CHAPTER 3 - AFFECTED ENVIRONMENT

3.1 INTRODUCTION

This chapter presents descriptions of the environmental resources and local features that could be affected by one or more of the flood remediation alternatives. Some resources or features unlikely to affect or be affected by the alternatives (e.g., climate and geology) are described rather briefly. Other resources or features identified during the scoping process as important issues are described in much more detail. The arrangement of topics and the numbering of sections in this chapter is the same as the arrangement of these topics and section numbers used in Chapter 4 (Environmental Consequences).

3.2 CLIMATE, GEOLOGY, AND SOILS

Climate

Climate in the Nolichucky River watershed ranges from wet, cool summers and cold winters in the higher elevations of the North Carolina and Tennessee mountains to a moderate, four-season climate at the lower elevations of Greene, Cocke, Washington, and adjacent counties in east Tennessee. The Greeneville agriculture experimental station, maintained by the University of Tennessee, is the most representative weather station for the area around Nolichucky Reservoir; however, only air temperature and precipitation are recorded at that station. The Bristol (Tri-Cities) Airport observation site, maintained by the National Weather Service, is the most representative reporting station for the Nolichucky Reservoir area for winds, humidity, and other recorded weather events. A weather station on Mount Mitchell, operated by Mount Mitchell State Park, provides pertinent information for the upstream part of the Nolichucky River basin.

Average annual precipitation ranges from 44 inches in east Tennessee to 78 inches in the higher elevations of North Carolina. Precipitation in east Tennessee ranges from 2 to 5 inches per month, while precipitation in the higher elevations normally results in 5- to 8-inch monthly totals year-round. The largest amount of 24-hour precipitation observed during a 56-year period at the Greeneville experimental station was 5.03 inches on

May 7, 1984. The extreme 24-hour precipitation observed over a 30-year period at Mount Mitchell was 16.50 inches that occurred during tropical storm Frances on September 8, 2004. High rainfall amounts have occurred in very localized parts of the watershed (for example, at scattered locations northeast and south of Greeneville in early August 2001); however, those events have not included the gauging stations.

Minimum and maximum temperatures in the higher elevations of North Carolina normally range from 19 to 35 degrees Fahrenheit (°F) in January and 53 to 67°F in July. Average annual snowfall normally ranges from 10 inches in east Tennessee to 81 inches at Mount Mitchell. Extreme 24-hour snowfall at the Greeneville experimental station over a 56-year period was 13 inches during the "Storm of the Century" on March 13, 1993. Extreme 24-hour snowfall at Mount Mitchell over a 27-year period was 3 feet also on March 13, 1993. Annual pan evaporation measured from April to October averages 35 inches in east Tennessee and 37 inches in the lower elevations of North Carolina. The probability of a tornado occurring at Nolichucky Dam is approximately once in 2,946 years. Table 5 presents more detailed climate normals for the east Tennessee part of the Nolichucky watershed, and Table 6 presents detailed climate normals for the Mount Mitchell area.

Table 5. Climate Statistics Representing the Nolichucky Reservoir Area

Month	Temperature Normals Greeneville Exp.Station (1971-2000)[1]		Precipitation Normals Greeneville Exp. Station (1971-2000)[1]		Average Snowfall Greeneville Exp. Station (1948-2003)[2]		Average Relative Humidity (%) at four selected times of the day (EST) Bristol WSO AP (1971-2000)[3]				Average Thunderstorm Days Bristol WSO AP (1943-2003)[3]	Average Days with Heavy Fog Bristol WSO AP (1943-2003)[3]	Average Wind Speed Bristol WSO AP (1964-2003)[3]		Prevailing Wind Direction Bristol WSO AP (1973-2003)[3]
	F	C	inches	cm	inches	cm	01	07	13	19	Days	Days	mph	km/h	Degrees
Jan	33.4	0.8	3.53	9.0	3.7	9.4	78	82	63	67	0.3	3.3	6.2	10.0	240
Feb	36.8	2.7	3.48	8.8	2.8	7.1	76	81	59	62	0.9	2.5	6.4	10.3	240
Mar	44.5	6.9	4.31	10.9	1.3	3.3	73	81	53	56	2.0	1.4	7.2	11.6	240
Apr	52.1	11.2	3.72	9.4	0.4	1.0	73	82	50	52	3.5	1.6	6.7	10.8	240
May	61.1	16.2	4.47	11.4	0.0	0.0	84	89	55	61	6.6	3.8	5.4	8.7	240
Jun	69.3	20.7	4.22	10.7	0.0	0.0	88	90	58	64	8.1	4.0	4.7	7.6	240
Jul	73.5	23.1	4.73	12.0	0.0	0.0	90	92	61	67	9.0	4.8	4.3	6.9	230
Aug	72.0	22.2	3.80	9.7	0.0	0.0	90	94	60	69	7.3	7.2	3.9	6.3	060
Sept	65.7	18.7	3.25	8.3	0.0	0.0	90	94	58	70	3.3	5.4	4.3	6.9	060
Oct	53.7	12.1	2.35	6.0	T	T	86	91	53	66	0.8	5.1	4.2	6.8	060
Nov	44.4	6.9	3.00	7.6	0.5	1.3	80	85	56	65	0.4	2.9	5.4	8.7	240
Dec	36.4	2.4	3.42	8.7	1.4	3.6	79	83	62	68	0.2	3.2	5.8	9.3	240
Annual	53.6	12.0	44.28	112.5	9.8	24.9	82	87	57	64	42.4	45.2	5.4	8.7	240

Source: Data from the University of Tennessee Greeneville Experimental Station and the Bristol Airport (Tri-Cities) National Weather Service Station.

[1] Climatography of the United States No. 81 Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1971-2000, Tennessee, National Oceanic and Atmospheric Administration.

[2] Greeneville Experimental Station Snow Earthinfo SD Central 2004 (Summary), 56 years 1948-2003.

[3] Local Climatological Data 2003 Annual Summary for Bristol WSO AP (Tri-Cities), National Weather Service, National Climatic Data Center, National Oceanic and Atmospheric Administration

Symbols and Abbreviations

% = Percent
°C = Degree Celsius
°F = Degree Fahrenheit
cm = Centimeters
EST = Eastern Standard Time
Exp. = Experimental
km/h = Kilometers per Hour
mph = Miles per Hour
WSO AP = Weather Service Office, Airport

Table 6. Climate Statistics Representing the Upper Nolichucky River Watershed

Month	Temperature Normals at Mount Mitchell (1953-1965 and 1988-2004)		Precipitation Normals at Mount Mitchell (1948-1962 and 1988-2004)		Average Snowfall at Mount Mitchell (1953-1965 and 1988-2004)	
	°F	°C	inches	cm	inches	cm
Jan	26.7	-2.9	6.9	17.5	18.1	46.0
Feb	28.9	-1.7	6.6	16.8	19.6	49.8
Mar	33.1	0.6	7.7	19.6	15.2	38.6
Apr	42.4	5.8	6.2	15.7	6.6	16.8
May	50.6	10.3	5.4	13.7	1.3	3.3
Jun	56.3	13.5	6.1	15.5	0.0	0.0
Jul	59.7	15.4	6.6	16.8	0.0	0.0
Aug	59.0	15.0	7.2	18.3	0.0	0.0
Sept	54.5	12.5	7.9	20.1	0.0	0.0
Oct	46.2	7.9	5.3	13.5	1.1	2.8
Nov	37.0	2.8	5.9	15.0	4.4	11.2
Dec	29.3	-1.5	6.2	15.7	14.7	37.3
Annual	43.6	6.4	78.0	198.1	81.0	205.7

Source: Data from Mount Mitchell State Park.

Symbols and Abbreviations
°C = Degree Celsius
°F = Degree Fahrenheit
cm = Centimeters

Geology

The Nolichucky River watershed occupies parts of two physiographic provinces. Upstream parts of the watershed (upstream from about Dry Creek at River Mile 87.5) and the higher slopes along the eastern side of the river are in the Blue Ridge Province. The remainder of the watershed and most of the length of the Nolichucky River are located in the Valley and Ridge Province (DeBuchananne and Richardson 1956).

The approximate one-third of the watershed located in the Blue Ridge Province consists of high, steep ridges with narrow valleys. Streams that originate in the Blue Ridge Province are underlain mostly by rocks of Precambrian and Cambrian age. The mountains in this part of the watershed rise 1,000 to 2,500 feet above the adjacent lowlands. The western part of the Blue Ridge Province is characterized by long, narrow individual ridges, aligned parallel to the trend of the range and similar to the more subdued ridges of the Valley and Ridge Province. The main mountain mass along the Tennessee-North Carolina state line is a mix of peaks and valleys that appear to have no regular pattern (Luther 1977).

According to Hardeman (1966), the oldest Precambrian rocks in the region include these formations: Roan Gneiss (consisting of gneiss, hornblende, migmatite, mica, schist, and amphibolite), Cranberry Granite (consisting of granite, migmatite, gneiss, monzonite, diorite, greenstone, mica, schist, and pegmatite), Beech Granite (porphyritic granite), Snowbird Group (consisting of slate, sandstone, graywacke, phyllite, quartzite, and siltstone) and Sandsuck Formation (consisting of shale, sandstone, and quartz-pebble conglomerate). Mica flakes are common in the soils developed from these rocks and are a good indicator of the Precambrian source of the sediment derived from these soils.

Cambrian age rocks in the Blue Ridge Province include the Chilhowee Group (sandstones, siltstones, shale, graywackes, and quartzites), Shady Dolomite, Rome Formation and Honaker Dolomite (all dolomites and limestones) (Ibid).

The Valley and Ridge Province consists of alternating valleys and ridges at the surface that form a more gentle topography and wider valleys than occur in the Blue Ridge Province. This topography reflects varying resistance to weathering of the strongly folded and faulted rocks in this province. The distribution of valleys and ridges in this province also is closely associated with the major streams that drain the area (DeBuchananne and Richardson 1956).

In the Valley and Ridge Province, the Nolichucky River watershed is underlain by formations ranging in age from Middle Cambrian to Late Ordovician. Formations in this area include the Honaker Dolomite, Nolichucky Shale, Maynardville Limestone and the Knox Group. In the area of Nolichucky Reservoir, the river is aligned with the general southwest-to-northeast trend of the Valley and Ridge Province. Rocks under this part of the watershed consist mainly of the Middle Cambrian dolomites, limestones, and shales, while the rocks under the Nolichucky

River between the reservoir and the Blue Ridge Province are principally dolomite and limestone (Hardeman 1966).

Soils

The most common soil classifications in Greene County are various types and phases of Dunmore. These soils range from silt loams to cherty silty clay loams to stony loams. Dunmore soils occur in about 28 percent of the total area in the county (USDA 1958).

Although all soil phases are not considered prime farmland, Dunmore soils also are the most prevalent soils found within the 500-year floodplain around Nolichucky Reservoir, where they occur on about 298 acres (19 percent of the area). These moderately deep to deep soils have developed on the uplands by the weathering of the underlying limestone rock. All of these soils are well-drained and have firm to very firm silty clay subsoils. Slopes are predominantly rolling to hilly, but some are on steep slopes. The silt loams and silty clay loams with slopes less than 12 percent are suitable for agricultural crops. The cherty loams and clays have low fertility and generally are unsuitable for growing crops (Ibid).

The second and third most prevalent types of soils around the reservoir are the different phases of Waynesboro and Nolichucky loams. The Waynesboro loams cover about 240 acres, and the Nolichucky loams cover about 204 acres of the area around Nolichucky Reservoir. The Waynesboro and Nolichucky loams have developed on stream terraces from water-transported materials derived chiefly from shale and sandstone rocks. Other soils that have developed on these stream terraces are Altavista (52 acres), Buncomb (100 acres), State (92 acres), Cumberland (98 acres), and Sequatchie (51 acres). Sequatchie loams are derived from shales and sandstones and are located on the low terraces. The Cumberland soils consist of mixed material; their fine texture indicates that most of the materials were derived from limestone. Altavista, Buncomb, and State soils consist chiefly of materials derived from granite, gneiss, and schist (Ibid).

There are 52 different specific soil classifications within the 500-year floodplain area around Nolichucky Reservoir. A complete description of these soils can be found in the Soil Survey of Greene County, Tennessee (USDA 1958). Soil types covering between 10 and 50 acres in this area include Dewey silty clay loams, Greendale silt loams, Groseclose cherty silt loams, Hamblen fine sandy loams, Lindside silt loams, Litz shaly silt loams, and Pace cherty silt loams.

Approximately 20 percent (about 79,800 acres) of the soils in Greene County are classified as prime farmland (Ibid). These are soils that have the chemical and physical properties to sustain high crop yields economically (Federal Farmland Protection Policy Act 1981). In the 500-year floodplain area around Nolichucky Reservoir, there are 22 different soil types classified as prime farmland (Table 7). These soils occupy about 490 acres, or 20 percent of the area. Soil types represented by more than 50 acres are Congaree loam (71.3 acres), Congaree fine sandy loam (59.6 acres), and Chewacla silt loam (63.4 acres). The Congaree loam is high in fertility and contains a moderate amount of organic matter. The Congaree fine sandy loam and the Chewacla silt loam are moderate in fertility and organic matter. The Congaree soils are suited for high-intensity cropping. The Chewacla soils have restricted internal drainage, but high productivity can be obtained with artificial drainage systems. About 356 acres of these prime farmland soils occur within the 100-year floodplain (Table 7).

The floodplain areas in Greene, Cocke, and Hamblen counties downstream from Nolichucky Dam contain the same types of soils that occur upstream from Nolichucky Dam (USDA 1958; 1944; 1946). In general, the same trend in prime farmland soils also occur downstream (USDA 1999). As in the area upstream from the dam, Congaree prime farmland soils are abundant in the bottomlands along the river. About half of the Nolichucky River floodplain in Cocke County is prime farmland soil (USDA 1944; USEPA 1994).

Table 7. Prime Farmland Soils Within the 500-Year and 100-Year Floodplains Upstream From Nolichucky Dam

Soil Type	Phase	Acres Within the 500-Year Floodplain	Acres Within the 100-Year Floodplain
Altavista loam	undulating	18.9	11.4
Camp loam	level	5.8	4.9
Chewacla silt loam	level	63.4	62.1
Congaree fine sandy loam	level	59.6	53.5
Congaree loam	level	71.3	62.6
Cumberland silt loam	undulating	35.0	9.7
Emory silt loam	level	7.3	3.3
Greendale silt loam	level	37.7	19.7
Hamblen fine sandy loam	level	26.4	17.5
Hermitage silt loam	undulating	2.1	2.1
Lindside silt loam	level	19.5	4.7
Melvin silt loam	level	8.8	6.8
Nolichucky loam	undulating	2.2	0.4
Ooltewah silt loam	level	2.3	0.9
Pace silt loam	undulating	3.7	3.7
Prader silt loam	level	3.6	3.4
Roanoke loam	level	1.8	0.9
Sequatchie loam	level	33.3	33.0
Staser fine sandy loam	level	12.5	11.9
State loam	level	46.5	31.0
Waynesboro loam	undulating	24.7	12.6
Weaver silt loam	level	3.7	----
Totals		490.1	356.1

3.3 GROUNDWATER

As described in Section 3.2, much of the bedrock in the area drained by the Nolichucky River has been folded; includes a variety of geologic faults; and has been eroded to form high mountains, lower ridges, and valleys. The water content of rain and snow that falls in this watershed ranges from 48 inches per year in east Tennessee to 78 inches per year in the mountains of North Carolina (see Section 3.2). The majority of precipitation runs off the land surface into streams (see Section 3.4). Depending on factors such as land cover and slope, much of the remaining precipitation recharges the groundwater. Groundwater moves down through soil and bedrock until it either flows out onto the land surface or enters deeper bedrock fractures. In areas like the Nolichucky

River basin, the complex geology controls groundwater occurrence, movement, and availability.

In both the Blue Ridge and Valley and Ridge Physiographic Provinces, groundwater occurs in soil, bedrock fractures, and in relatively shallow sand and gravel deposits along the rivers and streams. Typically, there are more open fractures in the rocks closer to ground surface than at depth (Brahana et al. 1986). Groundwater moves along these fractures in the bedrock and through pores in the soils and sediments. In areas not substantially affected by man, groundwater levels tend to be farther from the surface in upland areas and closer to the surface in the valleys.

In the Blue Ridge Province, most of the available groundwater occurs in fractured igneous and metamorphic rocks. In the Ridge and Valley Province, groundwater occurs in interconnected fractures and solution channels, mostly in limestone and dolomite sedimentary rocks. The complex fracturing and faulting of the formations in these provinces, accompanied by the presence of shale and siltstone beds in some areas (which can limit the movement of groundwater), has produced a number of small, independent, or poorly connected groundwater systems within the bedrock. The Honaker dolomite is one of the most productive formations in the area, although well yields can be highly variable (Maclay 1962; DeBuchananne and Richardson 1956).

In both of these physiographic provinces, relatively recent deposits of sand and gravel in valleys and along streams can be valuable sources of water. In the Blue Ridge Province, these deposits include material derived from the natural weathering of the bedrock formations. In the Valley and Ridge Province, these deposits include material derived from the weathering of the local bedrock and sediment from the Blue Ridge Province transported into the area by streams.

Water flow through a soil or sediment depends to some degree on the sizes of the particles in the ground and how well they are sorted. Many of the crystalline metamorphic and igneous rocks in the Blue Ridge Physiographic Province tend to form relatively permeable soils and sediments. In many places around Nolichucky Reservoir, thick deposits of these sediments are very permeable. Based on the sizes of particles found in sediments deposited along the Nolichucky Reservoir (see Section 3.4) the hydraulic conductivity of these materials ranges from 2.3×10^{-7} to 9.5×10^{-4} centimeters per second (cm/s). Micaceous, silty sand appears to be the sediment with highest hydraulic conductivity values (on the order of 10^{-4} cm/s). Even though these appear to be very small numbers, they indicate that water can move relatively easily through most of the sandy sediments found along the Nolichucky River.

Nolichucky Dam and the water held behind it have raised the groundwater level in the area surrounding the reservoir. The water in the reservoir has filled spaces in the adjacent soil and rock. The reservoir has more effect on the groundwater level near the dam, because that is where the pool level differs most from the original water level in the river. Near the upstream end of the reservoir, the pool level is only slightly higher than the original river channel and the change in the groundwater table is very small. During high-flow events, water flows into the ground from the floodwater all around the reservoir, to return to the reservoir and river after the flood has passed.

Groundwater Quality

Groundwater within the Blue Ridge Province is generally suitable for drinking and other uses, but iron, manganese, and sulfate occur locally in objectionable amounts. The chemical quality of groundwater in the Valley and Ridge province is somewhat variable but is generally suitable for municipal supplies and other purposes. Table 8 presents a summary of typical characteristics of groundwater from these areas.

Table 8. Typical Characteristics of Groundwater in the Blue Ridge and Ridge and Valley Parts of the Nolichucky River System

Groundwater Sources	Water Type	Dissolved Solids (mg/L)	Hardness (mg/L)	pH	Iron (mg/L)
Blue Ridge crystalline and undifferentiated sedimentary rocks	calcium-magnesium bicarbonate	120	63 (soft)	6.7	0.1 (max. 25)
carbonate rocks	calcium bicarbonate	330	280 (very hard)	7.5	0.1 (max. 8)
Valley and Ridge carbonate rocks	calcium-magnesium bicarbonate	330	280 (very hard)	7.4	0.1 (max. 8)
undifferentiated rocks	calcium bicarbonate	150	100 (moderately hard)	7.4	0.1 (max. 14)

Source: Information summarized from Trapp and Horn (1997).

Abbreviations
max. = maximum
mg/L = milligrams per liter

Groundwater Use

The Tennessee Department of Environment and Conservation (TDEC), Division of Water Supply, maintains a database of known wells across the state. Unfortunately, this database was not established until the mid-1980s and does not include preexisting wells. In an attempt to identify active wells located near Nolichucky Reservoir, TVA compared the locations of existing public water service lines in the area (obtained from the Glenn Hills Utility District) and the locations of residences, barns, and other structures observed on recent aerial photographs. The results indicate that as many as 100 buildings exist within one-half mile of the reservoir but more than 300 feet from a public water line. Based solely on the distance to a water line, these buildings might be assumed either to be served by a groundwater well or do not have a water source. This information has not been verified through contacts with residents or the property owners.

