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The quantity of water withdrawn for public supply during 2000 was estimated to be 662 Mgal/d, which is an increase of 15 percent from 1995 (tables 19, 20, 21, and 26).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.

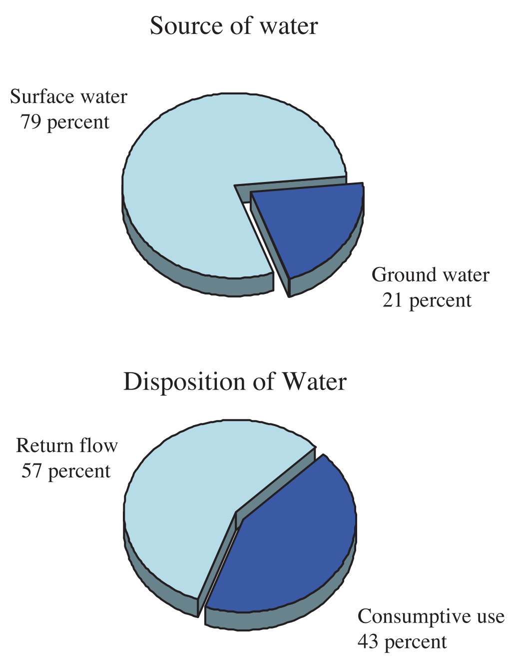

Figure 19. Source and disposition of water used for public supply in the Tennessee River watershed in 2000.

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.

