DETERMINATION OF THE 100-YEAR FLOOD PLAIN ON UPPER THREE RUNS AND SELECTED TRIBUTARIES, AND THE SAVANNAH RIVER AT THE SAVANNAH RIVER SITE, SOUTH CAROLINA, 1995

By Timothy H. Lanier

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 96-4014

Prepared in cooperation with the
U.S. DEPARTMENT OF ENERGY

Columbia, South Carolina
1996

U.S. DEPARTMENT OF THE INTERIOR

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WITH THE FOLLOWING 3 SENTENCES.

The relation and an impervious area of 5.0 percent were used to obtained a 100-year flow of 1,170 ft^3/s. This flow was adjusted using methods described in Guimaraes and Bohman (1992) for determining flood frequency at or near a gaged site on the same stream. A 100-year flow of 1,110 ft^3/s was obtained, compared to 1,080 ft^3/s computed by log-Pearson methods.

CONTENTS

Abstract 1
Introduction 1
Purpose and scope 2
Description of study area 2
Acknowledgment 5
Hydrologic and hydraulic data collection 5
Flood frequency 6
Upper Three Runs 6
Crouch Branch, McQueen Branch, Mill Creek, and Reedy Branch 11
Tims Branch 13
Tinker Creek 14
Savannah River 14
Determination of the 100-year flood plain 16
Model selection and development 16
Upper Three Runs 16
Tims Branch 17
Crouch Branch 17
Tinker Creek 35
McQueen Branch 40
Mill Creek 40
Reedy Branch 44
Savannah River 44
Summary 56
Selected references 57
Appendix - List of elevation reference marks 59

PLATES

1-3. Maps showing areal extent of the 100-year flood for:
1. Upper Three Runs and selected tributaries at the Savannah River Site, near Aiken, South Carolina
2. The Savannah River from river mile 144 to river mile 163
3. The Savannah River from river mile 125 to river mile 144

FIGURES

1. Map showing Savannah River Site with site areas and streams in Aiken, Allendale, and Barnwell Counties, S.C. 3
2. Map showing Savannah River Site boundaries, drainage basins, and streams 4
3. Graph showing relation of 100-year recurrence-interval flow and drainage area for Upper Three Runs 12
4. Graph showing relation of flow at river mile 187.1 to flow at river mile 159.4 for the Savannah River 15

5-10. Graphs showing the flood profile of Upper Three Runs, Savannah River Site, S.C., from:
- 5. Station 10000 to Station 20000 and Station 20000 to Station 30000 18
- 6. Station 30000 to Station 40000 and Station 40000 to Station 50000 19
- 7. Station 50000 to Station 60000 and Station 60000 to Station 70000 20
- 8. Station 70000 to Station 80000 and Station 80000 to Station 90000 21
- 9. Station 90000 to Station 100000 and Station 100000 to Station 110000 22
- 10. Station 110000 to Station 111000 23

11-13. Graphs showing the flood profile of Tims Branch, Savannah River Site, S.C., from:
- 11. Station 900 to Station 10000 27
- 12. Station 10000 to Station 20000 28
- 13. Station 20000 to Station 27900 29

14. Graph showing the flood profile for the right basin of Crouch Branch, Savannah River Site, S.C., from Station 0 to Station 5900 32
15. Graph showing the flood profile for the left basin of Crouch Branch, Savannah River Site, S.C., from Station 0 to Station 6700 33

16-18. Graphs showing the flood profile of Tinker Creek, Savannah River Site, S.C., from:
- 16. Station 0 to Station 10000 and Station 10000 to Station 20000 36
- 17. Station 20000 to Station 30000 and Station 30000 to Station 40000 37
- 18. Station 40000 to Station 50000 and Station 50000 to Station 55000 38

19. Graph showing the flood profile of McQueen Branch, Savannah River Site, S.C., from Station 0 to Station 5500 41
20. Graph showing the flood profile of McQueen Branch, Savannah River Site, S.C., from Station 5500 to Station 10800 42

21-23. Graphs showing the flood profile of Mill Creek, Savannah River Site, S.C., from:
- 21. Station 0 to Station 8000 45
- 22. Station 8000 to Station 16000 46
- 23. Station 16000 to Station 24000 47

24-27. Graphs showing:
- 24. The flood profile of Reedy Branch, Savannah River Site, S.C., from Station 0 to Station 6000 50
- 25. The flood profile of Reedy Branch, Savannah River Site, S.C., from Station 6000 to Station 11800 51
- 26. Relation of stage to flow at river mile 159.4 for the Savannah River 53
- 27. The flood profile for the Savannah River from river mile 125.7 to river mile 163.8 54

TABLES

1. Summary of 100-year recurrence-interval flows for Upper Three Runs and its tributaries 7
2. Summary of 100-year recurrence-interval flows for the Savannah River at selected locations 11
3-9. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of:
    3. Upper Three Runs 24
    4. Tims Branch 30
    5. Crouch Branch 34
    6. Tinker Creek 39
    7. McQueen Branch 43
    8. Mill Creek 48
    9. Reedy Branch 52
10. Cross-section location, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of the Savannah River 55

CONVERSION FACTORS, VERTICAL DATUM, AND ACRONYMS

Multiply	By	To obtain
foot (ft)	0.3048	meter
foot per mile (ft/mi)	0.1894	meter per kilometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

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.

In this report, the station number represents the distance in feet upstream from the mouth of the subject stream. For example, Station 37600 on Upper Three Runs is 37,600 feet upstream from the mouth of Upper Three Runs.

In this report, the river mile represents the distance in miles upstream from the mouth of the Savannah River. The river miles were established by the U.S. Army Corps of Engineers.

Acronyms

SRS - Savannah River Site
USDOE - U. S. Department of Energy
USGS - U.S. Geological Survey
USC&GS - U.S. Coastal and Geodetic Survey

DETERMINATION OF THE 100-YEAR FLOOD PLAIN ON UPPER THREE RUNS AND SELECTED TRIBUTARIES, AND THE SAVANNAH RIVER AT THE SAVANNAH RIVER SITE, SOUTH CAROLINA, 1995

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Abstract

The 100-year flood plain was determined for Upper Three Runs, its tributaries, and the part of the Savannah River that borders the Savannah River Site. The results are provided in tabular and graphical formats. The 100-year flood-plain maps and flood profiles provide water-resource managers of the Savannah River Site with a technical basis for making flood-plain management decisions that could minimize future flood problems and provide a basis for designing and constructing drainage structures along roadways.

A hydrologic analysis was made to estimate the 100-year recurrence-interval flow for Upper Three Runs and its tributaries. The analysis showed that the well-drained, sandy soils in the headwaters of Upper Three Runs reduce the high flows in the stream; therefore, the South Carolina upper Coastal Plain regional-rural-regression equation does not apply for Upper Three Runs. Consequently, a relation was established for 100-year recurrence-interval flow and drainage area using streamflow data from U.S. Geological Survey gaging stations on Upper Three Runs. This relation was used to compute 100-year recurrence-interval flows at selected points along the stream. The regional regression equations were applicable for the tributaries to Upper Three Runs, because the soil types in the drainage basins of the tributaries resemble those normally occurring in upper Coastal Plain basins. This was verified by analysis of the flood-frequency data collected from U.S. Geological Survey gaging station 02197342 on Fourmile Branch.

Cross sections were surveyed throughout each reach, and other pertinent data such as flow resistance and land-use were collected. The surveyed cross sections and computed 100-year recurrence-interval flows were used in a step-backwater model to compute the 100-year flood profile for Upper Three Runs and its tributaries. The profiles were used to delineate the 100-year flood plain on topographic maps.

The Savannah River forms the southwestern border of the Savannah River Site. Data from previously published reports were used to delineate the 100-year flood plain for the Savannah River from the downstream site boundary at the mouth of Lower Three Runs at river mile 125 to the upstream site boundary at river mile 163.

INTRODUCTION

In 1951, the U.S. Department of Energy (USDOE), formerly the Atomic Energy Commission, created the Savannah River Site (SRS) to produce nuclear materials for national defense. The SRS is located in parts of Aiken, Barnwell, and Allendale Counties, South Carolina. The operation of the first nuclear production reactor, R, began in 1953. In addition, there are four other nuclear reactors at the SRS, which are located in areas C, K, L, and P. Reactors R and P were permanently deactivated in 1964 and 1991, respectively, and except for the restart testing of K reactor in 1991, all of the remaining reactors have been placed on stand-by since the late 1980's. Other areas on the SRS include reactor materials (area M), separation (areas F and H), waste management (areas E, F, H, S, Y, and Z), heavy water processing (area D), administration (areas A, B, and CS), the Savannah River Ecology Laboratory, and the Savannah River Laboratory (fig. 1) (Arnett and others, 1992).

In 1992, the U.S. Geological Survey (USGS) in cooperation with the USDOE, initiated an investigation to determine the areal extent of the inundation caused by the 100-year recurrence interval flow (100-year flow) for the Savannah River along the SRS boundary and for the major streams and their tributaries on the SRS, with the exception of Lower Three Runs.

Purpose and Scope

This report documents the approximate boundaries of the 100-year flood plain on the SRS for Upper Three Runs and selected tributaries and the reach of the Savannah River that borders the SRS. Selected tributaries of Upper Three Runs include Tims Branch, Crouch Branch, Tinker Creek, McQueen Branch, Mill Creek, and Reedy Branch (fig. 2). Step backwater methods will be used to approximate the 100-year flood-plain boundaries for Upper Three Runs and selected tributaries. Two existing reports on the Savannah River will be used to approximate the 100-year flood plain on the reach of the Savannah River that borders the SRS. One-hundred-year flows at selected locations, and graphical and tabular profiles of the 100-year flood are listed in tables for Upper Three Runs and selected tributaries, and for the reach of the Savannah River that borders the SRS. Descriptions and elevations of elevation reference marks (ERM) are listed in the appendix.

Less-than-detailed methods, which require less cross-sectional definition, were used to compute the 100-year flood-plain boundaries. In particular, cross sections were surveyed primarily at road crossings or other easily accessible locations. Intermediate cross sections were interpolated using these surveyed cross sections and 7.5-minute topographic maps (U.S. Geological Survey, 1963-79). This method was requested by the USDOE, because extreme accuracy was not warranted.

Description of Study Area

The SRS occupies more than 300 mi^2 along the Georgia-South Carolina border in parts of Aiken, Barnwell, and Allendale Counties, South Carolina. The southwestern boundary of the SRS is formed by the Savannah River. The five major streams that drain into the Savannah River from the SRS are Upper Three Runs, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs (fig. 2). The SRS is located in the upper Coastal Plain physiographic province of South Carolina, which encompasses about 20 percent of the State (fig. 1). The general topography of the upper Coastal Plain consists of rounded hills with gradual slopes; however, some areas of highly irregular terrain exist in the province, and some elevations exceed 700 ft above sea level. The highest elevation on the SRS is approximately 420 ft above sea level, near Tims Branch and the northwest boundary of SRS (fig. 2). The land-surface elevation at the boundary of the upper and lower Coastal Plains, located southeast of the SRS, is usually less than 200 ft above sea level. Upper Coastal Plain stream slopes range from 5 to 20 ft/mi, and many of the streams are bordered by swamps with wide flood plains relative to the size of the stream (Zalants, 1990).

The study area includes Upper Three Runs, its major tributaries (pl. 1), and the reach of Savannah River that forms the southwestern boundary (pls. 2 and 3). Upper Three Runs begins near the town of Aiken, S.C. (fig. 1), and flows into the Savannah River south of Augusta, Ga., at river mile 157.5 (pl. 2). The total drainage area of Upper Three Runs at its confluence with the Savannah River is approximately 206 mi^2; approximately 99 mi^2 of the basin lies in the northern and western parts of the SRS.

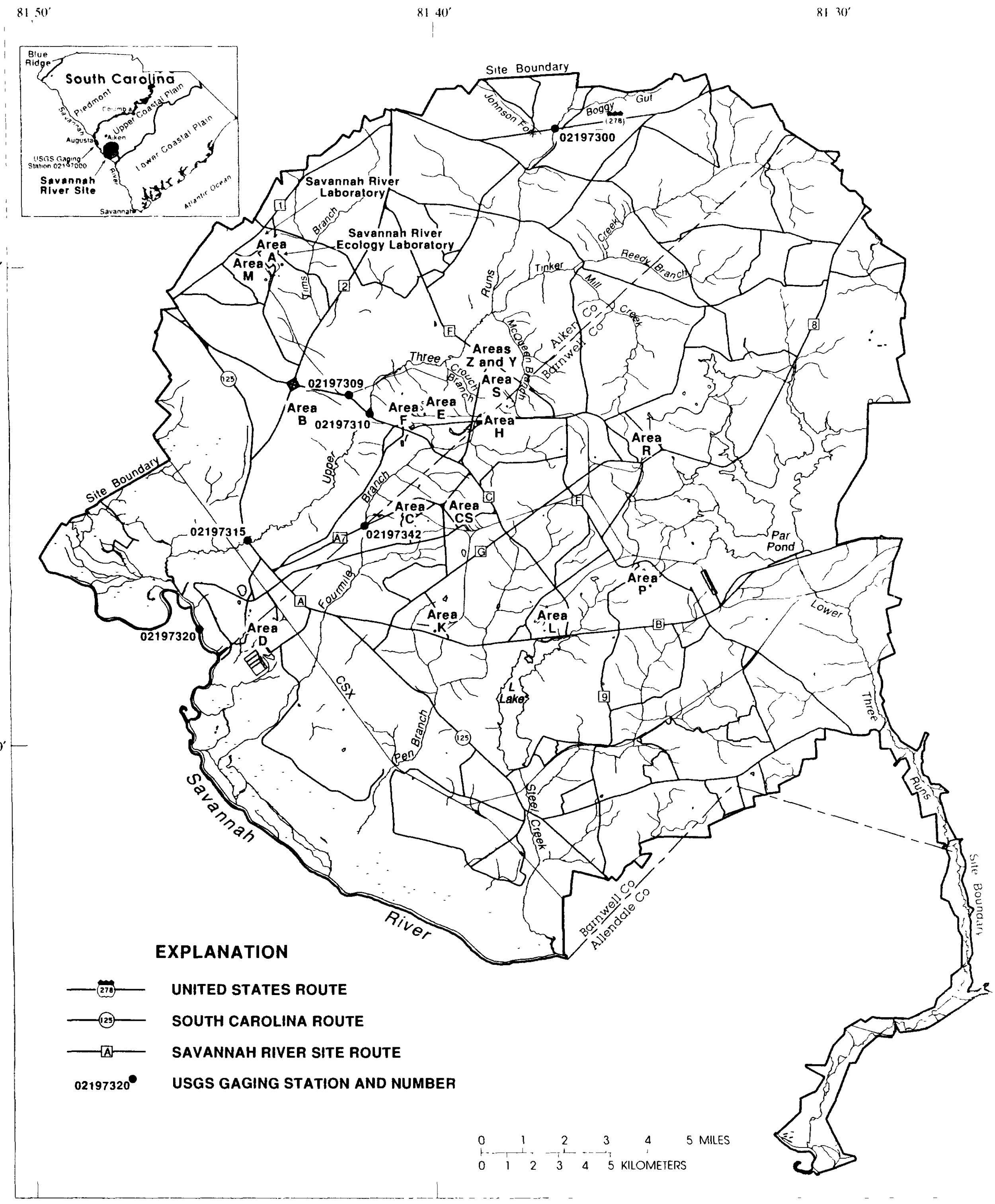
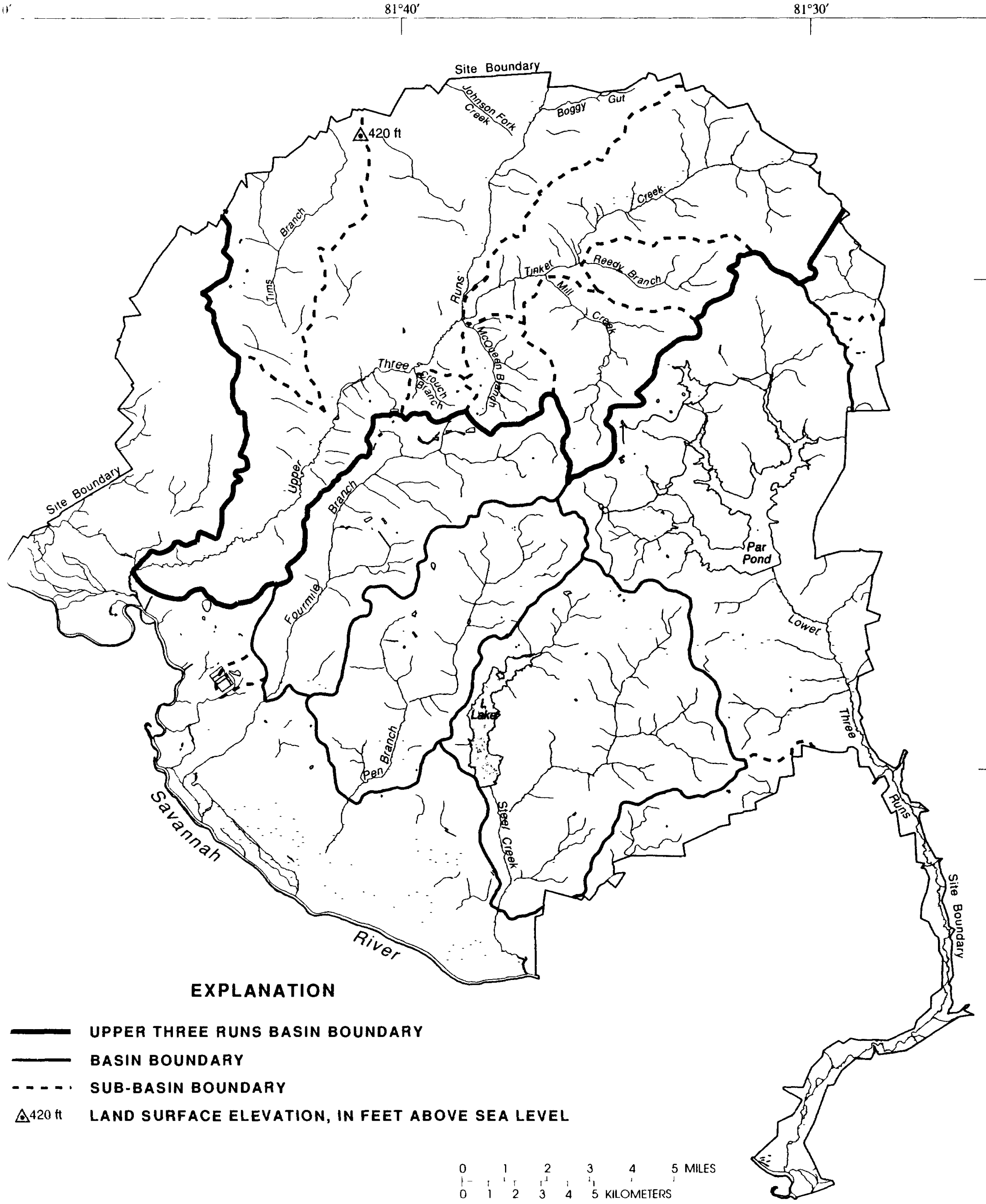


Figure 1. Savannah River Site with site areas and streams in Aiken, Allendale, and Barnwell Counties, S.C.



re 2. Savannah River Site boundaries, drainage basins, and streams.

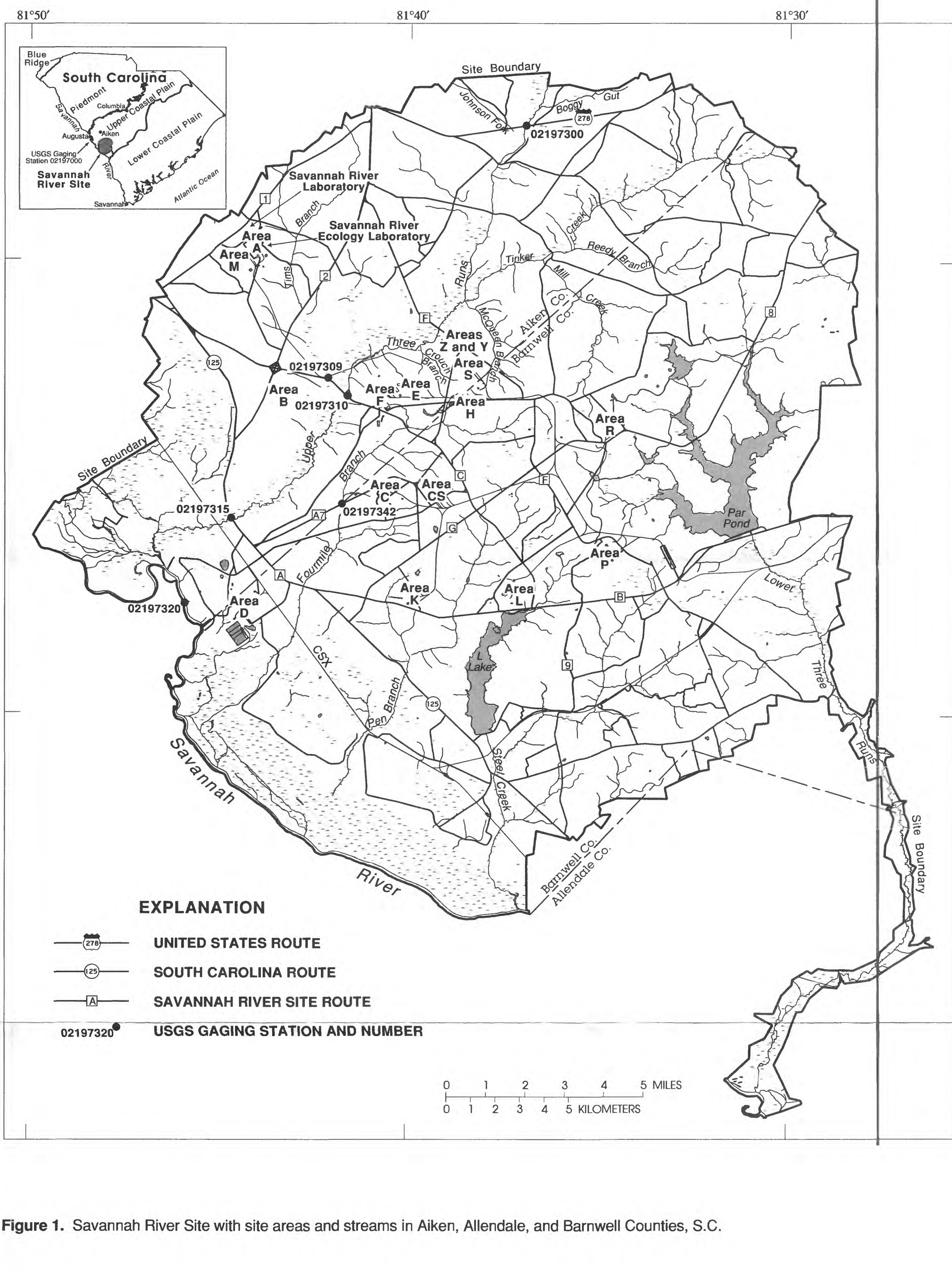


Figure 1. Savannah River Site with site areas and streams in Aiken, Allendale, and Barnwell Counties, S.C.

