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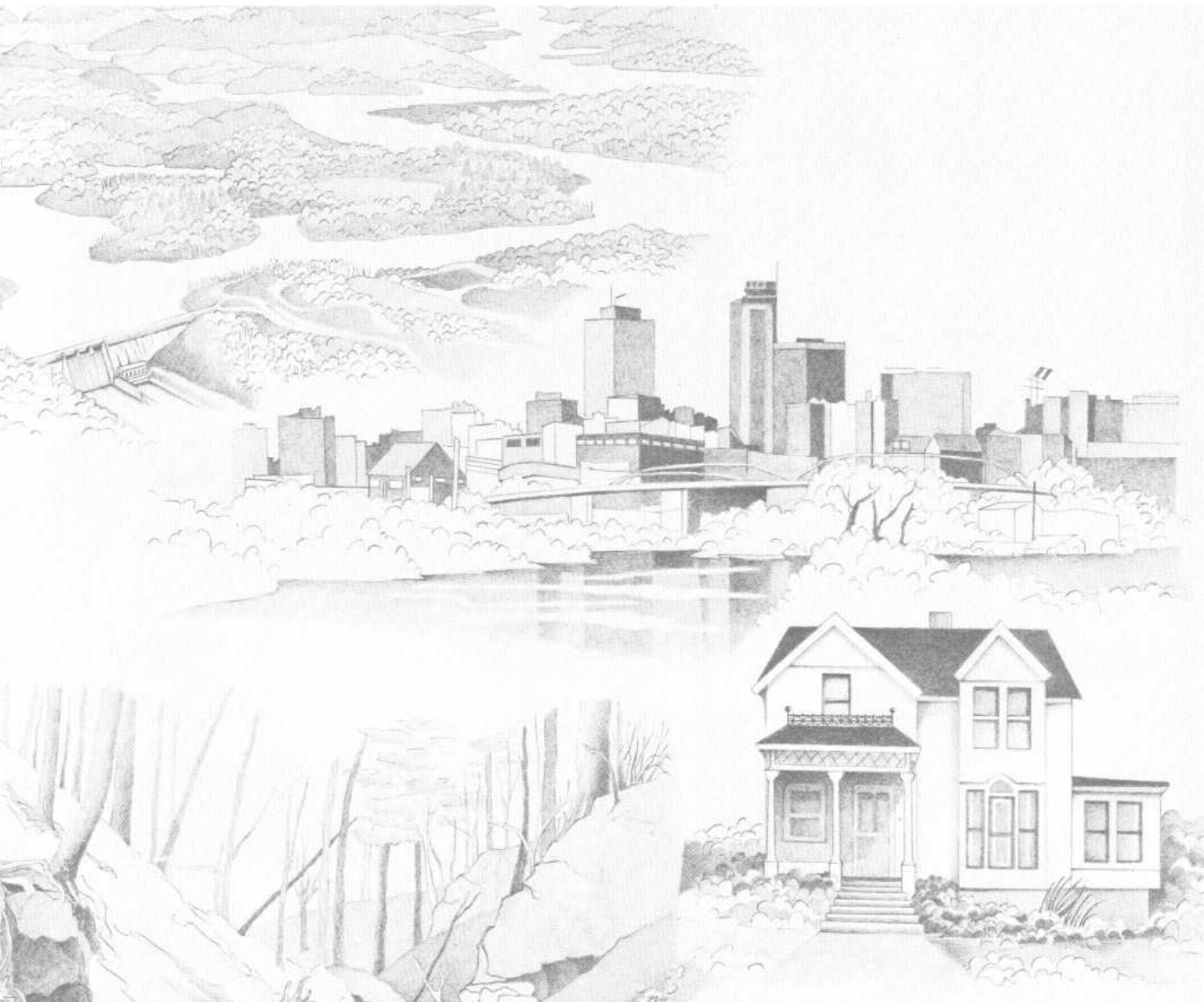
WATER-RESOURCES INVESTIGATIONS REPORT 84-4074

DROUGHT-RELATED IMPACTS ON MUNICIPAL AND MAJOR SELF- SUPPLIED INDUSTRIAL WATER WITHDRAWALS IN TENNESSEE--PART B



Prepared by
U. S. GEOLOGICAL SURVEY

in cooperation with
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TENNESSEE VALLEY AUTHORITY, Office of Natural Resources and Economic Development, Division of Air and Water Resources, Regional

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Public and Self-Supplied Commercial and Industrial Water Users

Currently, there are 22 public, community water-supply facilities and 15 large, self-supplied commercial and industrial water users whose use exceeds 0.1 Mgal/d in the Tennessee part of the French Broad River basin. Detailed inventories containing information and data relative to each community or self-supplied user's source of water, average daily water use, source capacity, population served, treatment plant and storage capacities, and water supply, quantity-related problems are contained in tables 11 and 12 of appendix I, respectively. Total water withdrawal at the present time for public and large, self-supplied commercial and industrial purposes in the French Broad River basin equals about 46.4 Mgal/d. The location and water-supply source of all public and large, self-supplied commercial and industrial water users inventoried in the French Broad River basin are shown in figures 18 and 19, respectively.

Figure 18--Explanation

Site No.	Facility name
1	Newport WS
2	Greeneville WC
3	North Greene UD
4	Dandridge WD
5	Lakeland UD
6	White Pine WD
7	Forks of the River Industrial Park WS
8	Knox-Chapman UD
9	English Mountain WS
10	Pigeon Forge WS
11	Gatlinburg WS
12	Sevierville WS
13	Webb Creek UD
14	Erwin Utility Board
15	Jonesboro UD

At the present time, public water systems serve about 145,000 people or 84 percent of the basin's 1980 population. Average daily water use or withdrawal for public purposes equals about 17.9 Mgal/d of which approximately 15.5 Mgal/d or 87 percent is extracted from surface-water sources and 2.4 Mgal/d or 13 percent from ground-water sources. Major community water-supply facilities whose average daily use exceeds 1.0 Mgal/d include the following:

Facility name	Average water use (Mgal/d)
Newport WS	3.000
Greeneville WC	5.500
Knox-Chapman UD	1.500
Gatlinburg WS	1.965
Erwin Utility Board	1.600
Jonesboro UD	1.250

