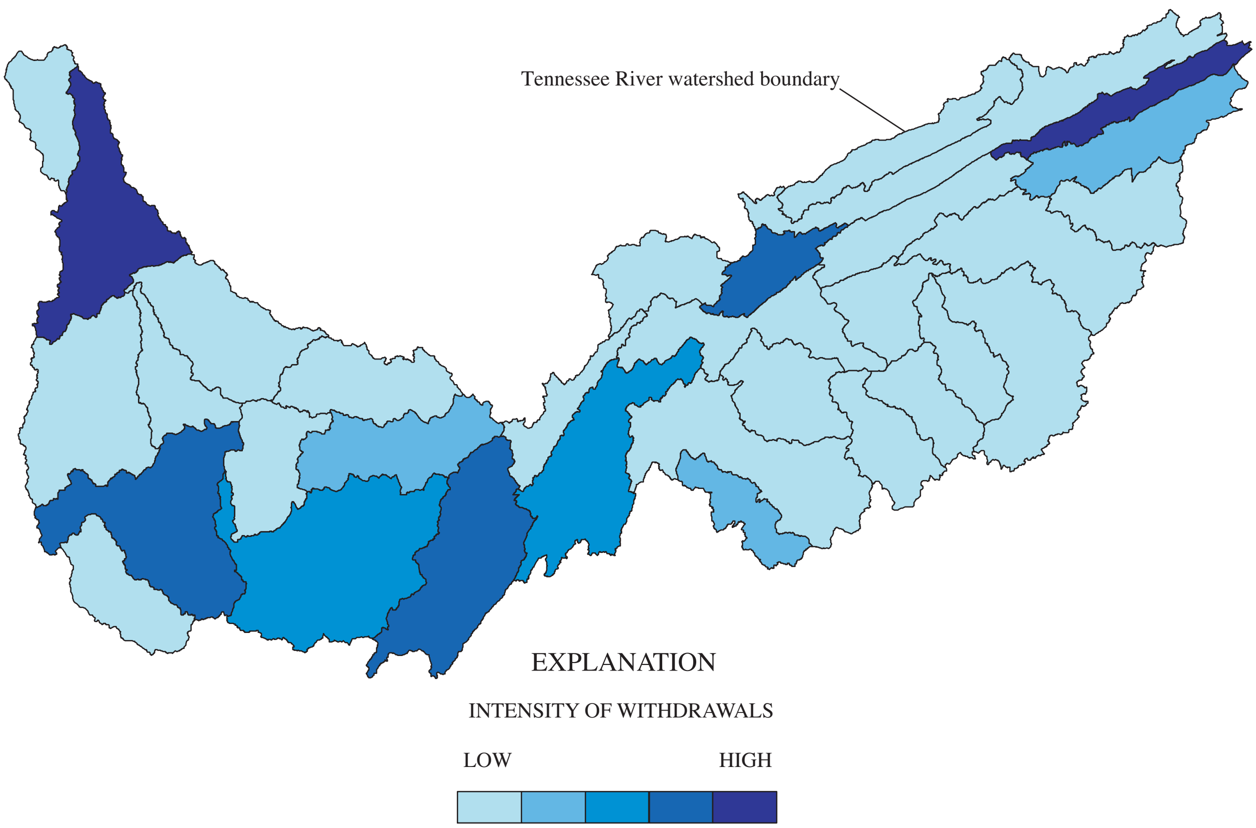


Figure 10. Intensity of per capita use withdrawals by hydrologic unit in the Tennessee River watershed in 2000.

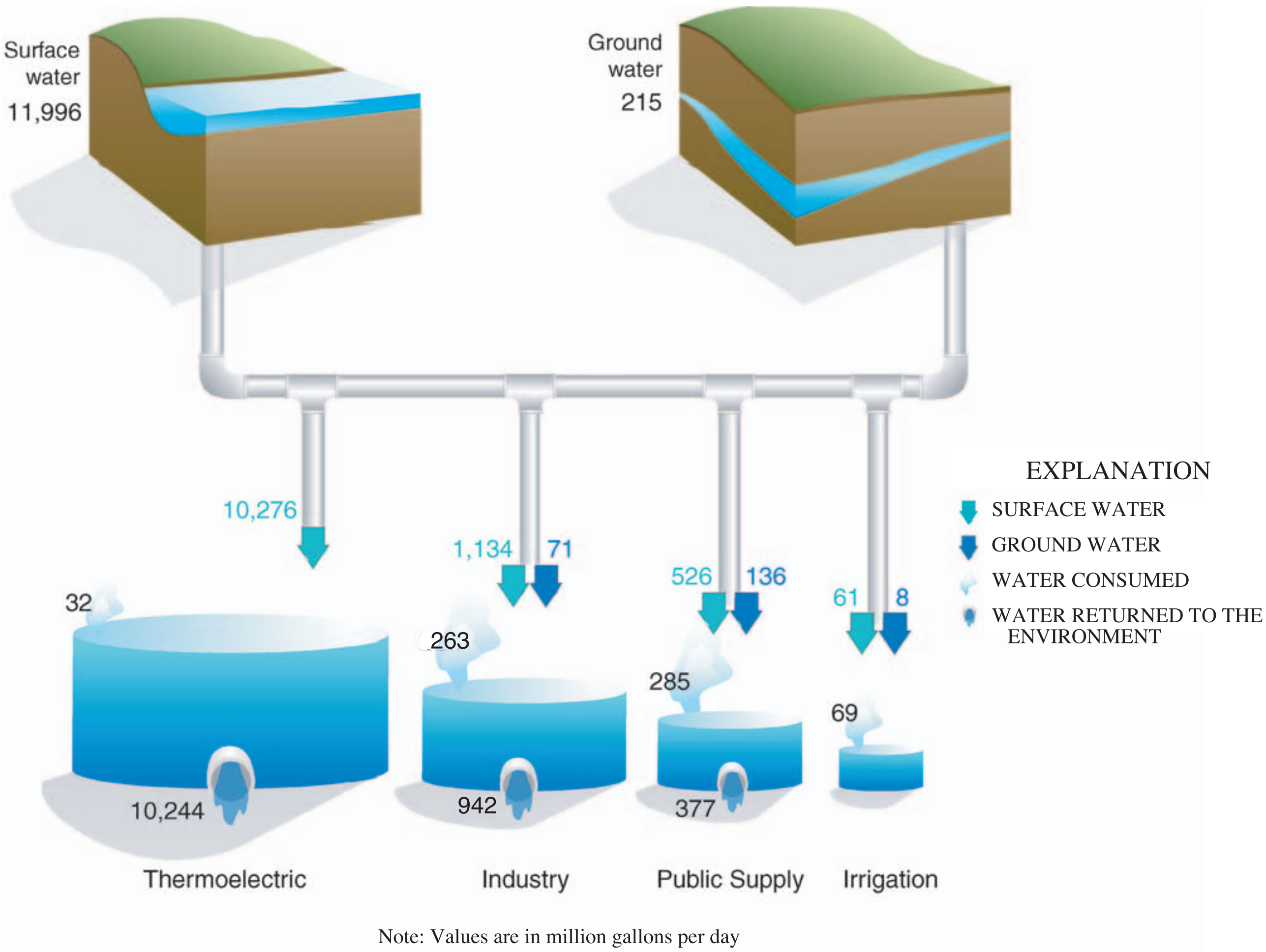
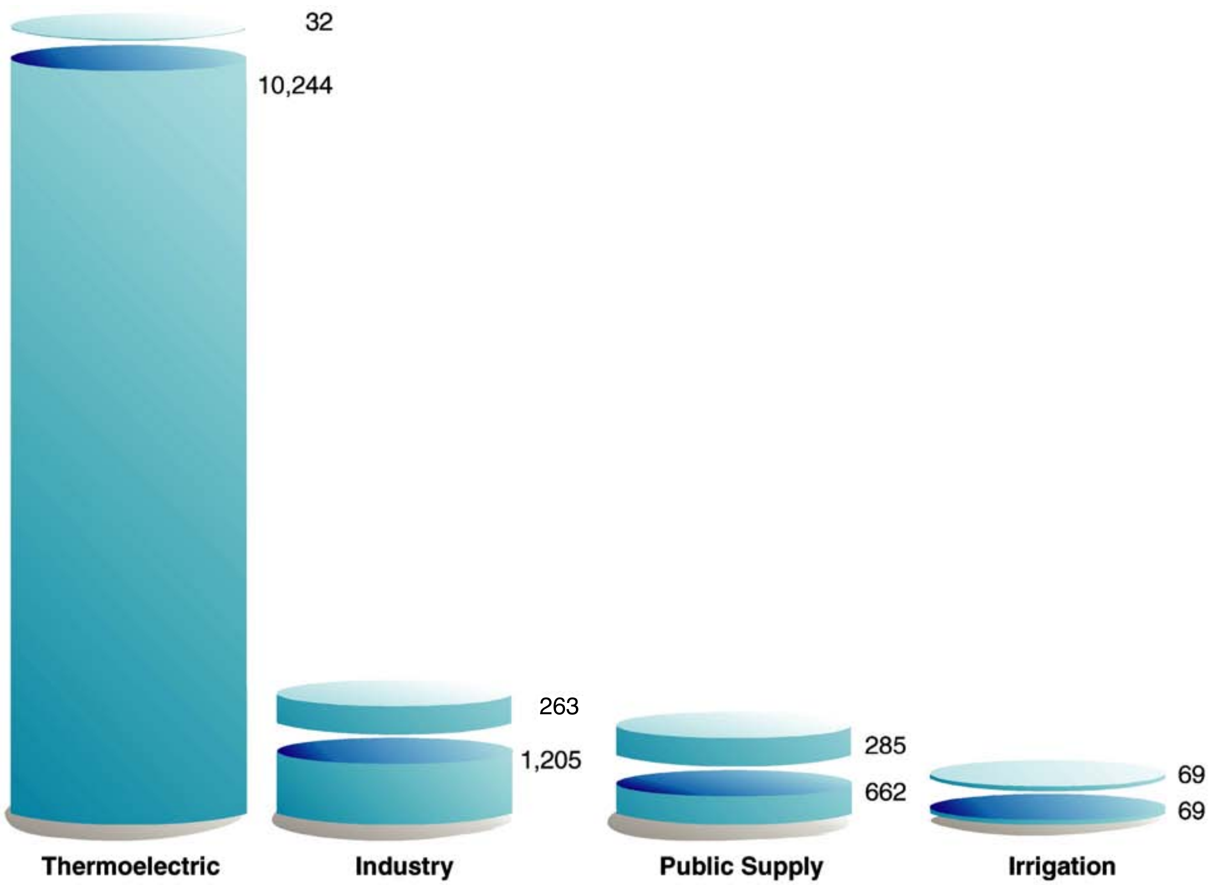


Figure 11. Source, use, and disposition of water in the Tennessee River watershed in 2000.

Water withdrawn for thermoelectric power is used for cooling water, and most of this water is returned to the Tennessee River. As a result, thermoelectric power use has little impact on overall water availability in the watershed because the resulting consumptive use is low. By category, withdrawals and consumptive use are compared as follows. Thermoelectric power water withdrawals are more than eight times larger than industrial water withdrawals (fig. 12). Public supply water withdrawals are slightly more than one-half of industrial water withdrawals, and irrigation water withdrawals are slightly more than one-tenth of public-supply withdrawals. Consumptive use accounts for 5 percent of the total water withdrawals. Consumptive use for irrigation is more than twice that of thermoelectric power. Consumptive use for industry (263 Mgal/d) and public supply (285 Mgal/d) is about the same for both categories, and together these two categories account for about 84 percent of the total consumptive use. The combined consumptive use for industry and public supply is about 17 times greater than that of thermoelectric power.



Note: Consumptive use is indicated in top layer and total water withdrawn is indicated in lower layer.

Figure 12. Comparison of water withdrawal and consumptive use by category, in million gallons per day, in the Tennessee River watershed in 2000.

Table 1. Total offstream water use by water-use tabulation area in 2000

[Figures may not add to totals because of independent rounding. All values are in million gallons per day. Net water demand and consumptive use are expressed as integers. WUTA, water-use tabulation area]

Water-use tabulation area Reservoir catchment area	Withdrawal **Surface water**	 **Ground water**	 **Total water**	**Total return flow**	**Net water demand** ***Consumptive use***
Cherokee					
Watauga	12.40	9.40	21.80	2.85	19
South Holston	21.30	8.01	29.31	2.33	27
Boone	0.00	3.72	3.72	23.62	-20
Fort Patrick Henry	513.10	.00	513.10	.00	513
Cherokee	639.22	13.00	652.22	1,103.66	-451
WUTA total	**1,186.02**	**34.13**	**1,220.15**	**1,132.46**	**88**
Douglas					
Douglas	**110.78**	**11.98**	**122.76**	**57.50**	**65**
Fort Loudoun					
Fort Loudoun	77.52	1.60	79.12	56.39	23
Cumulative consumptive use					***176***
Fontana-Tellico					
Fontana	4.64	1.13	5.76	3.37	2
Santeetlah	0.44	.00	0.44	.00	0.4
Tellico	4.16	0.57	4.73	1.09	4
WUTA total	**9.23**	**1.70**	**10.93**	**4.46**	**6**
Norris					
Norris	29.88	3.42	33.30	10.69	23
Melton Hill	500.36	1.58	501.94	479.33	23
WUTA total	**530.25**	**4.99**	**535.24**	**490.02**	**45**
Hiwassee-Ocoee					
Chatuge	1.73	0.18	1.91	0.27	2
Nottely	0.60	0.55	1.15	0.24	.9
Hiwassee	0.93	0.00	0.93	0.10	.8
Apalachia	2.94	0.00	2.94	.00	3
Blue Ridge	33.25	0.05	33.30	0.33	33
Ocoee	0.01	1.11	1.12	24.63	-24
WUTA total	**39.46**	**1.90**	**41.36**	**25.57**	**16**
Watts Bar-Chickamauga					
Watts Bar	1,494.66	1.11	1,495.77	1,366.58	129
Chickamauga	1,667.10	24.02	1,691.12	1,775.56	-84
WUTA total	**3,161.76**	**25.13**	**3,186.89**	**3,142.13**	**45**
Cumulative consumptive use					***288***

Table 1. Total offstream water use by water-use tabulation area in 2000—Continued

Water-use tabulation area Reservoir catchment area	Withdrawal Surface water	 Ground water	 Total water	Total return flow	Net water demand *Consumptive use*
Nickajack					
Nickajack	62.94	9.86	72.80	60.49	12
Cumulative consumptive use					***300***
Guntersville					
Guntersville	1,594.42	7.86	1,602.28	1,585.93	16
Cumulative consumptive use					***317***
Tims Ford					
Tims Ford	58.57	2.80	61.37	40.50	21
Wheeler-Wilson					
Wheeler	2,449.02	45.82	2,494.84	2,328.13	167
Wilson	53.77	3.36	57.13	27.81	29
WUTA total	**2,502.79**	**49.18**	**2,551.96**	**2,355.94**	**196**
Cumulative consumptive use					***533***
Pickwick					
Pickwick	1,308.23	5.41	1,313.64	1,291.56	22
Cedar Creek	3.00	1.13	4.13	.00	4
Upper Bear Creek	2.81	0.16	2.97	.00	3
WUTA total	**1,314.04**	**6.70**	**1,320.74**	**1,291.56**	**29**
Cumulative consumptive use					***563***
Normandy					
Normandy	26.30	2.11	28.41	2.19	26
Kentucky					
Kentucky	1,322.24	54.94	1,377.17	1,317.30	60
Watershed total	**11,996**	**215**	**12,211**	**11,562**	**649**

Table 2. Total offstream water use by hydrologic unit in 2000

[Figures may not add to totals because of independent rounding. Water-use transactions in million gallons per day; gross per capita use, in gallons per day]

Hydrologic unit code	Population	Gross per capita use	Withdrawal			Total return flow	Net water demand
			Surface water	Ground water	Total water		
06010101	32,017	19,446	621.90	0.71	622.61	0.00	623
06010102	238,626	2,273	534.40	8.00	542.40	488.56	54
06010103	163,921	129	12.20	9.01	21.21	13.46	8
06010104	178,460	166	17.32	12.30	29.62	632.52	-603
06010105	338,535	147	47.09	2.70	49.79	19.93	30
06010106	72,472	498	35.45	0.65	36.10	27.31	9
06010107	107,541	129	11.62	2.31	13.92	5.78	8
06010108	164,582	164	16.57	10.43	27.01	11.39	16
06010201	419,747	524	218.28	1.62	219.90	59.07	161
06010202	36,959	114	3.95	0.26	4.21	2.17	2
06010203	43,448	48	1.22	0.88	2.10	1.20	0.9
06010204	48,438	107	4.60	0.57	5.17	1.09	4
06010205	142,559	194	25.13	2.58	27.71	9.90	18
06010206	64,584	83	4.50	0.83	5.33	0.42	5
06010207	181,670	10,172	1,845.46	2.44	1,847.90	486.73	1,361
06010208	68,681	135	9.06	0.21	9.27	1,347.86	-1,339
06020001	467,720	3,600	1,652.85	30.87	1,683.71	1,757.61	-74
06020002	202,501	433	83.11	4.48	87.59	79.05	9
06020003	25,753	1,309	33.25	0.45	33.71	24.96	9
06020004	30,169	112	2.36	1.03	3.39	0.62	3
06030001	145,766	10,969	1,592.06	6.83	1,598.89	1,585.32	14
06030002	505,179	4,730	2,374.82	14.87	2,389.69	2,259.60	130
06030003	71,769	1,261	59.88	30.60	90.49	48.25	42
06030004	46,328	348	12.98	3.12	16.10	2.27	14
06030005	198,508	7,206	1,422.52	7.87	1,430.40	1,378.51	52
06030006	40,750	197	5.84	2.19	8.03	1.63	6
06040001	77,951	124	5.45	4.19	9.64	22.87	-13
06040002	99,674	286	26.36	2.11	28.47	9.63	19
06040003	115,264	39	4.36	0.09	4.45	8.94	-4
06040004	22,681	130	1.20	1.75	2.94	1.33	2
06040005	66,943	19,782	1,289.19	35.07	1,324.26	1,274.45	50
06040006	86,427	407	21.32	13.84	35.16	0.01	35
Watershed total	**4,505,623**	**2,710**	**11,996**	**215**	**12,211**	**11,562**	**649**

Table 3. Total offstream water use by county in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

State County	Withdrawal Surface water	 Ground water	 Total water	Total return flow	Net water demand
Alabama					
Colbert	1,317.44	1.54	1,318.98	1,303.09	15.89
Cullman	1.15		1.15		1.15
Dekalb	7.20	2.48	9.68	5.73	3.95
Franklin	3.02	1.13	4.16	1.61	2.54
Jackson	1,565.74	1.01	1,566.75	1,570.19	-3.44
Lauderdale	14.75	0.85	15.60	10.80	4.81
Lawrence	67.43		67.43	49.90	17.54
Limestone	2,139.65	7.78	2,147.43	2,119.34	28.09
Madison	36.36	27.27	63.63	36.39	27.23
Marion	2.50		2.50		2.50
Marshall	17.30	3.31	20.61	8.60	12.01
Morgan	203.40	8.16	211.56	122.17	89.39
Winston	0.31	0.16	0.47		0.47
State total	**5,376.25**	**53.69**	**5,429.94**	**5,227.82**	**202.12**
Georgia					
Catoosa	1.24	8.18	9.42	2.39	7.03
Dade	1.79	0.47	2.26	0.28	1.98
Fannin	1.29	0.02	1.31	0.33	0.98
Rabun	1.63		1.63	1.40	0.23
Towns	0.81		0.81	0.27	0.54
Union	0.60	0.55	1.15	0.24	0.91
Walker	3.93	6.64	10.57	10.02	0.55
State total	**11.29**	**15.86**	**27.15**	**14.93**	**12.22**
Kentucky					
Calloway		4.90	4.90		4.90
Graves		0.05	0.05		0.05
Livingston	20.10	2.44	22.54	0.22	22.32
Lyon			0.00	0.01	-0.01
Marshall	12.97	6.08	19.05	0.04	19.01
McCracken		0.78	0.78		0.78
State total	**33.07**	**14.26**	**47.33**	**0.27**	**47.07**
Mississippi					
Tishomingo	.02	4.36	4.38	0.34	4.04
State total	**.02**	**4.36**	**4.38**	**0.34**	**4.04**
North Carolina					
Avery	0.20	1.42	1.62	1.56	0.06
Buncombe	32.01	1.63	33.64	15.71	17.93
Cherokee	1.71	0.00	1.71	0.00	1.71
Clay	0.04	0.18	0.22	0.10	0.12
Graham	0.94		0.94		0.94
Haywood	34.62	0.20	34.82	25.91	8.91
Henderson	8.54	0.25	8.79	3.08	5.71
Jackson	0.88	0.85	1.73	0.89	0.84
Macon	1.53	0.26	1.79	0.77	1.02
Madison	0.26	0.24	0.50	0.19	0.31
Mitchell	1.38	3.59	4.96	0.61	4.35
Swain	0.34	0.02	0.36	0.31	0.05