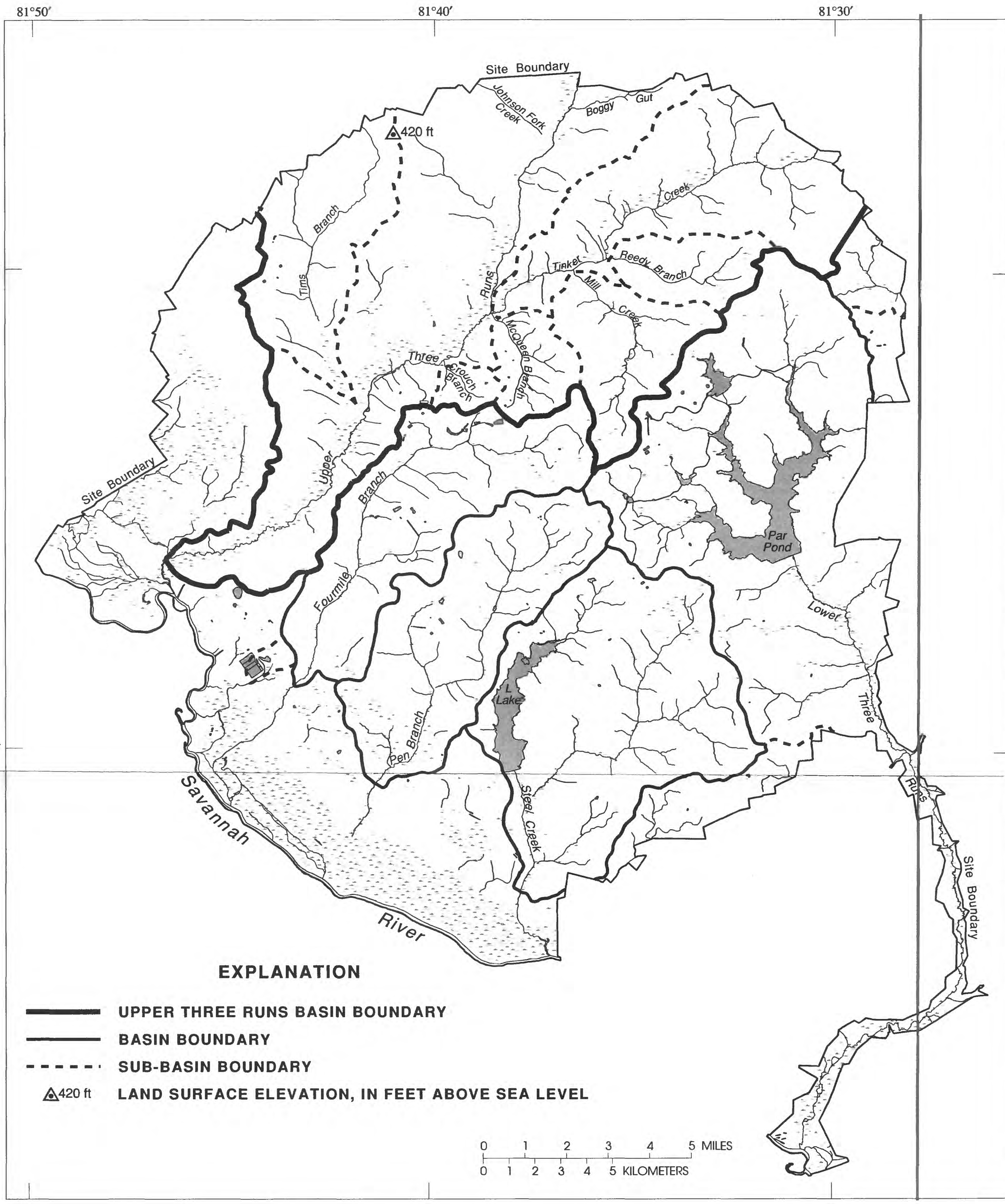


Figure 2. Savannah River Site boundaries, drainage basins, and streams.

APPENDIX

List of Elevation Reference Marks

Cross-section elevations were referenced to sea level using ERM located on the SRS. The ERM's used are described in the appendix. In areas where no ERM's were located, a Global Positioning System was used to establish temporary ERM's. Standard surveying levels were used to reference the temporary ERM's to more permanent structures.

Manning's roughness coefficients used in the hydraulic computations were estimated for the channels and flood plains using engineering judgement. Coefficient estimates were based on field notes, photographs, and methods documented by Arcement and Schneider (1984) and by Barnes (1967).

Cross sections on the Savannah River were obtained by McDonald and Sanders (1987) by using U.S. Army Corps of Engineers' navigation charts to define the geometry of the main channel and 7.5-minute series topographic maps (U.S. Geological Survey, 1963-79) to define the elevations of the flood plains. Because the simulated elevation and flow on the Savannah River for the March 1956 flood matched the observed elevation and flow at gaging station 02197320, Savannah River near Jackson, S.C. (fig. 1), the elevation and flow data from McDonald and Sanders (1987) were considered to have adequate accuracy for purposes of this study.

FLOOD FREQUENCY

Methods described by the U.S. Water Resources Council (1981) and gaging station peak-flow data were used to compute 100-year flow on Upper Three Runs. Flood-flow regionalization methods described in Guimaraes and Bohman (1992) and Bohman (1992) were used on all tributaries to Upper Three Runs. Data from Sanders and others (1990) and McDonald and Sanders (1987) were used to determine the 100-year flow on the reach of the Savannah River that borders the SRS. The results of the hydrologic analysis on Upper Three Runs and its tributaries, and the Savannah River near the study area are presented in tables 1 and 2, respectively.

Upper Three Runs

The headwaters of Upper Three Runs are located in deep, well-drained, sandy soils (Rogers, 1977; 1985; 1990). Because these soils are better drained than most soils in the upper Coastal Plain, the high flows of Upper Three Runs are reduced, and base flows are increased. For this reason, the regional-rural-regression equations developed to estimate selected recurrence interval flows in the upper Coastal Plain physiographic region (Guimaraes and Bohman,1992) could not be used on Upper Three Runs. Therefore, 100-year flows were computed at gaging stations 02197300 and 02197310 by fitting the logarithms of peak flows to a Pearson type-III distribution (log-Pearson method) as described by the U.S. Water Resources Council (1981).

Peak flows at gaging station 02197310, which has 17 years of record, were adjusted to peak flows at gaging station 02197300, which has 26 years of record, using the method described in appendix 7 of Bulletin 17B of the U.S. Water Resources Council (1981). This method uses a correlation of flows at the two sites to adjust the mean and standard deviation of the logarithms of peak flows at the short-record site to those at the long-record site. The adjusted mean and standard deviation of the logarithms of flows are then used to recompute the selected recurrence-interval flows at the shorter-record site.

A relation of 100-year flow and drainage area was plotted for the 100-year flows computed using the regional-rural-regression equation and the log-Pearson method (fig. 3) at gaging stations 02197300 and 02197310. The 100-year flows computed with the rural regression equation were much higher than the 100-year flows computed using the log-Pearson method. This difference can be directly attributed to the exceptionally deep and sandy soils found in the headwaters of the Upper Three Runs Basin.

In the study area, the major tributaries to Upper Three Runs are Boggy Gut, Johnson Fork, Tinker Creek, Crouch Branch, and Tims Branch (fig. 1). Boggy Gut and Johnson Fork were not included in the study. Within the SRS, the major tributaries to Tinker Creek are Reedy Branch, Mill Creek, and McQueen Branch (pl. 1), and are included in the study. The downstream study limit is the confluence of Upper Three Runs and the Savannah River (pl. 2), whereas the upstream limit is the SRS boundary on Upper Three Runs and at the U.S. Route 278 crossing of Tinker Creek just upstream from the SRS boundary (pl. 1). The Upper Three Runs and Tinker Creek Basins have drainage areas of 74.0 and 9.6 mi^2, respectively, upstream of the study limits.

The Upper Three Runs Basin is predominantly rural; however, the Tims Branch, McQueen Branch, and Crouch Branch Basins have significant industrialization. These industrialized locations include areas A, F, H, M, and S (fig. 1).

The Savannah River originates in the Blue Ridge Province and flows into the Atlantic Ocean near Savannah, Ga. (fig. 1). The river forms the southwestern boundary of the SRS. The flood plain in this area is 8,000- to 12,900-ft wide, most of which is in South Carolina.

Acknowledgment

The author is grateful to Lee Davis, USDOE, for his logistical and administrative support of this project.

HYDROLOGIC AND HYDRAULIC DATA COLLECTION

Hydrologic data, which includes drainage area, soil type, impervious area, and peak-flow records at USGS gaging stations, were used to estimate the 100-year flow for Upper Three Runs and its tributaries. The drainage area for each basin was delineated using 7.5-minute series topographic maps (U.S. Geological Survey, 1963-79) at selected locations along the reach. These locations were selected based on major tributary confluences, changes in drainage-area shape, and (or) changes of imperviousness within the drainage basin. Soil types were determined from the Natural Resources Conservation Service (NRCS), [formerly the Soil Conservation Service (SCS)] soil reports of Aiken and Barnwell Counties and the Savannah River Plant Area (Rogers, 1977; 1985; 1990). Urbanized areas in the drainage basins were determined from aerial photographs, 7.5-minute series topographic maps (U.S. Geological Survey, 1963-79), the SRS Atlas (Savannah River Site, 1994), and field inspections. Percentage-imperviousness data associated with urbanized areas were obtained from Cronshey and others (1986). Peak-flow data were obtained from USGS gaging stations 02197300, Upper Three Runs at Route U.S. 278; 02197310, Upper Three Runs at Road C; and 02197315, Upper Three Runs at Road A (fig. 1). However, data from gaging station 02197315 were not used, because flow is affected by backwater from the Savannah River. Other peak-flow data in the Upper Three Runs Basin are available, but these records were not used because of short record length or flow regulation. However, data from one station outside of the Upper Three Runs Basin, gaging station 02197342, Fourmile Branch at Road A-7 (fig. 1), were used to verify the methods of regionalization of selected recurrence interval flows described by Guimaraes and Bohman (1992).

Cross sections for the step-backwater analysis of Upper Three Runs and its tributaries were surveyed by USGS personnel. These cross sections were taken upstream and (or) downstream of bridge and culvert crossings, along road grades at these crossings, and at selected locations along the streams, such as natural or man-made expansions or contractions and powerline right-of-ways. In addition, elevation data and structural geometry for all bridges and culverts were determined. Synthesized cross sections were developed using surveyed cross-sectional data and 7.5-minute series topographic maps (U.S. Geological Survey, 1963-79).

Table 1. Summary of 100-year recurrence-interval flows for Upper Three Runs and its tributaries

[mi^2, square miles; ft^3/s, cubic feet per second; ft, feet; --, cross-section not surveyed]

Location (plate 1)	Drainage area (mi^2)	100-year flow (ft^3/s)	Cross-section name
Upper Three Runs			
Station 15289, CSX Railway bridge 2,425 ft downstream from Road A	204	1,875	BR20
Station 48058, just upstream from confluence with Tims Branch; 169 ft upstream Road C	176	1,620	--
Station 68465, Road F	165	1,520	BR140
Station 74915, just upstream from the confluence with Tinker Creek; 6,450 ft upstream from Road F	108	1,000	--
Station 88075, 90 ft upstream from Tyler Bridge Road	105	975	--
Station 102276, U.S. Route 278	86.6	806	BR230
Station 105576, just upstream from confluence with Boggy Gut; 3,300 ft upstream from U.S. Route 278	75.7	706	--
Tims Branch			
Station 1400	17.0	[1]819	--
Station 9500	14.6	738	--
Station 13124, Road 2	13.8	710	C70
Station 15600	13.1	685	--
Station 17250	12.3	655	--
Station 19466, Steed Pond Road	11.7	633	RD101
Station 22587, just upstream from Powerline road between Road D-1 and Steed Pond Road	10.9	603	--
Station 24625	4.35	320	--
Station 24675	[2].484	277	--

Table 1. Summary of 100-year recurrence-interval flows for Upper Three Runs and its tributaries--Continued

[mi^2, square miles; ft^3/s, cubic feet per second; ft, feet; --, cross-section not surveyed]

Location (plate 1)	Drainage area (mi^2)	100-year flow (ft^3/s)	Cross-section name
McQueen Branch			
Station 1000, 1,000 ft upstream from the confluence with Tinker Creek	[3]4.29	563	--
Station 7150, 1,120 ft upstream from unnamed road between Z area and Road E-2, 3,450 ft downstream from Road F	[4]1.88	454	--
Station 9400, 3,370 ft upstream from unnamed road between Z area and Road E-2, 1,200 ft downstream from Road F	[5].909	488	--
Reedy Branch			
Station 500, 500 ft upstream from the confluence with Tinker Creek	5.27	365	--
Station 4025, 575 ft downstream from breached dam located at Station 4600	4.72	338	--
Station 6750	3.77	290	--
Station 9600	3.15	256	--
Station 11600, Road 2-1	2.87	240	RD21
Mill Creek			
Station 150, 150 ft upstream from the confluence with Tinker Creek	9.42	545	--
Station 10250	4.79	342	--
Station 13500	3.62	282	--
Station 18600	1.95	184	--

Table 1. Summary of 100-year recurrence-interval flows for Upper Three Runs and its tributaries--Continued

[mi^2, square miles; ft^3/s, cubic feet per second; ft, feet; --, cross-section not surveyed]

Location (plate 1)	Drainage area (mi^2)	100-year Flow (ft^3/s)	Cross-section name
Tinker Creek			
Station 0, Confluence of Tinker Creek and Upper Three Runs	49.0	1,700	--
Station 6350	48.8	1,680	SEC16
Station 9300	47.7	1,670	--
Station 15472, Tyler Bridge Road	36.9	1,400	BRD30
Station 22000	30.2	1,220	--
Station 24900	28.6	1,170	--
Station 28600	27.5	1,140	--
Station 32700	26.0	1,100	--
Station 37600	22.9	1,010	--
Station 40800	20.5	932	--
Station 42100	18.3	862	--
Station 47145, Kennedys Pond Road	16.3	796	BR120
Station 49000	12.1	648	--
Station 54925, U. S. Route 278	9.61	553	BR140

Table 1. Summary of 100-year recurrence-interval flows for Upper Three Runs and its tributaries--Continued

[mi^2, square miles; ft^3/s, cubic feet per second; ft, feet; --, cross-section not surveyed]

Location (plate 1)	Drainage area (mi^2)	100-year Flow (ft^3/s)	Cross-section name
Crouch Branch			
Station 2000	[6]1.09	618	--
Station 3650, Left unnamed tributary: Confluence of left and right unnamed tributaries	[7].420	366	--
Station 5650, Left unnamed tributary: 780 ft downstream of Road 4	[8].145	478	--
Station 3650, Right unnamed tributary: Confluence of left and right unnamed tributaries	[9].415	443	--
Station 5750, Right unnamed tributary: Road 4	[10].229	518	RD4R

[1]Because the U.S. Government M Line Railway culvert ponds flow, only 430 ft^3/s reaches this point. The remaining flow crosses the basin divide and flows into Upper Three Runs.

[2]Impervious area is 14 percent.

[3]Impervious area is 4 percent.

[4]Impervious area is 8 percent.

[5]Impervious area is 16 percent.

[6]Impervious area is 18 percent.

[7]Impervious area is 21 percent.

[8]Impervious area is 62 percent.

[9]Impervious area is 26 percent.

[10]Impervious area is 48 percent.

Table 2. Summary of 100-year recurrence-interval flows for the Savannah River at selected locations

[ft^3/s, cubic feet per second]

Cross-section location (plates 2 and 3)	100-year flow (ft^3/s)
River mile 125.7	160,000
River mile 129.4, confluence of Lower Three Runs and the Savannah River	150,000
River mile 132.6	154,000
River mile 136.9	156,000
River mile 143.2, confluence of Steel Creek and the Savannah River	160,000
River mile 143.4	160,000
River mile 147.8, confluence of Pen Branch and the Savannah River	157,000
River mile 148.8	158,000
River mile 151.5, confluence of Fourmile Branch and the Savannah River	160,000
River mile 153.0	160,000
River mile 159.4	160,000
River mile 160.0, confluence of Upper Three Runs and the Savannah River	159,000
River mile 163.1	160,000

A relation for 100-year flow and drainage area was established by drawing a straight line through the 100-year flow at gaging station 02197300 computed by the log-Pearson method and the adjusted log-Pearson 100-year flow at gaging station 02197310. This relation is used to compute flows at selected points along Upper Three Runs. The 100-year flow can be estimated using the equation:

$$Q_{100} = 10.0\,(A)^{0.984} , \qquad (1)$$

where

Q_{100} is the 100-year recurrence-interval flow, in cubic feet per second; and

A is the drainage area, in square miles.

Crouch Branch, McQueen Branch, Mill Creek, and Reedy Branch

The regionalized-rural and urban-regression equations developed by Guimaraes and Bohman (1992) and Bohman (1992) were used to compute the 100-year flow for Crouch Branch, McQueen Branch, Mill Creek, and Reedy Branch. As described earlier, these methods could not be applied to the main stem of Upper Three Runs; therefore, additional analyses were made on other streams within the SRS to verify that the regional regression equations accurately compute 100-year flows.

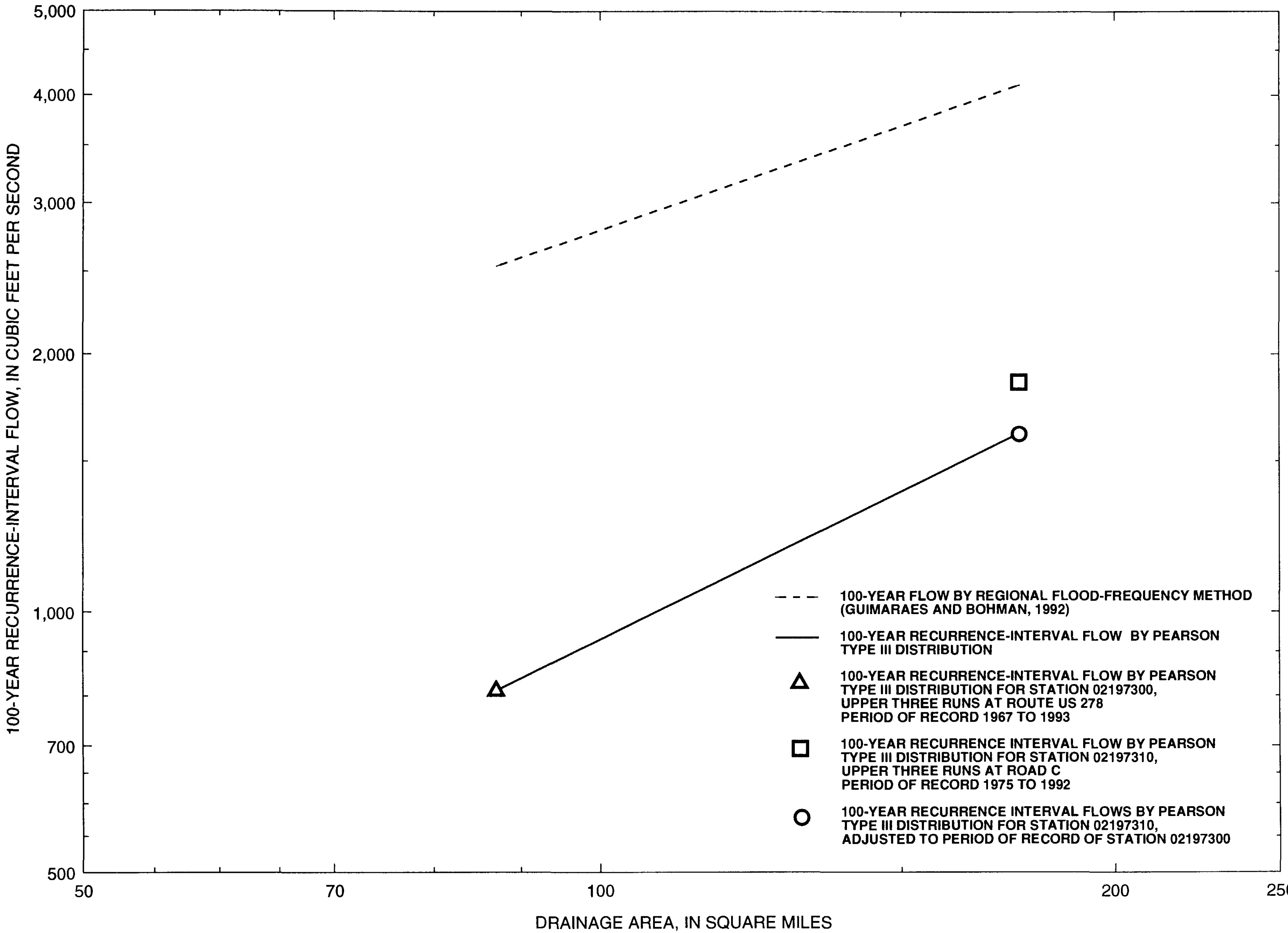


Figure 3. Relation of 100-year recurrence-interval flow and drainage area for Upper Three Runs.

Soil types in these four basins resemble those normally occurring in upper Coastal Plain drainage basins. These upper Coastal Plain soil types also are in the Fourmile Branch Basin (fig. 2). Therefore, 100-year flows were computed using the log-Pearson method and 23 years of peak-flow data from gaging station 02197342, Fourmile Branch at Road A-7 (fig. 1), and were compared to the 100-year flows computed using the regional-rural and urban-regression equations. This comparison showed that the regional-rural and urban-regression equations reasonably describe the 100-year flows of Fourmile Branch and, because the soil types are similar, are applicable to Crouch Branch, McQueen Branch, Mill Creek, and Reedy Branch.

Using the peak-flow data of gaging station 02197342, a 100-year flow of 1,080 ft^3/s was computed using the log-Pearson method. However, the 100-year flow computed with the regional rural regression equation was 663 ft^3/s. This large difference in computed flows is probably the result of the 5.0-percent imperviousness of the basin. However, the lower limit of imperviousness used to develop the regional urban regression equations presented by Bohman (1992) is 10 percent. Therefore, a relation of impervious area to flow was established for the drainage area of Station 02197342, using the rural flows with zero-percent imperviousness and the urban regional flows using 10- to 50-percent imperviousness. The relation and an impervious area of 5.0 percent were used to obtain a 100-year flow of 1,170 ft^3/s, compared to 1,080 ft^3/s computed by log-Pearson methods. The flows are well within the 95-percent confidence limits of both methods. Therefore, the regionalized-rural and urban-regression equations were used to compute the 100-year flows on the tributaries to Upper Three Runs.

The equations are:

for rural watersheds (Guimaraes and Bohman, 1992)

$$RQ_{100} = 116\,(A)^{0.69}\,, \qquad (2)$$

and for urban watersheds (Bohman, 1992)

$$UQ_{100} = 10.4(A)^{0.506}(TIA)^{0.932}(RQ_{100})^{0.280}\,, \qquad (3)$$

where

- RQ_{100} is the 100-year recurrence-interval flow for rural drainage basins, in cubic feet per second;
- A is the drainage area, in square miles;
- UQ_{100} is the 100-year recurrence-interval flow for urban drainage basins, in cubic feet per second; and
- TIA is the total impervious area, in percent of total drainage area.

Equation 2 is limited to drainage areas larger than 4.4 mi^2. However, the relation was extended downward to 1.95 mi^2, because no other regional regression equations specific to South Carolina were available. This extrapolation seems to be viable, because the logarithmic regional relation is linear. In addition, the relations for other areas are generally linear throughout the range of data, and therefore, it is expected that the relation for the upper Coastal Plain could be extrapolated below a drainage area of 4.4 mi^2.

Equation 3 requires that the impervious area be greater than 10 percent, and the drainage area be greater than 0.18 mi^2 and less than 41.0 mi^2. All of the tributaries with urbanization meet the drainage area requirement. However, three have impervious areas of less than 10 percent. For these tributaries, the previously described method to adjust flows for urbanization at Station 02197342 was used to compute flows for areas having less than 10-percent imperviousness.