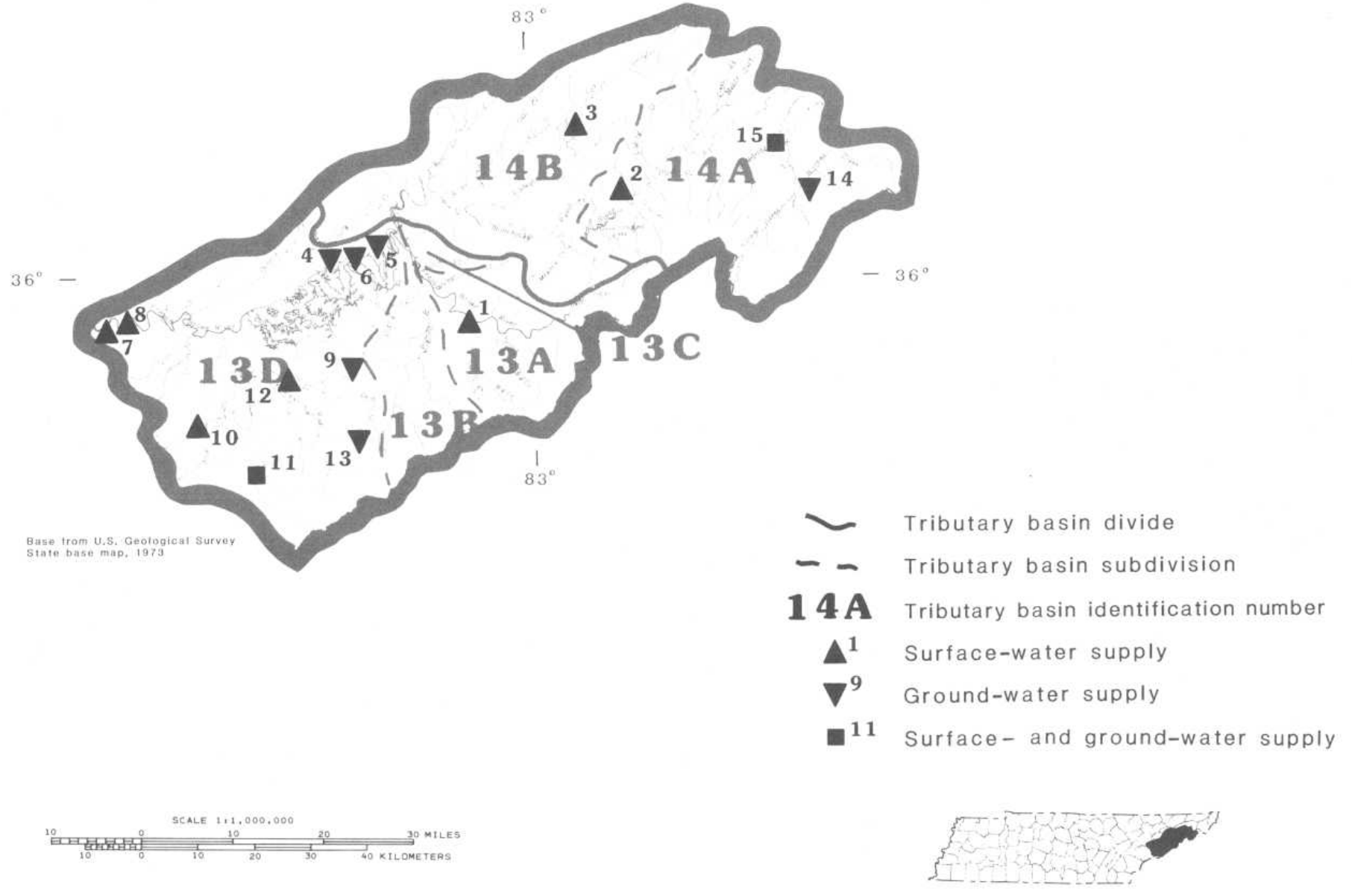

Figure 18.--Public water-supply facilities, French Broad River basin.

Combined, these systems account for 83 percent of the basin's total water use for public purposes.

Figure 19--Explanation

Site No.	Facility name
1	Ball Metal and Chemical Corp. (Greeneville)
2	Nolichucky Sand Co. (Greeneville)
3	Parvin Sand Co. (Afton)
4	Pet, Inc. (Greeneville)
5	Tennessee Electrominerals Corp. (Greeneville)
6	American Enka Co. (Lowland)
7	Bush Brothers and Co. (Chestnut Hill)
8	American Limestone Co. (Knoxville)
9	Modine Manufacturing Co. (Knoxville)
10	Arnold Engineering Co. (Sevierville)
11	Cherokee Textile Mills (Sevierville)
12	Clinchfield Railroad (Erwin)
13	Moody Dunbar, Inc. (Limestone)
14	Moody Dunbar Pepper Plant (Limestone)

Self-supplied commercial and industrial users use (withdraw) about 28.5 Mgal/d, of which about 27.0 Mgal/d or 95 percent is from surface-water sources and 1.5 Mgal/d or 5 percent from ground-water sources. Slightly over 80 percent or 23.0 Mgal/d of the total water withdrawal for commercial and industrial purposes is by American Enka Co. at Lowland. Consumptive water use equals about 1.4 Mgal/d.

Summarized below is a list of the specific water-supply problems now being experienced by individual communities and self-supplied commercial and industrial water users in the French Broad River basin. The number in parentheses following each identified problem indicates the number of communities and (or) self-supplied water users who are now or have experienced this problem in the past. Note, these are not listed in order of frequency of occurrence or overall severity.

- High chlorine demand. (1)
- Drastic to moderate fluctuations in turbidity following periods of heavy rain and flooding. (8)
- Occasional clogging of water-supply intakes due to excessive siltation. (2)
- Poor water quality due to fecal coliform from upstream campgrounds. (1)
- Occasional industrial spills. (1)
- Occasional low streamflows. (1)

Water-Supply Adequacy Analysis

The French Broad River drains 2,298 mi^2 or approximately 1,471,000 acres of land and water area in Tennessee. Surface- and ground-water resources are quite substantial and are replenished by an abundant rainfall whose long-term

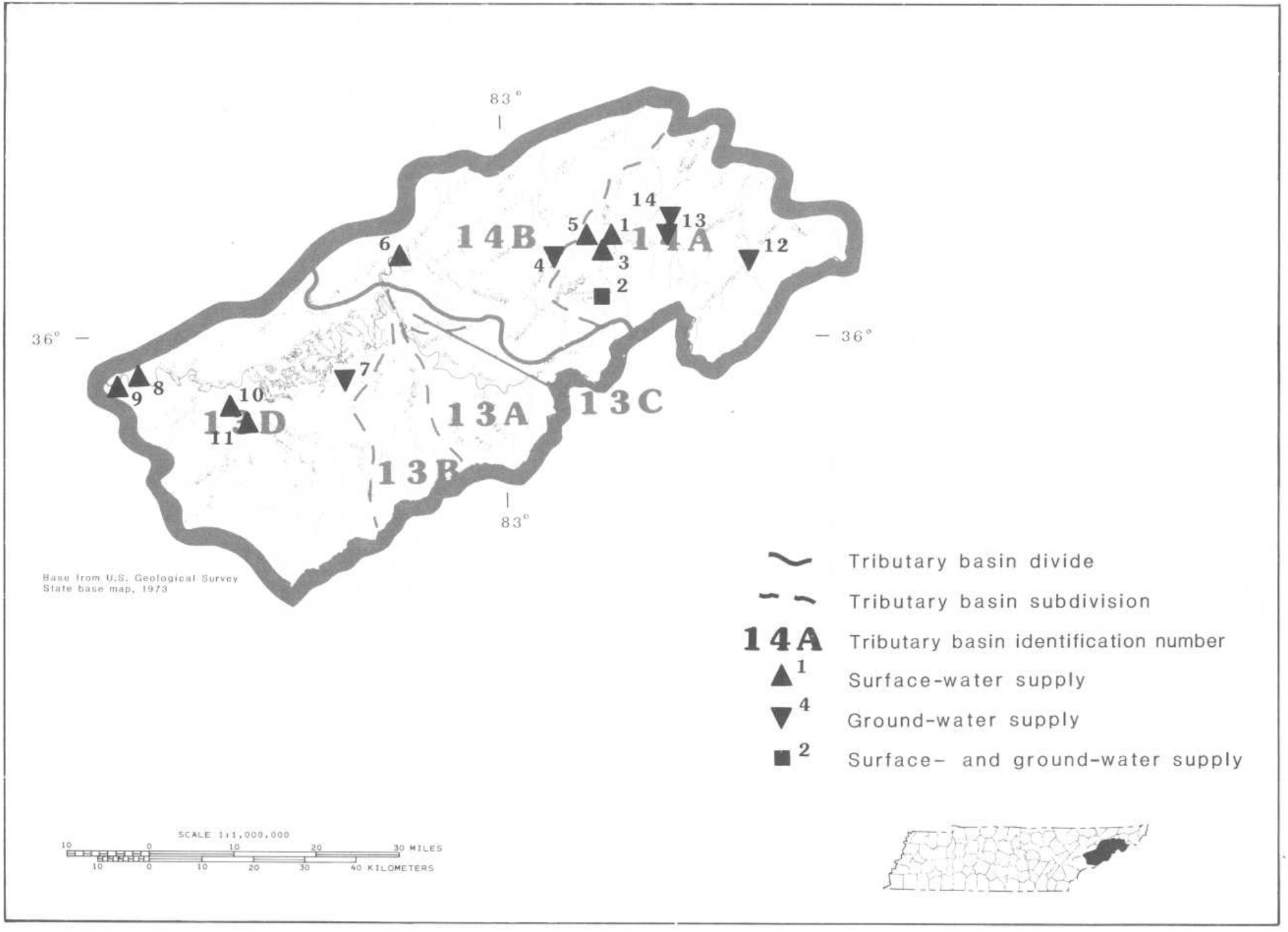

Figure 19.--Self-supplied commercial and industrial water users, French Broad River basin.