Table 3. Total offstream water use by county in 2000—Continued

State County	Withdrawal Surface water	 Ground water	 Total water	Total return flow	Net water demand
North Carolina—Continued					
Transylvania	2.19	0.58	2.77	0.95	1.82
Watauga	1.15	0.28	1.43	0.60	0.83
Yancey	0.57	0.00	0.57	0.31	0.26
State total	**86.35**	**9.50**	**95.85**	**50.99**	**44.86**
Tennessee					
Anderson	489.82	0.97	490.79	476.63	14.17
Bedford	5.70	0.83	6.53	3.36	3.18
Benton	4.28	19.36	23.64	1.59	22.05
Bledsoe	0.20	0.39	0.59	0.14	0.45
Blount	14.57	0.26	14.84	7.18	7.65
Bradley	12.01	1.38	13.39	9.93	3.46
Campbell	2.57	0.52	3.09	1.19	1.90
Carroll		0.69	0.69	0.14	0.54
Carter	0.05	7.53	7.59	2.44	5.14
Claiborne	2.60	0.23	2.83	0.42	2.41
Cocke	5.09	0.46	5.54	1.40	4.14
Coffee	60.60	0.06	60.66	41.33	19.33
Cumberland	5.02	0.21	5.23	2.22	3.01
Decatur	1.29	0.23	1.52	0.49	1.02
Dickson	1.53		1.53		1.53
Franklin	2.42	2.02	4.43	0.98	3.45
Giles	3.64	0.21	3.85	2.27	1.58
Grainger	0.06	0.05	0.10	0.14	-0.03
Greene	11.86	0.01	11.87	6.96	4.91
Grundy	0.75		0.75	0.26	0.49
Hamblen	9.25	1.05	10.30	4.09	6.21
Hamilton	1,608.78	14.18	1,622.97	1,585.72	37.24
Hancock	0.34		0.34	0.15	0.20
Hardin	24.53	2.41	26.94	20.92	6.03
Hawkins	624.46	1.15	625.61	622.39	3.22
Henderson	3.59	0.37	3.96	1.15	2.80
Henry	0.02	3.06	3.08	2.07	1.01
Hickman	2.33	0.00	2.33	0.44	1.89
Houston		0.16	0.16		0.16
Humphreys	1,273.53	11.37	1,284.90	1,270.71	14.19
Jefferson	2.79	12.17	14.97	3.36	11.61
Johnson	1.24	0.99	2.23	0.69	1.54
Knox	62.38	1.16	63.55	50.43	13.12
Lawrence	1.90	2.41	4.31	2.07	2.24
Lewis	0.10	1.59	1.69	0.78	0.92
Lincoln	1.65	2.17	3.81	1.18	2.63
Loudoun	13.87	1.20	15.07	8.30	6.77
Marion	2.64	0.71	3.36	0.80	2.55
Marshall	2.76	0.14	2.90	4.20	-1.29
Maury	12.30	1.10	13.40	8.18	5.22
McMinn	67.79	2.36	70.15	68.47	1.68
McNairy	0.01	0.98	0.99	0.26	0.73
Meigs	0.32	0.58	0.90	0.22	0.68
Monroe	5.08	0.57	5.65	2.66	2.99
Moore	1.02	0.75	1.77	0.61	1.17

Table 3. Total offstream water use by county in 2000—Continued

State County	Withdrawal Surface water	Withdrawal Ground water	Withdrawal Total water	Total return flow	Net water demand
Tennessee—Continued					
Morgan	1.05	0.00	1.05	0.64	0.41
Perry	0.76	0.00	0.76	0.25	0.51
Polk	32.12	0.44	32.56	24.67	7.89
Rhea	176.59	0.80	177.38	159.55	17.83
Roane	1,351.06	0.20	1,351.25	1,348.77	2.48
Sequatchie	0.67	0.00	0.67	0.47	0.19
Sevier	7.66	0.24	7.90	5.28	2.61
Stewart	0.00	0.02	0.02	0.00	0.02
Sullivan	521.83	0.38	522.21	485.05	37.17
Unicoi	0.09	5.93	6.02	1.46	4.55
Union	0.00	0.58	0.58	0.38	0.19
Washington	13.27	0.41	13.68	11.40	2.28
Wayne	0.87	0.20	1.07	0.35	0.73
Williamson	0.00	0.05	0.05	0.00	0.05
State total	**6,452.71**	**107.31**	**6,560.02**	**6,257.22**	**302.8**
Virginia					
Lee	0.78	0.58	1.36	0.00	1.36
Russell	13.59	0.48	14.07	0.00	14.07
Scott	1.05	0.01	1.06	0.00	1.06
Smyth	2.93	4.09	7.03	0.00	7.03
Tazewell	2.43	0.57	3.00	6.02	-3.02
Washington	8.43	3.26	11.69	2.33	9.36
Wise	7.42	0.89	8.32	2.54	5.78
State total	**36.64**	**9.88**	**46.52**	**10.89**	**35.63**
Watershed total	**11,996**	**215**	**12,211**	**11,562**	**649**

Table 4. Total water use by category and water-use tabulation area in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day; WUTA, water-use tabulation area]

Water-use tabulation area / Reservoir catchment area	Thermoelectric power: Water withdrawal	Thermoelectric power: Cooling water return flow	Industrial: Water withdrawal	Industrial: Return flow	Public supply: Water withdrawal	Public supply: Waste-water return flow	Irrigation: Water withdrawal	Total: Water withdrawal	Total: Return flow
Cherokee									
Watauga	0.00	0.00	0.64	0.47	21.04	2.38	0.12	21.80	2.85
South Holston	0.00	0.00	0.83	0.47	26.25	1.86	2.23	29.31	2.33
Boone	0.00	0.00	0.00	0.04	3.72	23.58	0.00	3.72	23.62
Fort Patrick Henry	0.00	0.00	496.70	0.00	16.40	0.00	0.00	513.10	0.00
Cherokee	621.00	621.00	10.72	467.53	20.22	15.13	0.28	652.22	1,103.66
WUTA total	**621.00**	**621.00**	**508.89**	**468.51**	**87.63**	**42.95**	**2.63**	**1,220.15**	**1,132.46**
Douglas									
Douglas	**4.97**	**0.00**	**42.28**	**28.49**	**73.07**	**29.01**	**2.44**	**122.76**	**57.50**
Fort Loudoun									
Fort Loudoun	**0.00**	**0.00**	**5.02**	**1.37**	**72.42**	**55.03**	**1.68**	**79.12**	**56.39**
Fontana-Tellico									
Fontana	0.00	0.00	1.94	1.36	3.83	2.01	0.00	5.76	3.37
Santeetlah	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.44	0.00
Tellico	0.00	0.00	0.00	0.00	4.68	1.09	0.05	4.73	1.09
WUTA total	**0.00**	**0.00**	**1.94**	**1.36**	**8.94**	**3.10**	**0.05**	**10.93**	**4.46**
Norris									
Norris	9.24	0.00	6.24	0.21	17.56	10.48	0.26	33.30	10.69
Melton Hill	469.00	469.00	1.48	0.90	31.40	9.43	0.05	501.94	479.33
WUTA total	**478.24**	**469**	**7.72**	**1.11**	**48.97**	**19.91**	**.31**	**535.24**	**490.02**
Hiwassee-Ocoee									
Chatuge	0.00	0.00	0.04	0.00	1.88	0.27	0.00	1.91	0.27
Nottely	0.00	0.00	0.00	0.00	1.00	0.24	0.15	1.15	0.24
Hiwassee	0.00	0.00	0.08	0.00	0.75	0.10	0.11	0.93	0.10
Apalachia	0.00	0.00	0.00	0.00	2.89	0.00	0.05	2.94	0.00
Blue Ridge	0.00	0.00	31.77	0.00	1.47	0.33	0.07	33.30	0.33
Ocoee	0.00	0.00	0.00	24.37	1.11	0.26	0.01	1.12	24.63
WUTA total	**0.00**	**0.00**	**31.88**	**24.37**	**9.09**	**1.20**	**0.39**	**41.36**	**25.57**
Watts Bar-Chickamauga									
Watts Bar	1,484.10	1,345.00	0.03	0.24	9.53	21.34	2.12	1,495.77	1,366.58
Chickamauga	1,571.40	1,693.50	68.36	68.14	47.39	13.92	3.97	1,691.12	1,775.56
WUTA total	**3,055.50**	**3,038.50**	**68.38**	**68.37**	**56.91**	**35.26**	**6.09**	**3,186.89**	**3,142.13**
Nickajack									
Nickajack	**0.00**	**0.00**	**23.66**	**15.30**	**48.78**	**45.19**	**0.35**	**72.80**	**60.49**
Guntersville									
Guntersville	**1,546.00**	**1,546.00**	**10.97**	**19.49**	**42.43**	**20.45**	**2.88**	**1,602.28**	**1,585.93**

Table 4. Total water use by category and water-use tabulation area in 2000—Continued

Water-use tabulation area / Reservoir catchment area	Thermoelectric power		Industrial		Public supply		Irrigation	Total	
	Water withdrawal	Cooling water return flow	Water withdrawal	Return flow	Water withdrawal	Waste-water return flow	Water withdrawal	Water withdrawal	Return flow
Tims Ford									
Tims Ford	**0.00**	**0.00**	**56.26**	**35.93**	**4.86**	**4.57**	**0.26**	**61.37**	**40.50**
Wheeler-Wilson									
Wheeler	2,108.00	2,107.00	229.62	147.86	110.82	73.27	46.39	2,494.84	2,328.13
Wilson	0.00	0.00	30.01	21.01	23.16	6.80	3.96	57.13	27.81
WUTA total	**2,108.00**	**2,107.00**	**259.63**	**168.87**	**133.98**	**80.07**	**50.35**	**2,551.96**	**2,355.94**
Pickwick									
Pickwick	1,251.00	1,251.00	53.61	26.66	8.92	13.89	0.11	1,313.64	1,291.56
Cedar Creek	0.00	0.00	0.00	0.00	4.13	0.00	0.00	4.13	0.00
Upper Bear Creek	0.00	0.00	0.00	0.00	2.97	0.00	0.00	2.97	0.00
WUTA total	**1,251.00**	**1,251.00**	**53.61**	**26.66**	**16.02**	**13.89**	**0.11**	**1,320.74**	**1,291.56**
Normandy									
Normandy	**0.00**	**0.00**	**1.45**	**0.00**	**26.26**	**2.19**	**0.69**	**28.41**	**2.19**
Kentucky									
Kentucky	**1,211.00**	**1,211.00**	**133.17**	**82.55**	**32.35**	**23.74**	**0.65**	**1,377.17**	**1,317.30**
Watershed total	**10,276**	**10,244**	**1,205**	**942**	**662**	**377**	**68.9**	**12,211**	**11,562**

Table 5. Total water use by category and hydrologic unit in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

Hydrologic unit code	Thermoelectric power		Industrial		Public supply		Irrigation	Total	
	Water withdrawal	Cooling water return flow	Water withdrawal	Return flow	Water withdrawal	Waste-water return flow	Water withdrawal	Water withdrawal	Return flow
06010101	621.00	0.00	0.00	0.00	1.61	0.00	0.00	622.61	0.00
06010102	0.00	0.00	497.53	465.70	42.64	22.87	2.23	542.40	488.56
06010103	0.00	0.00	0.05	0.04	21.04	13.42	0.12	21.21	13.46
06010104	0.00	621.00	10.72	2.94	18.62	8.58	0.28	29.62	632.52
06010105	4.97	0.00	4.48	2.25	40.34	17.68	0.00	49.79	19.93
06010106	0.00	0.00	29.00	22.63	6.27	4.68	0.83	36.10	27.31
06010107	0.00	0.00	1.61	0.72	11.83	5.06	0.48	13.92	5.78
06010108	0.00	0.00	7.78	4.08	18.10	7.32	1.13	27.01	11.39
06010201	139.10	0.00	5.02	0.24	73.80	58.84	1.98	219.90	59.07
06010202	0.00	0.00	2.16	1.36	2.05	0.81	0.00	4.21	2.17
06010203	0.00	0.00	0.07	0.00	2.03	1.20	0.00	2.10	1.20
06010204	0.00	0.00	0.00	0.00	5.11	1.09	0.05	5.17	1.09
06010205	9.24	0.00	6.24	0.21	12.23	9.69	0.01	27.71	9.90
06010206	0.00	0.00	0.00	0.00	5.33	0.42	0.00	5.33	0.42
06010207	1,814.00	469.00	1.51	0.90	32.26	16.83	0.13	1,847.90	486.73
06010208	0.00	1,345.00	0.00	0.00	7.29	2.86	1.98	9.27	1,347.86
06020001	1,571.40	1,693.50	24.33	15.30	83.89	48.80	4.10	1,683.71	1,757.61
06020002	0.00	0.00	67.52	68.14	19.53	10.91	0.54	87.59	79.05
06020003	0.00	0.00	31.77	24.37	1.85	0.59	0.09	33.71	24.96
06020004	0.00	0.00	0.00	0.00	3.23	0.62	0.16	3.39	0.62
06030001	1,546.00	1,546.00	10.97	19.49	39.21	19.83	2.72	1,598.89	1,585.32
06030002	2,108.00	2,107.00	169.45	99.20	67.33	53.41	44.91	2,389.69	2,259.60
06030003	0.00	0.00	56.26	37.34	33.98	10.92	0.26	90.49	48.25
06030004	0.00	0.00	0.32	0.07	14.38	2.20	1.40	16.10	2.27
06030005	1,251.00	1,251.00	143.47	94.93	31.91	32.58	4.02	1,430.40	1,378.51
06030006	0.00	0.00	0.00	0.00	8.00	1.63	0.03	8.03	1.63
06040001	0.00	0.00	0.07	19.89	9.26	2.98	0.32	9.64	22.87
06040002	0.00	0.00	1.45	2.05	26.26	7.57	0.75	28.47	9.63
06040003	0.00	0.00	0.00	2.45	4.31	6.49	0.14	4.45	8.94
06040004	0.00	0.00	0.09	0.00	2.83	1.33	0.03	2.94	1.33
06040005	1,211.00	1,211.00	105.19	58.09	7.89	5.35	0.18	1,324.26	1,274.45
06040006	0.00	0.00	27.82	0.00	7.33	0.01	0.00	35.16	0.01
Watershed total	**10,276**	**10,244**	**1,205**	**942**	**662**	**377**	**68.9**	**12,211**	**11,562**

Table 6. Total water use by category and county in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

State County	Thermoelectric power Water withdrawal	Thermoelectric power Cooling water return flow	Industrial Water withdrawal	Industrial Return flow	Public supply Water withdrawal	Public supply Waste-water return flow	Irrigation Water withdrawal	Total Water withdrawal	Total Return flow
Alabama									
Colbert	1,251.00	1,251.00	60.02	47.45	7.96	4.64		1,318.98	1,303.09
Cullman			1.15					1.15	0.00
Dekalb			1.11	0.88	8.57	4.85		9.68	5.73
Franklin					4.13	1.61	0.03	4.16	1.61
Jackson	1,546.00	1,546.00	9.20	18.09	8.95	6.10	2.60	1,566.75	1,570.19
Lauderdale					13.74	10.80	1.86	15.60	10.80
Lawrence			59.85	47.26	2.19	2.64	5.39	67.43	49.90
Limestone	2,108.00	2,107.00			11.01	12.34	28.42	2,147.43	2,119.34
Madison			1.34	1.03	49.86	35.36	12.43	63.63	36.39
Marion					2.50			2.50	0.00
Marshall			0.66	0.52	19.82	8.08	0.13	20.61	8.60
Morgan			166.96	99.20	42.90	22.97	1.70	211.56	122.17
Winston					0.47			0.47	0.00
State total	**4,905.00**	**4,904.00**	**300.29**	**214.42**	**172.10**	**109.40**	**52.55**	**5,429.94**	**5,227.82**
Georgia									
Catoosa					8.53	2.39	0.89	9.42	2.39
Dade					1.70	0.28	0.56	2.26	0.28
Fannin					1.22	0.33	0.09	1.31	0.33
Rabun			1.63	1.36		0.04		1.63	1.40
Towns					0.81	0.27		0.81	0.27
Union					1.00	0.24	0.15	1.15	0.24
Walker			2.35	2.31	7.63	7.72	0.59	10.57	10.02
State total	**0.00**	**0.00**	**3.98**	**3.67**	**20.89**	**11.26**	**2.28**	**27.15**	**14.93**
Kentucky									
Calloway			1.59		3.31			4.90	0.00
Graves					0.05			0.05	0.00
Livingston			22.29		0.25	0.22		22.54	0.22
Lyon				0.01				0.00	0.01
Marshall			15.45		3.61	0.04		19.05	0.04
McCracken					0.78			0.78	0.00
State total	**0.00**	**0.00**	**39.33**	**0.01**	**8.01**	**0.26**	**0.00**	**47.33**	**0.27**
Mississippi									
Tishomingo					4.36	0.34	0.02	4.38	0.34
State total	**0.00**	**0.00**	**0.00**	**0.00**	**4.36**	**0.34**	**0.02**	**4.38**	**0.34**
North Carolina									
Avery			0.59	0.47	1.03	1.09		1.62	1.56
Buncombe	4.97		2.48	1.38	26.19	14.33		33.64	15.71
Cherokee			0.08		1.64	0.00		1.71	0.00
Clay			0.04		0.18	0.10		0.22	0.10
Graham					0.94			0.94	0.00
Haywood			28.55	22.53	6.27	3.38		34.82	25.91
Henderson			0.97	0.87	7.82	2.21		8.79	3.08
Jackson			0.07		1.66	0.89		1.73	0.89
Macon			0.24		1.55	0.77		1.79	0.77
Madison					0.50	0.19		0.50	0.19
Mitchell			3.84	0.00	1.13	0.61		4.96	0.61
Swain					0.36	0.31		0.36	0.31

Table 6. Total water use by category and county in 2000—Continued

State County	Thermoelectric power		Industrial		Public supply		Irrigation	Total	
	Water withdrawal	Cooling water return flow	Water withdrawal	Return flow	Water withdrawal	Waste-water return flow	Water withdrawal	Water withdrawal	Return flow
North Carolina—Continued									
Transylvania			1.03	0.00	1.74	0.95		2.77	0.95
Watauga					1.43	0.60		1.43	0.60
Yancey			0.00		0.57	0.31		0.57	0.31
State total	**4.97**	**0.00**	**37.88**	**25.25**	**53.00**	**25.74**	**0.00**	**95.85**	**50.99**
Tennessee									
Anderson	469.00	469.00	1.48	0.90	20.23	6.73	0.08	490.79	476.63
Bedford				0.06	6.52	3.29	0.01	6.53	3.36
Benton			22.10		1.54	1.59	0.00	23.64	1.59
Bledsoe					0.39	0.14	0.20	0.59	0.14
Blount					14.29	7.18	0.55	14.84	7.18
Bradley			2.50	2.41	10.66	7.52	0.23	13.39	9.93
Campbell					2.84	1.19	0.25	3.09	1.19
Carroll					0.56	0.14	0.13	0.69	0.14
Carter				0.04	7.53	2.40	0.05	7.59	2.44
Claiborne					2.82	0.42	0.01	2.83	0.42
Cocke			0.45	0.10	4.09	1.30	1.00	5.54	1.40
Coffee			55.04	35.93	5.21	5.41	0.42	60.66	41.33
Cumberland					3.25	2.22	1.98	5.23	2.22
Decatur			0.07		1.38	0.49	0.06	1.52	0.49
Dickson					1.53			1.53	0.00
Franklin					4.31	0.98	0.13	4.44	0.98
Giles			0.32	0.07	3.30	2.20	0.23	3.85	2.27
Grainger					0.03	0.14	0.08	0.10	0.14
Greene			3.35	3.49	8.11	3.48	0.41	11.87	6.96
Grundy					0.75	0.26		0.75	0.26
Hamblen					10.29	4.09	0.02	10.30	4.09
Hamilton	1,537.00	1,536.00	22.27	13.00	62.38	36.73	1.32	1,622.97	1,585.72
Hancock					0.34	0.15	0.00	0.34	0.15
Hardin			23.60	19.89	3.11	1.02	0.23	26.94	20.92
Hawkins	621.00	621.00	0.56	0.53	4.00	0.86	0.04	625.61	622.39
Henderson					3.91	1.15	0.05	3.96	1.15
Henry					3.05	2.07	0.03	3.08	2.07
Hickman				0.08	2.29	0.35	0.04	2.33	0.44
Houston					0.16			0.16	0.00
Humphreys	1,211.00	1,211.00	71.59	58.08	2.31	1.63		1,284.90	1,270.71
Jefferson			11.64	2.31	3.23	1.05	0.10	14.97	3.36
Johnson			0.01		2.18	0.69	0.04	2.23	0.69
Knox			0.21	0.18	62.04	50.25	1.29	63.55	50.43
Lawrence				0.23	4.29	1.84	0.03	4.31	2.07
Lewis			0.09		1.51	0.78	0.10	1.69	0.78
Lincoln					3.48	1.18	0.34	3.81	1.18
Loudoun			4.95	0.12	10.09	8.18	0.04	15.07	8.30
Marion					3.35	0.80	0.00	3.36	0.80
Marshall				1.99	2.90	2.21		2.90	4.20
Maury			1.44	2.36	11.63	5.82	0.33	13.40	8.18
McMinn			64.90	65.73	5.24	2.74	0.00	70.15	68.47
McNairy					0.97	0.26	0.02	0.99	0.26
Meigs					0.58	0.22	0.32	0.90	0.22
Monroe				0.12	5.58	2.54	0.07	5.65	2.66

Table 6. Total water use by category and county in 2000—Continued

State County	Thermoelectric power		Industrial		Public supply		Irrigation	Total	
	Water withdrawal	Cooling water return flow	Water withdrawal	Return flow	Water withdrawal	Waste-water return flow	Water withdrawal	Water withdrawal	Return flow
Tennessee—Continued									
Moore			1.23	0.38	0.55	0.23		1.78	0.61
Morgan					1.05	0.64		1.05	0.64
Perry					0.75	0.25	0.01	0.76	0.25
Polk			31.77	24.37	0.63	0.31	0.17	32.56	24.67
Rhea	173.50	157.50			3.46	2.05	0.42	177.38	159.55
Roane	1,345.00	1,345.00			6.25	3.77	0.00	1,351.25	1,348.77
Sequatchie					0.65	0.47	0.02	0.67	0.47
Sevier			0.01	0.65	7.51	4.64	0.37	7.90	5.28
Stewart					0.02			0.02	0.00
Sullivan			496.70	465.23	25.43	19.82	0.08	522.21	485.05
Unicoi			0.04	0.10	5.93	1.36	0.05	6.02	1.46
Union					0.58	0.38	0.00	0.58	0.38
Washington				0.02	13.16	11.38	0.52	13.68	11.40
Wayne					1.03	0.35	0.04	1.07	0.35
Williamson					0.05			0.05	0.00
State total	**5,356.50**	**5,339.50**	**816.33**	**698.35**	**375.31**	**219.36**	**11.87**	**6,560.02**	**6257.22**
Virginia									
Lee			0.00		1.36			1.36	0.00
Russell	9.24	0.00	3.79		1.03		0.01	14.07	0.00
Scott					1.06			1.06	0.00
Smyth			0.00		4.88		2.15	7.03	0.00
Tazewell			0.28	0.21	2.72	5.81		3.00	6.02
Washington			0.83	0.47	10.86	1.86		11.69	2.33
Wise			2.17		6.15	2.54		8.32	2.54
State total	**9.24**	**0.00**	**7.06**	**0.68**	**28.06**	**10.21**	**2.15**	**46.52**	**10.89**
Watershed total	**10,276**	**10,244**	**1,205**	**942**	**662**	**377**	**68.9**	**12,211**	**11,562**

Table 7. Surface-water withdrawal by category and water-use tabulation area in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day; WUTA, Water-use tabulation area]