3.4 SURFACE WATER AND SEDIMENTATION

Surface Water

As indicated in Section 3.2, the Nolichucky River arises in the highlands of the Blue Ridge Physiographic Province in North Carolina and flows westward across part of the Valley and Ridge Province in Tennessee. The drainage area consists of 1,756 square miles, located in parts of Avery, Mitchell, and Yancey counties in North Carolina; and Cocke, Greene, Hamblen, Jefferson, Unicoi, and Washington counties in Tennessee (Figure 1). The Nolichucky River is formed where the North Toe and Cane rivers flow together in North Carolina, southeast of Erwin, Tennessee. From there, the river flows in a general southwestern direction for 110 miles to where it empties into the French Broad River near White Pine, Tennessee. Major tributaries in the Nolichucky River system are Lick Creek (mouth at River Mile 16.0, drainage area 266 square miles); Big Limestone Creek (mouth at River Mile 68.6, drainage area 79.2 square miles); North Indian Creek (mouth at River Mile 94.2, drainage area 59.3 square miles); South Indian Creek (mouth at River Mile 95.6, drainage area 81.0 square miles); Cane River (mouth at River Mile 110.8, drainage area 158 square miles); and North Toe River (mouth at River Mile 110.8, drainage area 442 square miles) (TVA 1970).

The water in the Nolichucky River, as measured at the TVA gauging station near Lowlands, Tennessee (River Mile 10.3), is moderately hard (average hardness of 79 milligrams per liter [mg/L]), with moderate alkalinity (average total alkalinity of 67 mg/L) (TVA 1993). The average pH in 1993 was 7.8, and dissolved oxygen levels ranged from 87 to 100 percent of saturation. Average organic nitrogen (0.223 mg/L), nitrate+nitrite nitrogen (0.56 mg/L), total phosphorus (0.075 mg/L), and dissolved orthophosphate (0.024 mg/L) were slightly above average concentrations found at 12 stream monitoring sites across the Tennessee Valley.

In 1971 there were 29 domestic wastewater discharges into the Nolichucky watershed, including seven municipal treatment facilities and 22 schools, hospitals, and other institutions. At that time, there also were 22 industrial discharges into the watershed, including eight plants producing mica, feldspar, kaolin, or olivine in the Spruce Pine mining district within the North Toe and South Toe watersheds (TVA 1971).

Many of the discharges in existence in 1971 were inadequately treated, and water quality problems occurred in the streams into which they flowed. At that time, the identified water quality impacts included low dissolved oxygen from organic loading, bacterial contamination, color (from dyeing operations), nuisance odors, sedimentation, and high concentrations of ammonia, turbidity, metals, nitrates, phosphates, and other contaminants. Most of these problems were considered to be local issues in the late 1960s and early 1970s (Ibid).

Two sections of the Nolichucky River suffered from substantial impacts to water quality according to the 1971 report. One of these impacts was related to the discharge of the American Enka plant, at Nolichucky River Mile 7.5. Downstream from the discharge of this synthetic fiber plant, low dissolved oxygen, low pH, and toxic levels of zinc were measured. In addition, "essentially no fauna were found in a 5-mile reach of the river below the Enka waste discharge" (Ibid).

The more extensive and substantial impacts to water quality in the Nolichucky watershed discussed in the 1971 report were related to sedimentation associated with the surface mines in the North Toe River watershed. A biological survey conducted by TVA in 1969 found that a 30-mile reach of the North Toe River was "essentially a biological desert," apparently related to high turbidity and sediment deposition (TVA 1971: 27). The river was characterized as "biologically degraded" as far downstream as Nolichucky Dam (River Mile 46), and was "impacted" for an additional 22 miles downstream from the dam. As stated in the report, "This constitutes a river reach degraded in water quality for a distance of more than 135 miles." In 1971, these identified sedimentation impacts did not violate state water quality criteria then in effect either in North Carolina or Tennessee.

In 2000, 73 industrial and 47 domestic discharges existed in the Nolichucky River watershed (USEPA 2000). Domestic discharges include single-family homes and municipal treatment plants for Burnside, Erwin, Greeneville, and other communities. Industrial discharges include mines and mineral processing operations, a nuclear fuel processing facility, textile and furniture manufacturing plants, and others. All of these discharges are regulated under the NPDES programs administered by Tennessee and North Carolina.

Surface Water

As indicated in Section 3.2, the Nolichucky River arises in the highlands of the Blue Ridge Physiographic Province in North Carolina and flows westward across part of the Valley and Ridge Province in Tennessee. The drainage area consists of 1,756 square miles, located in parts of Avery, Mitchell, and Yancey counties in North Carolina; and Cocke, Greene, Hamblen, Jefferson, Unicoi, and Washington counties in Tennessee (Figure 1). The Nolichucky River is formed where the North Toe and Cane rivers flow together in North Carolina, southeast of Erwin, Tennessee. From there, the river flows in a general southwestern direction for 110 miles to where it empties into the French Broad River near White Pine, Tennessee. Major tributaries in the Nolichucky River system are Lick Creek (mouth at River Mile 16.0, drainage area 266 square miles); Big Limestone Creek (mouth at River Mile 68.6, drainage area 79.2 square miles); North Indian Creek (mouth at River Mile 94.2, drainage area 59.3 square miles); South Indian Creek (mouth at River Mile 95.6, drainage area 81.0 square miles); Cane River (mouth at River Mile 110.8, drainage area 158 square miles); and North Toe River (mouth at River Mile 110.8, drainage area 442 square miles) (TVA 1970).

The water in the Nolichucky River, as measured at the TVA gauging station near Lowlands, Tennessee (River Mile 10.3), is moderately hard (average hardness of 79 milligrams per liter [mg/L]), with moderate alkalinity (average total alkalinity of 67 mg/L) (TVA 1993). The average pH in 1993 was 7.8, and dissolved oxygen levels ranged from 87 to 100 percent of saturation. Average organic nitrogen (0.223 mg/L), nitrate+nitrite nitrogen (0.56 mg/L), total phosphorus (0.075 mg/L), and dissolved orthophosphate (0.024 mg/L) were slightly above average concentrations found at 12 stream monitoring sites across the Tennessee Valley.

In 1971 there were 29 domestic wastewater discharges into the Nolichucky watershed, including seven municipal treatment facilities and 22 schools, hospitals, and other institutions. At that time, there also were 22 industrial discharges into the watershed, including eight plants producing mica, feldspar, kaolin, or olivine in the Spruce Pine mining district within the North Toe and South Toe watersheds (TVA 1971).

Many of the discharges in existence in 1971 were inadequately treated, and water quality problems occurred in the streams into which they flowed. At that time, the identified water quality impacts included low dissolved oxygen from organic loading, bacterial contamination, color (from dyeing operations), nuisance odors, sedimentation, and high concentrations of ammonia, turbidity, metals, nitrates, phosphates, and other contaminants. Most of these problems were considered to be local issues in the late 1960s and early 1970s (Ibid).

Two sections of the Nolichucky River suffered from substantial impacts to water quality according to the 1971 report. One of these impacts was related to the discharge of the American Enka plant, at Nolichucky River Mile 7.5. Downstream from the discharge of this synthetic fiber plant, low dissolved oxygen, low pH, and toxic levels of zinc were measured. In addition, "essentially no fauna were found in a 5-mile reach of the river below the Enka waste discharge" (Ibid).

The more extensive and substantial impacts on water quality in the Nolichucky watershed discussed in the 1971 report were related to sedimentation associated with the surface mines in the North Toe River watershed. A biological survey conducted by TVA in 1969 found that a 30-mile reach of the North Toe River was "essentially a biological desert," apparently related to high turbidity and sediment deposition (TVA 1971: 27). The river was characterized as "biologically degraded" as far downstream as Nolichucky Dam (River Mile 46), and was "impacted" for an additional 22 miles downstream from the dam. As stated in the report, "This constitutes a river reach degraded in water quality for a distance of more than 135 miles." In 1971, these sedimentation impacts did not violate state water quality criteria then in effect either in North Carolina or Tennessee.

In 2000, 73 industrial and 47 domestic discharges existed in the Nolichucky River watershed (USEPA 2000). Domestic discharges include single-family homes and municipal treatment plants for Burnside, Erwin, Greeneville, and other communities. Industrial discharges include mines and mineral processing operations, a nuclear fuel processing facility, textile and furniture manufacturing plants, and others. All of these discharges are regulated under the NPDES programs administered by Tennessee and North Carolina.

Under present water quality regulations, state governments are required to identify beneficial uses of all surface waters and to establish criteria that specify when those uses are, or are not, being supported. State designated uses for some of the larger streams in the watershed are shown in Table 9 (North Carolina Department of Environment and Natural Resources 2006, Tennessee Department of Environment and Conservation 2006). The states also publish a 303 (d) list of streams that are impaired and do not fully support their designated uses. Table 9a shows the three listed streams in North Carolina that are in the Nolichucky River Watershed (North Carolina Department of Environment and Natural Resources 2006a). Tennessee lists 108 streams or stream segments in the Tennessee portion of the Nolichucky Watershed that do not fully meet their designated uses (Tennessee Department of Environment and Conservation 2006a). Table 9a identifies several of the larger Tennessee streams that are listed.

Table 9. State Designated Uses for the Larger Streams in the Nolichucky River Watershed

State/Stream	Description	Designated Uses [1]
North Carolina		
Nolichucky River	From source to NC-TN stateline	B
North Toe River	From source to 0.2 mile upstream of Pyatt Creek	WS-V, Tr
North Toe River	From 0.2 mile upstream of Pyatt Creek to Town of Spruce Pine water supply intake	WS-IV, Tr
North Toe River	From Town of Spruce Pine intake to Mitchell Co. SR 1187	C, Tr
Cane River	From source to 1.0 mile upstream of Burnsville water supply intake	WS-II, Tr, HQW
Cane River	From 1.0 mile upstream from Burnsville intake to intake	WS-II, Tr, HQW
Cane River	From Burnsville intake to Nolichucky River	C, Tr
Jacks Creek	From source to North Toe River	C
South Toe River	From Source to U.S. Hwy. 19E	B, Tr, ORW
Big Crabtree Creek	From source to North Toe River	C, Tr
Tennessee		
Nolichucky River	Mile 0.0 to 5.3	DOM, IWS, FAL, REC, LWW, IRR, HQW
Nolichucky River	Mile 5.3 to 7.7	IWS, FAL, REC, LWW, IRR
Nolichucky River	Mile 7.7 to 100.8 (TN-NC stateline)	DOM, IWS, FAL, REC, LWW, IRR, HQW
Bent Creek	Mile 0.0 to origin	FAL, REC, LWW, IRR, HQW
Lick Creek	Mile 0.0 to 49.0	DOM, IWS, FAL, REC, LWW, IRR
Lick Creek	Mile 49.0 to origin	IWS, FAL, REC, LWW, IRR
Little Chucky Creek	Mile 0.0 to origin	FAL, REC, LWW, IRR, HQW
Sinking Creek	Mile 0.0 to origin	FAL, REC, LWW, IRR, HQW
Big Limestone Creek	Mile 0.0 to origin	FAL, REC, LWW, IRR
North Indian Creek	Mile 0.0 to origin	DOM, IWS, FAL, REC, LWW, IRR, HQW

[1] **North Carolina uses:** B-primary and secondary contact recreation, fishing, wildlife, fish, and aquatic life, agriculture; C-secondary recreation, fishing, wildlife, fish, and aquatic life, agriculture; WS-water supply classes from most protected (I) to least protected (V) with all classes protected for Class C uses; Tr-trout waters; ORW-Outstanding Resource Waters; HQW-high quality waters. **Tennessee uses:** DOM-domestic water supply; IWS-industrial water supply; FAL fish and aquatic life; REC-recreation; LWW-livestock watering and wildlife; IRR-irrigation, HWQ-high quality waters (only applies to portions of the stream).

Table 9a. Larger Streams in the Nolichucky River Watershed That do not Fully Support Their Designated Uses

State/Stream	Size (Miles)	Causes Sources	
North Carolina			
North Toe River	11.3	Turbidity, Impaired biological integrity	
Jacks Creek	8.5	Impaired biological integrity	
Cane River	3.5	Turbidity	
Tennessee (Partial Listing)			
Nolichucky River (8 sections)	84.8	Loss in biological integrity due to siltation, Escherichia coli	Agriculture, Pasture Grazing, Source in Other State,
Bent Creek	13.7	Escherichia coli	Pasture Grazing
Lick Creek (7 sections)	69.5	Nutrients, Loss in biological integrity due to siltation, Other habitat alterations, Escherichia coli, Habitat loss due to alteration in stream-side or littoral vegetative cover	Pasture Grazing
Sinking Creek	23.4	Escherichia coli	Pasture Grazing
Big Limestone Creek (2 sections)	11.9	Nitrate, Phosphorus, Loss in biological integrity due to siltation, Escherichia coli	Pasture Grazing
Davy Crockett Lake	383 acres	Loss in biological integrity due to siltation	Agriculture, Source in Other State,
North Indian Creek	8.0	Loss in biological integrity due to siltation	Discharges from Municipal Separate Storm Sewer System

Sedimentation

As previously described, sedimentation has been a significant problem in the Nolichucky River system for many years. Relatively little sedimentation data have been collected over the years, but enough information is available to show that the large volume and long duration of the sediment load in the Nolichucky watershed is unique in the Tennessee River system. In recent decades, regulations affecting the sediment sources have resulted in declining sedimentation rates and improvements to water quality; however, so much sediment remains in the river channel that high sedimentation rates in parts of the Nolichucky River are likely to continue for many more years.

Sediment transported by a stream can be considered to exist in two categories: suspended sediment and bed load. Suspended sediment consists of the silt and smaller particles (particles smaller than 0.075 millimeters in diameter) that can be moved downstream within the flowing water. Bed load consists of the larger particles (mostly sand and gravel) that are rolled, tumbled, bounced, or slid along the bottom of the stream by the force of the water. It is important to distinguish between bed load and suspended sediment, because different techniques are required to sample each category, larger and smaller size particles are moved down the river at different rates, and different particle sizes often are deposited in different places.

The smaller particles that make up suspended sediment only settle out when the water slows or becomes still; the smaller the particles, the longer it takes for settling to occur. Under most circumstances, this means that most suspended sediment will move through a river system at essentially the same speed as the flowing water. Except in large areas of still water, such as in lakes or reservoirs, most of the suspended material that does settle out also is likely to be resuspended and moved on downstream during the next high-flow event.

In contrast, bed load material is moved only when the force of the water is strong enough to start the particles moving and keep them rolling or tumbling down the river. Bed load material moves more slowly than the flow of water, settles out in any area with slower flows, and can remain in place for long periods of time between flow events with enough energy to move it. Larger bed load particles, such as cobbles and boulders, also can shield smaller particles from the force of the flowing water. When large quantities of bed load materials are introduced into a stream, it could take decades before all of that material is transported out of the river system.

Dams and other obstructions in a stream also have effects on the movement of suspended sediment and bed load materials. In the first few miles downstream from a dam, the energy in the river channel is concentrated in a much shallower depth than it was upstream and, typically, is capable of moving larger particles than are being carried into the channel. In most streams (including the Nolichucky River), the channel just downstream from a dam contains much less bed load material than would be there if the dam were not present. Outside the channel of most streams (including the Nolichucky River), the slower water flow has less energy and heavier particles settle out when the moving water cannot continue to support their weight.

Because of the differences in the ways suspended and bed load sediments are moved, substantial caution is required when interpreting sedimentation data from any stream, including the Nolichucky River. Suspended sediment measurements alone do not adequately describe the total sediment load in the river, nor does the amount of material that has settled in Nolichucky Reservoir. If some activity introduces a wide range of new sediment particle sizes into the river, measuring the amount of suspended sediment might provide an indirect estimate of the severity of the bed load impacts. In contrast, if an ongoing sediment source was eliminated, the remaining suspended sediment load from that source would be carried away relatively quickly, but the final amount of bed load material from that source would be transported out of the area over a much longer length of time.

Suspended Sediment

In 1935-1937, and again in 1963-1965, TVA measured suspended sediment loads at a number of locations across the Tennessee River system, including the Nolichucky River at Embreeville (River Mile 89.0) (TVA undated). The 1930s study was intended to establish baseline sediment transport rates and to estimate the sedimentation rates that would occur in various reservoirs. Revisiting some of the same sites in the 1960s was intended to provide updated sedimentation information related to the effects of land-use changes that had occurred in the Valley. These studies showed that, in the 1930s, the annual yield of suspended sediment from the Nolichucky watershed (981 tons per square mile) was the second highest of the stations sampled (the highest was 1,097 tons per square mile in the Elk River at Prospect, Tennessee). Other watersheds yielded from 145 to 796 tons per square mile.

In the 1960s, the suspended sediment yield at the Nolichucky River site was measured as 708 tons per square mile. At least part of this change was considered to be due to drier weather conditions during the study period, so the actual sediment load in the Nolichucky watershed was estimated to be less than 10 percent lower than it had been in the 1930s. During the 1960s sampling period, the other stations yielded suspended sediment levels as much as 50 percent lower than their estimated yields in the 1930s (with the effects of different weather patterns taken into account). Because of the reductions in yield at the other stations, the Nolichucky sediment yield was the highest of the watersheds studied in the 1960s. The second-highest yield, 411 tons per square mile, was encountered at a site on the Duck River in Tennessee (TVA undated).

TVA has not collected any sediment transport data in the Nolichucky River system since the 1960s; however, TDEC has a water quality monitoring station on the Nolichucky River at River Mile 98.5, 9.5 river miles upstream from the TVA Embreeville site. TDEC collected suspended sediment data at River Mile 98.5 during a two-year period in the mid-1960s, and from 1972 through 1994.

The 1960s data from the TDEC site are similar to the TVA data for the same period at Embreeville, and the more recent data from River Mile 98.5 suggest a progressive decline in suspended sediments at that site since the 1960s (Figure 5). This trend suggests that sediment control measures at the mine sites and the reclamation of mined land have been effective in reducing suspended sediment levels in the river.

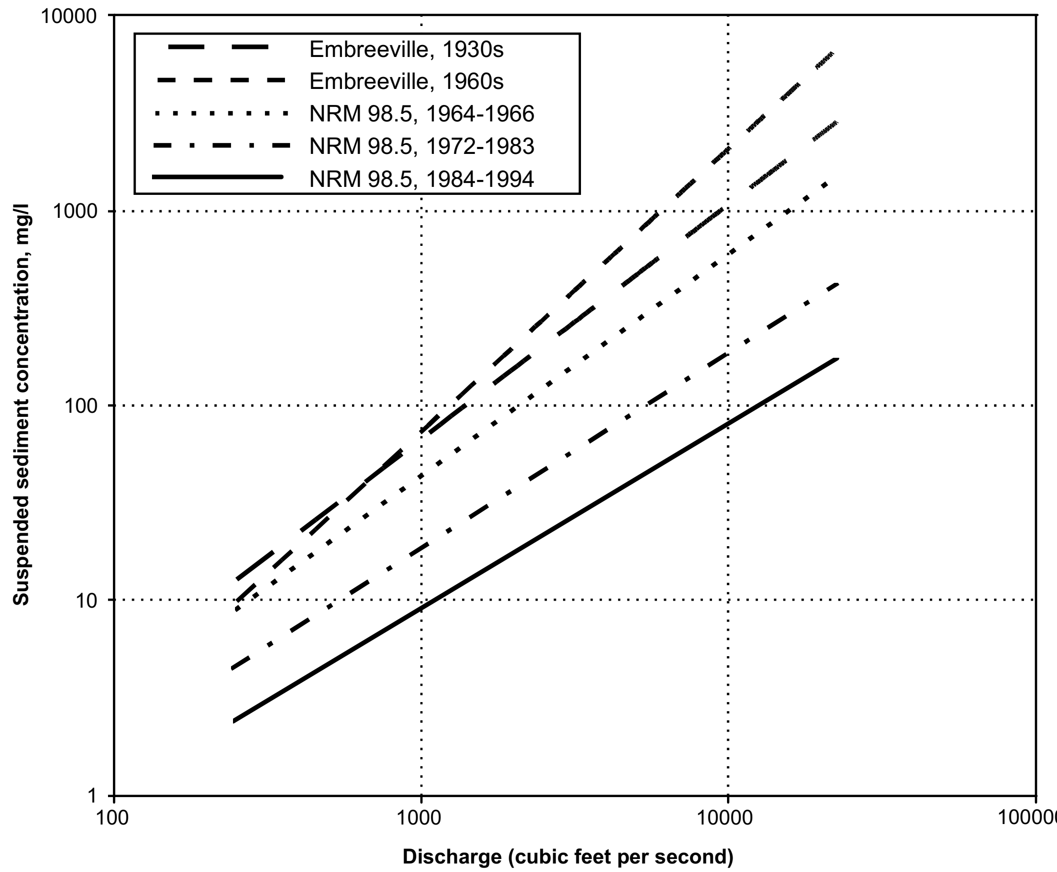

Figure 5. Suspended Sediment Concentrations as a Function of Stream Discharge at Two Sites Upstream From Nolichucky Reservoir

Very little suspended sediment data are available from the Nolichucky River downstream from Nolichucky Dam. Few stations have been sampled, and no single station has been monitored for long enough to demonstrate long-term trends clearly. The stations where monitoring has occurred also are separated by many river miles, so any comparisons could be affected by flows from tributaries with suspended sediment concentrations different from those in the main river.