Tims Branch

Soil types in the Tims Branch Basin, except for the extreme upstream part, are loamy soils similar to the soils of the other tributaries studied. The extreme upstream part of the basin is made up of excessively-well drained soils similar to those in the upper part of Upper Three Runs

(Rogers, 1977; 1985; 1990) and may reduce the peak flows on the stream.

The 100-year flow computed using data from gaging station 02197309, Tims Branch at Road C, (fig. 1) and the log-Pearson method was 147 ft^3/s, compared to 836 ft^3/s computed by regional regression equations. However, the station data was not used because of its short period of record (11 years), and because measured flood flows could be affected by storage behind the U.S. Government M-Line Railway and the breached pond just upstream of Road 2. This storage would reduce the peak flows measured at the gaging station and cause a bias in the flood-frequency calculation using the peak-flow data. Therefore, the upper Coastal plain regional- rural and urban-regression equations (Guimaraes and Bohman, 1992, Bohman, 1992) were used for Tims Branch. However, these equations could produce profiles that represent a probable maximum elevation to be expected for the 100-year flood rather than the most likely elevation.

The study area extends upstream to Road D-1, because runoff from urbanization at areas A and M reach Tims Branch at this point. The study was terminated at Road D-1 (pl. 1) because 43 percent of the basin of the left tributary and 66 percent of the basin of the right tributary are composed of excessively-well drained soils. These excessively-well drained soils are similar to soils in the Upper Three Runs basin where the regional regression equations do not apply. Therefore, it was assumed that the equations would also not apply for the area upstream of Road D-1.

Tinker Creek

Parts of the Tinker Creek Basin are composed of sandy soils of the type located in the upper part of the Upper Three Runs Basin (Rogers, 1977; 1985; 1990). As discussed in the Upper Three Runs section, flood flows of Upper Three Runs are lower than indicated by regional regression equations for the upper Coastal Plain because of storage in these soils. Therefore, it seems possible that flood flows in Tinker Creek could be lower than would be indicated by the regional regression equations. The 100-year flow cannot be estimated using gaging station data, because no long-term data exists for Tinker Creek. The 100-year flow could be determined using 100-year flows at gaging station 02197300, Upper Three Runs at Route U.S. 278, but a much larger part of the Tinker Creek Basin consists of soils not as well-drained as those in the upper part of the Upper Three Runs Basin. Therefore, the regional-rural-regression equation (Guimaraes and Bohman, 1992) was used to compute 100-year flows because no other flood-frequency methods were available. This could produce profiles that represent a probable maximum elevation to be expected for the 100-year flood, rather than the most likely elevation.

Savannah River

Sanders and others (1990) determined a 100-year flow of 180,000 ft^3/s for regulated conditions during the period 1952-85 at gaging station 02197000 (river mile 187.1), Savannah River at Augusta, Ga. (fig. 1). McDonald and Sanders (1987) determined water-surface elevations and streamflow at selected locations downstream of river mile 187.1 using flood hydrographs from gaging station 02197000 at river mile 187.1 and a one-dimensional unsteady-flow model. The 100-year flows at the study area (river miles 125-163) were determined by first developing a relation of flows at mile 187.1 to flows at selected river miles bordering the study area using the data presented by McDonald and Sanders (1987). Then, the 100-year flow developed by Sanders and others (1994) for river mile 187.1 was entered into each relation to produce the 100-year flow at each selected river mile. An example is shown in figure 4 of the relation of flows at river mile 187.1 to river mile 159.4.

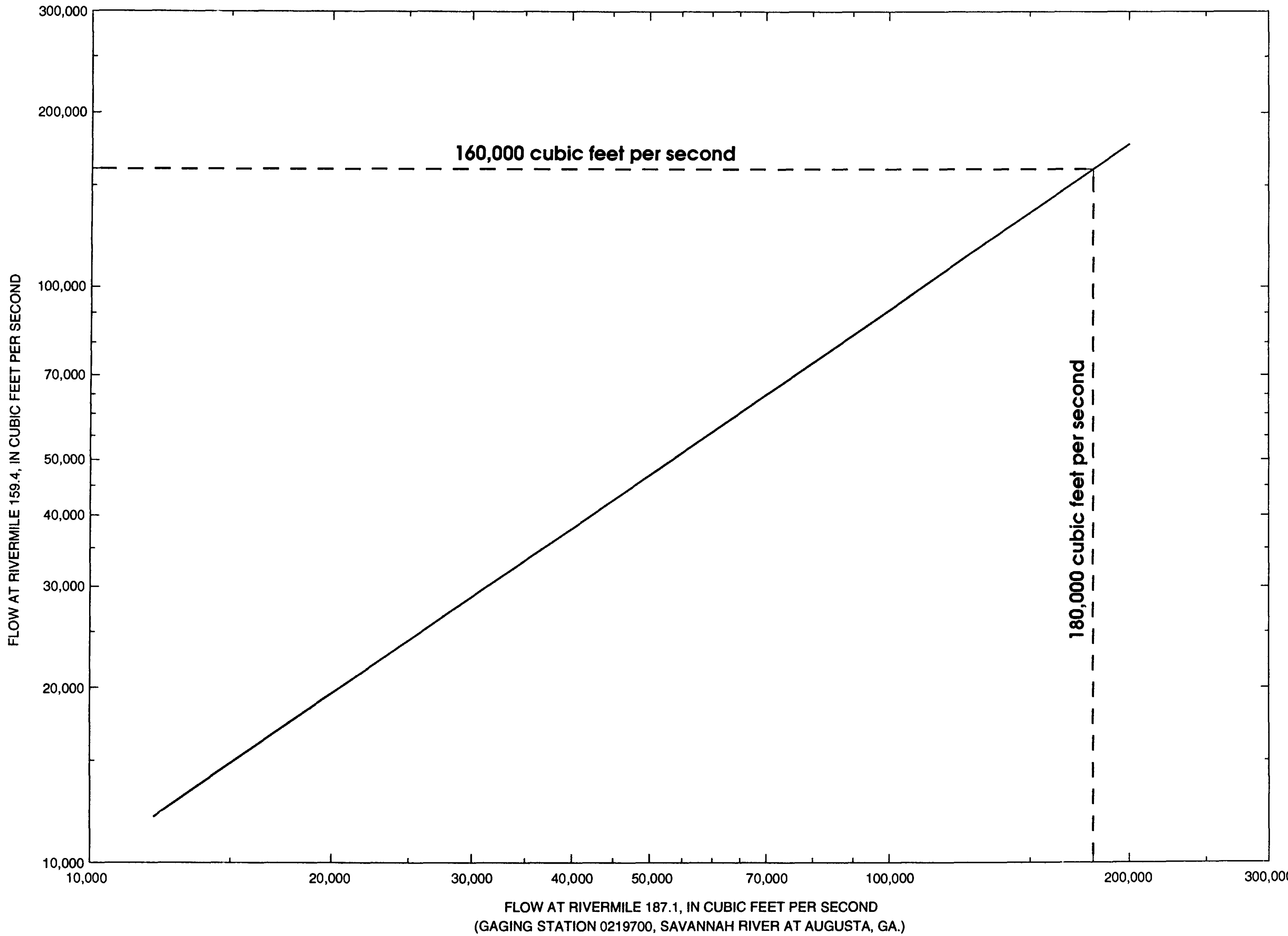


Figure 4. Relation of flow at river mile 187.1 to flow at river mile 159.4 for the Savannah River.

DETERMINATION OF THE 100-YEAR FLOOD PLAIN

Step-backwater computations were utilized to determine the 100-year flood plain on Upper Three Runs and its tributaries. The hydraulic analysis on the Savannah River used flood frequency and profile data from previously published reports to delineate the 100-year flood plain.

Model Selection and Development

Water-surface elevations for the 100-year flows were computed for Upper Three Runs and its tributaries by using the USGS/Federal Highways Administration step-backwater water-surface profile computer model (WSPRO) (Shearman and others, 1986; Shearman, 1990).

The downstream limit of the Upper Three Runs study area was located at the confluence of the Savannah River. For all tributaries to Upper Three Runs, the most downstream cross sections were located at the tributary confluence with Upper Three Runs. Because the drainage area of Upper Three Runs is much larger than the drainage areas of the tributary streams, it was assumed that at the time of the 100-year flood, the flow in the tributary stream would have peaked and receded before peak flow occurred on Upper Three Runs. This assumption was made for the Upper Three Runs/Savannah River confluence as well. Therefore, the starting water-surface elevations at the most downstream cross sections of Upper Three Runs and its tributaries were computed using the slope-conveyance option of the WSPRO model. The average flood-plain slopes between the confluence and the initially surveyed cross section on each stream were used.

The WSPRO model can compute backwater caused by bridges without subdividing the reach. However, the reach must be subdivided at culvert outfalls and a separate culvert-flow computation must be made to determine the backwater caused by the culvert. The culvert backwater was calculated using the USGS A-526 culvert-flow model (Matthai and others, undated; Bodhaine, 1968). The water-surface elevation at the approach to the culvert was used as the initial water-surface elevation for the WSPRO analysis of the next upstream reach.

McDonald and Sanders (1987) used the USGS model known as J879 (Land, 1978) to simulate flows on the Savannah River. This model is designed to simulate one-dimensional, subcritical, gradually varied, unsteady flow. The initial discharge conditions are computed by a step-backwater subprogram. The model then simulates the movement of a flood wave down the channel and computes discharge and elevation at each cross section as a function of time.

Upper Three Runs

Upper Three Runs was analyzed from its confluence with the Savannah River to the SRS boundary. Station 0 is located at the confluence of Upper Three Runs and Savannah River. The 110,500 ft-long study segment consists of 36 surveyed and 110 synthetic cross sections. The overall 100-year flood-plain depths for the entire reach were less than expected. This can be directly attributed to the 100-year flows being lower than were computed using regional-regression equations.

Within the study area, there are six highway bridges and two railway bridges that cross Upper Three Runs. The highway bridges are located on Roads A, C, and F, Tyler Bridge Road, Road 8-1, and Route U.S. 278 at Stations 17714, 47889, 68465, 87985, 95223 and 102276, respectively. The CSX and M Line U.S. Government Railway bridges cross Upper Three Runs at Stations 15289 and 51629, respectively (pl. 1). In addition, there are six powerline roads that cause contractions but do not cross Upper Three Runs. These roads are located at an unnamed road, Bush Road, Cato Road, Road F-4, Road F-5, and Monroe Owens Road at Stations 21749, 22839, 29289, 59309, 69474, and 77214, respectively (pl. 1). In the area of Upper Three Runs affected by backwater from the Savannah River, the 100-year flood-plain widths range from 800 ft at Station 25800 to

4,180 ft at Station 6990. Outside of this area, the flood-plain widths range from 189 ft at Station 109929 to 1,750 ft at Station 79100. Backwater caused by the road and railway bridges ranges from less than 0.1 ft at Route U.S. 278 to 0.9 ft at the CSX Railway. In addition, flow overtops Tyler Bridge Road and Road 8-1 by 0.1 ft and 0.3 ft, respectively. Graphical and tabular profiles of Upper Three Runs are shown in figures 5 through 10 and table 3, respectively. The areal extent of the inundation caused by a 100-year flood on Upper Three Runs is shown in plate 1.

Tims Branch

Tims Branch was analyzed from 875 ft upstream from its confluence with Upper Three Runs to approximately 750 ft downstream of Road A-1. Station 0 is located at the confluence of Tims Branch and Upper Three Runs. The area between Station 0 and Station 875 cannot be analyzed using step-backwater methods because the flow divides as it overtops a small road, gaging station 02197309, Tims Branch at Road C (fig. 1). Once the flow crosses the road, it branches in several directions and cannot be defined using the one-dimensional flow model WSPRO and, therefore, will not be included in the study.

The 26,753 ft-long study segment of Tims Branch consists of 18 surveyed and 105 synthetic cross sections. Within the study area, there are five culvert crossings and two breached dams. The culverts are located at M Line U.S. Government Railway, Road 2, Steed Pond Road, the powerline road between Steed Pond Road and Road D-1, and an unnamed gravel road downstream of Road A-1 at Stations 3050, 13124, 19466, 22470 and 27550, respectively. The two breached dams are located at Station 13462, just upstream of Road 2 and Station 22305, just downstream of the powerline road between Steed Pond Road and Road D-1 (pl. 1). Three 10-ft by 10-ft box culverts on Road 2 were analyzed as a cross section rather than a culvert. This method was used because the culverts act as an expansion rather than a contraction on the stream. Flow through the two corrugated metal pipes crossing Steed Pond Road was not computed as culvert flow, because the pipes were in poor condition and approximately 90 percent of the total flow overtopped the road. The crossing and culverts were represented as a cross section with a channel of the same area as the pipes included in the cross section. The channel was located where the culverts cross the road. The depth of flow over Steed Pond Road is 1.5 ft. Flow through the 2.5-ft diameter reinforced concrete pipe on the powerline road between Steed Pond Road and Road D-1 was not computed as culvert flow because approximately 90 percent of the total flow overtops the road. The crossing was analyzed using the same method used on the Steed Pond Road crossing. The depth of flow over the powerline road is 0.9 ft. Ponding occurs along Road D-1 between Stations 24380 and 24750, which runs parallel to Tims Branch. The maximum depth of ponding on the road is 0.8 ft at a low point caused by a natural dip in the topography.

Profile computations are terminated at Road D-1 for reasons described earlier. The 100-year flood-plain widths range from 32 ft at Station 26450 to 963 ft at Station 19450 (pl. 1). Graphical and tabular profiles of Tims Branch are shown in figures 11 through 13 and table 4, respectively. The areal extent of the inundation caused by a 100-year flood on Tims Branch is shown in plate 1.

Crouch Branch

Crouch Branch was analyzed from its confluence with Upper Three Runs to Road 4 (pl. 1). Station 0 is located at the confluence of Crouch Branch and Upper Three Runs. The stream was divided into three reaches. The divisions were required because the stream branches into two unnamed tributaries 3,560 ft upstream of the confluence with Upper Three Runs (pl. 1). Graphical and tabular profiles of Crouch Branch are shown in figures 14 and 15, and table 5, respectively. The areal extent of the inundation caused by a 100-year flood on Crouch Branch is shown in plate 1.

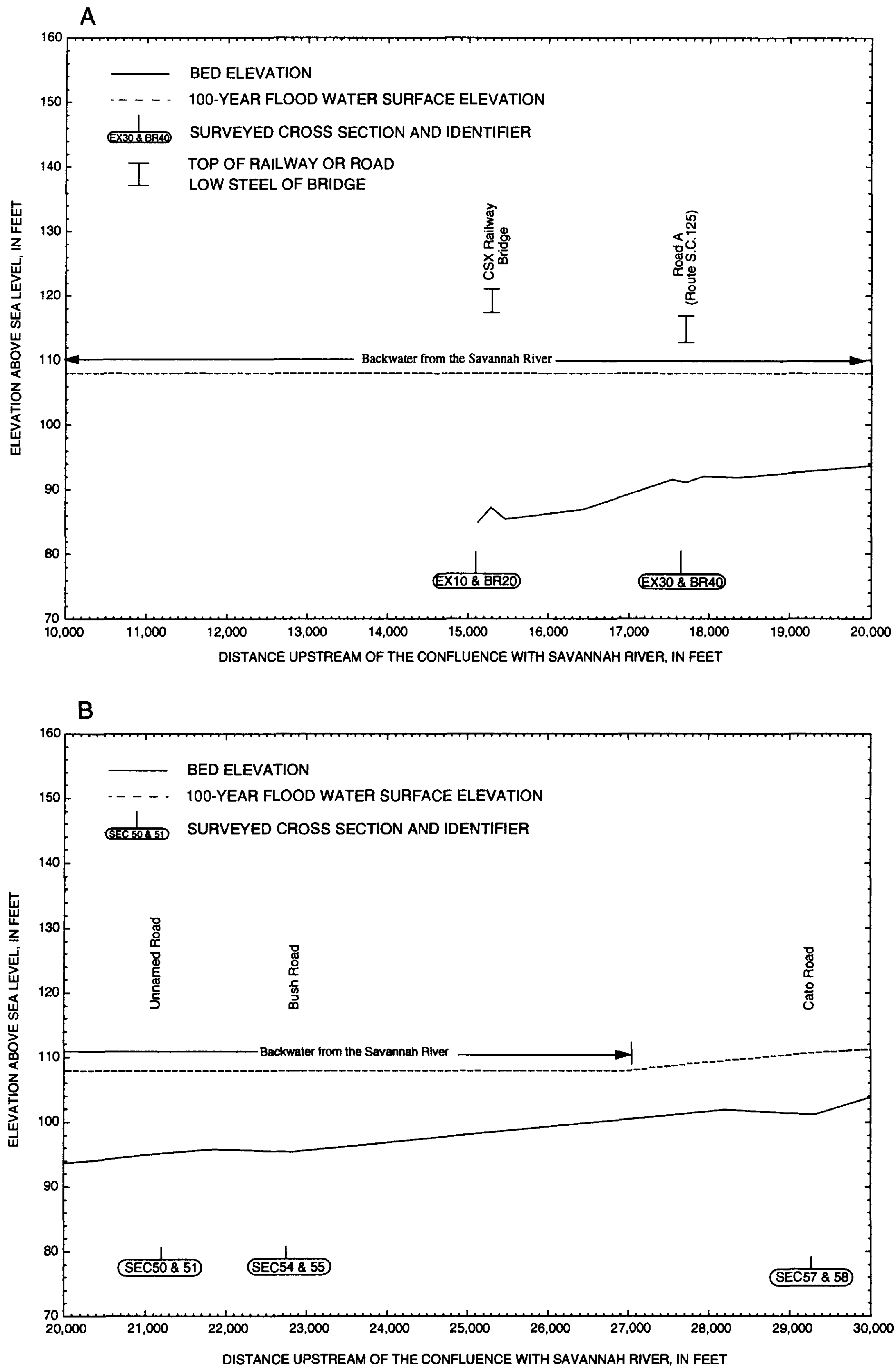
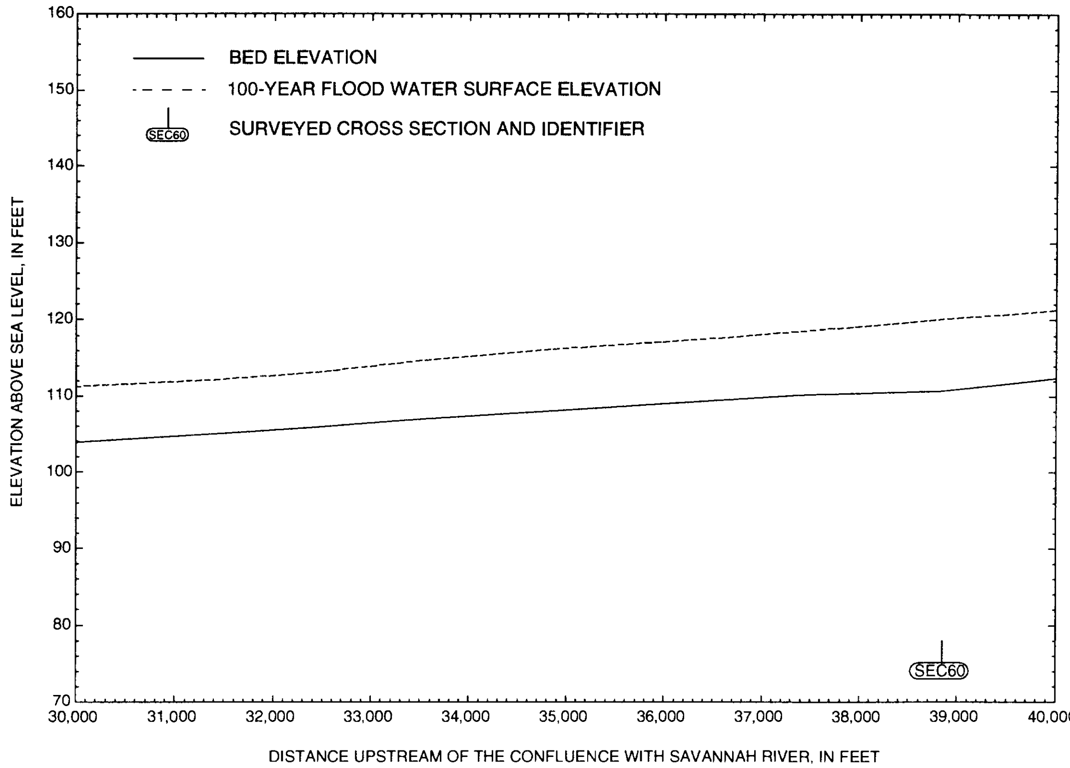


Figure 5. Flood profile of Upper Three Runs, Savannah River Site,S.C., from (A) Station 10000 to Station 20000 and (B) Station 20000 to Station 30000.

A



B

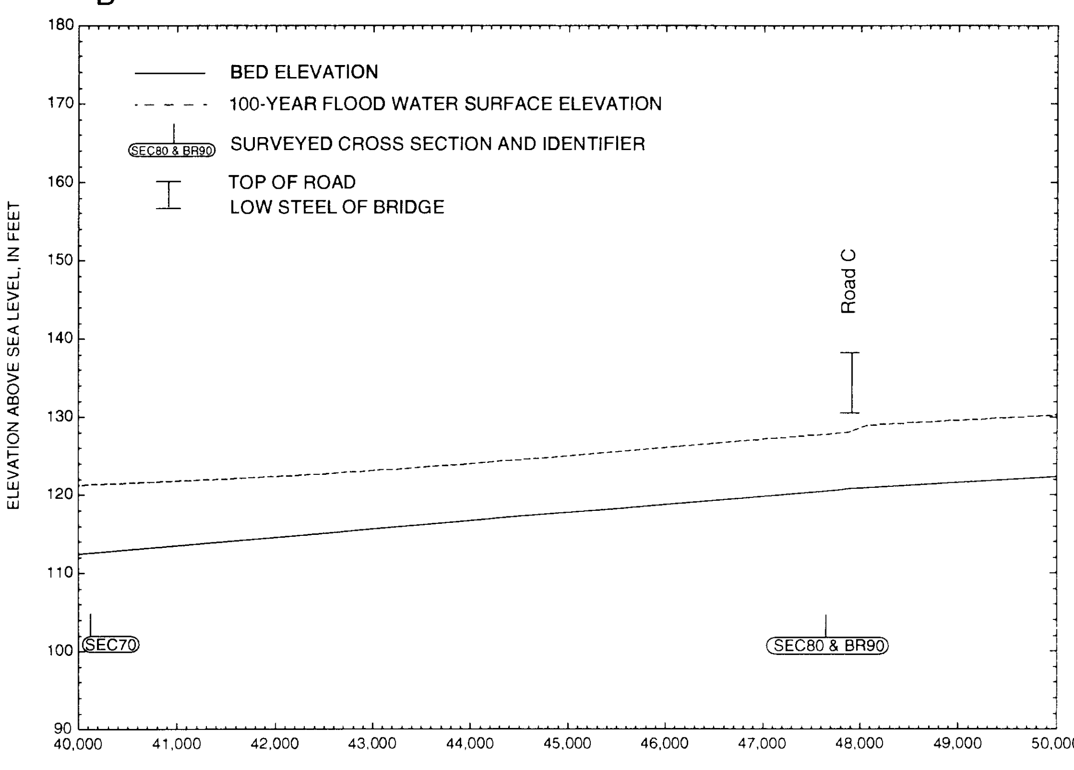


Figure 6. Flood profile of Upper Three Runs, Savannah River Site, S.C., from (A) Station 30000 to Station 40000 and (B) Station 40000 to Station 50000.

