Water-Resources Investigations Report 92-4082

RECENT SEDIMENTATION AND SURFACE-WATER FLOW PATTERNS ON THE FLOOD PLAIN OF THE NORTH FORK FORKED DEER RIVER, DYER COUNTY, TENNESSEE

Prepared by the
U.S. GEOLOGICAL SURVEY

in cooperation with the
TENNESSEE WILDLIFE RESOURCES AGENCY

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Cover photograph. *South side outlet of Tigrett Wildlife Management Area, Dyer County, Tennessee. Note roots of old cypress stump and roots of small tree on top of stump. Photograph by Bradley A. Bryan, U.S. Geological Survey.*

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Nashville, Tennessee
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Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	259.0	hectare
square mile (mi^2)	2.590	square kilometer
	Volume	
cubic foot (ft^3)	0.02832	cubic meter
cubic foot (ft^3)	28.317	liter
cubic foot (ft^3)	28,317	cubic centimeter
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
	Sediment Deposition	
foot per year (ft/yr)	30.48	centimeter per year

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

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By **William J. Wolfe** *and* **Timothy H. Diehl**

ABSTRACT

Sedimentation in the 19th and 20th centuries has had a major effect on surface-water drainage conditions along a 7-mile section of the North Fork Forked Deer River flood plain, Dyer County, Tenn. During the century prior to 1930, 5 to 12 feet of sediment were deposited over much of the flood plain, resulting in channel obstruction and widespread flooding. The estimated bankfull capacity of the natural channel before it was channelized in 1916 was comparable to the base flow of the river during the 1980's.

Ditching of the river between 1916 and 1921 was followed by reductions in sedimentation rates over parts of the flood plain. However, the effects of sedimentation have persisted. Occlusions along the natural channel of the river have divided this stream reach into a series of sloughs. These sloughs continue to fill with sediment and are surrounded by ponds that have expanded since 1941.

Degradation of the North Fork Forked Deer ditch may eventually reduce ponding over much of the flood plain. Active incision of headcuts in both banks of the ditch is enhancing the drainage of widespread ponded areas. These headcuts likely will have limited effect on drainage of most tributaries.

The highest recent sedimentation rates, in places more than 0.2 foot per year, are concentrated near the flood-plain margin along tributary streams. In conjunction with beaver dams and debris, ongoing sedimentation has blocked flow in several tributaries, posing a flood hazard to agricultural land near the flood-plain margin. The occluded tributaries likely will continue to overflow unless they are periodically dredged or their sediment loads are reduced.

INTRODUCTION

Obstructed surface-water drainage is a recurrent problem in the flood plains of most major streams in West Tennessee (Ashley, 1910; Tennessee State Planning Commission, 1936; Robbins and Simon, 1983). Little information is available on valley-bottom drainage conditions at the time of initial European settlement in the early and mid-1800's, but by the late 1800's many channels in West Tennessee were choked by sediment and debris (Ashley, 1910; Morgan and McCrory, 1910). Land clearing and row-crop agriculture in upland parts of drainage basins during the 19th century greatly accelerated upland erosion and valley-bottom sedimentation over their pre-settlement rates (Happ and others, 1940; Trimble, 1976; Knox, 1987; Barnhardt, 1988a, 1988b). Subsequent flooding of the valley bottoms hampered logging and farming operations. This led local landowners to seek engineering solutions to drainage problems in the early 1900's (Ashley, 1910).

Efforts to improve drainage focused on increasing channel capacity through such means as straightening, dredging, and snagging the channels, and clearing the banks of vegetation (Robbins and Simon, 1983). Such measures were commonly effective over the short term, but improvement of drainage was often temporary or accompanied by unforeseen and undesirable side effects. Commonly, the dredged channels filled quickly with sediment, or became deeper and wider, damaging adjacent forest and agricultural land in the process (Robbins and Simon, 1983).

In some instances, channel modifications may impede, rather than encourage, drainage on the flood plain adjacent to the channel. Spoil banks are generally too low to keep flood water from entering the flood plain. Natural levee deposits and sand splays may accumulate along the spoil banks, further isolating the flood plain from the channel and promoting ponding. These effects resemble the problems that channel modifications are intended to correct, and complicate efforts to understand and alleviate drainage problems in the flood plains of modified channels.

The Tigrett Wildlife Management Area (WMA), and adjacent areas of the flood plain of the North Fork Forked Deer River, near Dyersburg, Tenn. (fig. 1), are characterized by drainage conditions typical of the valley bottoms of many modified streams in the region. Large areas of the flood plain are ponded throughout the year, and substantial tracts of cypress (*Taxodium distichum*) and bottomland hardwoods are dead or dying. Owners of agricultural land adjacent to the WMA have complained of increased flooding along tributary streams (J.W. Johnson, Tennessee Wildlife Resources Agency, written commun., 1991).

Management of drainage in the WMA and similar areas, whether for wildlife, timber, or agriculture, requires an understanding of the present surface-water flow patterns. Because flood-plain drainage is partly determined by the distribution and accumulation of sediment, such understanding requires knowledge of the flood-plain sediments and the factors that control their deposition.

The U.S. Geological Survey (USGS), in cooperation with Tennessee Wildlife Resources Agency (TWRA), conducted a study to identify the major surface-water flow paths in the flood plain, to assess their relation to recent sedimentation, and to improve understanding of the effects of recent sedimentation on surface-water drainage conditions in the flood plain of the North Fork Forked Deer River. The study was conducted in and near the Tigrett WMA (fig. 1) in 1991.

Purpose and Scope

This report describes the results of the study of the North Fork Forked Deer River flood plain. The study focused on two major objectives: (1) the determination of recent (since about 1800) sedimentation rates; and (2) the identification and location of major surface-water flow paths and determination of their relation to recent sedimentation.

The study objectives were accomplished in several stages.

1. Literature on sedimentation and drainage problems in the study area was reviewed.
2. Stratigraphic relations of the upper 20 feet of flood-plain sediments were established through field investigations and examination of the logs of soil borings.
3. Recent rates of flood-plain sedimentation were determined at selected sites by radiocarbon dating and tree-ring analysis.
4. Locations and approximate dimensions of major surface-water flow paths in the study area were determined by field surveys and analysis of survey records, bridge plans, and aerial photographs.

Fieldwork was accomplished between May and September 1991, and was largely confined to the flood plain of the North Fork Forked Deer River along a reach 2.5 to 10 miles upstream from Dyersburg, Tenn. (fig. 1). Data collection included radiocarbon dating of buried tree stumps, tree-ring analysis, calculation of sedimentation rates, and measurement of channel-bed and water-surface elevations. Published and unpublished reports, maps, survey records, and aerial photographs provided background for this study.

Previous Studies

Accounts of drainage problems in West Tennessee were published in the early 1900's. Ashley (1910) outlined the organization and financing of drainage districts in 1910, and reported that the obstruction of some channels by sediment and debris was a relatively recent phenomenon. He attributed channel and valley sedimentation to agricultural practices in the uplands and noted that long-term solutions to valley drainage problems must encompass entire drainage basins (Ashley, 1910).

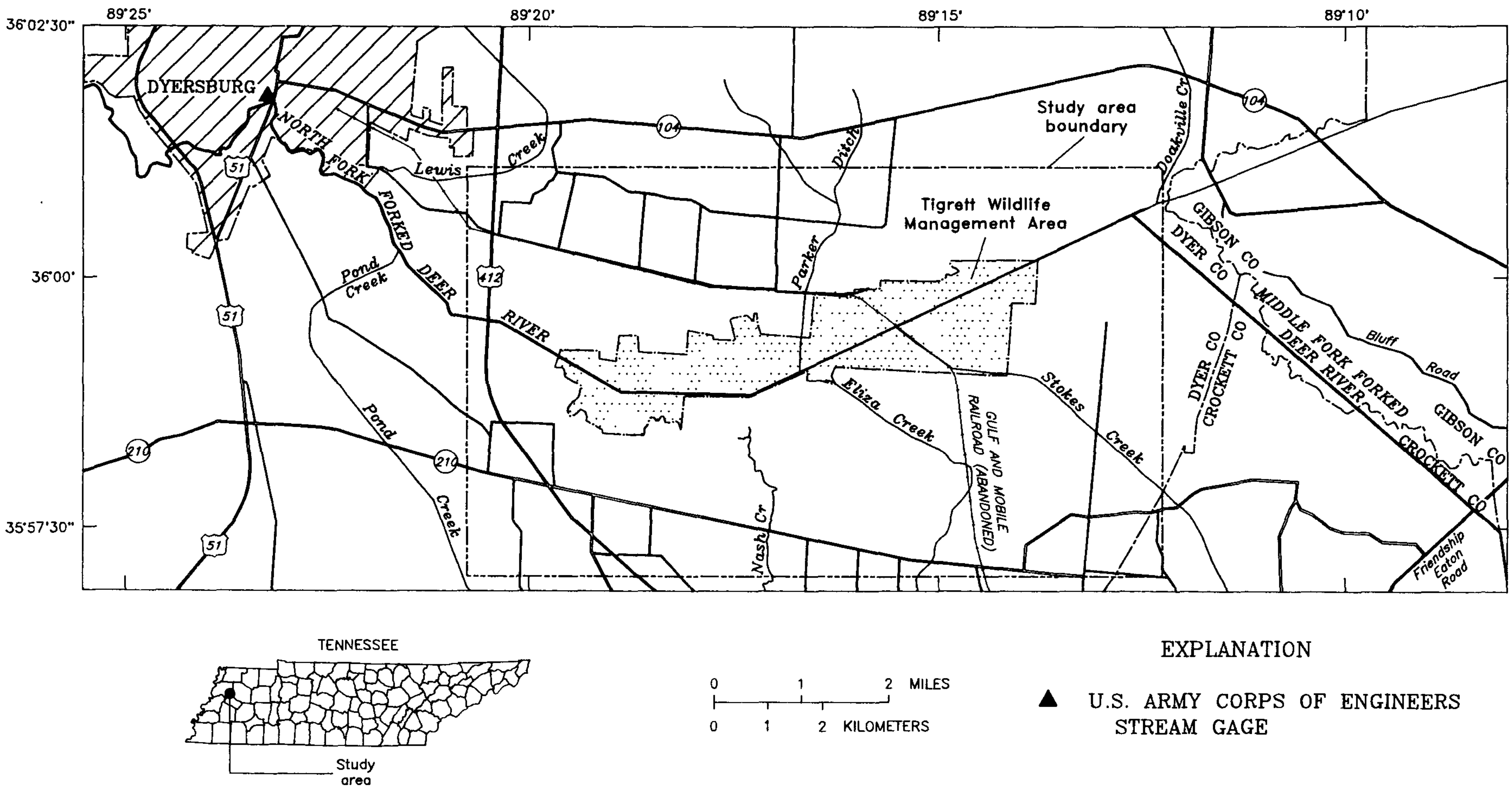

Figure 1. Location of the study area near Dyersburg, Tennessee.