Water-use tabulation area Reservoir catchment area	**Thermoelectric power**	**Industrial**	**Public supply**	**Irrigation**	**Total water withdrawal**
Cherokee					
Watauga		0.24	12.07	0.10	12.40
South Holston		0.24	18.85	2.20	21.30
Boone					0.00
Fort Patrick Henry		496.70	16.40		513.10
Cherokee	621.00	0.60	17.38	0.24	639.22
WUTA total	**621.00**	**497.78**	**64.70**	**2.55**	**1,186.02**
Douglas					
Douglas	4.97	36.09	67.73	1.98	110.78
Fort Loudoun					
Fort Loudoun		5.00	71.18	1.33	77.52
Fontana-Tellico					
Fontana		1.91	2.73		4.64
Santeetlah			0.44		0.44
Tellico			4.11	0.05	4.16
WUTA total	**0.00**	**1.91**	**7.28**	**0.05**	**9.24**
Norris					
Norris	9.24	5.28	15.10	0.26	29.88
Melton Hill	469.00	1.48	29.83	0.05	500.36
WUTA total	**478.24**	**6.76**	**44.93**	**0.31**	**530.25**
Hiwassee-Ocoee					
Chatuge		0.04	1.70		1.73
Nottely			0.45	0.15	0.60
Hiwassee		0.08	0.75	0.11	0.93
Apalachia			2.89	0.05	2.94
Blue Ridge		31.77	1.41	0.07	33.25
Ocoee				0.01	0.01
WUTA total	**0.00**	**31.88**	**7.20**	**0.38**	**39.46**
Watts Bar-Chickamauga					
Watts Bar	1,484.10	0.03	8.67	1.87	1,494.66
Chickamauga	1,571.40	68.24	24.55	2.91	1,667.10
WUTA total	**3,055.50**	**68.27**	**33.22**	**4.78**	**3,161.76**
Nickajack					
Nickajack		18.74	44.00	0.20	62.94
Guntersville					
Guntersville	1,546.00	9.18	36.37	2.88	1,594.42
Tims Ford					
Tims Ford		55.48	2.90	0.20	58.57

Table 7. Surface-water withdrawal by category and water-use tabulation area in 2000—Continued

Water-use tabulation area Reservoir catchment area	**Thermoelectric power**	**Industrial**	**Public supply**	**Irrigation**	**Total water withdrawal**
Wheeler-Wilson					
Wheeler	2,108.00	221.46	78.08	41.48	2,449.02
Wilson		29.48	20.33	3.96	53.77
WUTA total	**2,108.00**	**250.94**	**98.41**	**45.43**	**2,502.79**
Pickwick					
Pickwick	1,251.00	53.08	4.04	0.11	1,308.23
Cedar Creek			3.00		3.00
Upper Bear Creek			2.81		2.81
WUTA total	**1,251.00**	**53.08**	**9.85**	**0.11**	**1,314.04**
Normandy					
Normandy		1.44	24.25	0.61	26.30
Kentucky					
Kentucky	1,211.00	97.20	13.60	0.44	1,322.24
Watershed total	**10,276**	**1,134**	**526**	**61.3**	**11,996**

Table 8. Surface-water withdrawal by category and hydrologic unit in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

Hydrologic unit code	Thermoelectric power	Industrial	Public supply	Irrigation	Total water withdrawal
06010101	621.00	0.00	0.91		621.90
06010102		496.94	35.25	2.20	534.40
06010103		0.04	12.07	0.10	12.20
06010104		0.60	16.47	0.24	17.32
06010105	4.97	4.00	38.12		47.09
06010106		28.41	6.21	0.83	35.45
06010107			11.18	0.44	11.62
06010108		3.89	11.97	0.72	16.57
06010201	139.10	5.00	72.57	1.61	218.28
06010202		2.13	1.82		3.95
06010203		0.07	1.15		1.22
06010204			4.55	0.05	4.60
06010205	9.24	5.28	10.60	0.01	25.13
06010206		0.00	4.50	0.00	4.50
06010207	1,814.00	1.51	29.83	0.12	1,845.46
06010208			7.29	1.77	9.06
06020001	1,571.40	19.29	59.22	2.94	1,652.85
06020002		67.51	15.12	0.49	83.11
06020003		31.77	1.41	0.07	33.25
06020004			2.20	0.16	2.36
06030001	1,546.00	9.18	34.17	2.72	1,592.06
06030002	2,108.00	161.29	65.49	40.04	2,374.82
06030003		55.48	4.21	0.20	59.88
06030004		0.32	11.28	1.38	12.98
06030005	1,251.00	142.41	25.11	4.02	1,422.54
06030006			5.81	0.03	5.84
06040001		0.07	5.13	0.26	5.45
06040002		1.44	24.25	0.67	26.36
06040003			4.22	0.14	4.36
06040004			1.17	0.03	1.20
06040005	1,211.00	75.81	2.34	0.04	1,289.19
06040006		21.32			21.32
Watershed total	**10,276**	**1,134**	**526**	**61.3**	**11,996**

Table 9. Surface-water withdrawal by category and county in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

State County	Thermoelectric power	Industrial	Public supply	Irrigation	Total water withdrawal
Alabama					
Colbert	1,251.00	58.96	7.48		1,317.44
Cullman		1.15			1.15
Dekalb			7.20		7.20
Franklin			3.00	0.03	3.02
Jackson	1,546.00	9.18	7.96	2.60	1,565.74
Lauderdale			12.89	1.86	14.75
Lawrence		59.85	2.19	5.39	67.43
Limestone	2,108.00		8.10	23.55	2,139.65
Madison		1.34	22.59	12.43	36.36
Marion			2.50		2.50
Marshall			17.17	0.13	17.30
Morgan		158.80	42.90	1.70	203.40
Winston			0.31		0.31
State total	**4,905.00**	**289.28**	**134.29**	**47.68**	**5,376.25**
Georgia					
Catoosa			0.65	0.59	1.24
Dade			1.70	0.09	1.79
Fannin			1.22	0.07	1.29
Rabun		1.63			1.63
Towns			0.81		0.81
Union			0.45	0.15	0.60
Walker		0.84	2.50	0.59	3.93
State total	**0.00**	**2.47**	**7.33**	**1.49**	**11.29**
Kentucky					
Livingston		19.85	0.25		20.10
Marshall		12.97			12.97
State total	**0.00**	**32.82**	**0.25**	**0.00**	**33.07**
Mississippi					
Tishomingo				0.02	.02
State total	**0.00**	**0.00**	**0.00**	**0.02**	**.02**
North Carolina					
Avery		0.20			0.20
Buncombe	4.97	2.02	25.01		32.01
Cherokee		0.08	1.64		1.71
Clay		0.04			0.04
Graham			0.94		0.94
Haywood		28.41	6.21		34.62
Henderson		0.97	7.57		8.54
Jackson		0.07	0.81		0.88
Macon		0.21	1.32		1.53
Madison			0.26		0.26
Mitchell		0.34	1.04		1.38
Swain			0.34		0.34
Transylvania		1.00	1.19		2.19
Watauga			1.15		1.15
Yancey			0.57		0.57
State total	**4.97**	**33.33**	**48.05**	**0.00**	**86.35**

Table 9. Surface-water withdrawal by category and county in 2000—Continued

State County	Thermoelectric power	Industrial	Public supply	Irrigation	Total water withdrawal
Tennessee					
Anderson	469.00	1.48	19.27	0.07	489.82
Bedford			5.69	0.01	5.70
Benton		2.90	1.38		4.28
Bledsoe				0.20	0.20
Blount			14.27	0.30	14.57
Bradley		2.50	9.33	0.18	12.01
Campbell			2.32	0.25	2.57
Carter				0.05	0.05
Claiborne			2.59	0.01	2.60
Cocke			4.09	1.00	5.09
Coffee		55.00	5.20	0.40	60.60
Cumberland			3.25	1.77	5.02
Decatur		0.07	1.17	0.05	1.29
Dickson			1.53		1.53
Franklin			2.35	0.06	2.42
Giles		0.32	3.09	0.23	3.64
Grainger				0.06	0.06
Greene		3.35	8.11	0.41	11.86
Grundy			0.75		0.75
Hamblen			9.25	0.00	9.25
Hamilton	1,537.00	18.74	52.11	0.93	1,608.78
Hancock			0.34	0.00	0.34
Hardin		23.60	0.74	0.20	24.53
Hawkins	621.00	0.56	2.86	0.04	624.46
Henderson			3.54	0.05	3.59
Henry				0.02	0.02
Hickman			2.29	0.04	2.33
Humphreys	1,211.00	61.41	1.12		1,273.53
Jefferson		0.04	2.70	0.05	2.79
Johnson		0.00	1.22	0.02	1.24
Knox		0.08	61.12	1.19	62.38
Lawrence			1.90	0.00	1.90
Lewis				0.10	0.10
Lincoln			1.31	0.34	1.65
Loudoun		4.95	8.88	0.04	13.87
Marion			2.64	0.00	2.64
Marshall			2.76		2.76
Maury		1.44	10.60	0.26	12.30
McMinn		64.90	2.89	0.00	67.79
McNairy				0.01	0.01
Meigs				0.32	0.32
Monroe			5.01	0.07	5.08
Moore		0.47	0.55		1.02
Morgan			1.05		1.05
Perry			0.75	0.01	0.76
Polk		31.77	0.19	0.16	32.12
Rhea	173.50		2.71	0.38	176.59
Roane	1,345.00		6.06	0.00	1,351.06
Sequatchie			0.65	0.02	0.67
Sevier			7.29	0.37	7.66
Sullivan		496.70	25.08	0.05	521.83
Unicoi		0.04		0.05	0.09

Table 9. Surface-water withdrawal by category and county in 2000—Continued

State County	Thermoelectric power	Industrial	Public supply	Irrigation	Total water withdrawal
Tennessee—Continued					
Washington			13.16	0.11	13.27
Wayne			0.83	0.03	0.87
State total	**5,356.50**	**770.33**	**315.97**	**9.92**	**6,452.71**
Virginia					
Lee			0.78		0.78
Russell	9.24	3.79	0.55	0.01	13.59
Scott			1.05		1.05
Smyth			0.78	2.15	2.93
Tazewell		0.00	2.43		2.43
Washington		0.24	8.19		8.43
Wise		1.49	5.93		7.42
State total	**9.24**	**5.52**	**19.72**	**2.15**	**36.64**
Watershed total	**10,276**	**1,134**	**526**	**61.3**	**11,996**

Table 10. Ground-water withdrawal by category and water-use tabulation area in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day; WUTA, water-use tabulation area]

Water-use tabulation area Reservoir catchment area	**Industrial**	**Public supply**	**Irrigation**	**Total water withdrawal**
Cherokee				
Watauga	0.40	8.98	0.02	9.40
South Holston	0.59	7.39	0.03	8.01
Boone	0.00	3.72		3.72
Fort Patrick Henry				0.00
Cherokee	10.12	2.85	0.03	13.00
WUTA total	**11.11**	**22.94**	**0.08**	**34.13**
Douglas				
Douglas	6.19	5.34	0.45	11.98
Fort Loudoun				
Fort Loudoun	0.02	1.24	0.34	1.60
Fontana-Tellico				
Fontana	0.03	1.09		1.13
Santeetlah				0.00
Tellico		0.57		0.57
WUTA total	**0.03**	**1.66**	**0.00**	**1.70**
Norris				
Norris	0.95	2.46	0.00	3.42
Melton Hill		1.58		1.58
WUTA total	**0.95**	**4.04**	**0.00**	**4.99**
Hiwassee-Ocoee				
Chatuge	0.00	0.18		0.18
Nottely		0.55		0.55
Hiwassee	0.00			0.00
Apalachia			0.00	0.00
Blue Ridge		0.05		0.05
Ocoee		1.11		1.11
WUTA total	**0.00**	**1.90**	**0.00**	**1.90**
Watts Bar-Chickamauga				
Watts Bar		0.85	0.25	1.11
Chickamauga	0.12	22.84	1.06	24.02
WUTA total	**0.12**	**23.69**	**1.32**	**25.13**
Nickajack				
Nickajack	4.92	4.78	0.15	9.86
Guntersville				
Guntersville	1.79	6.07		7.86

Table 10. Ground-water withdrawal by category and water-use tabulation area in 2000—Continued

Water-use tabulation area Reservoir catchment area	**Industrial**	**Public supply**	**Irrigation**	**Total water withdrawal**
Tims Ford				
Tims Ford	0.78	1.96	0.06	2.80
Wheeler-Wilson				
Wheeler	8.16	32.74	4.92	45.82
Wilson	0.53	2.83		3.36
WUTA total	**8.69**	**35.57**	**4.92**	**49.18**
Pickwick				
Pickwick	0.53	4.88		5.41
Cedar Creek		1.13		1.13
Upper Bear Creek		0.16		0.16
WUTA total	**0.53**	**6.17**	**0.00**	**6.70**
Normandy				
Normandy	0.01	2.01	0.09	2.11
Kentucky				
Kentucky	35.97	18.76	0.21	54.94
Watershed total	**71.1**	**136**	**7.62**	**215**

Table 11. Ground-water withdrawal by category and hydrologic unit in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

Hydrologic unit code	Industrial	Public supply	Irrigation	Total water withdrawal
06010101	0.00	0.71		0.71
06010102	0.59	7.38	0.03	8.00
06010103	0.01	8.98	0.02	9.01
06010104	10.12	2.15	0.03	12.30
06010105	0.48	2.22		2.70
06010106	0.59	0.06		0.65
06010107	1.61	0.65	0.04	2.31
06010108	3.89	6.13	0.41	10.43
06010201	0.02	1.23	0.37	1.62
06010202	0.03	0.22		0.26
06010203	0.00	0.88		0.88
06010204		0.57		0.57
06010205	0.95	1.63	0.00	2.59
06010206	0.00	0.83		0.83
06010207		2.43	0.01	2.44
06010208			0.21	0.21
06020001	5.04	24.67	1.16	30.87
06020002	0.01	4.41	0.05	4.48
06020003		0.43	0.02	0.45
06020004		1.03		1.03
06030001	1.79	5.04		6.83
06030002	8.16	1.84	4.87	14.87
06030003	0.78	29.76	0.06	30.60
06030004		3.10	0.02	3.12
06030005	1.06	6.81		7.87
06030006		2.19		2.19
06040001		4.13	0.06	4.19
06040002	0.01	2.01	0.09	2.11
06040003		0.09	0.00	0.09
06040004	0.09	1.66	0.00	1.75
06040005	29.38	5.55	0.15	35.07
06040006	6.50	7.33		13.84
Watershed total	**71.1**	**136**	**7.62**	**215**

Table 12. Ground-water withdrawal by category and county in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

State County	Industrial	Public supply	Irrigation	Total water withdrawal
Alabama				
Colbert	1.06	0.48		1.54
Dekalb	1.11	1.37		2.48
Franklin		1.13		1.13
Jackson	0.02	0.99		1.01
Lauderdale		0.85		0.85
Limestone		2.91	4.87	7.78
Madison		27.27		27.27
Marshall	0.66	2.65		3.31
Morgan	8.16			8.16
Winston		0.16		0.16
State total	**11.01**	**37.81**	**4.87**	**53.69**
Georgia				
Catoosa		7.88	0.30	8.18
Dade			0.47	0.47
Fannin			0.02	0.02
Union		0.55		0.55
Walker	1.51	5.13		6.64
State total	**1.51**	**13.56**	**0.79**	**15.86**
Kentucky				
Calloway	1.59	3.31		4.90
Graves		0.05		0.05
Livingston	2.44			2.44
Marshall	2.47	3.61		6.08
McCracken		0.78		0.78
State total	**6.50**	**7.75**	**0.00**	**14.26**
Mississippi				
Tishomingo		4.36		4.36
State total	**0.00**	**4.36**	**0.00**	**4.36**
North Carolina				
Avery	0.39	1.03		1.42
Buncombe	0.45	1.18		1.63
Cherokee	0.00			0.00
Clay	0.00	0.18		0.18
Haywood	0.14	0.06		0.20
Henderson	0.00	0.25		0.25
Jackson	0.00	0.85		0.85
Macon	0.03	0.22		0.26
Madison		0.24		0.24
Mitchell	3.50	0.09		3.59
Swain		0.02		0.02
Transylvania	0.03	0.55		0.58
Watauga		0.28		0.28
Yancey	0.00			0.00
State total	**4.55**	**4.95**	**0.00**	**9.50**

Table 12. Ground-water withdrawal by category and county in 2000—Continued

State County	Industrial	Public supply	Irrigation	Total water withdrawal
Tennessee				
Anderson		0.96	0.01	0.97
Bedford		0.83	0.00	0.83
Benton	19.20	0.16	0.00	19.36
Bledsoe		0.39		0.39
Blount		0.02	0.24	0.26
Bradley		1.33	0.05	1.38
Campbell		0.52		0.52
Carroll		0.56	0.13	0.69
Carter		7.53		7.53
Claiborne		0.23		0.23
Cocke	0.45	0.00	0.00	0.46
Coffee	0.04	0.01	0.02	0.06
Cumberland			0.21	0.21
Decatur		0.21	0.02	0.23
Franklin		1.96	0.06	2.02
Giles		0.21		0.21
Grainger		0.03	0.02	0.05
Greene	0.00	0.01		0.01
Hamblen		1.04	0.01	1.05
Hamilton	3.53	10.27	0.38	14.18
Hardin		2.38	0.03	2.41
Hawkins		1.15	0.00	1.15
Henderson		0.36	0.00	0.37
Henry		3.05	0.01	3.06
Hickman			0.00	0.00
Houston		0.16		0.16
Humphreys	10.18	1.19		11.37
Jefferson	11.60	0.53	0.04	12.17
Johnson	0.01	0.96	0.02	0.99
Knox	0.13	0.93	0.10	1.16
Lawrence		2.39	0.02	2.41
Lewis	0.09	1.51	0.00	1.59
Lincoln		2.17		2.17
Loudoun		1.20		1.20
Marion		0.71		0.71
Marshall		0.14		0.14
Maury		1.03	0.07	1.10
McMinn	0.00	2.35		2.36
McNairy		0.97	0.00	0.98
Meigs		0.58		0.58
Monroe		0.57		0.57
Moore	0.75			0.75
Perry			0.00	0.00
Polk		0.43	0.00	0.44
Rhea		0.76	0.04	0.80
Roane		0.20		0.20
Sevier	0.01	0.23		0.24
Stewart		0.02		0.02

Table 12. Ground-water withdrawal by category and county in 2000—Continued

State County	Industrial	Public supply	Irrigation	Total water withdrawal
Tennessee—Continued				
Sullivan	0.00	0.35	0.03	0.38
Unicoi	0.00	5.93	0.00	5.93
Union		0.58	0.00	0.58
Washington			0.41	0.41
Wayne		0.20	0.00	0.20
Williamson		0.05		0.05
State total	**46.00**	**59.35**	**1.96**	**107.31**
Virginia				
Lee	0.00	0.58		0.58
Russell	0.00	0.48		0.48
Scott		0.01		0.01
Smyth	0.00	4.09		4.09
Tazewell	0.28	0.29		0.57
Washington	0.59	2.67		3.26
Wise	0.68	0.22		0.89
State total	**1.54**	**8.34**	**0.00**	**9.88**
Watershed total	**71.1**	**136**	**7.62**	**215**

Thermoelectric Power

The total quantity of water withdrawn for use by thermoelectric power plants during 2000 was an estimated 10,276 Mgal/d, which is more than all of the other offstream categories combined and an increase of 28 percent since 1995 (tables 13, 14, 15, and 26). The increase in withdrawals reflects the operation of additional generating units at the power plants since 1995. Surface water is the sole source of supply. Nearly all of the surface water used at these facilities was returned to the river. Return flow was 10,244 Mgal/d. For this report, return flow is limited to cooling-water discharge and excludes stormwater runoff. Approximately 0.3 percent, or 32.2 Mgal/d, was consumptively used as a result of once-through cooling, cooling tower, or pond cooling (table 13; fig. 13).

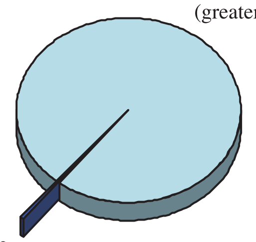


Figure 13. Disposition of water used by thermoelectric power plants in the Tennessee River watershed in 2000.

Table 13. Thermoelectric power water use by water-use tabulation area in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day; WUTA, Water-use tabulation area]

Water-use tabulation area Reservoir catchment area	**Surface-water withdrawal**	**Cooling water return flow**	**Net water demand**	**Power generated, in million kilowatt hours**
Cherokee				
Cherokee	621.00	621.00	0.00	5,193
Douglas				
Douglas	4.97		4.97	2,561
Norris				
Norris	9.24	0.00	9.24	3,323
Melton Hill	469.00	469.00	0.00	5,968
WUTA total	**478.24**	**469.00**	**9.24**	**9,291**
Watts Bar-Chickamauga				
Watts Bar	1,484.10	1,345.00	139.10	18,855
Chickamauga	1,571.40	1,693.50	-122.10	16,777
WUTA total	**3,055.50**	**3,038.50**	**17.00**	**35,632**
Guntersville				
Guntersville	1,546.00	1,546.00	0.00	9,595
Wheeler-Wilson				
Wheeler	2,108.00	2,107.00	1.00	18,807
Pickwick				
Pickwick	1,251.00	1,251.00	0.00	7,201
Kentucky				
Kentucky	1,211.00	1,211.00	0.00	8,064
Watershed total	**10,276**	**10,244**	**32.2**	**96,344**

Thermoelectric power plants in the Tennessee River watershed are primarily powered by coal and nuclear energy, with small amounts of oil and natural gas burned in combustion turbine units. Water is used for condenser and reactor cooling and to replenish the boilers to produce steam. Nine fossil-fueled and three nuclear-fueled plants are located in the watershed. These 12 plants generated about 96,344 gigawatt-hours in 2000 compared to 76,600 gigawatt hours in 1995 (Solley and others, 1998). The thermoelectric plants are primarily located along the main stem of the Tennessee River (fig. 14). The Kingston fossil-fueled and the Watts Bar and Sequoyah nuclear-fueled power plants in the Watts Bar-Chickamauga WUTA (3,056 Mgal/d of water), the Browns Ferry nuclear-fueled power plant in the Wheeler-Wilson WUTA (2,108 Mgal/d), and the Widows Creek fossil-fueled power plant in the Guntersville WUTA (1,546 Mgal/d) account for about 65 percent of the water withdrawals for thermoelectric power (table 13). The spatial distribution by HUC of thermoelectric power water withdrawals as a total is shown in figure 15.