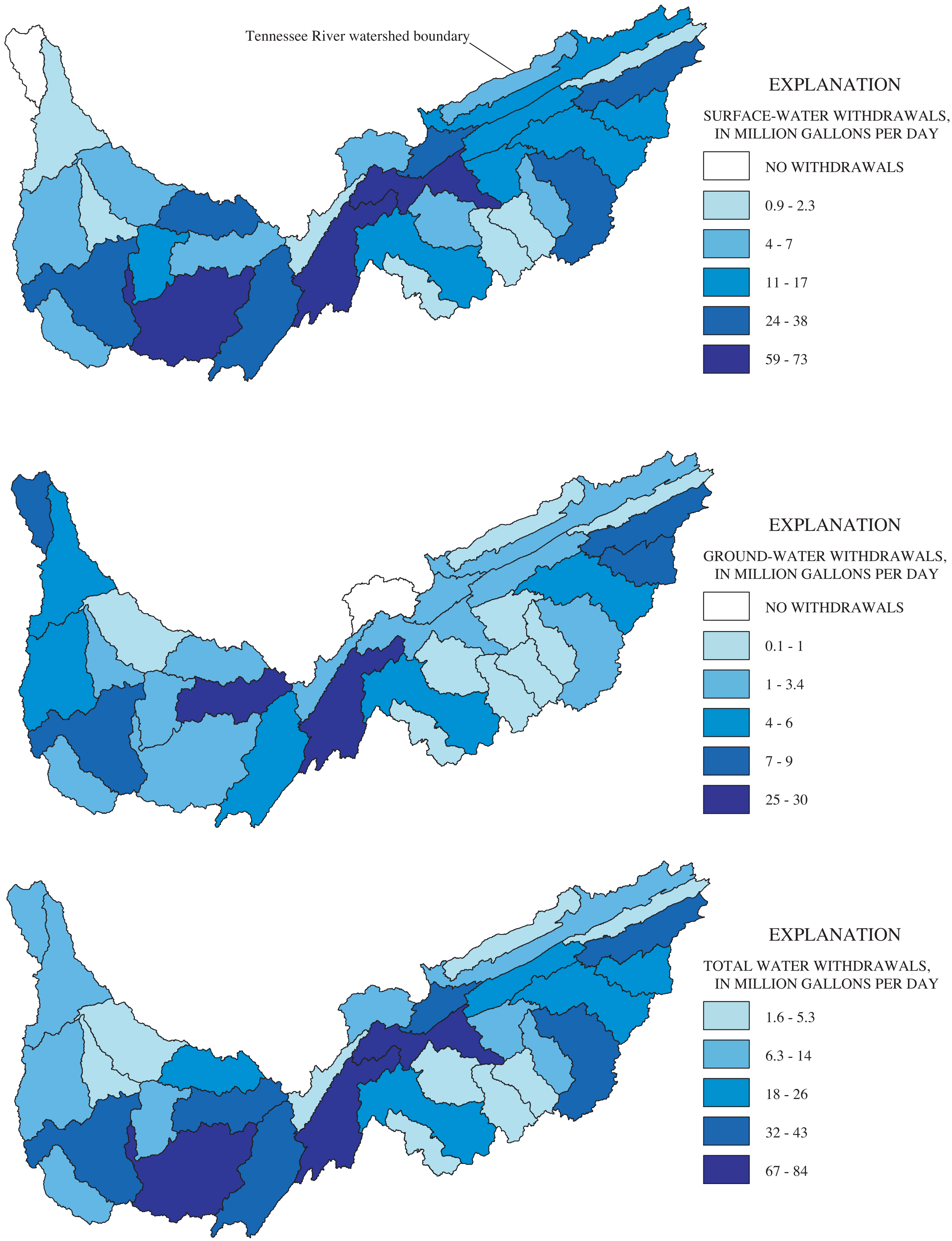

Figure 20. Public-supply withdrawals by source and by hydrologic unit in the Tennessee River watershed in 2000.