Morgan and McCrory (1910) described drainage problems in Gibson County, including that part of the North Fork Forked Deer River flood plain immediately upstream from the present study area. They reported conditions on the North Fork Forked Deer River flood plain similar to those observed in this study: channel segments filled with sediment and debris, numerous depressions and secondary channels, and tributaries that "disappear when they reach the bottoms, becoming ponds and sloughs" (Morgan and McCrory, 1910, p. 33). They also identified the threat of upland erosion to the long-term stability of constructed drainage channels.

Although the drainage ditches proposed by Morgan and McCrory (1910) were constructed, their recommendations for on-farm sediment stabilization and erosion control were apparently not implemented. Within 20 years of ditch construction along the North Fork Forked Deer River, the Tennessee State Planning Commission (1936) reported deteriorating channel conditions throughout the Obion and Forked Deer River basins. This deterioration included obstructed channels, increased ponding, and the death of bottomland trees. The Tennessee State Planning Commission (1936) attributed the recurrence of drainage problems to a lack of coordination among drainage districts and the failure of the districts to obtain adequate environmental data on which to base designs.

Recent studies of channelized streams in West Tennessee (Robbins and Simon, 1983; Simon and Hupp, 1986) indicated that a second cycle of channelization of streams throughout the region, in the 1930's and 1940's, provided only temporary improvement of flood-plain drainage problems. These recent studies focused on the adjustment of channel dimensions following channel modification. Robbins and Simon (1983) described six case studies in which they traced the history of channelization, and presented available data on changes in bed elevation and channel dimensions. They described the general evolution of straightened and dredged channels through stages of incision, widening, and filling with sediment (Robbins and Simon, 1983). Simon and Hupp (1986) developed this generalization into an empirical model of channel response following widespread channel modifications in the 1960's and 1970's.

Flood-plain sedimentation and its relation to land use and channel conditions were the focus of numerous studies in the Upper Mississippi Valley (Happ, 1944; Trimble, 1976; Magilligan, 1985; Knox, 1987) and northern Mississippi (Happ and others, 1940; Grissinger and Murphey, 1982; Grissinger and others, 1982; Schumm and others, 1984). These topics have received relatively little attention in West Tennessee. Bazemore and others (1991) investigated post-1900 flood-plain sedimentation near 11 highway crossings in West Tennessee. They reported mean sedimentation rates of -0.002 to 0.039 foot per year (ft/yr) and concluded that sedimentation at these sites is largely determined by local topography.

Barnhardt (1988a, 1988b) provided radiocarbon dates for flood-plain deposits in West Tennessee, and described stratigraphic cross sections in incised gullies about 50 miles south of the study area. The cross sections show about 3 feet of post-settlement alluvium deposited at an average rate of about 0.03 ft/yr. The post-settlement alluvium is underlain by 3 to 4 feet of Holocene alluvium deposited during the 5,000 years before European settlement at rates ranging from 0.0007 to 0.003 ft/yr (Barnhardt, 1988a, 1988b).

Acknowledgments

The authors acknowledge the assistance of several individuals and agencies in carrying out this research. The Memphis District, U.S. Army Corps of Engineers (COE), provided logs of soil borings and topographic survey data relevant to the study site. Mr. John M. Cook of Continental Engineering, Inc., provided channel profiles and cross sections of the North Fork Forked Deer River in the vicinity of the study area. Messrs. Robert S. Bell and Earl L. Willoughby, Jr., of Dyersburg, Tenn., were generous sources of information on local history, agriculture, and environmental change. Mr. Jimmy W. Johnson of Tennessee Wildlife Resources Agency assisted with field work and provided aerial photographs and unpublished maps.

STUDY AREA

This study was conducted in and near the Tigrett Wildlife Management Area in Dyer County, Tennessee (fig. 1). The study area lies within the Eastern Gulf Coastal Plain section of the Coastal Plain physiographic province (Fenneman, 1938). The subsurface geology of the area is dominated by mostly unconsolidated sediments of Tertiary age (Schreurs and Marcher, 1959; Cushing and others, 1964). Those areas not directly affected by streams are generally capped by a layer of Pleistocene loess (wind-deposited silt, clay, and fine sand), as thick as 100 feet in places (Schreurs and Marcher, 1959). The alluvial valleys of streams such as the Obion and Forked Deer Rivers and their larger tributaries are filled with Quaternary alluvium. Late Quaternary terraces, probably deposited 10,000 years ago or earlier (Saucier, 1987), form benches as wide as 2,000 feet, with 10 to 20 feet of relief above the adjacent flood plain.

At the downstream end of the study area, the North Fork Forked Deer River drains approximately 800 square miles in Dyer, Gibson, and Crockett Counties. Dyer and Gibson Counties were incorporated in 1823, and the area was rapidly settled. By the 1850's, large tracts of the well-drained loess uplands had been cleared and planted with cotton, tobacco, maize, and other row crops (Greene, 1901; Hulme and Hulme, 1982). Commercial farming of row crops expanded and intensified throughout the 19th century and remains the mainstay of the local economy.

Systematic channelization of the Forked Deer River began in the early 1900's. Clearing of the valley bottoms for timber proceeded rapidly after about 1880 (E.L. Willoughby, Jr., Dyersburg, oral commun., 1991; D.L. Porter, Tennessee Valley Authority, oral commun., 1991), while high agricultural prices provided an economic incentive to cultivate marginal lands. Drainage districts were organized to drain the bottoms in order to exploit their agricultural potential (Ashley, 1910; Morgan and McCrory, 1910). Planning for the construction of the North Fork Forked Deer ditch upstream from Dyersburg began around 1916, and construction was completed in 1921 (D.L. Porter, Tennessee Valley Authority, oral commun., 1992).

By the 1930's, the North Fork Forked Deer ditch and other dredged channels in the region were partly or completely filled with sediment, leading to a program of basinwide drainage management and ditch maintenance (Tennessee State Planning Commission, 1936). Despite these efforts, another cycle of channel sedimentation followed, requiring widespread dredging and clearing in the 1960's and 1970's (Robbins and Simon, 1983).

The geomorphic instability of the North Fork Forked Deer River flood plain has been accompanied by ecological instability. Areas that were formerly well-drained forest are now (1991) shallow ponds containing dead or dying trees, water-tolerant shrubs, or aquatic vegetation. Formerly clear, open oxbow ponds several feet deep have been filled completely with sediment or have become shallow marshland covered with floating aquatic plants and smartweed (*Polygonum* spp.). Local residents report a deterioration of fishing and waterfowl hunting since the 1950's. Meanwhile, beaver, trapped out by the 1940's, have become reestablished and their activities have further obstructed drainage over much of the flood plain (R.S. Bell, Dyersburg, Tenn., oral commun., 1991; D.L. Porter, Tennessee Valley Authority, oral commun., 1991).

FLOOD-PLAIN STRATIGRAPHY AND RECENT SEDIMENTATION RATES

The banks of the North Fork Forked Deer ditch are more than 12 feet high in many places, providing excellent exposures of flood-plain sediments. Fresh exposures also exist at the active headcuts into the north and south banks (sites 5 and 1, respectively, in figure 2). Field observations of flood-plain sediments focused on these exposures, and were made along the length of the study area. The scope of this study did not permit extensive cross-valley borings or excavations. However, a limited number of holes were augered by hand, and pits that had been dug in order to excavate trees were examined and logged. These field observations were supplemented by the logs of soil borings made along both sides of the North Fork Forked Deer ditch by the COE (Col. Clinton Willer, U.S. Army Corps of Engineers, written commun., 1991).

Flood-Plain Materials

The North Fork Forked Deer River flood plain is composed of 50 to 100 feet of Quaternary alluvium which unconformably overlies unconsolidated Tertiary sediments (Schreurs and Marcher, 1959). Only the upper 20 feet of flood-plain sediments are considered in this study.