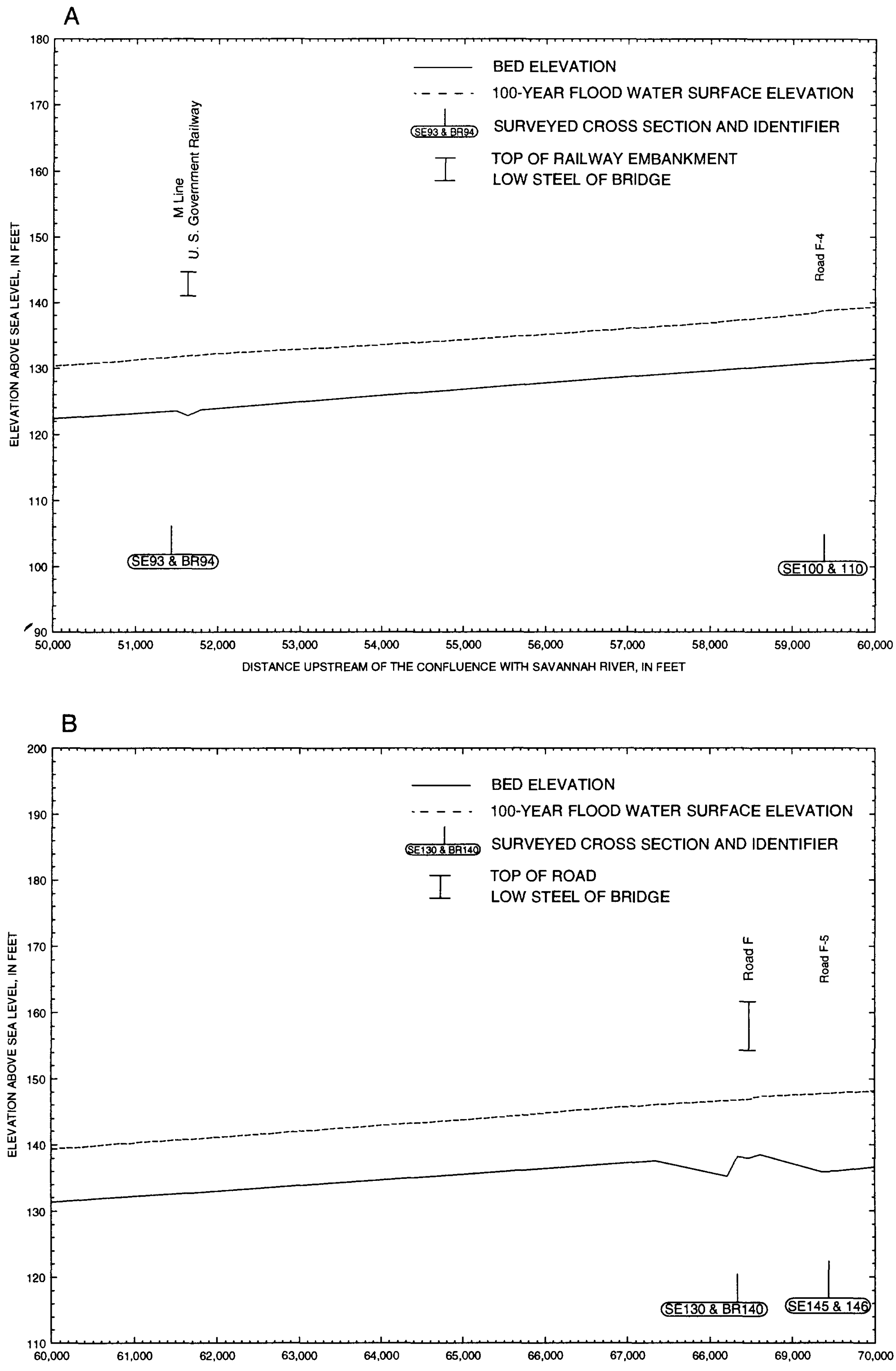
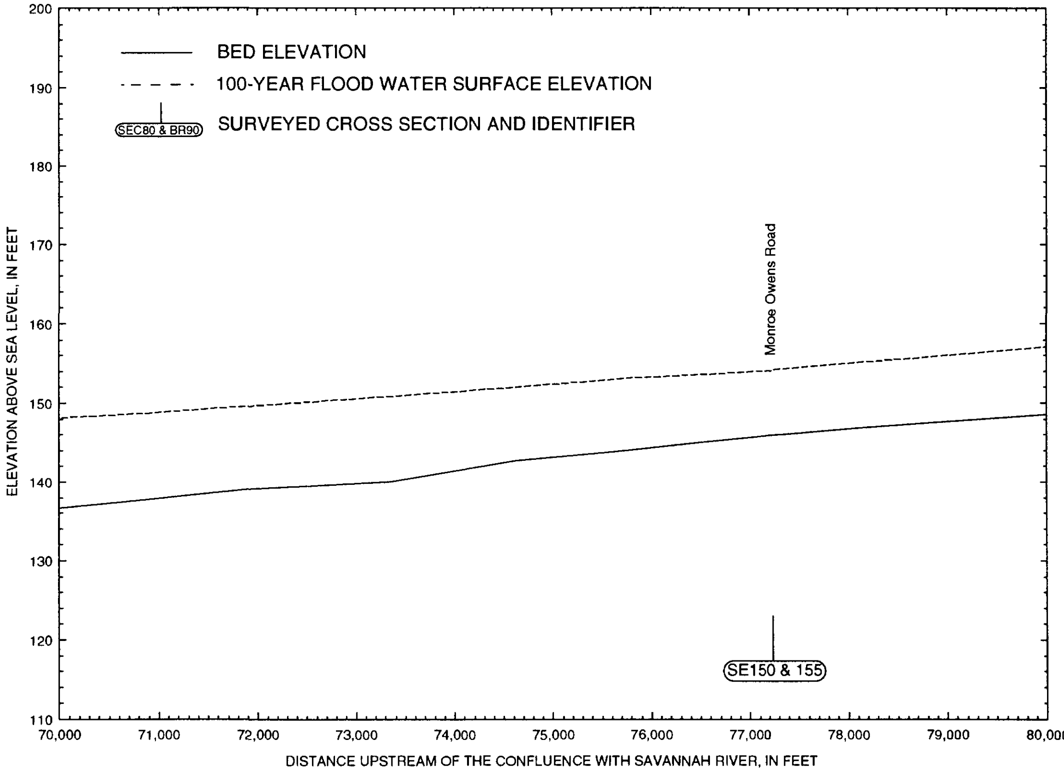


Figure 7. Flood profile of Upper Three Runs, Savannah River Site, S.C., from (A) Station 50000 to Station 60000 and (B) Station 60000 to Station 70000.

A



B

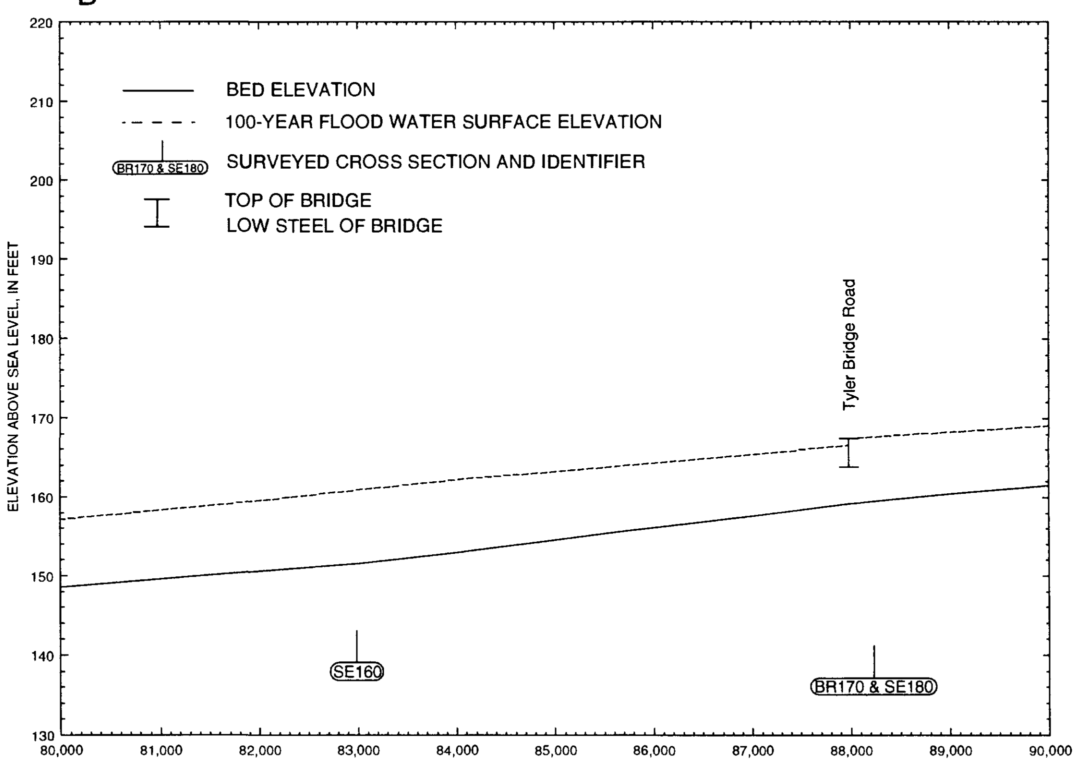
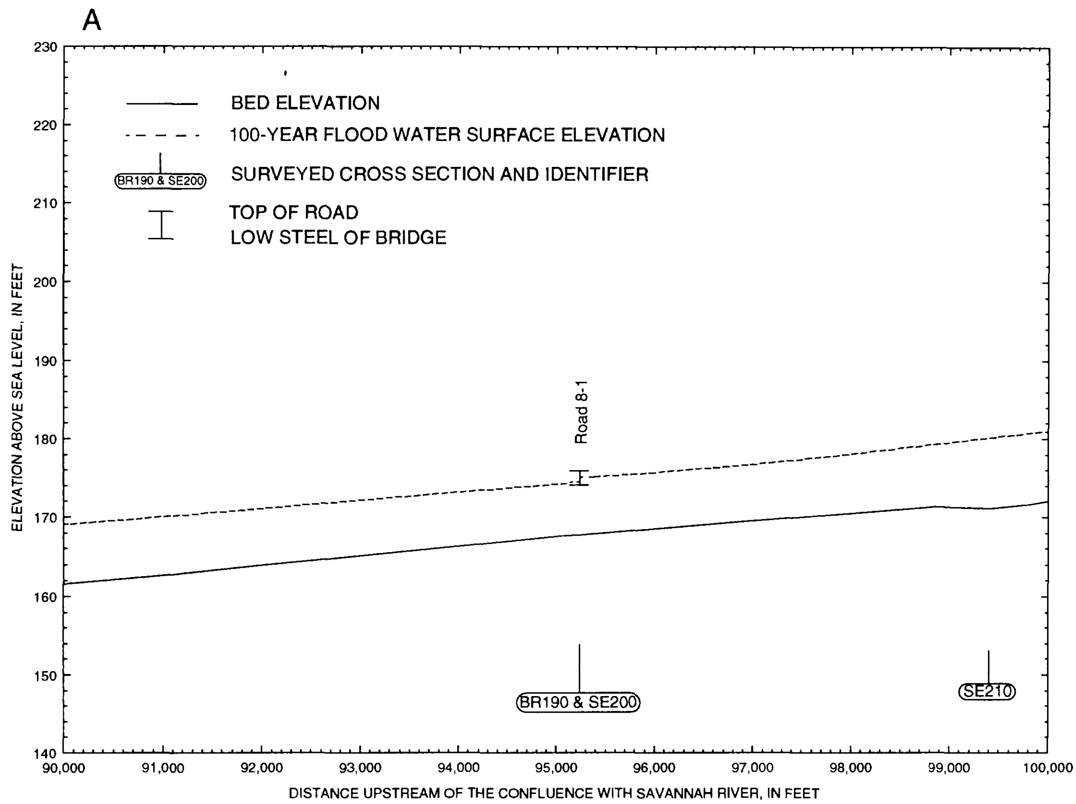


Figure 8. Flood profile of Upper Three Runs, Savannah River Site, S.C., from (A) Station 70000 to Station 80000 and (B) Station 80000 to Station 90000.



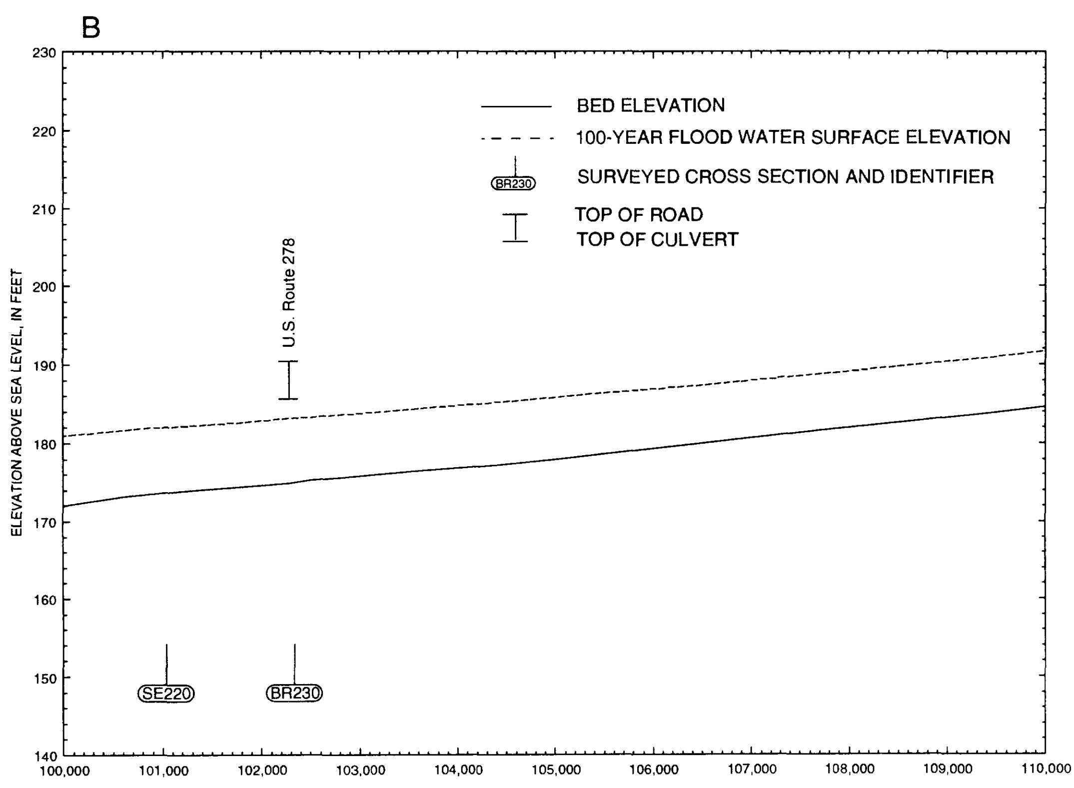


Figure 9. Flood profile of Upper Three Runs, Savannah River Site,S.C., from (A) Station 90000 to Station 100000 and (B) Station 100000 to Station 110000.

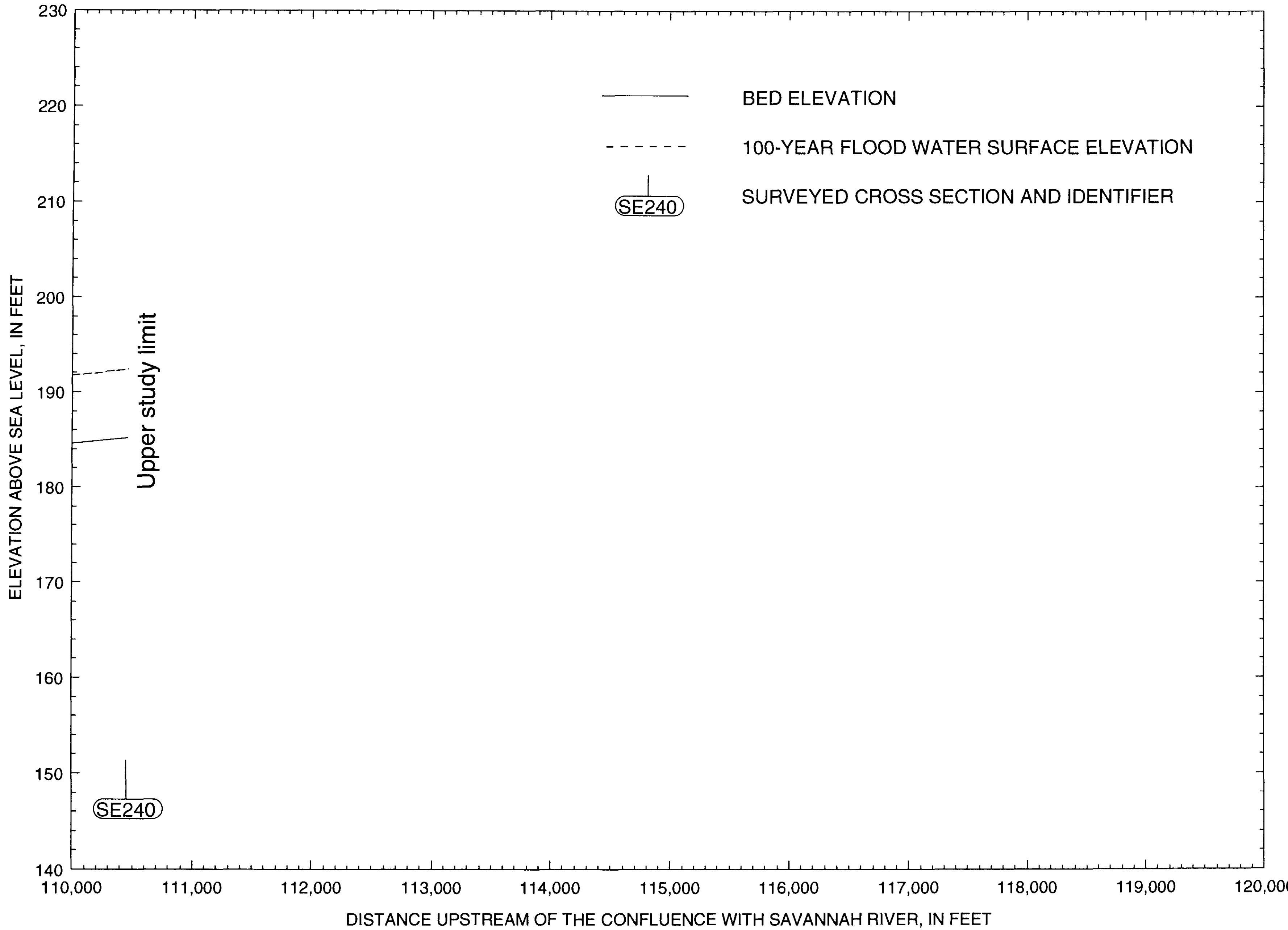


Figure 10. Flood profile of Upper Three Runs, Savannah River Site, S.C., from Station 110000 to Station 111000.

Table 3. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Upper Three Runs

[ft^3/s, cubic feet per second; ft, feet]

Cross-section location (plate 1)	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
161 ft downstream from CSX Railway	Surveyed	15128	EX10	1,875	2,800	[2]108.0
CSX Railway	Surveyed	15289	BR20	1,875	57	[2]108.0
174 ft upstream from CSX Railway	Synthetic	15463	APP21	1,875	2,450	[2]108.0
175 ft downstream from Road A (S.C. Route 125)	Surveyed	17539	EX30	1,875	1,850	[2]108.0
Road A (S.C. Route 125)	Surveyed	17714	BR40	1,875	79	[2]108.0
223 ft upstream from Road A (S.C. Route 125)	Synthetic	17937	APP41	1,875	1,570	[2]108.0
10 ft downstream from powerline; 4,025 ft upstream from Road A	Surveyed	21739	SEC50	1,875	2,600	[2]108.0
Powerline road; 4,035 ft upstream from Road A	Surveyed	21749	SEC51	1,875	2,550	[2]108.0
50 ft downstream from Bush Road	Surveyed	22789	SEC54	1,875	1,900	[2]108.0
Bush Road	Surveyed	22839	SEC55	1,875	1680	[2]108.0
50 ft downstream from Cato Road	Surveyed	29239	SEC57	1,875	794	110.69
Cato Road	Surveyed	29289	SEC58	1,875	745	110.74
9,550 ft upstream from Cato Road	Surveyed	38839	SEC60	1,875	551	120.12

Table 3. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Upper Three Runs--Continued

[ft^3/s, cubic feet per second; ft, feet]

Cross-section location (plate 1)	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
7,850 ft downstream from Road C	Surveyed	40039	SEC70	1,875	1,335	121.29
250 ft downstream from Road C	Surveyed	47639	SEC80	1,875	898	127.82
Road C	Surveyed	47889	BR90	1,875	90	128.09
169 ft upstream from Road C	Synthetic	48058	APP91	1,875	580	128.96
200 ft downstream from M Line Railway	Surveyed	51429	SEC93	1,620	449	131.62
M Line Railway	Surveyed	51629	BR94	1,620	101	131.80
154 ft upstream from M Line Railway	Synthetic	51783	APP94	1,520	570	132.02
Road F-4	Surveyed	59309	SE100	1,520	366	138.41
20 ft upstream of Road F-4	Surveyed	59329	SE110	1,520	983	138.61
251 ft downstream from Road F	Surveyed	68214	SE130	1,520	1,388	146.66
Road F	Surveyed	68465	BR140	1,520	95	146.91
153 ft upstream from Road F	Synthetic	68618	AS140	1,520	1,640	147.33
Road F-5	Surveyed	69474	SE145	1,520	659	147.78
15 ft upstream of Road F-5	Surveyed	69489	SE146	1,520	1,278	147.82
Monroe Owens Road	Surveyed	77214	SE150	1,000	298	154.02
15 ft upstream from Monroe Owens Road	Surveyed	77229	SE155	1,000	1,091	154.17

Table 3. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Upper Three Runs--Continued

[ft^3/s, cubic feet per second; ft, feet]

Cross-section location (plate 1)	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
5,805 ft upstream from Monroe Owens Road	Surveyed	83019	SE160	1,000	245	160.93
76 ft downstream from Tyler Bridge Road	Synthetic	87909	EX170	1,000	600	166.51
Tyler Bridge Road	Surveyed	87985	BR170	1,000	75	[3]167.55
240 ft upstream from Tyler Bridge Road	Surveyed	88225	SE180	975	484	167.66
59 ft downstream from Road 8-1	Synthetic	95164	EX190	975	425	174.38
Road 8-1	Surveyed	95223	BR190	975	397	[3]174.97
360 ft upstream from Road 8-1	Surveyed	95589	SE200	975	507	175.32
2,867 ft downstream from Route U.S. 278	Surveyed	99409	SE210	975	594	180.16
1,262 ft downstream from Route U.S. 278	Surveyed	101014	SE220	806	484	182.00
200 ft downstream from U.S. Route 278	Synthetic	102076	EX220	806	500	182.89
U.S. Route 278	Surveyed	102276	BR230	806	174	183.14
227 ft upstream from U.S. Route 278	Synthetic	102503	AP235	806	550	183.31
Upstream boundary from the Savannah River Site	Surveyed	110464	SE240	706	268	192.41

[1]All surveyed cross sections are shown on plate 1; synthetic cross sections are not shown on plate 1.
[2]Water-surface elevation influenced by backwater from Savannah River.
[3]Flow overtops the road.