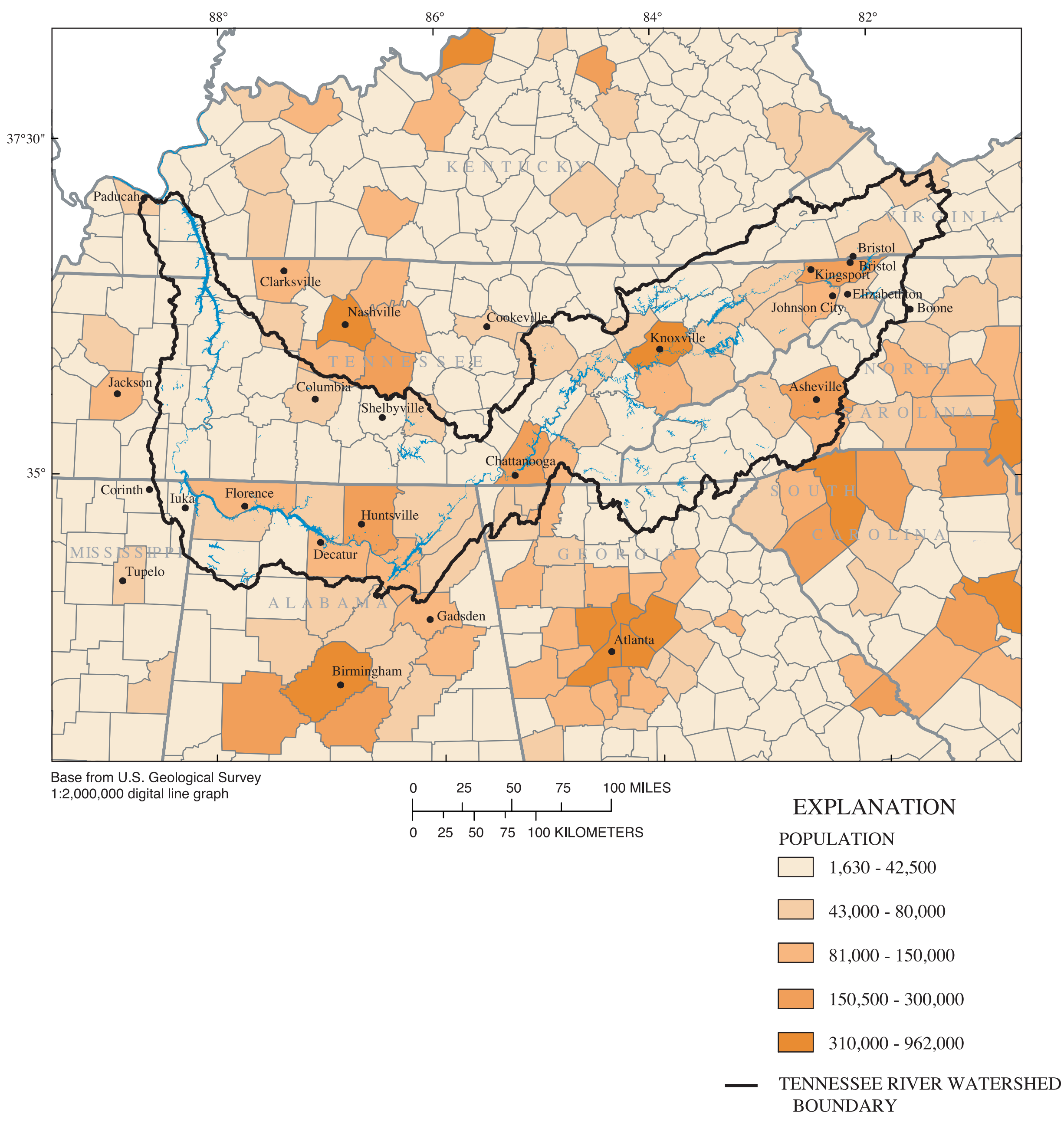

Figure 21. Population distribution in the Tennessee River watershed and surrounding areas by county in 2000.

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]

Water-use tabulation area Reservoir catchment area	Withdrawal 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: Ground water	Withdrawal: Surface water	Withdrawal: Total water	Wastewater return flow	Net water demand
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).

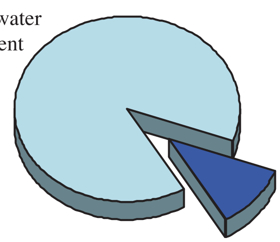

Figure 22. Source of water used for irrigation in the Tennessee River watershed in 2000.