The relation between water availability, water use, and demographic and socioeconomic indicators over time has important implications for water use and management (Case and Alward, 1997), particularly for the thermoelectric power and industrial sectors. The electricity generated using water from the Tennessee River watershed, either for generating hydropower or for cooling water, accounted for about 67 percent of all the electricity generated by the TVA in 2000. The importance of the electricity generated, however, is much greater than the income from power sales. The electricity serves as a base for the economy of the region, which was valued in 2000 at about $246 billion for all goods and services (James H. Eblen, Tennessee Valley Authority, written commun., June 2002).

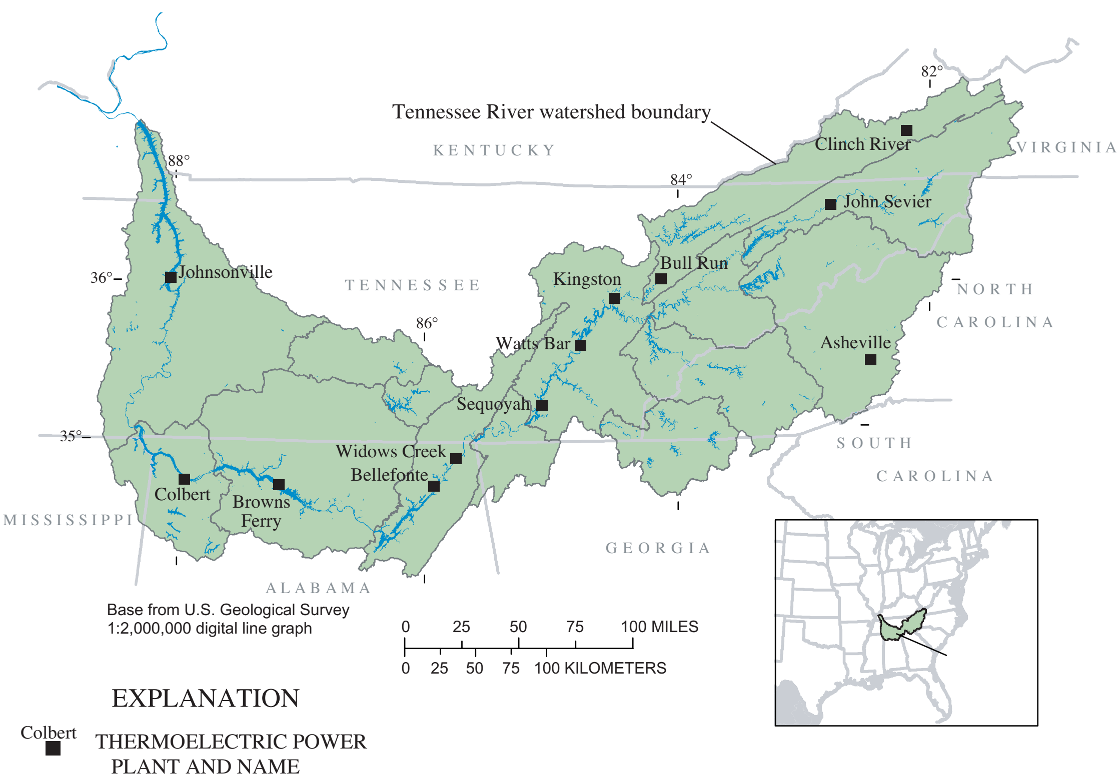


Figure 14. Distribution of thermoelectric power plants in the Tennessee River watershed in 2000.

Table 14. Thermoelectric power water use by hydrologic unit in 2000

[Figures may not add to totals because of independent rounding. Water-use transactions in million gallons per day]

Hydrologic unit code	Surface-water withdrawal	Cooling water return flow	Net water demand	Power generated, in million kilowatt-hours
06010101	621.00		621.00	5,193
06010104		621.00	-621.00	
06010105	4.97		4.97	2,561
06010201	139.10		139.10	9,076
06010205	9.24	0.00	9.24	3,323
06010207	1,814.00	469.00	1,345.00	15,746
06010208		1,345.00	-1,345.00	
06020001	1,571.40	1,693.50	-122.10	16,777
06030001	1,546.00	1,546.00	0.00	9,595
06030002	2,108.00	2,107.00	1.00	18,807
06030005	1,251.00	1,251.00	0.00	7,201
06040005	1,211.00	1,211.00	0.00	8,064
Watershed total	**10,276**	**10,244**	**32.2**	**96,343**

Table 15. Thermoelectric power water use by county in 2000

[Figures may not add to totals because of independent rounding. Water-use transactions in million gallons per day]

State County	Surface-water withdrawal	Cooling water return flow	Net water demand	Power generated, in million kilowatt-hours
Alabama				
Colbert	1,251.00	1,251.00	0.00	7,201
Jackson	1,546.00	1,546.00	0.00	9,595
Limestone	2,108.00	2,107.00	1.00	18,807
State total	**4,905.00**	**4,904.00**	**1.00**	**35,603**
North Carolina				
Buncombe	4.97		4.97	2,561
State total	**4.97**	**0.00**	**4.97**	**2,561**
Tennessee				
Anderson	469.00	469.00	0.00	5,968
Hamilton	1,537.00	1,536.00	1.00	16,777
Hawkins	621.00	621.00	0.00	5,193
Humphreys	1,211.00	1,211.00	0.00	8,064
Rhea	173.50	157.50	16.00	9,076
Roane	1,345.00	1,345.00	0.00	9,778
State total	**5,356.50**	**5,339.50**	**17.00**	**54,858**
Virginia				
Russell	9.24	0.00	9.24	3,323
State total	**9.24**	**0.00**	**9.24**	**3,323**
Watershed total	**10,276**	**10,244**	**32.2**	**96,343**

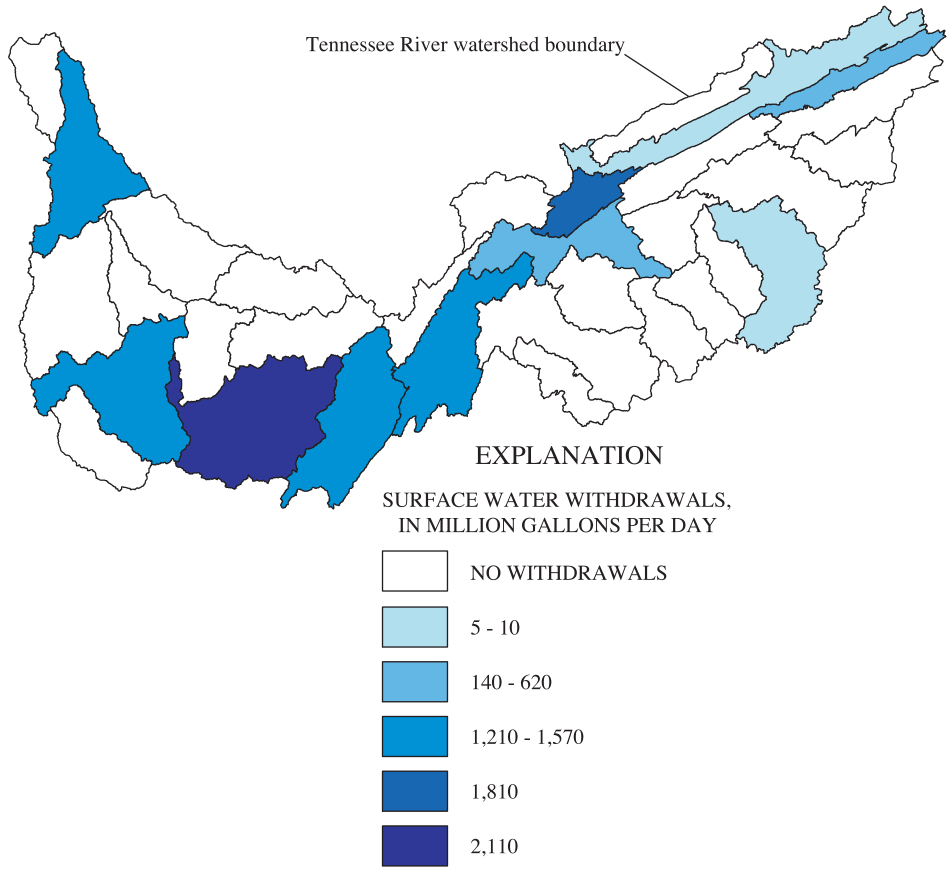


Figure 15. Thermoelectric power water withdrawals by hydrologic unit in the Tennessee River watershed in 2000.

Industrial

Water withdrawals for industrial use during 2000 were estimated to be 1,205 Mgal/d, which is an increase of 17 percent since 1995 (tables 16, 17, 18, and 26). Water withdrawals for industry account for about 10 percent of the total water withdrawals and for 62 percent of the nonpower water withdrawals. Return flows were estimated to be 942 Mgal/d and consumptive use to be 263 Mgal/d (table 16). Surface water supplied 94 percent of the water, 1,134 Mgal/d, for industrial purposes and ground water supplied the remaining 6 percent, 71.1 Mgal/d (fig. 16). The consumptive use of freshwater for industrial purposes was 22 percent and return flow was 78 percent of the disposition of the water.

Industrial water use includes water for such purposes as processing, washing, and cooling in facilities that manufacture products and for mining. Estimates of industrial and mining withdrawals were obtained from State agencies that issue permits or from the water-use inventory conducted in conjunction with this investigation. In the Tennessee River watershed, the major water-using industries are chemical and allied products, paper and allied products, and primary metals and account for about 79 percent (950 Mgal/d) of the industrial water withdrawals in 2000.

In 2000, mining water use was estimated to be 51 Mgal/d. Mining water use is for the extraction of minerals and other uses associated with quarrying, milling (crushing, screening, washing, and flotation), and other preparations done at a mine site. Dewatering is not considered as a mining water use unless the water is put to a beneficial use, such as washing or dust control. Water used in mining is difficult to quantify. Except for some washing and milling, water used at mining sites tends to be an impediment to or a byproduct of the extraction process. Unless water is needed for the mining operation, little attention is paid to quantities withdrawn.

Industrial return flow is water disposed from use in sanitary, process, or cooling activities and excludes stormwater runoff. Return-flow data for industry and mining were obtained from the USEPA, PCS database. A strict site-specific accounting of industrial withdrawals and return flows is difficult because of the different ways in which water is obtained and disposed. For example, industries that purchase water from a public supplier may discharge to a stream, and bypass the wastewater-treatment plant; or self-supplied industries may release water to a wastewater-treatment plant rather than to a stream. Uncertainty about the amount of return flow also may result from an industry including estimates of stormwater runoff in the sanitary, process, or cooling water return-flow volumes. Meter registration errors also may occur.

Industrial water withdrawals in the Cherokee and Wheeler-Wilson WUTA's were 509 and 260 Mgal/d, respectively, and account for the 64 percent of the industrial water withdrawals (table 16). The spatial distribution of industrial water withdrawals by HUC as a total and by source is shown in figure 17.

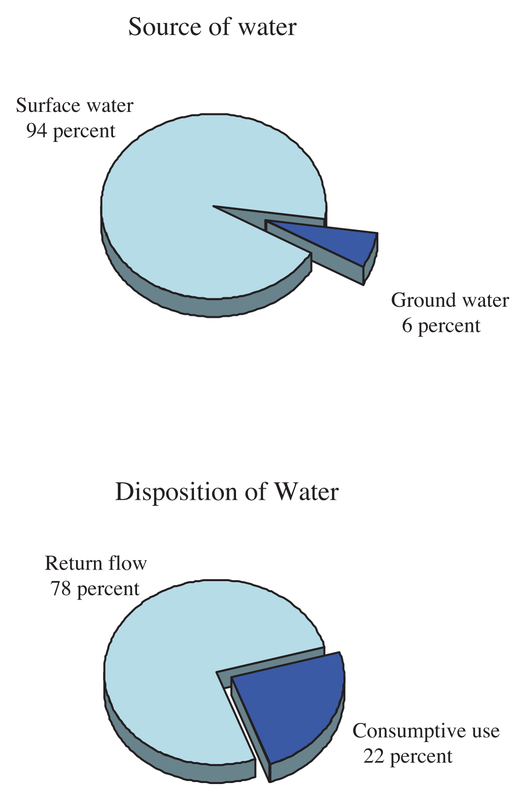


Figure 16. Source and disposition of water used by industry in the Tennessee River watershed in 2000.

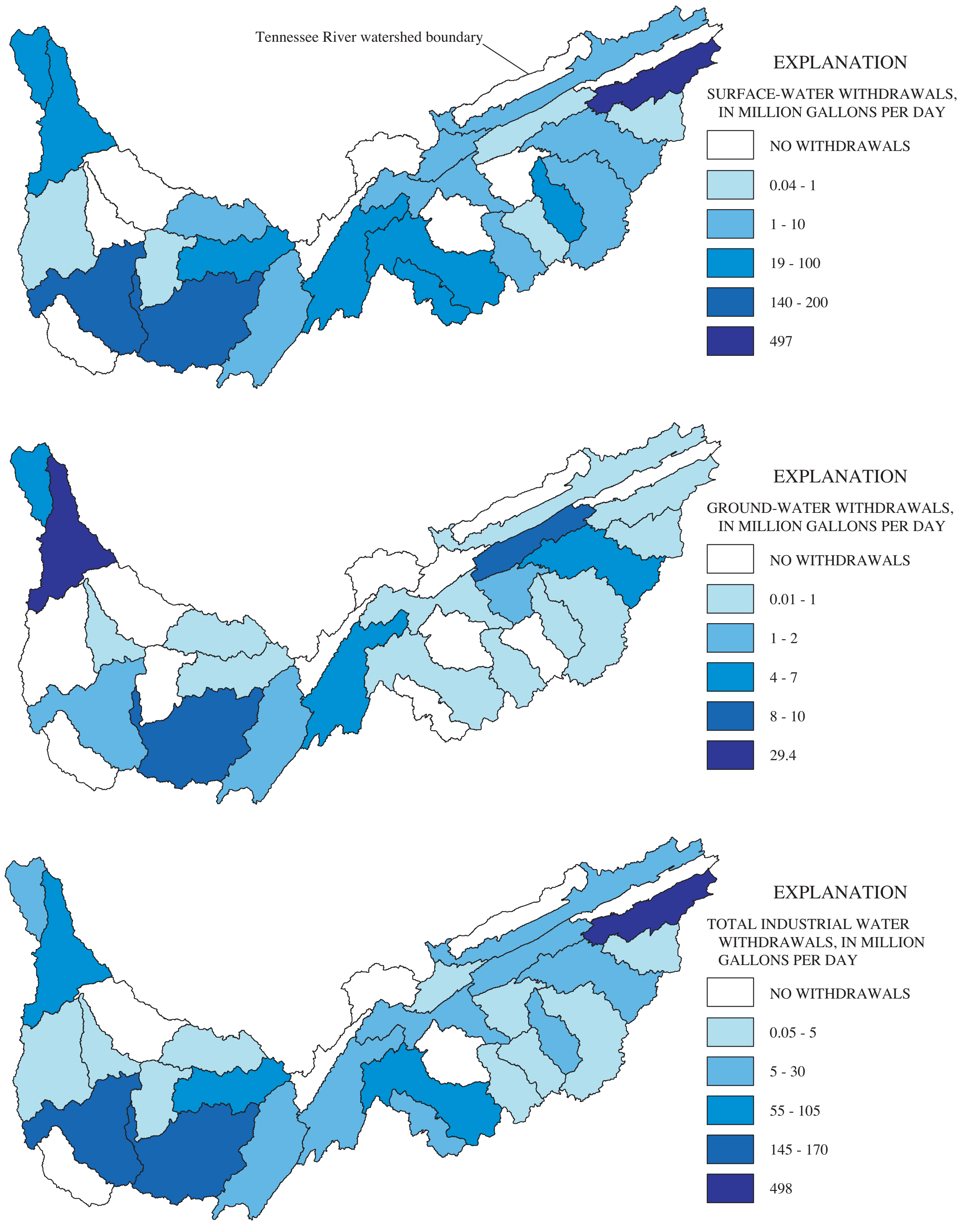


Figure 17. Industrial water withdrawals by source and by hydrologic unit in the Tennessee River watershed in 2000.

Many industries that depend on large amounts of water also are industries that provide relatively high earnings and are important to the economy of local communities. This link is evident in the Tennessee River watershed, where high water use in the chemical and paper industry involves the use of process water and large amounts of cooling water. The five counties in the watershed in which chemical or paper industries use large amounts of water, Lawrence and Morgan Counties in Alabama, and Humphreys, McMinn, and Sullivan Counties in Tennessee (fig. 5), directly generated about $1.0 billion of earnings in 1999 with an estimated total impact on the local economies between 2.0 and 2.5 billion dollars (U.S. Department of Commerce, 2001). The distribution of industrial water withdrawals by county is shown on figure 18.

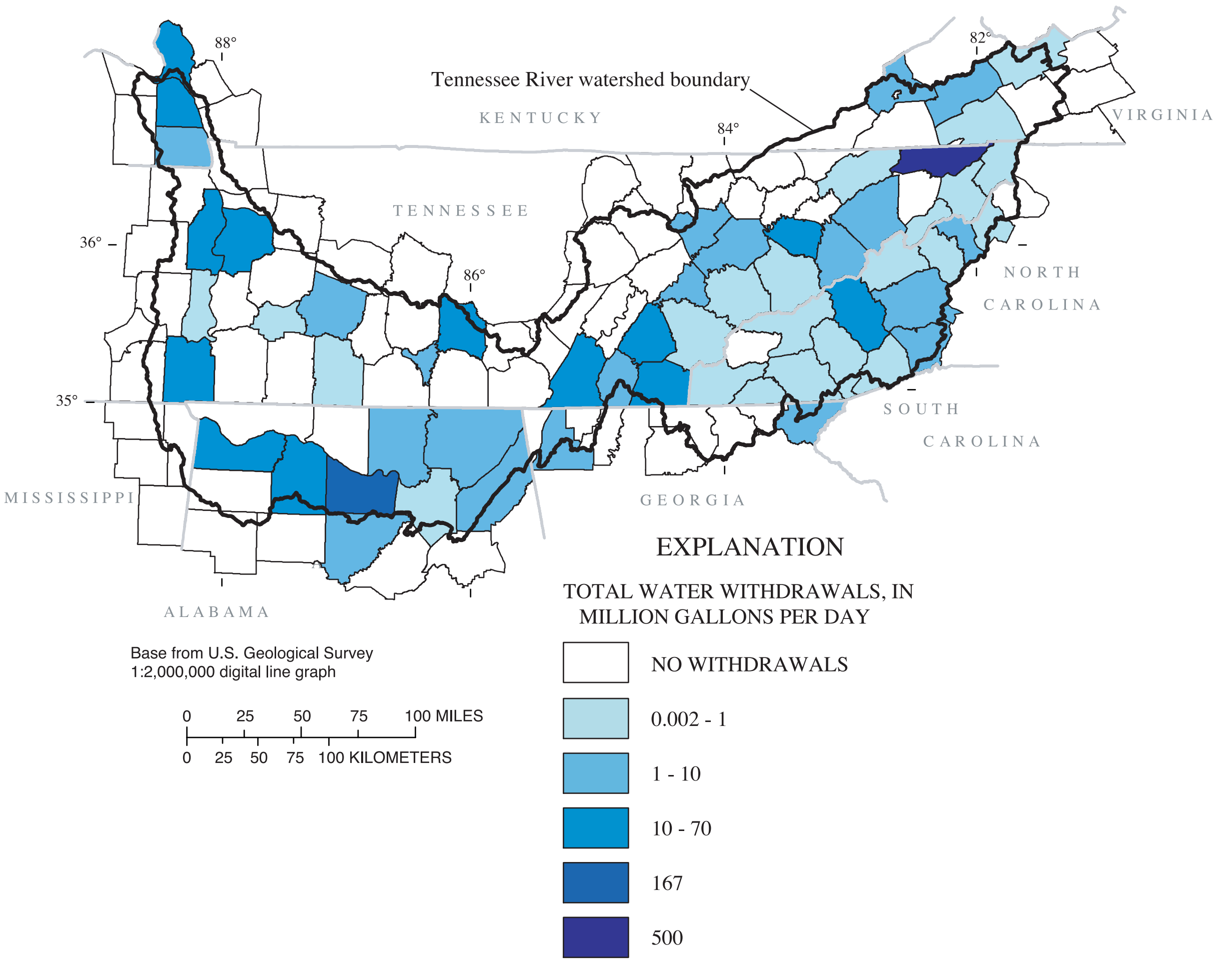


Figure 18. Industrial water withdrawals by State and county in the Tennessee River watershed in 2000.