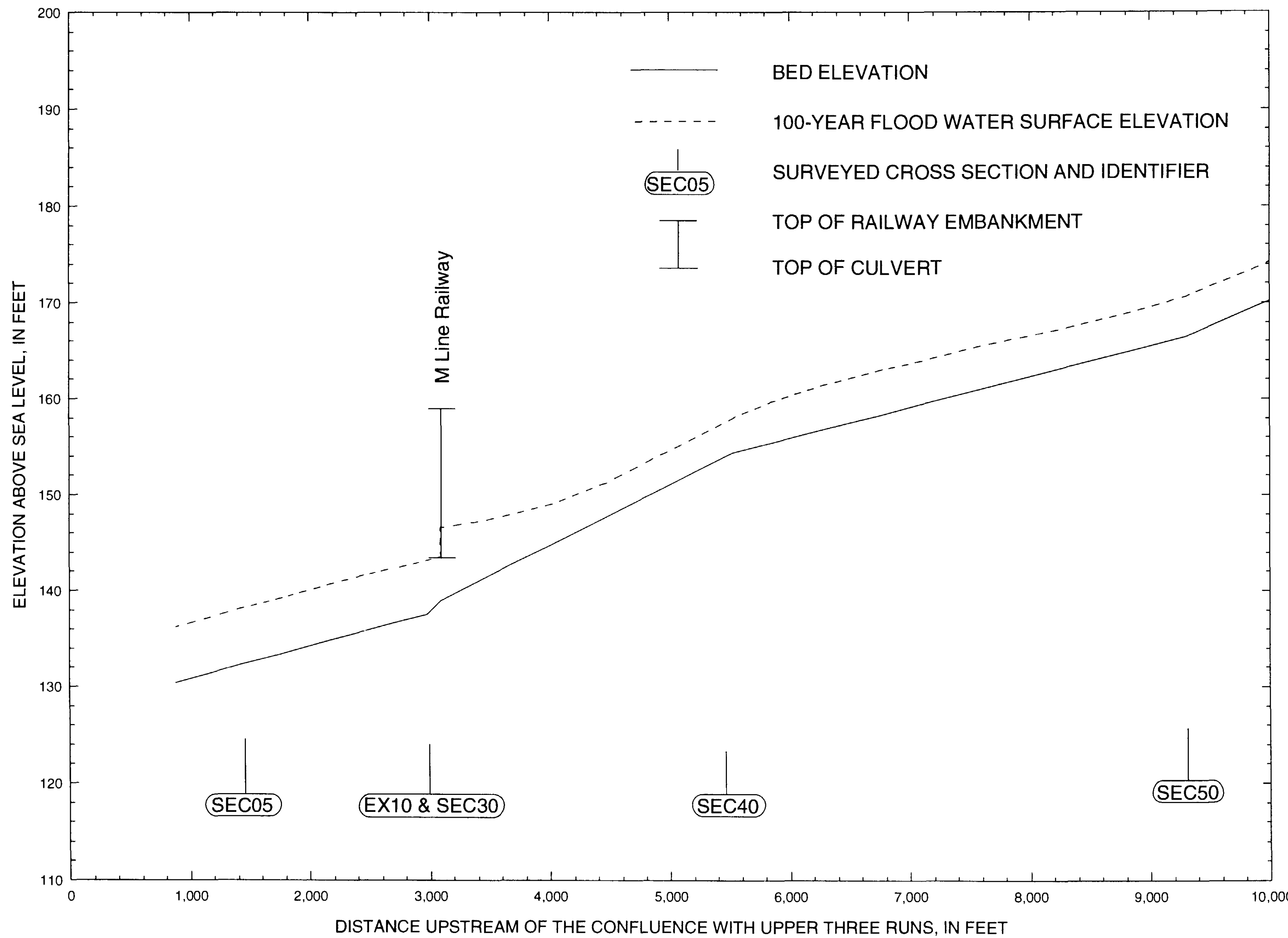


Figure 11. Flood profile of Tims Branch, Savannah River Site, S.C., from Station 900 to Station 10000.

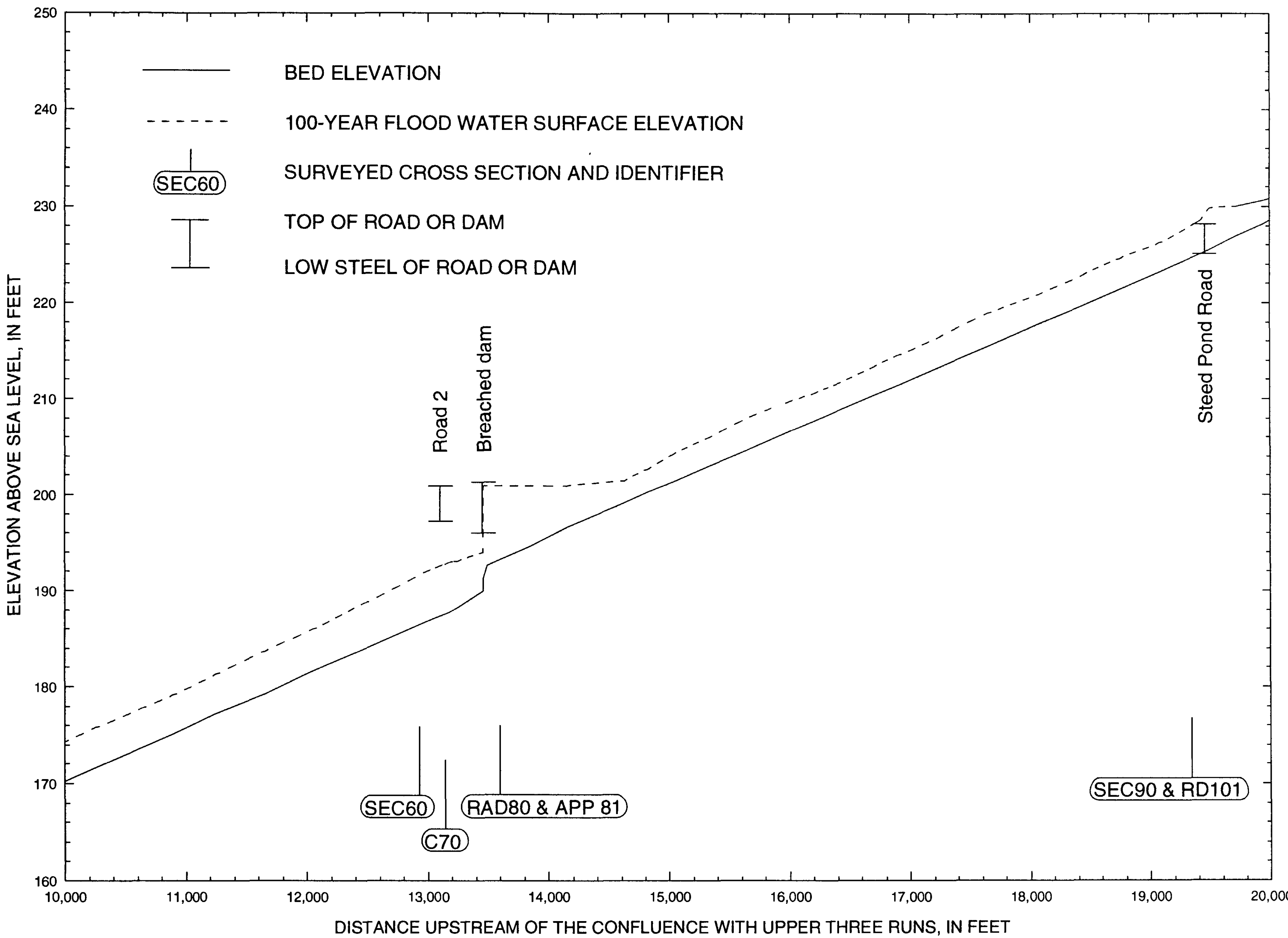


Figure 12. Flood profile of Tims Branch, Savannah River Site, S.C., from Station 10000 to Station 20000.

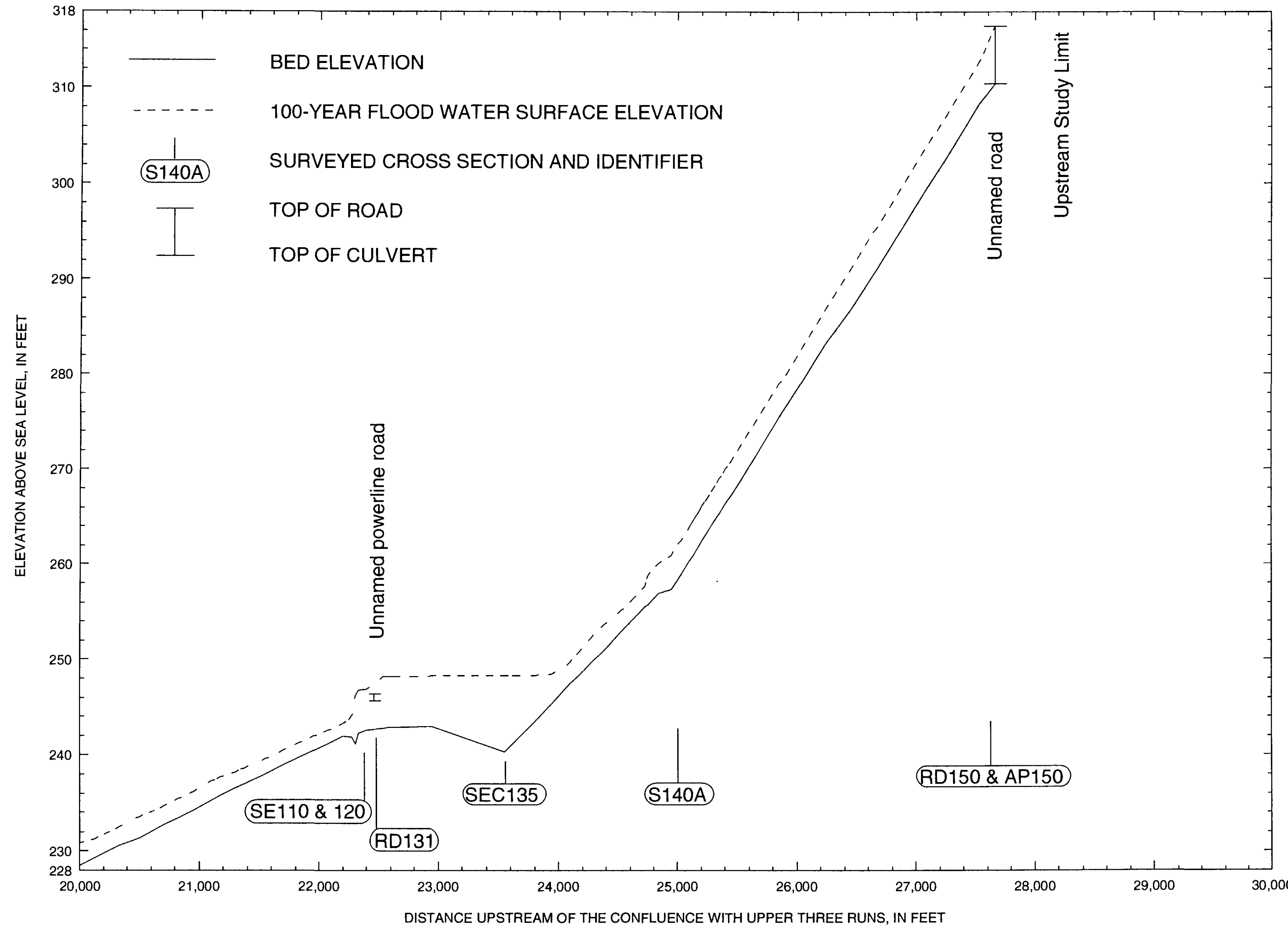


Figure 13. Flood profile of Tims Branch, Savannah River Site, S.C., from Station 20000 to Station 27900.

Table 4. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Tims Branch

[ft^3/s, cubic feet per second; ft, feet;--, no data]

Cross-section location (plate 1)	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
1,579 ft downstream from M Line Railway	Surveyed	1425	SEC05	430	121	138.12
29 ft downstream from M Line Railway	Surveyed	2975	EX10	430	176	143.22
91 ft upstream from M Line Railway	Surveyed	3095	SEC30	819	762	146.60
7,599 ft downstream from Road 2	Surveyed	5525	SEC40	819	962	157.97
3,824 ft downstream from Road 2	Surveyed	9300	SEC50	738	507	170.66
132 ft downstream from Road 2	Surveyed	12992	SEC60	710	595	192.00
Road 2	Surveyed	13124	C70	710	32	192.36
49 ft upstream from Road 2	Synthetic	13173	APP71	710	450	192.94
Top of dam upstream from Road 2	Surveyed	13463	RAD80	710	452	200.53
Upstream of dam upstream from Road 2	Surveyed	13492	APP81	710	551	200.93
95 ft downstream from Steed Pond Road	Surveyed	19371	SEC90	633	381	228.16
Steed Pond Road	Surveyed	19466	RD101	633	321	229.76
29 ft upstream from Steed Pond Road	Synthetic	19495	AP101	633	461	[2]229.84
195 ft downstream from unnamed powerline road	Surveyed	22275	SE110	633	394	243.97

Table 4. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Tims Branch--Continued

[ft^3/s, cubic feet per second; ft, feet;--, no data]

Cross-section location (plate 1)	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
Top of dam, 165 ft downstream of an unnamed powerline road	Surveyed	22305	SE120	633	313	246.30
72 ft downstream from unnamed powerline road, 1,400 ft downstream from Road D-1	Synthetic	22398	EX121	633	524	246.84
Unnamed powerline road	Surveyed	22470	RD131	633	569	[2]248.10
65 ft upstream from powerline road, 1,263 ft downstream from Road D-1	Synthetic	22535	AP131	633	590	248.16
1,180 ft upstream of unnamed powerline road	Surveyed	23650	SE135	320	472	248.31
2,630 ft upstream of unnamed powerline road	Surveyed	25100	S140A	277	89	264
76 ft downstream from unnamed road and 826 ft downstream from Road A-1	Synthetic	27523	S150F	277	33	312.67
Unnamed road and 750 ft downstream of Road A-1	Surveyed	27599	RD150	277	[3]--	316.49
19 ft upstream from unnamed road and 731 ft downstream Road A-1	Surveyed	27618	AP150	277	60	316.49

[1]All surveyed cross sections are shown on plate 1; synthetic cross sections are not shown on plate 1.
[2]Flow overtops the road.
[3]Flow is contained within the culvert.

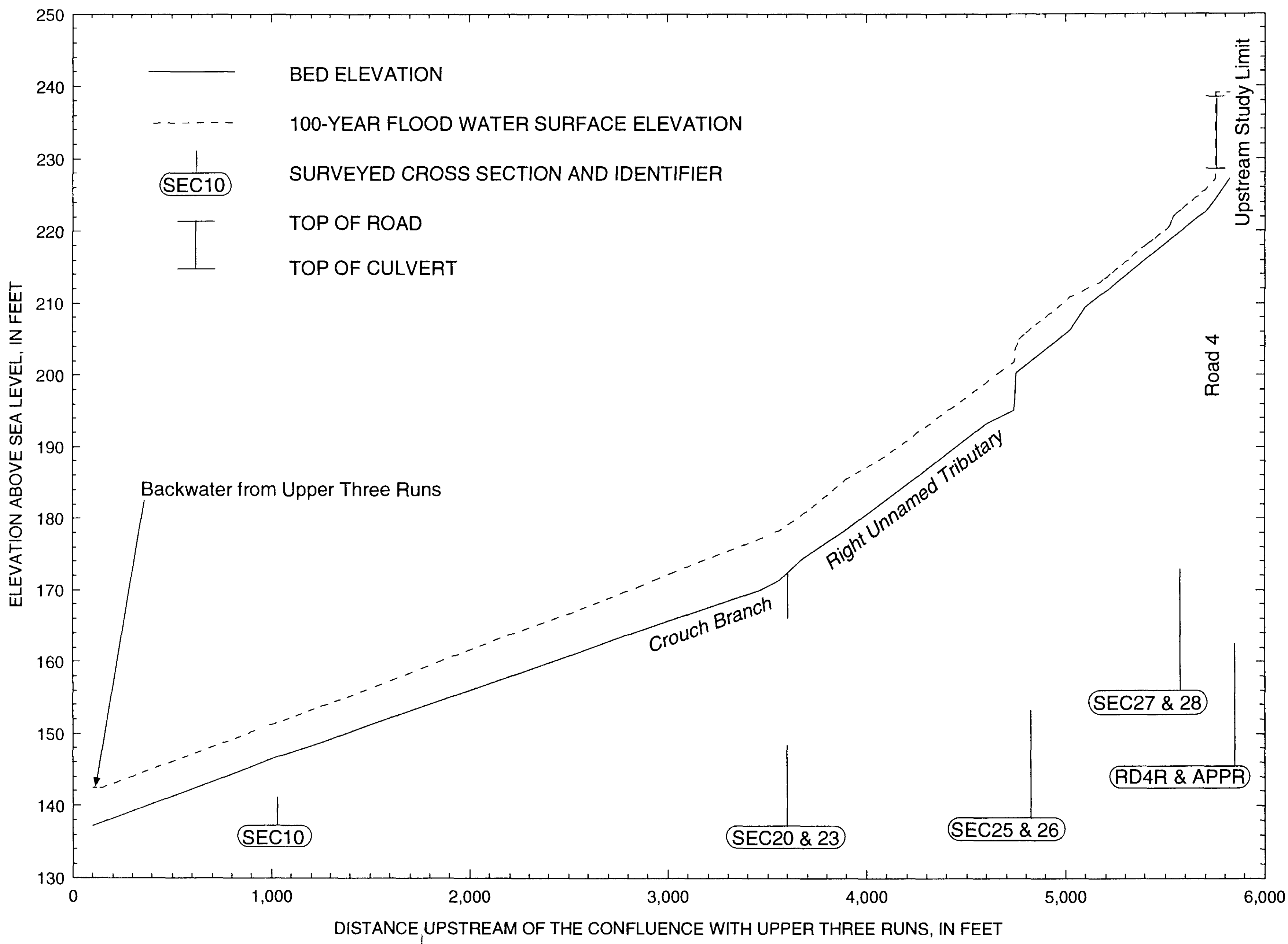


Figure 14. Flood profile for the right basin of Crouch Branch, Savannah River Site, S.C., from Station 0 to Station 5900.

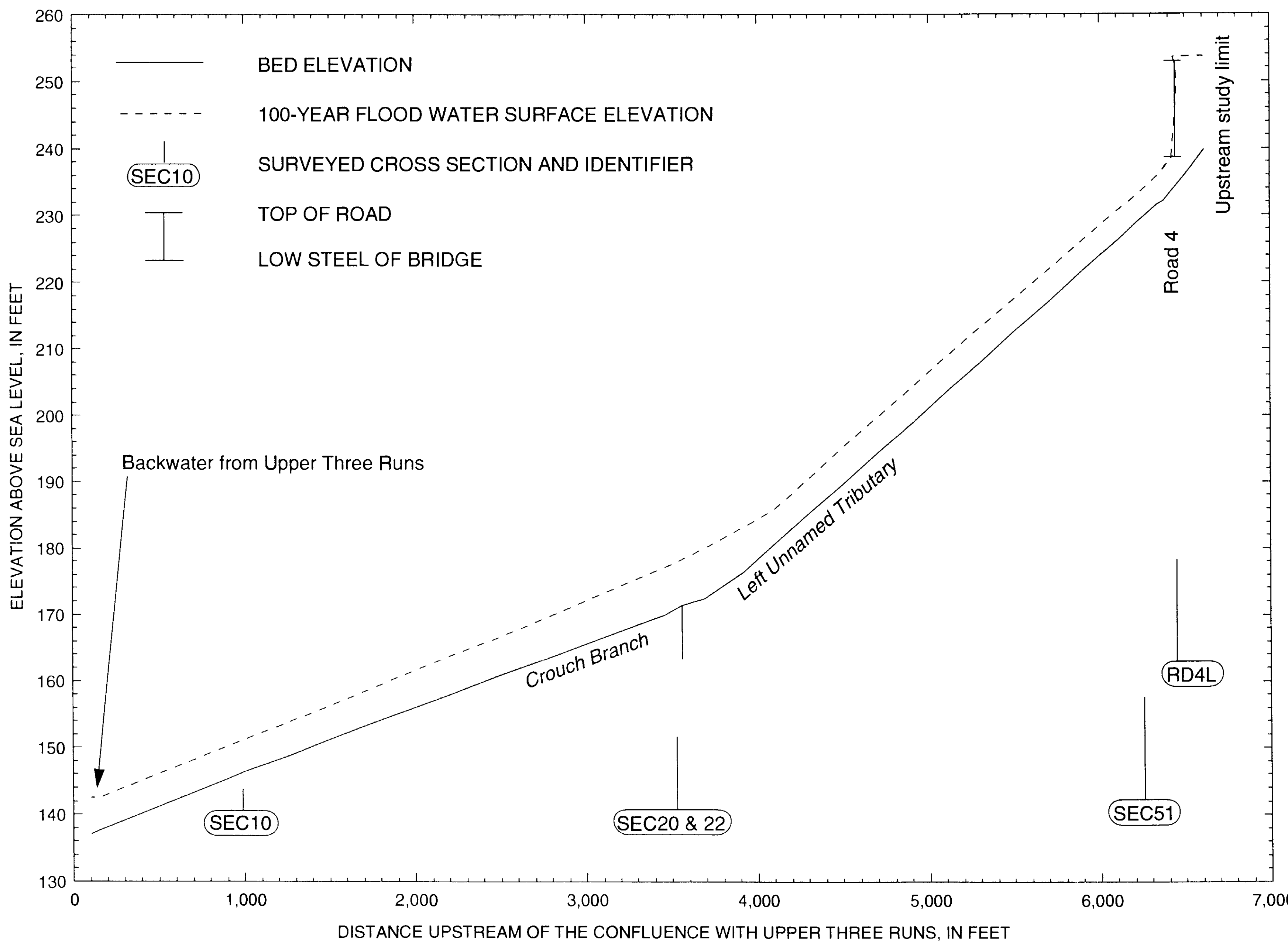


Figure 15. Flood profile for the left basin of Crouch Branch, Savannah River Site, S.C., from Station 0 to Station 6700.

Table 5. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Crouch Branch

[ft^3/s, cubic feet per second; ft, feet; --, no data]

Cross-section location	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
1,010 ft upstream from the mouth	Surveyed	1010	SEC10	618	151	151.34
100 ft downstream from fork	Surveyed	3460	SEC20	618	81	177.13
Left unnamed tributary						
Cross section surveyed 460 ft upstream from SEC20	Surveyed	3920	SEC22	366	23	183.18
Cross section surveyed 99 ft downstream from Road 4	Surveyed	6331	SEC51	478	97	235.74
58 ft downstream from Road 4	Synthetic	6372	CFAC1	478	150	236.81
Road 4, left unnamed tributary	Surveyed	6430	RD4L	478	288	[2]253.60
69 ft upstream from Road 4	Synthetic	6499	APPL	478	334	253.70
Right unnamed tributary						
Cross section surveyed 1,850ft downstream from Road 4	Surveyed	3900	SEC23	443	34	185.46
Cross section surveyed 1,007 ft downstream from Road 4	Surveyed	4743	SEC25	443	20	201.87
Cross section surveyed 935 ft downstream from Road 4	Surveyed	4815	SEC26	443	186	206.18
Cross section surveyed 285ft downstream from Road 4	Surveyed	5465	SEC27	443	198	219.31
100 ft downstream from Road 4	Surveyed	5650	SEC28	518	350	224.51

Table 5. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Crouch Branch--Continued

[ft^3/s, cubic feet per second; ft, feet; --, no data]

Cross-section location	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
Road 4, right unnamed tributary	Surveyed	5750	RD4R	518	202	[2]239.07
73 ft upstream from Road 4	Surveyed	5823	APPR	518	758	239.15

[1]All surveyed cross sections are shown on plate 1; synthetic cross sections are not shown on plate 1.
[2]Flow overtops the road.

