THE NATION'S WATER RESOURCES 1975-2000

Volume 4: Tennessee Region

Second National Water Assessment by the U.S. Water Resources Council

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December 1978

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Foreword

The Water Resources Planning Act of 1965 (Public Law 89-80) directs the U.S. Water Resources Council to maintain a continuing study of the Nation's water and related land resources and to prepare periodic assessments to determine the adequacy of these resources to meet present and future water requirements. In 1968, the Water Resources Council reported the results of its initial assessment. The Second National Water Assessment, a decade later, provides a comprehensive nationally consistent data base for the water resources of the United States. The results of the Second National Water Assessment were obtained by extensive coordination and collaboration in three phases.

Phase I: Nationwide Analysis

The Council member agencies researched, analyzed, and prepared estimates of current and projected water requirements and problems and the implications of the estimates for the future.

Phase II: Specific Problem Analysis

Regional sponsors, one for each of the 21 water resources regions, surveyed and analyzed State and regional viewpoints about (1) current and future water problems, (2) conflicts that may arise in meeting State and regional objectives, and (3) problems and conflicts needing resolution.

Phase III: National Problem Analysis

The Council conducted this final phase in three steps: (1) An evaluation of phases I and II, (2) an analysis that identified and evaluated the Nation's most serious water resources problems, and (3) the preparation of a final report entitled "The Nation's Water Resources--1975-2000."

The final report of the Second National Water Assessment consists of four separate volumes as described below. These volumes can assist Federal, State, local, and other program managers, the Administration, and the Congress in establishing and implementing water resources policies and programs.

Volume 1, Summary, gives an overview of the Nation's water supply, water use, and critical water problems for "1975," 1985, and 2000 and summarizes significant concerns.

Volume 2, Water Quantity, Quality, and Related Land Considerations, consists of one publication with five parts:

Part I, "Introduction," outlines the origin of the Second National Water Assessment, states its purpose and scope, explains the numerous documents that are part of the assessment, and identifies the individuals and agencies that contributed to the assessment.

Part II, "Water-Management Problem Profiles," identifies ten general water problem issues and their implications and potential consequences.

Part III, "Water Uses," focuses on the national perspectives regarding existing ("1975") and projected (1985 and 2000) requirements for water to meet offstream, instream, and flow-management needs. State-regional and Federal perspectives are compared.

Part IV, "Water Supply and Water Quality Considerations," analyzes the adequacy of fresh-water supplies (ground and surface) to meet existing and future requirements. It contains a national water budget; quantifies surface- and ground-water supplies, reservoir storage, and transfers of water within and between subregions; describes regional requirements and compares them to supplies; evaluates water quality conditions; and discusses the legal and institutional aspects of water allocation.

Part V, "Synopses of the Water Resources Regions," covers existing conditions and future requirements for each of the 21 water resources regions. Within each regional synopsis is a discussion of functional and location-specific water-related problems; regional recommendations regarding planning, research, data, and institutional aspects of solving regional water-related problems; a problem-issue matrix; and a comparative-analysis table.

Volume 3, Analytical Data, describes the methods and procedures used to collect, analyze, and describe the data used in the assessment. National summary data are included with explanatory notes. Volume 3 is supplemented by five separately published appendixes that contain data for the regions and subregions:

Appendix I, Social, Economic, and Environmental Data, contains the socioeconomic baseline ("1975") and growth projections (1985 and 2000) on which the water-supply and water-use projections are based. This appendix presents two sets of data. One set, the National Future, represents the Federal viewpoint; the other set, the State-Regional Future, represents the regional sponsor and/or State viewpoint.

Appendix II, Annual Water Supply and Use Analysis, contains baseline water-supply data and baseline and projected water withdrawal and water-consumption data used for the assessment. Also included are a water adequacy analysis, a natural flow analysis, and a critical-month analysis.

Appendix III, Monthly Water Supply and Use Analysis, contains monthly details of the water-supply, water-withdawal, and water-consumption data contained in Appendix II and includes an analysis of monthly water adequacy.

Appendix IV, Dry-Year Conditions Water Supply and Use Analysis, contains both annual and monthly baseline and projected water-withdrawal and water-consumption data for dry conditions. Also, a dry conditions water-adequacy analysis is included.

Appendix V, Streamflow Conditions, contains detailed background information on the derivation of the baseline streamflow information. A description of streamflow gages used, correction factors applied, periods of record, and extreme flows of record, are given for each subregion. Also included is the State-Regional Future estimate of average streamflow conditions.

Volume 4, Water Resources Regional Reports, consists of separately published reports for each of the 21 regions. Synopses of these reports are given in Volume 2, Part V.

For compiling and analyzing water resources data, the Nation has been divided into 21 major water resources regions and further subdivided into 106 subregions. Eighteen of the regions are within the conterminous United States; the other three are Alaska, Hawaii, and the Caribbean area.

The 21 water resources regions are hydrologic areas that have either the drainage area of a major river, such as the Missouri Region, or the combined drainage areas of a series of rivers, such as the South Atlantic-Gulf Region, which includes a number of southeastern States that have rivers draining directly into the Atlantic Ocean and the Gulf of Mexico.

The 106 subregions, which are smaller drainage areas, were used exclusively in the Second National Water Assessment as basic data-collection units. Subregion data point up problems that are primarily basinwide in nature. Data aggregated from the subregions portray both regional and national conditions, and also show the wide contrasts in both regional and national water sources and uses.

The Second National Water Assessment and its data base constitute a major step in the identification and definition of water resources problems by the many State, regional, and Federal institutions involved. However, much of the information in this assessment is general and broad in scope; thus, its application should be viewed in that context, particularly in the area of water quality. Further, the information reflects areas of deficiencies in availability and reliability of data. For these reasons, State, regional, and Federal planners should view the information as indicative, and not the only source to be considered. When policy decisions are to be made, the effects at State, regional, and local levels should be carefully considered.

In a national study it is difficult to reflect completely the regional variations within the national aggregation. For example, several regional reviewers did not agree with the national projections made for their regions. These disagreements can be largely attributed either to different assumptions by the regional reviewers or to lack of representation of the national data at the regional level. Therefore, any regional or State resources-management planning effort should consider the State-regional reports developed during phase II and summarized in Volume 4 as well as the nationally consistent data base and the other information presented in this assessment.

Additional years of information and experience show that considerable change has occurred since the first assessment was prepared in 1968. The population has not grown at the rate anticipated, and the projections of future water requirements for this second assessment are considerably lower than those made for the first assessment. Also, greater awareness of environmental values, water quality, ground-water overdraft, limitations of available water supplies, and energy concerns are having a dramatic effect on water-resources management. Conservation, reuse, recycling, and weather modification are considerations toward making better use of, or expanding, available supplies.

CONTENTS

Illustrations

Physiography

Description

The Tennessee Region, shown in Figure 6-1, is the drainage area of the Tennessee River above its confluence with the Ohio River. It encompasses a total area of approximately 42,640 square miles (about 27.3 million acres)[1] and includes parts of Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia. About 1,054 square miles (675,000 acres) of this area is water surface.

The region extends in a north-south direction for about 220 miles, from the Virginia-West Virginia State line to about 40 miles north of Birmingham, Alabama. The east-west extension is 400 miles, from 50 miles east of Bristol, Tennessee-Virginia, to Paducah, Kentucky.

The Tennessee River is approximately 652 miles long, all of which is impounded at normal full pool levels of the reservoirs on the Tennessee and Ohio Rivers. The Tennessee River is formed by the confluence of the French Broad and Holston Rivers at Knoxville, Tennessee, and flows into the Ohio River at Paducah, Kentucky. The river forms a rough U shape and has seven major tributaries with over 2,200 square miles of drainage areas each, and numerous tributaries with drainage areas less than 1,000 square miles each.

Forests cover about 53 percent of the region, with the eastern half being more heavily forested. Cropland and rangeland are found throughout the region but are more common in the western part and are very scarce in the North Carolina portion of the region (see Figure 6-2).

Geology

The Tennessee Region is heterogeneous, encompassing parts of six physiographic provinces. Predominantly crystalline rocks of the Blue Ridge Mountains underlie and border the region on the east. Strata along the eastern margin of the basin are strongly folded and broken by faults (valley and ridge area). The intensity of folding and faulting decreases to the west, and in the western part of the region the strata are nearly horizontal (Cumberland Plateau, Highland River, and Central Basin area). Farther to the west, along the western margin of the Tennessee Region, sediments of the Coastal Plain province overlie the basin.

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[1]This is the sum of the areas of counties used to approximate the hydrologic area of the region. Land use and other socioeconomic data are related to this area. The drainage area within the hydrologic boundary is 40,810 square miles.