Keeping these limitations in mind, some qualitative comparisons can be made between stations located upstream and downstream from the reservoir that were sampled during the same time periods. During the same set of storm events in the 1930s, TVA sampled suspended sediments at Jones Bridge (River Mile 10.7, near Morristown) and near Embreeville (River Mile 90.5). Similarly, some of the TDEC data collected in the 1970s at River Mile 98.5 can be compared with a station downstream from Nolichucky Dam (River Mile 45.7) that was sampled during the same period. Other TDEC data collected at River Mile 98.5 in the 1990s can be compared with a station at Hale Bridge (River Mile 28.0) that also was sampled during that decade. These three paired sets of data are plotted on Figure 6.

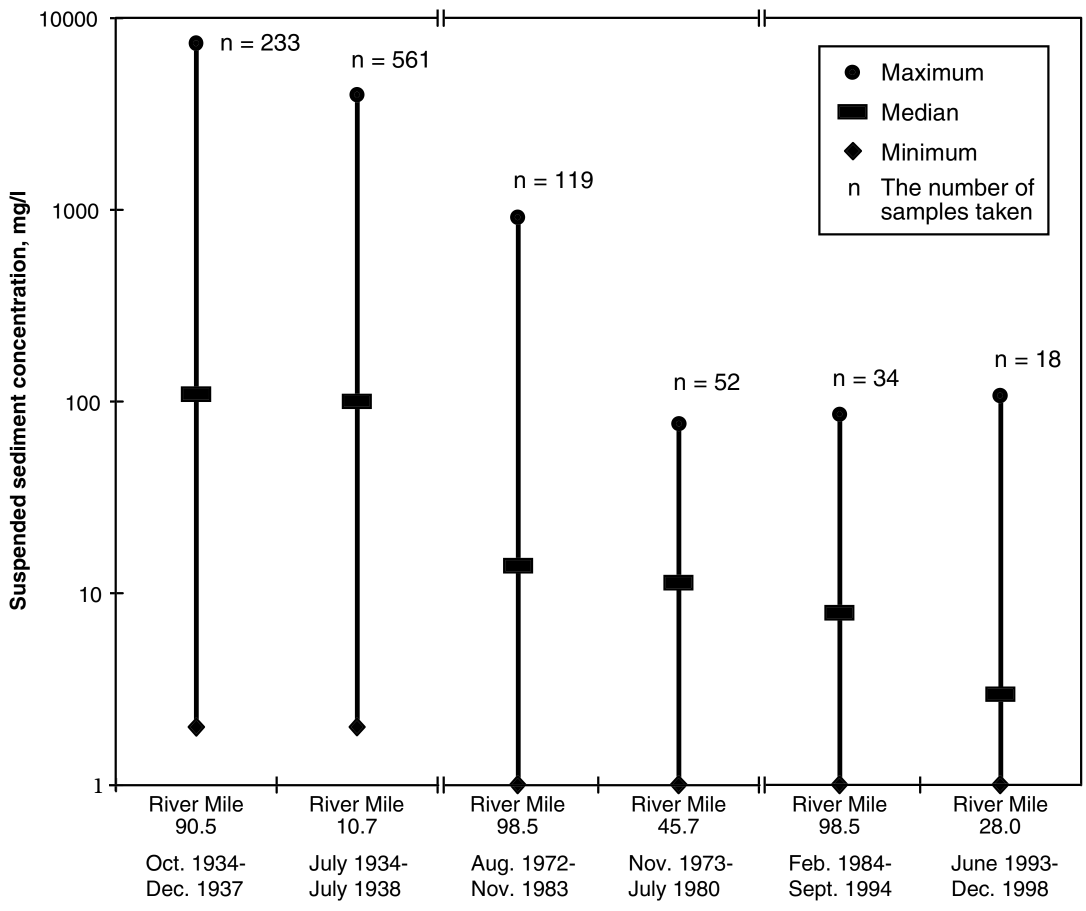

Figure 6. Comparison of Suspended Sediment Concentrations Upstream and Downstream from Nolichucky Dam During Three Time Intervals Between the 1930s and the 1990s.

The information presented in Figure 6 indicates that the suspended sediment concentrations downstream from Nolichucky Dam also apparently decreased substantially from the 1930s to the 1970s, and may have decreased some more from the 1970s to the 1990s. In addition, each of these three comparisons indicates that, during the same time periods, the suspended sediment concentrations were only slightly higher at the upstream sites than they were at the downstream sites. These data suggest that, even in the 1930s when Nolichucky Reservoir had more ability to retain sediment than it does now, the reservoir had relatively little effect on suspended sediment concentrations in the river (however, especially in the 1930s, the data could have been affected by sediment coming from tributaries between the dam and the Morristown sampling site). If the reservoir does not have much effect on the amount of suspended sediment in the river, all of these data could suggest that agriculture and other nonpoint sources now supply at least as much of the total suspended sediment load in the Nolichucky River as is coming from the mining sources in North Carolina.

Bed Load

Information about the movement of bed load sediment also is important to understand the complete sedimentation picture affecting Nolichucky Reservoir. Unfortunately, no historic bed load data are available from this river system, and it could take several years to collect useful quantitative bed load data. To complete this part of the EIS, TVA gathered anecdotal and semi-quantitative information about the composition of bed load deposits in the Nolichucky River. This information, along with data about historical sedimentation rates in the reservoir, can serve to describe the present condition of bed load materials in the river.

People who have had reason to watch conditions in the Nolichucky River over a long period of time have helped describe how sand and other bed load deposits have changed over the years, and have given some insight into how the Nolichucky compares with other rivers in the region. Ken Chase, a former TVA contractor, indicated that a point bar near River Mile 97, which had been used by local residents as a recreation area because of its sandy beach, is now mostly covered with cobbles. According to

Terry Phillips, U.S. Geological Survey (USGS), and Ken Earl, Greeneville Water-Sewer Commission, the operation of both the USGS stream gage at Embreeville (River Mile 89.0) and the Greeneville water supply intake (River Mile 57.2) routinely are affected by sediment levels higher than on other comparable streams. Mr. Phillips, however, indicated that a sand bar near the gage, where he had taken water measurements in the past, no longer is there. In a recent EA, TVA noted that the Nolichucky Sand Company wanted to start dredging sand at Nolichucky River Mile 49-50, in part, because “In recent years, river flows and flood events have not been adequate to replenish the sand at [a previously approved dredging site at] River Mile 60.0” (TVA and USACE 1999). These observations suggest that bed load deposits upstream from Nolichucky Reservoir and the amount of bed load entering Nolichucky Reservoir, though larger than in other similar streams in the region, are becoming smaller than they were in the past.

Between 2004 and 2006, Vulcan Materials, Inc., which acquired Nolichucky Sand Company, removed an average of 70,000 ton per year (Steve Whittenburg, Vulcan Materials, Inc., personal communication, August, 2006). Based on this removal rate, there appears to be roughly an equivalent annual accumulation of sediment.

One way to evaluate bed load transport conditions in a stream is to study the size of the particles that make up the stream bottom at several sites along its length. This technique involves comparing the average diameter of particles in the streambed at each site with the average particle size that the energy in the flowing water would be capable of transporting from that site (Buffington and Montgomery 1999). For example, if the average particle size at a site is small (say, sand size) but the stream has enough energy to move much larger particles (cobbles), we could conclude that a lot of bed load sediment is available at that site, and the total amount of bed load material the stream is able to move is controlled by the amount of energy available in the moving water. Such a site would be considered to be transport-limited, because much more sediment is available than the energy in the water can move. If, however, the streambed consists mostly of cobbles and the energy available in the flowing water could only transport sand-size particles, we can conclude that relatively little bed load material is available and the site would be considered to be supply-limited.

For this evaluation, TVA studied the sizes of particles in the sediment and calculated bed load particle-size transport capabilities at five sites in the Nolichucky River basin and at a reference site outside of the watershed. These sites were located at North Toe River Mile 27.0, Cane River Mile 1.6, Nolichucky River Mile 92.5 (3.5 miles upstream from the USGS Embreeville gage), Nolichucky River Mile 31.6 (downstream from Nolichucky Dam near Easterly Bridge), and Little River Mile 35.3 (Blount County, Tennessee, at the edge of Great Smoky Mountains National Park). The North Toe River site is located immediately downstream from most of the surface mines near Spruce Pine, North Carolina, and the Cane River site is in an adjacent watershed with mixed land uses, but including little or no mining. The River Mile 92.5 site represents river conditions not far upstream from Nolichucky Reservoir, and the site at Easterly Bridge represents river conditions not far downstream from Nolichucky Dam. The Little River site is located on a relatively pristine stream in the same physiographic province and provides a basis of comparison.

Analysis of the particle-size measurement data, along with observations made at the sites, indicate that more sand bed load is present in the North Toe River downstream from the historic mining area compared to the other sites. From observations of sand bars, sandy stream banks, and the stratification of sediment in the channel, we can infer that the amount of sandy bed load moving through the system was much higher in the past.

By contrast, very little bed load sediment was observed in the channel at River Mile 31.6, not far downstream from Nolichucky Dam, where the riverbed was predominately bedrock. This suggests that Nolichucky Reservoir traps most of the material that is transported as bed load. Modeling indicates that sand and fine gravel can be carried out of the reservoir during high flows; however, little deposition of that material occurs at this site.

Reservoir Sediments

TVA measures sedimentation rates by conducting periodic surveys of the bottom surface elevations in each reservoir. On Nolichucky Reservoir, bottom elevation surveys have been conducted on nine occasions since 1938. The information collected during these surveys can be used to calculate the amount of sediment that had accumulated in the reservoir at each of these times (Figure 7). The two lines on this figure indicate the changes in the amount of sediment present below the elevation of the top of the dam (1,240.9 feet above mean sea level) and below the arbitrary upper limits of the survey (at elevation 1,251.0).

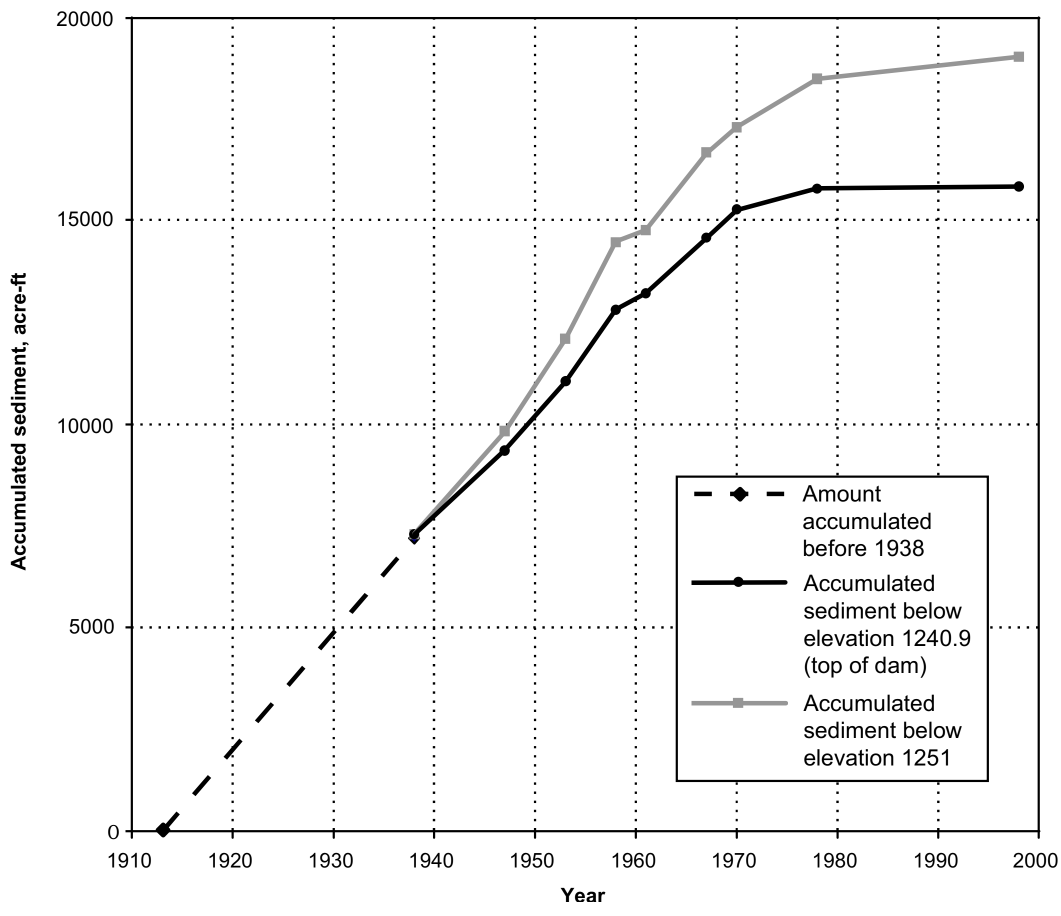

Figure 7. Volume of Accumulated Sediment in Nolichucky Reservoir, Calculated From TVA Transect Surveys

Figure 7 also shows changes in sedimentation rates over the 61-year sampling period. Sediment accumulated at a fairly uniform rate at least between 1938 and 1970, averaging 268 acre-feet per year below elevation 1,240.9 and 304 acre-feet per year below elevation 1,251. Starting around 1970, the sedimentation rates began decreasing. Between 1970 and 1978, the average annual rate was 67 acre-feet below elevation 1,240.9 and 140 acre-feet below elevation 1,251.0. Between 1978 and 1998, the average annual rate was 2.3 acre-feet below 1,240.9 and 28 acre-feet below elevation 1,251. The reduction in sedimentation rates can be explained in at least two ways: a decreasing sediment supply coming from the upstream sources and/or the decreasing trapping efficiency of the reservoir as its volume has been reduced by earlier sediment accumulations. More than likely, both of these recent changes have contributed to the decreased sedimentation rates.

Through natural processes, any stream tends to develop a channel that holds the flow of a 1.5- to 2-year recurrence interval flood, and tends to deposit sediment to form a relatively level floodplain along this channel (Leopold 1994). This process is well advanced around Nolichucky Reservoir. The river flow has developed a distinct channel (200 to 400 feet wide) in the sediment deposits, and the steep hillsides and bluffs that define the narrow valley of the Nolichucky River limit the potential for this channel to migrate. Natural levees have formed along the sides of this channel, and low areas located between the levees and the valley wall are the only remaining places where sediment can be deposited in or along the reservoir.

In 1938, when the first sediment measurements were taken, the water volume in Nolichucky Reservoir was calculated to be 10,275 acre-feet below elevation 1,240.9 and 18,895 acre-feet below elevation 1,251.0. In 1998, when the most recent survey was conducted, the remaining volume in the reservoir was calculated to be 1,716 acre-feet below elevation 1,240.9 and 7,156 acre-feet below elevation 1,251.0. The river channel occupies about 3,600 acre-feet along the length of the reservoir, so the actual remaining volume below elevation 1,251.0 is about 3,560 acre-feet, and no additional volume remains below elevation 1,240.9.

Sediment Analyses

The physical and chemical characteristics of the sediments in Nolichucky Reservoir were determined by analyzing core samples collected at five land-accessible sites (River Miles 46.0, 46.6, 47.7, 56.6, and 60.4). These sediment samples were collected using a stainless steel hydraulic push-coring device containing a plastic insert liner, approximately 2 inches in diameter. The intent was to sample down to the original streambed or as deep as possible at each site. The sample cores extended down to the anticipated depth of the original streambed at River Miles 46.6 (31 feet), 56.6 (16 feet), and 60.4 (10 feet); however, rock obstructions limited sample depths at River Mile 46.0 to 26 feet and at River Mile 47.7 to 36 feet. The sampling site at River Mile 46.0 was located just upstream from Nolichucky Dam where the sediment was anticipated to be approximately 60 feet deep. The obstruction encountered at 26 feet may indicate that the coring device had hit part of the concrete plug installed in 1972 or 1973 adjacent to the turbine penstocks.

Each of the cores was examined for the presence of radionuclides in the field as it was collected. All the field screening results for the radionuclides were equivalent to background levels. One sample from each core also was sent to the TVA Western Area Radiological Laboratory in Muscle Shoals, Alabama, to be analyzed for gross alpha and gross beta activity and for selected gamma isotopes. Alpha, beta, and gamma results indicated values normally found in nature. No radioactivity above what is normally found in nature was present in these samples.

All sediment cores were characterized in the field using the Unified Soil Classification System (American Society for Testing and Materials 1993). Results of these characterizations indicated the sediments were predominantly micaceous sand with minor amounts of silt and clay. Five composite samples of apparently similar sediments collected at various sites and depths were submitted to S&ME Inc. of Knoxville, Tennessee, for more detailed characterization. Table 10 presents the sediment descriptions and grain-size data provided by S&ME Inc. and, essentially, confirms the grain-size characterizations made in the field.

Other intervals from the cores collected at all five locations were sent to the TVA Environmental Chemistry Laboratory in Chattanooga, Tennessee, for chemical analysis. Historical information and existing data suggesting potential contaminant sources were used to identify a list of metals, volatile and semivolatile organics, pesticides, and polychlorinated biphenyls (PCBs) to be included in the chemical analyses.

Table 10. Results of Grain-Size Analysis of Composite Sediment Samples From Nolichucky Reservoir

Sample No.	**1**	**2**	**3**	**4**	**5**
Description	Brown micaceous silty sand	Brown micaceous silty sand	Yellow/ brown sandy silt	Brown micaceous silty sand	Brown micaceous sandy elastic silt
Percent Gravel	0	0	0	0	0
Percent Sand	80.05	87.61	44.64	84.79	47.31
Percent Silt	15.69	7.75	31.00	11.57	36.11
Percent Clay	4.26	4.64	24.36	3.64	16.58

The results of the chemical analyses are summarized in Table 11. In all 15 samples (including 2 duplicate samples), none of the volatile and semivolatile organics, pesticides, or PCBs were found at levels above the detection limits associated with the standard analytical tests that were used. Similarly, of the 26 metals analyzed, 8 (antimony, boron, cadmium, mercury, molybdenum, nickel, silver, and strontium) were not encountered at levels above the method detection limits.

Eighteen metals were present in the sediment at levels above the method detection limits (Table 11). All of these metals occur naturally in the rocks and soils of this region (Tennessee Department of Conservation 1973). Five of the metals present above the detection limits in some or all of the samples have been studied well enough to identify effect concentration guidelines (USEPA 2002). The consensus-based threshold and probable effect concentrations (TEC and PEC values, respectively) for these five metals (arsenic, chromium, copper, lead, and zinc) also are presented in Table 11. As indicated in the USEPA guidelines (Ibid), the TEC value

Table 11. Chemical Analyses Results From Segments of Sediment Core Samples Collected at Various Sites in Nolichucky Reservoir During 2000

River Mile Location	46.0	46.0	46.0	46.0	46.6	46.6	46.6	46.6	46.6	47.7	47.7	47.7	47.7	56.6	60.4
Segment Depth (feet)	**0-4**	**8-16**	**20-31***	**20-31***	**0-8**	**8-12**	**12-16**	**20-26***	**20-26***	**0-8**	**12-16**	**20-24**	**32-36**	**8-16**	**0-10**
Metal (TEC; PEC)															
Aluminum	9200	12000	19000	19000	-	-	-	31000	31000	-	-	-	-	-	
Arsenic (9.79; 33.0)	1.2	1.4	3.6	5.1	<5.0	<5.0	<5.0	<0.65	4.8	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Barium	49	70	120	110	110	120	90	170	170	55	79	70	100	87	30
Beryllium	<0.1	<0.1	0.21	0.20	-	-	-	0.83	0.61	-	-	-	-	-	
Calcium	690	1200	1800	1700	-	-	-	830	840	-	-	-	-	-	
Chromium (43.4; 111)	12	15	22	21	18	20	21	31	28	12	13	12	13	11	6.7
Cobalt	<5.0	5.2	8.6	8.0	-	-	-	6.4	<5.0	-	-	-	-	-	
Copper (31.6; 149)	4.7	8.1	15	14	-	-	-	16	15	-	-	-	-	-	
Iron	10000	12000	18000	18000	-	-	-	33000	31000	-	-	-	-	-	
Lead (35.8; 128)	18	21	30	29	43	49	14	8.7	7.2	20	20	19	23	17	14
Magnesium	1900	2300	3100	2900	-	-	-	4000	4000	-	-	-	-	-	
Manganese	190	290	510	460	-	-	-	300	240	-	-	-	-	-	
Selenium	<1.0	<1.0	<1.0	<1.0	<5.0	<5.0	<5.0	<1.0	<1.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Silicon	240	360	460	450	-	-	-	-	-	-	-	-	-	-	
Tin	<5.0	<5.0	8.1	<5.0	-	-	-	<5.0	<5.0	-	-	-	-	-	
Titanium	540	670	890	870	-	-	-	1300	1300	-	-	-	-	-	
Vanadium	15	20	34	32	-	-	-	82	71	-	-	-	-	-	
Zinc (121; 459)	61	69	100	98	-	-	-	69	66	-	-	-	-	-	

Notes: All analytical results, threshold effect concentrations (TEC) and probable effect concentrations (PEC) are presented in milligrams per kilogram (mg/kg) dry weight.