Reach 1, which is 3,560-ft long, represents the part of Crouch Branch from its confluence with Upper Three Runs to the point where Crouch Branch divides into two unnamed tributaries. The reach consists of 2 surveyed and 14 synthesized cross sections. There are no bridge or culvert crossings within Reach 1. The 100-year flood-plain widths range from 73 ft at Station 3560 to 287 ft at Station 2780 (pl. 1).

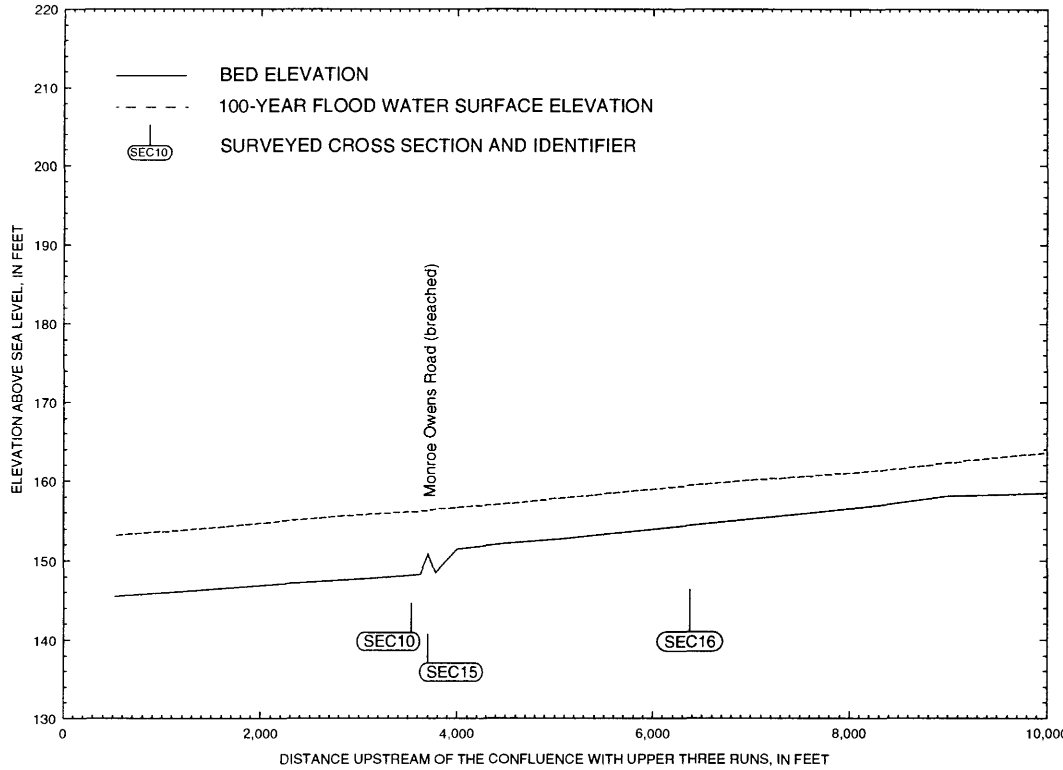
Reach 2 is 2,148-ft long and consists of 5 surveyed and 24 synthesized cross sections. This reach represents the right tributary from its confluence with Crouch Branch to the upstream study limit at Road 4. Road 4 crosses the right fork of Crouch Branch at Station 5750. The 100-year flood-plain widths range from 18 ft at Station 4075 to 198 ft at Station 5210 (pl. 1). The 100-year flood overtops Road 4 by 0.5 ft (fig. 14).

Reach 3, which is 2,815-ft long, represents the left tributary from its confluence with Crouch Branch to the upstream study limit at Road 4 and Station 6500. The reach consists of 3 surveyed and 15 synthesized cross sections. The 100-year flood-plain widths range from 18 ft at Station 4110 to 292 ft at Station 5710 (pl. 1). The 100-year flood overtops Road 4 by 0.7 ft (fig. 15).

Tinker Creek

Tinker Creek was analyzed from its confluence with Upper Three Runs to Route U.S. 278. Station 0 is located at the confluence of Tinker Creek and Upper Three Runs. The 55,000 ft-long study segment consists of 19 surveyed and 64 synthesized cross sections. There are four highway bridges and two breached roads or dams. The bridges are located on Tyler Bridge Road, Road 8-1, Kennedys Pond Road, and U.S. Route 278 at Stations 15472, 27000, 47145, and 54925, respectively. The breached roads are located on Monroe Owens Road and Hickson Mill Road at Stations 3700 and 40300, respectively (pl. 1). The 100-year flood-plain widths range from 200 ft at Station 51315 to 1,500 ft at Station 7650 (pl. 1). Backwater caused by the bridges range from 0.2 ft at U.S. Route 278 to 4.2 ft at the Kennedys Pond Road. Flow overtops Tyler Bridge Road and Road 8-1 by 0.3 ft and 0.8 ft, respectively. Graphical and tabular profiles of Tinker Creek are shown in figures 16 through 18 and table 6, respectively. The areal extent of the inundation caused by a 100-year flood on Tinker Creek is shown in plate 1.

A



B

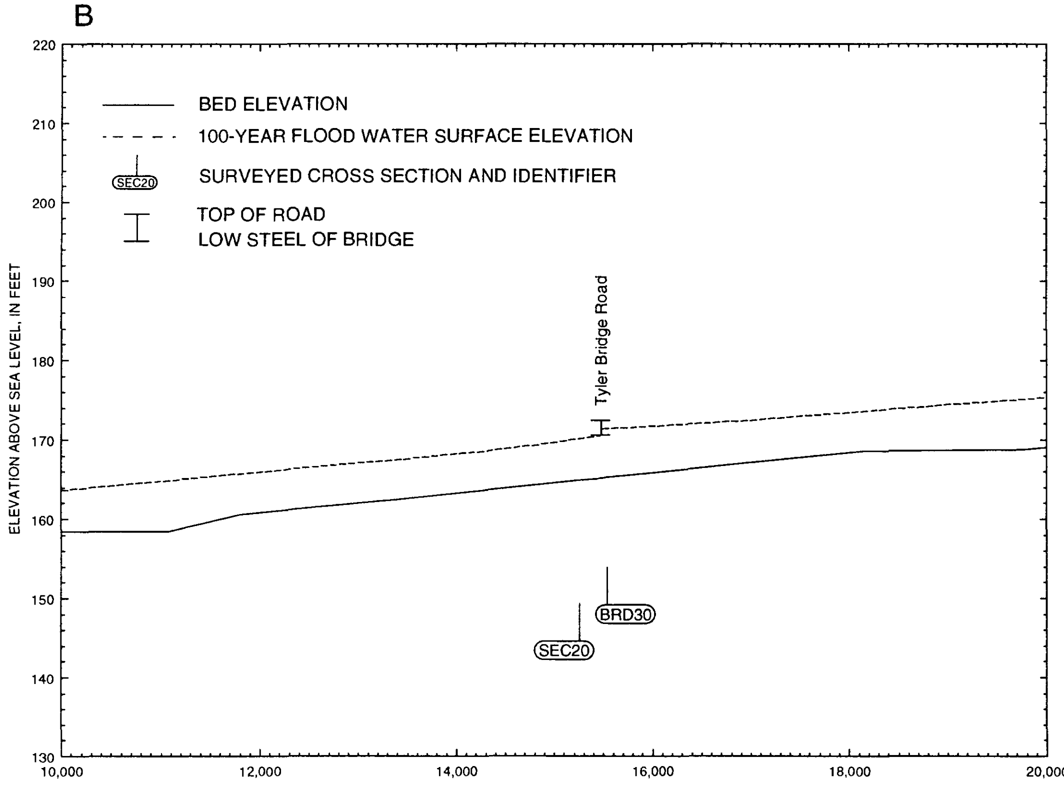


Figure 16. Flood profile of Tinker Creek, Savannah River Site,S.C., from (A) Station 0 to Station 10000 and (B) Station 10000 to Station 20000.

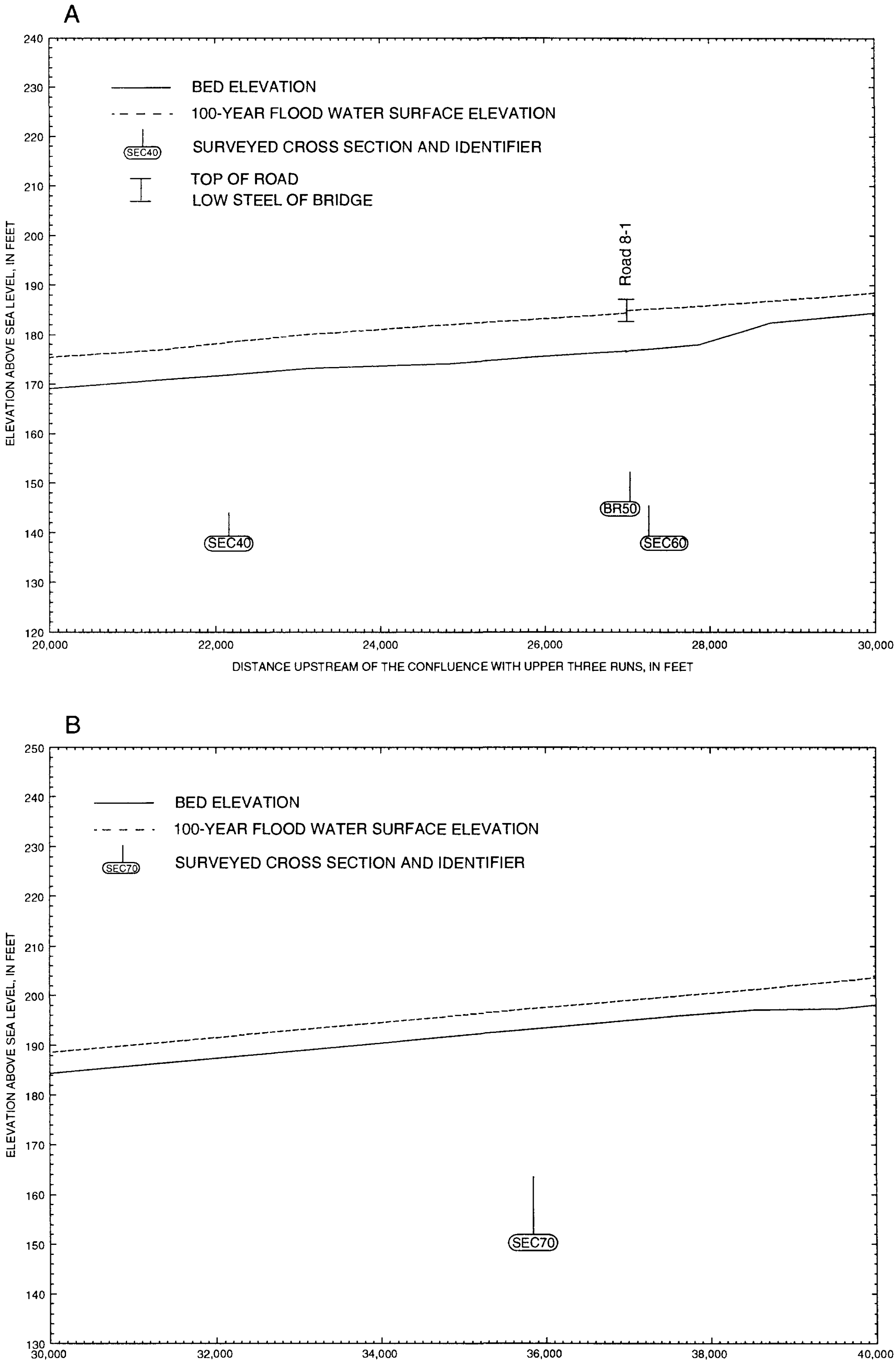


Figure 17. Flood profile of Tinker Creek, Savannah River Site,S.C., from (A) Station 20000 to Station 30000 and (B) Station 30000 to Station 40000.

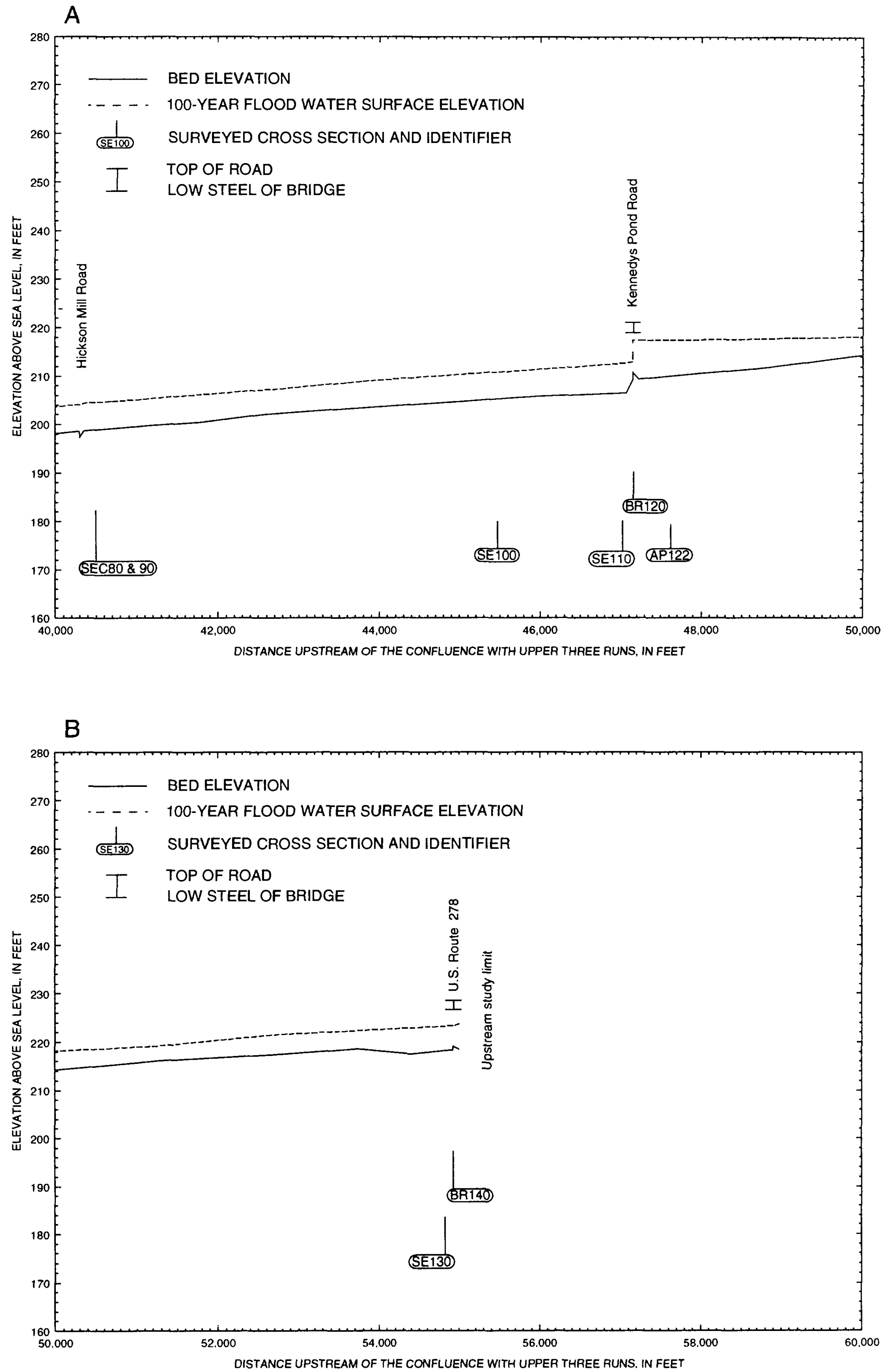


Figure 18. Flood profile of Tinker Creek, Savannah River Site,S.C., from (A) Station 40000 to Station 50000 and (B) Station 50000 to Station 55000.

Table 6. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Tinker Creek

[ft^3/s, cubic feet per second; ft, feet]

Cross-section location	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
156 ft downstream from Monroe Owens Road	Surveyed	3544	SEC10	1,700	1,152	156.11
Monroe Owens Road	Surveyed	3700	SEC15	1,700	801	156.22
2,650 ft upstream from Monroe Owens Road	Surveyed	6350	SEC16	1,670	985	159.37
235 ft downstream from Tyler Bridge Road	Surveyed	15237	SEC20	1,400	724	170.13
Bridge at Tyler Bridge Road	Surveyed	15472	BRD30	1,400	259	[2]171.32
62 ft upstream from Tyler Bridge Road	Synthetic	15534	APP20	1,400	832	171.40
4,850 ft downstream from Road 8-1	Surveyed	22150	SEC40	1,220	719	178.43
43 ft downstream from Road 8-1	Synthetic	26957	EX50	1,140	792	184.34
Bridge at Road 8-1	Surveyed	27000	BR50	1,140	391	[2]184.82
250 ft upstream from Road 8-1	Surveyed	27250	SEC60	1,140	851	185.15
4,150 ft downstream from Hickson Mill Road	Surveyed	36150	SEC70	1,010	625	197.79
Hickson Mill Road	Surveyed	40300	SEC80	932	399	203.98
449 ft upstream from Hickson Mill Road	Surveyed	40749	SEC90	932	815	204.82
1,145 ft downstream from Kennedys Pond Road	Surveyed	46000	SE100	796	390	211.36
80 ft downstream from Kennedys Pond Road	Surveyed	47065	SE110	796	431	212.71
Kennedys Pond Road	Surveyed	47145	BR120	796	34	214.71

Table 6. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Tinker Creek--Continued

[ft^3/s, cubic feet per second; ft, feet]

Cross-section location	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
72 ft upstream from Kennedys Pond Road	Surveyed	47217	AP122	796	722	217.39
45 ft downstream from U.S. Route 278	Surveyed	54880	SE130	553	356	223.37
U.S. Route 278	Surveyed	54925	BR140	553	30	223.37
82 ft upstream from U.S. Route 278	Synthetic	55007	AP130	553	368	223.75

[1]All surveyed cross sections are shown on plate 1; synthetic cross sections are not shown on plate 1.
[2]Flow overtops the road.

McQueen Branch

McQueen Branch was analyzed from its confluence with Tinker Creek to Road F. Station 0 is located at the confluence of McQueen Branch and Tinker Creek. The 10,700 ft-long study segment consists of 7 surveyed and 44 synthesized cross sections. Within the study area, there are two culvert crossings and one breached dam that cross McQueen Branch. The culvert crossings are located at the unnamed road between area Z and Monroe Owens Road, and Road F at Stations 6030 and 10600, respectively. The breached dam is located at Station 6106, just upstream of the unnamed road between area Z and Monroe Owens Road (pl. 1). The 100-year flood-plain widths range from 67 ft at Station 7545 to 432 ft at Station 800 (pl. 1). The unnamed Road between area Z and Monroe Owens Road is overtopped by 0.9 ft. Road F is not overtopped, but causes 4 ft of backwater. Graphical and tabular profiles of McQueen Branch are shown in figures 19 and 20, and table 7, respectively. The areal extent of the inundation caused by a 100-year flood on McQueen Branch is shown in plate 1.

Mill Creek

Mill Creek was analyzed from its confluence with Tinker Creek to Woodward Road (pl. 1). Station 0 is located at the confluence of Mill Creek and Tinker Creek. The 24,000 ft-long stream segment consists of 13 surveyed and 77 synthetic cross sections. Within the study area, there are 4 culvert crossings and 3 breached dams. The culvert crossings are at Road E-2, the unnamed road between Monroe Owens Road and Road 2-1, Monroe Owens Road, and Woodward Road at Stations 800, 7433, 22763 and 23820, respectively. The breached dams are located at Stations 1260, 10500, and 15250 (pl. 1). The 100-year flood-plain widths range from 122 ft at Station 23842 to 1033 ft at Station 14988 (pl. 1). Road E-2, an unnamed road, Monroe Owens

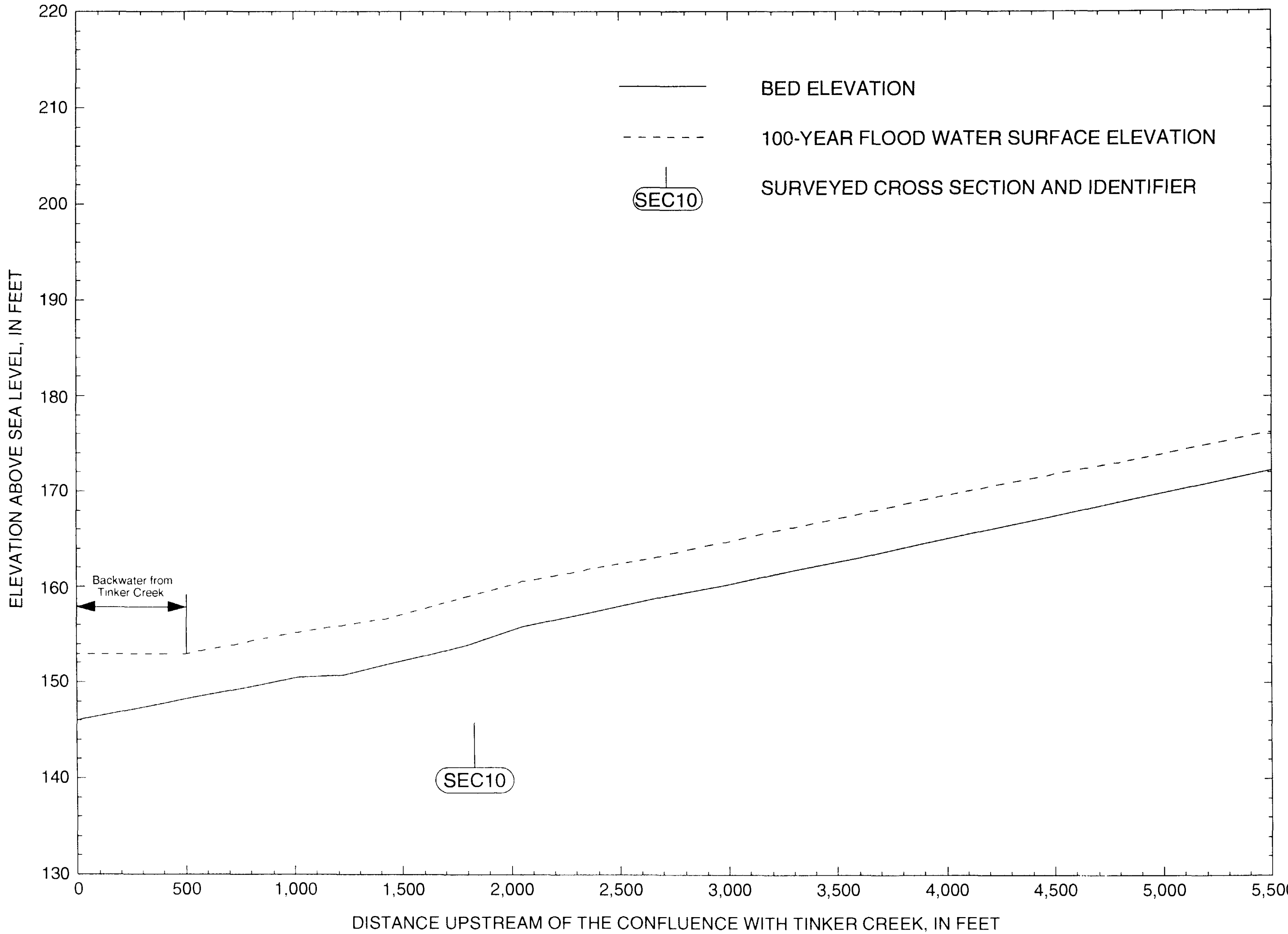


Figure 19. Flood profile of McQueen Branch, Savannah River Site, S.C., from Station 0 to Station 5500.