(1941-70) average varies from 51.53 inches above Newport to 49.20 inches above Douglas Dam to 47.28 inches above Knoxville. Average annual runoff ranges from 16 to 22 inches as one moves eastward through the basin except for the Great Smoky Mountains part of the basin where runoff ranges from 38 to 40 inches. September, October, and November are the driest months of the year with July being the wettest month. Small, unregulated streams are often characterized by low streamflow conditions during extended drought periods during the late summer and fall months.

Current water use or withdrawal for public and large, self-supplied commercial and industrial water users in the French Broad River basin equal approximately 46.4 Mgal/d. Public water systems use about 17.9 Mgal/d, of which approximately 15.5 Mgal/d or 87 percent is withdrawn from surface-water sources and 2.4 Mgal/d or 13 percent from ground-water sources. Self-supplied commercial and industrial use was about 28.5 Mgal/d, of which about 27.0 Mgal/d or 95 percent was from surface-water sources and 1.5 Mgal/d or 5 percent from ground-water sources. Slightly over 80 percent or 23.0 Mgal/d of the total water withdrawn for commercial and industrial purposes is by American Enka Co. at Lowland. Consumptive water use equals about 1.4 Mgal/d.

Generally, the basin's public-water supplies, particularly those served via surface-water sources, appear to be adequate from a quantity standpoint to meet the basin's current needs. However, two communities - Erwin and White Pine - which get their water from springs and wells, respectively, are currently withdrawing slightly more water than their dependable, long-term source capacity. Both of these communities could expect to face water deficiencies either during extended drought periods or because of increased water use due to industrial expansion or an increase in population. Two communities, English Mountain and Lakeland, are presently being served by ground-water sources of unknown capacity. However, neither of these communities is experiencing any water-supply shortages at the present time and none are anticipated because both of these systems are quite small with average daily water use of 0.016 Mgal/d at English Mountain and 0.003 Mgal/d at Lakeland.

Analysis of the basin's water supplies for self-supplied commercial and industrial users indicates that while several users in Greene, Jefferson, Unicoi, and Washington Counties are utilizing surface- and (or) ground-water sources whose dependable source capacity is either unknown or less than the current average daily use, none of these users is currently experiencing any water-supply shortages. It is possible, however, that some of these industries could face serious water-supply shortages during times of extended drought conditions and should seek additional or other more dependable sources.

Water systems which are currently utilizing surface- and (or) ground-water resources which are inadequate or of unknown capacity should consider exploring the availability of alternative, cost-effective water-supply sources to augment or meet their future water needs if necessary. While the basin's water resources are subject to contamination from a variety of sources; existing and pending Federal, State, and local statutes relative to water-quality protection and maintenance or improvement should ensure that current water quality will be maintained with little, if any, future degradation of the basin's water resources. Potential sources of contamination include (1) leachate from municipal and industrial waste disposal facilties and septic

tank systems; (2) agricultural pollution from fertilizers, pesticides and herbicides, and livestock wastes; and (3) runoff from surface mine lands and quarries.

Although there are periods of extended drought which cause seasonal water table declines and periodic local problems with adequate ground water supplies, observation-well data indicate there are no long-term, regional water table declines. Periodic local problems associated with a decline in an area's water table are caused by excessive withdrawals. To alleviate this problem, optimum ground-water withdrawal rates should be determined during the initial test pumping of the source.

HATCHIE RIVER BASIN

Basin Description

The Tennessee part of the Hatchie River basin, including that part of the alluvial Mississippi River valley between the Obion and Loosahatchie Rivers, covers 2,260 mi^2 of land and water area and consists of all or parts of the following tributary basins as delineated by the Geological Survey and the Tennessee Department of Water Management in 1982.

Tributary basin No. (fig. 20)	Basin description	Tennessee drainage area (square miles)
41B	Mississippi Alluvial Valley in Tennessee from the Obion River to the Hatchie River.	235
41C	Mississippi Alluvial Valley in Tennessee from the Hatchie River to the Loosahatchie River.	148
42A	Hatchie River basin above Searles including Little Hatchie Creek.	424
42B	Hatchie River basin from Searles to Hillsville.	628
42C	Hatchie River basin from Hillsville to mouth.	825

The Hatchie River basin encompasses all or major parts of Haywood, Hardeman, Lauderdale, McNairy, and Tipton Counties as well as minor parts of Chester, Fayette, Madison and Shelby Counties. A map of West Tennessee which delineates the area drained by the Hatchie River basin is shown in figure 20.

Topography

The Hatchie River basin consists of that part of West Tennessee drained by the Hatchie River as well as that part of the alluvial Mississippi River valley between the Obion and Loosahatchie Rivers.

The Hatchie River originates south of the Tennessee-Mississippi State line and flows in a northwesterly direction for about 185 miles across McNairy, Hardeman, Haywood, Tipton, and Lauderdale Counties to its confluence with the Mississippi River at river mile 773.3, approximately 34 miles due north of the city of Memphis. Major tributaries include the Tuscumbia River, Porters Creek, Clear Creek, Glover Creek, Bear Creek, Big Muddy Canal, Indian Creek, and Spring Creek. The drainage area of this basin is approximately 2,609 mi^2. Of this, approximately 1,877 mi^2 are in the West Tennessee area. Elevations range from about 230 to 665 feet above sea level. Topography is characterized as gently rolling, interrupted by small ditches and drainage divides. Some gullied topography has developed and swampy conditions are common.