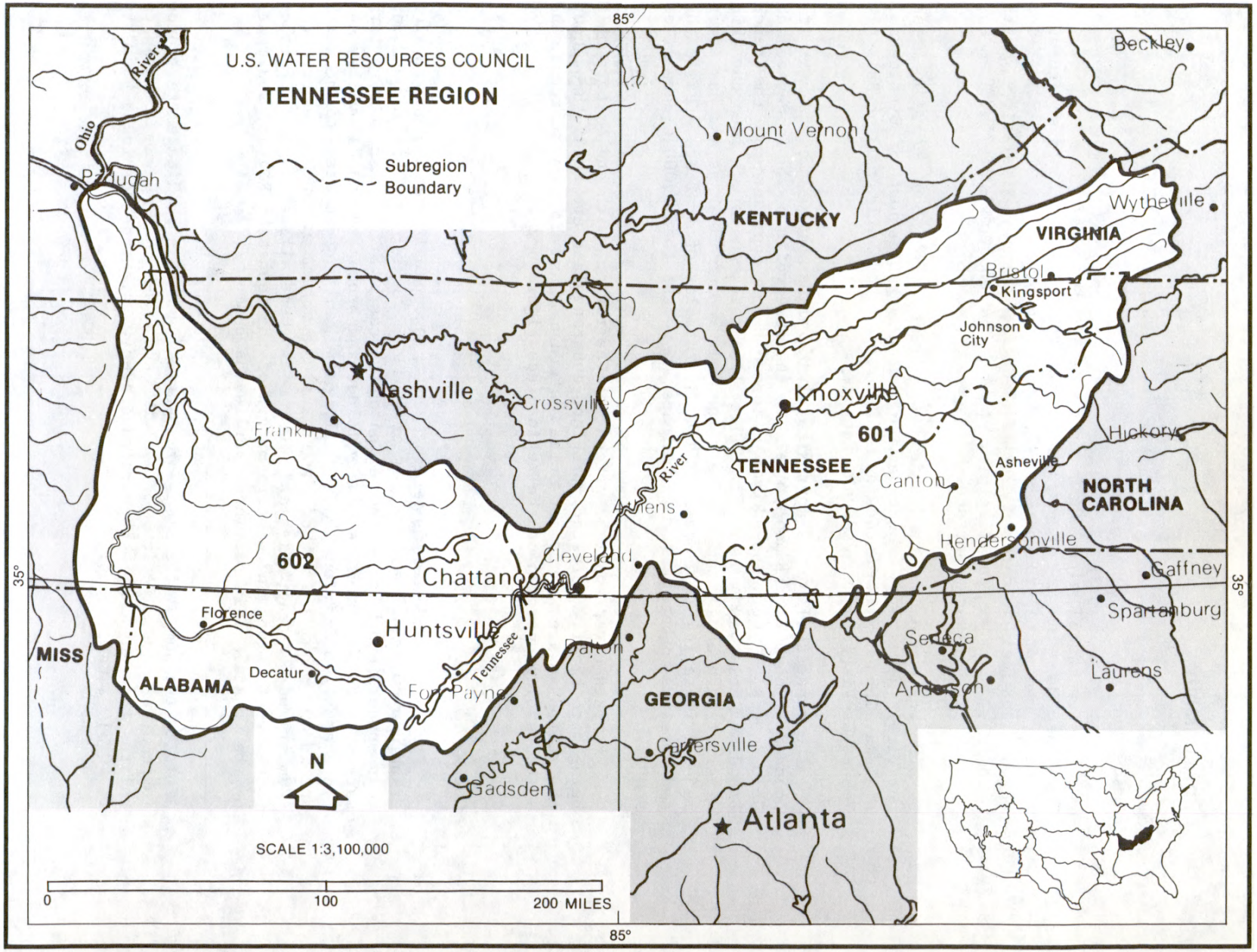

Figure 6-1. Region Map

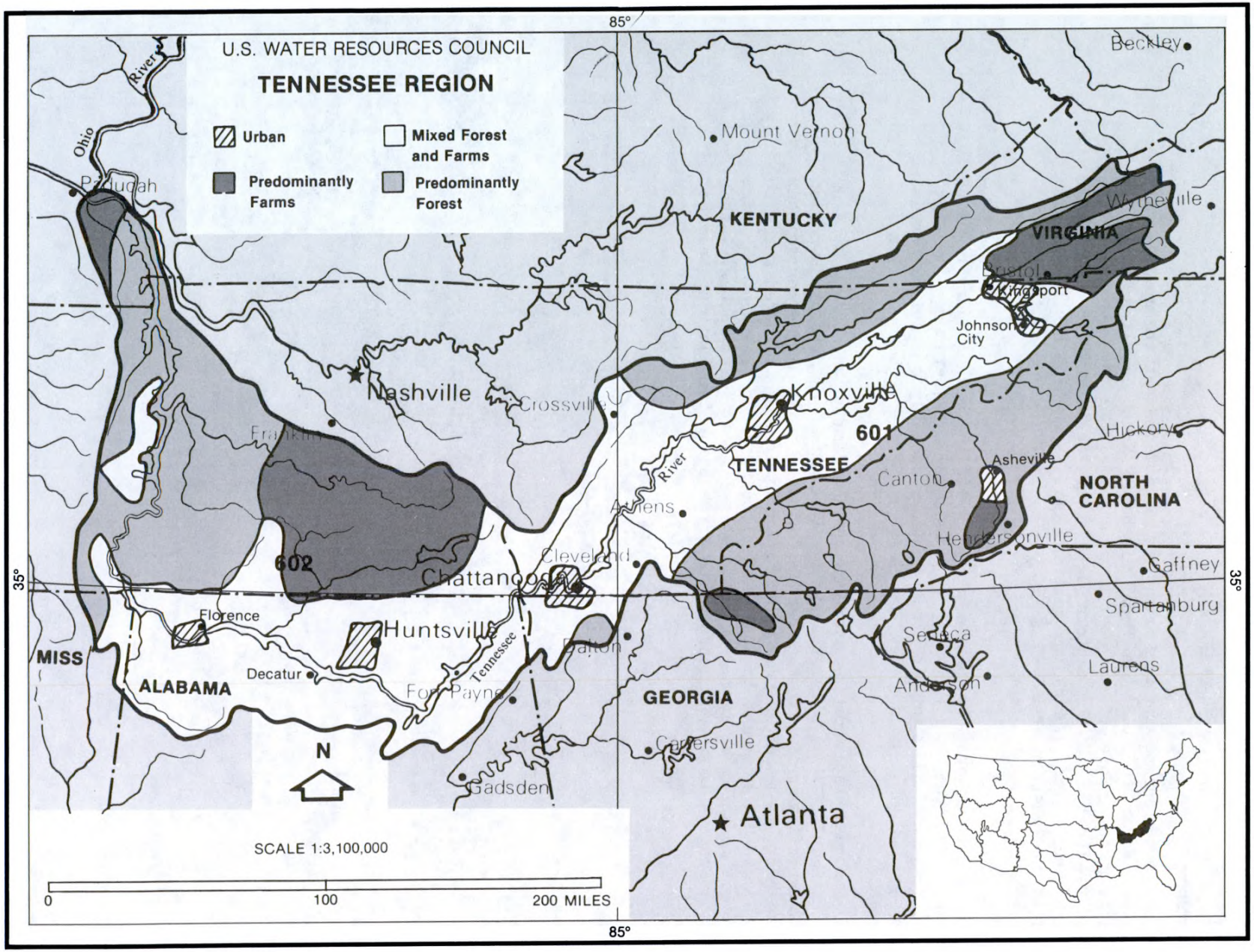

Figure 6-2. Present Land Use

Topography

The elevations of the region range from 302 feet at the mouth of the Tennessee River to 6,684 on Mount Mitchell, North Carolina, near its eastern border. Some of the most rugged terrain in the eastern United States is located in the eastern half of the region, while much of the western half is covered by low rolling hills. Some high bluffs are also found in the western area.

Climate

The region enjoys a moderate climate with the mean January temperatures ranging from 33° to 43° F and mean July temperatures from 66° to 81° F. Snowfall averages about 8 inches annually and seldom remains on the ground more than a few days except in the higher mountain peak areas.

The annual precipitation averages nearly 52 inches and has varied from 38 to 71 inches. Generally, the average in the western half of the region is fairly uniform and near the average for the region. In the mountainous eastern half, it averages from about 40 inches in some sheltered areas to 90 inches in higher mountain areas. September, October, and November are the driest months with average rainfalls of 2-1/2 to 3-1/2 inches. Other months average 4 to 5-1/2 inches, with March being the month of heaviest rainfall.

People and the Resources

Basic to any identification of problems of the people and their water and related land resources is an analysis of the current and future activities which give rise to these problems. Estimates and projections of the population, economy, land and water resources, and other parameters were made as explained elsewhere in the national assessment reports. These data are for the Nation, the regions, and subregions and are referred to as the National Future (NF). State and Regional representatives prepared alternative estimates called the State-Regional Future (SRF) where they disagreed with the NF data. A discussion of the differences between these sets of data and the implications of the variations is included at the end of this section. All data presented are NF unless identified as SRF.

Population

The population of the Tennessee Region was 3.57 million in 1975, which was about 1.6 percent of the national total. By the year 2000, the regional population is expected to reach 4.62 million. Most of the people of the region live in smaller cities and towns or rural areas. About 20 percent of the population live in the nine largest cities, of which only three--Knoxville, Chattanooga, and Huntsville--have populations greater than 100,000. Knoxville, Tennessee, is the largest city, with a population estimated at 183,000 in 1975. Just over 50 percent of the present population is located in the SMSA counties, which make up 24 of the 93 counties in the county approximation of the Tennessee Region. This percentage should increase to about 55 percent by 2000 as people continue to move to the larger cities and their suburbs.

Economy

About 1.36 million people were employed in 1975 in the region. The 1975 total personal earnings were about $12,873 billion. The major earnings sector of the economy was manufacturing with 35 percent of the total. The "Other" category shown in Table 6-1 includes wholesale and retail trade, government, services, transportation, communities, public utilities, construction, finance, insurance, and real estate.

Table 6-1.--Tennessee Region earnings--1975, 1985, 2000
(million 1975 dollars)

Earnings sector	1975	1985	2000
Manufacturing	4,519	6,927	11,560
Agriculture	439	423	484
Mining	198	228	311
Other	7,717	12,337	23,008
Total	12,873	19,915	35,363

All categories will have increased earnings by 2000. Manufacturing is expected to remain the leader with 33 percent of the total. The greatest relative increase in earnings will be in the "other" category, which will increase to 65 percent of the total by 2000 from 60 percent of the total in 1975. The largest increase in the individual manufacturing categories should be in chemical and allied products, expected to be 36 percent of the total manufacturing earnings by 2000.

Of the manufacturing earnings, machinery production represents about 25 percent of total manufactured earnings; other earnings are spread over machinery, primary metals, transportation equipment, and other categories. Agricultural earnings contribute about 3.4 percent of the total earnings, and mining, about 1.5 percent.

Total earnings are expected to nearly triple in the next 25 years, while per capita earnings should more than double. By the year 2000, employment is projected to reach 1.9 million.

Natural Resources

The resources of the region provide employment and numerous recreational activities. Nearly 53 percent of the region is forested; the North Carolina portion is about 80 percent forested. The recreational sites include the Great Smoky Mountain National Park, the Nation's most visited national park, and nationally known tourist attractions in the Chattanooga area. Harvested cropland covers only about 9 percent of the region. Less than 3 percent of the land is urbanized (Table 6-2).

Table 6-2.--Tennessee Region surface area and 1975 land use

Surface area or land-use type	1,000 acres	Percentage of total surface area
Surface area		
Total	27,290	100
Water	675	2.5
Land	26,615	97.5
Land use		
Cropland	4,431	16.2
Pasture and range	3,532	12.9
Forest and woodland	14,404	52.8
Other agriculture	908	3.3
Urban	668	2.5
Other[1]	2,672	9.8

[1] Includes water areas less than 40 acres in size and streams less than 660 feet wide.

Coal reserves are located in several areas of the region but are more concentrated in the Virginia portion. Reserves of bituminous coal are estimated at 814 million tons. About one-half have sulfur content

of less than 1 percent. The western part of the region is currently one of the Nation's major sources of phosphate, but mining is expected to decline because the phosphate reserves are being depleted. New zinc and copper deposits have been discovered in the eastern part of the region. Talc, mica, limestone, sandstone, and other stones are of local commercial importance in various parts of the region. The copper, iron, and zinc sulfides mined and processed in the Copperhill, Tennessee, area provide employment in three States and are of importance to several manufacturing industries in the southeast part of the region.

Agriculture

Soils vary from place to place but are generally low in fertility. Intensive programs have been and are being conducted to stimulate development of the agriculture and agricultural business potential. These programs have transformed the region's agriculture over the past four decades; erosion has been reduced, and yields are higher. Agricultural sales have increased from $113 million in 1934 to $1.6 billion in 1974. Farming is more diversified, with livestock and livestock products accounting for 70 percent of all farm product sales.

Between 1975 and 2000 harvested cropland will increase by 706,000 acres. Cropland not harvested is expected to be reduced by some 694,000 acres. About 56 percent of the cropland is now harvested. This is expected to increase to 72 percent by 2000. Irrigated cropland is projected to increase from 15,000 to 23,000 acres (Table 6-3).

Table 6-3.--Projected changes in cropland and irrigated farmland in the Tennessee Region -- 1975, 1985, 2000

(1,000 acres)

Land category	1975	1985	2000
Total cropland-------	4,431	4,384	4,443
Cropland harvested---	2,484	2,588	3,190
Irrigated farmland---	15	19	23

Energy

Electric power production totaled over 68,000 gigawatt-hours in 1975. There are about 40 operating hydroelectric plants in the region. They produced about 28 percent of the energy produced in the region in 1975. This percentage is expected to fall to about 6 percent by 2000. Fossil fuels presently produce about 68 percent of the total energy, while the rest is produced at the region's one nuclear plant. By 2000 the region is expected to generate 263,000 gigawatt-hours annually; about 73 percent of this is projected to come from nuclear plants (Table 6-4). The hydroelectric plants are used primarily to meet peak power demands. The addition of at least one major pump storage plant will help the hydroelectric plants meet this demand. The principal coal deposits in the region are found in Virginia. Coal for the region's steam plants is imported from surrounding regions.

Table 6-4.--Tennessee Region electric power generation--1975, 1985, 2000 (gigawatt-hours)

Fuel Source	1975	1985	2000
Fossil	46,041	38,847	56,705
Nuclear	2,722	109,101	190,553
Conventional hydropower	19,372	15,426	15,426
Total generation	68,135	163,374	262,684

Navigation

The Tennessee River has a useful slack-water channel for its entire length from Knoxville, Tennessee, to Paducah, Kentucky, a distance of about 650 miles. The minimum depth is 11 feet and the minimum width is 300 feet with some widening on bends. Navigation is also provided on the Hiwassee River to Charleston, Tennessee, and on the Clinch River to Clinton, Tennessee (Figure 6-3).

The Tennessee River is a key element of the Nation's inland waterway system. In the domestic transportation system, the inland waterways network provides for the long-distance movements of bulk commodities. Ports on the Tennessee are directly connected with ports in 21 States. Coal and coke made up 34 percent of the traffic, by weight, in 1974. Stone, sand, and gravel made up 30 percent. Chemicals, the third most important commodity by weight, made up 9 percent.