Soil borings by the COE (Col. Clinton Willer, U.S. Army Corps of Engineers, written commun., 1991) indicate that the entire study area is underlain by fine to medium, saturated sand, the upper boundary of which is generally 15

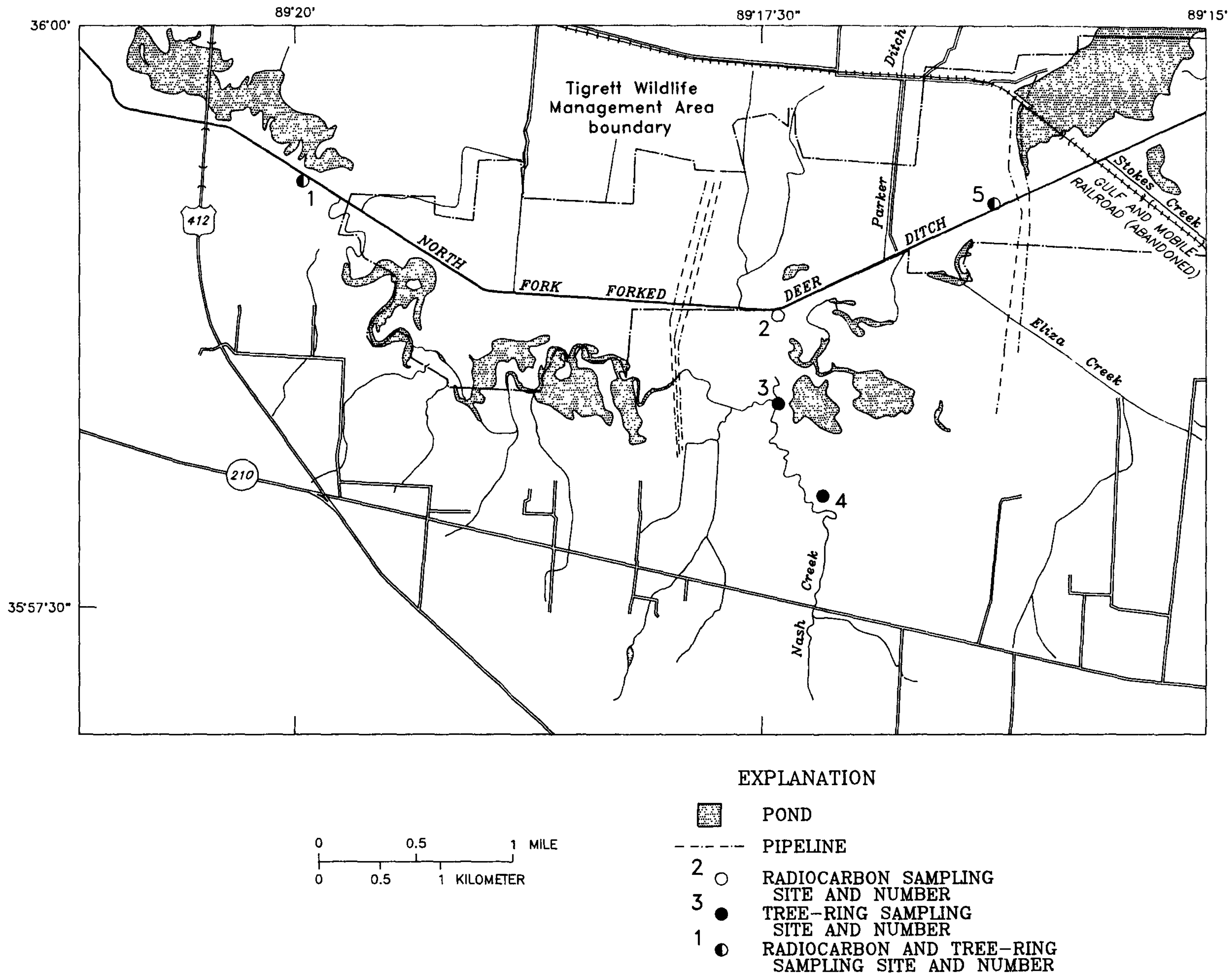

Figure 2. Location of radiocarbon and tree-ring sampling sites in Dyer County, Tennessee.

to 20 feet below land surface. This unit was not observed in the field. Its stratigraphic position and texture indicate an origin similar to that of channel-lag deposits described in northern Mississippi (Happ and others, 1940; Grissinger and others, 1982).

Immediately above the sand is a layer of massive silts and clays about 10 feet thick. Only the upper 1 to 6 feet of this unit was examined in the field. The massive silts and clays range in color from light gray to green gray, depending on the depth to the water table. At some locations, this unit is homogeneous. Elsewhere, it contains sand lenses, wood and leaf fragments, or hard iron-oxide concretions 0.2 to 1 inch in diameter. The massive silts and clays are generally firm to hard, but can be soft when saturated. Some exposures exhibit moderate plasticity. The massive silts and clays are fine-grained alluvial deposits, probably derived from reworked loess.

The massive silts and clays are overlain by a layer of silty clay 0.5 to 1 foot thick. This layer is chiefly differentiated from the underlying material by abundant red mottles. The mottles are distinctly worm-like in appearance, and probably represent the former locations of plant roots. At some locations, the mottled silty clay contains elongate, tubular cavities, filled with sand and generally less than 1 inch in diameter. These cavities are apparently remnants of former root channels or small animal burrows.

At several locations throughout the study area, erosion of the ditch banks or incision of headcuts has exposed buried cypress stumps. The root systems of these trees generally are located within the mottled silty clay. Where the mottled clay is above the water table, it commonly exhibits a dark brown color which contrasts with the overlying and underlying materials; elsewhere, it is generally gray in color.

Several observations suggest that the mottled silty clay is a buried soil. The presence of root-sized and shaped mottles and cavities in this layer and its dark brown color at some locations suggest the accumulation of organic matter. Although this supposition has not yet been confirmed through laboratory analysis, it is strongly supported by the presence of buried cypress roots exclusively in this layer at several locations throughout the study area. This soil shares the textural characteristics and relatively high cohesion of the massive silts and clays immediately beneath it, and is apparently a flood-plain soil developed on the surface of the massive silts and clays.

The upper boundary of the mottled silty clay, generally 5 to 12 feet below the present flood-plain surface, crops out on the North Fork Forked Deer ditch banks, forming a distinct lineation traceable at least from the Gulf and Mobile Railroad bridge downstream past the U.S. Highway 412 bridge (fig. 2). The association of exposed cypress root collars with the mottled silty clay is especially striking along this lineation. Together, the mottled silty clay and the underlying massive silts and clays represent the most cohesive materials in the upper 20 feet of the flood-plain sediments. These cohesive layers form resistant, steep-sided shelves or benches protruding into the channel several inches to several feet further than the upper banks. At one location, about 0.5 mile downstream of the abandoned Gulf and Mobile Railroad bridge (site 5, fig. 2), massive gray clay forms a broad shelf extending roughly 20 feet from the right (north) bank into the channel.

The upper 5 to 12 feet of the North Fork Forked Deer River flood plain is composed of yellow, brown, and gray silts and clays with local lenses of sand. Though similar in texture, this material is generally softer and more friable than the underlying deposits, commonly breaking to fine crumbs between the fingers. At several locations, these sediments are stratified, with individual layers generally less than 1 inch thick. Commonly, identifiable remains of deciduous leaves separate the layers, particularly within 3 feet of the flood-plain surface. Live roots, wood fragments, and occasional fragments of charcoal are found throughout this unit. Red mottles are far less common than in the underlying mottled silty clay, but are present in some places, generally at depths greater than 3 feet below land surface.

Along the North Fork Forked Deer ditch, the stratified silts and clays are locally overlain with dredge spoil, a poorly sorted mixture of silt, clay, sand, and woody debris. Where dredge spoil is absent, a weakly developed organic soil commonly constitutes the top 3 inches of the flood plain. This soil is distinguished from the stratified silts and clays immediately below it primarily by its surface leaf litter and abundant fine roots.

Recent Sedimentation Rates

A central objective in this investigation was to determine the rates and timing of sediment deposition in the upper part of the North Fork Forked Deer River flood plain in the study area. Flood-plain deposition of fine-grained sediments is a major geomorphic process along natural meandering channels (Reineck and Singh, 1980). At the outset of this study, it was unclear whether the top 5 to 12 feet of stratified silts and clays that cover the North Fork Forked Deer River flood plain had been deposited by natural processes over several thousand years, or if their deposition had been accelerated by human activity and occurred over less than 150 years. Studies in West Tennessee (Barnhardt 1988a, 1988b) and northern Mississippi (Happ and others, 1940; Schumm and others, 1984; Grissinger and others, 1982) report post-settlement alluvium thicknesses ranging from less than 1 foot to more than 10 feet. Because no regional synthesis of Holocene stratigraphy has been established for West Tennessee, examination of sediments in the field was an insufficient basis to distinguish pre-settlement from post-settlement alluvium.

Nonetheless, several observations indicated that the upper 5 to 12 feet of stratified silts and clays in the study area were deposited over the past few hundred years. Preservation of stratification in the presence of abundant roots and burrowing animals is unlikely over extended periods of time. Most of these sediments are soft or friable, and show little evidence of post-depositional weathering such as iron-oxide concretions. Buried cypress stumps show a general concordance in the elevations of their root collars coinciding with a lithologic transition below which the clays and silts are stiffer, more massive in structure, and contain iron-oxide mottles and concretions. These observations indicate an abrupt change in the properties of sediments deposited on the flood plain or in the rate of deposition. The lower boundary of the stratified silts and clays marks this transition.

Radiocarbon dating of buried cypress stumps provided a means of determining the maximum age of the stratified silts and clays. Wood samples were collected from buried stumps at three sites along or near the North Fork Forked Deer ditch (sites 1, 2, and 5; fig. 2). Care was taken to select upright stumps that appeared to be undisturbed. At all three sites, the root systems of these stumps coincided with the mottled silty clay layer, and had been buried, until recently, by about 7 feet of stratified silts and clays.