PCBs, pesticides, volatile and semivolatile organics, antimony, boron, cadmium, mercury, molybdenum, nickel, silver, and strontium were included in the analyses but were not detected in any of these samples.

TEC and PEC values as identified in USEPA 2002 (see text)

* = Duplicate analyses were conducted from these two core samples.
\- = Constituent not analyzed in this sample.
< = Less than

identifies a sediment concentration below which most organisms are unlikely to be affected adversely by that substance, while the PEC value identifies a concentration above which adverse effects of the substance would be expected on at least some types of organisms. The band between these two values represents concentrations that should be evaluated more carefully to determine if adverse effects could occur.

Four of the five metals present in the Nolichucky Reservoir sediments for which effect concentration guidelines have been established were detected at levels lower than the TEC value (arsenic, chromium, copper, and zinc). Only two of the 15 sediment core samples for lead indicated concentrations slightly above the TEC value (35.8 mg/kg) but well below the PEC value (128 mg/kg). The average of the lead results from all 15 samples (22.3 mg/kg) is below the TEC value. The presence of lead in soil is not necessarily indicative of contamination. The concentration of lead in uncontaminated/natural soil is primarily related to the geology of the parent material from which the soil was formed. According to Lindsay (1979), the common range of lead in soils is from 2 to 200 mg/kg. Shacklette and Boerngen (1984) report that the amount of lead in surficial soils of the United States range from <10 to 700 mg/kg. Lead (Pb) content of agricultural soils ranges from >1 to 135 mg/kg with a median value of 11 mg/kg (Holmgren et al. 1993). Inner-city neighborhoods in most major U.S. cities have mean or medium soil Pb concentrations in excess of 1,000 mg/kg with reported values as high as 50,000 mg/kg (Angle et al. 1974; Johnson et al. 1975; Bornschein 1986; Mielke et al. 1989, and Madhaven et al. 1989). Most of the elevated lead levels in urban soils are assumed to be derived from various anthropogenic sources: industrial emissions, vehicular emissions, and exterior lead paint.

Lead has a tendency to form compounds of low solubility with the major anions found in natural water. In the natural environments, the divalent form (Pb2+) is the stable ionic species of lead. Hydroxide, carbonate, sulfide, and, more rarely, sulfate may act as solubility controls in precipitating lead from water. A major fraction of lead carried by river water is expected to be in an undissolved form. This can consist of colloidal particles or larger undissolved particles of lead carbonate, lead oxide, lead hydroxide, or other lead compounds incorporated in other components of surface particulate matter from runoff (Xintaras 1992). The ratio of lead in suspended solids to lead in dissolved form has been found to vary from 4:1 in rural streams to 27:1 in urban streams (USEPA 1989).

Lead may mobilize from soil when lead-bearing soil particles run off to surface waters during precipitation events. The downward movement of lead from soil by leaching is extremely slow under most natural conditions (National Science Foundation 1977). The conditions that induce leaching are the presence of lead in soil at concentrations that approach or exceed the adsorption capacity of the soil, the presence of soil materials that are capable of forming soluble chelates with lead, and a decrease in pH of the leaching solution.

Although 2 of the 15 sediment core samples indicated lead concentrations slightly above the TEC value, available literature suggests that concentrations of lead in sediment of the Nolichucky River are well within natural ranges expected for this region.

3.5 AQUATIC LIFE

The fish, insects, and other aquatic species that live in the Nolichucky River system have been studied from time to time over the years; however, much of that work was focused on demonstrating the effects of excess sediment. More extensive studies on the aquatic life in the river were conducted in the late 1950s (Mullican et al. 1960), in 1980 and 1981 (Ahlstedt 1986; Barr et al. 1986), and in 1998 (Carter et al. 1999). TVA also sampled the aquatic life in part of the Nolichucky River for this evaluation (see Appendix B). Few of these studies have covered the entire length of the river, and none of them have included all of the types of aquatic species that probably occur there. The following discussion, organized by the major groups of aquatic species, focuses on the present status of aquatic life in three general zones along the length of the Nolichucky River: the reach just upstream from Nolichucky Reservoir, within the reservoir pool itself, and in the river from Nolichucky Dam downstream toward its mouth in Douglas Reservoir. Information from previous studies also is presented to indicate how the present communities relate to what was there in the past.

Insects and Other Invertebrates (except Mussels)

During the summer of 2000, TVA sampled the insects and other bottom-dwelling species at five sites on the Nolichucky River. One of these sites, at River Mile 60.5, was located not far upstream from the accumulations of sediment in Nolichucky Reservoir, and another of these sites, at River Mile 50.3, was located in the reservoir pool. The other three sites, at River Miles 42.6, 27.9, and 8.5, were located downstream from Nolichucky Dam.

At each site, biologists used both quantitative and qualitative techniques to sample the variety and abundance of the insects, worms, snails, and other animals that were present. The samples were sorted and identified in the laboratory, and tables were produced listing the presence and abundance of each identified species (or other taxonomic level) that was encountered (see Appendix B).

As summarized in Table 12, a total of 164 bottom-dwelling aquatic species (excluding mussels) was found at the five sampling sites. The most species found at any site (96) came from the location not far downstream from Nolichucky Dam, at River Mile 42.6, while the fewest species (49) were found at the site within the reservoir at River Mile 50.3. Very similar numbers of species (83-88) were found at the three other sites, even though one of those sites was located upstream from the reservoir and the other two were 20 river miles apart, well downstream from Nolichucky Dam.

Modern biologists use details in the results from studies such as this to learn more about the bottom-dwelling animal communities at different locations. A technique called the Benthic Index of Biotic Integrity (IBI), described in Appendix B, compares specific parts of the results from a sampled site to what a site on that type of stream might produce if it were in excellent condition (Kerans and Karr 1994). Evaluated in this way, the bottom-dwelling community at the site in Nolichucky Reservoir (River Mile

Table 12. Summary of the Numbers of Species (and Other Identified Taxa) Encountered During Benthic Invertebrate Sampling at Five Sites on the Nolichucky River During 2000

Sample Locations	Mayflies, Stoneflies, and Caddisflies	Other Insects	Mollusks (Except Mussels)	Other Animals	Overall Totals
River Mile 8.5	26	40	7	15	88
River Mile 27.9	20	46	5	14	85
River Mile 42.6	28	49	3	16	96
River Mile 50.3	12	30	2	5	49
River Mile 60.5	20	49	3	11	83
Group Totals	47	82	9	26	164

Note: Extracted from Appendix B.

50.3) was rated "poor," while all four of the other sites were rated "fair." The parts of the sampling results that contributed to these relatively low ratings at all of the sites were lower than expected overall abundance, much lower than expected percentages of some feeding types, and fewer than expected numbers of some mollusk species. The results from the site in Nolichucky Reservoir rated extremely low on virtually all of the measures, perhaps related to the fact that few stream-dwelling species typically live in the shifting sand substrates that occur at that site (Appendix B).

Two earlier studies include detailed information on the bottom-dwelling species present in the main channel of the Nolichucky River: one conducted in 1954 and 1958 (Mullican et al. 1960) and the other conducted in 1980 and 1981 (Barr et al. 1986). These studies, summarized in Table 13, examined a site at River Mile 60.4 in 1958 and at River Mile 27.8 in 1980-81, essentially the same locations as sites examined in 2000. Two of the other sites examined in the 1950s (at River Miles 7.4 and 11.4) are near a site examined in 2000 (River Mile 8.5).

The overall totals and numbers of species in the various categories included in Tables 12 and 13 suggest that substantially fewer species were encountered at the comparable sites in earlier years than were found there in 2000. For example at River Mile 60.5, the data from 1958 include a total of 36 species, while 86 species were encountered there in 2000. At River Mile 27.8, 61 species were encountered in 1980-81, while 85 species were found there in 2000.

Table 13. Summary of the Numbers of Species (and Other Identified Taxa) Encountered During Benthic Invertebrate Sampling at Sites on the Nolichucky River in Earlier Years

Survey Date and Sample Locations	Mayflies, Stoneflies, and Caddisflies	Other Insects	Mollusks (Except Mussels)	Other Animals	Overall Totals
1954 & 1958					
River Mile 7.4	15	21	5	5	46
River Mile 11.4	26	25	5	6	62
River Miles 7.4 and 11.4 combined	32	35	7	8	82
1958					
River Mile 60.4	17	12	4	3	36
River Mile 89.0	0	10	5	6	21
River Miles 60.4 and 89.0 combined	17	18	6	6	47
1980-81					
River Mile 27.8	23	22	7	9	61

Source: Data from Mullican et al. 1960; Barr et al. 1986

While these numbers might indicate substantial differences between the aquatic communities at these sites as much as 50 years apart, the results also might reflect important differences in how the samples were collected and how many of the animals were identified to the species level during each study.

Examination of the information from the downstream sites sampled in the 1950s may help address some of the possible differences between the various studies. The sites at River Miles 7.4 and 11.4 were both sampled in 1954 and, again, in 1958 (Mullican, et al. 1960). While the number of species encountered at each of these sites during the 1950s (46 and 62 species, respectively) are substantially lower than the 88 species encountered at River Mile 8.5 in 2000, when the data from these two

1950s sites are considered together, the combined species total (82 species) is much more similar to the results from the recent work. While no 1950s data are available from another site very close to River Mile 60.4, if the data from the next upstream site examined at that time (River Mile 89.0) are included, the combined species total (47) is still quite different from the 86 species encountered at River Mile 60.5 in 2000.

The available data suggest that cautious conclusions can be made about how the number of bottom-dwelling species in the Nolichucky River has changed over time, especially when the numbers of species encountered at more than one site during earlier studies are included. The available comparisons indicate that fewer species probably existed in the river upstream from Nolichucky Dam in the 1950s (about 50) than occur there now (approximately 85). Somewhat more species occurred 20 river miles downstream from Nolichucky Dam in the early 1980s (about 60 species), but still fewer than occur there now (about 90). The number of species found near the downstream end of the river during the 1950s (about 80) is much closer to what was found there in 2000 (about 90). If these indications are correct, they suggest that more bottom-dwelling aquatic species are able to live in the Nolichucky River upstream from Nolichucky Reservoir now than occurred there about 50 years ago, while the numbers of species have increased only slightly in the part of the river downstream from Nolichucky Dam.

Mussels

During the survey work conducted in 2000, TVA and TWRA biologists searched for freshwater mussels at or near the five sites where the bottom-dwelling animal sampling had been conducted, as well as at five other sites between Nolichucky Dam and the low-head dam at Nolichucky River Mile 7.7. Surveys of native freshwater mussels require different sampling techniques than those used for aquatic insects and other bottom-dwelling species. Mussels tend to be widely scattered, even in suitable habitat, and are too large to be routinely collected with the equipment used to sample for insects and other small aquatic animals.

The techniques and detailed results from this mussel survey are presented in Appendix B. This survey, summarized in Table 14, encountered 803 live representatives of 20 native mussel species were encountered at the 10 sampling sites. No live mussels were found at the site examined upstream from Nolichucky Reservoir (River Mile 60.5) or at the site in the reservoir (River Mile 50.6). Downstream from Nolichucky Dam, the same number of mussel species (13) was found in all three approximate thirds of the river length but more live animals were found in the middle third (an average of 227 per site) than either upstream or downstream from there (80 per site in the downstream third and 42 per site in the upstream third). The overall average number of live mussels found during this survey was 80 animals per site, and the average catch per person-hour of search effort was 11.4 animals per hour.

Table 14. Summary of the Results From the Native Mussel Survey Conducted on the Nolichucky River During 2000

River Mile Reaches	Number of Sites	Number of Species	Number of Mussels	Average Number per Site	Catch per Person-Hour
8.5 - 14.9	2	13	160	80.0	13.3
15.0 - 29.9	2	13	475	227.5	33.9
30.0 - 45.9	4	13	168	42.0	5.3
46.0 - 59.9	1	0	0	0	0
60.0 -	1	0	0	0	0
Survey Totals	10	20	803	80.3	11.5

Source: Data from information presented in Appendix B.

The most abundant mussel species encountered during this survey was the spike (*Elliptio dilatata*) at 32.4 percent of the total, followed by the purple wartyback (*Cyclonaias tuberculata*) at 29.6 percent, and the pocketbook (*Lampsilis ovata*) at 13.8 percent. Together, these three species accounted for 75.8 percent of the total mussels found during this survey.

Only one previous survey of native mussels in the Nolichucky River is available for comparison with this recent work. In 1980, TVA aquatic biologists conducted a float survey of the Nolichucky River from

Nolichucky Dam downstream to near its mouth (Ahlstedt 1986). This survey, summarized in Table 15, encountered 888 live representatives of 21 native mussel species at the 41 sampling sites. None of the collection sites was located upstream from, or within, Nolichucky Reservoir.

Table 15. Summary of the results from the native mussel survey conducted on the Nolichucky River during 1980

River Mile Reaches	Number of Sites	Number of Species	Number of Mussels	Average Number per Site
0 - 14.9	10	15	277	27.7
15.0 - 29.9	17	15	371	21.8
30.0 - 45.9	14	17	240	17.1
46.0 - 59.9	0	-	-	-
60.0 -	0	-	-	-
Survey Totals	41	21	888	21.6

Source: Data from Ahlstedt (1986).

Downstream from Nolichucky Dam, a nearly constant number of mussel species (15-17) was found in three reaches and, on average, more individuals were found with distance downstream from the dam (from an average of 17 per site in the upstream third to an average of nearly 28 per site in the downstream third). The overall average number of live mussels encountered at each site was 21.6 animals. Collection effort data were not recorded during the 1980 survey.

Ahlstedt (1986), during the 1980 survey, found the most abundant mussel species was the purple wartyback at 39.8 percent of the total, followed by the pocketbook at 19.8 percent, and the threeridge (*Amblema plicata*) at 13.6 percent. Together, these three species accounted for 73.2 percent of the total mussels found during that survey.

Comparison of the Tables 14 and 15 indicates that similar numbers of mussel specimens and species were found during both of these surveys (888 in 1980 and 803 in 2000). Two of the three most abundant species encountered were the same during both surveys (the purple wartyback and pocketbook); however, the pocketbook accounted for about the same percentage of the animals in both years (19.8 percent in 1980 and 13.8

percent in 2000) while the purple wartyback made up a larger percentage of the catch in 1980 (38.8 percent) than it did in 2000 (29.6 percent). In addition, the third most abundant species in 1980 (threeridge) dropped to twelfth place in 2000 (Appendix B), and the most abundant species in 2000 (spike) had been fourth in 1980 (Ahlstedt 1986).

The comparison of Tables 14 and 15 also indicates that the average number of mussels found in each third of the downstream river reach was substantially higher in 2000 than it was in 1980. This difference might not indicate anything more than a greater collection effort used in 2000. The fact that many more mussels per site were found in the middle third of the downstream reach (River Miles 15-30) during the 2000 survey, however, seems to represent a different pattern than the steady increase with distance down the length of the river indicated in the data from the 1980 survey. Together, these numbers suggest that more mussels probably occur throughout the part of the Nolichucky River downstream from Nolichucky Dam now than existed there in 1980, and, apparently, mussel habitat has improved most in the middle third of this river reach.

Fish

Also during 2000, TVA used a variety of sampling techniques to examine the fish species that live in the Nolichucky River. These collections were made at the same five sites where the general invertebrate and some of the mussel collections were made. The field crew sampled all identifiable habitats at each site and attempted to find all of the fish species that were present. Most individuals were identified in the field; however, some identification was verified in the laboratory.

Results of the fish sampling effort are presented in Appendix B and are summarized in Table 16. Of the overall total of 63 species, the most species found at any site (46) was encountered at River Mile 42.6, not far downstream from Nolichucky Dam, and the fewest number of species (29) was found at River Mile 50.3, in Nolichucky Reservoir. Identical numbers of species (40) were found at all three of the other sites, in spite of the fact that one of those sites was located upstream from the reservoir and the other two were 20 river miles apart, well downstream from Nolichucky Dam.

Table 16. Summary of the Results of the Fish Survey Conducted at Five Sites on the Nolichucky River During 2000.

Sample Locations	Number of Fish Examined	Number of Species Included	Index of Biotic Integrity Rating
River Mile 8.5	1,969	40	good
River Mile 27.9	908	40	good
River Mile 42.6	1,559	46	good/excellent
River Mile 50.3	1,319	29	poor/fair
River Mile 60.5	1,251	40	good
Totals	7,006	63	

Source: Extracted from Appendix B.

The fish information collected during these site visits was used to compare the fish communities using IBI techniques (Karr 1981). This technique, described in Appendix B, compares specific parts of the results from a fish sample to what a site on that type of stream might show if it were in excellent condition. Evaluated in this way, the fish community at the site in Nolichucky Reservoir rated "poor/fair," the site not far downstream from Nolichucky Dam rated "good/excellent," and all three of the other sites rated "good." The "good" rating from this evaluation of the site at River Mile 8.5 is consistent with several recent IBI evaluations of that site during the last decade (TVA unpublished data). The sampling results that contributed most to these ratings were the numbers of native fish species present, including the fact that some expected species were consistently absent. Results from other similar evaluations suggest that consistent "good" ratings may indicate that relatively low-level adverse impacts are affecting some habitats and are preventing the fish communities from achieving "excellent" ratings (see Appendix B).

The TWRA conducted a more extensive survey of fish populations in the Nolichucky River in 1998 (Carter et al. 1999). Results from that survey, summarized in Table 17, include a very similar total number of species in the river (62) and only slightly lower numbers of species found within the river reaches where the TVA sites were located. The lower species counts found during the TWRA survey (focused on evaluating game fish populations) is consistent with the fact that a wider variety of sampling techniques were used during the more broadly focused TVA survey.

Table 17. Summary of the Results From the Fish Survey at 31 Sites on the Nolichucky River Conducted by Tennessee Wildlife Resource Agency During 1998.

River Mile Reaches	Number of Sites Examined	Number of Species Included
0 - 14.9	4	36
15.0 - 29.9	5	38
30.0 - 45.9	5	33
46.0 - 59.9	4	18
60.0 - 99.1	13	43
Totals	31	62

Source: Data extracted from Carter et al. 1999.

Two earlier evaluations of fish in the Nolichucky River have been conducted: one during the late 1950s (reported in Mullican et al. 1960), and the other in 1980 (reported in Barr et al. 1986). These studies, summarized in Table 18, found fewer fish species in the river reach downstream from River Mile 14.9 (26) and in the reach upstream from Nolichucky Reservoir (28) in 1958 than were found in those areas in recent years (for example, 40 species in each area in 2000). The number of fish species encountered in the middle third of the reach downstream from Nolichucky Dam in 1980 (38 species) is the same as the number found there in 1998 and very close to the 40 species found there in 2000. The numbers of fish species reported during the 1958 study probably was lower than it might have been if more emphasis had been given to identifying nongame species (Mullican et al. 1960).

Table 18 Summary Results From Earlier Fish Evaluations on the Nolichucky River.

River Mile Reaches (year examined)	Number of sites examined	Number of species included
0 - 14.9 (1958)	2	26
60.0 - 95.9 (1958)	4	28
15.0 - 29.9 (1980)	1	38

Source: Data from Mullican et al. 1960; Barr et al. 1986.

Summary

Considered together, the available information about the bottom-dwelling invertebrates, mussels, and fish living in the Nolichucky River indicates that the quality of aquatic life varies in different parts of the river and, in some areas, has changed over the last 40 years. Just upstream from Nolichucky Reservoir, the present fish community rates “good,” the bottom-dwelling community rates “fair,” and there are few or no native mussels. Older information about the numbers of species encountered in that part of the river suggests that more species occur there now than in the late 1950s. In Nolichucky Reservoir, the present fish and bottom-dwelling communities both rate “poor,” and there are few or no native mussels. No previous information is available to indicate how aquatic life in the reservoir has changed over time. Downstream from Nolichucky Dam, the quality of the present fish, bottom-dwelling animal, and mussel communities varies. The present bottom-dwelling community was rated as “fair” at all sampling sites, while the mussel community was found to be most abundant in the middle part of this reach (River Miles 15.0-29.9). The fish community rated “good/excellent” at River Mile 42, the nearest site downstream from the dam, and rated “good” in the middle and lower parts of the downstream reach. Where it exists, older information from this part of the river suggests that all three of these areas now support much more abundant and diverse communities than were present as much as 40 years ago.

3.6 WETLANDS

Wetlands are areas where the soils are saturated with, or covered by, water for at least part of the year. The soil conditions in these areas, and the types of plant and animal life they support, are determined mainly by the amount of water that is present. Most wetlands are dominated by plants that can live in areas that are flooded frequently or have standing water for long periods of time. These habitats are generally teeming with life, because of the abundant water and nutrient supplies that are available to a wide variety of aquatic and terrestrial plant and animal species. In many places, established wetlands also are important in controlling erosion, improving water quality, preventing flooding and storm damage, and helping to recharge groundwater.