The region's navigation system transported over 28 million tons in 1975. Improved facilities may be required at three of the dams to meet projected demands, especially after the completion of the Tennessee-Tombigbee Waterway. This waterway will connect the Tennessee River system to the Warrior River system and, consequently, will provide a more direct route to the Gulf of Mexico.

Environment

The stress of urban living and its accompanying economic affluence have caused increasing numbers of people to turn to open spaces for outdoor recreation. The enthusiasm for boating, camping, hiking, fishing, and picnicking is causing substantial impact on the environment. The region has many interesting places to visit that offer relaxation and in which people have a deep sense of pride. Foremost among these is the Great Smoky Mountains National Park.

The many lakes, scenic mountain streams, and forested areas of the eastern part of the region have contributed to thriving resort and recreation-oriented enterprises. The connecting reservoir system, with its navigation pools and locks, makes recreational boating a favorite pastime. State parks and State forests enhance recreation opportunities throughout the region. Portions of six national forests are located in the region.

National historical sites include the Biltmore Estate at Asheville, North Carolina; Andrew Johnson National Historical Site; the Boatyard Historical District at Kingsport, Tennessee; James K. Polk House; Tellico Blockhouse; Jack Daniels Distillery; Jonesboro Historic District; and

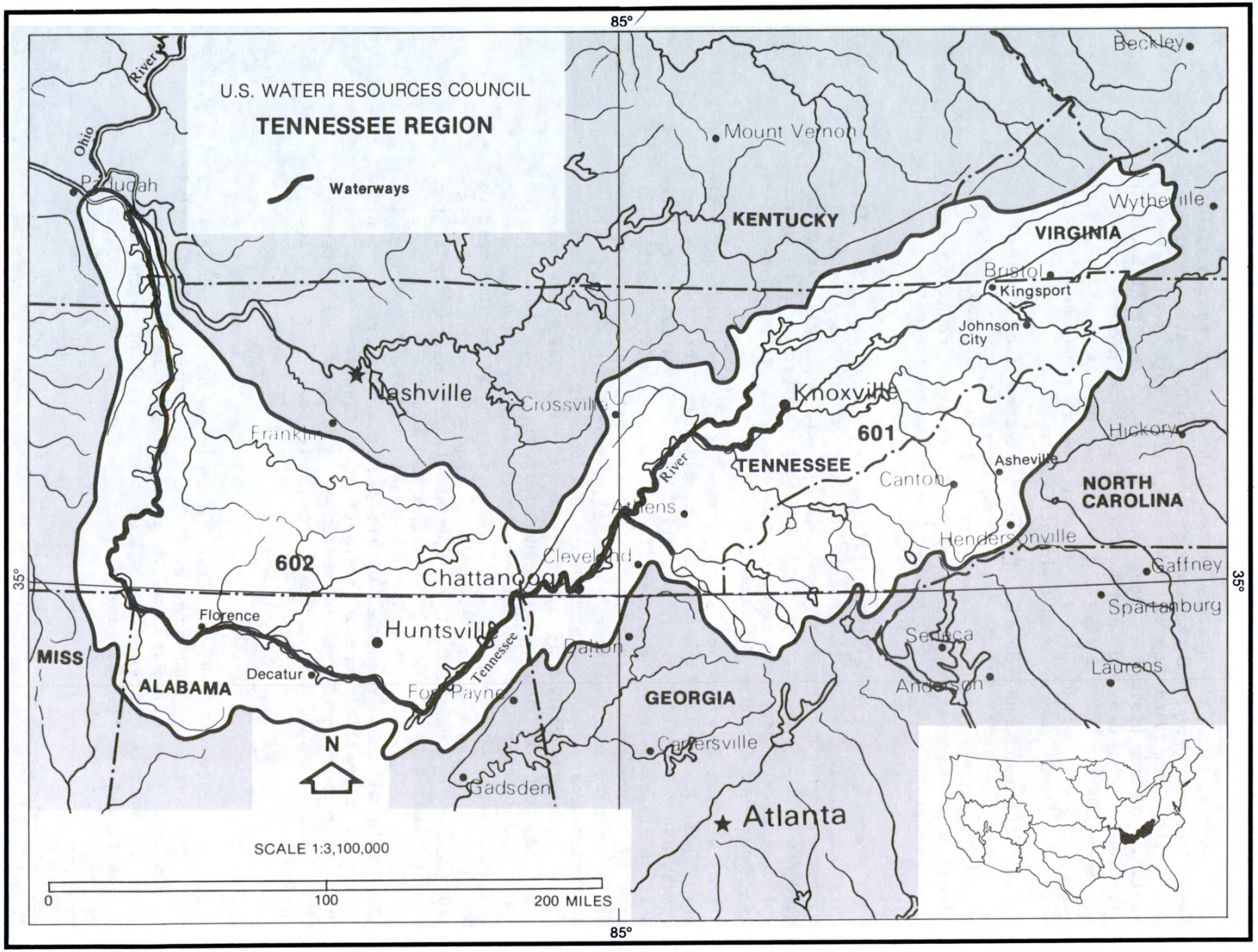

Figure 6-3. Navigation System

Sycamore Shoals, where colonists gathered prior to the battle of Kings Mountain. The Chickamauga and Chattanooga and the Shiloh National Military Parks and the Cumberland Gap National Historical Park are located in the region. Another historical monument is Wilson Dam in Alabama. The construction of the dam and surrounding complex to produce munitions for use in World War I indirectly led to the establishment of TVA. There are many excellent museums in the region; probably the best known is the Museum of Atomic Energy at Oak Ridge, Tennessee.

Commercial resorts have developed throughout the region on the manmade lakes. There are over 675,000 acres of water surface in the region. Of this, an estimated 560,000 acres are available for recreation. An additional 30,000 acres of water surface is expected to be in use by 2000. In addition, over 1,600 miles of streams are presently used for canoeing.[1]

The demand for water-related activities in 1975 was about 31 million activity occasions. By 2000 the demand is expected to exceed 43 million. Except for canoeing, the resources of the region are sufficient to meet expected demands. However, specific localities experience recreation water shortages. Since good recreational areas for canoeing are often remote, access and location are sometimes problems.

Three wilderness areas and parts of two others are located in the region. These are Joyce Kilmer-Slickrock, Ellicott Rock, Shining Rock, Gee Creek, and Cohutta. Two more potential wilderness areas -- the Obed and Buffalo Rivers -- have been identified. The Obed River has been designated as a national scenic river, and the Buffalo River is under investigation as a national scenic river (Figure 6-4). In addition, parts of the French Broad, Nolichucky, Hiwassee, and Buffalo Rivers and Tuckahoe Creek have been designated as State scenic rivers. There are numerous national and State wildlife refuges and management areas in the region. At present, 30 species of wildlife are on the national endangered species list. Land Between the Lakes is a 170,000-acre recreation site operated by TVA. It is located between Kentucky Lake on the Tennessee River and Barkley Lake on the Cumberland River and is only partially in the region. One of its features is a 5,000-acre Environmental Education Center.

Renewable wildlife resources in the region are important from the standpoint of commercial tourist attractions. Tennessee ranks number one in the 12 southeastern States in the number of resident and nonresident fishing licenses issued and number three in resident hunting licenses issued.

Water

The data collected and projected in this report on the region's water are for assessing the water situation and current and potential problems related to water and its use. The water withdrawals and consumption data are for average years. All values are consistent with NF data unless identified specifically as SRF.

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[1] Water surface acreage and stream miles came from TVA sources.

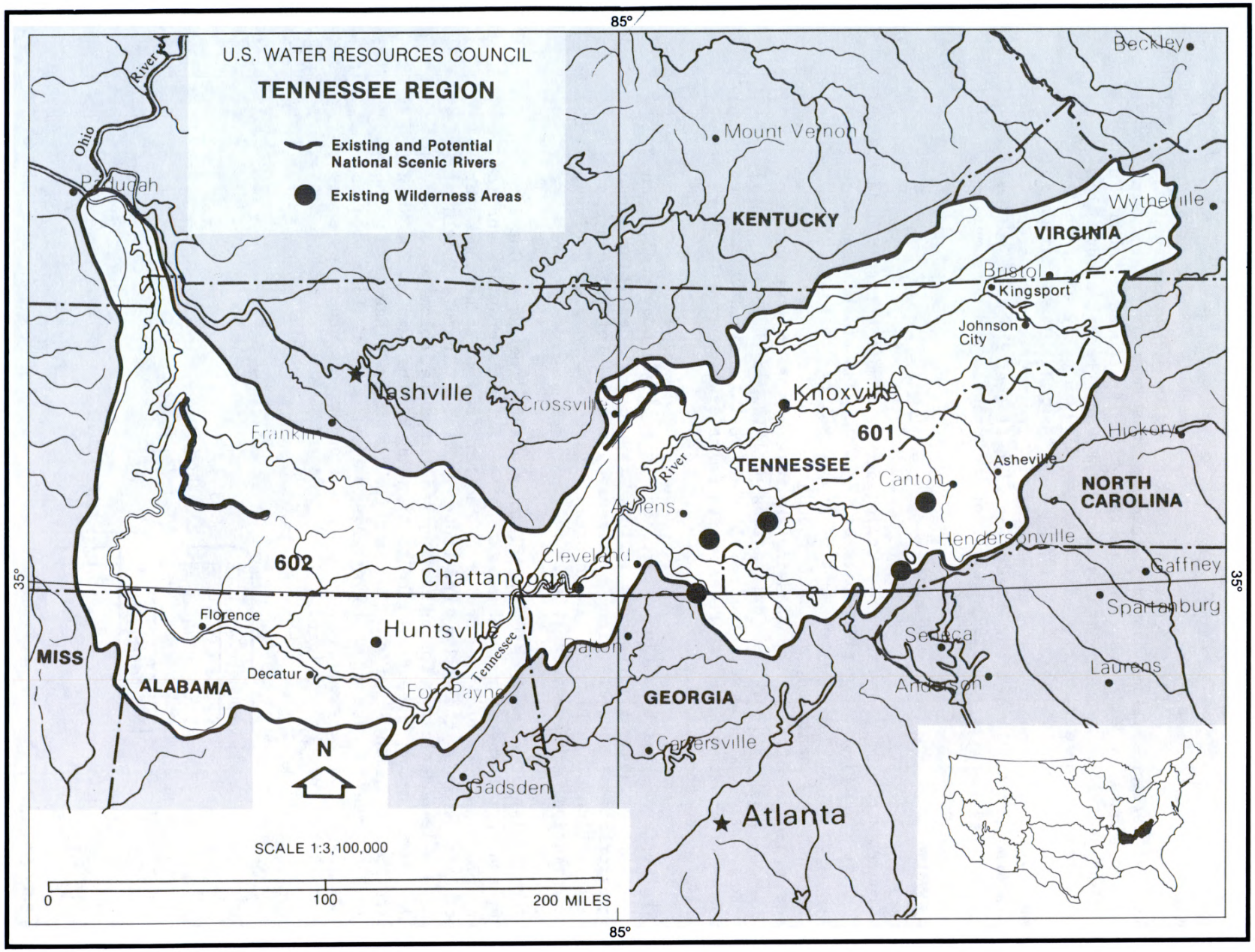


Figure 6-4. Environmental Resources

Surface Flow

The total surface flow occurring in the region in an average year is about 41 billion gallons per day (bgd). In a very dry year, which occurs about once in 20 years, this surface flow is reduced to about 36 bgd. Many individual streams are reduced by a much greater amount than is indicated by these figures. Extreme low flows usually occur in the fall. Floods occur at all times of the year but are most common in spring. Rainfall and runoff are highest in the mountainous areas of the eastern part of the region. Figure 6-5 illustrates 1975 average flows in the Tennessee River with 1975 levels of withdrawals and consumption.