Radiocarbon ages for the three samples ranged from 80 to 170 years before 1950 with standard deviations of 60 to 70 years (table 1). Because of the limitations of radiocarbon analysis in precisely determining ages less than 300 years before 1950, a conservative interpretation of the radiocarbon dates is that the 6.9 to 7.5 feet of sediment burying these trees was deposited after 1700. However, most or all of this deposition probably occurred after European settlement in the 1820's and 1830's.

Tree-ring analysis of living trees was used to determine current (since about 1960) sedimentation rates at selected sites on the flood plain. Ring counts reflect tree age, and the depth of the root collar below the ground surface is a useful estimate of sediment deposition since germination. Fifty-seven cores were collected from 22 trees of 6 species at 4 sites (tables 2 and 3) and examined to estimate tree age. At sites 1, 2, and 3 (fig. 2), root collars of living trees were not buried. The maximum age of trees without buried root collars defines a lower limit for the age of the flood-plain surface at these locations. Each of these sites includes trees 60 to 65 years old, indicating that accelerated sedimentation in these areas ended before about 1930 (B.A. Bryan, U.S. Geological Survey, written commun., 1991). Based on field examination of bank exposures, however, recent sedimentation in at least some parts of the flood plain averaged about 10 feet. Most of this sediment was probably

Table 1. Radiocarbon ages, sampling locations, and depths of burial of cypress stumps *(Taxodium distichum)*

[Analysis by Murray Tanners, Beta Analytic, Inc., 1991]

C-14 age (radiocarbon years before 1950 plus or minus one standard deviation)	Sampling site number (see figure 2)	Depth of root crown below flood plain, in feet
170 +/- 60	1	6.9
80 +/- 70	5	7.3
120 +/- 70	2	7.5

deposited between 1830, when agricultural clearing was rapidly expanding (Greene, 1901; Hulme and Hulme, 1982), and 1930. The sedimentation rate during this period, therefore, probably averaged about 0.1 ft/yr. This rate is about 4 to 16 times the modern sedimentation rates (0.006-0.025 ft/yr) reported by Bazemore and others (1991) along the Middle Fork Forked Deer River near the Friendship-Eaton Road (fig. 1).

At site 4, along Nash Creek (fig. 2), the root collars of living trees were buried by sediment. Four trees, ranging in age from 8 to 26 years (B.A. Bryan, U.S. Geological Survey, written commun., 1991), were examined (table 2). The root collars of these trees were buried by 2 to 5 feet of stratified silt containing abundant, horizontal, deciduous leaves. Dividing depths of burial by tree ages gives local recent sedimentation rates at this site of 0.17 to 0.24 ft/yr. These extremely high sedimentation rates occur immediately downstream of the point at which ditch maintenance on Nash Creek ends. Sedimentation rates near other tributary streams were not measured; however, local residents report high current sedimentation rates in similar settings elsewhere on the North Fork Forked Deer River flood plain (R.S. Bell, Dyersburg, Tenn., oral commun., 1991).

Table 2. Tree ages and calculated sedimentation rates based on tree-ring analyses

[Analyses by B.A. Bryan, U.S. Geological Survey. Sedimentation rates calculated as depth of burial divided by age of tree]

Sampling site number (see figure 2)	Number of trees examined	Number of cores examined	Range of tree ages, in years	Range of calculated sediment ion rates, in feet per year
1	10	27	25-65	0
3	5	15	51-61	0
4	4	6	8-26	0.17-0.24
5	3	9	35-65	0

Radiocarbon dating of buried tree stumps and tree-ring analyses indicate two distinct sediment sources whose changing relative importance has largely determined the

Table 3. Number of trees sampled for tree-ring analysis, by sampling site and species

Sampling site number (see figure 2)	Species	Common name	Number of trees sampled
1	*Betula nigra*	River birch	2
1	*Fraxinus pennsylvanica*	Green ash	3
1	*Taxodium distichum*	Bald cypress	5
3	*Fraxinus pennsylvanica*	Green ash	4
3	*Quercus michauxii*	Swamp chestnut oak	1
4	*Acer negundo*	Boxelder	1
4	*Fraxinus pennsylvanica*	Green ash	2
4	*Ulmus species*	Elm	1
5	*Fraxinus pennsylvanica*	Green ash	3

spatial and temporal patterns of sedimentation on the North Fork Forked Deer River flood plain. Radiocarbon dating establishes a period of accelerated sedimentation, beginning after 1700 and probably triggered by agricultural clearing after about 1830. The source of this sedimentation appears to have been the basins of the North and Middle Forks, Forked Deer River upstream from the present study area. Based on the thick (5 to 12 feet) deposits of post-settlement alluvium near the natural North Fork Forked Deer River channel, sediment from upstream sources was delivered to the flood plain by overflow of the North Fork Forked Deer River. Analysis of living trees near the natural North Fork Forked Deer River channel and the North Fork Forked Deer ditch indicates that accelerated sedimentation in these areas had ended before 1930, possibly because the new ditch had a greater capacity to transport and store sediment than did the natural North Fork Forked Deer River channel.

The second source of sediment in the study area is the drainage basins of Nash, Eliza, and Stokes Creeks, and other nearby tributaries. The overall contribution of tributary sedimentation (deposition of sediment near tributary channels without delivery to the main channel) to the historical sediment budget of the North Fork Forked Deer River flood plain has yet to be established. Field observations indicate that areas near the lower reaches of tributaries are currently the areas of sedimentation rates in the flood plain, at least in the present study area. Anecdotal evidence indicates that tributary sedimentation accelerated during the 1950's and 1960's. One factor that may account for increased sediment delivery to the flood plain by tributaries during this period is consolidation of land holdings adjacent to the flood plain after 1950. This consolidation was accompanied by widespread removal of hedge rows (R.S. Bell, Dyersburg, Tenn., oral commun., 1991), possibly remobilizing previously deposited sediment from these sites. Probably, such increased sediment delivery to the flood plain has interacted with changes in the depositional environment, such as increased ponding by beavers, to accelerate sedimentation along the lower reaches of the tributaries.

SURFACE-WATER FLOW PATTERNS

The surface-water flow pattern in the study area reflects ongoing geomorphic evolution in response to multiple human disturbances. The natural channel was the dominant flow path in the study area until channelization. Natural-channel characteristics just prior to channelization are indicated by the characteristics of its least-disturbed sections, supplemented by aerial photographs and contemporary descriptions (Morgan and McCrory, 1910). As a result of channelization and repeated ditch maintenance, the North Fork Forked Deer ditch is the dominant flow path. Segments of the natural channel, tributary channels, and low areas of the flood plain act as flow paths during floods, and some of those flow paths remain ponded following floods. The North Fork Forked Deer ditch is actively degrading, as are several flood-plain flow paths that drain directly into it. The headward erosion of these flow paths is gradually reducing the extent and depth of ponding in several areas.

Location and Condition of the Natural Channel

The natural channel, defined as the main channel of the North Fork Forked Deer River immediately prior to construction of the North Fork Forked Deer ditch in about 1916, can be traced through nearly all of the study area. Several maps (Thirteenth Surveyors District, 1819; Tennessee Valley Authority, 1936; C.S. Yelverton, Tennessee Wildlife Resources Agency, written commun., 1967) show part or all of the natural channel, with varying degrees of accuracy. Aerial photographs taken in 1941 and 1985 generally show the channel location in those sections where the maps disagree. The 1941 photographs include stereo coverage showing several sections of the natural channel at approximately bankfull stage, providing a basis for calculating the width of the natural channel.

The elevations of the water surface, the bed, and the flood plain along most of the natural channel sections in the study area were surveyed in July and August 1991. Vertical control was provided by 1974 survey records (J.M. Cook, Continental Engineering Inc., written commun., 1991). At the time of the 1991 survey, flow in the ponded areas was negligible, and all water surfaces, except that in the North Fork Forked Deer ditch, were assumed to be level. The vertical precision of this survey was about 0.1 foot.

The dimensions of the natural channel prior to channelization were estimated from soundings of the easternmost section of the natural channel in the study area (figs. 3 and 4). This section appears to be the one least