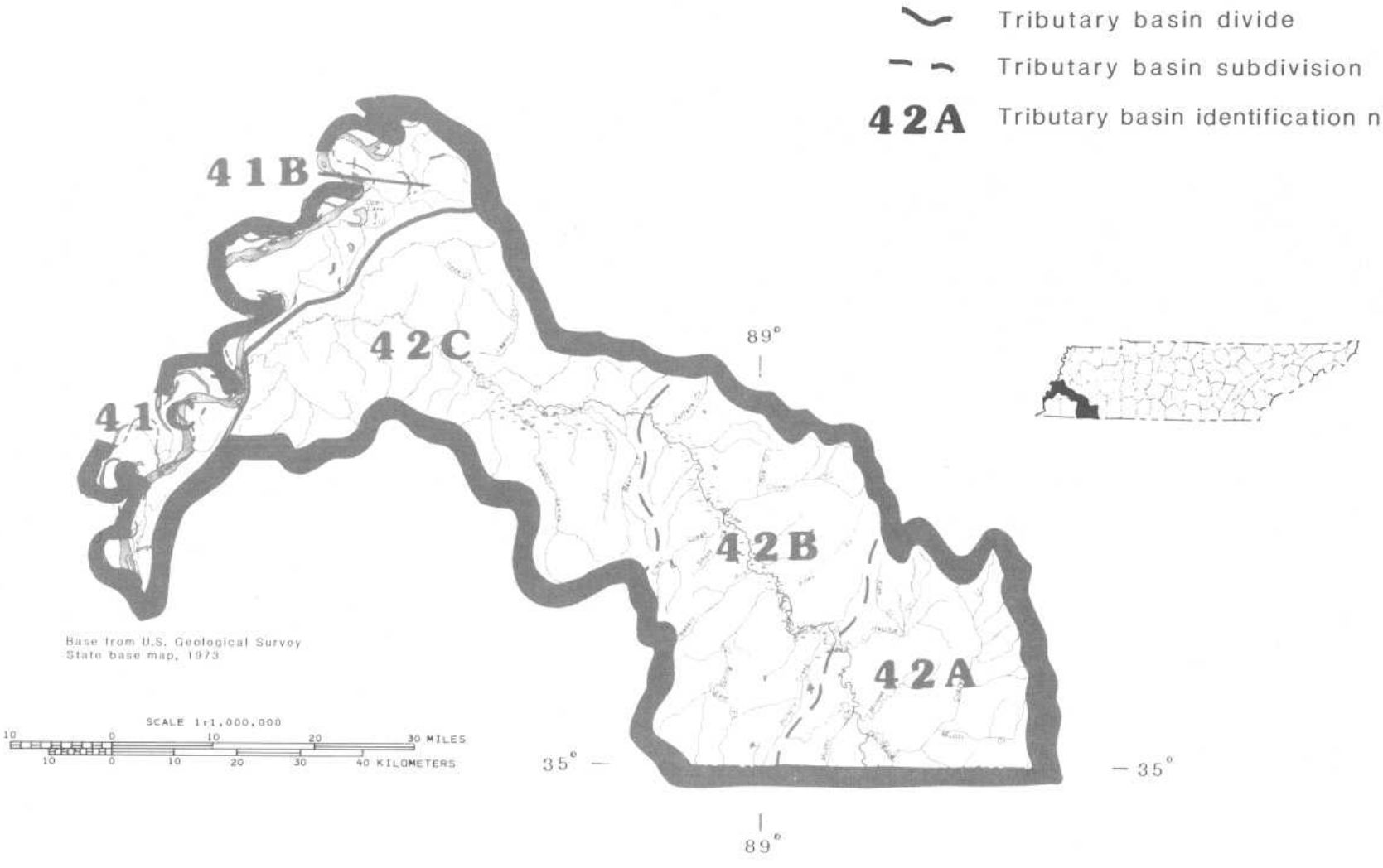

Figure 20.--Hatchie River basin.

From the mouth of the Obion River, the Mississippi River flows in a southerly direction for about 79 miles along the western boundary of the Hatchie River basin to the mouth of the Loosahatchie River. At the mouth of the Loosahatchie River, the Mississippi River has a drainage area of approximately 927,900 mi^2. Of this, approximately 383 mi^2 are included within the alluvial valley in the Hatchie River basin. The Mississippi River is the outlet for all streams in the State located west of the Tennessee Valley.

Hydrology

Surface Water

Surface- and ground-water resources of this basin are replenished by an ample rainfall whose long-term (1941-70) average is approximately 49 inches. From 1970-79, the average precipitation was approximately 56 inches. The average 1979 rainfall was approximately 66 inches. Annual (1979) and long-term (1941-70) precipitation data for selected NWS rainfall stations in the Hatchie River basin are presented in table 25. The 1970-79 precipitation averages for these same rainfall stations with their high and low year of precipitation are presented in table 26.

The months of August, September, and October are usually the driest with the average rainfall ranging from 2.75 to 3.51 inches. During the remainder of the year, average rainfall ranges from 3.56 to 5.42 inches with March usually being the wettest month.

The surface-water supply for this basin is derived from precipitation and runoff within the area, streamflow including ground-water discharge entering the area from adjacent areas, and ground-water discharge to streams within the area. Average discharge data for selected hydrologic data stations are presented in table 27. Theoretically, there is a large quantity of surface water available for use in this basin. However, because of the small number of available storage sites and the increased evaporative losses of surface water that occur with this development, this quantity is not realistically obtainable.

Ground Water

West Tennessee embraces two physiographic provinces. One is the West Tennessee Plain, including the subdivision known as the West Tennessee Uplands, and the other is the Mississippi River Valley.

The West Tennessee Plain extends from the western margin of the Western Valley of the Tennessee River, or the divide, known as the West Tennessee Uplands, separating eastward flowing drainage to the Tennessee River from streams flowing westward to the Mississippi River. This area contains three major drainage basins: the Obion-Forked Deer, the Hatchie, and the Memphis Area which includes the Loosahatchie River, Wolf River, and Nonconnah Creek.

West Tennessee lies in the region known as the Mississippi embayment. This is an area in which Paleozoic limestones were downwarped in the geologic past

Table 25.--Precipitation data for 1979 and for the period 1941-70 for selected rainfall stations, Hatchie River basin

Station location	Station owner	Elevation above sea level (feet)	Period of record (years)	1979 Precipitation (inches)	Long-term annual precipitation (inches)
Covington	NWS	310	97	63.48	50.76
Ripley	NWS	335	18	61.87	48.98
Brownsville	NWS	330	97	61.19	50.69
Brownsville sewage plant	NWS	355	38	64.70	46.25
Bolivar Water Works	NWS	455	92	71.46	49.09
Selmer	NWS	470	55	75.11	51.08

Table 26.--Precipitation data for the period 1970-79 for selected rainfall stations, Hatchie River basin

Station location	Precipitation (inches)				
	High	Year	Low	Year	10-year average
Covington	63.48	1979	40.51	1977	55.47
Ripley	63.18	1975	40.43	1977	54.82
Brownsville	70.23	1974	42.58	1971	53.96
Brownsville sewage plant	66.70	1974	41.00	1971	54.21
Bolivar Water Works	71.46	1979	44.45	1970	56.54
Selmer	75.11	1979	45.49	1976	60.28

Table 27.--Average discharge data for selected hydrologic data stations, Hatchie River basin

Station name and location (county)	River mile	Drainage area (square miles)	Period of record (years)	Average discharge		
				Cubic feet per second	Inches per year	Cubic feet per second per square mile
Mississippi River at Memphis (Shelby).[a]	734.7	928,700	45	528,071	7.72	0.57
Hatchie River at Bolivar (Hardeman).	135.1	1,480	52	3,311	30.46	2.24
Hatchie River at Rialto (Tipton).	34.0	2,308	44	3,370	19.82	1.46

[a] This hydrologic data station is actually located outside the Hatchie River basin. However, its discharge data is representative of the Mississippi River in this basin.

forming a trough with its axis or deepest part roughly parallel to the present course of the Mississippi River and extending from the Gulf Coast northward to the southern tip of Illinois. Its eastern margin lies in parts of Kentucky, Tennessee, Alabama, and Mississippi while its western margin lies in parts of Missouri, Arkansas, Louisiana, and Texas. During geologic time, the sea successively advanced and receded in the trough depositing sediments consisting of uncemented sand and clay with minor amounts of other materials. Thick non-marine sediments were also deposited. Consequently, these sands and clays are at the surface east of the Mississippi River and dip at the rate of 15 to 30 ft/mi westward toward the river where they begin to rise again and reappear west of the river although covered by alluvial deposits. Inclination of the water-bearing sands and the presence of clay layers and lenses cause the water in the sands to be under artesian pressure away from the outcrop area. In West Tennessee, the oldest sediments appear on the surface near the Tennessee River and dip westward reaching a depth of over 3,000 feet below the Mississippi River.

Inasmuch as the sand aquifers are continuous through the West Tennessee Plain and extend into other states, it is not practical to discuss them on a river basin basis but rather on a regional basis. While almost any sand body in any formation may furnish adequate supplies of freshwater for domestic use at or near its outcrop area, there are four major aquifers that are capable of furnishing relatively large supplies for municipalities and industries. From oldest to youngest these aquifers are the Coffee Sand and McNairy Sand of Cretaceous age and the Wilcox Formation and the Claiborne Formation of Tertiary age. In the Memphis area, the Wilcox and Claiborne aquifers are respectively known as the "1,400-foot sand", or the Fort Pillow Sand, and the "500-foot sand", or the Memphis Sand." The outcrop areas and dominant recharge areas of these aquifers occur as bands trending from south-southwest to north-northeast across West Tennessee. The eastern margin of the outcrop area of the Coffee Sand lies near the Tennessee River and the outcrop areas of the younger aquifers occur successively to the west until the Claiborne, including the Memphis Sand, is hidden from view near Paris, Jackson, and Somerville by a blanket of relatively recent loess and terrace deposits which extend westward to the Mississippi River Valley.