Ground Water

Ground water in the Tennessee Valley occurs almost entirely under water table conditions, except in part of the area west of the Tennessee River. There is no regional movement of ground water. Instead, ground-water systems are localized, and their boundaries conform more or less to surface drainage divides, encompassing drainage areas in most cases of less than 10 square miles. The implications of this are that the general depth to the water table is relatively shallow and that the distance traveled by ground water from point of recharge to point of discharge is short; generally a few thousand feet.

The Tennessee Valley includes parts of six geologic provinces, each with distinct ground-water characteristics. Figure 6-6 identifies these geologic formations, and the ground-water use potential for these areas. The eastern Blue Ridge Province is an area of extremely complex geology, with no principal aquifer identified.

The Highland Rim Province is underlain by cherty limestone. One formation, the Fort Payne Chert, occurs extensively in this province and is in many places a very prolific aquifer. Another area where ground-water potential is high is the Valley and Ridge Province. In this province, the surface is underlain by folded and faulted limestone, dolomite, shale, and sandstone in long subparallel belts trending northeasterly. The Knox dolomite can be identified as the principal aquifer since it is the principal source of base flow to streams and it is the formation in which nearly all large-yield springs and wells occur. It underlies about half the surface of the province.

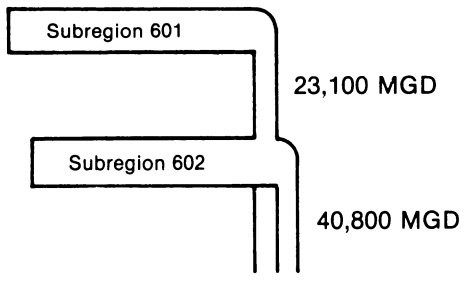


Figure 6-5. Streamflow

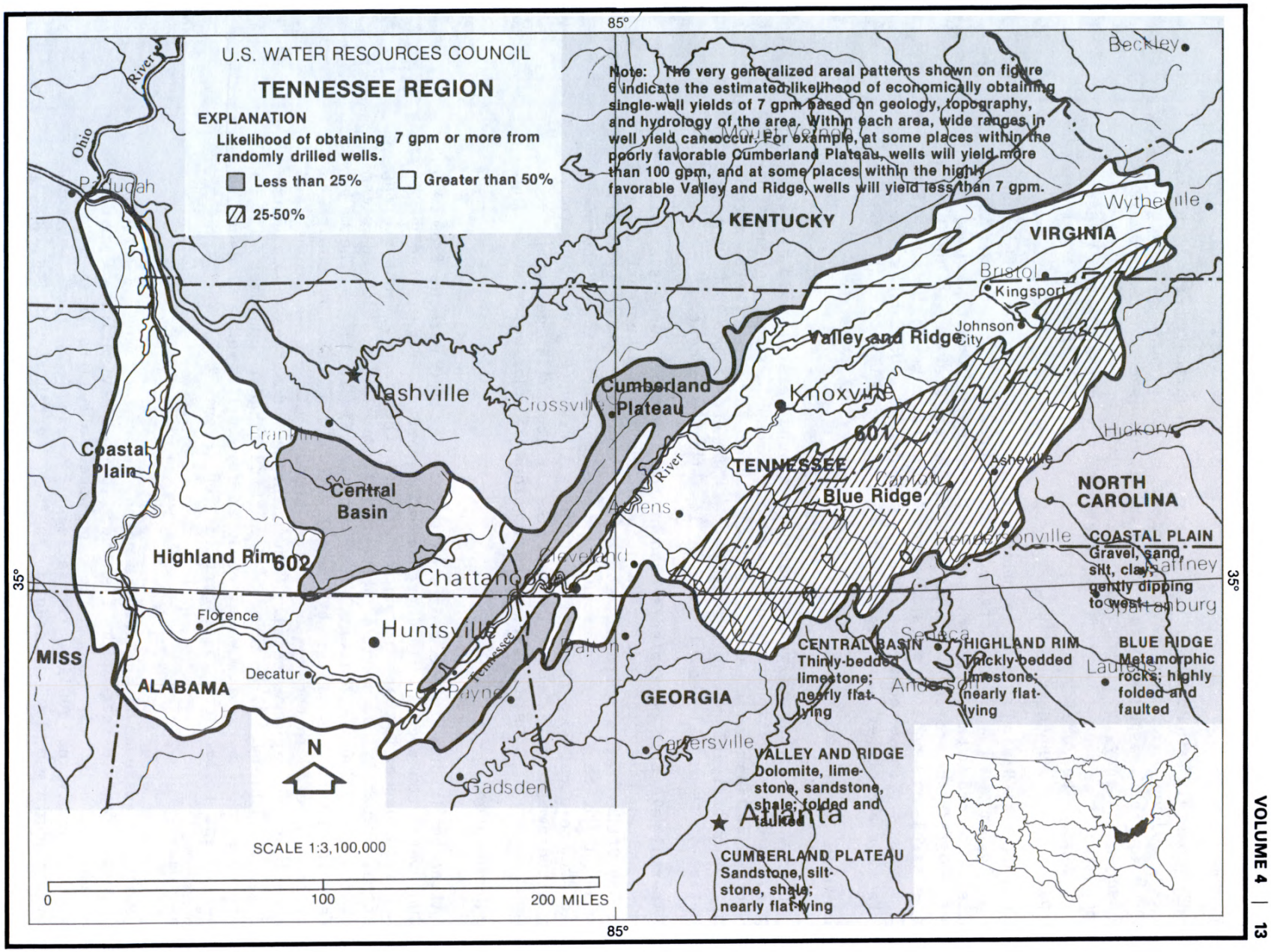


Figure 6-6. Major Aquifers

The Coastal Plain Province is underlain by unconsolidated sand, gravel, and clay. These have been divided into several formations. Some are prolific aquifers, especially farther west in Tennessee and in the Jackson Purchase of Kentucky. Within the Tennessee Valley, part of the area is the recharge area for some major aquifers that occur at greater depth farther west. The McNairy Sand is probably the principal aquifer within this part of the Tennessee Valley.

The Central Basin Province is underlain principally by shaly limestone that has low to very low ground-water potential throughout most of the area. This is reflected in the very low base-flow discharges of most streams that originate within the province. The Cumberland Plateau Province is underlain almost entirely by sandstone and shale formations that make up the so-called "coal measures." These rocks also are a poor source of ground water, except very locally where they have been fractured.

Water Withdrawals

Total water withdrawn from streams and ground water in 1975 averaged about 7.4 bgd. Irrigation presently withdraws much less than 1 percent of this to use on less than 1 percent of the harvested cropland. The amount of water for irrigation should increase by 50 percent by 2000, but its percentage of the total should still be less than 1 percent.

Thermal electric powerplants account for about 65 percent of withdrawals, and manufacturing industries account for about 28 percent (Figure 6-7). By 2000 water withdrawals for thermal electric power generation are expected to be about 76 percent, and the manufacturing withdrawals should drop to about 11 percent of the total withdrawn (Figure 6-7). Total water withdrawals are expected to decrease by about 1.4 bgd by the year 2000. These projections are based on assumptions of major water recycling.

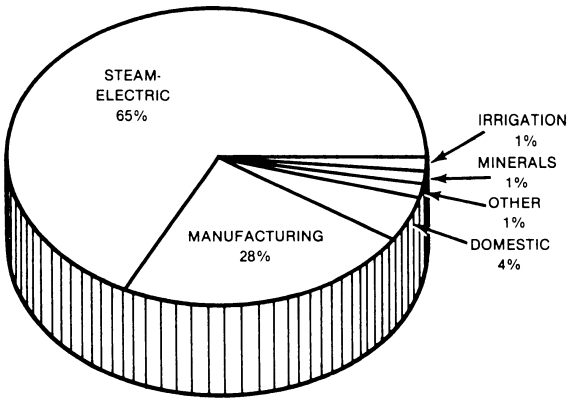
Water Consumption

Although withdrawals are projected to decrease by 19 percent from 1975 to 2000, water consumed should increase by 251 percent from 0.3 bgd to 1.1 bgd. Water consumed is that water not returned to the stream. Manufacturing industries presently use about 47 percent, followed by domestic and steam electric with 19 and 13 percent, respectively (Figure 6-7). The major increase in consumption will be by thermal electric plants. By 2000 these plants are expected to consume over nine times their present amount and 38 percent of the region's total. Manufacturing industries will consume the largest quantity, 47 percent. The third largest consumer will be domestic uses at 7 percent. Water consumed for irrigation will decrease from 4 percent in 1975 to 1.5 percent in 2000 (Figure 6-7).

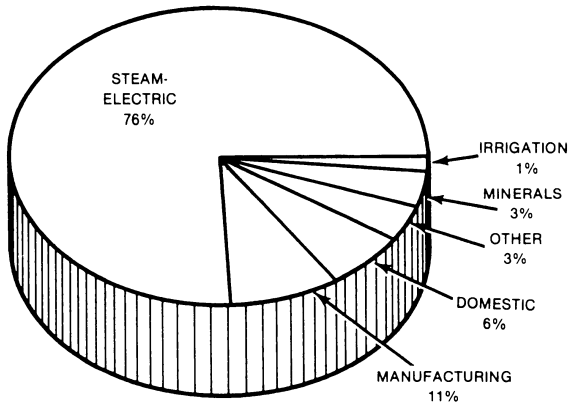
Instream Uses

Many streams uses do not require actual removal of water. Principal among these uses are recreation, fish and wildlife, navigation, waste disposal, and hydroelectric power. These purposes do require minimum levels of water quantity and quality for satisfactory use. In fact, a stream must provide minimum flows in order to sustain the habitat of its aquatic forms.

ANNUAL FRESHWATER WITHDRAWALS

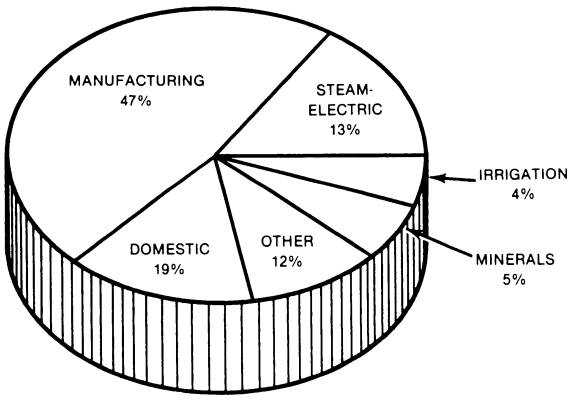


1975
Total Withdrawals — 7,412 MGD

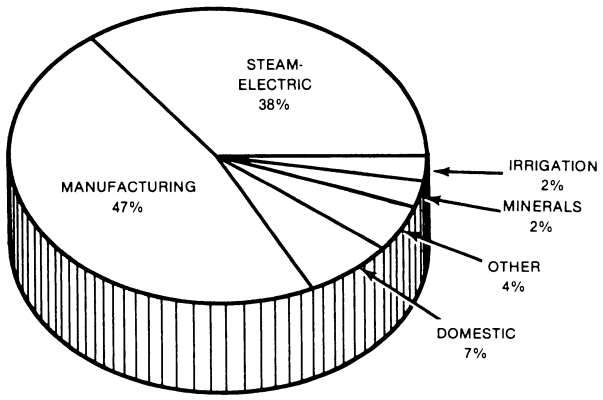


2000
Total Withdrawals — 6,013 MGD

ANNUAL FRESHWATER CONSUMPTION



1975
Total Consumption — 313 MGD



2000
Total Consumption — 1,105 MGD

Figure 6-7. Withdrawals and Consumption

Water Supply and Demand

This region has an abundance of fresh water. A comparison of current annual use with annual supply illustrates this. Total annual withdrawals average about 18 percent of total streamflow in an average year. The decreased withdrawals by 2000 will lower this total to about 15 percent. Consumption is presently about 4 percent of withdrawals or less than 1 percent of total streamflow. This will increase to 18 percent of withdrawals and about 2.7 percent of total streamflow by 2000.