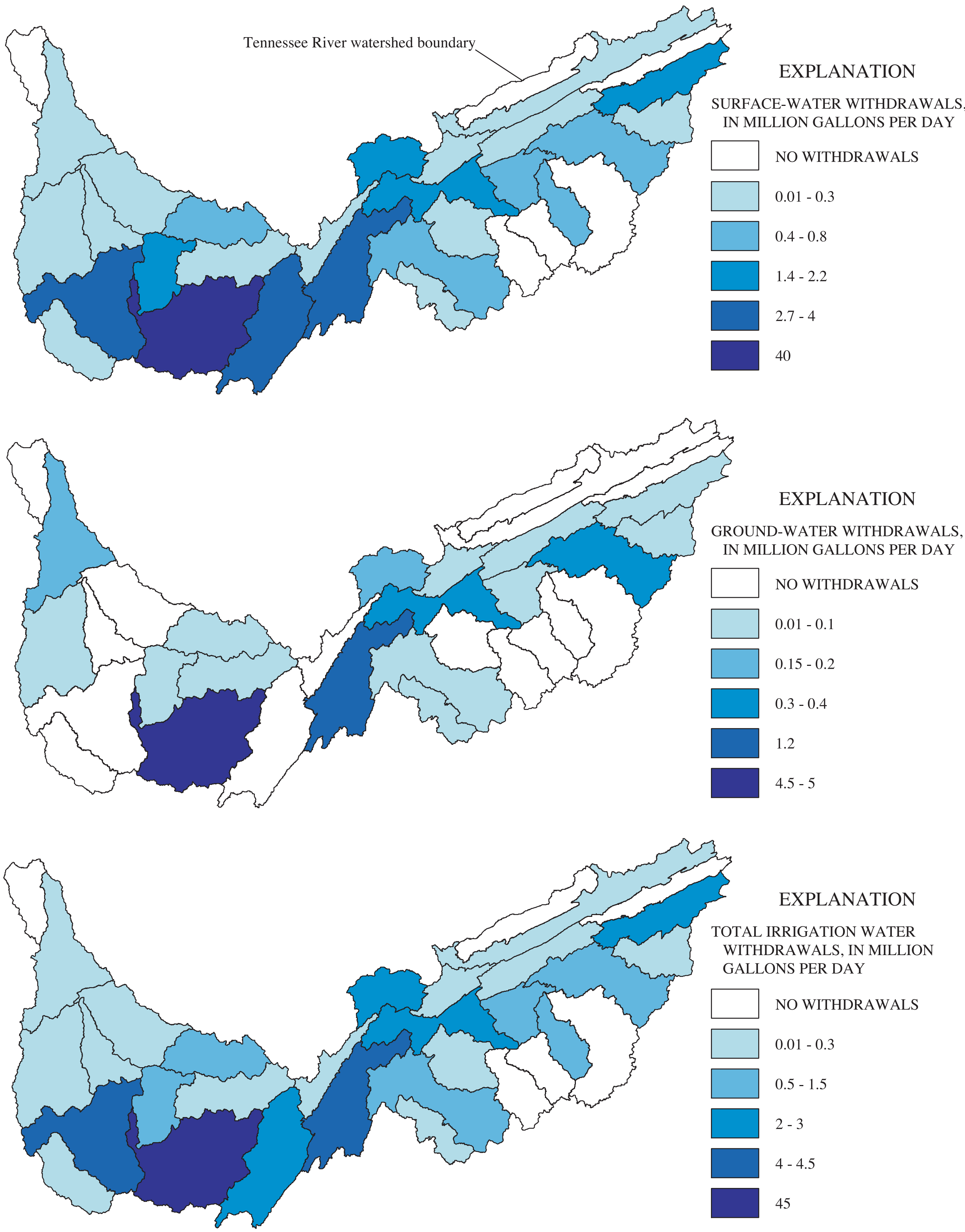

Figure 23. Irrigation withdrawals by source and by hydrologic unit in the Tennessee River watershed in 2000.

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.