The Coffee Sand of Upper Cretaceous age is present in northern Mississippi and crops out in a belt in Tennessee from southwestern Hardin County to the Kentucky State line in northeastern Henry County. This outcrop belt is approximately 6 miles wide near the Mississippi-Tennessee border and becomes narrower to the north-northeast where it merges with the younger McNairy Sand near the Kentucky line. Its thickness ranges from approximately 200 feet near the Mississippi line and thins northeastward to less than 50 feet in southern Henry County. It has been estimated to underlie an area of approximately 6,000 mi^2 overall. The Coffee Sand is the oldest and smallest of the four major aquifers, and wells producing from it generally have lower yields. The larger yield wells producing from this aquifer probably do not supply much more than 300 gal/min. The Coffee Sand dips beneath the surface westward from its outcrop area and is at a depth of some 3,000 feet or more at Memphis. Water in the aquifer becomes relatively highly mineralized near the Fayette-Shelby County line.

The McNairy Sand is present in northern Mississippi and extends across Tennessee into Kentucky. Its outcrop belt is approximately 12 miles wide in

McNairy County and thins northward to less than 8 miles in Benton County. The outcrop area is narrowest near the Kentucky line. The McNairy Sand is approximately 200 feet thick in the northern end of the embayment and thickens to some 375 feet in the subsurface at Memphis. It has been estimated that this sand underlies approximately 11,000 mi^2 of Tennessee and Kentucky. The McNairy Sand is an excellent aquifer particularly at or near its outcrop area. Yields of wells drilled into it range from 250 to 500 gal/min. Like the Coffee Sand, the McNairy Sand dips westward from its outcrop area into the subsurface and lies at a depth of some 2,400 feet at Memphis. If freshwater is defined as water having a concentration of no more than 1,000 mg/L total dissolved solids, then the McNairy Sand is at the base of the zone of freshwater at Memphis as the water in it there contains the limit of total dissolved solids. Presently, it is not used as a source of water in the Memphis area.

The Wilcox Formation contains an aquifer known in the Memphis area as the "1,400-foot sand," or Fort Pillow Sand, which is present in Mississippi and extends across West Tennessee into Kentucky. Its outcrop is narrow in Tennessee due to thinning and overlap by the overlying Claiborne Formation. In some

Facility name	Average water use (Mgal/d)
Bolivar WD	1.137
Brownsville UD	1.310
Covington WD	1.351
Ripley WD	1.522
Selmer WD	1.500

Together, these systems account for about 74 percent of the total water use for public purposes.

Figure 21--Explanation

Site No.	Facility name	Site No.	Facility name
1	Bolivar WD	11	Covington WD
2	Middleton WD	12	First UD of Tipton County
3	Toone WD	13	Henning WD
4	Western Mental Health Institute	14	Stanton WD
		15	Mercer UD
5	Whiteville WS	16	Bethel Springs WD
6	Brownsville Utility Department	17	Brighton WD
7	Fort Pillow State Prison		
8	Ripley WD		
9	Lauderdale County WS		
10	Selmer WD		

Self-supplied commercial and industrial users currently withdraw about 3.9 Mgal/d of which 3.0 Mgal/d or 77 percent is obtained from sandpits and 0.9 Mgal/d or 23 percent is withdrawn from ground-water sources. The basin's only major self-supplied commercial and industrial user is the Bolivar Sand Company (3.000 Mgal/d) in Bolivar.

Only one facility in the basin reported a specific water-supply problem experienced during the period surveyed. This problem was a high level of iron content in the water.

Water-Supply Adequacy Analysis

The Hatchie River basin covers 2,260 mi^2 (1,446,400 acres) of land and water area. This basin's surface- and ground-water resources are replenished by substantial rainfall whose long-term (1941-70) average is approximately 49 inches. The driest months of the year are usually August, September, and October with March usually being the wettest month.

Total present water use or withdrawal for public and large self-supplied commercial and industrial purposes in the Hatchie River basin amounts to approximately 13.1 Mgal/d. Of this amount, public-water systems use about 9.2 Mgal/d, all of which is withdrawn from ground-water sources. Self-supplied commercial

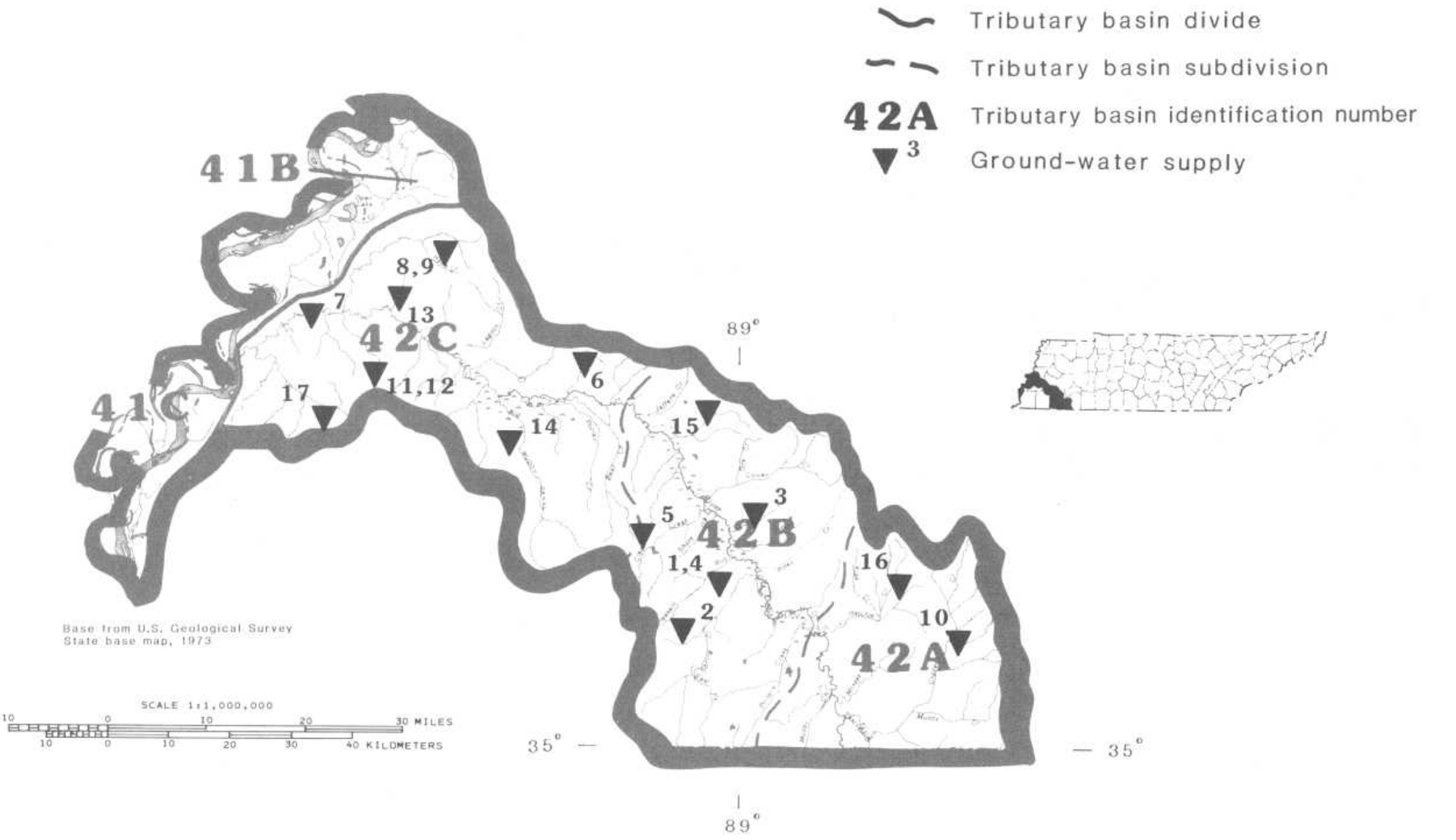

Figure 21.--Public water-supply facilities, Hatchie River basin.