However, while these overall annual figures show no water shortage in the region or in either aggregated subregion, they can be misleading. The areas near the watershed boundary do not have these large quantities of water available. Some industrial towns in the headwater areas experience water shortages in times of drought, as do some communities near the basin rim. In most cases the water is available, but conflicts arise over its use. An example of this is the demand for water in the South Fork Holston River at Kingsport, Tennessee. Domestic and manufacturing uses conflict with recreation and hydroelectric generation. The supply is adequate to meet either the instream or withdrawal demands, but it is not always adequate to meet both.

Comparative Analysis

Table 6-5 compares the National Future (NF) and State-Regional Future (SRF) estimates of streamflows and water use in the Tennessee Region. Both estimates need to be considered in decisions and plans for water-related problems. The amount of water required to meet the SRF projected manufacturing demands is much greater than that required in the NF projections. The NF assumed future high rates of recirculation as a conservation and cost-minimization measure, while the SRF assumed there would be little pressure to conserve because of the region's abundance of water, except in those headwater areas where the recirculation rates are already very high. Differences in irrigation water are high, but irrigation uses an insignificant portion of the region's water, and any effect on the region's resource will be very localized.

Table 6-5.--Socioeconomic and volumetric data summary: the Tennessee Region

Category	1975		1985		2000	
	NF	SRF	NF	SRF	NF	SRF
SOCIOECONOMIC DATA (1000)						
Total population	3,565	3,565	4,034	4,034	4,615	4,615
Total employment	1,359	1,359	1,617	1,617	1,943	1,943
Streamflow at outflow point(s)	40,800	40,800	40,466	NE	40,008	NE
VOLUMETRIC DATA (mgd)						
-Base conditions-						
Total streamflow	41,113	NE	41,113	NE	41,113	NE
Fresh-water withdrawals	7,412	7,292	7,131	8,858	6,013	8,893
Agriculture	41	41	50	55	58	72
Steam electric	4,799	4,799	5,738	5,738	4,581	4,581
Manufacturing	2,093	1,973	765	2,487	671	3,537
Domestic	263	263	319	319	383	383
Commercial	90	90	102	102	116	116
Minerals	110	110	140	140	186	186
Public lands	1	1	2	2	3	3
Fish hatcheries	15	15	15	15	15	15
Other	0	0	0	0	0	0
Fresh-water consumption	313	304	647	555	1,105	818
Agriculture	38	41	46	54	54	71
Steam electric	42	42	231	231	417	417
Manufacturing	147	135	266	166	514	210
Domestic	59	59	69	69	76	76
Commercial	11	11	12	12	14	14
Minerals	15	15	21	21	27	27
Public lands	1	1	2	2	3	3
Fish hatcheries	0	0	0	0	0	0
Other	0	0	0	0	0	0
Ground-water withdrawals	271	271	NE	277	NE	277
Evaporation	0	0	0	0	0	0
Instream approximation						
Fish and wildlife	38,480	38,480	38,480	38,480	38,480	38,480
Navigation	16,100	16,720	16,100	17,754	16,100	18,102

NE - Not estimated.

Problems

Although the total water supply and use situation is excellent in the Tennessee Region, there are many water-related problems which deserve serious and early attention. The problems have been identified by the State and Federal officials participating in this assessment.

Water Quality

At present surface-water quality is a major problem in many areas of the region. Several of the major tributaries are adversely affected over most of their reaches, with restrictions on their uses. Two major reservoirs have been severely affected by sediment, while some embayments of others are polluted by industrial or domestic wastes. The major causes of poor water quality are:

a. The pulp and paper industry, especially in North Carolina.

b. Chemical and allied products, the third largest manufacturing employer in the region.

c. Other industrial wastes.

d. Improperly treated municipal waste.

e. Erosion and subsequent sedimentation.

f. Runoff from mined areas.

g. Thermal discharges from steam electric plants.

h. Low dissolved oxygen levels from reservoirs due to thermal stratification.

The most severe problem resulting from pulp and paper industrial discharge is at Canton, North Carolina. During periods of low flow, almost all of the flow of the Pigeon River is used by the plant; when the waste is returned to the stream, the water quality parameters of the stream include dissolved oxygen (D.O.) levels less than 5.0 mg/l; fecal coliform bacteria concentrations exceeding 1,000/100 ml; color; and toxic substances. The otherwise scenic stream below Canton is thus impaired for recreation and water supply, and the fish and other aquatic life habitat are adversely affected. However, the State of North Carolina expects the problem on the Pigeon River to be alleviated under the limits contained in the National Pollutant Discharge Elimination System Permit currently being processed.

Leachate from muck ponds at an abandoned chemical plant in Saltville, Virginia, has impaired water quality in the North Fork Holston River. Chlorides in excess of 500 mg/l and mercury are the primary polluting agents. They affect the stream's use for water supply and impair the fish and other aquatic life. Mercury concentrations in the fish have resulted in warnings not to eat fish caught in the stream.

Over 500 tons of DDT has been deposited in the sediments of the Huntsville Spring Branch-Indian Creek Embayment of Wheeler Reservoir in north Alabama. Most of the DDT is susceptible to resuspension and uptake by biological organisms. Unacceptable DDT residues have appeared in fish taken from Wheeler Reservoir in north Alabama, and DDT is being picked up by migratory waterfowl. The U.S. Army is cleaning up the Redstone Arsenal manufacturing site, but there is no plan to correct problem areas outside the Redstone Arsenal.

Highly visual evidence of the effects of pollution can be found at Copperhill, Tennessee. Open roasting of copper ore in the 19th century killed virtually all the vegetation on about 36 square miles of land and has prevented reforestation of much of it. The resultant erosion continues despite reforestation efforts largely by the Tennessee Copper Company. Erosion has caused heavy siltation in the Ocoee River and its reservoirs below Copperhill. Copper mining and smelting and sulfuric acid production also contribute to the water quality problems in the river. Among the pollutants are D.O. levels lower than 5.0 mg/l; low pH; suspended solids; toxic metals; and sulfates. The Ocoee River is impaired for fish and other aquatic life, recreation, and water supply. Future waste treatment practices will probably reduce most of the pollutants to a satisfactory level, but erosion and sediments are expected to remain a serious problem in the Ocoee River between river miles 11.9 and 37.4.

Water quality degradation due to municipal and/or industrial discharges occurs throughout the region. The smaller tributaries at Chattanooga, Tennesse, especially Chattanooga and Citico Creeks, are heavily polluted because of the concentration of industries. Water quality is impaired by D.O. levels less than 5.0 mg/l; high coliform bacteria counts exceeding 1,000/100 ml; low Ph of 6.0; presence of phenols in excess of 0.1 mg/l; and toxic substances. Chattanooga is developing an areawide plan which, when implemented, should significantly improve water quality.

Municipal waste discharges cause low D.O. levels and high fecal coliform bacteria counts at several locations in streams in the region. Another example of this condition exists on the Obed River below Crossville, Tennessee. Because of low base flows, the Obed River provides very little dilution for treated waste waters, resulting in D.O. levels below 5.0 mg/l; fecal coliform bacteria concentrations exceeding 1,000/100 ml; and Ph of less than 6.5. Since part of the Obed River has been declared a national scenic river, deterioration of water quality greatly reduces the recreational use of the river immediately below the outfall. Advanced treatment facilities planned for Crossville should alleviate the problem in the future.

Coal mining has been extensive in southwest Virginia and is occurring in several other locations in the regions, notably the Emory River basin, which includes the scenic Obed River. Runoff from mined areas pollutes streams with acids, suspended solids, and iron. New mines are generally not a severe threat to water quality since effective methods are being taken to control pollution; however, the large number of abandoned mines is a major problem to several streams. Nonfuel mining has caused large increases in sediment in some streams. The problem is probably most pronounced in the Nolichucky Basin.

The Tennessee Region has several steam electric plants which discharge heated water into the Tennessee and Holston Rivers. The newer plants are being built with supplemental cooling towers, which lower the temperatures of waters returned to the stream during critical periods but also reduce the quantity of water returned.

During certain times of the year thermal stratification occurs in the deeper reservoirs, and the D.O. in the lower elevations is reduced. When water is released from these levels, the stream reaches below the dams can be low in oxygen, impairing fish and aquatic life.

Flooding

Flooding is a problem that affects urban and rural areas throughout the region. Cities along the Tennessee River and its tributaries are frequently flooded. Rural areas throughout the region have flooding problems, but the situation is more critical in the east where the rough terrain confines cropland farming to frequently flooded valley bottomlands.

The region experiences an average annual $72 million in flood losses. (All flood damages, unless otherwise noted, are in 1975 dollars.) Without future flood-control action, damages are projected to reach $116 million by the year 2000. If flood plain regulations and structural measures continue to be implemented according to past trends, the average annual damage level will still rise to $93 million.

About 120 of more than 400 communities with problems have populations of over 2,500 people. Of these, 16 cities are subject to average annual flood damages in excess of $150,000; several others have average annual damages over $75,000. Over 100 of the communities have enacted some form of flood-plain regulations.

Water Quantity

Problems with streamflows in the region are generally due to conflicts in use rather than in the quantity of streamflows. However, very low flows occur naturally in the Emory River.

The tributary reservoirs are operated under criteria established to optimize the original project purposes. No minimum releases are required, and the flow below the dams at times is very low. This condition is detrimental to aquatic life and recreational use of the waterway. The problem of adequate minimum releases for instream needs, particularly in anticipation of significant increases in coal production, requires continuing review.

Another form of water-use conflict has occurred at the dams and reservoirs because recreation interests have developed the lakeshores. Fluctuating water levels caused by operations to meet other project purposes limit recreational use. A water-use conflict occurs in the South Fork Holston River at Kingsport, Tennessee. Fort Patrick Henry Reservoir has a high recreational use, and the dam has hydropower units. Industries below the dam use large quantities of water and have had to go to extensive recycling to meet their demands. TVA and these industries have reached an agreement concerning the minimum quantity of water to be released.

Thus, the upper limit of this major supply source has been reached.

Some smaller communities located near the rim of the basin develop water supply problems during droughts. The problem is most pronounced in Marion, Grundy, Cumberland, and Morgan Counties in Tennessee. Except for Crossville, Tennessee, most of the affected communities are under 1,000 in population. Streamflows in these locations are generally intermittent because of very small drainage areas, and the ground water is unreliable because of the small recharge areas and type of aquifers. This type of water supply problem is very localized in the Tennessee Region.

Most of the coal production is in upstream areas with low streamflows. Because water used in mining can be reused many times, water supply has not been a major problem, but it could become a problem if coal production increases greatly.

The streams in the Emory River Basin have very low base flows, with dry streams being common in summer and fall. The communities in Cumberland and Morgan Counties with water supply problems are in this basin. The Obed River, a national scenic river, is the Emory's main tributary. Besides being a threat to aquatic life, the low flows cause the stream to be degraded by the discharge of treated municipal waste.

The total water surface in the region is adequate to meet recreational demand. However, the demand is sometimes located at some distance from the available supply. On some potential recreation streams, limited access prevents optimum use. However, even though considerable traveling to reach recreation sites may be necessary, all residents of the region are not far from a variety of water-related recreation activities.

Land-Use Conflicts

The Buffalo River in western Tennessee has been proposed as a national scenic river. Some of the landowners and developers have resisted efforts to implement this proposal. A similar conflict occurred in east Tennessee concerning the Obed River, where a compromise allowed part of the proposed reach to be included in the national scenic river system. In the Obed River Basin there are strippable coal reserves which, even with reclamation practices, could mar the scenic wilderness canyons.

Land-use conflicts cause, or aggravate, most of the problems in the Tennessee Region. Residential and industrial development on the flood plains results in rapidly escalating damages. Predominantly vacation homes built indiscriminately in upstream scenic areas have adversely affected the water quality of those streams by increasing sediments and domestic wastes in the streams. There has been commercial dredging of gravel in the reservoirs, especially Chickamauga. The dredging has adversely affected the habitat of some fish.