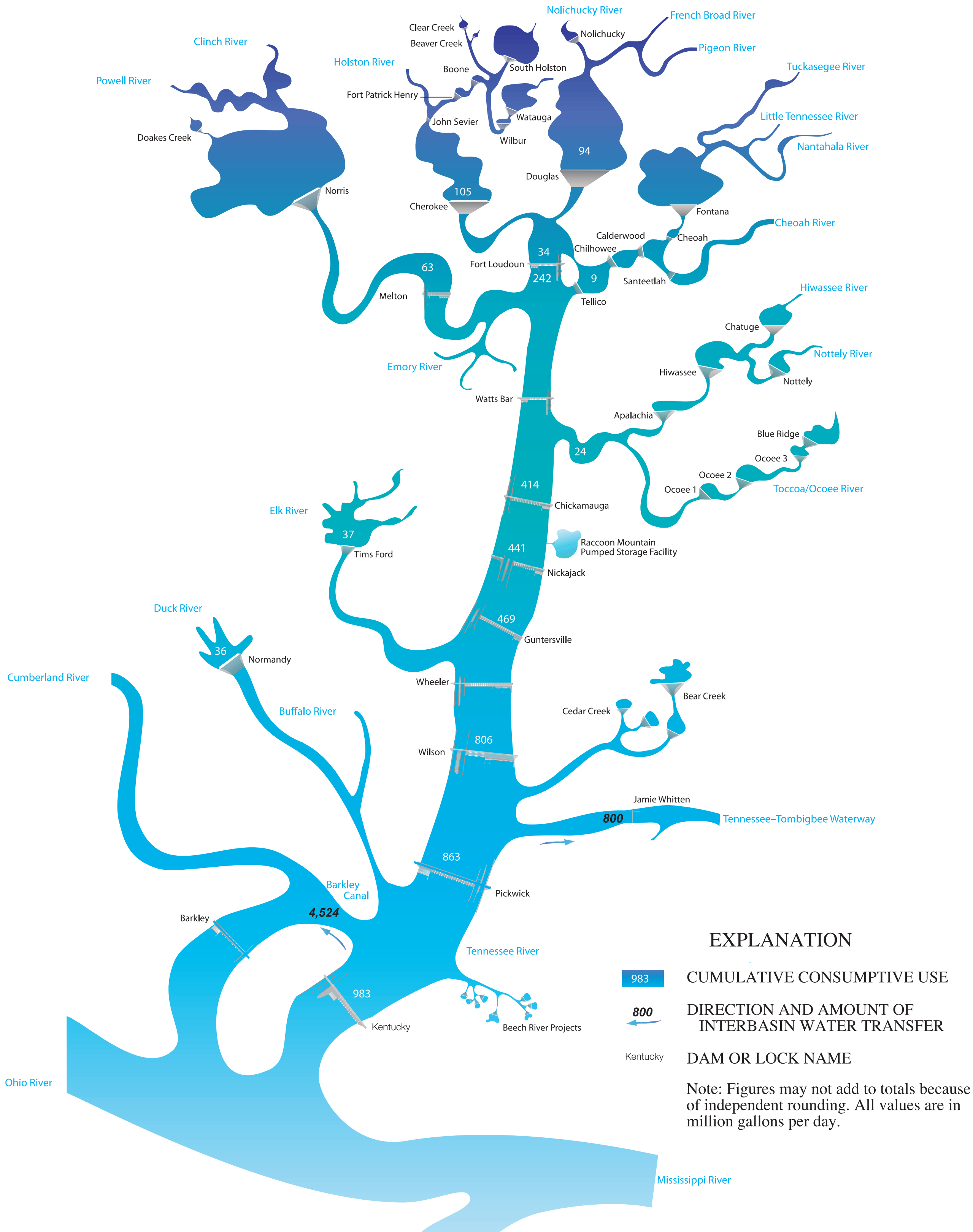

Figure 24. Projected cumulative consumptive use at major water-use tabulation area junctures in the Tennessee River watershed in 2030.