Figure 22--Explanation

Site No.	Facility name
1	Armira Corp. (Bolivar)
2	Bolivar Sand Co. (Bolivar)
3	Colonial Fiber Co. (Covington)

and industrial users use about 3.9 Mgal/d, of which about 3.0 Mgal/d or 77 percent is obtained from sandpits and 0.9 Mgal/d or 23 percent is withdrawn from ground-water sources.

Generally, the basin's public water-supply systems are adequate in quantity to meet the basin's present needs, and no single aquifer has been developed anywhere near its potential. No water-supply shortage problems were reported by any of the public water-supply systems or by any of the large, self-supplied water users.

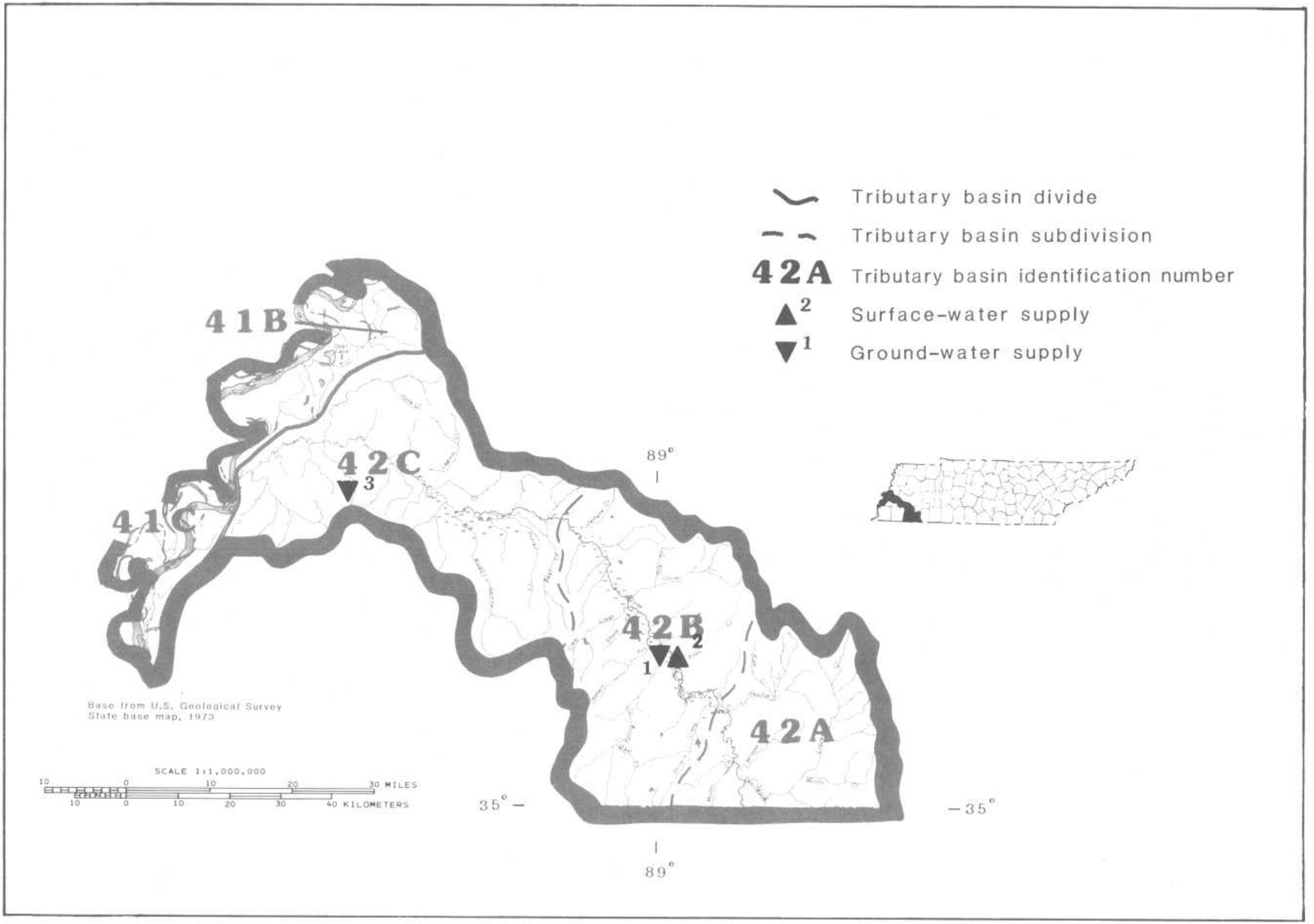

Figure 22.--Self-supplied commercial and industrial water users, Hatchie River basin.

HOLSTON RIVER BASIN

Basin Description

The Tennessee part of the Holston River basin covers 2,253 mi^2 of land and water area and consists of all or parts of the following tributary basins as delineated by the Geological Survey and the Tennessee Department of Water Management in 1982.

Tributary basin No. (fig. 23)	Basin description	Tennessee drainage area (square miles)
15A	South Fork Holston River above South Holston Dam to the Tennessee State line.	161
15B	South Fork Holston River from South Holston Dam to the river's mouth, excluding the Watauga River in Tennessee.	402
15C	Watauga River above Watauga Dam to the Tennessee State line.	265
15D	Watauga River from Watauga Dam to the river's mouth.	401
16A	Holston River from the confluence of the North and South Forks of the Holston River to Cherokee Dam.	651
16B	Holston River from Cherokee Dam to the river's mouth.	348
48	North Fork Holston River from the Virginia State line to the river's mouth.	25

This basin's hydrologic area encompasses all or major parts of Carter, Grainger, Hamblen, Hawkins, Johnson, Sullivan, and Washington Counties as well as minor parts of Jefferson, Knox, and Union Counties in northeast Tennessee. A map of the east Tennessee part of the Tennessee River basin which highlights the Holston River basin is shown in figure 23.

Topography

On the whole, the basin is a broad, lowland belt characterized in places by minor parallel ridges and intervening valleys corresponding to the northeast-southwest trend of the Tennessee Valley. The Holston River and its principal tributaries including the North, South, and Middle Forks of the Holston River and the Watauga River plus numerous smaller streams such as Beech, Big, Big Flat, Caney, Poor Valley, Richland, Robertson, Roseberry, and Swanpond Creeks flow in broad, winding courses in the intervening valleys. While the main river valleys are characterized by steep side slopes, the smaller tributary streams are characterized by relatively flat valley slopes. Average stream