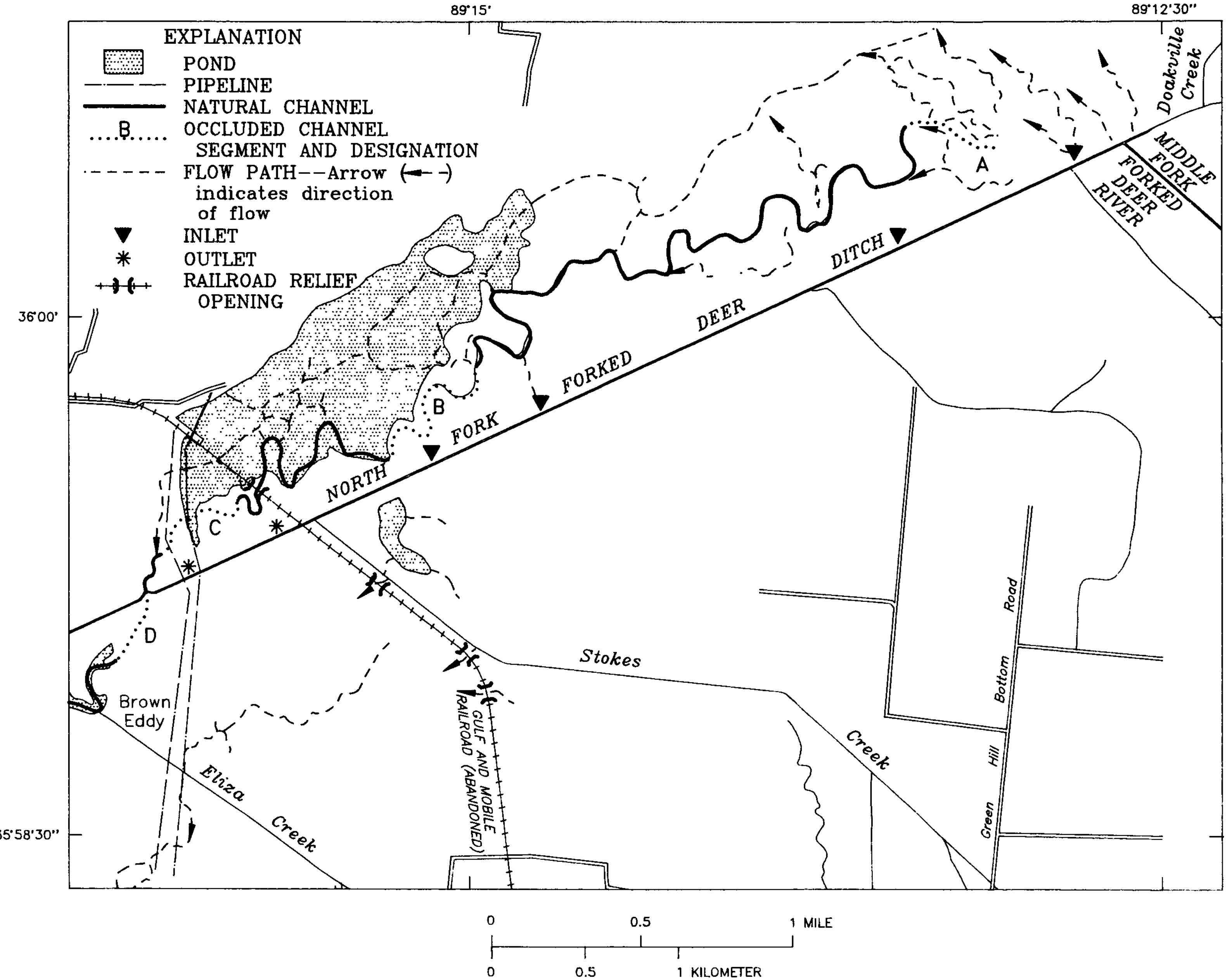

Figure 3. Hydrography of the eastern part of the study area, Dyer County, Tennessee.

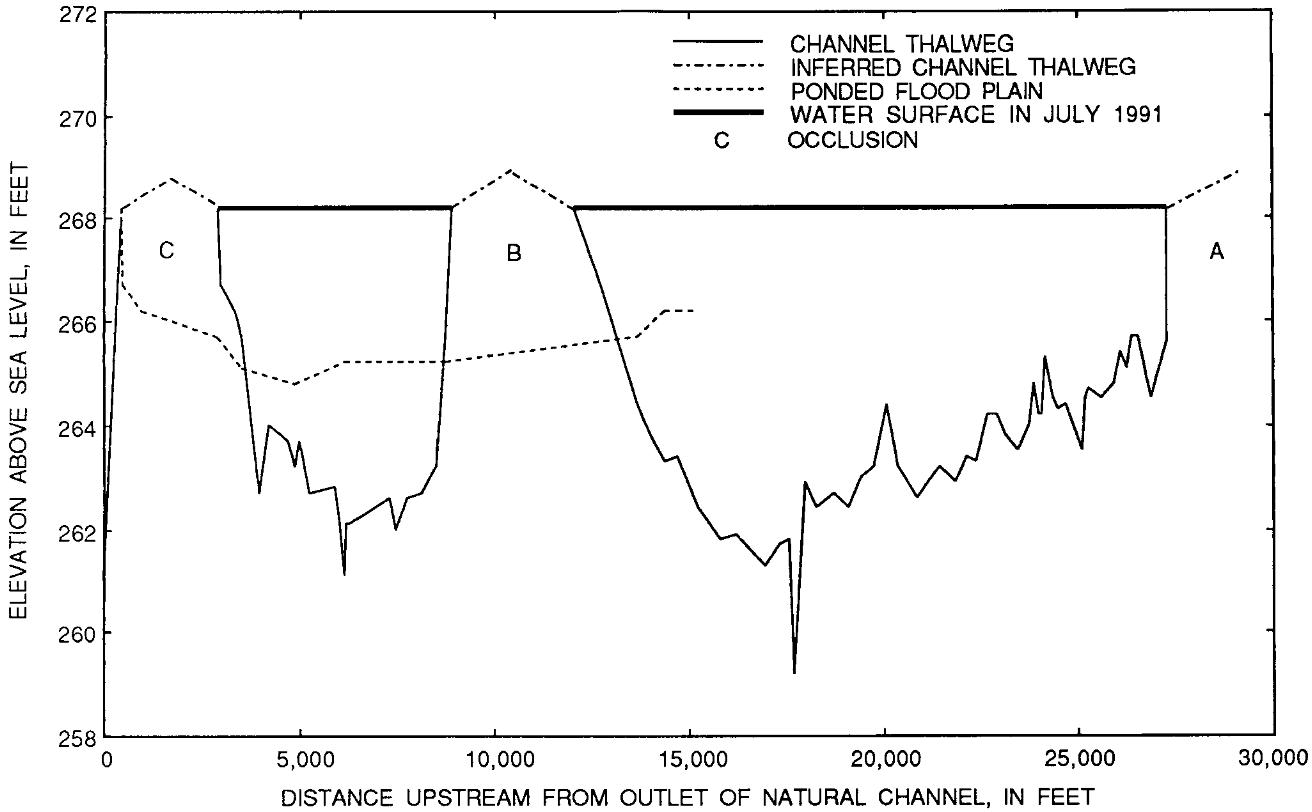

Figure 4. Longitudinal profile along the natural channel, north of the main ditch of the North Fork Forked Deer River, in Dyer County, Tennessee.

altered by sedimentation following channelization. The bed of this channel section lies as much as 7 feet below the surrounding flood plain; this depth was used as an estimate of the depth of the natural channel. Analysis of 1941 aerial photographs indicates the width of the natural channel ranged from 40 to 50 feet along most sections, with some sections as wide as 60 feet. Morgan and McCrory (1910) reported that the natural channel in Gibson County, immediately upstream from the study area, had a top width of 60 to 70 feet and an average bankfull depth of not more than 5 feet.

The sinuosity, slope, and roughness of the natural channel were estimated on the basis of study area characteristics and typical conditions in West Tennessee channels. The sinuosity of the natural channel was estimated to be 2.1, based on the ratio of the length of the natural channel sections in the study area to the length of the corresponding reach of the North Fork Forked Deer ditch (fig. 3 and 5). The slope of the North Fork Forked Deer ditch through the study area is about 0.00027, and this slope divided by the sinuosity of the natural channel is about 0.00013, which was used as the estimated slope of the natural channel. This slope is in the low end of the normal range for natural-channel slopes in West Tennessee. The roughness (Manning's n) of the natural channel was estimated to be 0.03, which would be typical of a smooth channel free of woody debris.

The bankfull discharge of the natural channel before ditch construction was estimated based on the following assumed characteristics: a width of 50 feet, a depth of 7 feet, a slope of 0.00013, a roughness of 0.03, and a rectangular cross section. The bankfull discharge was calculated to be about 600 cubic feet per second. This discharge is equivalent to a typical summer base-flow discharge of the North Fork Forked Deer River at Dyersburg (U.S. Army Corps of Engineers, 1981-89) under present conditions. The small bankfull capacity is consistent with statements by Morgan and McCrory (1910), which describe the river as incapable of carrying any sizable flood within its banks.

The natural channel has been divided into discontinuous sections by sediment deposits (occlusions) that have nearly or completely filled it. The proximal source of most of the occlusions (A-D, fig. 3; A-C, fig 4; D-F, K, and L, fig. 5; and D-F and K, fig. 6) is probably the North Fork Forked Deer ditch. Other occlusions (G-J; figs. 5 and 6) are apparently the result of sedimentation at the outlets of tributary streams.

Primary Flow Path--the North Fork Forked Deer Ditch

The North Fork Forked Deer ditch is the main flow path in the study area. The top width of the ditch is about 80 feet, and the bottom width is about 40 feet. Soundings of the North Fork Forked Deer ditch during base-flow conditions indicate water depths of 2 to 5 feet, with an average depth of about 3 feet. During floods, flow enters the flood plain from the ditch through tributary mouths and breaches in the spoil banks. Flow into the flood plain was observed at a river stage about 5 feet above base flow. At this stage, flow entered the flood plain through a breach in the spoil bank north of the North Fork Forked Deer River, about 2.3 miles upstream from the railroad bridge, and through the northernmost relief opening in the railroad causeway south of the North Fork Forked Deer River (fig. 3). Other breaches in the spoil banks have higher minimum elevations, ranging from about 8 to 13 feet above base-flow stage.

The banks of the ditch are predominantly silt and clay. The upper banks consist of poorly consolidated, stratified silts and clays. The lower banks, and parts of the bed, are more cohesive, massive silts and clays.

The bed of the ditch is predominantly sand, with shelves of silt or clay near the base of the banks in some locations. The bed is about 2 to 8 feet above the contact between the massive silts and clays and the poorly consolidated sand (Col. Clinton Willer, U.S. Army Corps of Engineers, written commun., 1991). The depth of the unconsolidated sand on the bed of the ditch was not measured; some of this sand is underlain by the massive silts and clays, and some may be in direct contact with the underlying sands.