Table 16. Industrial water use by water-use tabulation area in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day; WUTA, water-use tabulation area]

Water-use tabulation area Reservoir catchment area	Withdrawal: Ground water	Withdrawal: Surface water	Withdrawal: Total water	Return flow	Net water demand
Cherokee					
Watauga	0.40	0.24	0.64	0.47	0.17
South Holston	0.59	0.24	0.83	0.47	0.36
Boone	0.00		0.00	0.04	-0.04
Fort Patrick Henry		496.70	496.70		496.70
Cherokee	10.12	0.60	10.72	467.53	-456.81
WUTA total	**11.11**	**497.78**	**508.89**	**468.51**	**40.38**
Douglas					
Douglas	6.19	36.09	42.28	28.49	13.80
Fort Loudoun					
Fort Loudoun	0.02	5.00	5.02	1.37	3.66
Fontana-Tellico					
Fontana	0.03	1.91	1.94	1.36	0.58
Santeetlah			0.00		0.00
Tellico			0.00		0.00
WUTA total	**0.03**	**1.91**	**1.94**	**1.36**	**0.58**
Norris					
Norris	0.95	5.28	6.23	0.21	6.02
Melton Hill		1.48	1.48	0.90	0.58
WUTA total	**0.95**	**6.76**	**7.72**	**1.11**	**6.61**
Hiwassee-Ocoee					
Chatuge	0.00	0.04	0.04		0.04
Nottely			0.00		0.00
Hiwassee	0.00	0.08	0.08		0.08
Apalachia			0.00		0.00
Blue Ridge		31.77	31.77		31.77
Ocoee			0.00	24.37	-24.37
WUTA total	**0.00**	**31.88**	**31.88**	**24.37**	**7.51**
Watts Bar-Chickamauga					
Watts Bar		0.03	0.03	0.24	-0.21
Chickamauga	0.12	68.24	68.36	68.14	0.22
WUTA total	**0.12**	**68.27**	**68.38**	**68.37**	**0.01**
Nickajack					
Nickajack	4.92	18.74	23.67	15.30	8.36
Guntersville					
Guntersville	1.79	9.18	10.97	19.49	-8.52
Tims Ford	0.78	55.48	56.26	35.93	20.33

Table 16. Industrial water use by water-use tabulation area in 2000—Continued

Water-use tabulation area Reservoir catchment area	**Withdrawal**			**Return flow**	**Net water demand**
	Ground water	**Surface water**	**Total water**		
Wheeler-Wilson					
Wheeler	8.16	221.46	229.62	147.86	81.76
Wilson	0.53	29.48	30.01	21.01	9.00
WUTA total	**8.69**	**250.94**	**259.63**	**168.87**	**90.76**
Pickwick					
Pickwick	0.53	53.08	53.61	26.66	26.95
Cedar Creek			0.00		0.00
Upper Bear Creek			0.00		0.00
WUTA total	**0.53**	**53.08**	**53.61**	**26.66**	**26.95**
Normandy					
Normandy	0.01	1.44	1.45		1.45
Kentucky					
Kentucky	35.97	97.20	133.17	82.55	50.61
Watershed total	**71.1**	**1,134**	**1,205**	**942**	**263**

Table 17. Industrial water use by hydrologic unit in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

Hydrologic unit code	Withdrawal Ground water	Surface water	Total water	Return flow	Net water demand
06010101	0.00	0.00	0.00		0.00
06010102	0.59	496.94	497.53	465.70	31.83
06010103	0.01	0.04	0.05	0.04	0.01
06010104	10.12	0.60	10.72	2.94	7.78
06010105	0.48	4.00	4.48	2.25	2.23
06010106	0.59	28.41	29.00	22.63	6.37
06010107	1.61		1.61	0.72	0.89
06010108	3.89	3.89	7.78	4.08	3.70
06010201	0.02	5.00	5.02	0.24	4.79
06010202	0.03	2.13	2.16	1.36	0.80
06010203	0.00	0.07	0.07		0.07
06010205	0.95	5.28	6.23	0.21	6.02
06010206	0.00	0.00	0.00		0.00
06010207		1.51	1.51	0.90	0.61
06020001	5.04	19.29	24.33	15.30	9.02
06020002	0.01	67.51	67.52	68.14	-0.62
06020003		31.77	31.77	24.37	7.40
06030001	1.79	9.18	10.97	19.49	-8.52
06030002	8.16	161.29	169.45	99.20	70.25
06030003	0.78	55.48	56.26	37.34	18.92
06030004		0.32	0.32	0.07	0.25
06030005	1.06	142.41	143.47	94.93	48.54
06040001		0.07	0.07	19.89	-19.82
06040002	0.01	1.44	1.45	2.05	-0.60
06040003			0.00	2.45	-2.45
06040004	0.09		0.09		0.09
06040005	29.38	75.81	105.19	58.09	47.10
06040006	6.50	21.32	27.82		27.82
Watershed total	**71.1**	**1,134**	**1,205**	**942**	**263**

Table 18. Industrial water use by county in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

State County	Withdrawal Ground water	 Surface water	 Total water	Return flow	Net water demand
Alabama					
Colbert	1.06	58.96	60.02	47.45	12.57
Cullman		1.15	1.15		1.15
Dekalb	1.11		1.11	0.88	0.23
Jackson	0.02	9.18	9.20	18.09	-8.89
Lawrence		59.85	59.85	47.26	12.59
Madison		1.34	1.34	1.03	0.31
Marshall	0.66		0.66	0.52	0.14
Morgan	8.16	158.80	166.96	99.20	67.76
State total	**11.01**	**289.28**	**300.29**	**214.42**	**85.87**
Georgia					
Rabun		1.63	1.63	1.36	0.27
Walker	1.51	0.84	2.35	2.31	0.04
State total	**1.51**	**2.47**	**3.98**	**3.67**	**0.31**
Kentucky					
Calloway	1.59		1.59		1.59
Livingston	2.44	19.85	22.29		22.29
Lyon			0.00	0.01	-0.01
Marshall	2.47	12.97	15.45		15.45
State total	**6.50**	**32.82**	**39.33**	**0.01**	**39.32**
North Carolina					
Avery	0.39	0.20	0.59	0.47	0.12
Buncombe	0.45	2.02	2.48	1.38	1.10
Cherokee	0.00	0.08	0.08		0.08
Clay	0.00	0.04	0.04		0.04
Haywood	0.14	28.41	28.55	22.53	6.02
Henderson	0.00	0.97	0.97	0.87	0.10
Jackson	0.00	0.07	0.07		0.07
Macon	0.03	0.21	0.24		0.24
Mitchell	3.50	0.34	3.84	0.00	3.84
Transylvania	0.03	1.00	1.03	0.00	1.03
Yancey	0.00		0.00		0.00
State total	**4.55**	**33.33**	**37.88**	**25.25**	**12.63**
Tennessee					
Anderson		1.48	1.48	0.90	0.58
Bedford			0.00	0.06	-0.06
Benton	19.20	2.90	22.10		22.10
Bradley		2.50	2.50	2.41	0.09
Carter			0.00	0.04	-0.04
Cocke	0.45		0.45	0.10	0.35
Coffee	0.04	55.00	55.04	35.93	19.11
Decatur		0.07	0.07		0.07
Giles		0.32	0.32	0.07	0.25
Greene	0.00	3.35	3.35	3.49	-0.13
Hamilton	3.53	18.74	22.27	13.00	9.27
Hardin		23.60	23.60	19.89	3.71
Hawkins		0.56	0.56	0.53	0.03

Table 18. Industrial water use by county in 2000—Continued

State County	Withdrawal Ground water	 Surface water	 Total water	Return flow	Net water demand
Tennessee—Continued					
Hickman			0.00	0.08	-0.08
Humphreys	10.18	61.41	71.59	58.08	13.51
Jefferson	11.60	0.04	11.64	2.31	9.34
Johnson	0.01	0.00	0.01		0.01
Knox	0.13	0.08	0.21	0.18	0.03
Lawrence			0.00	0.23	-0.23
Lewis	0.09		0.09		0.09
Loudoun		4.95	4.95	0.12	4.83
Marshall			0.00	1.99	-1.99
Maury		1.44	1.44	2.36	-0.92
McMinn	0.00	64.90	64.90	65.73	-0.82
Monroe			0.00	0.12	-0.12
Moore	0.75	0.47	1.23	0.38	0.85
Polk		31.77	31.77	24.37	7.40
Sevier	0.01		0.01	0.65	-0.63
Sullivan	0.00	496.70	496.70	465.23	31.47
Unicoi	0.00	0.04	0.04	0.10	-0.07
Washington			0.00	0.02	-0.02
State total	**46.00**	**770.33**	**816.33**	**698.37**	**117.98**
Virginia					
Lee	0.00		0.00		0.00
Russell	0.00	3.79	3.79		3.79
Smyth	0.00		0.00		0.00
Tazewell	0.28	0.00	0.28	0.21	0.07
Washington	0.59	0.24	0.83	0.47	0.36
Wise	0.68	1.49	2.17		2.17
State total	**1.54**	**5.52**	**7.06**	**0.68**	**6.38**
Watershed total	**71.1**	**1,134**	**1,205**	**942**	**263**

Public Supply

The quantity of water withdrawn for public supply during 2000 was estimated to be 662 Mgal/d, which is an increase of 15 percent from 1995 (tables 19, 20, 21, and 26). During the period from 1995 to 2000, population in the Tennessee River watershed increased 7 percent, from 4.20 to 4.51 million (U.S. Bureau of the Census, 2001). In 1995, public suppliers served water to 77 percent of the population or 3.25 million people. Although population-served numbers were not collected at the county level by the USGS for 2000, the percentage of the population served by public water-supply systems in 2000 is assumed to be the same or higher than in 1995. Applying the 1995 value of 77 percent to the 2000 population estimate, the population served is estimated as 3.47 million people. Water withdrawals for public supply account for about 5 percent of the total water use and 34 percent of the nonpower water use in the watershed. Surface water was the source for 79 percent, or 526 Mgal/d, of the water withdrawal (fig. 19). The remaining 21 percent, or 136 Mgal/d, of the water is from springs and wells. About 57 percent, or 377 Mgal/d, of the water was returned to the river. Consumptive use accounted for the remaining 43 percent, or 285 Mgal/d.

Public-supply withdrawals and wastewater releases may only indirectly relate to each other. In part, the sewer infrastructure is not as extensive as the water distribution infrastructure, particularly in rural communities where septic tanks are more common. Water released to a septic tank is not readily available for reuse and is classified as a consumptive use. The balance between public-supply withdrawals and wastewater releases also may be affected by how industrial water is disposed. For example, water that is released from a self-supplied industrial facility may be conveyed to a POTW instead of discharging directly to a stream.

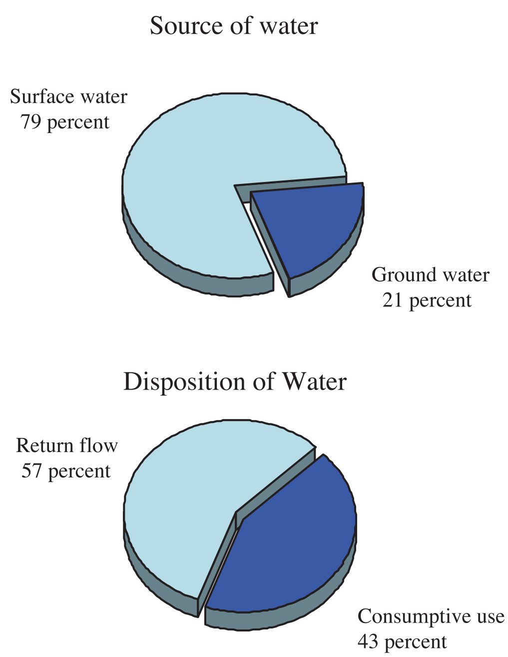


Figure 19. Source and disposition of water used for public supply in the Tennessee River watershed in 2000.

The completeness of the public-supply withdrawal and wastewater release data varies. Information on public supply generally is available from the State office responsible for implementing the USEPA Safe Drinking Water Act or for permitting water withdrawals within that State. Data for public-supply withdrawals usually are accurate because local and State agencies maintain nearly complete information. The public-supply systems included in this report mostly are systems serving at least 25 people, or a minimum of 15 connections. A few smaller water systems reporting pumpage to State permitting programs also are included in the total. These smaller systems are supplied by ground water and include motels, restaurants, schools, churches, or campgrounds. The municipal wastewater release data used in this study are from USEPA, PCS files; this dataset can be less complete than the corresponding State's database.

The large public-supply withdrawals, for the most part, correspond to the population centers. The Wheeler-Wilson WUTA provides water to the cities of Huntsville and Decatur, Alabama; the Cherokee WUTA to Kingsport and Johnson City, Tennessee; the Douglas WUTA to Jonesborough and Greeneville, Tennessee; the Fort Loudoun WUTA to Knoxville, Tennessee; and the Nickajack WUTA to Chattanooga, Tennessee. Public-supply withdrawals in the above mentioned WUTAs account for 63 percent of the total public-supply withdrawals (table 19). The spatial distribution of public-supply water withdrawals by HUC as a total and by source is shown in figure 20.

The proximity of the multi-county population centers such as Atlanta, Birmingham, and northeastern Mississippi to the watershed divide and the growing water needs of the region raises questions about the potential of future interbasin transfers from the Tennessee River watershed. Water withdrawn from the Tennessee River watershed to supply these areas would reduce the amount of water remaining in the river for use downstream of the water transfer points. Although the potential amounts of water that would be transferred are unknown, data presented in this report can be used to investigate the effects of future interbasin transfers. The major population centers of the Tennessee River watershed and the surrounding areas are shown on figure 21.

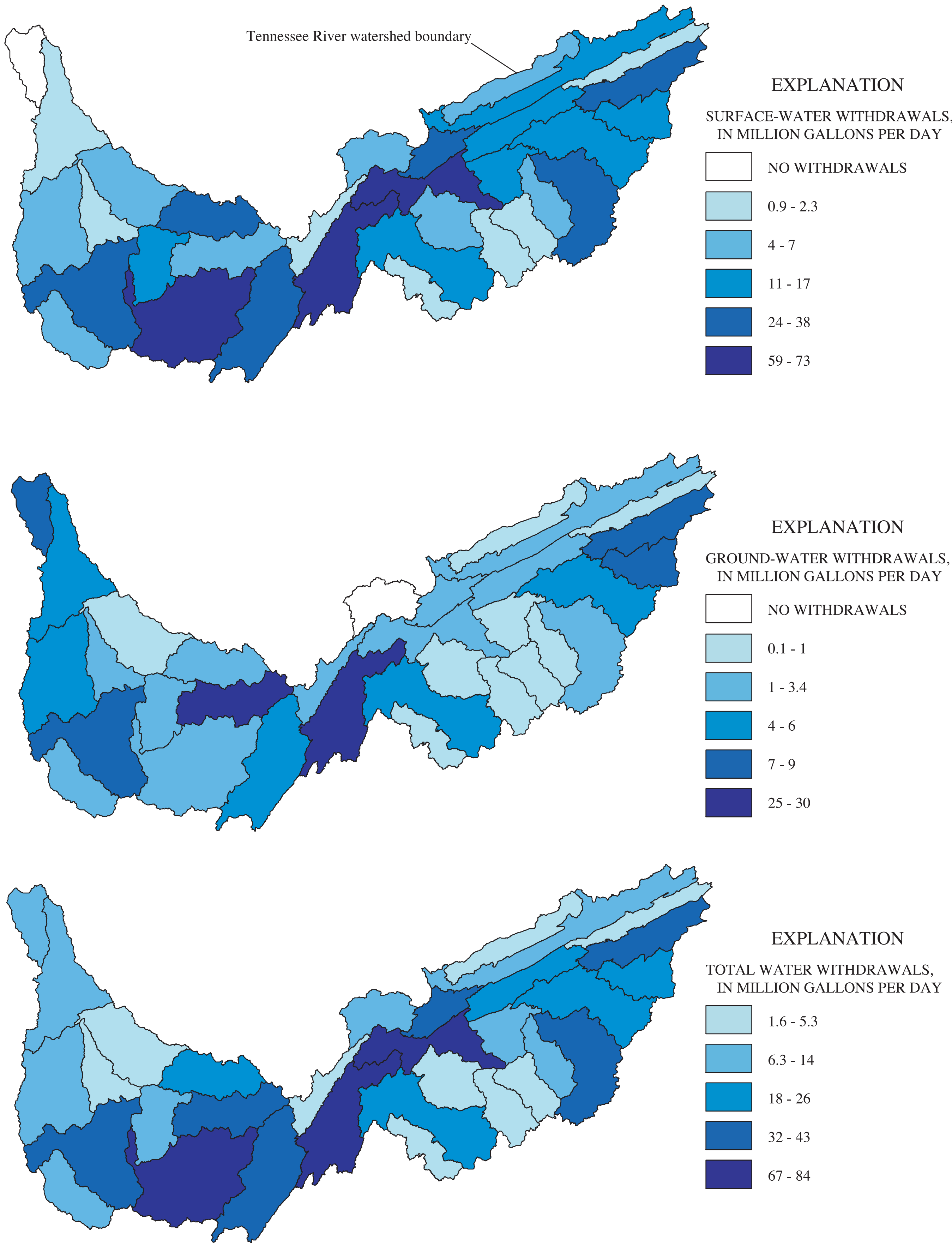


Figure 20. Public-supply withdrawals by source and by hydrologic unit in the Tennessee River watershed in 2000.

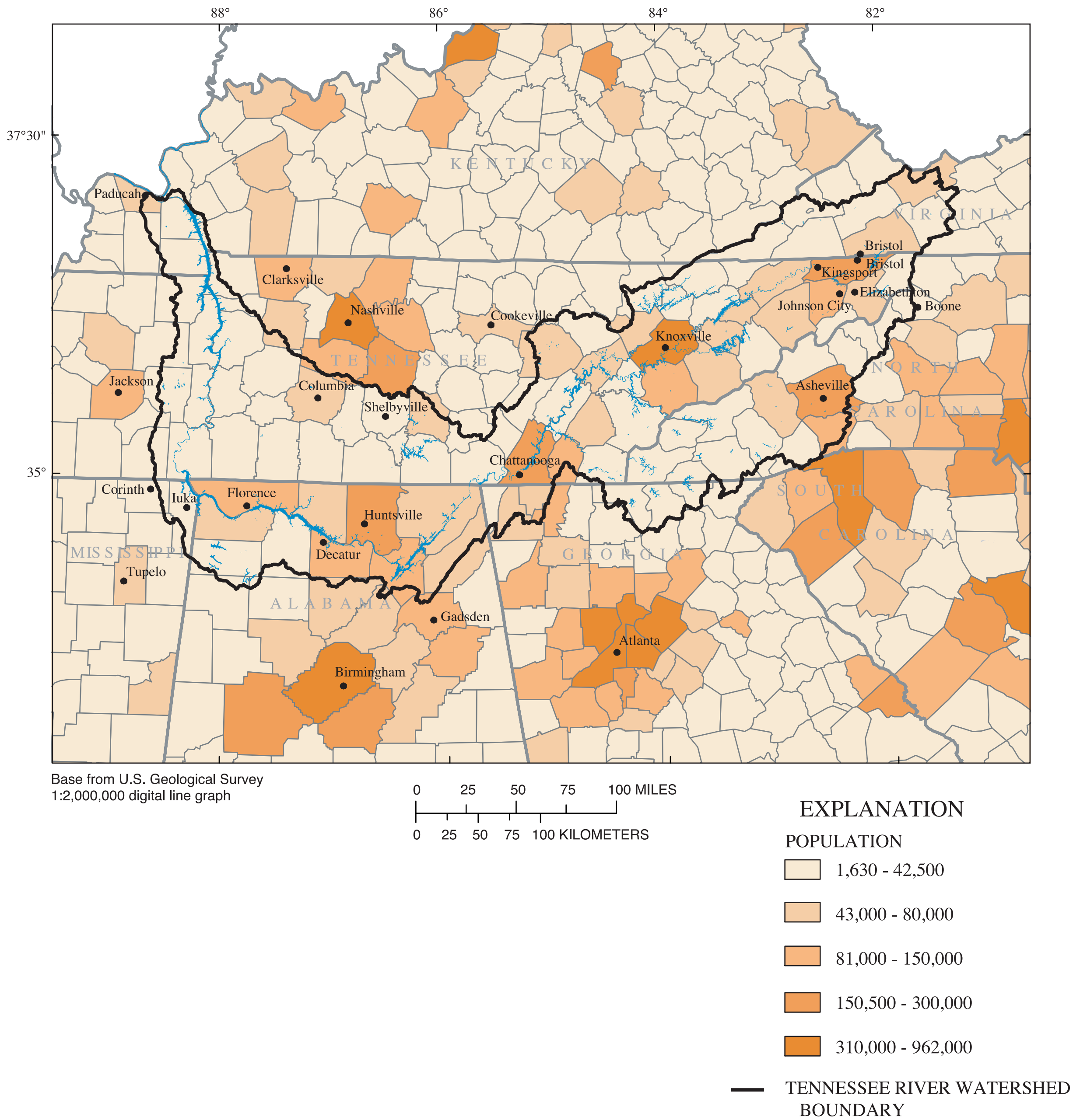


Figure 21. Population distribution in the Tennessee River watershed and surrounding areas by county in 2000.

Table 19. Public-supply water use by water-use tabulation area in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day; WUTA, water-use tabulation area]

	Withdrawal				
Water-use tabulation area Reservoir catchment area	**Ground water**	**Surface water**	**Total water**	**Wastewater return flow**	**Net water demand**
Cherokee					
Watauga	8.98	12.07	21.04	2.38	18.66
South Holston	7.39	18.85	26.25	1.86	24.39
Boone	3.72		3.72	23.58	-19.86
Fort Patrick Henry		16.40	16.40		16.40
Cherokee	2.85	17.38	20.22	15.13	5.09
WUTA total	**22.94**	**64.70**	**87.63**	**42.95**	**44.68**
Douglas					
Douglas	5.34	67.73	73.07	29.01	44.06
Fort Loudoun					
Fort Loudoun	1.24	71.18	72.42	55.03	17.39
Fontana-Tellico					
Fontana	1.09	2.73	3.83	2.01	1.82
Santeetlah		0.44	0.44		0.44
Tellico	0.57	4.11	4.68	1.09	3.59
WUTA total	**1.66**	**7.28**	**8.94**	**3.10**	**5.84**
Norris					
Norris	2.46	15.10	17.56	10.48	7.08
Melton Hill	1.58	29.83	31.40	9.43	21.97
WUTA total	**4.04**	**44.93**	**48.97**	**19.91**	**29.06**
Chatuge	0.18	1.70	1.88	0.27	1.60
Nottely	0.55	0.45	1.00	0.24	0.76
Hiwassee		0.75	0.75	0.10	0.65
Apalachia		2.89	2.89		2.89
Blue Ridge	0.05	1.41	1.47	0.33	1.14
Ocoee	1.11		1.11	0.26	0.85
WUTA total	**1.90**	**7.20**	**9.09**	**1.20**	**7.90**
Watts Bar-Chickamauga					
Watts Bar	0.85	8.67	9.53	21.34	-11.82
Chickamauga	22.84	24.55	47.39	13.92	33.47
WUTA total	**23.69**	**33.22**	**56.91**	**35.26**	**21.65**
Nickajack					
Nickajack	4.78	44.00	48.78	45.19	3.59
Guntersville					
Guntersville	6.07	36.37	42.43	20.45	21.99
Tims Ford					
Tims Ford	1.96	2.90	4.86	4.57	0.29

Table 19. Public-supply water use by water-use tabulation area in 2000—Continued

Water-use tabulation area Reservoir catchment area	**Withdrawal** **Ground water**	 **Surface water**	 **Total water**	**Wastewater return flow**	**Net water demand**
Wheeler-Wilson					
Wheeler	32.74	78.08	110.82	73.27	37.55
Wilson	2.83	20.33	23.16	6.80	16.36
WUTA total	**35.57**	**98.41**	**133.98**	**80.07**	**53.91**
Pickwick					
Pickwick	4.88	4.04	8.92	13.89	-4.98
Cedar Creek	1.13	3.00	4.13		4.13
Upper Bear Creek	0.16	2.81	2.97		2.97
WUTA total	**6.17**	**9.85**	**16.02**	**13.89**	**2.12**
Normandy					
Normandy	2.01	24.25	26.26	2.19	24.08
Kentucky					
Kentucky	18.76	13.60	32.36	23.74	8.61
Watershed total	**136**	**526**	**662**	**377**	**285**

Table 20. Public-supply water use by hydrologic unit in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