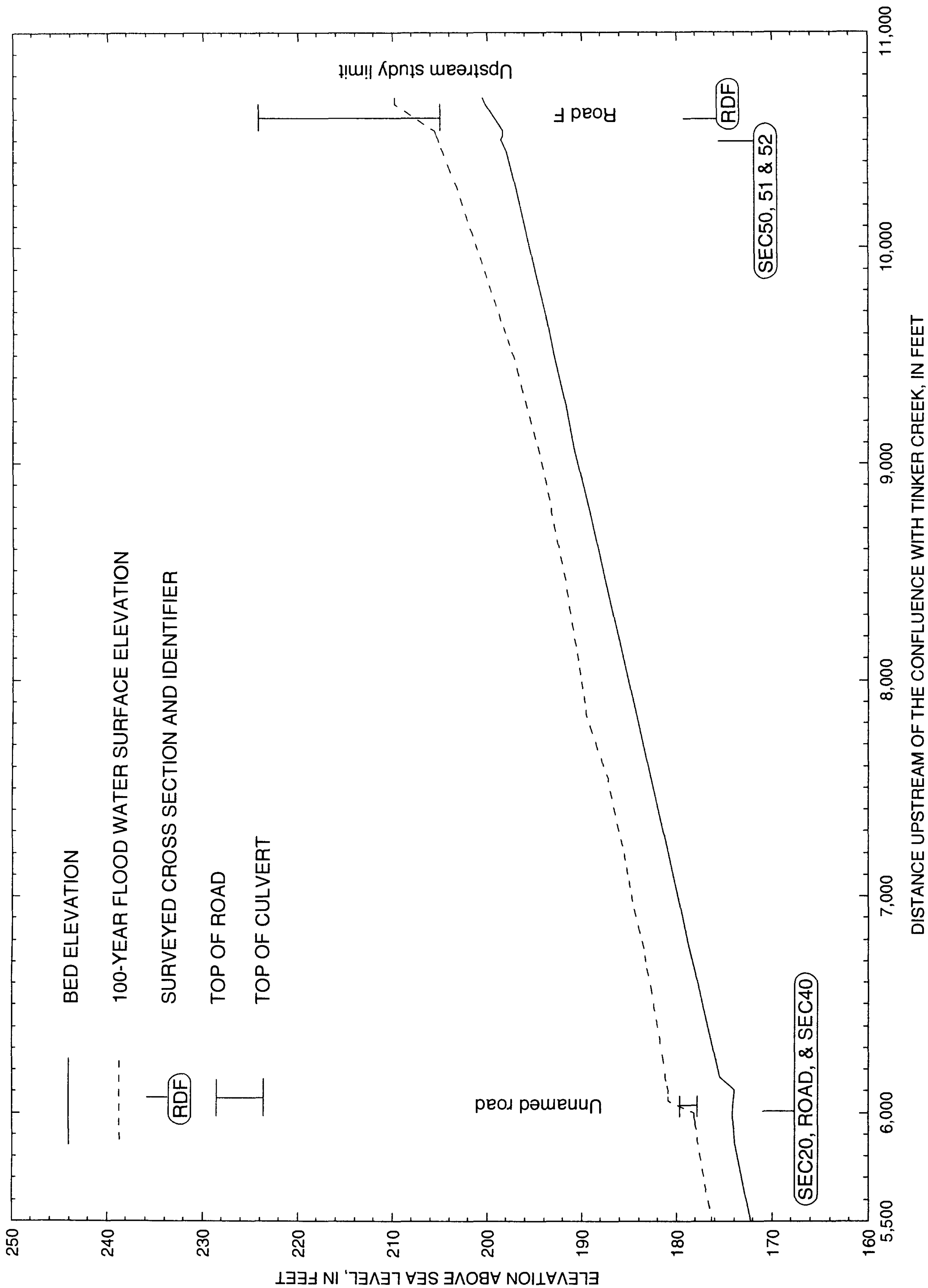


Figure 20. Flood profile of McQueen Branch, Savannah River Site, S.C., from Station 5500 to Station 10800.

Table 7. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of McQueen Branch

[ft^3/s, cubic feet per second; ft, feet; --, no data]

Cross-section location	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
1,800 ft upstream from the mouth	Surveyed	1800	SEC10	563	161	159.02
160 ft downstream from unnamed road	Surveyed	5870	SEC20	563	187	177.81
Unnamed road	Surveyed	6030	ROAD	563	151	[2]180.76
76 ft upstream from unnamed road	Surveyed	6106	SEC40	563	97	180.92
151 ft downstream from Road F	Surveyed	10449	SEC50	488	109	204.67
93 ft downstream from Road F	Surveyed	10507	SEC51	488	76	205.22
78 ft downstream from Road F	Surveyed	10522	SEC52	488	80	205.36
Road F	Surveyed	10600	RDF	488	[3]--	209.80
80 ft upstream from Road F	Synthetic	10680	APRO	488	173	209.80

[1]All surveyed cross sections are shown on plate 1; synthetic cross sections are not shown on plate 1.
[2]Flow overtops the road.
[3]Flow is contained within the culvert.

Road, and Woodward Road are overtopped by a depth of flow of 0.7, 1.1, 0.5, and 0.9 ft, respectively. Graphical and tabular profiles of Mill Creek are shown in figures 21 through 23 and table 8, respectively. The areal extent of the inundation caused by a 100-year flood on Mill Creek is shown in plate 1.

Reedy Branch

Reedy Branch was analyzed from its confluence with Tinker Creek to Road 2-1 (pl. 1). Station 0 is located at the confluence of Mill Creek and Tinker Creek. The 12,000 ft-long stream segment consists of 5 surveyed and 24 synthetic cross sections. Within the study area, one breached dam is located at Station 4600, and one road crossing, Road 8-1, at Station 11600 (pl. 1). The 100-year flood-plain widths range from 143 ft at Station 4550 to 403 ft at Station 8000 (pl. 1). Road 8-1 is overtopped by a depth of 0.7 ft (fig. 25). Graphical and tabular profiles of Reedy Branch are shown in figures 24 and 25, and table 9, respectively. The areal extent of the inundation caused by a 100-year flood on Reedy Branch is shown in plate 1.

Savannah River

The 100-year flood plain on the Savannah River was determined by using information developed by McDonald and Sanders (1987) and Sanders and others (1990). Flood elevations for the study area were determined by first establishing a relation of stage to flow at selected river miles; an example for river mile 159.4 is shown in figure 26. Then, the 100-year flood elevation was obtained by applying the 100-year flow documented in the flood-frequency section of this report (fig. 4) to the relation of stage to flow (fig. 26).

Within the study area, the 100-year flood-plain widths range from 6,000 ft at river mile 130.2 to 14,000 ft at river mile 156.7 (pls. 2 and 3). Graphical and tabular profiles of the Savannah River are shown in figure 27, and table 10, respectively. The areal extent of the inundation caused by a 100-year flood on the Savannah River is shown in plates 2 and 3.

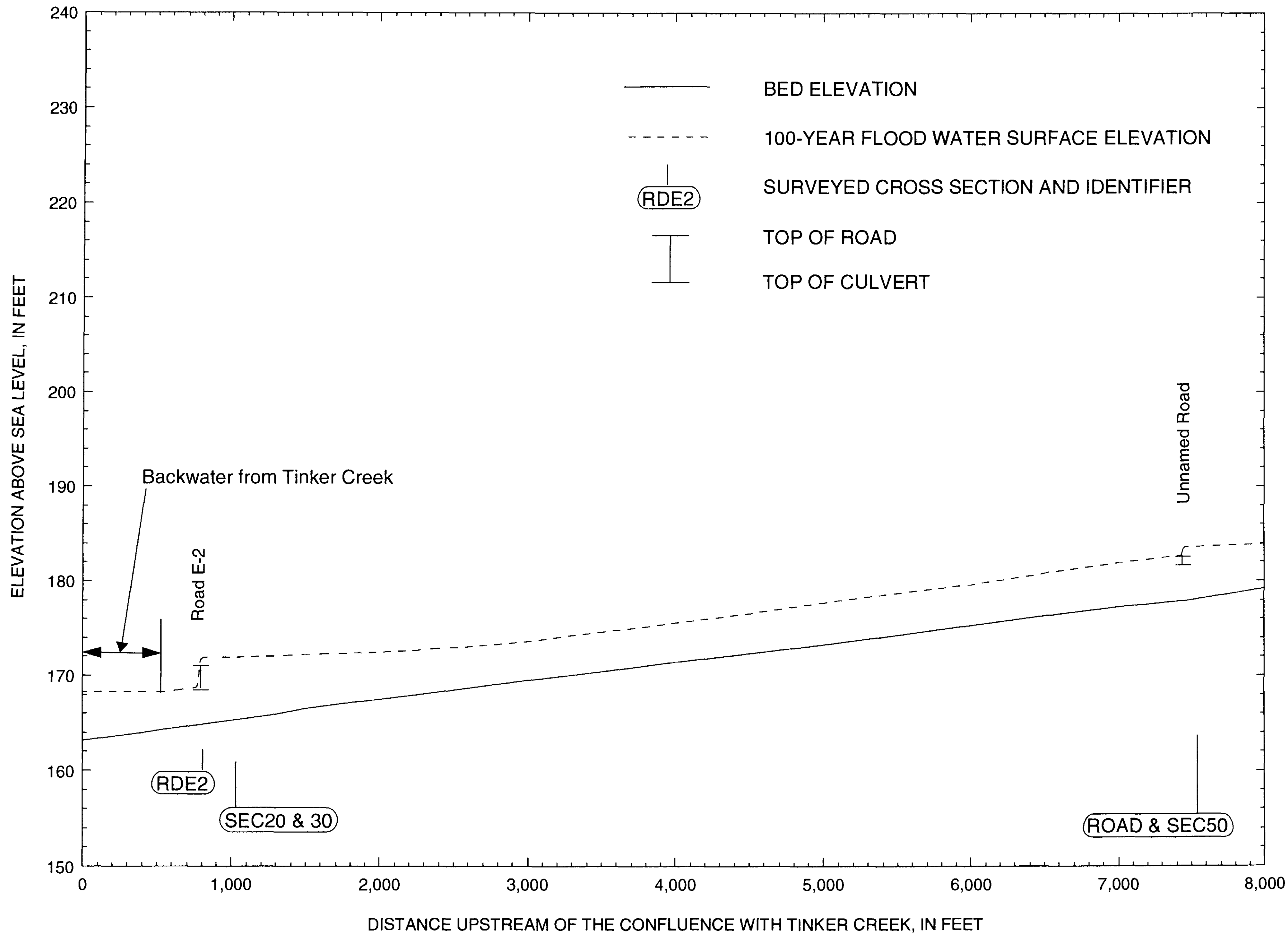


Figure 21. Flood profile of Mill Creek, Savannah River Site, S.C., from Station 0 to Station 8000.

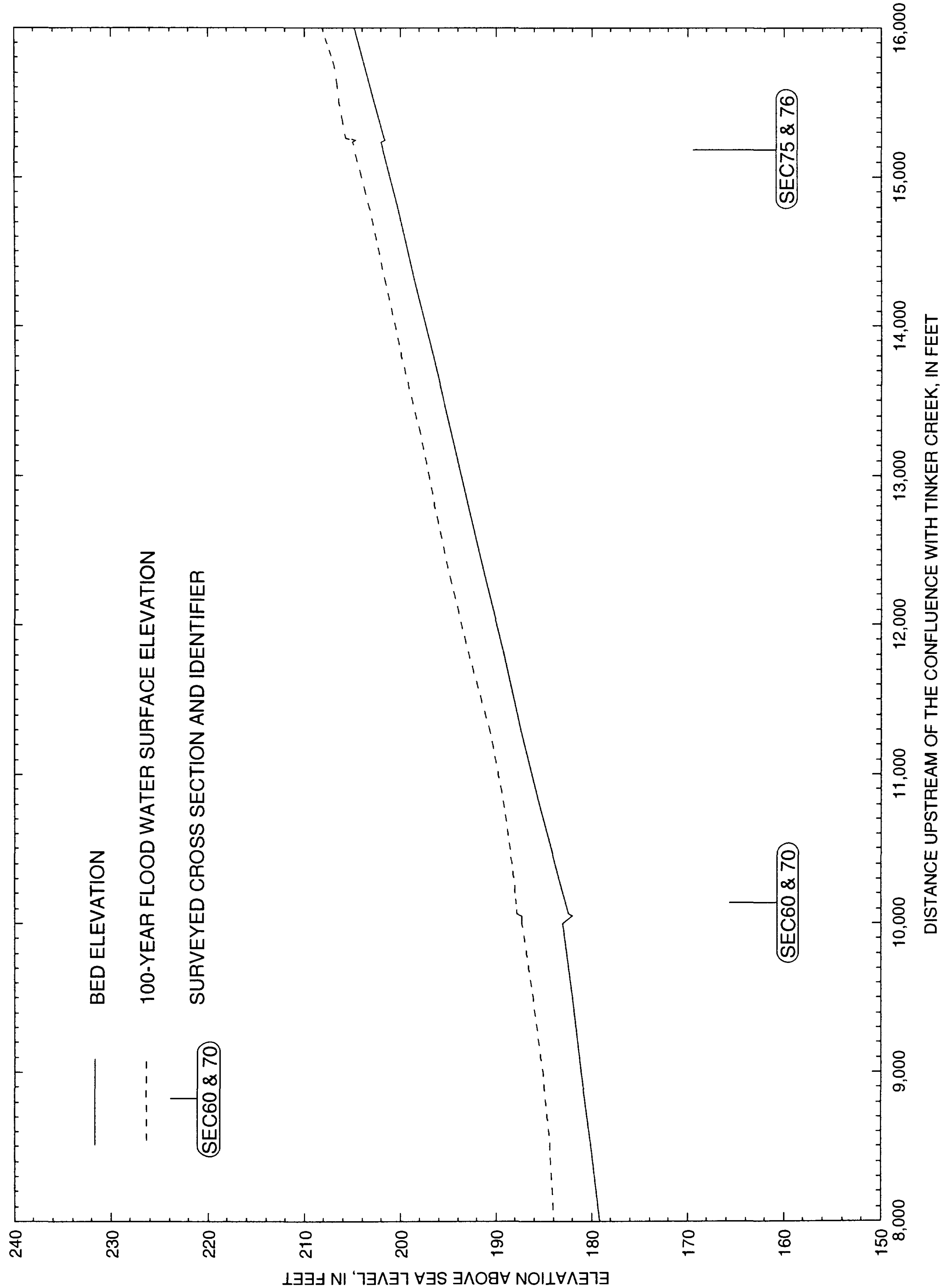


Figure 22. Flood profile of Mill Creek, Savannah River Site, S.C., from Station 8000 to Station 16000.

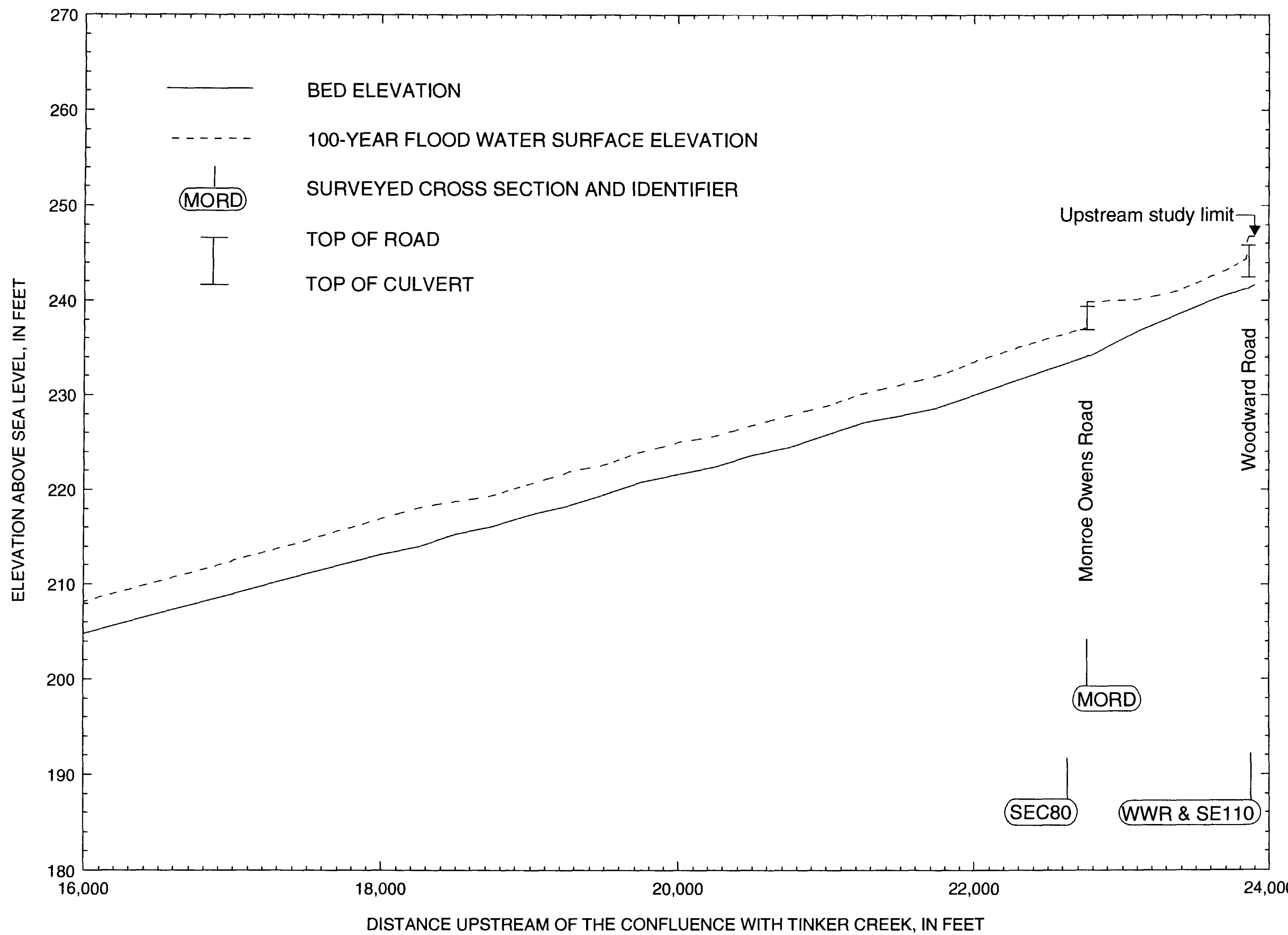


Figure 23. Flood profile of Mill Creek, Savannah River Site, S.C., from Station 16000 to Station 24000.

Table 8. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Mill Creek

[ft^3/s, cubic feet per second; ft, feet]

Cross-section location	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain Width (ft)	100-year flood water-surface elevation (ft, above sea level)
29 ft downstream from Road E-2	Synthetic	771	EXT20	545	278	168.73
Road E-2	Surveyed	800	RDE2	545	155	[2]171.80
165 ft upstream from Road E-2	Surveyed	965	SEC20	545	333	171.97
Dam crossing 460 ft upstream of Road E-2	Surveyed	1260	SEC30	545	79	172.06
15 ft downstream from unnamed road	Synthetic	7427	EXT50	545	359	182.69
Unnamed road	Surveyed	7442	ROAD	545	230	[2]183.40
108 ft upstream from unnamed road	Surveyed	7550	SEC50	545	414	183.92
Old breached dam	Surveyed	10050	SEC60	545	72	187.35
177 ft upstream from breached dam	Surveyed	10227	SEC70	545	355	188.03
Breached dam	Surveyed	15250	SEC75	282	21	204.72
12 ft upstream from breached dam	Surveyed	15262	SEC76	282	125	205.70
158 ft downstream from Monroe Owens Road	Surveyed	22613	SEC80	184	105	236.48
Monroe Owens Road	Surveyed	22771	MORD	184	67	[2]239.84
14 ft upstream from Monroe Owens Road	Synthetic	22785	APP80	184	173	239.93

Table 8. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Mill Creek--Continued

[ft^3/s, cubic feet per second; ft, feet]

Cross-section location	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft^3/s)	Flood-plain Width (ft)	100-year flood water-surface elevation (ft, above sea level)
8 ft downstream from Woodward Road	Synthetic	23842	EX110	184	122	244.38
Woodward Road	Surveyed	23850	WWR	184	125	[2]246.58
47 ft upstream from Woodward Road	Surveyed	23897	SE110	184	278	246.72

[1]All surveyed cross sections are shown on plate 1; synthetic cross sections are not shown on plate 1.
[2]Flow overtops road.

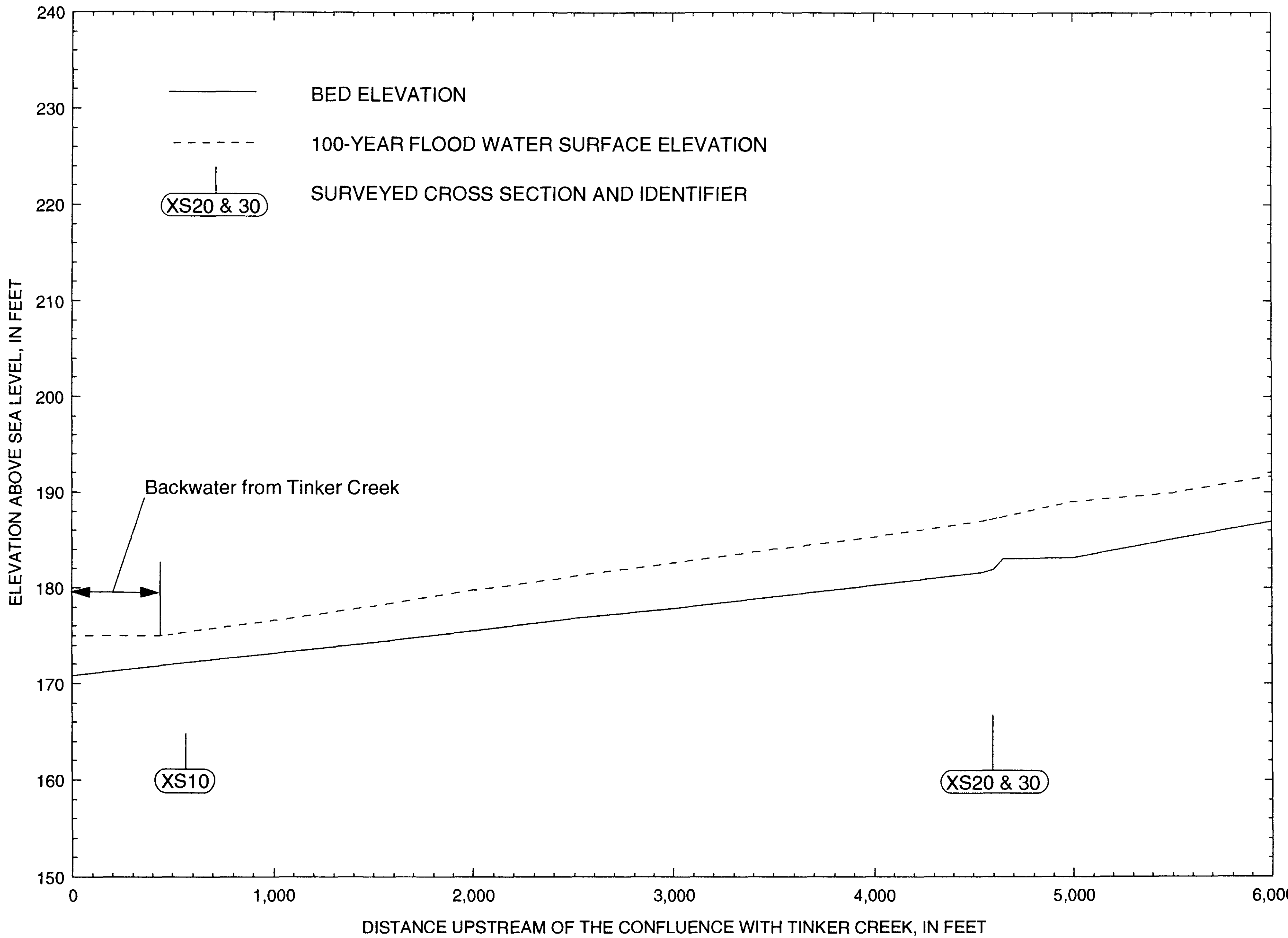


Figure 24. Flood profile of Reedy Branch, Savannah River Site, S.C., from Station 0 to Station 6000.