Some wetlands are protected under both state and federal laws because of the benefits they provide. These "jurisdictional wetlands" meet specific criteria established by the USACE for dominant plant species, soil types, and the presence of water. Jurisdictional wetlands are protected under Section 404 of the Clean Water Act, which is administered by the USACE. In addition, Executive Order 11990 (Protection of Wetlands) addresses wetlands located on federal property or affected by federal projects. In Tennessee, activities in wetlands also are regulated by TDEC under the authority of the Tennessee Water Quality Control Act of 1977.

The USFWS has produced National Wetland Inventory maps for much of the United States using a habitat-based classification system (Cowardin et al. 1979). This classification system starts out by identifying whether the wetland is a noncoastal marsh, swamp, or pond (palustrine; P), part of a lake (lacustrine; L), or part of a stream (riverine; R). The classification system also identifies more detailed features of the habitat and the vegetation that is present, such as whether the area is primarily covered by trees (forested; PFO1), shrubs and saplings (scrub-shrub; PSS1), nonwoody plants (emergent wetland or marsh; PEM1), and whether the area is flooded permanently (H), semipermanently (F), seasonally (C), or temporarily (A).

The following paragraphs describe the types of wetlands that have been identified in pertinent parts of the Nolichucky River watershed. These identifications are based on the National Wetland Inventory maps, interpretation of color infrared photography taken in March 2000, and field reconnaissance.

Upstream From Nolichucky Reservoir

According to the National Wetland Inventory maps, relatively few wetlands occur in and adjacent to the river upstream from Nolichucky Reservoir. These wetlands tend to be forested, scrub-shrub, or emergent marsh wetlands confined to areas along tributary streams and around farm ponds. Streamsides, pond areas, and floodplains are the primary locations for wetlands in the hilly part of east Tennessee. The wetlands in these areas tend to be relatively small due to the topography and modifications to improve the drainage for agriculture and other land uses. Most of these wetlands are supplied with water from groundwater seeps or adjacent streams. Some wetlands in this part of the river basin might not meet the USACE jurisdictional wetlands criteria because of past stream modification, agricultural drainage, or because water is not present long enough for wetland soils to develop.

Nolichucky Reservoir

The National Wetland Inventory maps and aerial photography interpretation indicated that extensive wetland areas occur in Nolichucky Reservoir and on the adjacent floodplain. These wetlands include forested (PFO1), scrub-shrub (PSS1), and emergent marsh (PEM1) wetlands, combinations of scrub-shrub and emergent marsh (PSS/EM1) wetlands, and flooded areas along the edge of the reservoir (L2UB).

Wetlands identified during the interpretation of recent aerial photography for the Nolichucky Reservoir area are presented in Table 19 and Figure 8. (The other land use information derived from the aerial photography presented in Table 19 is discussed in Section 3.10.) As indicated in this table, an estimated 318.0 acres of wetlands were identified within the 500-year floodplain associated with Nolichucky Reservoir. Nearly all of these wetlands (316.8 acres) occur within the 100-year floodplain around this reservoir. Most of these wetlands (280.6 acres) were identified as temporarily flooded and seasonally flooded forest areas (wetland categories PFO1A and PFO1C), while the remaining areas (37.4 acres) were classified as permanently flooded and seasonally flooded scrub-shrub and emergent wetlands (categories S/EM1, PSPEM1H, PEM1C, and PSS1C).

All together, the wetlands cover 12.2 percent of the area within the 500-year floodplain and 14.6 percent of the area within the 100-year floodplain around Nolichucky Reservoir.

Table 19. Wetlands Identified During Interpretation of Aerial Photography of the Floodplain Areas Around Nolichucky Reservoir

Land Use Categories	Land Use Code	Area Within the 100-Year Floodplain		Area Within the 500-Year Floodplain	
		Acres	Percent	Acres	Percent
Wetland Categories					
Palustrine Forested Wetlands	PFO1A	226.9	10.4	227.6	8.7
Palustrine Forested Wetlands	PFO1C	52.8	2.4	53.0	2.0
Mixed Palustrine Scrub-Shrub Emergent Wetlands	PSS/EM1	10.4	0.5	10.5	0.4
Palustrine Emergent Wetlands	PEM1H	9.7	0.4	9.7	0.4
Palustrine Emergent Wetlands	PEM1C	9.5	0.4	9.5	0.4
Palustrine Scrub-Shrub Wetlands	PSS1C	7.5	0.3	7.7	0.3
Wetland subtotal		**316.8**	**14.6**	**318.0**	**12.2**
Other Uses					
Agriculture	various	592.9	27.2	880.8	33.8
Forested	various	621.3	28.6	729.2	28.0
Water	5	601.5	27.6	602.8	23.1
Developed	various	43.7	2.0	75.4	2.9
Overall Totals		**2176.2**	**100.0**	**2606.3**	**100.0**

Field surveys confirmed most of the map and photographic interpretation information. The primary difference identified during the fieldwork was in the classification of specific wetlands. Many of the areas indicated as forested wetlands (PFO1) on the National Wetland Inventory map or during the photographic interpretation were found to include substantial areas of emergent marsh and scrub-shrub wetlands (PEM1 and PSS1). In addition, some scrub-shrub and emergent marsh wetlands were found in small areas along the reservoir shoreline that had not been indicated on the National Wetland Inventory map or were identified during the photographic interpretation. These changes do not affect the total wetland acreage estimate; however, the acreage and percentage of scrub-shrub and emergent marsh (PSS1 and PEM1) wetlands in this area probably are larger than indicated in Table 19. Some of the floodplain areas indicated as temporarily flooded forested wetlands (PFO1A) may not meet the USACE criteria for jurisdictional wetlands because of the absence of wetland soils.

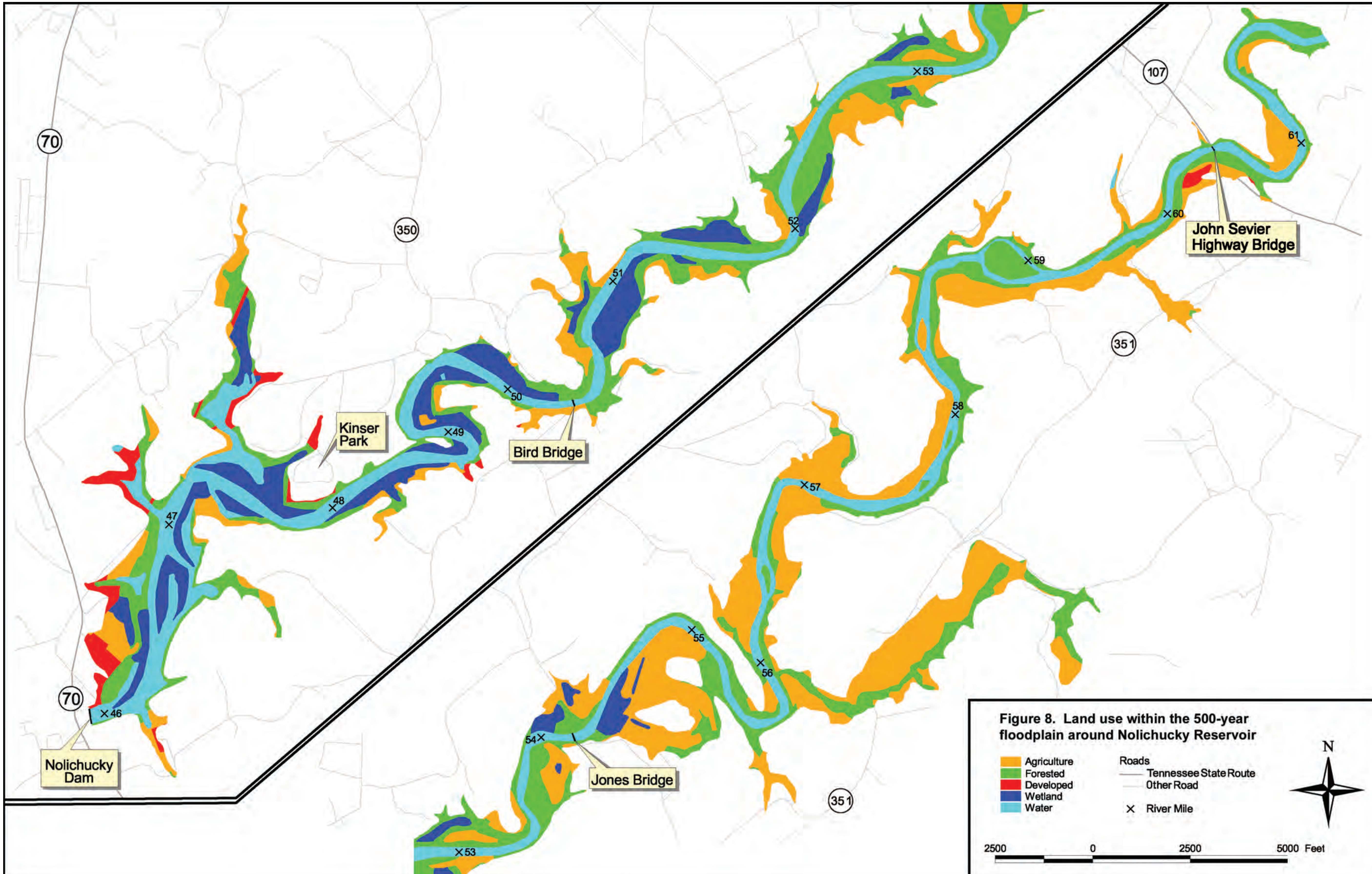

Figure 8. Land use within the 500-year floodplain around Nolichucky Reservoir

These extensive wetlands have developed from Nolichucky Dam upstream to about River Mile 55 because of two interacting factors: the stable water level maintained by Nolichucky Dam and the large volume of sediment that has accumulated in the reservoir. Nolichucky Dam prevents the water level in the reservoir from dropping lower than the spillway height (elevation 1,240.9 feet). This stable, minimum pool level maintains shallow water areas in the reservoir, supports high groundwater levels in the floodplain, and slows subsurface drainage out of the floodplain. Over the years, the sediment that has accumulated in Nolichucky Reservoir has formed many shallow areas where wetland communities could develop. Sediment accumulations on the enlarging floodplain also have partially or completely blocked the mouths of tributaries and have impounded water from those streams before they flow into the reservoir.

Some of the wetlands in and around Nolichucky Reservoir exist on the islands, sandbars, in creek mouths, and in other areas where sediment has been deposited by the moving water. Most of these wetlands occur between the dam and about River Mile 49. These areas are permanently to semipermanently flooded by the water level in the reservoir. Trees and shrubs that exist in these wetlands include black willow, American elm, silver maple, box elder, sycamore, and buttonbush. Herbaceous plants typically found here include sedges, spikerush, jewelweed, smartweed, false nettle, waterwillow, and dock.

Large areas of wetlands are found in depressions, old flood channels, and along tributary streams in the reservoir floodplain. Most of these wetlands are located upstream from River Mile 48, although two scrub-shrub and emergent marsh (PSS/EM1) wetlands are located on the grounds of the environmental education center near River Mile 47.0. These wetlands have saturated soils and water on the surface as a result of the high groundwater level and, in some cases, incoming streams. Surface runoff and occasional river flooding also contribute water to these areas; however, groundwater is the main water source. The depths of the groundwater and the surface water elevations in these areas are directly linked to the water surface elevation in the reservoir.

The dominant plant species in the floodplain forested (PFO1) wetlands include silver maple, box elder, American elm, sycamore, spicebush, moneywort, ground ivy, and microstegium. In the scrub-shrub and emergent marsh (PSS1 and PEM1) wetlands, the dominant woody species are black willow and buttonbush. The dominant herbaceous species in these wetlands are arrowhead, green arum, jewelweed, sedge, and smartweed. Other dominant and commonly occurring species in these areas include rice cutgrass, false nettle, bur-reed, cattail, lizard's tail, and monkey-flower. (A more extensive list of the plants that occur in the wetlands around Nolichucky Reservoir is presented in Appendix C.) In some of the emergent marsh wetlands, arrowhead forms an almost solid cover over the water. Arrowhead and green arum are not typically found in wetlands in east Tennessee in the numbers, the density, or the thriving growth with which they occur in the Nolichucky wetlands.

Although a few of the floodplain wetlands in the reservoir area have been impacted by cattle, many of the areas are relatively undisturbed by human activity. The variety and expanse of wetlands that occur in and along Nolichucky Reservoir are quite uncommon in other parts of east Tennessee. No other reservoir or river floodplain in east Tennessee has the specific combination of water regime, habitat diversity, overall wetland area, and absence of disturbance that exists around Nolichucky Reservoir.

Downstream From Nolichucky Dam

The National Wetland Inventory maps indicate that relatively few wetlands occur along the Nolichucky River and its floodplain from Nolichucky Dam downstream to approximately River Mile 6. The National Wetland Inventory maps have identified forested wetlands (PFO1) with temporary (A) and seasonal (C) flooding in streamside zones along tributary streams. The water sources for wetlands in these areas typically are groundwater seeps and overbank flooding. Some of these areas may not meet the USACE wetland criteria due to the absence of surface water or a high groundwater table for long enough during the growing season to develop wetland soils.

Between the mouth of the Nolichucky River and River Mile 6, the National Wetland Inventory map indicates the occurrence of more than 100 acres of forested (PFO1C) wetlands and semipermanently, seasonally, and temporarily flooded scrub-shrub (PSS1) and emergent marsh (PEM1) wetlands. These wetlands are located on islands, along the river shoreline, in portions of the floodplain, and in tributary stream embayments within an area influenced by Douglas Dam on the French Broad River. The primary water sources for these wetlands are surface water in Douglas Reservoir and the high groundwater table. The dominant plant species in these areas include black willow, sycamore, red maple, box elder, smooth alder, and buttonbush.

While many of the wetlands in the Nolichucky River basin are relatively undisturbed by human use, the continued diversity of plant and animal life they support appears to be threatened by a nonnative plant. Populations of purple loosestrife (*Lythrum salicaria*) were found in many wetland habitats around Nolichucky Reservoir. High densities of this invasive plant were found in the island and sandbar wetlands close to the dam, on tree stumps and stationary logs all around the reservoir shoreline, and in many of the floodplain wetlands. Individual plants also were seen in at least one location downstream from Nolichucky Dam. Each purple loosestrife plant can produce millions of seeds and the species can spread rapidly—by seed and by plant fragments—throughout a wetland or a river system. Initially introduced to North American in the early 1800s, purple loosestrife spread throughout the northeast United States and reached the Midwest by the 1930s. It now occurs in scattered populations throughout most of the United States, including many sites in the Tennessee River Valley (Tennessee Exotic Pest Plant Council 1997). Once it becomes established, this plant dominates formerly diverse wetlands, excluding other plant species and the variety of animal species that depend upon them.

In summary, the wetlands that exist along the Nolichucky River upstream and downstream from Nolichucky Reservoir are more or less typical in abundance, size, and community composition to other wetlands in the Valley and Ridge Physiographic Province in east Tennessee. In contrast, the extensive wetlands that now exist in and around Nolichucky Reservoir are very uncommon in this part of the state, because of their size, abundance, water regime, and mixture of different habitat types. These wetlands appear to have developed in and around Nolichucky Reservoir because of the stability of the water level and the accumulation of so much sediment in the reservoir pool.

3.7 FLOODPLAINS AND FLOOD RISK

Information exists about floods on the Nolichucky River from as early as 1900. The largest known flood on this river occurred in May 1901. Since Nolichucky Dam was built in 1913, the largest known flood in the Nolichucky River system occurred in November 1977. Upstream from Nolichucky Dam at the USGS Embreeville gage (River Mile 89.0), the maximum level reached during the November 1977 flood was several feet lower than the 1901 flood. Immediately upstream from Nolichucky Dam, however, the November 1977 flood exceeded the 1901 flood level by more than 40 feet. Other information about the flood history along the Nolichucky River is available in records maintained by the USGS and TVA.

As indicated in Section 1.2, Nolichucky Dam and Powerhouse were built as a single-purpose hydropower production project. The project does not have a flood protection purpose; however, it does affect flood elevations upstream from the dam. Nolichucky Dam is 482 feet long, with a 359-foot long spillway, and a height of about 70 feet above the riverbed at the spillway crest elevation 1,240.9. The reservoir formed by this dam extends upstream for about 6 river miles, to River Mile 52.

Large amounts of sand and silt from past mining operations in North Carolina have accumulated in the reservoir pool upstream from Nolichucky Dam (see Sections 1.2 and 3.4). When TVA acquired the Nolichucky Project in 1945, the reservoir pool was estimated to contain approximately 7,200 acre-feet of sediment and approximately 10,300 acre-feet of water (for a combined total of 17,500 acre-feet of reservoir volume) below elevation 1,240.9. Since then, TVA has periodically monitored the amount of sediment that has accumulated (see Section 1.2 and Figure 7) and has calculated the remaining water volume in the reservoir (see Section 3.4). In 1999, when the sediment volume was last evaluated, the remaining water volume in the reservoir pool was estimated to be about 1,700 acre-feet below elevation 1,240.9 (the elevation of the spillway). This open water volume is probably maintained by continued scouring in the active river channel.

The height and width of the spillway part of Nolichucky Dam controls the water level in the reservoir pool. During high-flow events, water that cannot pass through the spillway backs up behind the dam and spreads out onto the floodplain. Land acquisition around any reservoir is generally based on the impacts the dam is projected to have on upstream flood elevations. Two common levels of flooding that are often calculated are the 100-year and 500-year recurrence interval floods. In common language, these estimates describe the flood with 1 in 100 chances (100-year flood) or 1 in 500 chances (500-year flood) of being equaled or exceeded during any given year. (More on this subject is presented in Section 2.3.)

In 1998, partly in response to letters and questions from local property owners, TVA began reviewing the areas around Nolichucky Reservoir that could be affected during flood events. Cross sections of the reservoir were surveyed at locations where previously surveyed sections had been used to determine sediment volumes. Along with flow data for the projected 10-year through 500-year flood levels, these data were used to develop a computer model of the reservoir (using the USACE Hydrologic Engineering Center – River Analysis System Program) and to calculate present flood elevations (USACE 2006). The model also was adjusted to reflect conditions within the reservoir as they would have been in 1945 when TVA acquired the project. The results of this analysis (Figure 3) indicate that, in some areas, the 500-year flood level has increased by as much as 12 feet above what it would have been in 1945. The model results also show that, even in 1945, the area that would have been impacted by Nolichucky Dam during flood events would have included land in private ownership.

Flood elevations upstream from Nolichucky Dam have increased over the years because the reservoir has filled with sediment. During a flood, additional water can move through a deep reservoir relatively easily, because the cross sectional area is large and the water already there offers very little resistance to being moved. If the same reservoir were full of sediment, the additional water would flow through a smaller area, there would be more resistance along the bottom, and, as a result, water would back up higher on the floodplain.

Upstream from Nolichucky Dam, the present 100-year flood elevation along the river varies from elevation 1,260.3 at the dam site (River Mile 46) to elevation 1,317.3 at River Mile 62.06 (the upper limit of the floodplain study area). The 500-year flood elevation varies from elevation 1,266.3 at the dam site to elevation 1,329.2 at River Mile 62.06. These flood elevations are shown on the map presented in Appendix A. For many purposes, the 100-year flood elevation is the more important of these estimates, because it is often used as the basis for local floodplain regulations.

Downstream from Nolichucky Dam, flood elevations have been determined between Nolichucky River Miles 6.44 and 15.07. These data are published in the Federal Emergency Management Agency (FEMA) Hamblen County, Tennessee, Flood Insurance Study (FEMA 1991a). For the remainder of the Nolichucky River in Hamblen, Cocke, and Greene counties, flood insurance maps are published showing the limits of the approximate 100-year floodplain (Zone A) (FEMA 1998, 1991b).

Dam Safety

The *Federal Guidelines for Dam Safety* (FEMA 1979) require that dams with a direct federal interest, including Nolichucky Dam, must be inspected periodically, and necessary maintenance must be conducted throughout their operating life to verify and protect the structural integrity of the dam and appurtenant structures, assuring protection of human life and property. A dam is defined in these guidelines as an artificial barrier that impounds or diverts water and is: (1) 25 feet or more in height or (2) has an impounding capacity of 50 acre-feet or more. These periodic inspections are intended to help identify conditions that might disrupt normal operation of the dam or threaten its safety in time for them to be corrected.

TVA has inspected and maintained Nolichucky Dam since it became part of the system in 1945. In June 1964, inspections and stability investigations indicated the spillway was not safe, based on safety standards at that time. As a result of that study, the flashboards were removed from the spillway structure, lowering the full pool level to elevation 1,240.9. In 1972 and 1973, the dam was strengthened by placing additional concrete on the downstream face of the spillway to provide structural stability, and a gate 10 feet high and 25 feet wide was installed to permit small drawdowns of the reservoir. The gated spillway crest was at elevation 1,230.9. In 1995, a reinforced concrete bulkhead was constructed on the upstream side of the existing spillway gate, rendering it inoperable. At present, Nolichucky Dam meets federal dam safety guidelines and is included in the TVA periodic dam monitoring program.