Hydrologic unit code	Withdrawal			Wastewater return flow	Net water demand
	Ground water	Surface water	Total water		
06010101	0.71	0.91	1.61		1.61
06010102	7.38	35.25	42.64	22.87	19.77
06010103	8.98	12.07	21.04	13.42	7.62
06010104	2.15	16.47	18.62	8.58	10.05
06010105	2.22	38.12	40.34	17.68	22.66
06010106	0.06	6.21	6.27	4.68	1.59
06010107	0.65	11.18	11.83	5.06	6.77
06010108	6.13	11.97	18.10	7.32	10.78
06010201	1.23	72.57	73.80	58.84	14.96
06010202	0.22	1.82	2.05	0.81	1.24
06010203	0.88	1.15	2.03	1.20	0.83
06010204	0.57	4.55	5.11	1.09	4.02
06010205	1.63	10.60	12.23	9.69	2.54
06010206	0.83	4.50	5.33	0.42	4.91
06010207	2.43	29.83	32.26	16.83	15.43
06010208		7.29	7.29	2.86	4.42
06020001	24.67	59.22	83.89	48.80	35.08
06020002	4.41	15.12	19.53	10.91	8.62
06020003	0.43	1.41	1.85	0.59	1.25
06020004	1.03	2.20	3.23	0.62	2.61
06030001	5.04	34.17	39.21	19.83	19.37
06030002	1.84	65.49	67.33	53.41	13.92
06030003	29.76	4.21	33.98	10.92	23.06
06030004	3.10	11.28	14.38	2.20	12.18
06030005	6.81	25.11	31.91	32.58	-0.67
06030006	2.19	5.81	8.00	1.63	6.37
06040001	4.13	5.13	9.26	2.98	6.28
06040002	2.01	24.25	26.26	7.57	18.69
06040003	0.09	4.22	4.31	6.49	-2.18
06040004	1.66	1.17	2.83	1.33	1.50
06040005	5.55	2.34	7.89	5.35	2.54
06040006	7.33		7.33	0.01	7.32
Watershed total	**136**	**526**	**662**	**377**	**285**

Table 21. Public-supply water use by county in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

State County	Withdrawal Ground water	 Surface water	 Total water	Wastewater return flow	Net water demand
Alabama					
Colbert	0.48	7.48	7.96	4.64	3.32
Dekalb	1.37	7.20	8.57	4.85	3.72
Franklin	1.13	3.00	4.13	1.61	2.52
Jackson	0.99	7.96	8.95	6.10	2.85
Lauderdale	0.85	12.89	13.74	10.80	2.94
Lawrence		2.19	2.19	2.64	-0.45
Limestone	2.91	8.10	11.01	12.34	-1.33
Madison	27.27	22.59	49.86	35.36	14.50
Marion		2.50	2.50		2.50
Marshall	2.65	17.17	19.82	8.08	11.74
Morgan		42.90	42.90	22.97	19.93
Winston	0.16	0.31	0.47		0.47
State total	**37.81**	**134.29**	**172.10**	**109.40**	**62.70**
Georgia					
Catoosa	7.88	0.65	8.53	2.39	6.14
Dade		1.70	1.70	0.28	1.42
Fannin		1.22	1.22	0.33	0.89
Rabun			0.00	0.04	-0.04
Towns		0.81	0.81	0.27	0.54
Union	0.55	0.45	1.00	0.24	0.76
Walker	5.13	2.50	7.63	7.72	-0.09
State total	**13.56**	**7.33**	**20.89**	**11.26**	**9.63**
Kentucky					
Calloway	3.31		3.31		3.31
Graves	0.05		0.05		0.05
Livingston		0.25	0.25	0.22	0.03
Marshall	3.61		3.61	0.04	3.57
McCracken	0.78		0.78		0.78
State total	**7.75**	**0.25**	**8.01**	**0.26**	**7.75**
Mississippi					
Tishomingo	4.36		4.36	0.34	4.02
State total	**4.36**	**0.00**	**4.36**	**0.34**	**4.02**
North Carolina					
Avery	1.03		1.03	1.09	-0.06
Buncombe	1.18	25.01	26.19	14.33	11.86
Cherokee		1.64	1.64	0.00	1.64
Clay	0.18		0.18	0.10	0.08
Graham		0.94	0.94		0.94
Haywood	0.06	6.21	6.27	3.38	2.89
Henderson	0.25	7.57	7.82	2.21	5.61
Jackson	0.85	0.81	1.66	0.89	0.77
Macon	0.22	1.32	1.55	0.77	0.78

Table 21. Public-supply water use by county in 2000—Continued

State County	Withdrawal Ground water	 Surface water	 Total water	Wastewater return flow	Net water demand
North Carolina—Continued					
Madison	0.24	0.26	0.50	0.19	0.31
Mitchell	0.09	1.04	1.13	0.61	0.52
Swain	0.02	0.34	0.36	0.31	0.05
Transylvania	0.55	1.19	1.74	0.95	0.79
Watauga	0.28	1.15	1.43	0.60	0.83
Yancey		0.57	0.57	0.31	0.26
State total	**4.95**	**48.05**	**53.00**	**25.74**	**27.26**
Tennessee					
Anderson	0.96	19.27	20.23	6.73	13.50
Bedford	0.83	5.69	6.52	3.29	3.23
Benton	0.16	1.38	1.54	1.59	-0.05
Bledsoe	0.39		0.39	0.14	0.25
Blount	0.02	14.27	14.29	7.18	7.10
Bradley	1.33	9.33	10.66	7.52	3.14
Campbell	0.52	2.32	2.84	1.19	1.65
Carroll	0.56		0.56	0.14	0.41
Carter	7.53		7.53	2.40	5.13
Claiborne	0.23	2.59	2.82	0.42	2.40
Cocke	0.00	4.09	4.09	1.30	2.79
Coffee	0.01	5.20	5.21	5.41	-0.20
Cumberland		3.25	3.25	2.22	1.03
Decatur	0.21	1.17	1.38	0.49	0.89
Dickson		1.53	1.53		1.53
Franklin	1.96	2.35	4.31	0.98	3.33
Giles	0.21	3.09	3.30	2.20	1.10
Grainger	0.03		0.03	0.14	-0.11
Greene	0.01	8.11	8.11	3.48	4.63
Grundy		0.75	0.75	0.26	0.49
Hamblen	1.04	9.25	10.29	4.09	6.19
Hamilton	10.27	52.11	62.38	36.73	25.66
Hancock		0.34	0.34	0.15	0.20
Hardin	2.38	0.74	3.11	1.02	2.09
Hawkins	1.15	2.86	4.00	0.86	3.14
Henderson	0.36	3.54	3.91	1.15	2.75
Henry	3.05		3.05	2.07	0.98
Hickman		2.29	2.29	0.35	1.93
Houston	0.16		0.16		0.16
Humphreys	1.19	1.12	2.31	1.63	0.68
Jefferson	0.53	2.70	3.23	1.05	2.18
Johnson	0.96	1.22	2.18	0.69	1.49
Knox	0.93	61.12	62.04	50.25	11.79
Lawrence	2.39	1.90	4.29	1.84	2.45
Lewis	1.51		1.51	0.78	0.73
Lincoln	2.17	1.31	3.48	1.18	2.29
Loudoun	1.20	8.88	10.09	8.18	1.90
Marion	0.71	2.64	3.35	0.80	2.55
Marshall	0.14	2.76	2.90	2.21	0.70
Maury	1.03	10.60	11.63	5.82	5.81

Table 21. Public-supply water use by county in 2000—Continued

State County	Withdrawal Ground water	 Surface water	 Total water	Wastewater return flow	Net water demand
Tennessee—Continued					
McMinn	2.35	2.89	5.24	2.74	2.50
McNairy	0.97		0.97	0.26	0.71
Meigs	0.58		0.58	0.22	0.36
Monroe	0.57	5.01	5.58	2.54	3.04
Moore		0.55	0.55	0.23	0.32
Morgan		1.05	1.05	0.64	0.41
Perry		0.75	0.75	0.25	0.50
Polk	0.43	0.19	0.63	0.31	0.32
Rhea	0.76	2.71	3.46	2.05	1.41
Roane	0.20	6.06	6.25	3.77	2.48
Sequatchie		0.65	0.65	0.47	0.17
Sevier	0.23	7.29	7.52	4.64	2.88
Stewart	0.02		0.02		0.02
Sullivan	0.35	25.08	25.43	19.82	5.61
Unicoi	5.93		5.93	1.36	4.57
Union	0.58		0.58	0.38	0.19
Washington		13.16	13.16	11.38	1.78
Wayne	0.20	0.83	1.03	0.35	0.69
Williamson	0.05		0.05		0.05
State total	**59.35**	**315.97**	**375.31**	**219.36**	**155.95**
Virginia					
Lee	0.58	0.78	1.36		1.36
Russell	0.48	0.55	1.03		1.03
Scott	0.01	1.05	1.06		1.06
Smyth	4.09	0.78	4.88		4.88
Tazewell	0.29	2.43	2.72	5.81	-3.09
Washington	2.67	8.19	10.86	1.86	9.00
Wise	0.22	5.93	6.15	2.54	3.61
State total	**8.34**	**19.72**	**28.06**	**10.21**	**17.85**
Watershed total	**136**	**526**	**662**	**377**	**285**

Irrigation

The quantity of water withdrawn for irrigation during 2000 was an estimated 68.9 Mgal/d (tables 22, 23, 24, and 26). Irrigation withdrawals during 2000 were 44 percent more than in 1995. The increase could be a result of more comprehensive data collection, a change in estimation techniques, a difference in temperature and precipitation, or an actual increase in irrigated acreage. Irrigation represents 0.6 percent of the total water withdrawals and 4 percent of the nonpower water withdrawals in the Tennessee River watershed. Surface water was the source of water for about 89 percent of the irrigation water withdrawals; ground water was the source of the remaining 11 percent (fig. 22). Irrigation water was primarily applied by sprinkler and microirrigation systems. The efficiency of the application was assumed to be 100 percent; that is, no runoff occurred at the sites. Consumptive use, therefore, is 100 percent, or 68.9 Mgal/d.

Irrigation water use includes all water artificially applied to farm and horticultural crops, as well as water used to irrigate golf courses. In the Tennessee River watershed, irrigation is used to supplement natural precipitation to increase the number of plantings per year, to increase the yield of crops, or to reduce the risk of crop failures during droughts.

Information about the number of acres irrigated and the quantity of water withdrawn is obtained from a variety of sources such as State agencies responsible for permitting, a State's Cooperative Extension Service, or the U.S. Department of Agriculture, Natural Resources and Conservation Service (appendix A). Methods for estimating withdrawals for irrigation vary. In some instances, water withdrawals are based on theoretical estimates of water required to raise a given crop in an area. In other instances, accurate records of water application rates are available. Obtaining reliable estimates of consumptive use is difficult.

The most intensive irrigation in the watershed is in the Wheeler-Wilson WUTA, which accounts for 73 percent of the total, or 50.4 Mgal/d (table 22). The spatial distribution of irrigation water withdrawals by HUC as a total and by source is shown in figure 23 and table 23. Alabama is the leading irrigation state in the Tennessee River watershed, withdrawing 76 percent of the total irrigation water (table 24).

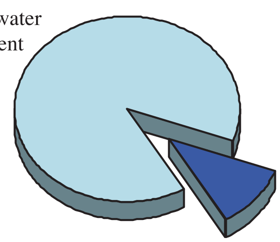


Figure 22. Source of water used for irrigation in the Tennessee River watershed in 2000.

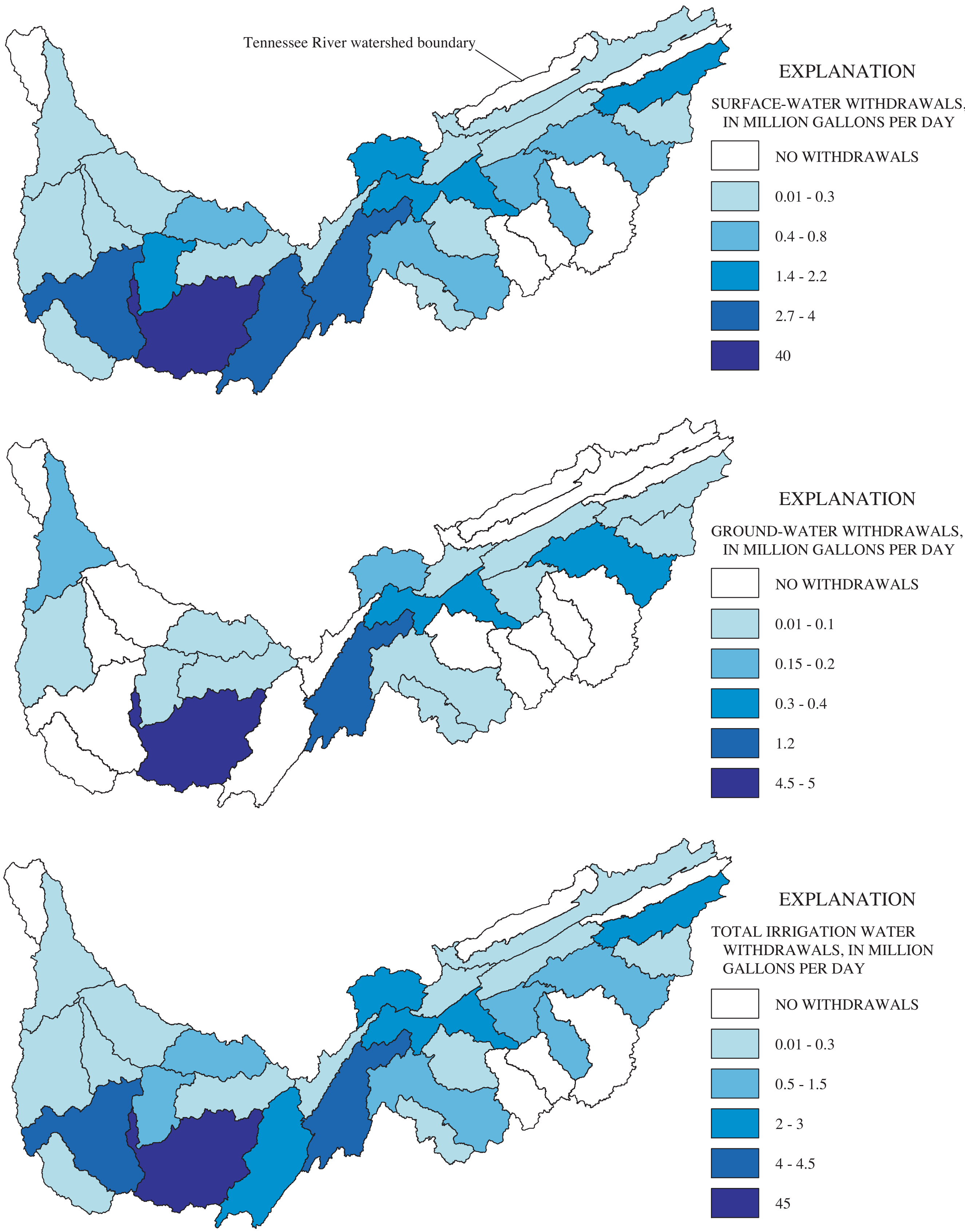


Figure 23. Irrigation withdrawals by source and by hydrologic unit in the Tennessee River watershed in 2000.

Table 22. Irrigation withdrawal by water-use tabulation area in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day; WUTA, water-use tabulation area]

Water-use tabulation area Reservoir catchment area	**Ground-water withdrawal**	**Surface-water withdrawal**	**Total water withdrawal**
Cherokee			
Watauga	0.02	0.10	0.12
South Holston	0.03	2.20	2.23
Boone			0.00
Fort Patrick Henry			0.00
Cherokee	0.03	0.24	0.28
WUTA total	**0.08**	**2.55**	**2.63**
Douglas			
Douglas	0.45	1.98	2.44
Fort Loudoun			
Fort Loudoun	0.34	1.33	1.68
Fontana-Tellico			
Fontana			0.00
Santeetlah			0.00
Tellico		0.05	0.05
WUTA total	**0.00**	**0.05**	**0.05**
Norris			
Norris	0.00	0.26	0.26
Melton Hill		0.05	0.05
WUTA total	**0.00**	**0.31**	**0.31**
Hiwassee-Ocoee			
Chatuge			0.00
Nottely		0.15	0.15
Hiwassee		0.11	0.11
Apalachia	0.00	0.05	0.05
Blue Ridge		0.07	0.07
Ocoee		0.01	0.01
WUTA total	**0.00**	**0.38**	**0.39**
Watts Bar-Chickamauga			
Watts Bar	0.25	1.87	2.12
Chickamauga	1.06	2.91	3.97
WUTA total	**1.32**	**4.78**	**6.09**
Nickajack			
Nickajack	0.15	0.20	0.35
Guntersville			
Guntersville		2.88	2.88
Tims Ford	0.06	0.20	0.26
Wheeler-Wilson			
Wheeler	4.92	41.48	46.39
Wilson		3.96	3.96
WUTA total	**4.92**	**45.43**	**50.35**
Pickwick			
Pickwick		0.11	0.11
Cedar Creek			0.00
Upper Bear Creek			0.00
WUTA total	**0.00**	**0.11**	**0.11**
Normandy			
Normandy	0.09	0.61	0.69
Kentucky			
Kentucky	0.21	0.44	0.65
Watershed total	**7.62**	**61.3**	**68.9**

Table 23. Irrigation withdrawal by hydrologic unit in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

Hydrologic unit code	Ground-water withdrawal	Surface-water withdrawal	Total water withdrawal
06010102	0.03	2.20	2.23
06010103	0.02	0.10	0.12
06010104	0.03	0.24	0.28
06010106	0.00	0.83	0.83
06010107	0.04	0.44	0.48
06010108	0.41	0.72	1.13
06010201	0.37	1.61	1.98
06010204	0.00	0.05	0.05
06010205	0.00	0.01	0.01
06010206	0.00	0.00	0.00
06010207	0.01	0.12	0.13
06010208	0.21	1.77	1.98
06020001	1.16	2.94	4.10
06020002	0.05	0.49	0.54
06020003	0.02	0.07	0.09
06020004	0.00	0.16	0.16
06030001	0.00	2.72	2.72
06030002	4.87	40.04	44.91
06030003	0.06	0.20	0.26
06030004	0.02	1.38	1.40
06030005	0.00	4.02	4.02
06030006	0.00	0.03	0.03
06040001	0.06	0.26	0.32
06040002	0.09	0.67	0.75
06040003	0.00	0.14	0.14
06040004	0.00	0.03	0.03
06040005	0.15	0.04	0.18
Watershed total	**7.62**	**61.3**	**68.9**

Table 24. Irrigation withdrawal by county in 2000

[Figures may not add to totals because of independent rounding. Water values in million gallons per day]

State County	Ground-water withdrawal	Surface-water withdrawal	Total water withdrawal
Alabama			
Franklin		0.03	0.03
Jackson		2.60	2.60
Lauderdale		1.86	1.86
Lawrence		5.39	5.39
Limestone	4.87	23.55	28.42
Madison		12.43	12.43
Marshall		0.13	0.13
Morgan		1.70	1.70
State total	**4.87**	**47.68**	**52.55**
Georgia			
Catoosa	0.30	0.59	0.89
Dade	0.47	0.09	0.56
Fannin	0.02	0.07	0.09
Union		0.15	0.15
Walker		0.59	0.59
State total	**0.79**	**1.49**	**2.28**
Mississippi			
Tishomingo		0.02	0.02
State total	**0.00**	**0.02**	**0.02**
Tennessee			
Anderson	0.01	0.07	0.08
Bedford	0.00	0.01	0.01
Benton	0.00		0.00
Bledsoe		0.20	0.20
Blount	0.24	0.30	0.55
Bradley	0.05	0.18	0.23
Campbell		0.25	0.25
Carroll	0.13		0.13
Carter		0.05	0.05
Claiborne		0.01	0.01
Cocke	0.00	1.00	1.00
Coffee	0.02	0.40	0.42
Cumberland	0.21	1.77	1.98
Decatur	0.02	0.05	0.06
Franklin	0.06	0.06	0.13
Giles		0.23	0.23
Grainger	0.02	0.06	0.08
Greene		0.41	0.41
Hamblen	0.01	0.00	0.02
Hamilton	0.38	0.93	1.32
Hancock		0.00	0.00
Hardin	0.03	0.20	0.23
Hawkins	0.00	0.04	0.04
Henderson	0.00	0.05	0.05
Henry	0.01	0.02	0.03
Hickman	0.00	0.04	0.04

Table 24. Irrigation withdrawal by county in 2000—Continued

State County	Ground-water withdrawal	Surface-water withdrawal	Total water withdrawal
Tennessee—Continued			
Jefferson	0.04	0.05	0.10
Johnson	0.02	0.02	0.04
Knox	0.10	1.19	1.29
Lawrence	0.02	0.00	0.03
Lewis	0.00	0.10	0.10
Lincoln		0.34	0.34
Loudoun		0.04	0.04
Marion		0.00	0.00
Maury	0.07	0.26	0.33
McMinn		0.00	0.00
McNairy	0.00	0.01	0.02
Meigs		0.32	0.32
Monroe		0.07	0.07
Perry	0.00	0.01	0.01
Polk	0.00	0.16	0.17
Rhea	0.04	0.38	0.42
Roane		0.00	0.00
Sequatchie		0.02	0.02
Sevier		0.37	0.37
Sullivan	0.03	0.05	0.08
Unicoi	0.00	0.05	0.05
Union	0.00		0.00
Washington	0.41	0.11	0.52
Wayne	0.00	0.03	0.04
State total	**1.96**	**9.92**	**11.87**
Virginia			
Russell		0.01	0.01
Smyth		2.15	2.15
State total	**0.00**	**2.15**	**2.15**
Watershed total	**7.62**	**61.3**	**68.9**

PROJECTIONS OF WATER USE

From 2000 to 2030, total water withdrawals in the Tennessee River watershed are projected to increase from 12,211 to 13,990 Mgal/d, or about 15 percent (table 25). That projected increase in water withdrawals of 1,779 Mgal/d is as follows: thermoelectric power, 11 percent (1,152 Mgal/d); industry, 31 percent (368 Mgal/d); public supply, 35 percent (32 Mgal/d); and irrigation, 37 percent (25.2 Mgal/d) (table 26). Total consumptive use is projected to increase 331 Mgal/d to 980 Mgal/d, or about 51 percent (table 25). Per capita use is estimated as 2,370 gal/d, or about 13 percent less than in 2000 (table 26).