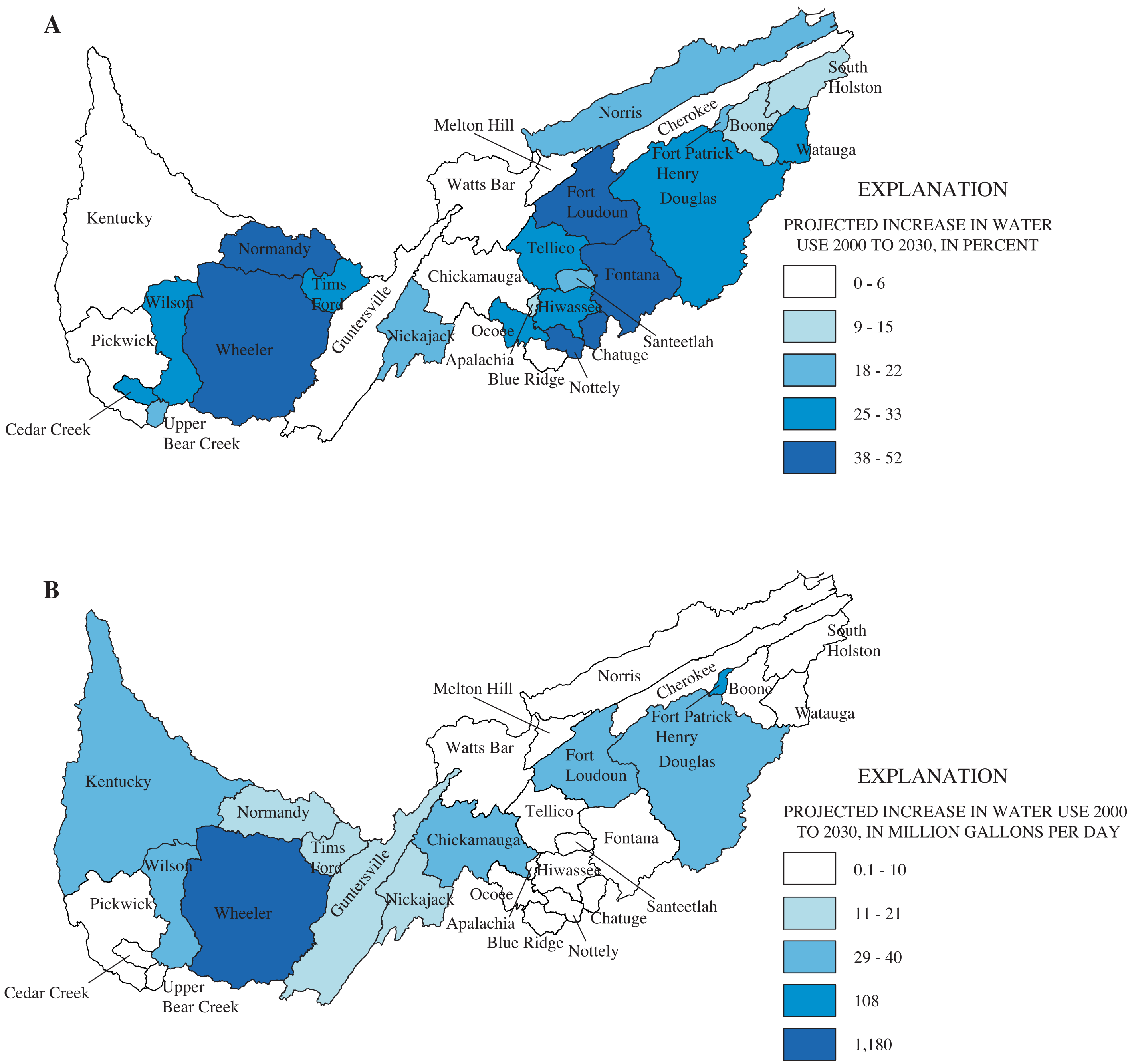

Figure 25. (A) Projected percent and (B) volume increases in water withdrawals by reservoir catchment area in the Tennessee River watershed from 2000 to 2030.