3.8 TERRESTRIAL LIFE

The Nolichucky River basin has its headwaters in the Blue Ridge Physiographic Province and flows westward into the Valley and Ridge Physiographic Province (Fenneman 1938). The natural terrestrial plant and animal communities that occur in this watershed can all be considered a part of the Appalachian/Blue Ridge Forests Ecoregion (Ricketts et al. 1999). The forests in this region, the Oak-Chestnut Forest Region as defined by Braun (1950), originally were dominated by a variety of oak species and, until it was virtually eliminated by a fungal blight, American chestnut. With the loss of chestnut from these forests, other trees have become more abundant, particularly red oaks, maples, beech, buckeyes, basswood, and tulip tree. In the lowland valley floors, the natural forests are dominated by white oaks, with more evenly mixed or hemlock communities occurring in coves and ravines.

Around Nolichucky Reservoir, much of the original vegetation has been modified by human use. Generally, the valleys and lower ridge slopes have been cleared for use as agricultural fields, while steeper slopes and some ridges have been cleared for pasture or hay production. The ridges are forested, although repeated timber harvests have occurred on most sites. The present terrestrial habitats surrounding Nolichucky Reservoir can be broadly characterized in three communities: grasslands, upland hardwood forests, and floodplain hardwood forests. Together, these three broad community types account for 76 percent of the area within the 500-year floodplain boundary. Most of the other 24 percent of this area is occupied by water in the reservoir.

From May through July 2000, TVA conducted field studies to evaluate the terrestrial plant and wildlife species present in these habitats. The following paragraphs describe the general results of the fieldwork. Appendix C lists the terrestrial plants and animals that were identified along the Nolichucky River during this study. As indicated below, most of the habitats and species encountered during the field surveys are locally and regionally abundant.

Grasslands, including hayfields, pastures, row crops, and residential areas, now occur on more than 956 acres (37 percent) of the area within the 500-year floodplain surrounding Nolichucky Reservoir (see Section 3.10). These habitats exist occasionally along the river corridor but are more abundant away from the reservoir. The vegetation in these areas typically includes the featured crop and a variety of weed species. Depending upon characteristics of the individual sites, the weeds may include sericea lespedeza, Japanese honeysuckle, buttercups, smartweeds, numerous grasses, pokeweed, and dandelion.

Grasslands provide habitat for a variety of common animal species. Amphibians and reptiles that can occur in these areas include American toad, garter snake, and black racer. Birds that nest in grasslands include common yellowthroat, eastern meadowlark, grasshopper sparrow, field sparrow, and northern bobwhite. Mammals often found in grasslands include woodchuck, eastern cottontail rabbit, opossum, coyote, and white-tailed deer.

Upland hardwood forests are fairly continuous along the steeper slopes, wooded tributaries, and valley areas adjacent to Nolichucky Reservoir. Upland forest habitats cover approximately 730 acres (28 percent) of the area within the 500-year floodplain associated with Nolichucky Reservoir (see Section 3.10). Mixtures of white oak, northern red oak, tulip tree, and buckeye, with occasional stands of rhododendron, hemlock, and beech, characterize these moderately dry to very dry forests. Nonwoody plants living on the forest floor include Mayapple, fire pink, dwarf crested iris, bloodroot, Solomon's seal, horsemint, wild ginger, grape fern, and Christmas fern.

Rock outcrops, bluff faces, and cliffs, which occur on the steepest part of the river shoreline, range from being sparsely to completely forested. Depending upon where they occur, these areas vary from moist, dripping rock faces to extremely dry bluff tops. Where they are forested, the trees are mostly red cedar, Virginia pine, white pine, and hemlock. The nonwoody plants on these rock faces typically include cliff brake fern, rock cress, and stonecrop.

Amphibians and reptiles commonly found in woodland tributaries and caves within upland hardwood forests include northern slimy salamander, dusky salamander, eastern box turtle, and northern copperhead. Birds that commonly nest in upland hardwood communities include red-eyed vireo, white-breasted nuthatch, and great crested flycatcher. Mammals often observed in this habitat type include white-tailed deer, eastern chipmunk, red fox, big brown bat, and eastern gray squirrel.

Forest habitats along the river likely support the highest numbers of Neotropical migrant songbirds and breeding habitat and serve as a migration corridor for these birds, many of which have undergone significant population declines in recent years. Bare rock faces and bluffs in these forest habitats provide nesting sites for black vultures, turkey vultures, and a variety of other birds and bats.

Floodplain hardwood forests, which occur on approximately 280 acres (11 percent) of the 500-year floodplain around Nolichucky Reservoir (also discussed in Section 3.6), occur primarily upstream from Nolichucky Dam along the banks and backwaters of the main river corridor. These low-lying forests also occur on many of the islands located in the river channel downstream from the dam. Although some of these forests are heavily impacted by cattle, the majority of them are undisturbed natural communities. These areas are characterized by permanent to seasonally flooded sandy soils and mixtures of basswood, sycamore, box elder, river birch, silver maple, and black willow trees. Scrub-shrub and emergent wetlands occur within these floodplain hardwood forests, as well as along sandbars, islands, and stream embayments upstream from Nolichucky Dam. These habitats are usually characterized by a fringe of floodplain forest with nonwoody wetland species in the center.

Floodplain hardwood forests provide habitat for a variety of amphibians and reptiles, including spring peeper, green frog, and broadhead skink. Birds frequently encountered during the field surveys of these habitats included yellow-billed cuckoo, wood thrush, yellow-throated warbler, and wood duck. Mammals found in floodplain hardwood forests include eastern mole, river otter, raccoon, and northern short-tailed shrew. Islands and mudflats adjacent to these forests provide resting and foraging habitat for shorebirds, nesting and foraging habitat for wading birds, and foraging sites for river otters and raccoons.

A number of wading birds and two heron colonies were encountered during the fieldwork downstream from Nolichucky Dam. Heron colonies are places where groups of wading birds build their nests in the same or closely associated trees. Combined, the two colonies supported approximately 45 nests in 2000, many of which contained both adult and juvenile birds when they were seen. The establishment of heron colonies on the Nolichucky River is significant. Great blue heron populations, which declined in the late 1960s and early 1970s, are presently expanding onto unoccupied reservoirs and other suitable habitat areas. The presence of these heron colonies and the successful nesting activity indicates that the Nolichucky River provides suitable nesting habitat for wading birds, a previously uncommon situation in the eastern part of the Tennessee River system.

3.9 ENDANGERED AND THREATENED SPECIES

Information presented in Sections 3.5 and 3.8 indicates that a fairly wide variety of plant and animal species occur in the Nolichucky River and on the land adjacent to Nolichucky Reservoir. The parts of the Nolichucky River watershed that could be affected by this project are all located in Cocke, Greene, and Hamblen counties (Figure 2). Occurrence records available to the TVA Natural Heritage Project suggest that 16 plant and 24 animal species previously or presently known from these three counties are considered to be endangered, threatened, or in some other protection category by the federal government or the Tennessee state government. The names, habitat preferences, and county occurrence information for all of these species are presented in Appendix D. Table 20 summarizes the listing status of these species.

The aquatic and terrestrial field studies conducted for this evaluation included special efforts to find suitable habitats and populations of these federally and state-listed species. The results of these surveys are described below.

Table 20. Summary of the Numbers of Federal and Tennessee Endangered, Threatened, and Other Categories of Protected Species Known From the Three Counties Included in this Evaluation

Categories	Animals	Plants	Totals
Federal Status			
Endangered	7	0	7
Threatened	1	0	1
Identified Candidates	1	0	1
Federal Totals	9	0	9
Tennessee Status			
Endangered	8	3	11
Threatened	2	9	11
Other Status	14	4	18
Tennessee Totals	24	16	40

Note: Species protected at both the federal and state levels are counted in both totals.

Plants

The 16 listed plant species known from Cocke, Greene, and Hamblen counties are listed in Table 21. Prior to the fieldwork for this project, a review of the information stored in the TVA Natural Heritage database indicated that only four of these species (bitter-cress, pink lady- slipper, turkey beard, and witch-alder) had been encountered within 5 miles of Nolichucky Reservoir. Potential habitats for these four species, as well as a wide variety of other habitats in the area, were searched during the spring and summer field investigations. The only listed plant encountered by the field crews was branching whitlow-wort, a species listed as special concern in Tennessee. This plant grows in dry upland woodlands, often over limestone, and is most frequently found associated with cedar trees on limestone cliffs or shaley, talus slopes. The species was found at three sites along Nolichucky Reservoir: at approximate River Miles 46.2, 49.6, and 51.0. Each of these populations exist on steep rock faces approximately 10-15 feet above the existing water surface, all located below the 500-year flood elevation.

Table 21. Endangered, Threatened, and Special Concern Plant Species Known From the Area Within the Nolichucky River Watershed That Could be Affected by One or More of the Action Alternatives.

Common Name	Scientific Name	Federal Status	Tennessee Status	Likely in Affected Area?
Alabama grapefern	*Botrychium jenmanii*		T	No
Bitter-cress	*Cardamine flagellifera*		T	No
Branching whitlow-wort	*Draba ramosissima*		S	Yes
Broadleaf tickseed	*Coreopsis latifolia*		E	No
Bugbane	*Cimicifuga rubifolia*		T	No
Climbing fumatory	*Adlumia fungosa*		T	No
Clinton lily	*Clintonia borealis*		S	No
Fraser sedge	*Cymophyllus fraserianus*		S	No
Green-and-gold	*Chrysogonum virginianum*		T	No
Marsh-marigold	*Caltha palustris*		E	No
Pink lady-slipper	*Cyprepedium acaule*		E-CE	No
Purple milkweed	*Asclepias purpurascens*		S	No
Sapsuck	*Buckleya distichophylla*		T	No
Sedge	*Carex ruthii*		T	No
Spinulose woodfern	*Dryopteris carthusiana*		T	No
Witch-alder	*Fothergilla major*		T	No

Status Abbreviations:
E - Endangered; E-CE - Endangered, Commercially Exploited; S - Special Concern; T – Threatened

Animals

Twenty-six aquatic and terrestrial animal species have been encountered at one time or another in the three counties that could be affected by this project (Table 22). These species, and other listed species that might occur in the habitats along the Nolichucky River were sought during the fieldwork conducted in 2000. As indicated in Table 22, 17 of these species now appear likely to occur in areas that could be affected by one or more of the project alternatives. The following paragraphs provide the basis for these determinations and pertinent information about the species that were, or were not, encountered.

Mussels

Six of the eight native mussel species included in Table 22 were not encountered during the survey conducted for this project (see Appendix B). Two of these species (finerayed pigtoe and greenblossom) were last observed in the Nolichucky River in 1913 (Ortmann 1918). One of the other species (pink mucket) was last observed in this river in 1964 (H. D. Athearn collection material) and another (Cumberland bean) is represented only by long-dead (relict) shells found along the river bank (S. A. Ahlstedt, USGS, personal communication). The available information suggests that none of these four species still occur in the Nolichucky River watershed (respectively: Neves 1984; Ahlstedt 1984a; 1985; 1984b).

The birdwing pearlymussel also was not found during the mussel survey conducted for this project; however, there is good reason to believe that it still exists in the Nolichucky River. In 1982, TVA transplanted 1,000 individuals of this species into the Nolichucky River at a site approximately 20 miles downstream from Nolichucky Dam (Jenkinson 1983). This population has been monitored from time to time over the years and, in 1995, a small birdwing pearlymussel was found at the transplant site, suggesting that at least some of the introduced animals had reproduced successfully (Aquatic Resources Center 1996). Outside of the Nolichucky River, a relatively large population of this species occurs in the middle reach of the Duck River, and extremely small populations occur in parts of the Clinch, Elk, and Powell rivers (Ahlstedt 1984c).

Table 22. Endangered, Threatened, and Special Concern Animal Species Known From the Area Within the Nolichucky River Watershed That Could be Affected by One or More of the Alternatives

Common Name	Scientific Name	Federal Status	Tennessee Status	Likely in affected area?
Mussels				
Birdwing pearlymussel	*Lemiox rimosus*	E	E	Yes
Cumberland bean	*Villosa trabilis*	E	E	No
Finerayed pigtoe	*Fusconaia cuneolus*	E	E	No
Green blossom	*Epioblasma torulosa gubernaculum*	E	E	No
Oyster mussel	*Epioblasma capsaeformis*	E	E	Yes
Pink mucket	*Lampsilis abrupta*	E	E	No
Fluted Kidneyshell	*Ptychobranchus subtentum*	C	D	Yes
Spectaclecase	*Cumberlandia monodonta*	C		Yes
Fish				
Blue sucker	*Cycleptus elongatus*		T	Yes
Chucky madtom	*Noturus crypticus* .	C	E	No
Highfin carpsucker	*Carpiodes velifer*		D	Yes
Snail darter	*Percina tanasi*	T	T	No
Tangerine darter	*Percina aurantiaca*		D	Yes
Tennessee dace	*Phoxinus tennesseensis*		D	No
Amphibians				
Eastern hellbender	*Cryptobranchus alleganiensis*		D	Yes
Pigmy salamander	*Desmognathus wrighti*		D	No
Bird (nesting)				
Common barn-owl	*Tyto alba*		D	Yes
Swainson's warbler	*Limnothlypis swainsonii*		D	Yes
Mammals				
Common shrew	*Sorex cinereus*		D	Yes
Gray bat	*Myotis grisescens*	E	E	Yes
Meadow jumping mouse	*Zapus hudsonius*		D	Yes
Smoky shrew	*Sorex fumeus*		D	Yes
Southeastern shrew	*Sorex longirostris*		D	Yes
Southern bog lemming	*Synaptomys cooperi*		D	Yes
Southern rock vole	*Microtus chrotorrhinus carolinensis*		D	No
Woodland jumping mouse	*Napaeozapus insignis*		D	Yes

Status Abbreviations: C - Identified Candidate; D - Deemed in Need of Management; E - Endangered; T - Threatened

A mussel species now being considered a candidate for possible federal listing as endangered or threatened was found during the 2000 mussel survey. Single live individuals of the spectaclecase were encountered at two of the collection sites: River Miles 11.4 and 35.4 (Appendix B). Eight individuals of this species also were found at seven sites in this river downstream from Nolichucky Dam during a 1980 survey (Ahlstedt 1986). Elsewhere, the spectaclecase is known to persist in the Clinch and Powell rivers, in a few scattered locations on the Tennessee River, and in other scattered locations from Minnesota and western Pennsylvania south to the Gulf of Mexico (Parmalee and Bogan 1998).

The other listed mussel species found during the mussel survey conducted in 2000 was the oyster mussel. A single live member of this federally listed endangered species was found at River Mile 11.4, about 35 miles downstream from Nolichucky Dam (Appendix B). A single live specimen of this species also was found in the downstream part of the Nolichucky River during a 1980 mussel survey on the Nolichucky River (Ahlstedt 1986). During both of these surveys, the oyster mussel accounted for less than 0.1 percent of the live mussels that were encountered. Other oyster mussel populations may still occur in the Big South Fork of the Cumberland River and parts of the Clinch, Powell, North Fork Holston, Little Pigeon, and Duck Rivers in the Tennessee River basin (Butler and Biggins 1998). In 2004, the USFWS designated 8 units of critical habitat for this species, including a 5-mile reach of the Nolichucky River downstream from Nolichucky Dam (River Miles 9–14; USFWS 2004).

Fish

Two of the six fish species listed in Table 22 were encountered during the survey conducted in 2000, and three of these species were found during the TWRA survey conducted in 1998. Pertinent information about all six of these species is presented in the following paragraphs.

The blue sucker inhabits relatively deep, swift waters over firm substrates in larger rivers (Etnier and Starnes 1993). It occurs throughout the Mississippi River basin and Gulf coastal drainages from the Mobile basin to the Rio Grande River. Blue suckers have been collected recently at two nearby sites in the Nolichucky River: River Mile 30.9 during the TWRA 1998 survey (Carter et al. 1999) and River Mile 42 during the TVA survey for this project (Appendix B). Both of these sites are located downstream from Nolichucky Dam.

The chucky madtom is a recently described species that is apparently closely related to members of the elegant madtom species group (*Noturus elegans*). The range of this madtom is uncertain, but it is believed to occur only in smaller tributary streams in the middle and upper parts of the Tennessee River system in Alabama and Tennessee (Mayden and Kuhajda 2000; Boschung and Mayden 2003). Within the Nolichucky River watershed, the chucky madtom is known only from Little Chucky Creek, a tributary that flows into the river at River Mile 23.5. This fish was not encountered during either recent survey of the main Nolichucky River (Carter et al. 1999; Appendix B) but was encountered at an upstream site on Little Chucky Creek during 2004 (TVA unpublished record). This rare madtom is unlikely to occur in habitats that could be affected by this project (Burr and Eisenhour 1994).

The highfin carpsucker still occurs in parts of the Mississippi River basin, in various rivers along the Gulf Coast to the Choctawhatchee River, and in the Santee and Cape Fear rivers in the Atlantic drainage of North Carolina (Etnier and Starnes 1993). This fish apparently prefers a habitat of gravel substrate in relatively clear, medium to large rivers. During the recent surveys of the Nolichucky River, this species was collected at one site downstream from Nolichucky Dam (River Mile 42; see Appendix B) and at one site upstream from Nolichucky Reservoir (River Mile 74.3; Carter et al. 1999).

The snail darter is restricted to the upper Tennessee River system, where it occurs in parts of the main river channel and in the lower reaches of some tributaries (Etnier and Starnes 1993). TVA transplanted 61 snail darters into a site on the Nolichucky River (River Mile 17.8) in 1975 as part of the snail darter recovery effort but discontinued stocking this site because of possible adverse effects on another restricted fish (Biggins and Eager 1983). In 1980, an adult snail darter was observed at Nolichucky River Mile 11.4. This fish might have been part of a small reproducing population in the river or could have been an escapee from a population then being held at the Morristown Fish Hatchery, about 5 stream miles upstream from where the individual was observed. Snail darters have not been encountered during any subsequent fish survey on the Nolichucky River (Carter et al. 1999; see Appendix B).

The tangerine darter is restricted to clearer portions of large to moderate-size headwater tributaries in the upper Tennessee River system, upstream from the Hiwassee River system (Etnier and Starnes 1993). The habitat typically occupied by this fish is deeper riffles, runs, and pools with large rubble, boulder, and bedrock substrates. During recent surveys of the Nolichucky River, tangerine darters have been encountered at two sites downstream from Nolichucky Dam (River Miles 42.5 and 45.7) and at five sites upstream from Nolichucky Reservoir (River Miles 60.5, 82.9, 93.8, 98.0, and 99.1) (Carter et al. 1999; see Appendix B).

The Tennessee dace occurs in very small, low-gradient, woodland streams in the upper Tennessee River drainage (Etnier and Starnes 1993). There is a single historic record from the Nolichucky River system more than 100 years ago, and one record in Cocke County, from a site outside the Nolichucky River watershed. Tennessee dace were not collected in either recent survey of the Nolichucky River (Carter et al. 1999; see Appendix B) and the species is not likely to occur in areas that would be affected by this project.

Amphibians

Two amphibians are listed in Table 22: the eastern hellbender and the pygmy salamander. The eastern hellbender typically occurs in medium- to large-size streams where large rocks and logs provide shelter and breeding sites (Redmond and Scott 1996). While there is only one recent hellbender record from the Nolichucky River (a 1987 siting at River Mile 15), some suitable habitat for this large salamander probably occurs wherever large rocks are relatively free of sediment.

The pigmy salamander is restricted to high-elevation habitats in the Blue Ridge Mountains along the Tennessee/North Carolina border (Ibid). Even though this species is known to occur in parts of Cocke and Greene counties, it is quite unlikely to exist within the river corridor and would not be affected by this project.

Birds

The common barn owl is the only listed bird species that has been identified as nesting in or near the project area (Table 22). During the fieldwork for this project, no common barn owls were observed; however, there is an abundance of suitable grassland foraging habitat for this species, and caves, buildings, and hollow trees in the area likely provide suitable nesting sites.

While no other listed birds were observed nesting in this project area during the fieldwork, individuals of four listed species were seen under circumstances that suggested they may be seasonal residents. Three of these species (great egret [*Casmerodius albus*], snowy egret [*Egretta thula*], and little blue heron [*Egretta caerulea*]) are all colonial wading birds, and all three are listed as in need of management in Tennessee. All three of these wading birds are uncommon in Tennessee, especially in the eastern part of the state; however, the great egret population is increasing, and its breeding range is expanding across the state. Nesting activity was not confirmed for any of these species during the Nolichucky fieldwork; however, seasonally or permanently flooded wetlands, mature woodlands, coves, shallow water areas, and existing heron colonies along the Nolichucky River would serve as suitable habitat for all three of them.