Adding consumptive use at select WUTA junctures results in a cumulative consumptive use of 241 Mgal/d at Fort Loudoun for 2030 (fig. 24). Cumulative consumptive use at the Watts Bar-Chickamauga WUTA is 413 Mgal/d; Nickajack, 440 Mgal/d; Guntersville, 468 Mgal/d; Wheeler-Wilson, 804 Mgal/d; and Pickwick, 861 Mgal/d. As calculated at the terminus of the Kentucky WUTA at the Kentucky Dam, consumptive use is 980 Mgal/d. The projected average daily volume is 800 Mgal/d through the Jamie Whitten lock on the Tennessee-Tombigbee Waterway and indicates a potential maximum long-term flow based on the USACE design criteria of the lock (S.E. Gibson, Manager, Water Supply Projects, Tennessee Valley Authority, written commun., 2002)

Table 25. Water-use projections for the Tennessee River watershed by water-use tabulation area in 2030

[Figures may not add to totals because of independent rounding. All values expressed as integers and in million gallons per day]

Water-use tabulation area	Total water withdrawal	Net water demand	Cumulative consumptive use
Cherokee	1,347	105	
Douglas	156	94	
Fort Loudoun	116	34	
			241
Fontana-Tellico	15	9	
Norris	560	63	
Hiwassee-Ocoee	56	24	
Watts Bar-Chickamauga	3,253	76	
			413
Nickajack	100	27	
			441
Guntersville	1,626	28	
			468
Tims Ford	109	37	
Wheeler-Wilson	3,806	300	
			804
Pickwick	1,353	57	
			861
Normandy	39	36	
Kentucky	1,436	84	
Watershed total	**13,990**		**980**

(fig. 24). The average daily diversion of flow is projected to be 4,524 Mgal/d for hydroelectric power generation at Barkley Dam; the 4,524 Mgal/d at Barkley Canal for 2030 is based on an annual commitment to the USACE for hydroelectric power generation (H. Morgan Goranflo, Manager, Reservoir Operations, Tennessee Valley Authority, oral commun., 2002).

Water use was projected for industry, public supply, and irrigation using county-level demographic and economic data for 2030 developed by Woods and Poole Economics, Inc. (2001) and TVA. Manufacturing and mining earnings were used to project industrial withdrawals and return flows; number of households, for public-supply withdrawals and wastewater releases; and farm earnings, for irrigation. The county-specific projection factor, or multiplier, was applied to each water-use record in the database to produce estimates for the 2030 water use. The records of estimated use for 2030 were then aggregated to the RCA and WUTA. Based on an analysis of the potential need for additional water demand in parts of the watershed characterized by unregulated streamflow and for the purposes of the water-use projections, for some sites, the 2000 water-use transaction for a data record was assigned to one RCA and the additional future growth to another RCA. The projections of thermoelectric power water withdrawals and return flows were provided by the TVA and added to 2030 estimates for a total (Charles E. Bohac, Water Supply, TVA, oral commun., 2002).

To identify locations of future potential water-supply problems at a broad spatial scale, information on the spatial distribution of the change in percentage and in volume of water withdrawals by RCA can be used along with hydrologic, demographic, and socioeconomic data for the coinciding drainage areas. The RCAs showing the largest percentage of change are Fontana, Fort Loudoun, Wheeler, Nottely, Chatuge, and Normandy (fig. 25). The Wheeler RCA shows the largest volume increase in water withdrawals (fig. 26).

Standard deviation is a descriptive statistic that is a measure of the deviation of a data value to the mean for the data set. The distribution of percentage change from the mean for the RCAs for industry and public supply from 2000 to 2030 is shown on figure 26. For industry, the Fort Loudoun, Melton Hill, and Watauga RCAs indicate a percentage increase greater than one standard deviation, and the Tims Ford RCA indicates a change greater than two standard deviations. For public supply, the Chickamauga, Fontana, Guntersville, Nottely, Watts Bar, and Wheeler RCAs indicate a percentage increase within one standard deviation, and the Blue Ridge and Chatuge RCAs indicate a change greater than two standard deviations.

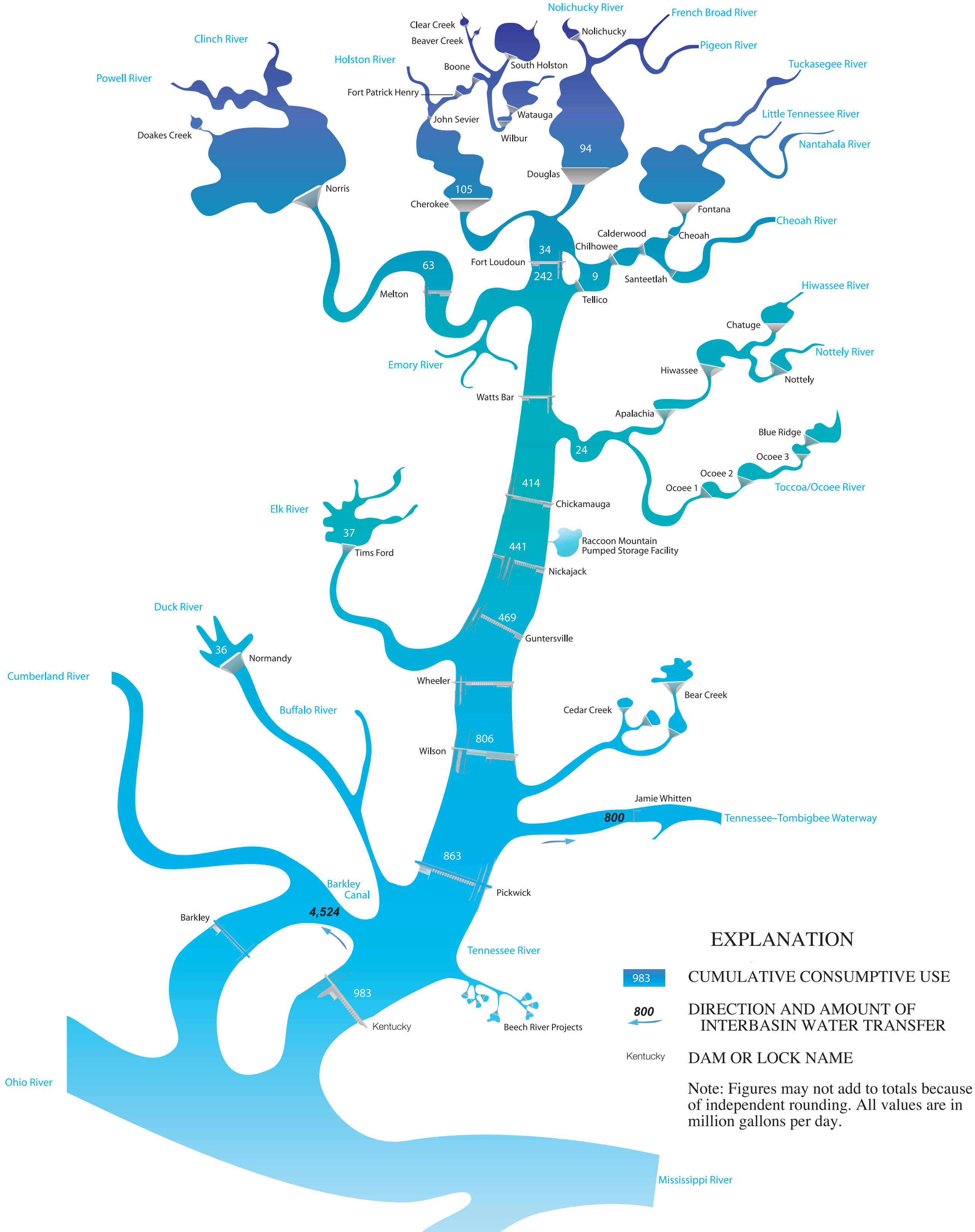


Figure 24. Projected cumulative consumptive use at major water-use tabulation area junctures in the Tennessee River watershed in 2030.

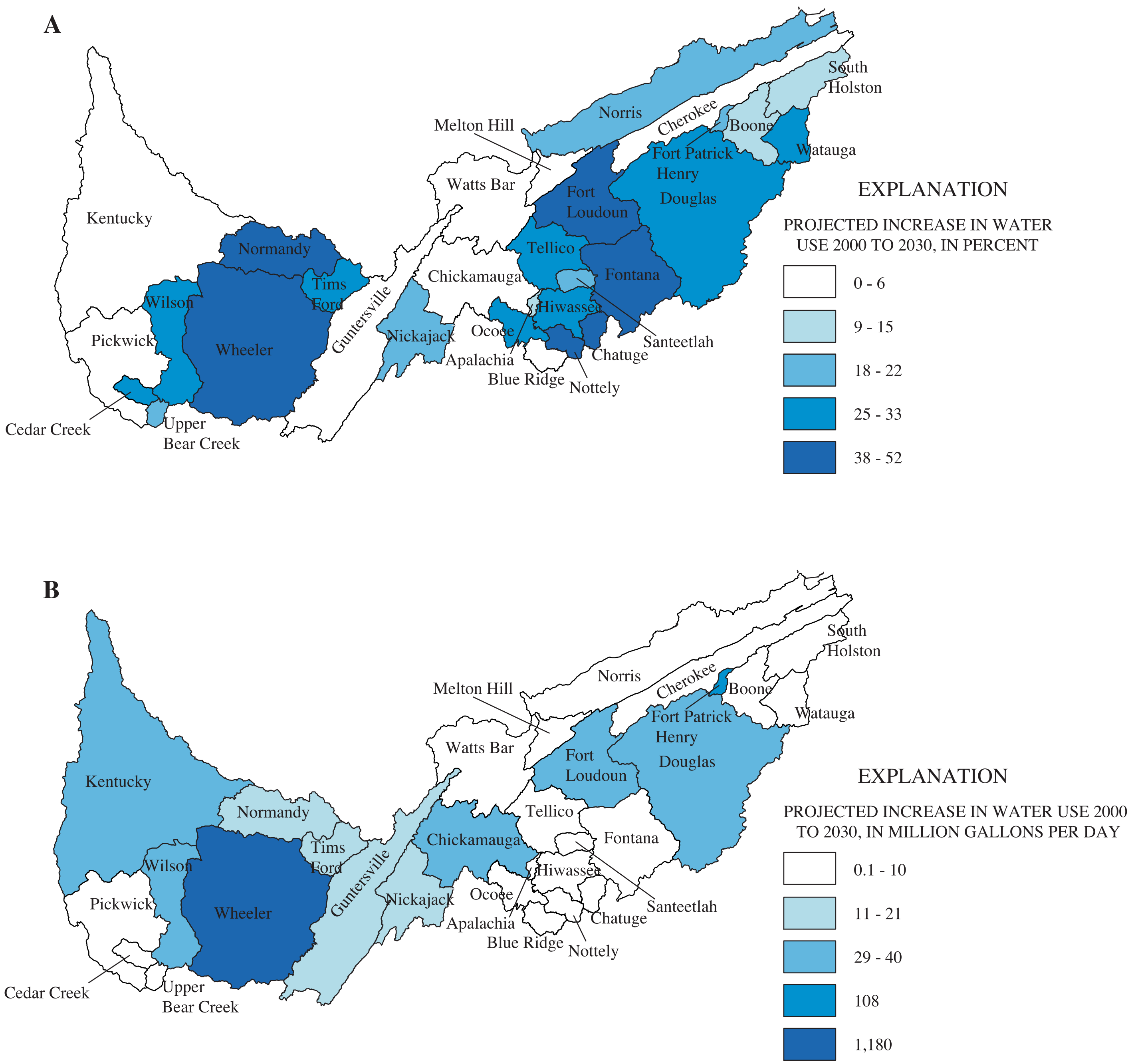


Figure 25. (A) Projected percent and (B) volume increases in water withdrawals by reservoir catchment area in the Tennessee River watershed from 2000 to 2030.

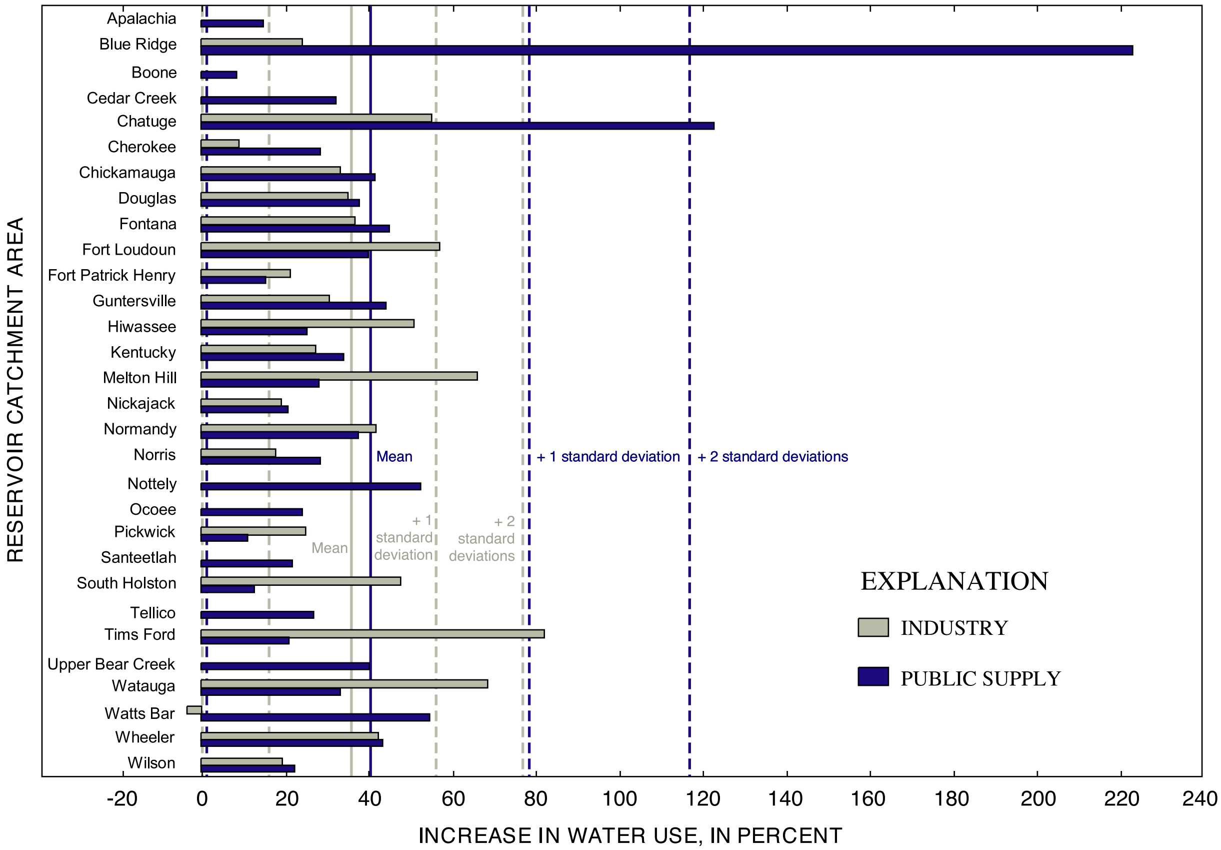


Figure 26. Projected percent increase in industrial and public-supply water use in the Tennessee River watershed from 2000 to 2030.

TRENDS IN WATER USE

After continual increases in withdrawals in the Tennessee River watershed from 1965 to 1980, withdrawals decreased from 1980 to 1985, and remained steady from 1985 through 1995 (table 26; figs. 27 and 28). The 2000 estimate is nearly the same as the estimate for 1980, the highest year of record, with 12,260 Mgal/d. All categories of water use have increased since 1995. Self-supplied domestic and livestock water withdrawals were not estimated for 2000. Total water withdrawals for 2000 are estimated at 12,211 Mgal/d, an increase of 22 percent from 1995.

Per capita use for 2000 was 2,710 gal/d. Per capita use had declined from 3,200 gal/d in 1980 to 2,350 gal/d by 1990. The decline in per capita use is related to the decline in water withdrawals that occurred in the thermoelectric power and industrial sectors. New technologies in the industrial sector that require less water, improved plant efficiencies, increased water recycling, and changes in laws and regulations to reduce the discharge of pollutants resulted in decreased water use and less water being returned to the river. The same pattern appears in the national water-use data (Solley and others, 1998). Water conservation can be an effective water-demand strategy that allows maximum benefits to be gained from the use of the watershed's resources.

The smallest ground-water withdrawals occurred in 1970 (170 Mgal/d) and the largest in 1990 (305 Mgal/d) (table 26). Total ground-water withdrawals have varied between these two rates of use since 1970, and the change in ground-water demand is

Table 26. Trends of estimated water use in the Tennessee River watershed, 1965 to 2030

[All values in million gallons per day; data for 1965-1995 adapted from MacKichan (1951, 1957), MacKichan and Kammerer (1961), Murray (1968), Murray and Reeves (1972, 1977), and Solley and others (1983, 1988, 1993, 1998). The water-use data are in million gallons per day and are rounded to two significant figures for 1960-1980, and three significant figures for 1985-1995; population is in thousands; per capita use is in gallons per day; percentage change is calculated from the unrounded numbers; *, not estimated in 2000; figures may not add to totals because of independent rounding]

	1965	1970	1975	1980	1985	1990	1995	2000	2030	Percent change 2000-2030
Population										
Population	3,107	3,234	3,319	3,677	3,848	3,911	4,198	4,506	5,903	31
Population served by public supply	1,730	2,080	2,370	2,680	2,940	3,030	3,250	[a]3,470	4,546	31
Per capita use	2,400	2,400	3,200	3,200	2,390	2,350	[b]2,382	2,710	2,370	-12
Offstream use										
Total withdrawals	7,400	7,870	10,270	12,260	9,193	9,205	[b]10,008	12,211	13,990	15
Thermoelectric power	5,900	6,100	8,700	9,300	6,810	7,070	[b]8,010	10,276	11,428	11
Industrial[c]	1,050	1,400	1,600	2,000	1,760	1,190	1,030	1,205	1,573	31
Public supply	250	300	330	410	469	511	574	662	895	35
Irrigation	8.8	6.6	8.1	6.8	10	30	48	68.9	94.1	37
Rural	100	83	79	102	121	257	269	*		
Source of water										
Surface water	7,200	7,700	10,000	12,000	8,960	8,900	9,750	11,996		
Ground water	200	170	270	260	233	305	258	215		

[a] Estimated
[b] Revised
[c] Industrial and mining water use

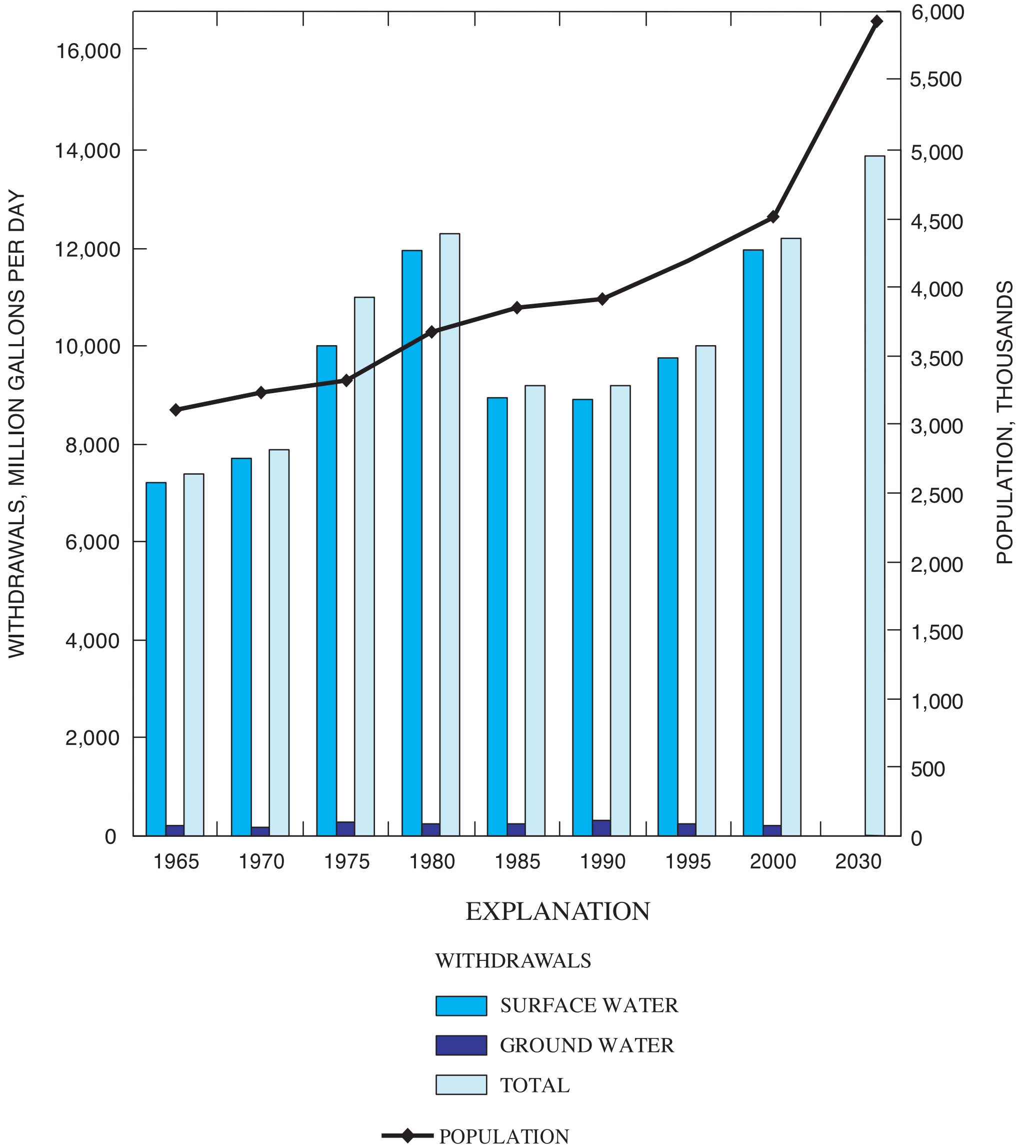


Figure 27. Trends in surface- and ground-water withdrawals and population for 1965 to 2000, and projection of total water withdrawal in 2030 for the Tennessee River watershed.

largely influenced by changes in the industrial category. In 2000, most of the estimated 215 Mgal/d of ground water was used for public supply (136 Mgal/d), an increase of 9 percent from 1995 (Solley and others, 1998).