The location of the ditch has changed little since its original construction. At four points in the study area, substantial deviations from the original alignment were observed. Two of these deviations are at intersections of the ditch and the natural channel. The largest deviation is at the point where the natural channel intersects the ditch about 0.6 mile downstream from the Gulf and Mobile Railroad bridge (fig. 3). Based on the available maps and aerial photographs, a meander in the ditch developed between 1941 and 1967 and has changed little since 1967. A second, smaller meander is located at sampling site 1 (fig. 2), another intersection of the natural channel and the ditch. A small island 1.5 miles upstream from the U.S. Highway 412 bridge has appeared since 1941. A small meander about 1 mile upstream from the U.S. Highway 412 bridge was present in 1941 and has changed little since then.

Present Location of Flood-Plain Flow Paths

The North Fork Forked Deer ditch and Parker Ditch (fig. 1) divide the flood plain in the study area into areas that drain independently during base-flow conditions. Field investigations of flood-plain flow paths focused on three areas: north of the North Fork Forked Deer ditch between Doakville Creek and Parker Ditch (fig. 1), south of the North Fork Forked Deer ditch between Stokes Creek and U.S. Highway 412 (fig. 1), and north of the North Fork Forked Deer ditch between Parker Ditch and U.S. Highway 412.

Flow Paths between Doakville Creek and Parker Ditch

The area between Doakville Creek and Parker Ditch is dominated by a single pond about 3 miles long and as much as 0.5 mile wide. This pond includes the deepest and most extensive area of ponded flood plain, and the longest and deepest section of natural channel in the study area. No significant tributaries enter this area of the flood plain, and the absence of sediment sources other than the North Fork

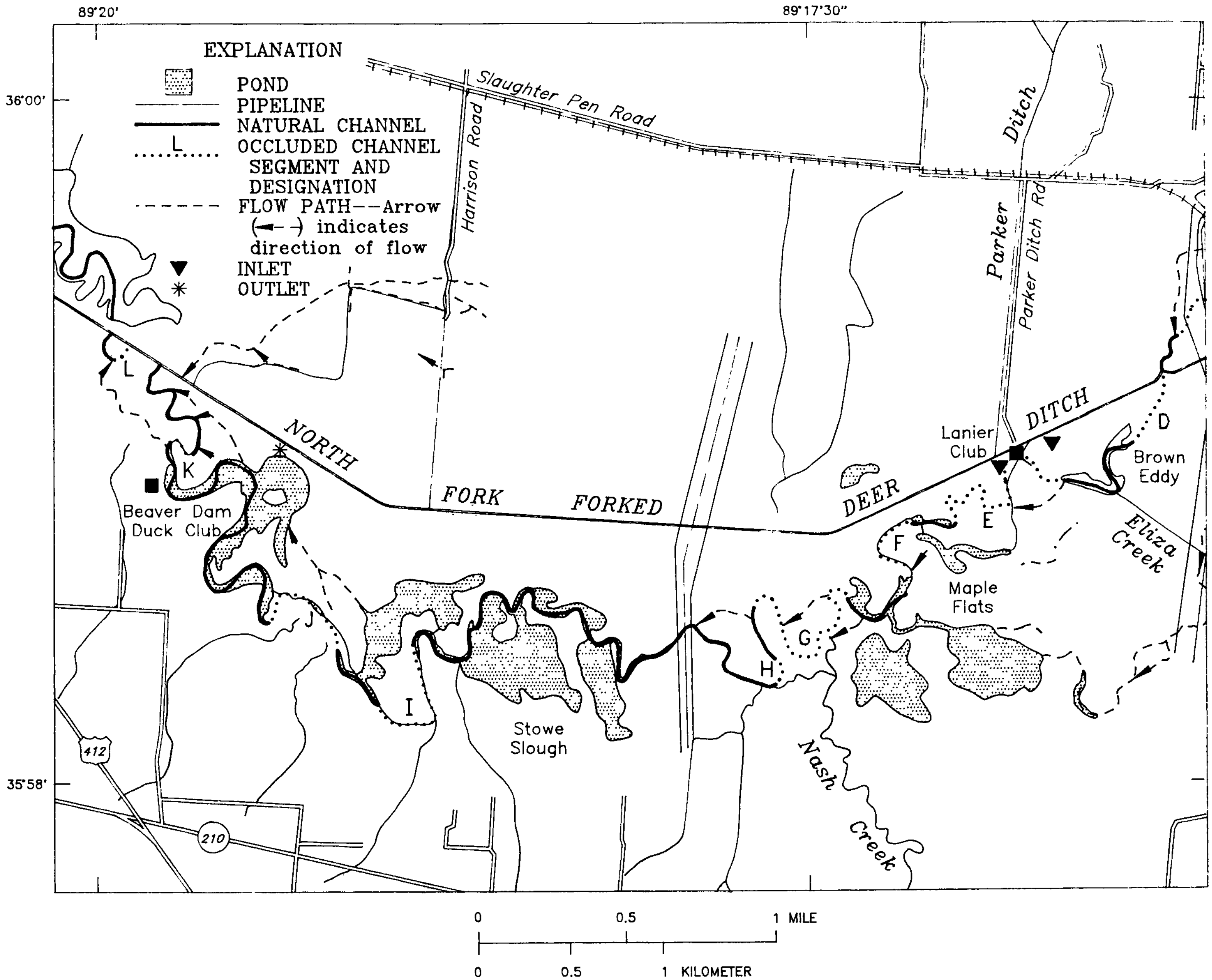

Figure 5. Hydrography of the western part of the study area, Dyer County, Tennessee.

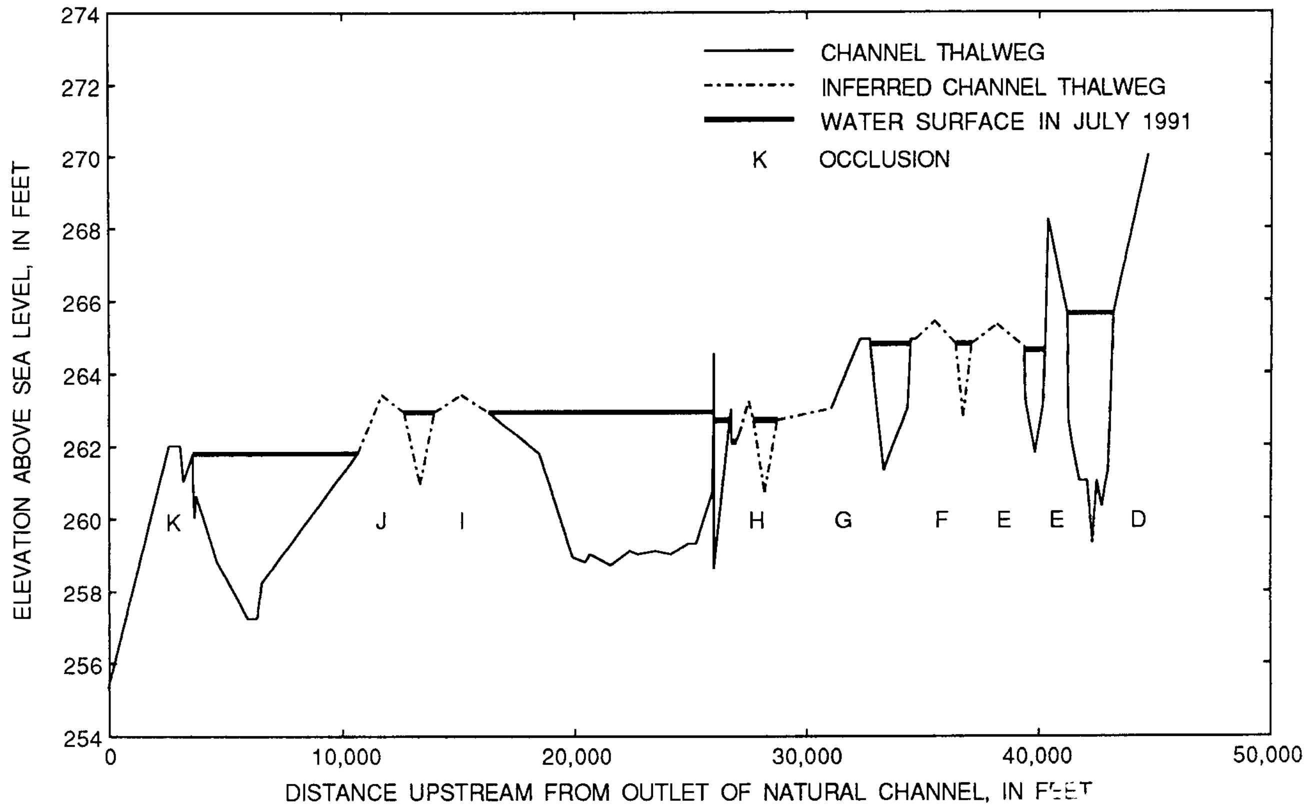

Figure 6. Longitudinal profile along the natural channel, south of the main ditch of the North Fork Forked Deer River, in Dyer County, Tennessee.

Forked Deer ditch helps account for the large extent and continuity of this pond.

Four breaches in the spoil bank admit water to the flood plain from the North Fork Forked Deer ditch (fig. 3). These breaches are visible from the ditch as actively eroding breaks in the levee. Several flow paths carry water across the flood plain from the ditch to the natural channel, and, particularly in the area of occlusion A, to a flow path along the north side of the valley (fig. 3) that is visible in the 1985 aerial photographs.

The eastern section of natural channel, between occlusions A and B (fig. 3), has dimensions apparently little altered since channelization. The average depth of this section ranges from 3 to 5 feet below the nearby flood plain (fig. 4). The western section of the natural channel, between occlusions B and C (fig. 3), has been filled with sediment to a depth of about 3 feet below the flood plain (fig. 4).