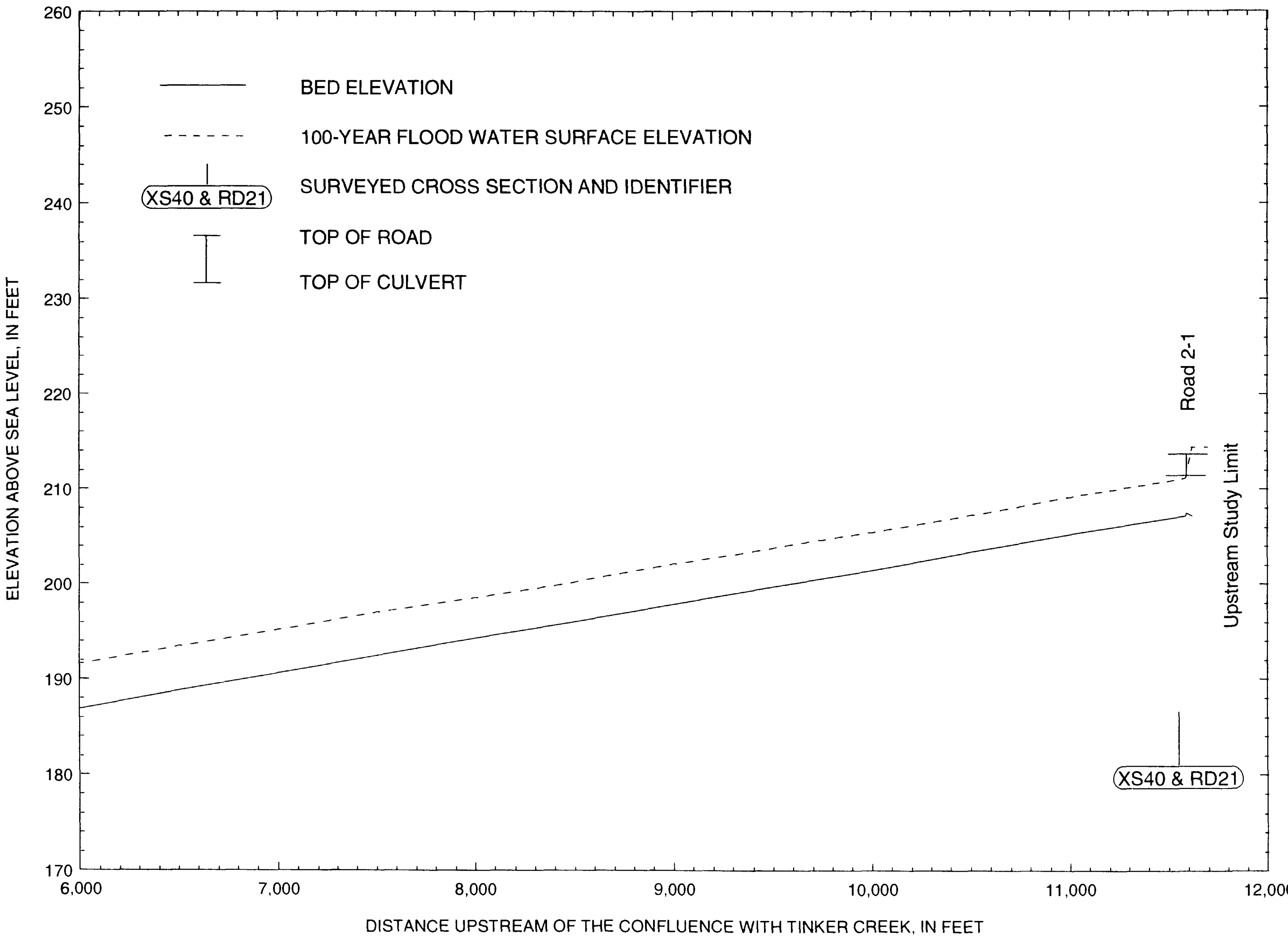


Figure 25. Flood profile of Reedy Branch, Savannah River Site, S.C., from Station 6000 to Station 11800.

Table 9. Cross-section location, type of cross section, cross-section station, cross-section name, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of Reedy Branch

[ft³/s, cubic feet per second; ft, feet]

Cross-section location	Type of cross section[1]	Cross-section station	Cross-section name	100-year flow (ft³/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
550 ft upstream from the mouth of Reedy Branch	Surveyed	550	XS10	365	340	176.04
50 ft downstream from dam	Surveyed	4550	XS20	338	143	187.02
Breached dam	Surveyed	4600	XS30	338	31	187.23
50 ft downstream from Road 8-1	Surveyed	11550	XS40	240	224	211.20
Road 8-1	Surveyed	11600	RD81	240	110	[2]214.59
17 ft upstream from Road 8-1	Synthetic	11617	APRO	240	317	214.71

[1]All surveyed cross sections are shown on plate 1; synthetic cross sections are not shown on plate 1.
[2]Flow overtops the road.

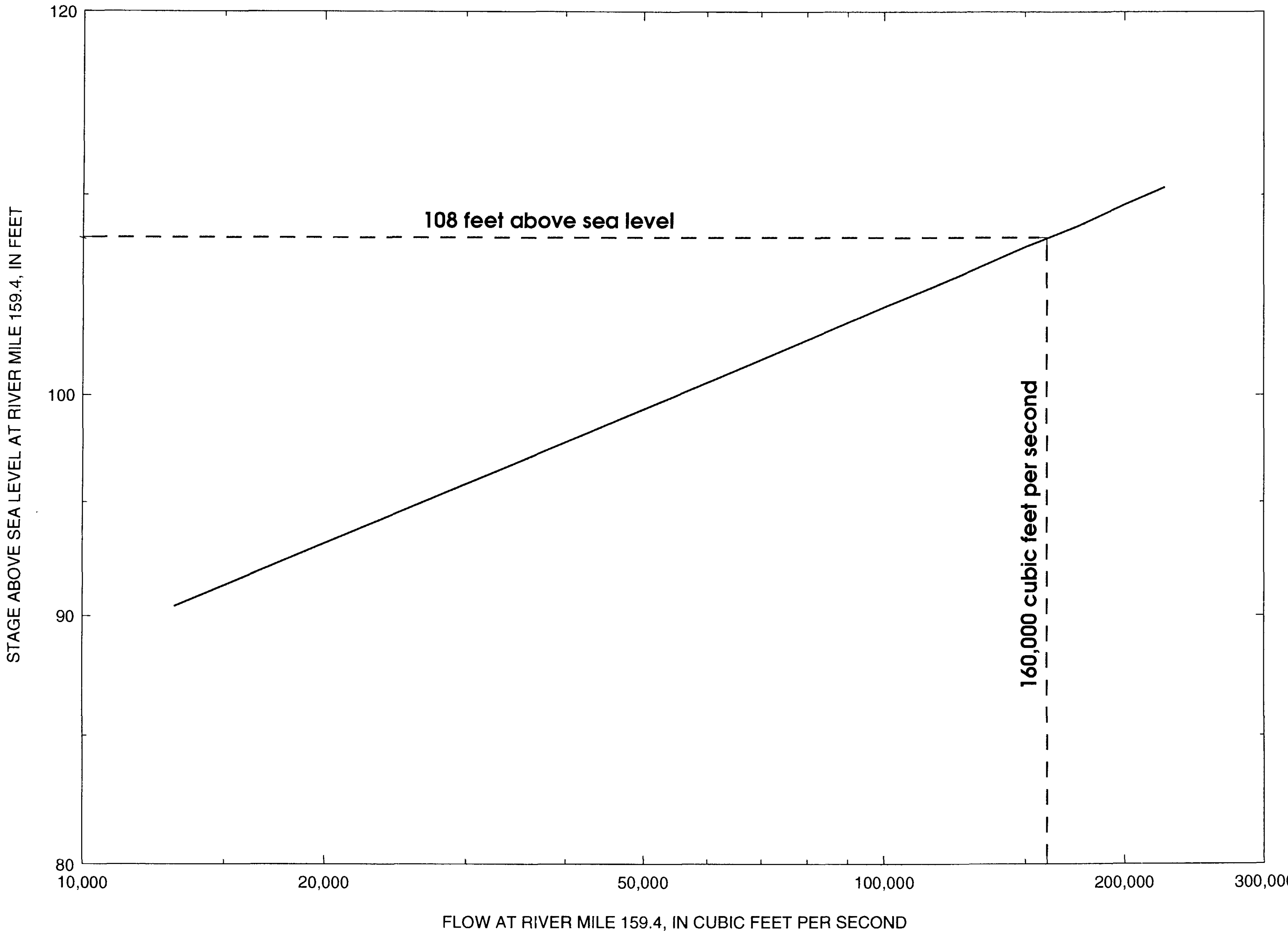


Figure 26. Relation of stage to flow at river mile 159.4 for the Savannah River.

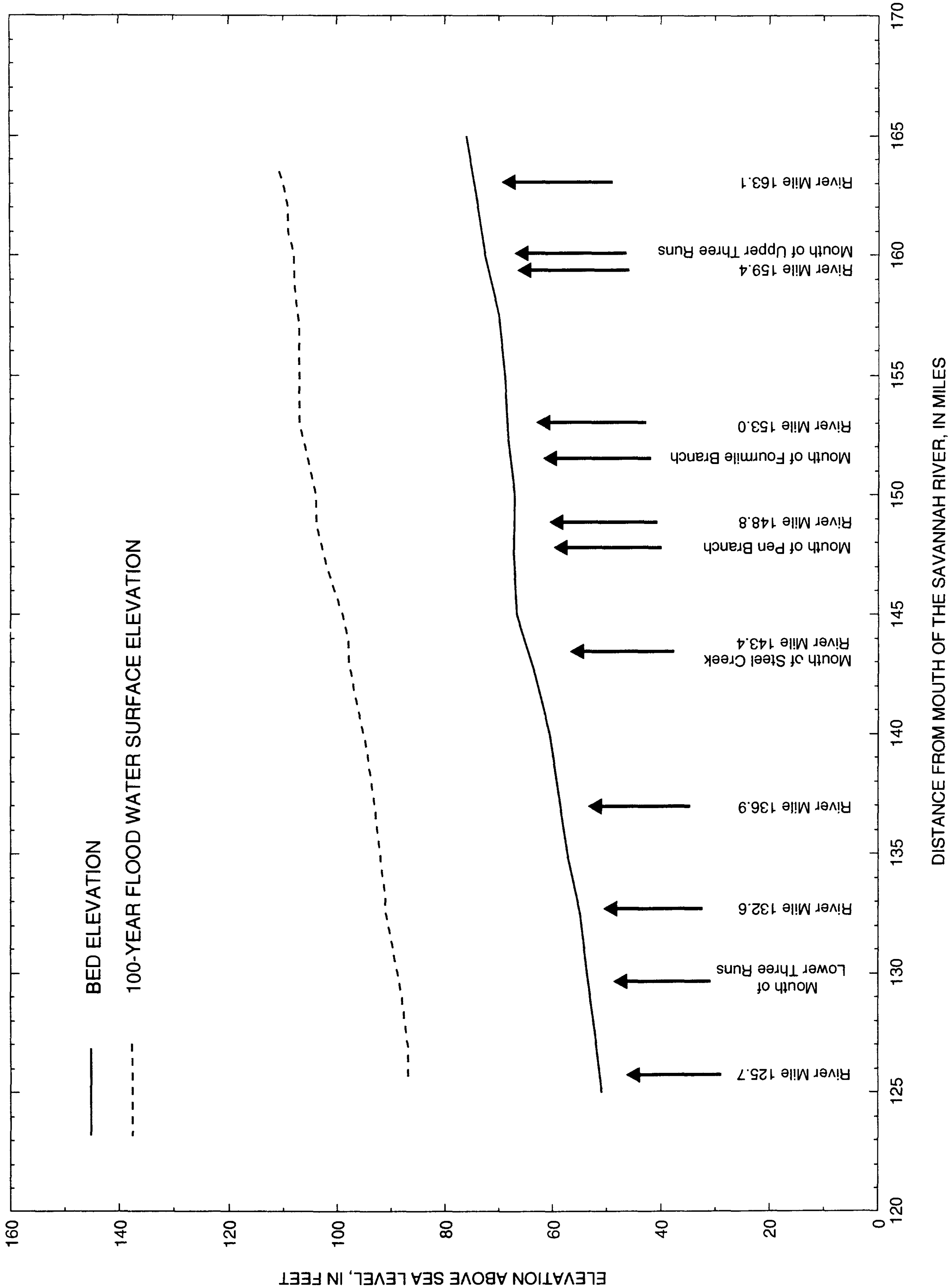


Figure 27. Flood profile for the Savannah River from river mile 125.7 to river mile 163.8.

Table 10. Cross-section location, 100-year flow, flood-plain width, and 100-year flood water-surface elevation for selected cross sections of the Savannah River

[ft^3/s, cubic feet per second; ft, feet; --, no data]

Cross-section location (plates 2 and 3)	100-year flow (ft^3/s)	Flood-plain width (ft)	100-year flood water-surface elevation (ft, above sea level)
River mile 125.7	160,000	10,300	87.0
River mile 129.4, Lower Three Runs/Savannah River confluence	150,000	[1]--	88.0
River mile 132.6	154,000	10,400	91.0
River mile 136.9	156,000	10,000	93.0
River mile 143.2	160,000	10,000	98.0
River mile 143.4, Steel Creek/Savannah River confluence	160,000	[1]--	98.0
River mile 147.8, Pen Branch/Savannah River confluence	157,000	[1]--	103.0
River mile 148.8	158,000	10,200	104.0
River mile 151.5, Fourmile Branch/Savannah River confluence	160,000	[1]--	106.0
River mile 153.0	160,000	10,600	107.0
River mile 159.4	160,000	12,900	108.0
River mile 160, Upper Three Runs/Savanah River confluence	159,000	[1]--	108.0
River mile 163.1	160,000	10,800	111.0

[1]Cross section extends into mouth of tributary.

SUMMARY

In 1951, the U.S. Department of Energy, formerly the Atomic Energy Commission, created the Savannah River Site to produce nuclear materials for national defense. The Savannah River Site occupies approximately 300 square miles along the Georgia-South Carolina border in parts of Aiken, Barnwell, and Allendale Counties, S.C. In 1992, the U.S. Geological Survey, in cooperation with the U.S. Department of Energy, initiated an investigation to determine the areal extent of inundation caused by the 100-year recurrence interval flow for the Savannah River along the Savannah River Site southwestern boundary, and for the major streams and their tributaries on the Savannah River Site, with the exception of Lower Three Runs. This report includes delineation of the 100-year flood plain in the Upper Three Runs Basin, which includes Upper Three Runs, Tims Branch, Crouch Branch, Tinker Creek, McQueen Branch, Mill Creek and Reedy Branch. The report also includes delineation of the 100-year flood-plain on the reach of the Savannah River that borders the Savannah River Site. The results are provided in tabular and graphical formats. The 100-year flood-plain maps and flood profiles provide water-resource managers of the SRS with a technical basis for making flood-plain management decisions that could minimize future flood problems and a basis for designing and constructing drainage structures along roadways.

A hydrologic analysis was made to estimate the 100-year recurrence interval flow for Upper Three Runs and its tributaries. The analysis showed that the well-drained, sandy soils of the headwaters of Upper Three Runs reduce the high flows on the main stem of the stream. Consequently, the U.S. Geological Survey Upper Coastal Plain regional-rural-regression equation for South Carolina was not applicable for Upper Three Runs. By using streamflow data gathered from gaging stations on Upper Three Runs, a relation of 100-year flow and drainage area was established. This relation was used to compute 100-year flows at selected points along the stream.

The U.S. Geological Survey regional-rural and urban-regression equations for South Carolina were used to compute the 100-year flows for Crouch Branch, McQueen Branch, Mill Creek, and Reedy Creek, because the soil types in these drainage basins closely resemble those normally occurring in upper Coastal Plain basins.

Excessively drained soils resembling those in the headwaters of Upper Three Runs occur in smaller quantities on Tims Branch and Tinker Creek, and may reduce peak flows. Due to storage effecting gaging station data on Tims Branch and no gaging station record on Tinker Creek, the regional-rural and urban-regression equations for South Carolina were used to compute 100-year flows. These flows could produce profiles that represent a probable maximum elevation to be expected for the 100-year flood rather than the most likely elevation.

Throughout each reach, cross sections were surveyed and other pertinent data such as flow resistance and land-use data were collected. The computed 100-year flows and surveyed cross sections were used in a step-backwater model to compute the 100-year flood plain for Upper Three Runs and its tributaries. The profiles computed by the step-backwater model were used to delineate the 100-year flood plain on topographic maps. Data from two previously published reports were used to determine the 100-year flood plain along the Savannah River, which forms the southwestern boundary of the Savannah River Site.

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APPENDIX

List of Elevation Reference Marks

APPENDIX

List of Elevation Reference Marks

[ft, feet; USGS, U.S. Geological Survey; USC&GS, U.S. Coastal and Geodetic Survey; in., inch; mi, mile]
(In this report, the words "right" and "left" refer to directions that would be reported by an observer facing downstream.)

Benchmark	Location	Elevation above sea level (ft)
UTR20	Chiseled X in the upstream left abutment headwall of the CSX Railway bridge crossing Upper Three Runs, 2,400 ft downstream of Road A. Established by the USGS.	121.30
UTR40	Chiseled square on top of the downstream right abutment headwall on the bridge crossing Upper Three Runs at Road A. Established by the USGS.	115.08
UTR90	Chiseled square on top of the downstream right corner of the curb on the bridge crossing Upper Three Runs at Road C. Established by the USGS.	135.39
UTR94A	Chiseled square in the upstream right headwall of the M line U.S. Goverment Railway bridge crossing Upper Three Runs, 3,700 ft upstream of Road C. Established by the USGS.	144.53
UTR94B	Chiseled square in the upstream left headwall of the M line U.S. Goverment Railway bridge crossing Upper Three Runs, 3,700 ft upstream of Road C. Established by the USGS.	144.55

APPENDIX

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Benchmark	Location	Elevation above sea level (ft)
UTR140	Chiseled square on the end of the downstream right curb of the bridge crossing Upper Three Runs at Road F. Established by the USGS.	158.70
UTR170	Chiseled square on the end of the upstream left curb of the bridge crossing Upper Three Runs at Tyler Bridge Road. Established by the USGS.	168.47
UTR190	Chiseled X on the end of the downstream left curb of the bridge crossing Upper Three Runs on Road 8-1. Established by the USGS.	175.94
UTR230	Chiseled square on the upstream left abutment on the bridge crossing Upper Three Runs at U.S. Route 278. Established by the USGS.	188.68
TC3	Chiseled square on the end of the upstream left curb of the bridge crossing Tinker Creek at Tyler Bridge Road. Established by the USGS.	173.38
TC50	Chiseled square on the upstream right abutment corner on the bridge crossing Tinker Creek at Road 8-1. Established by the USGS.	185.09

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Benchmark	Location	Elevation above sea level (ft)
TC9	Chiseled square on the end of the downstream right curb on the bridge crossing Tinker Creek at Kennedys Pond Road. Established by the USGS.	220.78
TC10	Chiseled square on the downstream left edge of the culvert crossing Tinker Creek at U.S. Route 278. Established by the USGS.	231.86
M101	Brass tablet located at crossing of CSX Railway and Road 3, 259 degrees north and across the track from mile post Number 438, 33 ft northeast of northeast rail, 49.5 ft southeast of the centerline of the road, 60.5 ft east of the center of the crossing. Established by the USC&GS.	153.372
P103	Brass tablet located in the top of the southwest end of the southeast headwall to a 48 in. diameter pipe, 26 ft southeast of the southeast rail of track about 0.1 mi northeast of the east end of the 135 ft railroad bridge crossing Upper Three Runs upstream of Road C. Established by the USC&GS.	136.965

APPENDIX

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Benchmark	Location	Elevation above sea level (ft)
Q103	Brass tablet located about 6.1 mi northeast along Road 3 from the CSX Railway crossing 6.5 mi northwest of Road C about 1.15 mi east of Road 2 overpass over Road C, between Road C and Savannah River railroad track on the outside of the curve in the track with east and northwest tangents, 56.5 ft north of the north lane of the road, 73 ft southwest of the southwest rail of the track. Established by the USC&GS.	176.647
2 WDK 1962 209	Brass tablet located 1.6 mi south of New Ellenton post office on S.C 19, thence 3.7 mi east on Route U.S. 278; 18 ft north of, and 0.5 ft higher than centerline of the road at bridge; in top of east end of north concrete headwall of bridge. Established by the USC&GS.	208.963
TMA 439 1952	Brass tablet located 1.6 mi south of New Ellenton post office on S.C. Route 19, thence 4.2 mi east on U.S. Route 278, thence 0.6 mi north on Road 781.4; 300 ft south and 40 ft east of center of wooden bridge; in concrete post; Atomic Energy Comission disk.	204.862

APPENDIX
List of Elevation Reference Marks--Continued

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Benchmark	Location	Elevation above sea level (ft)
X102	Brass tablet located 1.35 mi north on Road 4 from junction of Road C and Road 4, thence 0.9 mi northwest on M Line U.S. Government Railroad track, about 0.1 mi northwest of milepost No. 12, 85 ft southwest from the southwest rail of track, 2 ft southeast of the metal witness post, 1 ft above the level of the track. Established by the USC&GS.	249.350
S103	Brass tablet located 0.4 mi northwest from junction of Road 2 and Road D, on the outside of a long east-northwest curve, at a very small clearing southwest of the center line of the Road, 2 ft east of a metal witness post, about 4 ft below the level of the road. Established by the USC&GS.	302.148
R102	Brass tablet located 3.15 mi southwest of the junction of Road C and Road 3, about 0.4 mi northeast of four 6-ft diameter concrete pipes over Fourmile Creek, at the junction of the woods road leading north, 59 ft north of the center line of Road 3, 37 ft west of the center line of the woods road, 2 ft east of the metal witness post, 1.5 ft below the level of the highway. Established by the USC&GS.	200.154