Navigation

Industrial growth in the Tennessee Region and the completion of the Tennessee-Tombigbee Waterway will significantly increase barge traffic.

The waterway will provide a more economical and direct route to the Gulf of Mexico. The increased traffic will cause additional delays through existing locks, especially at Pickwick Landing, Chickamauga, and Kentucky. Part of the delay at Kentucky is related to Barkley Canal, which allows traffic between Kentucky Lake on the Tennessee River and Barkley Lake on the Cumberland River without passing through a lock. Because the Tennessee River below Kentucky Lake is shorter and straighter than the Cumberland River below Barkley Dam, some Cumberland River traffic locks through Kentucky.

Individual Problem Areas

Eight specific areas in the Tennessee Region with urgent problems concerning water and related land resources were identified:

1. Clinch-Powell
2. Holston
3. French Broad
4. Little Tennessee-Hiwassee
5. Emory
6. Chattanooga
7. Buffalo
8. Locks at Pickwick and Kentucky Dams

Figure 6-8a shows the location of these areas. A tabulation of the type of problems found in each problem area is illustrated in Figure 6-8b. The figure also illustrates the problems identified for each subregion by Federal agency representatives. A summary describing each area, its problems, and the effects of the problems follows the figures.

Problem Area 1: Clinch-Powell

Description

This problem area includes the drainage area of the Clinch and Powell Rivers upstream of Norris Reservoir. It is about 130 miles long, 30 miles wide at its widest point, and covers about 2,200 square miles of drainage area. It includes parts of Tennessee and Virginia. The topography is rugged, with narrow valleys separated by steep ridges running in a northeast to southwest direction.

Because the problem area includes the headwaters of the Clinch River Basin, surface- and ground-water sources are not plentiful throughout the area. The average flow of the Powell and Clinch Rivers at the exit points of the area is about 740 mgd and 1,340 mgd, respectively, but this is well below demand in the areas of maximum use. No large reservoirs are in the area.

Approximately 173,000 people live in the seven-county approximation of the problem area, which covers 3,068 square miles. The area contains a few towns with populations between 2,500 and 5,000, but none has a population over 5,000.

Water Issues

This is a coal mining area which could experience water supply problems if a large increase in coal production occurs. One site in the area was reportedly considered for a coal conversion plant; it would have required large quantities of water which might not have been available. Mining in the area is also the primary source of water pollution, adding sediments, iron, and magnesium to the streams and lowering the pH.

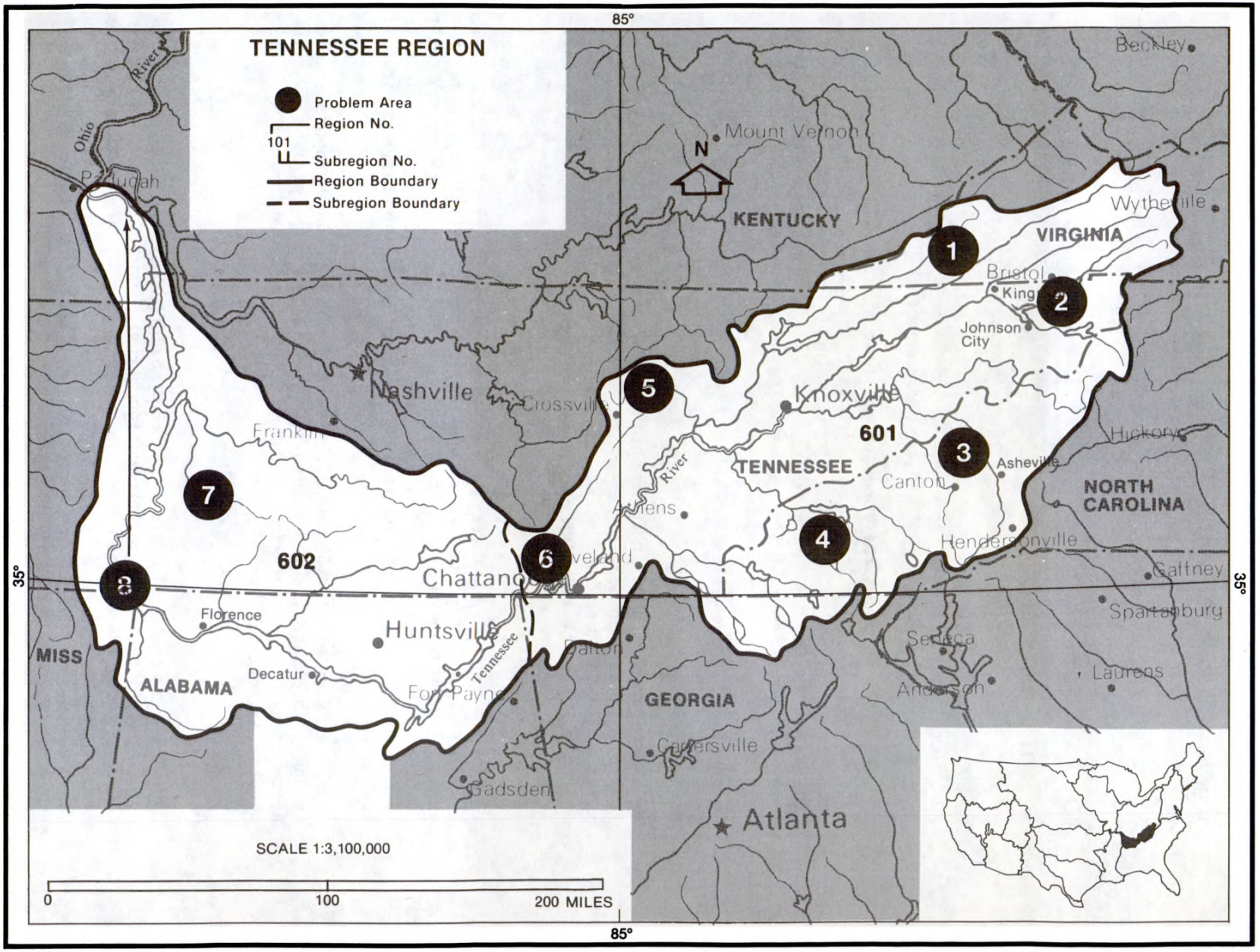


Figure 6-8a. Problem Map

TENNESSEE REGION (6)

PROBLEM MATRIX

Problem area		Problem issues O= Identified by Federal Agency Representatives X= Identified by State-Regional Representative													
		Water quantity				Water quality				Related lands					
No. on map	Name	Fresh surface	Ground	Marine and estuarine	Surface/depth	Fresh surface	Ground	Marine and estuarine	Surface/depth	Flooding	Drainage	Erosion and sedimentation	Dredge and fill	Water related use conflicts	Other
Subregion 601	Upper Tennessee					O				O		O			
Area 1	Clinch Powell	X				X				X		X			
2	Holston	X				X				X				X	
3	Grench Broad					X				X				X	
4	Little Tennessee-Hiwassee					X				X		X		X	
5	Emory	X				X				X		X		X	X
6	Chattanooga	X			X	X				X			X		
Subregion 602	Lower Tennessee					O				O		O			
Area 7	Buffalo	X								X		X			X
8	Locks at Pickwick and Kentucky Dams				X										

Figure 6-8b. Problem Matrix

Related Land Issues

Several communities have flood problems. The most serious is at Big Stone Gap, Virginia, where average annual damages exceed $17,000 per year. There is very little farming in the area. A large part of the agricultural land is located in the flood plain. Most of the mining in the area is by strip-mining. The older, nonreclaimed mines present an ugly scar on the otherwise scenic mountain area.

Institutional and Financial Issues

In an area with rugged terrain and a very limited amount of land suitable for development, there is considerable pressure to develop the land subject to frequent flooding. Local authorities need to enact and strictly enforce flood plain ordinances. Because most of the mining in the area is surface mining, Federal and State authorities need to be especially active to protect the environment.

Adverse Effects

Because of the lack of effective regulation of strip-mining, the environment of the problem area has suffered both by the scars left on the land by unclaimed mines and by adverse effects on water quality. Improper management of the mining activities and failure to utilize efficiently the limited water supplies of this upstream area could prevent the full use of the area's valuable coal resources and adversely affect the economy of the area. Failure to enact and properly enforce flood plain regulations will lead to rapidly escalating property damages and the possibility of high losses of life, since the mountainous terrain makes the area subject to flash floods.

Problem Area 2: Holston

Description

The Holston problem area is the drainage area of the Holston River above mile 115.2. This area is about 110 miles long, 60 miles wide at its widest point, and covers 2,883 square miles. The topography is rugged along the rim, with narrow valleys separated by steep ridges. In the central part of the area the terrain tends more toward rolling hills. The problem area is mostly in Virginia and Tennessee, with a small part in North Carolina.

Except for areas near the rim, surface- and ground-water resources are substantial. The average flow of the Holston is about 2,400 mgd at the exit point of the area. The area has numerous springs, and the limestone formations are capable of producing high yield wells. Four large reservoirs are located in the area.

The estimated population of the eight-county approximation of the

problem area, which covers 3,405 square miles, is 428,000. The three largest cities are Bristol, Tennessee-Virginia; Kingsport, Tennessee; and Johnson City, Tennessee, with populations between 30,000 and 45,000 each.

Water Issues

A few communities located near the rim of the basin could experience water supply problems during dry periods. However, the main water supply problem is a conflict over the use of the South Fork Holston River at Kingsport, Tennessee. A dam above the city provides recreation and hydroelectric power generation. Industries located at the city require a substantial quantity of water. An agreement between TVA and Kingsport's major industries ensures a minimum flow below the dam, but no greater quantity of water for withdrawal uses can reasonably be expected from the South Fork Holston River in the future. Water quality of area streams is adversely affected by municipal and industrial discharges, especially in the Kingsport, and Elizabethton, Tennessee, vicinities. Leachate from muck ponds at an abandoned chemical plant at Saltville, Virginia, continues to pollute the North Fork Holston River. Mercury from this source is especially detrimental. Water with low levels of dissolved oxygen is sometimes released from area reservoirs when thermal stratification occurs, resulting in adverse water quality effects downstream.

The operation of the reservoirs for flood control and power objectives can lower the recreational use of the reservoir and downstream reaches of the stream. The reach of the Holston River in the problem area is subject to the growth of aquatic weeds which, besides the esthetic effects, lower the dissolved oxygen concentrations. Mining activities have affected water quality in some reaches of area streams, primarily by the addition of sediment, iron, and magnesium. Chemical spills have also occurred in the Kingsport area.

Related Land Issues

The urban areas of Marion, Virginia; Bristol, Tennessee-Virginia; Johnson City, Tennessee; and Kingsport, Tennessee, suffer average annual flood damages in excess of $150,000 each. Twenty other communities in the area suffer average annual damages over $1,500. For all area communities the total average annual damages are estimated at over $1,220,000. Additionally, about 32,000 acres of farmland are frequently flooded. Although most of the coal mining in the area is done by deep-mining, some strip-mining does occur with the resultant marring of the land and increase in erosion.

Institutional and Financial Issues

The primary institutional issue is the adoption and enforcement of flood plain ordinances. The difficulty in enforcing the ordinances is in some cases aggravated by the lack of developable land outside the flood plains. In many cases, the addition of flood-control structures to alleviate flooding is not feasible. Most of the area coal mining is by deep mines. Even so, unless present regulations are properly enforced, deep mines present a considerable threat to the environment.

Adverse Effects

The water quality of the area streams is under assault from mining and industrial activities, municipal wastes, aquatic weeds, discharges of poor quality water from deep reservoirs, chemical spills, and an abandoned chemical plant. Fish caught in one reach of an area stream are unfit for human consumption because of mercury concentrations. Other stream reaches are impaired for uses as municipal and industrial water supplies. Fish and aquatic life are limited in some reaches. The recreation potential suffers from virtually every form of water quality degradation. The area has a multiplicity of recreational opportunities which cannot be fully exploited unless the water quality is improved and water-use conflicts are resolved. The same problems limit industrial growth. The area has considerable water resources, but conflicts in uses must be resolved and its quality must be protected for it to be efficiently used. If the limited land resources of the area outside the flood plains are not wisely developed, urban flood damages will continue to escalate as more of the flood plains are encroached upon.