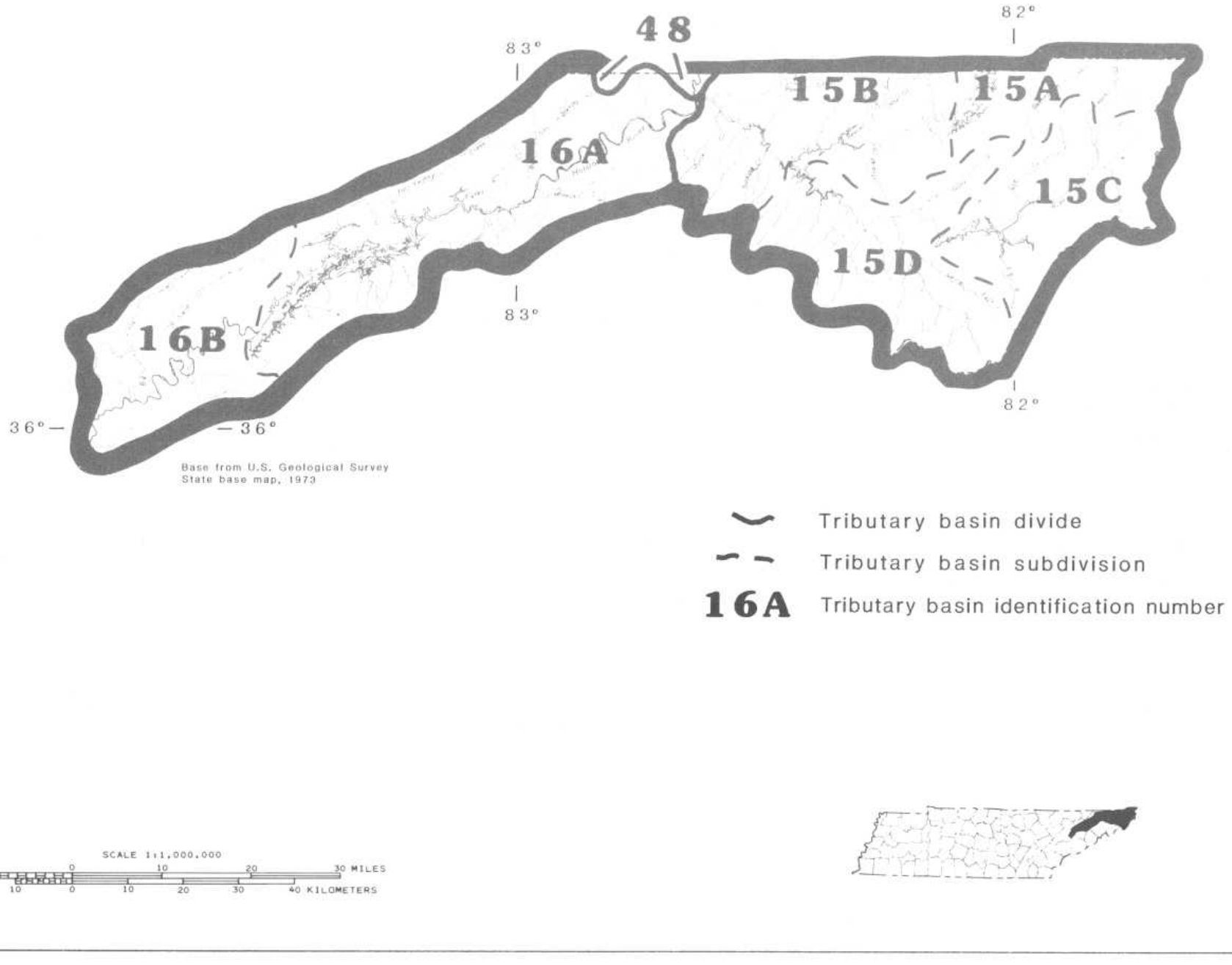

Figure 23.--Holston River basin.

slopes in the Tennessee part of the basin equal about 2.76 ft/mi. Basin elevations generally range from around 900 to 3,500 feet above sea level.

Hydrology

Surface Water

Surface- and ground-water resources in this basin are fed by an abundant rainfall whose long-term (1941-70) average ranges from 44.14 inches above Cherokee Dam to 47.28 inches above Knoxville. During the 10-year period from 1970-79, average annual precipitation above Cherokee Dam was 47.97 inches and ranged from 38.47 inches in 1970 to 55.64 inches in 1972. Above Knoxville, average annual precipitation for the same period was 51.19 inches with a low of 40.73 inches in 1970 and a high of 57.23 inches in 1972. Average precipitation data for watershed subdivisions of the Holston River basin during the 1970-79 time period are presented in table 29. Annual 1979 and long-term (1941-70), precipitation data for selected TVA and NWS rainfall stations in the Tennessee part of the Holston River basin are presented in table 30.

Usually, the months of September, October, and November are the driest months with average rainfall ranging from 2.45 to 3.13 inches above Cherokee Dam and 2.85 to 3.35 inches above Knoxville. Other months generally average about 3.60 to 4.92 inches above Cherokee Dam and 3.80 to 5.14 inches above Knoxville with July having the heaviest rainfall.

Average annual runoff in the Tennessee part of the Holston River basin ranges from about 15 to 22 inches as one moves northeastward from Knoxville. Average discharge data for selected hydrologic data stations in the Holston River basin are summarized in table 31. Much of this runoff occurs during the winter and spring months. During extended drought periods in the late summer and fall months; small, unregulated streams often go dry, particularly along the rim of the basin.

Major Reservoirs

Major reservoirs located in this basin and their total storage in acre-feet at normal minimum pool are Boone Reservoir (45,000); Cherokee Reservoir (393,000); Fort Patrick Henry Reservoir (22,700); South Holston Reservoir (326,000); Watauga Reservoir (323,000); and Wilbur Reservoir (388). Detailed information describing each reservoir's location and operation pattern follows:

Boone Reservoir

Location and drainage area.--Boone Reservoir is formed by Boone Dam which is located on the South Fork Holston River at river mile 18.6 about 1.4 miles below its confluence with the Watauga River in Sullivan and Washington Counties. Boone Dam controls 1,840 mi^2 of drainage area.

Reference period.--1960-81.

Reservoir discharge (minimum daily average flow).--Minimum daily average discharge from Boone Dam during the reference period ranged from a low of about

Table 29.--Precipitation data by watershed subdivision for the period 1970-79, Holston River basin

Watershed description	Precipitation (inches)				
	High	Year	Low	Year	10-year average
South Fork of the Holston River upstream from South Holston Dam.	59.10	1972	38.50	1978	47.87
Watauga River upstream from Watauga Dam.	60.30	1979	39.20	1970	50.74
South Fork of the Holston River from Kingsport to South Holston Dam and the Watauga River downstream from Watauga Dam.	54.70	1974	35.40	1970	47.41
Holston River from Cherokee Dam to Kingsport and the Tennessee part of the North Fork of the Holston River.	54.70	1972	39.70	1978	47.82
Holston River from Knoxville to Cherokee Dam.	62.80	1972	43.30	1970	52.85

Table 30.--Precipitation data for 1979 and for the period 1941-70 for selected rainfall stations, Holston River basin

Station location	Station owner	Elevation above sea level (feet)	Period of record (years)	1979 Precipitation (inches)	Long-term annual precipitation (inches)
Mountain City	TVA	2,280	16	48.39	45.00
South Holston Dam	TVA	1,535	34	54.26	46.97
Watauga Dam	TVA	1,714	33	59.02	49.48
Roan Mountain	TVA	2,550	29	52.22	45.83
Boone Dam	TVA	1,334	29	47.82	42.80
Kingsport	TVA	1,200	25	41.14	43.01
Elizabethton	TVA	1,512	88	47.12	41.96
John Sevier steam plant	TVA	1,120	27	50.19	44.56
Jefferson City	TVA	1,200	38	52.16	46.59
Cherokee Dam	TVA	1,012	39	59.67	44.46
Strawberry Plains	TVA	870	41	52.07	45.30
Johnson City	TVA	1,545	32	45.67	43.50
Bristol Airport	NWS	1,525	42	43.71	41.47
Rogersville	NWS	1,355	95	55.97	45.16

Table 31.--Average discharge data for selected hydrologic data stations operated by the U.S. Geological Survey, Holston River basin

Station name and location (county)	River mile	Drainage area (square miles)	Period of record (years)	Average discharge		
				Cubic feet per second	Inches per year	Cubic feet per second per square mile
Watauga River downstream from Wilbur Dam (Carter).	33.6	471	38	754	21.74	1.60
Doe River at Elizabethton (Carter).	1.0	137	65	225	22.30	1.64
Watauga River at Elizabethton (Carter).	25.9	692	50	1,100	21.59	1.59
Reedy Creek at Orebank (Sullivan).	9.8	36.3	17	46.8	17.51	1.29
Holston River at Surgoinsville (Hawkins).	118.7	2,874	40	3,820	18.05	1.33
Big Creek near Rogersville (Hawkins).	2.0	47.3	30	60.9	17.48	1.29
Beech Creek at Kepler (Hawkins).	6.6	47.0	15	52.9	15.28	1.13
Holston River near Knoxville (Knox).	5.5	3,747	47	4,766	17.27	1.27

17.0 ft^3/s (11.0 Mgal/d) in 1965 to a high of about 441.0 ft^3/s (285.0 Mgal/d) in 1980. The average, 1-day minimum discharge over the reference period was about 176.7 ft^3/s (114.4 Mgal/d).