More water continues to be withdrawn for thermoelectric power generation than for any other category. Thermoelectric power withdrawals are large, exclusively from surface water, and, therefore, determine the surface-water-use trends in the watershed. The dates of the operating schedules of the generating units at the power plants can be compared to the corresponding 5-year data-collection cycle to explain changes in the thermoelectric power withdrawals. For example, Browns Ferry nuclear power plant began operation in 1974, closed for a review of procedures in 1985, and began generating power for one unit in 1991 and a second unit in 1996. Sequoyah nuclear power plant began generating power in 1981 and Watts Bar nuclear power plant began generating power in 1996 (Tennessee Valley Authority, 2002). More than 99 percent of the water withdrawn for thermoelectric power generation is returned to the watershed, which is important in considering the reuse potential of the river. In the industrial sector, withdrawals declined 48 percent from 1980 to 1995. Although withdrawals

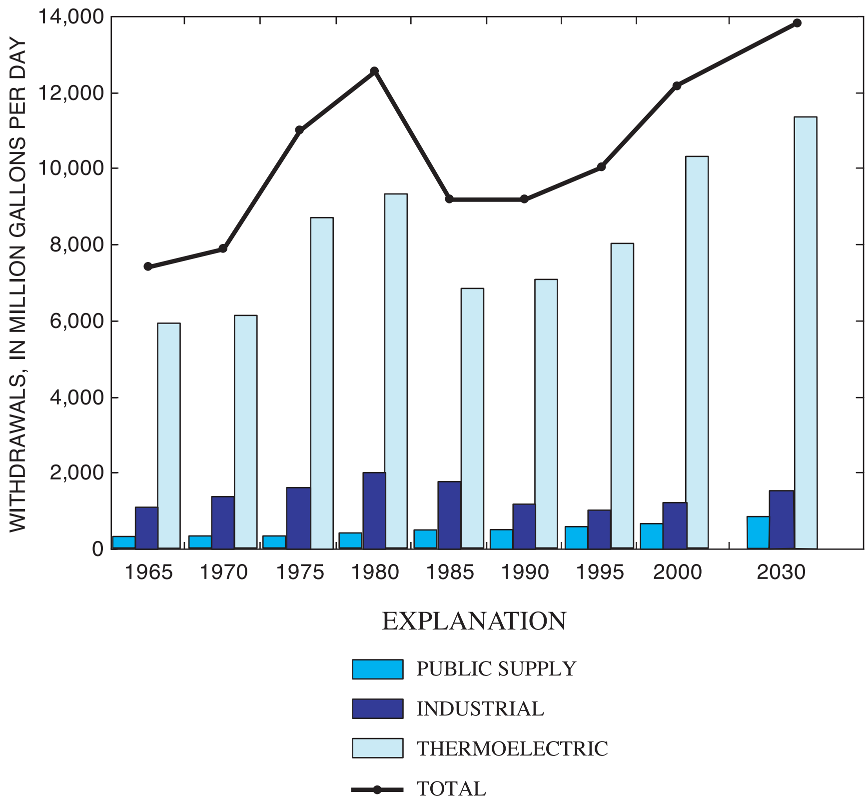


Figure 28. Trends in water withdrawal by water-use category from 1965 to 2000, and projected total withdrawal, 2030, for the Tennessee River watershed.

increased 17 percent from 1995 to 2000, the 2000 withdrawals are 40 percent less than in 1980.

The public-supply category shows continual increases from 1965 to 2000, largely because of growth in population and the extension of public-water supply pipelines to areas of counties that depended on private wells for drinking water. From 1990 to 2000, the rate of increase of public-supply withdrawals (30 percent) was twice that of the population (15 percent). However, that comparative rate of increase of withdrawals to population is unlikely to continue once the public-supply infrastructure has been fully developed. More importantly, the Tennessee River watershed is likely to continue to grow at a rate faster than the national average. The national average for population growth was 13 percent from 1990 to 2000 (U.S. Bureau of the Census, 2001).

Water withdrawals for irrigation have consistently increased from 1980 to 2000, from 6.8 to 68.9 Mgal/d. Periodic droughts in the watershed throughout the 1980s, changes in irrigation technology, affordable energy pricing, and increases in nursery and sod-farm enterprises and irrigated golf courses likely explain this change (Moore and others, 1990). This trend is likely to continue because of a combination of favorable climate, the abundance of water, and a shift of population to the southeastern United States.

Water-use data compiled and published at 5-year intervals by the USGS from 1965 to 1995 were used to evaluate trends in water use. Over time, the scope of the USGS water-use compilation and the definition of the categories also changed (Solley and others, 1998). Initially, in 1950, the USGS combined the Cumberland River and Tennessee River watersheds as one water-resources region. In 1965, the Tennessee River watershed became a separate water-resources region and the Cumberland River watershed was added to the Ohio. To compare the data consistently over time, total surface-, total ground-water withdrawals, and total withdrawals were compiled using the thermoelectric power, industrial, public supply, and irrigation category definitions from 1965 to 1995.

SUMMARY

The data from this report that are aggregated to reservoir catchment area (RCA) are intended to be input to the Tennessee Valley Authority (TVA) reservoir management models to evaluate alternative water-supply scenarios in the process of determining future multi-purpose reservoir management practices. Understanding how water use varies categorically, spatially, and temporally is important to the overall analysis of water supply in the Tennessee River watershed. In combination, the water-use, water-availability, and water-quality data for the watershed can be used to determine if future offstream and instream demands can be met by using the current water-management strategies.

For the Tennessee River watershed, estimates indicate that after increases in water withdrawals from 1965 to 1980, withdrawals declined from 1980 to 1985 and remained steady from 1985 to 1995. Water withdrawals during 2000 were estimated to average 12,211 million gallons per day (Mgal/d) of freshwater for offstream uses—22 percent more than the 1995 estimate. The 2000 estimate is nearly the same as the estimate for 1980, the highest year of record, with 12,260 Mgal/d. Self-supplied domestic and livestock withdrawals were not estimated for 2000. Return flow was estimated as 11,562 Mgal/d, 95 percent, of the water withdrawn during 2000. Consumptive water use accounts for the other 5 percent, 649 Mgal/d.

Offstream water-use categories are classified in this report as thermoelectric power, industrial, public supply, and irrigation. During 2000, thermoelectric power withdrawals were an estimated 10,276 Mgal/d; industrial, 1,205 Mgal/d; public supply, 662 Mgal/d; and irrigation, 68.9 Mgal/d. Return flows were estimated as thermoelectric power, 10,244 Mgal/d; industrial, 942 Mgal/d; and public supply, 377 Mgal/d. For thermoelectric power, consumptive use was estimated as 32.2 Mgal/d; industrial, 263 Mgal/d; public supply, 285 Mgal/d; and irrigation, 68.9 Mgal/d. During 2000, water withdrawals for thermoelectric power increased by 28 percent more than 1995, industrial by 17 percent, public supply by 15 percent, and irrigation by 44 percent.

Estimates of water withdrawals by source indicate that during 2000, total surface-water withdrawals were 98 percent of the total or 11,996 Mgal/d—23 percent more than during 1995. Total ground-water withdrawals were 215 Mgal/d, or 17 percent less than during 1995. More water continues to be withdrawn for thermoelectric power generation than for any other category. Thermoelectric power withdrawals are large, exclusively from surface water, and therefore determine the surface-water-use trends in the watershed. In 2000, most of the estimated 215 Mgal/d of ground water was used for public supply (136 Mgal/d), which is an increase of 9 percent from 1995.

Each category of use affects the reuse potential of the return flows differently. Besides water quality, reuse potential reflects the quantity of water available for subsequent uses. For water quantity, reuse potential is gaged by consumptive use, which is the difference between water withdrawals and return flow. Most of the water withdrawn from the Tennessee River is used for once-through cooling for thermoelectric power and industry, and therefore consumptive use is comparatively small.

Average per capita use for all offstream uses was 2,710 gallons per day per person in 2000, compared to the record high of 3,200 in 1975 and 1980. The intensity of use for the Tennessee watershed as measured as a function of area was 298,489 gallons per day per square mile in 2000.

In 2030 water withdrawals are projected to increase about 15 percent to 13,990 Mgal/d. By category, water withdrawals are projected to increase as follows: thermoelectric power, 11 percent, 1,152 Mgal/d; industry, 31 percent, 368 Mgal/d; public supply, 35 percent, 232 Mgal/d; and irrigation, 37 percent, 25.2 Mgal/d. Total consumptive use is projected to increase about 51 percent or 331 Mgal/d to 980 Mgal/d. For 2030, per capita use is calculated as 2,370 gallons per day, about 26 percent less than in 1980. Water transfers to the Tennessee-Tombigbee Waterway for navigation lockages are estimated as 200 Mgal/d for 2000 and 800 Mgal/d for 2030. The 800 Mgal/d is the potential maximum long-term flow based on the design of the lock. Water transfers through Barkley Canal averaged 3,361 Mgal/d for 2000, and are estimated to be an average of 4,524 Mgal/d in 2030. The 4,524 Mgal/d at Barkley Canal for 2030 is based on an annual commitment to the U.S. Army Corps of Engineers for hydroelectric power generation.

By RCA, the largest percentage increases from 2000 to 2030 as measured as the standard deviation from the mean are expected as follows. For industry, the Fort Loudoun, Melton Hill, and Watauga RCAs indicate a percentage increase greater than one standard deviation, and the Tims Ford RCA indicates a change greater than two standard deviations. For public supply, the Chickamauga, Fontana, Guntersville, Nottely, Watts Bar, and Wheeler RCAs indicate a percentage increase within one standard deviation, and the Blue Ridge and Chatuge RCAs indicate a change greater than two standard deviations.

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Glossary

GLOSSARY

Water-use terminology in this report is the same as that used in the series of USGS water-use Circulars which are cited in the Selected References section. The term "water use" as initially used in 1950 in the USGS water-use Circulars meant withdrawals of water; in the report for 1960, the term was redefined to include consumptive use of water as well as withdrawals. With the beginning of the USGS National Water-Use Information Program in 1978, the term was again redefined to include return flow and offstream and instream uses. In the water-use Circular for 1985, the term was redefined further to include withdrawals plus deliveries. In this report for 2000, water use is defined to include withdrawals, wastewater releases, return flow, and consumptive use for thermoelectric power, industrial, public supply, and irrigation.

TERMS USED IN THIS REPORT

acre-foot—the volume of water required to cover 1 acre of land (43,560 square feet) to a depth of 1 foot.

aquifer—a geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

commercial water use—water for motels, hotels, restaurants, office buildings, other commercial facilities, and institutions. The water may be obtained from a public supply or may be self supplied. *See also* public supply and self-supplied water.

consumptive use—that part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment; also referred to as water consumed.

conveyance loss—water that is lost in transit from a pipe, canal, conduit, or ditch by leakage or evaporation. Generally, the water is not available for further use; however, leakage from an irrigation ditch, for example, may percolate to a ground-water source and be available for further use.

cooling water—water used for cooling purposes, such as of condensers and nuclear reactors.

delivery/release—the amount of water delivered to the point of use and the amount released after use; the difference between these amounts is usually the same as the consumptive use. *See also* consumptive use.

domestic water use—water for household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. Also called residential water use. The water may be obtained from a public supply or may be self supplied. *See also* public supply and self-supplied water.

evaporation—the process by which water is changed from a liquid into a vapor. *See also* evapotranspiration and transpiration.

evapotranspiration—a collective term that includes water discharged to the atmosphere as a result of evaporation from the soil and surface-water bodies and as a result of plant transpiration. *See* also evaporation and transpiration.

freshwater—water that contains less than 1,000 milligrams per liter (mg/L) of dissolved solids; generally, more than 500 mg/L of dissolved solids is undesirable for drinking and many industrial uses.

ground water—generally all subsurface water as distinct from surface water; specifically, that part of the subsurface water in the saturated zone (a zone in which all voids are filled with water) where the water is under pressure greater than atmospheric.

hydroelectric power water use—the use of water in the generation of electricity at plants where the turbine generators are driven by falling water. Hydroelectric water use is classified as an instream use in this report.

in-channel use—*see* instream use.

industrial water use—water used for industrial purposes such as fabrication, processing, washing, and cooling, and includes such industries as steel, chemical and allied products, paper and allied products, mining, and petroleum refining. The water may be obtained from a public supply or may be self supplied. *See also* public supply and self-supplied water.

instream use—water that is used, but not withdrawn, from a ground- or surface-water source for such purposes as hydroelectric power generation, navigation, water-quality improvement, fish propagation, and recreation; sometimes called nonwithdrawal use or in-channel use.

irrigation water use—artificial application of water on lands to assist in the growing of crops and pastures or to maintain vegetative growth in recreational lands such as parks and golf courses.

kilowatt-hour (kWh)—a unit of energy equivalent to one thousand watt-hours.

million gallons per day—a rate of flow of water.

mining water use—water used for the extraction of minerals occurring naturally including solids, such as coal and ores; liquids, such as crude petroleum; and gases, such as natural gas. Also includes uses associated with quarrying, well operations (dewatering), milling (crushing, screening, washing, floatation, and so forth), and other preparations customarily done at the mine site or as part of a mining activity. Does not include water used in processing, such as smelting, refining petroleum, or slurry pipeline operations; these uses are included in industrial water use.

net water demand—the quantitative difference between water withdrawals and return flow. *See also* return flow, water-use transaction, withdrawal, wastewater-treatment return flow, or water transfer.

offstream use—water withdrawn or diverted from a ground- or surface-water source for public-water supply, industry, irrigation, livestock, thermoelectric power generation, and other uses. Sometimes called off-channel use or withdrawal.

per capita use—the average amount of water used per person during a standard time period, generally per day.

public supply—water withdrawn by public and private water suppliers and delivered to users. Public suppliers provide water for a variety of uses, such as domestic, commercial, thermoelectric power, industrial, and public water use. *See also* commercial water use, domestic water use, thermoelectric power water use, industrial water use, and public water use.

public-supply deliveries—water provided to users through a public-supply distribution system.

public water use—water supplied from a public-water supply and used for such purposes as firefighting, street washing, and municipal parks and swimming pools. *See also* public supply.

reclaimed wastewater—wastewater-treatment plant effluent that has been diverted for beneficial use before it reaches a natural waterway or aquifer.

recycled water—water that is used more than one time before it passes back into the natural hydrologic system.

residential water use—*see* domestic water use.

return flow—the water that reaches a ground- or surface-water source after release from the point of use and thus becomes available for further use.

reuse—*see* recycled water.

self-supplied water—water withdrawn from a surface- or ground-water source by a user rather than being obtained from a public supply.

Standard Industrial Classification (SIC) codes—four-digit codes established by the U.S. Office of Management and Budget and used in the classification of establishments by type of activity in which they are engaged.

surface water—an open body of water, such as a stream or a lake.

thermoelectric power water use—water used in the process of the generation of thermoelectric power. The water may be obtained from a public supply or may be self supplied. *See also* public supply and self-supplied water.

transpiration—process by which water that is absorbed by plants, usually through the roots, is evaporated into the atmosphere from the plant surface. *See also* evaporation and evapotranspiration.

wastewater—water that carries wastes from homes, businesses, and industries.

wastewater treatment—the processing of wastewater for the removal or reduction of contained solids or other undesirable constituents.

wastewater-treatment return flow—water returned to the hydrologic system by wastewater-treatment facilities.

water-resources region—designated natural drainage basin or hydrologic area that contains either the drainage area of a major river or the combined drainage areas of two or more rivers; of 21 designated regions, 18 are in the conterminous United States, and one each is in Alaska, Hawaii, and the Caribbean.

water-resources subregion—the 21 designated water-resources regions of the United States are subdivided into 222 subregions. Each subregion includes that area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin(s), or a group of streams forming a coastal drainage system.

water transfer—artificial conveyance of water from one area to another.

water use—(1) in a restrictive sense, the term refers to water that is actually used for a specific purpose, such as for domestic use, irrigation, or industrial processing; (2) broadly, water use pertains to human interaction with and influence on the hydrologic cycle, and includes elements such as water withdrawal, delivery, consumptive use, wastewater release, reclaimed wastewater, return flow, and instream use. *See also* instream use and offstream use.

water-use tabulation area—the boundaries of a water-use tabulation area are determined by the natural drainage area to account for water availability and the water-use transactions that occur within that drainage area. For this report, the water-use tabulation area accounts for the complete site-specific water-use transactions between adjoining reservoir catchment areas and is used to determine consumptive use at a large scale. *See also* consumptive use and net water demand.

water-use transaction—a water-use activity that is a water withdrawal, water delivery, water release, return flow or water transfer. *See also* delivery/release, return flow, wastewater-treatment return flow, water transfer, or withdrawal.

watt-hour—an electrical energy unit of measure equal to one watt of power supplied to, or taken from, an electrical circuit steadily for 1 hour.

withdrawal—water removed from the ground or diverted from a surface-water source for use. *See also* offstream use and self-supplied water.

Appendixes

Appendix A. Water-use data sources for the Tennessee River watershed in 2000

[Tennessee Valley Authority, TVA; Department of Energy, Energy Information Administration, DOE, EIA; Alabama Department of Economic and Community Affairs, ADECA; U.S. Geological Survey, Aggregated Water Use Data System, USGS, AWUDS; Water Resources Management Program, Environmental Protection Division, WRMP, EPD; U.S. Environmental Protection Agency, National Pollution Discharge Elimination System, Permit Compliance System, USEPA, NPDES, PCS; North Carolina Department of Environment, Health, and Natural Resources, NCDEHNR; Tennessee Department of Environment and Conservation, Division of Water Supply, TDEC, DWS; University of Georgia, UGA; Mississippi State University, MSU; U.S. Department of Agriculture, Natural Resources and Conservation Service, USDA, NRCS]

Water-use category	Data sources	Type of data
Thermoelectric		
Tennessee River watershed	TVA water-use survey; DOE, EIA electricity database	Withdrawal
Tennessee River watershed	TVA water-use survey; DOE, EIA electricity database	Return flow
Industry		
Alabama	ADECA; USGS AWUDS 1995 data, adjusted	Withdrawal
Georgia	WRMP, EPD	Withdrawal
Kentucky	Department of Water	Withdrawal
Mississippi	Office of Land and Water Resources	Withdrawal
North Carolina	TVA water-use survey	Withdrawal
Tennessee	TVA water-use survey; USGS water-use program	Withdrawal
Virginia	Department of Environmental Quality	Withdrawal
Tennessee River watershed	TVA water-use survey; USEPA, NPDES, PCS	Return flow
Public supply		
Alabama	ADECA; USGS, AWUDS 1995 data, adjusted	Withdrawal
Georgia	WRMP, EPD	Withdrawal
Kentucky	Department of Water	Withdrawal
Mississippi	Office of Land and Water Resources	Withdrawal
North Carolina	NCDEHNR; TVA water-use survey; USGS water-use survey	Withdrawal
Tennessee	TDEC, DWS; USGS water-use program	Withdrawal
Virginia	Department of Environmental Quality	Withdrawal
Wastewater releases		
Tennessee River watershed	USEPA, NPDES, PCS; adjustments to USGS, AWUDS 1995 data	Return flow
Irrigation		
Alabama	ADECA	Withdrawal
Georgia	UGA Cooperative Extension Service	Withdrawal
Kentucky	Department of Water; USGS water-use program	Withdrawal
Mississippi	MSU Agricultural Extension Office	Withdrawal
North Carolina	USGS water-use program	Withdrawal
Tennessee	USDA, NRCS; USGS water-use program	Withdrawal
Virginia	Department of Environmental Quality	Withdrawal

Appendix B. Hydrologic unit codes and names

[The map boundaries for hydrologic units are hydrographically defined, and the units are often used as a geographical framework for detailed water-resources planning. The hydrologic unit code (HUC) assigned to the hydrologic unit is an 8-digit number with each 2-digit number respectively indicating region, subregion, accounting unit, and cataloging unit. The Tennessee River watershed is designated by “06” and has 32 hydrologic units as mapped in figure 4 and listed in this table by code number and name.]

Hydrologic unit code	Hydrologic unit name
06010101	North Fork Holston
06010102	South Fork Holston
06010103	Watauga
06010104	Holston
06010105	Upper French Broad
06010106	Pigeon
06010107	Lower French Broad
06010108	Nolichucky
06010201	Watts Bar Lake
06010202	Upper Little Tennessee
06010203	Tuckasegee
06010204	Lower Little Tennessee
06010205	Upper Clinch
06010206	Powell
06010207	Lower Clinch
06010208	Emory
06020001	Middle Tennessee - Chickamauga
06020002	Hiwassee
06020003	Ocoee
06020004	Sequatchie
06030001	Guntersville
06030002	Wheeler
06030003	Upper Elk
06030004	Lower Elk
06030005	Pickwick
06030006	Bear
06040001	Lower Tennessee – Beech
06040002	Upper Duck
06040003	Lower Duck
06040004	Buffalo
06040005	Kentucky Lake
06040006	Lower Tennessee

Appendix C. Improving Hydropower and Water Quality at the Tennessee Valley Authority Dams

By Patrick A. March, Senior Manager, Resource Management, Tennessee Valley Authority

The Tennessee Valley Authority (TVA) is working to increase the efficiency and capacity of its 30 hydroplants with the goal of ensuring a reliable power supply at a reasonable price without degrading water quality (March and Fisher, 1999). As part of that effort, TVA has undertaken an aggressive program to automate and modernize hydrogeneration operations and equipment. Thirty-eight units have been modernized to year 2002, adding 342 megawatt-hours of peaking capacity and boosting efficiency by more than 4 percent. By the time this effort is complete (about 2013), TVA will have added an additional 750 megawatts of installed peaking capacity at a cost of 750 million dollars.

Where feasible, autoventing turbine technology is being implemented as TVA hydro units are modernized. Autoventing turbines or AVTs, induce air into the turbine releases using low-pressure areas identified in scale-model and numerical model tests. This technology was developed by TVA in cooperation with Voith Siemens Hydro and first implemented at TVA's Norris project near Knoxville, Tennessee. AVTs are the first turbines designed to aerate turbine releases while increasing the capacity and efficiency of the generating units.

AVTs are one of a variety of technologies TVA has implemented, either singly or in combination, as part of its Reservoir Releases Improvements program. This 5-year, 50 million dollar program, completed in 1996, addressed two major environmental problems faced by the hydropower industry: low levels of dissolved oxygen and intermittent drying out of the riverbed in tailwater areas. In addition to AVTs, TVA uses surface-water pumps, oxygen injection systems, aerating weirs, and air compressors and blowers to raise dissolved oxygen levels downstream from 16 of its hydropower dams. Turbine pulsing, weirs, and small hydropower units are used to maintain a minimum flow of water when hydro turbines are not operating at 13 dams. Together, these technologies have increased dissolved oxygen levels 1 to 5 milligrams per liter in more than 300 miles of river downstream from TVA dams and have improved water flows in 180 miles of rivers.