Problem Area 3: French Broad

Description

The French Broad problem area is the drainage area of the French Broad River above mile 73.8, which includes the Pigeon River. The area is about 70 miles long, 50 miles wide, and covers 2,570 square miles. The area is mountainous, ranging in elevation from 1,000 to 6,621 feet above mean sea level, with a relatively wide valley floor along the French Broad River upstream of Asheville, North Carolina. The area is mostly in North Carolina but includes a small part of Tennessee.

Surface water resources are substantial. The average flow at the exit point is over 2,700 mgd; about 800 mgd of this is supplied by the Pigeon River. At Asheville, which is approximately in the middle of the area, the French Broad River has a flow of over 1,300 mgd. The ground-water potential of the area has never been developed, but the wells in the eastern part generally have yielded less than 50 gallons per minute (gpm), while wells in the west generally yield from 50 to 135 gpm.

The six-county approximation of the problem area, covering 2,842 square miles, has a population of 310,000. Asheville is by far the largest city, with 49,000 people. Approximately two-thirds of the area's population lives in Buncombe and Henderson Counties, mostly in the relatively flat French Broad flood plain extending from Asheville to Hendersonville.

Water Issues

The waste-water discharges from pulp, paper, and board manufacturing plants are seriously degrading the water quality of the Pigeon River. The French Broad and some of its tributaries are scenic rivers with high recreation potential which cannot be fully utilized because of lack of

access and because of debris and pollution. The pollution is from municipalities and industries and from the development of second homes in upstream areas. Sediments are among the main detractors of the esthetic aspects of the mountain streams. Sediments are often caused by unsound land-use practices.

Related Land Issues

The average annual urban flood damages in the problem area are estimated at $3.8 million. Asheville experiences average annual damages in excess of $100,000. Because of one industrial plant, Pisgah Forest also has average annual flood damages over $150,000. About 61,000 acres of farmland are frequently subjected to flooding. A considerable threat to human life is present because of flash floods. The scenic upland areas have attracted numerous second homes whose development, without adequate planning, has greatly decreased the esthetic value of these areas. The rugged terrain of the area requires careful and sound land-use practices to prevent large increases in erosion. These sound land-use practices have often not been followed for highway construction, second-home development, logging operations, and farming.

Institutional and Financial Issues

Land-use planning in the French Broad problem area has been piecemeal and generally limited to the cities. The problems of the area require planning to limit development in flood plains and to regulate development of the scenic areas to prevent the destruction of their esthetic aspects. Land-use practices must be improved to prevent high erosion rates and to decrease sediment loads in the streams. No flood control structure exists in the area because of local opposition. Without these structures the regulation of flood-plain development becomes even more critical.

Adverse Effects

The random development of scenic upstream areas for second homes has lowered the esthetic value of these areas and lowered the water quality of the mountain streams by the addition of sediment and domestic wastes. The otherwise scenic Pigeon River has been degraded for many uses by industrial pollution. However, its water quality should improve with the addition of future treatment facilities.

The urban flood damages are very high in this area and can be expected to climb much higher unless more effective flood-plain ordinances, including regulations outside of city limits, are added and strictly enforced. By the year 2000, urban damages are expected to average $5.4 million annually. The recreation industry is thriving in the French Broad Basin, and it could be expanded. Deteriorating water quality and haphazard development, however, are threatening both the present industry and its expansion. Some of the best farmland in the Tennessee Region, supporting high-value horticulture, fruit, and vegetable farms, is threatened by the increasing frequency of flooding. The development of upstream areas has altered the drainage characteristics, leading to more frequent floods.

Problem Area 4: Little Tennessee-Hiwassee

Description

This problem area includes the drainage areas of the Little Tennessee River above mile 33.6 and the Hiwassee River above 34.4, which includes the drainage area of the Ocoee River. The area is about 90 miles long by 60 miles wide, and includes 3,978 square miles. The area includes extremely rugged terrain with numerous gorges and canyons and also broad, open, hilly valleys. The terrain of the Little Tennessee Basin is generally more rugged than in the Hiwassee Basin. The problem area includes part of Tennessee, North Carolina, and Georgia.

The area enjoys one of the highest average annual rainfalls in the United States, and the rugged terrain leads to high streamflows. The average streamflows of the Little Tennessee and Hiwassee Rivers at the exit points of the problem area are about 3,200 and 2,700 mgd, respectively. There are 26 principal dams in the area used for hydroelectric power generation, but the reservoirs behind several of the dams are relatively small. Ground-water yields in the area range from 0.5 to 1.25 mgd per square mile.

The population of the ten-county approximation of the area, covering 3,784 square miles, is 121,000. There is no town in the area with a population greater than 2,500.

Water Issues

Although there are no water supply problems in the area, several conflicts arise over the use of the water resource. Several dams were constructed in the upstream areas to make full use of the available flows for hydroelectric power generation. Recreational interests would like to use the resultant lakes for recreation, but the fluctuating lake levels, due to power and flood-control operations, limit their recreation value. Whenever water releases from the dams are stopped entirely, as happens occasionally, all white water downstream from the dams ceases immediately. Such problems are not apparent on the Little Tennessee or Hiwassee Rivers, where the upstream impoundments of Chilhowee and Appalachia Dams provide high quality recreational experiences. A recent agreement between TVA and the State of Tennessee will provide sufficient flow below the powerhouse on the Hiwassee River for recreation for trout fishermen and canoeists. This agreement alleviates a problem that existed previously.

The discharge from the deep reservoirs during periods of thermal stratification ordinarily contain low levels of dissolved oxygen which adversely affect the streams' water quality. Sediment levels are high in some areas because of agricultural and some mining activities. However, low oxygen discharges and heavy sediment loads are not characteristic of the Little Tennessee and Hiwassee Rivers, both of which have high oxygen levels from unstratified reservoir discharges. Because their watersheds emanate in the heavily forested Cherokee and Nantahala National Forests, silt and sediment are not problems. The Ocoee River, however, does receive a tremendous sediment load in Tennessee as it passes

through the Copper Basin. Chemical spills are not uncommon and poorly treated industrial wastes further degrade the stream. Where the Ocoee River is diverted from its streambed through a tunnel and wooden flue and tributary streams provide the only flow to the stream channel, the water quality is excellent and aquatic life thrives.

Related Land Issues

Twenty-seven communities have average annual flood damages exceeding $1,500. Total average annual damages in all communities are $480,000. About 90,000 acres of farmland are frequently flooded. About 36 square miles of land around Copperhill, Tennessee, were denuded of vegetation by air pollution during the 19th century because of the open roasting of copper ore. The resultant erosion and continuing air pollution have prevented reforestation of part of the area. The rugged terrain of much of the area increases its susceptibility to erosion when sound land-use practices are not followed for highway construction, second-home development, logging operations, and farming.

Institutional and Financial Issues

The conflict over the operation of the dams in the upper reaches of the basin is a primary problem. Another conflict arises from local resentment over the Federal Government's purchase of private land for inclusion in the national forests. Because of the rugged terrain, most of the developable land is in the flood plain. Careful planning is necessary to limit flood damages and prevent the loss of lives due to flash flooding.

Adverse Effects

The conflicts between power generation and recreational interests need to be resolved to allow efficient utilization of the area's resources. The full potential of both cannot be simultaneously developed, and the use of the resources for one will lower the potential of the other. The piecemeal development of the area will lead to greater flood damages, expected to reach $450,000 for annual urban damages by the year 2000, and a continuing deterioration of the water quality of the streams, further lowering recreation potential. The water quality of the Ocoee River should improve with better treatment facilities; however, sediments are expected to continue to degrade the streams downstream of the Copperhill area.

Problem Area 5: Emory

Description

The Emory problem area is the drainage area of the Emory River. It is a leaf-shaped area approximately 40 miles wide and 40 miles long and covers 865 square miles. The topography includes some of the most rugged scenery in the southeast. At the western part of the area, near the rim of the basin, the land is less rugged and is mostly used for agriculture. The problem area is totally in Tennessee.

The Emory Basin does not have an adequate supply of water despite an average flow in the Emory of about 1,100 mgd. The quantity of flow varies greatly so that the minimum flow is less than 0.1 mgd. The central part of the area is wilderness. The eastern part is located near the Clinch River where there is an adequate supply of water. The people in the western part of the country experience water shortages because the streams often go dry and the ground water is inadequate and unreliable.

The two-county approximation of the area covering 1,217 square miles has a population of 38,000. The only two towns in the area with populations greater than 1,000 are Harriman and Crossville.

Water Issues

The water supplies available in the western part of the basin are generally unreliable. Streams commonly go dry during the summer, and during extended dry periods ground-water yields decline below the demands. Crossville was forced to construct a reservoir when ground water proved unreliable; but, since it is near the rim of the basin, it has a very small watershed. Some utility districts in Morgan County experience considerable water supply difficulties during droughts. The low stream-flows provide little or no dilution of treated waste-water, allowing the Obed River, a national scenic river, to be polluted by the discharge of treated municipal waste. Runoff from mined areas is polluting the area's streams.

Related Land Issues

Average annual flood damages exceed $1,000 in four communities of the area.

Although part of the Obed River system has been declared a national scenic river, other stretches of the Obed River, Clear Creek, and Daddys Creek deserve this status but have not been designated as part of the national scenic river system. Past mining activity has badly marred the scenic quality of part of the basin, and the potential exists for further mining activity in the scenic areas not protected as scenic rivers. An even greater threat to the scenic and wild areas is piecemeal development, primarily by recreation interests and for second homes.

Institutional and Financial Issues

There is considerable conflict between coal mining and conservation interests over the status of various stretches of the Obed River, Clear Creek, and Daddys Creek. Private landowners and developers have also fought against the classification of some reaches as a national scenic river.

Adverse Effects

Average annual urban flood damages are expected to reach $166,000 by the year 2000 unless a more vigorous program of flood-plain regulation

is pursued. Unless the conflicts over the scenic river status are resolved, those areas can expect to lose their scenic and wilderness value. Improved treatment of municipal wastes is expected to reduce the damage to water quality from Crossville, but other developments in the upper reaches of the basin could add pollutants and sediment to the streams unless strict regulation of development occurs.

Problem Area 6: Chattanooga

Description

This problem area is the Chattanooga SMSA, consisting of three Georgia counties and three Tennessee counties covering a total of 2,109 square miles. The area consists of some very rough terrain and high bluffs, but also of wide valley floors and some uplands of rolling hills.

Since the Tennessee River with an average flow of over 23 bgd runs through the center of the area, the surface water resources are plentiful. There are two major reservoirs in the area; both are located on the Tennessee River. The limestone formations under the valley floors commonly produce wells with yields in excess of 1.0 mgd.

The population of the SMSA is about 393,000. The city of Chattanooga, Tennessee, has a population of 138,000. The next two largest cities--East Ridge and Red Bank-White-Oak--with populations of 21,000 and 14,000 respectively, are adjacent to Chattanooga.

Water Issues

Although most of the area has a plentiful water supply, some communities located near the rim of the Tennessee Basin, primarily in Marion County, Tennessee, experience recurring water shortages. Municipal and industrial waste discharges in the heavily industrialized Chattanooga vicinity have produced some of the most polluted streams in the region. Navigation on the Tennessee River plays an important part in the economy of the Tennessee Region. The increased barge traffic is expected to cause serious delays in locking through Chickamauga Dam between the years 1985 and 2000.

Related Land Issues

Average annual urban flood damages are estimated at over $3.5 million. About 56,000 acres of farmland are frequently flooded. The area has a rapidly growing population, and urban development is expanding into areas that were sparsely populated. Unsound land-use practices by some developers are increasing erosion and adding sediments to formerly clear streams. There are many scenic areas in the area; some are being threatened by piecemeal residential expansion.