Average number of days of zero flow.--During the reference period, Boone Dam has averaged slightly over 2 days of zero discharge per year ranging from a low of no days of zero discharge in all but 3 years since 1973 to a high of 11 days of zero discharge in 1964. Zero-discharge days, when they did occur, were most common during the months of May, June, and July. There were no instances of zero discharge for 3 or more consecutive days from Boone Dam during the reference period.

Existing agreements regarding reservoir releases.--None.

Cherokee Reservoir

Location and drainage area.--Cherokee Reservoir is formed by Cherokee Dam which is located on the Holston River at river mile 52.3 in Grainger and Jefferson Counties. Cherokee Dam controls 3,428 mi^2 of drainage area.

Reference period.--1960-81.

Reservoir discharge (minimum daily average flow).--Minimum daily average discharge from Cherokee Dam during the reference period ranged from a low of about 12.0 ft^3/s (7.8 Mgal/d) in 1963 to a high of about 168.0 ft^3/s (108.6 Mgal/d) in 1965. The average, 1-day minimum discharge over the reference period was approximately 60.9 ft^3/s (39.4 Mgal/d).

Average number of days of zero flow.--During the reference period, Cherokee Dam has averaged slightly over 70 days of zero discharge per year ranging from a low of 18 days in 1980 to a high of 120 days in 1964. Zero-discharge days were most common during the months of February, March, April, and May. During the reference period, there were 168 instances of zero discharge for 3 or more consecutive days from Cherokee Dam. In 36 of these instances during the years of 1960-68, 1970, 1972, 1976, 1977, 1980, and 1981; consecutive days of zero discharge from Cherokee Dam ranged from a low of 7 days in a number of years to a high of 44 days in 1981.

Existing agreements regarding reservoir releases.--Reservoir releases from Cherokee Dam are correlated with releases from Douglas Dam to provide a minimum average daily flow of 2,000.0 ft^3/s (about 1,292.6 Mgal/d) past Knoxville.

Fort Patrick Henry Reservoir

Location and drainage area.--Fort Patrick Henry Reservoir is formed by Fort Patrick Henry Dam which is located on the South Fork Holston River at river mile 8.2 in Sullivan County. Fort Patrick Henry Dam controls 1,903 mi^2 of drainage area.

Reference period.--1960-81.

Reservoir discharge (minimum daily average flow).--The minimum daily average discharge from Fort Patrick Henry Dam during the reference period ranged from a low of approximately 381.0 ft^3/s (246.2 Mgal/d) in 1963 to a high of about 780.0 ft^3/s (503.9 Mgal/d) in 1979. The average, 1-day minimum discharge during the reference period was approximately 628.9 ft^3/s (406.5 Mgal/d). Since 1970, the average, 1-day minimum discharge has been about 748.7 ft^3/s (483.9 Mgal/d).

Average number of days of zero flow.--None.

Existing agreements regarding reservoir releases.--Fort Patrick Henry Dam provides a minimum average daily reservoir release of 750.0 ft^3/s (about 484.7 Mgal/d) by contractual agreement between TVA and Tennessee Eastman Company at Kingsport.

South Holston Reservoir

Location and drainage area.--South Holston Reservoir is formed by South Holston Dam which is located on the South Fork Holston River at river mile 49.8 in Sullivan County. South Holston Dam controls 703 mi^2 of drainage area.

Reference period.--1960-81.

Reservoir discharge (minimum daily average flow).--The minimum daily average discharge from South Holston Dam during the reference period ranged from a low of approximately 2.0 ft^3/s (1.3 Mgal/d) in 1963 to a high of approximately 89.0 ft^3/s (57.5 Mgal/d) in 1980. The average, 1-day minimum discharge during the reference period was about 19.8 ft^3/s (12.8 Mgal/d).

Average number of days of zero flow.--During the reference period, South Holston Dam has averaged about 59 days of zero discharge per year ranging from a low of 1 day in 1981 to a high of 112 days in 1964 and 1966. Zero-discharge days were most common during the months of March, April, and May. During the reference period, there were 115 instances of zero discharge for 3 or more consecutive days from South Holston Dam. In 16 of these instances during the years of 1961, 1963-66, 1968, 1969, and 1971 consecutive days of zero discharge from South Holston Dam ranged from a low of 7 days in several years to a high of 15 days in 1961.

Existing agreements regarding reservoir releases.--Bristol, Tennessee, has a water-supply intake immediately below South Holston Dam which was in place prior to the dam's construction. Consequently, TVA has agreed to make special water releases whenever normal reservoir operation does not provide adequate water to meet the city's intake demands.

Watauga Reservoir

Location and drainage area.--Watauga Reservoir is formed by Watauga Dam which is located on the Watauga River at river mile 36.7 in Carter County. Watauga Dam controls 468 mi^2 of drainage area.

Reference period.--1960-81.

Reservoir discharge (minimum daily average flow).--The minimum daily average discharge from Watauga Dam during the reference period ranged from a low of approximately 2.0 ft^3/s (1.3 Mgal/d) in 1971 to a high of about 45.0 ft^3/s (29.1 Mgal/d) in 1978. The average, 1-day minimum discharge during the reference period was about 12.1 ft^3/s (7.8 Mgal/d). With the exception of 1978, the minimum daily average discharge since 1974 has averaged about 20.3 ft^3/s (13.1 Mgal/d).

Average number of days of zero flow.--During the 22-year reference period, Watauga Dam has averaged almost 56 days of zero discharge per year ranging from a low of 42 days in 1973 and 1975 to a high of 92 days in 1964. Days of zero-discharge were most common during the months of February, March, April, and May. During the reference period, there were 73 instances of zero discharge for 3 or more consecutive days from Watauga Dam. In four of these instances during the years of 1960, 1961, 1963, and 1972; consecutive days of zero discharge from Watauga Dam ranged from a low of 7 days in several years to a high of 9 days in 1960.

Existing agreements regarding reservoir releases.--Whenever necessary to maintain a minimum average flow of about 112.0 ft^3/s (72.4 Mgal/d) at Elizabethton, releases are made from both Watauga and Wilbur Dams.

Wilbur Reservoir

Location and drainage area.--Wilbur Reservoir is formed by Wilbur Dam which is located on the Watauga River at river mile 34.0 in Carter County. Wilbur Dam controls 471 mi^2 of drainage area.

Reference period.--1962-81.

Reservoir discharge (minimum daily average flow).--Minimum daily average discharge from Wilbur Dam during the reference period ranged from a low of about 12.0 ft^3/s (7.8 Mgal/d) in 1972 to a high of about 46.0 ft^3/s (29.7 Mgal/d) in 1964. The average, 1-day minimum discharge during the reference period was about 29.2 ft^3/s (18.9 Mgal/d).

Average number of days of zero flow.--None.

Existing agreements regarding reservoir releases.--Whenever necessary to maintain a minimum average flow of about 112.0 ft^3/s (72.4 Mgal/d) at Elizabethton, releases are made from both Watauga and Wilbur Dams.

Ground Water

Ground water in the Holston River basin in Tennessee occurs in fractures in the underlying rock formations that have been subjected to severe folding and faulting. With the exception of the westernmost edge of Carter County which lies in the Valley and Ridge physiographic province, both Johnson and Carter Counties lie in the Blue Ridge province. The easternmost edge of Sullivan County also lies in that province. The Holston River basin in this area is underlain primarily by noncarbonate rocks such as shale, sandstone, siltstone, and highly siliceous crystalline rock. Fractures in these rocks are not