One Swainson’s warbler was encountered during the field surveys conducted in 2000. Although this bird appeared to have established a breeding territory, attempts to find a nest were unsuccessful. Swainson’s warblers are typically found along mountain streams with a dense understory, often of rhododendron, and in swamp and river cane habitats. They are rarely reported in the Valley and Ridge Province although they regularly occur in nearby portions of the Blue Ridge Mountains. The wetlands and forested floodplains around Nolichucky Reservoir appear to be suitable habitat for this species, and future studies may confirm that it does breed there.

Mammals

Eight listed mammal species have been reported from the three counties in which the possible effects of this project could occur (Table 22). Field crews examined suitable habitats adjacent to Nolichucky Reservoir and along the river for a distance downstream from the dam for signs of these species. Three listed mammal species were observed during these studies; however, habitat conditions suggest that several of the other listed mammal species also could be present. Grasslands surrounding the reservoir appear to provide suitable habitat for the meadow jumping mouse, while the mature woodlands, floodplain forests, and wetlands in the area appear to be suitable for the woodland jumping mouse, southern bog lemming, and common shrew. The southern rock vole is generally restricted to high-elevation habitats (present in the eastern parts of Cocke and Greene counties) and is not expected to occur within the river corridor.

The gray bat, a federally and state-listed endangered species, occurs in a limited geographic range that includes limestone karst areas of the southeastern United States (Greenwalt 1976; USFWS 1982). Gray bats roost in caves year-round, occupying different caves during summer and winter months. In the spring and summer months (typically early April to early September), female gray bats form maternity colonies in specific caves—usually located near water—that contain passages with domed ceilings and pools of water (Tuttle 1976). Male gray bats occupy different (bachelor) caves during summer. In winter, both sexes hibernate in large numbers in just a few caves scattered across the Southeast. Gray bats forage primarily over water and among the vegetation along rivers and reservoirs (Henry 1998; Thomas and Best 2000). Results from various studies suggest that these bats can forage up to 22 miles (35 kilometers) from their roosts (Tuttle 1976; La Val et al. 1977; Thomas and Best 2000).

During the fieldwork for this project, a cave along the shore of the Nolichucky River several miles downstream from Nolichucky Dam was found to contain a gray bat maternity colony including approximately 8,000 adult females and 2,000 young gray bats. In late August, bats from this cave were captured, examined, and released to verify their identity. While the vast majority of the animals from the cave were gray bat females, approximately 15 male gray bats were captured, one of which had been banded. This bat had been banded in the Cherokee National Forest, approximately 9 air miles from the Nolichucky River cave (Laura Mitchell, Cherokee National Forest, personal communication, June, 2001). The number of males captured at the maternity cave in late August suggests that male gray bats also use this cave as they begin to migrate toward their winter roosts.

The information collected during this work indicates that this cave is used by gray bats throughout the summer months. More than likely, bats from this cave forage along the Nolichucky River for some distance, probably including areas both upstream and downstream from Nolichucky Dam. This cave is a significant find because only two other gray bat maternity colonies of this size are known in northeastern Tennessee (Brady et al. 1982).

During the other mammal fieldwork, smoky shrews and southeastern shrews were captured within the project area. Both species are listed as in need of management in Tennessee. The smoky shrew, which is restricted to the eastern part of Tennessee, was found in its typical habitat, moist woodlands with ample leaf litter, and in grassy areas and along streams (Choate et al. 1994). The southeastern shrew, which occurs in a variety of habitats throughout Tennessee, was found near wetlands and in forested floodplains along the Nolichucky River. Both shrews can be common in areas of suitable habitat (Kennedy and Harvey 1979).

In summary, one plant and 16 animal species listed at the federal or state level were encountered or are likely to occur in areas that could be affected by one or more of the alternatives. Three of these species (birdwing pearlymussel, oyster mussel, and gray bat) are federally and state-listed as endangered species, one (spectaclecase) is an identified candidate for federal listing, one (blue sucker) is listed as threatened in

Tennessee, one (branching whitlow-wort) is a plant listed as special concern in Tennessee, and the other 10 are animals listed as in need of management in Tennessee. These animals include two fish (highfin carpsucker and tangerine darter), an amphibian (eastern hellbender), two birds (common barn-owl and Swainson's warbler), and five mammals (common shrew, meadow jumping mouse, smoky shrew, southeastern shrew, and woodland jumping mouse). Among the three federally listed species, only the oyster mussel has designated critical habitat in the project area.

3.10 LAND USE

The land in the Nolichucky River watershed is used for a variety of purposes and can be examined from a variety of perspectives. Table 23 presents a summary of land uses in the entire watershed interpreted from satellite photography taken in the early 1990s (unpublished Landsat Multispectral Scanner data). Forests cover over 70 percent of the watershed area upstream from Nolichucky Dam but account for only about 33 percent of the area downstream from the dam. Most of the decrease in the relative amount of forest cover downstream from the dam is offset by an increase in the amount of pastureland (from about 25 percent pastureland upstream from Nolichucky Dam to almost 62 percent downstream). Other general patterns include the concept that most urban development in the watershed exists in the vicinity of Nolichucky Reservoir and that most mine lands in the watershed occur in the North Toe River basin.

Other sources of land use information focus just on Greene County. An evaluation of land use/land cover data compiled by the USEPA indicates that about 63 percent of the land in Greene County is being used for agricultural purposes (cropland and pasture), while forests cover about 33 percent, residences occupy about 2 percent, and about 2 percent is used for commercial, industrial, and communication purposes (USEPA 1994). During the 1990s, tobacco was the most important cash crop, followed by beef and dairy cattle (Oregon State University Information Services 1998).

Table 23. Land Use and Land Cover in the Nolichucky River Watershed (From Unpublished Landsat Multispectral Scanner Data Collected Around 1990)

	Open Water		Wetlands		Pasture		Cultivated		Forest		Urban		Strip Mined	
Watershed Name	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
North Toe River/Headwater	67.9	0.06	8.9	0.01	9994.6	8.62	730.6	0.63	102376	88.25	954.1	0.82	906.3	0.78
South Toe River	0.2	0.00			4302.7	7.70	265.4	0.47	50860.7	91.03	352.2	0.63	70.9	0.13
North Toe River/Pigpen Creek	140.9	1.17			1338	11.13	91.4	0.76	10449.1	86.93				
North Toe River/Cane Creek	165.6	0.71	7.1	0.03	2513.5	10.77	126.4	0.54	20532.6	87.96				
North Toe River/Jacks Creek	20.1	0.15			3022.8	21.94	181.9	1.32	10554.0	76.60				
Big Rock Creek	139.8	0.32			3866.2	8.83	192.8	0.44	39592.2	90.41				
Cane River/Upper	6.8	0.02	11.8	0.03	3672.3	8.90	258.1	0.63	37027.7	89.77	184.3	0.45		
Cane River/Lower	15.5	0.03	13.9	0.02	7513.3	12.73	477.0	0.81	50979.8	86.41				
North Toe River/Pigeon Roost	616.1	1.87			968.6	2.93	23.3	0.07	31412.2	95.13				
South Indian Creek									1445.9	100.00				
Nolichucky River/Cherokee Creek	975.9	1.37	25.8	0.04	19089.9	26.88	1122.4	1.58	49389.4	69.54	421.4	0.59		
South Indian Creek	18.7	0.04	10.8	0.02	2509.4	5.04	133.2	0.27	47113.8	94.60	17.6	0.04		
North Indian Creek	45.4	0.12	12.3	0.03	3694.4	9.83	108.5	0.29	33019.1	87.86	704.2	1.87		
Nolichucky River/Davy Crockett	1561.3	1.76	199.6	0.23	58042.0	65.32	4642.3	5.22	22503.9	25.32	1902.5	2.14		
Little Limestone Creek	16.1	0.08			14922.6	78.14	627.6	3.29	3250.9	17.02	280.1	1.47		
Big Limestone Creek	28.9	0.06	3.8	0.01	38781	77.02	3765.3	7.48	7774.9	15.44				
Horse Creek	13.3	0.10	13.9	0.11	6130.6	46.40	465.5	3.52	6588.3	49.87				
Camp Creek	23.9	0.12	16.0	0.08	6353.1	31.29	650.6	3.20	13263.6	65.32				
Total Upstream From Dam	3856.4	0.52	323.9	0.04	186715	24.94	13862.3	1.85	538134	71.88	4816.4	0.64	977.2	0.13
Nolichucky River	1688.8	1.78	50.9	0.05	56015.1	58.92	5877.5	6.18	31036.1	32.65	285.3	0.30	112.0	0.12
Cove Creek	3.8	0.02			6636.7	34.57	468.3	2.44	12089.8	62.97				
Little Chucky Creek	34.3	0.12	6.8	0.03	18449.5	65.63	816.6	2.91	8425.1	29.97	377.7	1.34		
Lick Creek	175.3	0.10	158.5	0.09	105540	62.58	7196.5	4.27	55314.4	32.80	179.5	0.11	95.7	0.06
Bent Creek	43.0	0.14	1.4	0.00	22171.4	73.12	1207.0	3.98	6897.9	22.75				
Long Creek	83.5	0.32	19.1	0.07	17753.8	67.93	1273.1	4.87	6863.6	26.26	143	0.55		
Total Downstream From Dam	2029	0.55	237	0.06	226567	61.65	16839	4.58	120627	32.82	986	0.27	208	0.06
Watershed Totals	5885	0.53	561	0.05	413282	37.03	30701	2.75	658761	59.02	5802	0.52	1185	0.11

Between 1970 and 1997 the number of housing units in the county increased by 40 percent (Oregon State University Information Services 1999).

Recent aerial photographs show considerable urban growth occurring between Greeneville and the Nolichucky Reservoir. Several golf courses, athletic fields, and campgrounds have been built in the area, and many residential areas have been developed within a 2-mile radius around Nolichucky Dam.

As part of this project, TVA staff evaluated color infrared aerial photographs of the area adjacent to Nolichucky Reservoir taken during the spring of 2000 to characterize present land uses within both the 500-year and the 100-year floodplains (see Sections 2.3 and 3.7 for flood level descriptions). After the Draft EIS was issued, TVA had additional aerial photography taken of the area (in March 2002) to help clarify the locations of the 100-year and 500-year floodplains (see Section 2.3). These evaluations, presented in Table 24 and illustrated on Figure 8, show that 28 percent of the area within the 500-year floodplain (729 acres out of the total of 2,606 acres) is forested, almost 26 percent (671 acres) was evaluated to be fair pasture, 23 percent (602 acres) is covered with water, and 12 percent (318 acres) is some form of wetland (discussed in Section 3.6). These four primary uses account for 89 percent of the area within the 500-year floodplain. The remainder of the land within this area is used for cropland and good pasture (together about 198 acres, almost 8 percent of the total), residential development (32 acres, 1 percent) and other types of development activities (all together about 43 acres, 1.6 percent of the total).

Within the 100-year floodplain (a total of 2,176 acres), forestland, fair pasture, water, and wetlands account for almost 92 percent of total area, a slightly larger percentage than the same four categories occupy within the 500-year floodplain. Larger percentages of the 100-year floodplain are occupied by water and wetlands, while a smaller percentage of this area is used as pasture. Residential developments occupy about 19 acres (almost 1 percent) of the 100-year floodplain, while all of the other development activities occupy about 25 acres (just over 1 percent of the total).

Table 24. Land use/land cover categories identified during interpretation of aerial photography of the floodplain areas around Nolichucky Reservoir.

Land Use Categories	Land Use Code	Area within the 100-year floodplain Acres	Area within the 100-year floodplain Percent	Area within the 500-year floodplain Acres	Area within the 500-year floodplain Percent
Forestland	4	621.3	28.6	729.2	28.0
Fair Pasture	213	453.0	20.8	670.6	25.7
Water	5	601.5	27.5	602.8	23.1
Wetlands	various	316.8	14.6	318.0	12.2
Cropland	210	123.4	5.7	185.8	7.1
Residential, low density	112	19.2	0.9	32.5	1.2
Golf Course	1207	20.0	0.9	28.9	1.1
Good Pasture	212	6.7	0.3	12.2	0.5
Rangeland	32	9.9	0.5	12.1	0.5
Campground	1213	1.0	0.0	6.7	0.3
Electric Transmission Right-of-Way	145	3.4	0.2	3.9	0.2
Commercial and Services	12	0.2	0.0	3.4	0.1
Totals		**2176.2**	**100.0**	**2606.3**	**100.0**

Although most of the land` in the identified floodplain is used for pasture and forest, several areas are presently used as cropland. In an area between Johnson and Bird islands, there are about 30 acres of cropland within the 500-year floodplain, 16 acres of which are located within the 100-year floodplain. The identified 500-year floodplain along Camp Creek contains portions of eight crop fields, 28 acres of which is within the 100-year floodplain and an additional 12 acres within the 500-year floodplain. Just upstream from the mouth of Camp Creek, portions of three crop fields within the 100-year floodplain total about 25 acres. Across the river from Simpson Island, 26 acres of cropland occurs within the 500-year floodplain, 11 acres of which are within the 100-year floodplain. As indicated in Section 3.2, prime farmland soils occur on approximately 490 acres (27.6 percent) of the land used for crops and pasture within the 500-year floodplain. Approximately 356 acres of these prime farmland soils (16.4 percent) occur within the 100-year floodplain.

Land ownership in this area is discussed in Section 2.3, summarized in Table 2, and illustrated in Appendix A. As indicated in that section, the federal government owns approximately 1,400 acres of land under and around Nolichucky Reservoir, and has flowage easements over an additional approximately 370 acres adjacent to the reservoir. The federal ownership rights represent approximately 60 percent of the area within the 100-year floodplain and approximately 51 percent of the area within the 500-year floodplain.

Most of the obviously developed land in the floodplain area is located within about 2.5 miles of Nolichucky Dam. The only substantial exception to this pattern identified during the examination of the aerial photography is 5.2 acres of commercial property within the 500-year floodplain that borders John Sevier Highway on the southeastern side of the river. Other starting or planned development activities would not be detectable on the aerial photographs. Even though the present acreage totals are relatively small, almost twice as much land within the 500-year floodplain is being used for residential development than within the 100-year floodplain. This difference may indicate increasing pressure to build homes on this rarely flooded land.

The aerial photographs also were used to make preliminary counts of the number of buildings within the 100- and 500-year floodplain areas around Nolichucky Reservoir. These buildings were examined in the field to determine which ones actually were located within the identified floodplains. The results of these adjusted counts, presented in Table 25, indicate that houses and mobile homes make up more than two-thirds of the structures within both the 100-year and 500-year floodplains. Most of the other buildings in both floodplain areas are barns.

Table 25. Types of Buildings Located in the Floodplain Areas Around Nolichucky Reservoir

Building Type	Within 100-Year Floodplain	Within 500-Year Floodplain
House	20	34
Mobile Home	12	15
Barn	12	22
Utility[1]	1	1
Totals	**45[2]**	**72[2]**

Note: Buildings within the 100-year floodplain are also included in the 500-year floodplain counts.

[1]The Greeneville water intake structure

[2]At lease 12 smaller structures also occur within the 100-year floodplain (17 in the 500-year floodplain). These structures include sheds, garages, and outhouses (restroom facilities).

3.11 VISUAL CHARACTER, RECREATION, AND MANAGED AREAS

Visual Character

The physical, biological, and cultural features of an area combine to make the visual character both identifiable and unique. Visual character of an area often is described in terms of its scenic integrity and scenic attractiveness. Scenic integrity indicates the degree of unity or wholeness of the visual character. Scenic attractiveness considers any outstanding or unique natural features, scenic variety, seasonal change, and strategic location.

Where and how the landscape is viewed also affects the aesthetic quality and sense of place. Views of a landscape are described in terms of what is seen in foreground, middleground, and background distances. In the foreground, an area within 0.5 mile of the observer, details of objects are easily distinguished in the landscape. In the middleground, normally between 1-4 miles from the observer, objects may be distinguishable, but their details are weak and they tend to merge into larger patterns. Details and colors of objects in the background, the distant part of the landscape, are not normally discernible unless they are especially large and standing alone. The impressions of an area's visual character can have a significant influence on how it is appreciated, used, and protected.

The visual character of the Nolichucky River watershed is typical of many east Tennessee River valleys. Most of the river corridor is wooded; however, steep, rocky banks and sandy islands also are present in some areas. The land away from the river consists primarily of heavily vegetated woodlands and gently rolling topography that merge into steep mountainous terrain to the southeast. The countryside is a varied mix of woodlands, open pasture, and isolated residential areas with few major highways. Together, the natural and developed elements in this watershed provide attractive scenic variety and form a relatively harmonious rural landscape.

The area around Nolichucky Reservoir includes sparse residential development and the shoreline is an object in the foreground or middleground view from some homes. Some wetland areas are visible from the river while navigating by boat. Scenic integrity is moderate to high. The natural and developed elements provide variety, scenic attractiveness, and visual harmony with few contrasting elements in the landscape.

The primary way to view the river upstream or downstream from Nolichucky Dam is by boat. Limited parts of the river can be viewed by motorists at bridge crossings where the river is in the immediate foreground and middleground. From the river, the bridge crossings are seen in the foreground.

Recreation

From a recreation perspective, Nolichucky Reservoir is located between Cherokee and Douglas reservoirs to the west and south and Watauga, South Holston, Fort Patrick Henry, and Boone reservoirs to the northeast. These larger, more open, reservoirs attract and support most of the typical water recreation activities in upper east Tennessee. Nolichucky Reservoir offers a relatively unique recreation resource in this area because its small size and narrow width do not attract the big boats, water skiers, and personal watercraft that are common on the larger reservoirs. Nolichucky is about the only reservoir in east Tennessee where a small boat or canoe can be on the water and not have to contend with the waves and noise of bigger, more powerful boats. The majority of the reservoir has little development along the immediate shoreline and provides a quiet, almost solitary recreation experience.

Recreational activities occurring on the reservoir include bank fishing, fishing from small boats, canoeing, and waterfowl hunting. Boat access to the reservoir is provided by ramps at River Mile 47.4 (Kinser Park) and at River Mile 50.3, adjacent to Bird Bridge. Both of these ramps are concrete and have small gravel parking lots.

Kinser Park is a 286 acre park located on the reservoir at River Mile 47. The park, developed on federal land but covered by a permanent recreation easement, includes a campground with 157 recreational vehicle campsites and approximately 60 tent camping sites. In addition, Kinser Park includes a water slide, swimming pool, miniature golf course, 9-hole golf course, tennis courts, and ball fields. This is primarily a facilities-oriented park where most visitors do not use many features associated with the reservoir.

Under a TVA license agreement, Cedar Creek Learning Center uses and maintains facilities adjacent to Nolichucky Dam as a residential environmental education center. This center provides continuing education services to about 2,200 children per year. Each visit is dedicated to bird watching, canoeing, plant identification, wildlife observation and/or other outdoor activities.

The Nolichucky River is a popular local recreation resource both upstream and downstream from Nolichucky Reservoir. TVA has developed boat access sites at River Miles 46 and 106.5, and owns potential access sites at River Miles 28, 54.1, 60.4, 70.5, and 86.6. TWRA maintains developed access sites at River Mile 32.1 (Easterly Bridge) and at River Mile 68.6 (Davy Crockett Birthplace State Park). The river provides anglers with the opportunity to catch all species of black bass, rock bass, and muskellunge; however, no angler use or harvest data are available (Carter et al. 1999). TWRA considers this river to support one of east Tennessee's better warm water sports fisheries (Ibid), and several local fishermen consider the Nolichucky to be one of the best smallmouth bass streams in the country.

Far upstream from Nolichucky Reservoir, the river is stocked with rainbow trout, which provides additional fishing opportunities. The Nolichucky Gorge, an upstream reach of the Nolichucky River near Erwin, Tennessee, is used by several commercial rafting companies and many recreational boaters. The U.S. Forest Service (1994) found part of the river in the gorge eligible for Wild and Scenic River designation.

Hunting in the vicinity of the Nolichucky River is a popular outdoor activity. The river corridor, in combination with surrounding agricultural activities and floodplain forests, provides quality habitat for a variety of game species, including white-tailed deer, gray squirrel, eastern cottontail rabbit, raccoon, eastern wild turkey, northern bobwhite, mourning dove, and waterfowl. A wildlife management area on the reservoir supports approximately 200 resident Canada geese and 500 migrant ducks (TVA and USACE 1999). The floodplain forests along the river provide quality wood duck nesting habitat. Open fields on the management area are managed for mourning doves. In the fall, wood ducks gather in the shallow waters near the dam before their migration. The wildlife management area is closed to waterfowl hunting during the regular statewide waterfowl season; however, wood ducks, teal, and Canada geese in the area can be harvested during special seasons. Typically, 50 to 75 hunters harvest several hundred doves from the management area during the first few days of dove season each September. Overall, hunting pressure on the wildlife management area is considered light (Ron Saunders, TWRA, personal communication, September 2000).

Managed Areas

Information available to the TVA Heritage database indicates that one designated resource management area occurs on Nolichucky Reservoir. Two other designated management areas occupy parts of the Nolichucky River watershed some distance downstream from Nolichucky Dam.