Much of the flood plain north and west of occlusion B is ponded to depths of 3 to 4 feet during the summer (fig. 4). The flow paths bypassing occlusions B and C through the flood plain (fig. 3) had a minimum water depth of about 2 feet in July and August 1991 (fig. 4). Field observations and aerial photographs indicate that in 1991 the water surface was close to its 1985 level, but about 3 feet higher than the level in 1941.

In this part of the ponded flood plain, a relation was observed between water depth and dominant vegetation. Ponded areas more than 3 feet deep generally were free of aquatic vegetation. Areas between 2 and 3 feet deep were dominated by floating aquatic plants, and areas less than 2 feet deep were dominated by emergents, particularly smartweed. Where the depth is less than 1 foot, the emergents form a dense stand through which a canoe cannot be paddled. Water elm (*Planera aquatica*) and buttonbush (*Cephalanthus occidentalis*) dominate the fringes of the ponded area.

The main flow path draining the area north of the North Fork Forked Deer ditch and east of Parker Ditch passes south along the west pipeline clearing, through dense emergent vegetation, to the natural channel, which flows into the North Fork Forked Deer ditch about 0.6 mile downstream from the Gulf and Mobile Railroad bridge (fig. 3). This section of the natural channel is actively eroding. Another outlet at the east edge of the west pipeline clearing has been dammed by beavers. A small, actively eroding channel about 200 feet long flows into the North Fork Forked Deer ditch just downstream from the railroad bridge (fig. 3).

Flow Paths between Stokes Creek and U.S. Highway 412

The flow pattern in this area is more complex than in the other two flood-plain areas. Major surface-water features include nine sections of natural channel separated by occlusions, and sections of the lower reaches of Eliza Creek and Nash Creek (figs. 3, 5, and 6). The depth of most of the natural channel sections has been reduced by sedimentation (fig. 6). Water is ponded at four or more elevations in this area, and the connection between ponded areas is obscure in some cases. Beaver dams cross many of the flood-plain flow paths, and control water levels in several ponds.

The main flow inlet from the ditch to this area of the flood plain is Stokes Creek. Three relief openings in the railroad causeway allow water to flow westward out of Stokes Creek into the flood plain (fig. 3); the northernmost is about 100 feet wide, and is kept open by contraction scour. Based on their appearance in 1985 aerial photographs, the other two openings are similar in size, largely unobstructed, and probably undergo contraction scour, indicating that they convey flow during floods.

A diffuse flow path begins west of the railroad causeway between the northern and middle relief openings and drains to the southwest (fig. 3), crossing an area that was mapped as a large pond in 1819 (Thirteenth Surveyors District, 1819). Based on 1985 aerial photographs, this flow path seems to mark the original location of Stokes Creek. The flow path crosses the Eliza Creek ditch at the pipeline clearings (fig. 3). The Eliza Creek ditch is largely occluded in this reach, and has been dammed by beaver. However, during floods, some flow follows the Eliza Creek ditch and enters the natural channel section known locally as "Brown Eddy" (figs. 3 and 5).

Eliza Creek leaves its ditch, flows south and west from the easternmost pipeline crossing, and enters an area locally known as "Maple Flats" (fig. 5). Maple Flats includes two sections of the natural channel upstream and downstream from occlusion F (figs. 5 and 6). It also includes a ponded section of an older channel that apparently was a slough in 1916 and now receives flow from Brown Eddy, Eliza Creek, and nearby areas of the flood plain. Water levels in the Maple Flats ponded areas did not differ significantly during the study period; these ponds seem to be hydraulically connected.

Two ditches were dug from the Lanier Club to Brown Eddy and Maple Flats (fig. 5). These ditches coincide roughly with the natural channel location through occlusion E. They are separated by a low causeway (fig. 6) and do not carry flow except during floods, when most of the flood plain is inundated with westerly flowing water.

During floods, flow passes south from the North Fork Forked Deer ditch to Brown Eddy through numerous breaches in the spoil bank. The minimum elevation of these openings near the Lanier Club (fig. 5) is about 9 to 10 feet above base-flow stage. A lower breach, just downstream from the Lanier Club, conducts flow from the North Fork Forked Deer ditch to the ditch from the Lanier Club to Maple Flats (fig. 5) when the river stage rises 8 feet above base-flow stage. This breach is partially blocked by a timber and rubber dam around which local scour is evident.

Nash Creek drains west into the natural channel below occlusion H and receives outflow from Maple Flats (fig. 5). Flow in the area of occlusions G and H follows a complex pattern that includes some sections of natural channel. The many beaver dams in this area force most flow to cross the flood plain.

The area west of and downstream from occlusion H is locally known as "Stowe Slough" (fig. 5), and includes sections of the natural channel upstream and downstream from occlusion I. This area was a slough in 1941, with ponding limited almost entirely to the channel; water levels at that time were apparently about 2 feet lower than in 1991. Flow leaves the downstream end of this channel section to the north into an area of ponded flood plain, then flows west and northwest through a series of beaver ponds, bypassing occlusions I and J (fig. 5).

The section of natural channel between occlusions J and K, and the ponded area adjacent to it, are accessible from the Beaver Dam Duck Club through an excavated ditch that carries no appreciable flow (figs. 5 and 6). The water depth in this area also has increased since 1941, at which time ponding was limited largely to the channel. This area has three outlets to the North Fork Forked Deer ditch. One outlet is a culvert 3 feet in diameter with a flap gate that drains this pond to the northeast into the North Fork Forked Deer ditch (fig. 5). This culvert is nearly plugged with woody debris and sediment.

A second outlet follows the original course of the river. Flow bypasses occlusion K to the north and enters a section of the natural channel that drains to the North Fork Forked Deer ditch. The upper part of this channel section is stable, with cypress knees visible on its banks and beds. Near the North Fork Forked Deer ditch, north of occlusion K (fig. 5), this natural channel segment shows signs of deepening and widening, including collapsed banks and cypress roots exposed by erosion.

The third outlet, west of occlusion L (fig. 5), is the largest and most actively eroding outlet. Flow leaves the ponded area to the northwest through the flood plain, bypassing occlusion K, and is eroding a channel through a cypress grove. It drops through an active headcut and enters the North Fork Forked Deer ditch through a short section of the natural channel. Downstream from the headcut, the incised channel has nearly vertical banks about 10 feet in height. Numerous buried cypress trees have been exposed by erosion of the banks, and trees growing on the flood plain near the channel are being undermined. This outlet seems to be passing an increasing share of the outflow from the pond.

Flow Paths between Parker Ditch and U.S. Highway 412

Overflow from the North Fork Forked Deer ditch enters this area during floods, and is the major source of flow. Tributary inflow from small ditches draining agricultural land north of the river probably occurs only immediately after rainfall. In contrast to the other two areas, the main impediments to flow across the flood plain are constructed levees rather than channel occlusions.

Drainage of this area to the North Fork Forked Deer ditch was formerly provided by a constructed ditch. This ditch follows a zig-zag course from where Harrison Road enters the North Fork Forked Deer River flood plain (fig. 5). The tributary ditch has been dammed by beavers to the level of the flood plain at several points. The culvert intended to carry flow west under Harrison Road into this ditch is not effective.

The main flow path draining this area is roughly parallel to the ditch, and apparently follows the pre-settlement location of the natural channel (Thirteenth Surveyors District, 1819). The upstream reach of this flow path is poorly defined and not confined to a channel. The levees that prevented water from flowing west and northwest to enter this flow path have been breached, but some of the breaches have been dammed by beavers. These beaver dams preserve the ponded conditions the levees originally were intended to create. An actively eroding gully about 500 feet long forms the section of this flow path immediately upstream from its confluence with the North Fork Forked Deer ditch.

Condition of Tributaries

The investigation of the condition of tributaries was based on field visits on foot and by canoe in the North Fork Forked Deer River flood plain, inspection of bridges outside the flood plain, and examination of aerial photographs.

The Stokes Creek ditch is unobstructed from the northernmost relief opening in the railroad causeway to the North Fork Forked Deer ditch (fig. 3). Upstream from this opening, the Stokes Creek ditch is obstructed by beaver dams. The presence of deeply ponded water at the Green Hill Bottom Road crossing indicates that occlusions extend upstream beyond the edge of the North Fork Forked Deer River flood plain.

The Eliza Creek ditch originally entered the natural channel at Brown Eddy (fig. 5). Its downstream end is now nearly occluded. Flow in Eliza Creek eventually enters Maple Flats.

Nash Creek is occluded at the boundary between cultivated fields and the forested flood plain near site 4 (fig. 2). At this point, flow has abandoned its original channel forming several new channels across a rapidly aggrading flood-plain surface. Backwater caused by this channel occlusion extends into the fields adjacent to Nash Creek.

Doakville Creek and Parker Ditch seem to be unobstructed, and to carry substantially their entire flows to the North Fork Forked Deer ditch. Parker Ditch has steep, bare banks, indicating that it has recently undergone degradation.

Other small tributaries, and the upstream reaches of Stokes, Eliza, and Nash Creeks, seem to have stable channels, and show little sign of rapid channel evolution. Based on examination of Nash Creek, however, channel occlusions and abrupt changes in channel location are most likely where these streams enter the flood plain.

Channel Evolution in the Study Area

Observations of active erosion and deposition in the study area indicate that the flow pattern is changing, and indicate the direction of this evolutionary change. The history and stratigraphy of the study area and the observed pattern of channel evolution along other channelized streams suggest the probable outcome of geomorphic evolution in the study area. This evolution is driven, however, by human actions in the North Fork Forked Deer River basin upstream from the study area, in small tributary basins that drain into the study area, and in the channel of the North Fork Forked Deer River downstream. Most of the trends discussed in the following paragraphs could be altered or reversed by changes in human activities outside the study area.