Institutional and Financial Issues

There has been resistance to the enforcement of flood-plain ordinances in Chattanooga, which sustains most of the area's flood damages, and to the construction of such local physical flood-control structures as levees. As a result, most of the flood plain has been developed. The increasing population is also encroaching on scenic upland areas. The large number of industries and the growing population require strict enforcement of discharge regulations to improve the poor water quality of the area's steams.

Adverse Effects

If a planned local flood-control project is completed at Chattanooga, average urban flood damages are still expected to reach $4.1 million by the year 2000. The project is expected to save over $520,000 per average year. Unless more active pollution abatement policies are pursued, some area streams will continue to be impaired for aquatic life, recreation, and as a water supply. Other streams will suffer from increased sediments unless sound land-use practices are followed. Scenic areas will be lost to piecemeal development without effective areawide planning.

Problem Area 7: Buffalo River

Description

The Buffalo River is a 124-mile river in west-central Tennessee. The problem area consists of the river and its adjacent lands. The average flow of the river is over 700 mgd. Throughout most of the reach of the river, its valley is relatively flat, and the terrain rises to about 300 feet above the river at a distance of from 2 to 3 miles on either side.

Only two incorporated communities are located in the area--Linden and Lobelville--which have populations of 1,070 and 820, respectively. The rest of the area is farmland or woods.

Water Issues

Domestic waste-water discharges lower the water quality of the Buffalo River, adversely impacting on aquatic life and recreation and impairing its potential status as a scenic river. Bank erosion is adding excess amounts of sediments to the river.

Related Land Issues

Much of the Buffalo River's flood plain is farmland, while the higher elevations are wooded. The upper reach of the river is a State scenic river and is being studied as a potential national scenic river. The remaining reach is also being proposed as a national scenic river. Bank erosion is lowering the scenic value of the area. Floods are frequent.

Institutional and Financial Issues

Various local and outside interests are in conflict over the river's potential designation as a scenic river.

Adverse Effects

Unless the conflicts over the status of the Buffalo River are resolved, the water quality of the river and the scenic qualities of the adjacent land will continue to deteriorate.

Problem Area 8: Locks at Pickwick and Kentucky Dams

Description

This problem area consists of the inadequate capacity of the navigation locks through Kentucky and Pickwick Landing Dams on the Tennessee River.

Institutional and Financial Issues

Traffic delays are increasing because of the growing barge traffic. The completion of the Tennessee-Tombigbee Waterway, connecting the Tennessee River ports to the Gulf of Mexico by a much shorter route, is expected to add even more traffic, especially at Pickwick Landing. Federal funding will be needed for additional lock capacity.

Adverse Effects

An additional lock has been authorized at Pickwick Landing Dam, and design funds have been appropriated. This will alleviate the most critical locking problems, but delays can be expected to increase. The situation at Kentucky Dam should not become critical during the near future.

Summary

The Tennessee Region has ample land and water resources to provide for an expanding economy with a quality environment. Its varied terrain has resulted from several geologic forces. The high average rainfall in the region provides an adequate water supply, with a few isolated exceptions, throughout the region. The region enjoys a moderate climate, with few extremes in either hot or cold temperatures. The growing season varies, primarily with elevation, from about 170 to 220 days in length. Natural resources include large tracts of moderate to good farmland; extensive forests in the eastern portion; coal, phosphate, and other minerals; an abundance of fresh water; and a variety of fish and wildlife.

While three cities have populations over 100,000 each, most citizens of the region live in the smaller cities and towns or in rural locations. The region has a diversified economy, with a slightly larger percentage of manufacturing employment than in the Nation. The manufacturing industry is varied and scattered throughout the region, with a heavy concentration at Chattanooga, Tennessee. Agricultural earnings constitute only about 3 percent of the region's total, but they are, nevertheless, important to some areas. Service-type industrial employment is growing, while mining is of great importance in Virginia and in some other areas.

Seven large and numerous small rivers feed the Tennessee River as it makes its U-shaped course through the region. Parts of seven States are drained, including 54 percent of Tennessee and smaller parts of Alabama, Georgia, Kentucky, Mississippi, North Carolina, and Virginia. The Tennessee River and the lower segments of the Clinch and Hiwassee Rivers provide inland navigation. The rivers, lakes, and numerous mountain streams provide a variety of recreational opportunities.

Water is withdrawn from the streams, lakes, and ground for a variety of uses, but between about two-thirds in 1975 to three-fourths in 2000 of the amount withdrawn is used or will be used by steam electric plants. About 4 percent of the water withdrawn is presently consumed; however, this percentage is expected to increase to 18 percent by the year 2000, while water withdrawn is expected to decrease by 19 percent. Restrictions on polluting discharges will require cities and industries to change their patterns of water use and to reuse more of the water withdrawn. The overall water supply situation in the region is excellent.

Despite the generally favorable situation with respect to water and related land resources, problems exist. The most severe are those associated with water quality, flooding, erosion and sedimentation, land- and water-use conflicts, local water supply, and navigational lock capacity.

Water and land problems are generally more severe in the upstream areas in the eastern part of the region and near Chattanooga at the center of the region. Water pollution is at its worst at the manufacturing centers and in upstream areas where paper and pulp plants are located. Flooding is a problem throughout the region and is most severe in the east where the rugged terrain has limited the amount of developable land and encouraged building in the flood plain. Water supply shortages are

very localized and generally limited to areas near the basin rim. Occasional shortages occur farther downstream because of conflicts in water use. These conflicts occur among recreation, hydroelectric power generation, and industrial water supply users.

Conclusions and Recommendations

This section consists of conclusions and recommendations concerning the resolution of severe water and related land problems within the region. The recommendations and conclusions are divided into nine areas pertaining to (1) Level B studies, (2) scenic rivers, (3) planning studies, (4) land reclamation, (5) endangered species, (6) point sources of pollution, (7) navigation, and (8) research.

Level B Studies

The problems in the Little Tennessee-Hiwassee and the French Broad problem areas are interdisciplinary and of such complexity that intermediate planning is needed to guide implementation studies.[1] The problems are also of a nature that any major planning studies should include agencies at Federal, State, and local levels. Consequently, both the Little Tennessee-Hiwassee and the French Broad problem areas are delineated as potential Level B study areas within the Tennessee Region. A Level B Proposal to Study (PTS) for the Hiwassee-Little Tennessee River Basins was submitted to the Water Resources Council for possible funding in fiscal year 1978. This PTS was resubmitted for fiscal year 1979 and continues to have regional priority.

A Level B PTS for the Virginia portion of the Tennessee Region was submitted for fiscal year 1977 and again for fiscal year 1978. However, the proposal was not recommended for funding by the Water Resources Council, and funding was not provided. The major problems in the area remain unresolved, and additional comprehensive planning is required. The Commonwealth of Virginia is currently developing a State water plan that would include the entire area in the PTS as it was developed along State lines. Since this study is underway and Level B priority in the Tennessee Region is being given to the Little Tennessee-Hiwassee and French Broad problem areas, it is recommended that further consideration of a Level B study for the Virginia area of the region be delayed until the results of these other studies start to become available. Should a Level B study continue to be warranted, consideration might be given to other study boundaries. For instance, one alternative might be a study area that consists of the Holston and the Clinch-Powell problem areas.

Scenic Rivers

Ninety-eight of the total 144 miles of the Obed River, Clear Creek, and Daddys Creek meet the general criteria set forth in the Wild and Scenic Rivers Act. However, the bill to amend the Wild and Scenic Rivers Act added only 40 of the 98 miles as a component of the National Wild

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[1] Intermediate between framework studies (Level A) are implementation studies (Level C).

and Scenic Rivers system. Local landowners and the Cumberland County Court did not endorse wild and scenic river status for the privately held portions of the Obed and its tributaries lying in Cumberland County. It is recommended that the U.S. Department of the Interior, Bureau of Outdoor Recreation, the Tennessee Department of Conservation, and TVA be charged with the task of attempting to develop a plan that has local support for adding more or all of the remaining reaches of those streams which meet the criteria for wild and scenic river status. All components of an acceptable plan should be included in a bill for addition to the Obed River as part of the national system.

The Southeastern Regional Office of the Bureau of Outdoor Recreation has recommended a National Wild and Scenic Rivers program for the Buffalo River, and this recommendation is hereby endorsed by the Tennessee Regional Assessment.

Planning Studies

Guidance in flood protection planning should be provided to communities as needed, to assist them in interpreting and applying technical data available from Federal Insurance Administration (FIA) studies and other sources. Some 100 towns or cities have been identified where average annual flood damages are estimated to exceed $1,500 in terms of 1975 dollars. Planning studies are recommended for these places and other locations where they are essential to prevent unwarranted increases in potential flood damages. Alternative plans should give consideration to both structural and nonstructural measures. Additional stream gages will be needed to support this effort, and it is recommended that the location for these gages be identified and they they be installed and operated as part of the Federal system of gages.

Land Reclamation

A great deal of land needs to be reclaimed in the Tennessee Region. Most of the problem stems from mining activities; however, erosion unrelated to mining is serious in certain areas. There are some unique situations such as Copperhill, where severe deforestation has occurred because of air pollution caused by an industrial process. Ongoing programs are not adequately dealing with this problem, and some type of additional assistance is needed. A plan to restore these sites is needed. It is recommended that USDA develop an inventory of these areas to include parameters describing the extent of land and water affected, the degree of degradation, and a description of any work being done to reclaim the sites. A projection of time required for the site to return to near normal conditions could be an informative part of the inventory. It is recommended that the inventory be kept current.

All coal-producing states in the region have legislation requiring reclamation of strip-mined lands. The major user of coal in the region, TVA, has taken the position that areas damaged by strip-mining can and must be restored, with the cost of restoration included in the price of the mineral. Hence, current legislation as well as concern shared increasingly by agencies and citizens is judged sufficient to ensure

reclamation of areas which are strip-mined in the future.

Endangered Species

The river muskellunge (Esox masquinongy ohioensis) has been listed as an endangered species by the State of Tennessee along with five other species of fish and 16 species of fresh-water mussels. Restocking programs now underway by the Tennessee Wildlife Resources Agency and Tennessee Technological University should bring the river muskie back to healthy numbers if acid wastes and siltation from strip-mining can be controlled.[1]

Point Source of Pollution

Federal and State programs to reduce water quality degradation from discharges of waste waters from point sources are progressing very well. Significant improvement has already been achieved in the quality of surface waters which were being degraded in this way. Studies are presently underway to determine the feasibility of reducing the mercury and chloride pollution caused by leachate from muck ponds at an abandoned chemical plant site in Saltville, Virginia.

Navigation

Traffic delay problems have been identified at the Kentucky, Pickwick, and Chickamauga locks. The delays at Kentucky and Pickwick are considered to be the most critical. The critical period for the Chickamauga lock is anticipated to come with the completion of the Tennessee-Tombigbee Waterway, which is not expected before 1985 to 2000.

Barge traffic problems at Kentucky lock are under study by the Corps of Engineers and TVA, and an additional lock at Pickwick has been authorized and design money appropriated. Since action is underway to correct the most critical problems and since the critical period for the remaining problem is still some time away, no recommendations seemed needed, and none was developed.

Research

Additional research is needed to better determine the effects on fish and aquatic life of (1) low concentrations of dissolved oxygen in reservoir releases, (2) temperature changes resulting from reservoir releases, (3) varying rates of reservoir releases, and (4) releases of reduced chemical constituents in water from the hypolimnion when stratification occurs. Research is also needed to develop a practical means for controlling aquatic weeds in rivers.

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[1] Newspaper article in the Knoxville News-Sentinel, "Muskies: The 'Other' Rare Fish," by Sam Venable, page D-10, July 3, 1977.

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THE NATION'S WATER RESOURCES — 1975-2000

Volume 4: Tennessee Region

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The purpose of the Council is to encourage the conservation, development, and utilization of water and related land resources on a comprehensive and coordinated basis by the Federal government, States, localities, and private enterprises with the cooperation of all affected Federal agencies, States, local government, individual corporations, business enterprises, and others concerned.