The **Nolichucky State Wildlife Management Area** is located on Nolichucky Reservoir, extending from Nolichucky Dam (River Mile 46.0) upstream to Bird Bridge (River Mile 50.5). This approximately 1,000-acre area is federal land that is managed by the TWRA under a license agreement. As indicated in above, the management area is closed to all hunting and access is restricted during the regular statewide waterfowl season. This allows the area to function as a waterfowl refuge during that time of the year. The closure period varies each year according to the statewide season, but usually occurs from early December through late January. Hunting for wood ducks, teal, and Canada geese is permitted during special seasons. A five-year management plan for this area was written for the period 1988 to 1992. This plan has not been updated, but overall management objectives remain unchanged. In addition to game management, this area also provides opportunities for viewing migrating waterfowl, winter resident ducks and geese, and a variety of wetland and forest species. A trail system around the reservoir exists, but most of the trails are in disrepair and public access is limited, especially at the dam site (Bob Ripley, TWRA, personal communication, September 2000).

The Nolichucky Reservoir area has been proposed as a possible National Natural Landmark (DeSelm 1984). The proposal indicated the area is noted for the combination of wetland and floodplain communities that occur around the reservoir and the migrating waterfowl these habitats attract. The National Landmark Program was established in the 1970s by the U.S. National Park Service to identify nationally significant examples of ecologically pristine or near-pristine landscapes. Nolichucky Reservoir, while considered to meet the listing criteria, has not been registered as a National Natural Landmark.

The **Joe Neill Easement** is a 150-acre tract located along the Nolichucky River at the mouth of Little Chucky Creek (River Mile 23.5). In 1999, the owners of this tract entered into a permanent conservation easement with the Tennessee Parks and Greenways Foundation to protect the rich aquatic diversity (including the chucky madtom) in Little Chucky Creek; the statewide significance of this area for water quality and recreational use; and the vegetative corridors that provide habitat for river otters, white-tailed deer, wood ducks, and wild turkey (Tennessee Parks and Greenways Foundation 1999a; TDEC 1998). This tract also is close to three TWRA wildlife management areas in the Lick Creek watershed and would help connect these areas to other wildlife areas across Tennessee. The conservation easement allows for operation of a canoe business on the Nolichucky River and timber harvesting on the tract, but hardwoods must be replanted in accordance with the foundation's guidelines (Kathleen Williams, Tennessee Parks and Greenways Foundation, personal communication, September 2000; Tennessee Parks and Greenways Foundation 1999b). The deed also places restrictions on development and prohibits any alteration of the surface of the land; any use that causes significant soil degradation or erosion; any use that causes significant pollution to surface or subsurface waters; and the draining, filling, dredging, or diking of Little Chucky Creek or the Nolichucky River by present or subsequent landowners (Tennessee Parks and Greenways Foundation 1999b).

The **Rankin Bottom State Wildlife Management Area** is a 1,255-acre area located north and south of Rankin Bridge on Douglas Reservoir adjacent to the mouth of the Nolichucky River (Ron Saunders, TWRA, personal communication, February 2000). This federal land is operated by TWRA under a lease agreement. TWRA opens the area for the hunting of waterfowl, small game, and big game species, including mourning dove, northern bobwhite, American woodcock, ruffed grouse, common snipe, gray squirrel, eastern cottontail, raccoon, opossum, and white-tailed deer (TWRA 2000). Waterfowl hunting is allowed during deer seasons (Ibid).

The **Rankin Bottoms State Wildlife Observation Area** consists of 740 acres within the Rankin Bottoms Wildlife Management Area that has been recognized by TWRA as having wildlife viewing opportunities. The mudflats, marshes, and sloughs in this area offer opportunities to view shorebirds, primarily during the fall migration. A variety of sandpipers, egrets, herons, and resident and migrating songbirds are common in this area during late summer and fall, while waterfowl, bald eagles, wintering songbirds, northern harriers, and short-eared owls occur here during the winter months (Hamel 1993). No observation facilities are available, so viewing must be done from the roadsides, shoreline, or on the water.

Various parts of the Nolichucky River watershed have been assessed as being of statewide or greater, regional, and local significance for its natural and scenic qualities. This rating, based on an overall aesthetic value, was determined by TDEC in cooperation with the Tennessee Scenic Rivers Association, TWRA, and the citizens of Tennessee. In a full assessment of the Nolichucky watershed, Meadow Creek (near River Mile 40) and Camp Creek (near River Mile 56) were both noted as having sections of regional natural and scenic significance. Nine streams within the geographic scope of this project were rated as locally significant (TDEC 1998).

3.12 CULTURAL RESOURCES

Relatively few studies of specific archaeological or historical sites have been conducted in the Nolichucky River watershed adjacent to Nolichucky Reservoir. The following information about known archaeological sites in Greene County is derived from the site files of the TDEC Division of Archaeology (Suzanne Hoyal, TDEC, personal communication, 2000).

Native Americans first entered the Nolichucky River valley and other areas in east Tennessee about 12,000 years ago. As in other parts of eastern North America, human occupation of the area is generally divided into five broad cultural periods: Paleo-Indian (10,000-8000 B.C.), Archaic (8000-1000 B.C.), Woodland (1000 B.C.-A.D. 900), Mississippian (A.D. 900-1650), and Historic (A.D. 1650-present). These periods are separated from each other based on the ways people used the land and the types of settlements they built. Short- and long-term living sites generally were located on floodplains and terraces along rivers and streams, while specialized campsites tended to be on higher terraces and away from streams.

The Paleo-Indians were mobile bands of hunters and gatherers. They hunted large Ice Age animals, such as mammoths and mastodons, and gathered edible wild plants, seeds, and nuts. Although only one transitional Paleo-Indian site (ca. 8000 B.C.) has been identified in Greene County, other Paleo-Indian sites almost certainly exist in the Nolichucky River valley.

At the beginning of the Archaic Period, the people still lived as hunters and gatherers; however, the climate was changing and the large animal species were dying out. Hunting strategies changed to deal with animals more typical of the modern environment, such as deer, bear, turkeys, fish, and turtles. As the forests changed from evergreen trees to the oak-hickory forests found in the area today, gathering assumed more importance and the people started collecting chestnuts, acorns, walnuts, and hickory nuts. Near the end of the Archaic Period, the people started to cultivate some local plant species such as sunflower, chenopodium, and amaranth. Thirty-six sites dating to the Archaic Period have been identified in Greene County.

The Woodland Period is characterized by the introduction of pottery and widespread trading networks, eventually including goods from as far away as the Great Lakes, the Ohio River valley, and the Gulf of Mexico. During this period, plant cultivation became more important and included corn and other crops that have origins in Mexico and Central America. Twenty Woodland Period sites have been recorded in Greene County.

A major change occurred around A.D. 900 when cultural influences from Mexico spread throughout the Southeast. During this Mississippian Period, permanent villages were established and societies became more complex with the development of a ruling class, craft specialization, and intensive horticulture based on corn, beans, and squash. Some settlements served as political centers, where temples and/or residences of the ruling class were constructed on top of pyramidal mounds. These chiefdom-level societies were described by Spanish explorers who traveled through the Southeast in the mid-16th century. Eight Mississippian Period sites have been identified in Greene County.

In the 16th and 17th centuries, the Cherokee Indian tribe began occupying villages in east Tennessee, including the Nolichucky River Valley. The Cherokees, who are related to the Iroquois Indians of the eastern Great Lakes/New York area, were distinct from the Mississippian culture, the ancestors of the Muscogean (Creek) Indians. The first contact with European colonists from the Atlantic coast occurred during the period of Cherokee settlement. These contacts are represented by the presence of European-manufactured trade items on Cherokee culture sites. Four sites from this period have been identified along the Nolichucky River in Greene County.

European settlement began in the Nolichucky valley about the middle of the 18th century, some of the earliest European settlements in Tennessee. By 1783, the population had grown sufficiently that Greene County was established as part of the state of North Carolina. A number of historical figures and events are associated with Greene County, including frontiersman Davy Crockett, actions during the American Civil War, and President Andrew Johnson (Semmer 1998). Sixty-five archaeological sites associated with historic European settlement have been identified in Greene County.

Archaeological Resources

The parts of the Nolichucky River valley that could be affected by this project can be divided into three sections: the area within the 500-year floodplain surrounding Nolichucky Reservoir, the area covered by the reservoir pool, and the floodplain downstream from the dam. Very few professional archaeological studies have been conducted in any of these areas.

Only three archaeological sites have been recorded within the 500-year floodplain associated with Nolichucky Reservoir. One of these sites, the Camp Creek site, was extensively investigated in the 1950s and is considered a benchmark site for the early Woodland Period in east Tennessee (Lewis and Kneberg 1957). The number of other sites that exist on the river terraces in this area is expected to be relatively high. Where systematic surveys have been conducted in similar areas (such as the upper Duck River basin, TVA 2000), the results indicate that archaeological site density on river terrace formations can easily be as high as one site per 10 acres. If this general pattern applies in this project area, there might be as many as 200 archaeological sites within the 500-year floodplain upstream from Nolichucky Dam. Some of these sites relatively close to the river probably are protected by sediment deposited since the dam was built.

No archaeological resources are known to occur in the area covered by the reservoir pool; however, some of that land would have been logical settlement sites during both the prehistoric and historic periods. A preimpoundment map of the area published in 1914 shows a number of cultural features adjacent to the river (Baldwin 1914). These sites included houses, outbuildings, bridges, a cemetery, a grist mill, and a ferry. Archaeological evidence of many of these historic features and a number of prehistoric sites may be preserved under the sediment deposits in the reservoir.

Twelve archaeological sites have been identified on the floodplain downstream from Nolichucky Dam. Five of these sites were found during surveys associated with bridge replacement projects. The seven remaining areas are mostly large, conspicuous sites reported by nonprofessional archaeologists. The floodplains and terraces of the Nolichucky River become progressively more extensive downstream from the dam, especially downstream from River Mile 27. There is an extremely high potential for archaeological sites to exist in these areas, particularly adjacent to the river bank. The density of these sites might be as high as one site per 10 acres in appropriate locations.

Historic Structures

TVA gathered preliminary information about historic structures around Nolichucky Reservoir and on the floodplain downstream from the dam by comparing recent and older maps of the area, then conducting a survey of those sites on the ground. Upstream from the dam, structures were identified within both the 100-year and 500-year floodplains. Downstream from the dam, structures were identified within a zone approximately in the floodplain. The survey used the evaluation standards required to nominate these structures for listing on the NRHP in accordance to Section 106 of the NHPA.

Most of the surviving buildings are individual homes or farm structures; however, the remains of a few small communities and mills also survive. Upstream from Nolichucky Dam, 34 structures were evaluated within the approximate limits of the 500-year floodplain. Nineteen of these structures, including Nolichucky Dam and Powerhouse, probably would be affected by a 500-year flood and could be considered eligible for listing on the NRHP. Eleven of these likely eligible structures, if they still exist, appear to be located within the 100-year floodplain. These structures include houses, a mill and mill dam, and Nolichucky Dam and Powerhouse. At this time, however, other than the dam and powerhouse, it is not known if these other privately owned structures still exist or whether they are still eligible for listing on the NRHP.

Downstream from the dam, at least 54 structures over 50 years old were identified in the floodplain. Of these, 47 probably would be considered eligible for listing on the NRHP. Other eligible structures might occur in the project area; however, relatively few unnoticed buildings should be in floodplain areas that could be affected by the alternatives.

3.13 SOCIOECONOMICS

As previously stated, Nolichucky Dam and Reservoir are located in Greene County, Tennessee. Interstate 81 and U.S. Route 11E run northeast-southwest through the county, connecting Greeneville with Morristown to the west and with Johnson City, Kingsport, and Bristol to the northeast. U.S. Route 321 runs southwest from Greeneville and connects with Interstate 40 at Newport. These major highways link the counties in this area into a single labor market, within which most of the people live and work. The seven counties in this labor market area are identified in Table 26.

The 2000 population in Greene County is 62,909, approximately 13 percent of the population in the entire labor market area (Table 26). Most of the people in this labor market area (53 percent) live in Sullivan and Washington counties, the central counties of the Johnson City-Kingsport-Bristol metropolitan area. During the 1980s and 1990s, this labor market area has

Table 26. Population Statistics for Counties in the Labor Market Area Surrounding Greene County, Tennessee

Counties	1980 Census	1990 Census	2000 Census	Percent Change 1980-1990	Percent Change 1990-2000
Cocke County	28,792	29,141	33,565	1.2	15.2
Greene County	**54,422**	**55,832**	**62,909**	**2.6**	**12.7**
Hamblen County	49,300	50,480	58,128	2.4	15.2
Hawkins County	43,751	44,565	53,563	1.9	20.2
Madison County NC	16,827	16,953	19,635	0.7	15.8
Sullivan County	143,968	143,596	153,048	- 0.3	6.6
Washington County	88,755	92,336	107,198	4.0	16.1
Market Area Total	425,815	432,903	488,046	1.7	12.7
Tennessee	4,591,023	4,877,203	5,689,283	6.2	16.7
United States (000)	226,546	248,710	281,422	9.8	13.2

Source: Bureau of the Census, U. S. Department of Commerce.

experienced relatively slow population growth compared to all of Tennessee, increasing by 1.7 percent from 1980 to 1990 and 12.7 percent from 1990 to 2000. In recent years, the rate of population growth has varied widely among the counties in the labor market area. For example, from 1990 to 2000, population growth rates ranged from 6.6 percent in Sullivan County to 20.2 percent in Hawkins County.

In 2004, the labor market area had an average labor force of almost 250,000 persons, of whom about 15 percent (almost 38,000 persons) lived in Greene County (Table 27). The unemployed part of the labor force in the market area was 13,496, 5.4 percent of the total. This unemployment rate was somewhat higher than the average rate for Tennessee, but very close to the national rate. At the county level, unemployment rates ranged from a low of 4.6 percent in Washington County to 7.6 percent in Cocke County. The unemployment rate in Greene County was relatively high, at 7.2 percent.

Table 27. Average 2004 Labor Force and Unemployment Statistics in Counties in the Labor Market Area Surrounding Greene County, Tennessee.

Counties	Civilian Labor Force	Unemployed	Unemployment Rate
Cocke County	16,760	1,280	7.6
Greene County	**37,580**	**2,690**	**7.2**
Hamblen County	31,130	1,500	4.8
Hawkins County	25,670	1,420	5.5
Madison County, NC	9,550	506	5.3
Sullivan County	74,820	3,610	4.8
Washington County	54,440	2,490	4.6
Market Area Total	249,950	13,496	5.4
Tennessee	2,934,000	144,900	4.9
United States (000)	147,401	8,149	5.5

Source: Tennessee Department of Labor and Workforce Development, Employment Security Division, and North Carolina Employment Security Commission

Table 28 summarizes employment by three broad job categories. A higher percentage of persons in this labor market work in manufacturing jobs than elsewhere in the state and the nation, while somewhat more work in farming, and fewer work in services. Greene County is considerably more oriented toward farming and slightly less oriented toward services than several other counties in the labor market area. Across Tennessee and the nation, a higher percentage of people in Greene County work in manufacturing than the average.

Table 28. Full- and Part-Time Employment by Industry in Counties in the Labor Market Area Surrounding Greene County, Tennessee

Counties	**Total Employment**	**Percent in Farming**	**Percent in Manufacturing**	**Percent in Services**
Cocke County	12,778	9.2	17.0	26.6
Greene County	**37,737**	**11.1**	**24.7**	**24.8**
Hamblen County	41,916	2.1	31.9	26.4
Hawkins County	20,184	11.8	24.5	22.3
Madison County NC	7,621	14.5	10.8	30.7
Sullivan County	90,023	1.9	17.6	36.0
Washington County	70,858	3.7	12.4	36.0
Market Area Total	281,117	5.0	19.7	31.5
Tennessee	3,463,526	3.1	12.7	36.0
United States (000)	167,033.5	1.8	9.5	38.6

Source: Bureau of Economic Analysis (1997), U. S. Department of Commerce, Regional Economic Information System, 1969-2002.

Average per capita personal income in 2002 was $24,275 in Greene County and $24,162 in the labor market area (Table 29). Both of these amounts are below the state average of $27,611 and less than 80 percent of the national average of $30,906. Cocke County had the lowest average personal income in the market area at $18,777, less than 61 percent of the national average. Sullivan County had the highest market area average at $26,306, about 85 percent of the national average.

Table 29. Per Capita Personal Income in the Labor Market Area Surrounding Greene County, Tennessee

Counties	Per Capita Income, 1992	Per Capita Income, 2002	Percent of Nation, 1992	Percent of Nation, 2002
Cocke County	13,492	18,777	64.7	60.8
Greene County	**15,638**	**24,275**	**75.0**	**78.5**
Hamblen County	16,990	24,747	81.5	80.1
Hawkins County	15,492	21,564	74.3	69.8
Madison County NC	13,812	21,097	66.2	68.3
Sullivan County	18,812	26,306	90.2	85.1
Washington County	18,006	24,323	86.3	78.7
Market Area Average	17,122	24,162	82.1	78.2
Tennessee	18,577	27,611	89.1	89.3
United States	20,854	30,906	100.0	100.0

Source: Bureau of Economic Analysis (1997), U.S. Department of Commerce, Regional Economic Information System, 1969-2002.

Between 1992 and 2002, the labor market area lost almost 4 percentage points in per capita income in comparison to the rest of the nation, falling from about 82 percent of the national average to about 78 percent. In contrast, the state remained slightly above 89 percent of the national average. Greene County gained more than 3 percentage points on the national average, from 75.0 to 78.5 percent. The average per capita income in Cocke, Hamblen, Hawkins, Sullivan, and Washington counties declined in comparison with the national average.

3.14 ENVIRONMENTAL JUSTICE

Environmental justice refers primarily to ensuring that no segment of the population bears a high burden of health or environmental impacts of society's activities. Some studies suggest that poor, predominantly minority, populations are exposed to more than a normal amount of adverse health and environmental impacts because of the way siting decisions are made for facilities with potential adverse effects. Other studies dispute these findings. Because of these concerns, Executive Order No. 12898 directed certain federal agencies and requested others to consider environmental justice in environmental reviews.

As indicated in Table 30, the minority population accounted for 4.1 percent of the total in Greene County and 5.5 percent of the total in the labor market area in 2000. Both of these percentages are considerably lower than the average minority percentage in Tennessee and across the nation. Almost 51 percent of the minority population in this labor market area lived in Sullivan and Washington counties. Hamblen County had the highest minority population (11.5 percent); the other counties in the area had relatively small minority populations.

Table 30. Minority and Low-Income Population for Counties in the Labor Market Area Surrounding Greene County, Tennessee

Counties	Total Population 2000	Nonwhite Population 2000	White Hispanic Population 2000	Percent Minority Population 2000	Percent Below Poverty Level 1999
Cocke County	33,565	1,288	221	4.5	22.5
Greene County	**62,909**	**2,250**	**350**	**4.1**	**14.5**
Hamblen County	58,128	5,396	1,271	11.5	14.4
Hawkins County	53,563	1,477	287	3.3	15.8
Madison County NC	19,635	466	165	3.2	15.4
Sullivan County	153,048	5,277	735	3.9	12.9
Washington County	107,198	6,732	888	7.1	13.9
Market Area Total	488,046	22,886	3,917	5.5	14.6
Tennessee	5,689,283	1,125,973	57,380	20.8	13.5
United States (000)	281,421.9	69,961.3	16,907.9	30.9	12.4

Source: Bureau of the Census, U. S. Department of Commerce

The poverty rate in the labor market area in 1999 was 14.6 percent, slightly higher than the state and national averages. The rate in Greene County was about the same at 14.5 percent. Poverty rates within the labor market area range from 12.9 percent in Sullivan County to 22.5 percent in Cocke County.

Nolichucky Reservoir is bordered on the northwest by Census Tract 905 and on the southeast by Census Tract 910. These census tracts are subcounty geographic units used by the U.S. Census Bureau and are among the smaller units for which the periodic census data are available. Areas northwest of the river from Nolichucky Dam downstream almost to the Cocke County line are in Census Tract 906, while the southeast side of the river is in Census Tract 911.

According to the 2000 Population Census, the areas on each side of the reservoir had lower percentages of minority populations than the county as a whole and lower poverty rates than the county average poverty rate. In 2000, the county population included 4.1 percent minorities, while Tract 905 had 3.2 percent and Tract 910 had 2.2 percent. The poverty rate for the entire county in 1999 was 14.5 percent, while the rate in Tract 905 was 12.0 percent and the rate in Tract 910 was 13.6 percent.

The census tracts downstream from the dam also had lower minority population shares in 2000. In Tract 906, the minority population share was 2.2 percent, while in Tract 911; the minority share was 2.8 percent. The poverty rate in Tract 906 was 13.0, somewhat lower than the county rate, but in Tract 911, the poverty rate was 15.2 percent, slightly higher than the county rate.

This page intentionally left blank