The North Fork Forked Deer ditch seems to be degrading and widening. In 1974, its top width was typically 60 feet; its bottom width, 12 feet; and the depth of its bed below the flood plain, 10 feet (J.M. Cook, Continental Engineering Inc., written commun., 1991). Since then, the bed of the North Fork Forked Deer River has degraded by about 4 feet at the U.S. Highway 412 bridge, by about 3 feet at the Parker Ditch access ramp, and by less than 1 foot at the Gulf and Mobile railroad bridge (fig. 2) based on 1991 surveys, the 1974 survey (J.M. Cook, Continental Engineering Inc., written commun., 1991), and bridge plans (Steve Hall, Tennessee Department of Transportation, written commun., 1991).

Degradation is progressing in an upstream direction. The vertical distance between the channel bed and the flood plain increases in the downstream direction in the study area, and field observations of Lewis Creek and the North Fork Forked Deer River at Dyersburg (fig. 1) indicate active degradation downstream. If channel evolution follows its normal course, degradation will likely intensify in the Wildlife Management Area. Barring further ditch maintenance, continued downstream dredging, or a substantial reduction in sediment inputs upstream, the present episode of degradation will likely be followed by one or two decades during which sand will gradually fill the ditch. At the end of this period of aggradation, the river may abandon sections of the ditch in the study area and find its own course, which may or may not follow present flood-plain flow paths.

The resistance of the massive silts and clays to erosion is the most important factor keeping the ditch close to its original alignment. If degradation penetrates these resistant materials to the underlying sands, bank stability may decrease, leading to accelerated widening and the development of meanders. On the other hand, should aggradation raise the level of the bed to the level of the poorly consolidated upper banks, the channel will be free to migrate laterally.

Several flow paths draining the flood plain are undergoing degradation in response to the degradation of the North Fork Forked Deer ditch. All the headcuts in the study area appear to be active rather than healing. Most knickpoints have a vertical face, with a plunge pool at the base, indicating headward migration. Many exposed roots and recent failures on the steep banks of the headcuts indicate that the channels are downcutting and widening. As these headcuts continue to grow, they will lower the level of standing water in the ponded areas they drain. The entire ponded area north of the North Fork Forked Deer ditch (figs. 3 and 4) and east of Parker Ditch (fig. 5), the ponded area downstream from occlusion J (figs. 5 and 6), and the poorly drained area north of the North Fork Forked Deer ditch and west of Harrison Road (fig. 5) will likely be affected.

Ponding along the lower reaches of several tributaries is apparently related to the deposition of fine-grained sediment delivered from their own basins, and occurs at elevations above those of the ponded water in the flood plain. These ponded areas and the depositional areas that cause them are relatively remote from the headcuts along the North Fork Forked Deer ditch, and consequently are not likely to be affected in the near future by the growth of these headcuts. The typical solution to such ponding is to excavate a ditch downstream to the next major ditch -- in this instance, the North Fork Forked Deer ditch. Such a tributary ditch will likely become ineffective with time unless regularly maintained and will have hydraulic effects on the flood plain it crosses, as exemplified by Stokes Creek. An ineffective ditch, or a ditch that does not extend downstream to the next larger ditch (for example, Eliza Creek), will likely deposit much of its sediment load at the edge of the flood plain, where the channel slope decreases. Sedimentation at that point could eventually lead to a restoration of ponded conditions in the fields upstream.

SUMMARY AND CONCLUSIONS

This report summarizes results of research conducted by the U.S. Geological Survey in cooperation with the Tennessee Wildlife Resources Agency to improve understanding of the relations between sedimentation and surface-water drainage conditions on the flood plain of the North Fork Forked Deer River near Dyersburg in West Tennessee. The research objectives were (1) to determine recent sedimentation rates in the study area, and (2) to identify and locate major surface-water flow paths and determine their relation to recent sedimentation. The objectives were accomplished by reviewing relevant literature, examining flood-plain sediments, age dating buried tree stumps and living trees, surveying water-surface and channel-bed elevations, and analyzing of maps, aerial photographs, survey records, and bridge plans.

Previous studies show that impeded drainage on the North Fork Forked Deer River flood plain is not a new problem, and that it existed prior to channelization of the Forked Deer River. In the early 1900's, and on several occasions since then, the North Fork Forked Deer River was channelized to alleviate drainage problems caused by excessive upland erosion and valley sedimentation. The relation between upland erosion, valley sedimentation, and drainage conditions in, and adjacent to, the flood plains of many West Tennessee streams was identified by some of the earliest proponents of channelization in West Tennessee.

The upper 15 to 20 feet of flood-plain sediments in the study area consist of fine-grained alluvium, underlain by sand. The fine-grained alluvium consists of several units, the lowest of which is a layer of massive silts and clays. This unit is overlain by a mottled silty clay which is probably a buried soil. These two cohesive units are more resistant to erosion than the overlying materials and form steep-sided benches along the banks of the North Fork Forked Deer ditch. Overlying the mottled silty clay is a 5- to 12-foot thick layer of poorly consolidated, stratified silts and clays, overlain locally by dredge spoil or weakly developed soil.

Radiocarbon analysis of buried cypress trees indicates that the stratified silts and clays were probably deposited near the North Fork Forked Deer River channel during the century prior to 1930 at rates on the order of 0.1 ft/yr. The cessation of flood-plain accretion before 1930 probably reflects the increased capacity of the North Fork Forked Deer ditch (completed in 1921) to transport and store sediment.

The highest sedimentation rates measured during this study, about 0.2 ft/yr, occurred along Nash Creek near the flood-plain margin. Sedimentation near tributaries along the valley margins seems to be the major ongoing process of flood-plain accretion.

The natural channel of the North Fork Forked Deer River, replaced as the primary flow path by the ditch constructed from 1916 to 1921, has been divided into a series of ponded sloughs by the ditch and by sediment deposition. Twelve major occlusions of the natural channel were mapped in the study area. Nonetheless, the natural channel can be traced through nearly all of the study area, and its original dimensions estimated. The estimated bankfull capacity of the natural channel immediately before channelization is comparable to the present base flow of the North Fork Forked Deer ditch.

There has been little change in the location of the North Fork Forked Deer ditch since its construction, because flow in the ditch is confined by cohesive lower banks. Degradation has the potential to destabilize the banks and to accelerate lateral migration of the channel by exposing the sands that lie below the present bed. Conversely, aggradation also could result in accelerated lateral migration by elevating the bed above the cohesive parts of the banks.

The pattern of flow in the flood plain is complex. The natural channel provides an important path for flood flow and flood-plain drainage, but it has been plugged by sediment, woody debris, and beaver dams in many areas. Most of the sediment plugging the natural channel probably was delivered by the North Fork Forked Deer ditch, but in several locations the source of the sediment was tributary streams. Current or abandoned tributary channels and low areas of the flood plain also function as flow paths, although flow is impeded in these areas by dense vegetation and beaver dams. In the area north of the North Fork Forked Deer ditch and west of Parker Ditch, flow is impeded by beaver dams and levees on the flood plain. The spoil banks along the North Fork Forked Deer ditch impede drainage from small areas of the flood plain, but have been breached at points where sections of natural channel intersect the ditch.

Of the tributaries entering the study area, only the two largest, Parker Ditch and Doakville Creek, have clear channels and provide effective drainage. The upstream reaches of these and other tributaries entering the study area seem to be generally stable, except for signs of bank retreat along Parker Ditch. The lower reaches of tributaries other than Parker Ditch and Doakville Creek are isolated from the North Fork Forked Deer ditch by occlusions of their channels, especially near the flood-plain margin, and by beaver dams and debris. Several of these streams are ponded, and inundate agricultural land adjacent to the flood plain. The sediment deposited in the occluded reaches seems to come from the watersheds of the tributaries themselves. Except for Doakville Creek and Parker Ditch, the tributaries that enter the Wildlife Management Area likely will not be affected by the channel evolution of the North Fork Forked Deer ditch in the near future.

Clearing tributary streams of sediment and other obstructions would alleviate flooding over the short term. However, as long as the tributaries carry high sediment loads, such measures will continue to be temporary solutions whose continued effectiveness will require periodic maintenance of channels. The stability of the upstream reaches of tributaries could be disrupted, if the downstream occluded reaches are substantially modified.

The North Fork Forked Deer ditch seems to be degrading and widening, and this degradation has stimulated rapid erosion of headcuts in the flow paths that drain the flood plain. Erosion of these headcuts has lowered water levels in the ponded areas immediately upstream from sampling site 1 and in the area north of the North Fork Forked Deer ditch and west of Parker Ditch, and has the potential to lower the water level in the ponded area north of the North Fork Forked Deer ditch and east of Parker Ditch. Degradation and widening of the North Fork Forked Deer ditch may continue for several years, but, in the absence of further ditch maintenance, is likely to be followed by a period of aggradation that could ultimately fill the ditch with sediment and divert flow into the flood plain.

This report presents a reconnaissance-level evaluation of the interaction between recent sedimentation and surface-water drainage in the Tigrett Wildlife Management Area and adjacent areas of the North Fork Forked Deer River flood plain. This evaluation has identified several areas where further research is needed. Two major issues not fully addressed in this study are (1) sedimentation patterns along such tributary streams as Stokes and Eliza Creeks, and (2) the frequency, duration, and magnitude of flooding of the North Fork Forked Deer River. Further investigation of these topics would aid managers in predicting hydroperiods and extent of flooding in various parts of the flood plain under different management alternatives. Additional studies of this type elsewhere in the Forked Deer River basin and in other drainage basins of West Tennessee also are needed to provide a framework in which to analyze local environmental problems such as those found in and around the Tigrett Wildlife Management Area.

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