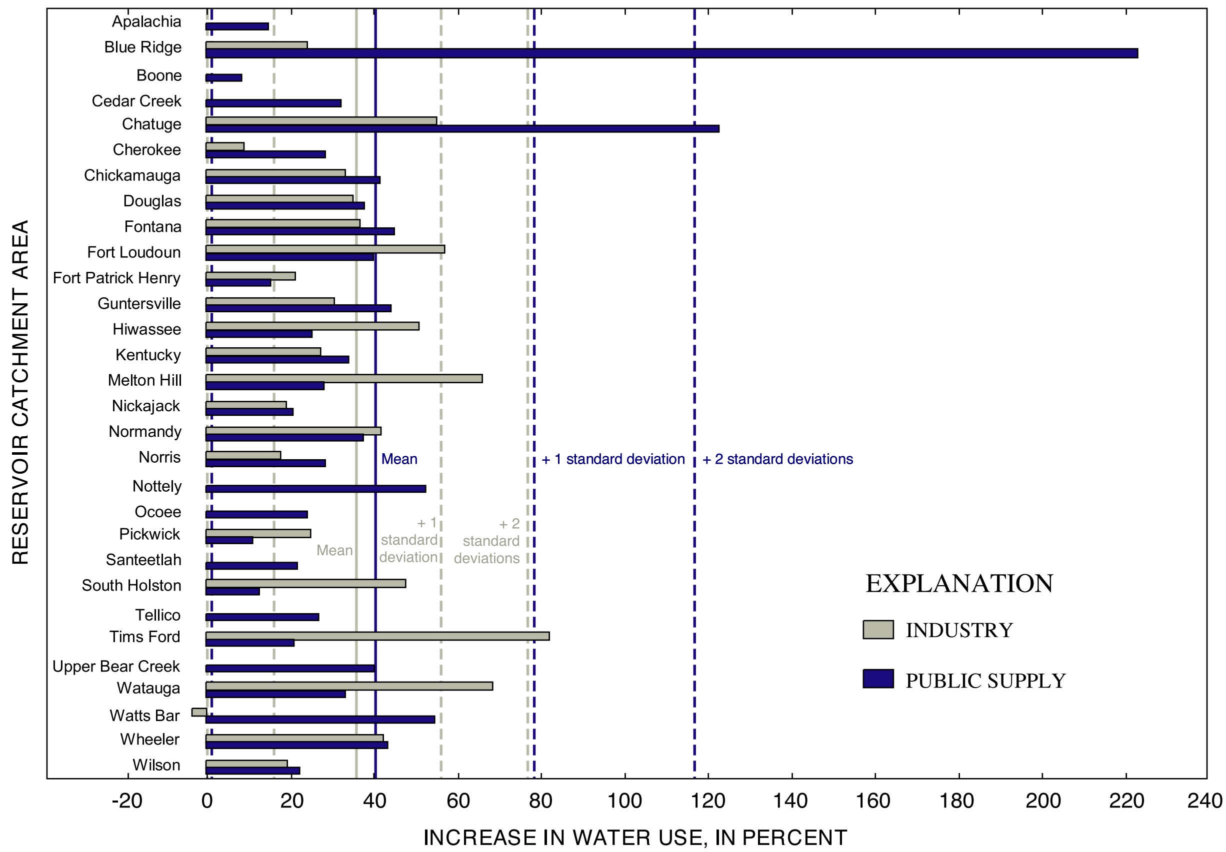

Figure 26. Projected percent increase in industrial and public-supply water use in the Tennessee River watershed from 2000 to 2030.

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

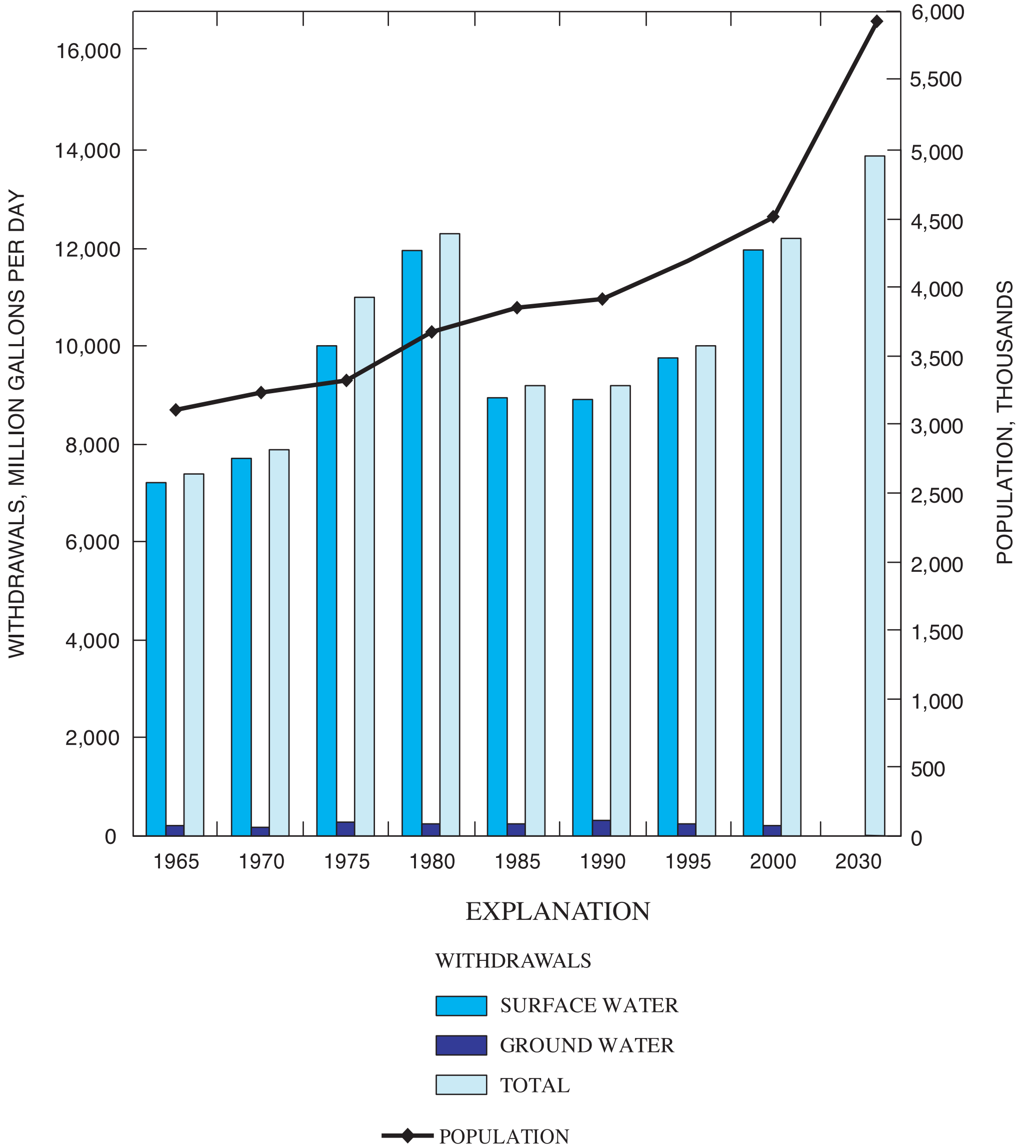

Figure 27. Trends in surface- and ground-water withdrawals and population for 1965 to 2000, and projection of total water withdrawal in 2030 for the Tennessee River watershed.

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

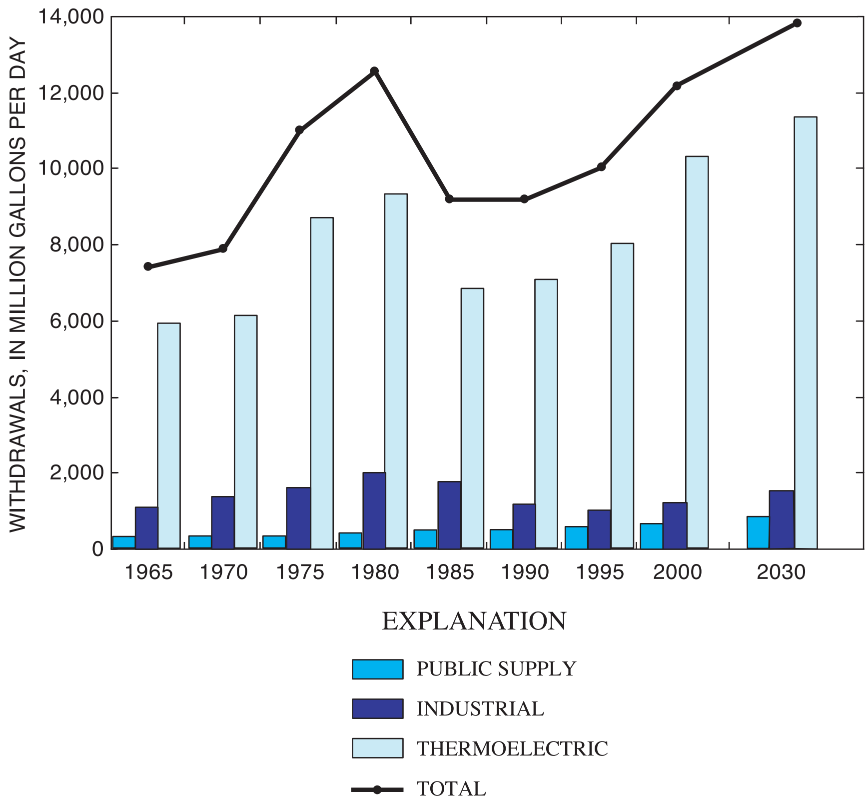

Figure 28. Trends in water withdrawal by water-use category from 1965 to 2000, and projected total withdrawal, 2030, for the Tennessee River watershed.

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.