SEDIMENTATION IN LAKE TUSCALOOSA, ALABAMA, 1982-86

By Larry J. Slack and James L. Pritchett

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CONVERSION FACTORS AND ABBREVIATIONS

For use of readers who prefer to use metric (International System) units, conversion factors for inch-pound units used in this report are listed below:

Multiply inch-pound unit	By	To obtain metric unit
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)

Temperature in degrees Fahrenheit (°F) can be converted to degrees Celsius (°C) as follows: °C = (°F - 32)/1.8

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

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ABSTRACT

Lake Tuscaloosa, created in 1969 by the impoundment of North River, provides the primary water supply for Tuscaloosa, Alabama, and surrounding areas. This report describes the rate of sedimentation in the lake from its principal tributaries. The rate of sediment deposition in the lake is low. The maximum sediment deposition from 1982 to 1986 at 17 lake cross sections was about 3.5 feet (or 0.9 foot per year) at a cross section that received drainage from Brush Creek basin. Brush Creek is an unmined basin with steep overland and channel slopes. At 15 of the 17 cross sections, the maximum sediment deposition was less than 2 feet (or 0.5 foot per year). Scour and fill processes (redistribution of the sediment) appear to be taking place at many of the cross sections.

INTRODUCTION

Lake Tuscaloosa (fig. 1), created in 1969 by the impoundment of North River, provides the primary water supply for Tuscaloosa, Alabama, and surrounding areas. The lake also is used for recreation and shoreline residential development. Land-use practices, such as coal mining, agriculture, timber clear-cutting, and residential development in basins that drain into the lake have caused concern about possible changes in the rate of sedimentation in the lake. This report has been prepared by the U.S. Geological Survey in cooperation with the city of Tuscaloosa.

Purpose and Scope

The purpose of this report is to describe the rate of sedimentation in Lake Tuscaloosa from its seven principal tributaries (fig. 1) on the basis of annual measurements at 17 cross sections from 1982 to 1986.

Previous Investigations

Previous investigations generally have been reconnaissance in nature. The most important ones are the following: Kenner and others (1975), Hubbard (1975, 1976a, and 1976b), and Cole (1985). The 39 cross sections in Lake Tuscaloosa at which Hubbard (1975) performed fathometric surveys were not monumented, so their exact locations could not be reestablished for this study. A companion report to this report describing the "Water quality of Lake Tuscaloosa and streamflow and water quality of selected tributaries to Lake Tuscaloosa, Alabama, 1982-86" was published as Water-Resources Investigations Report 87-4002 (Slack, 1987).

Data-Collection Methods

Cross sections were established at 17 locations in Lake Tuscaloosa in the fall of 1982 to measure changes in sedimentation. The cross sections were surveyed and monumented so they could be relocated accurately each year thereafter. The cross sections were selected near points of inflow from the seven principal tributaries because most settling and deposition of sediment occur where decreases in streamflow velocity occur. The contributing drainage area is that portion of the basin upstream of the lake's backwater. For the convenience of the reader, each of the 17 lake cross sections is referenced to the contributing stream.

Bottom profiles were recorded at each cross section by using a fathometer. The fathometer produced a pen trace of the lake bottom through reflection of a sonic signal. Cross-section widths were obtained by using a level. The traces were digitized and the profiles were adjusted to normalize mean channel widths. Water-surface elevation for each cross section was referenced to continuously recorded stage at the lake spillway on the date the fathometric survey was performed. Actual elevations upstream may vary from the stage at the spillway.

DESCRIPTION OF THE STUDY AREA

Lake Tuscaloosa, in north-central Tuscaloosa County, Alabama, receives surface runoff from a drainage area of 423 square miles (fig. 1). The principal streams discharging to Lake Tuscaloosa and percentage of mean inflow to the lake are: North River (including Cripple Creek, which drains to North River about 5 river miles before the river discharges to Lake Tuscaloosa), about 62 to 65 percent; Binion Creek, 13 to 20 percent; Brush Creek, less than 1 percent; Carroll Creek, 4 to 5 percent; Dry Creek, 2 percent; Tierce Creek, 1 percent; and Turkey Creek, 2 to 3 percent. (See fig. 1 and Slack, 1987.)

The study area has a subtropical climate characterized by warm, humid weather. The mean annual temperature is about 62°F (Frentz and Lynott, 1978). Precipitation is usually rain, with little or no snowfall. The mean annual rainfall is about 55 inches.

About 75 percent of the land in the study area is forested (Slack, 1987). Some of the cleared areas are used to produce crops. Surficial materials in several small areas in the study area have been disturbed by surface coal mining. However, they are estimated to be less than 5 percent of the total drainage area. Although the study area is sparsely populated, residential development near the lake has been practically continuous since the lake was formed.

Although the relatively impermeable Pottsville Formation of Pennsylvanian age underlies all of the study area, it is exposed mainly in the northeastern part. The Pottsville Formation consists mainly of sandstone, shale, and siltstone with shale being dominant (Metzger, 1965). Beds of coal and underclay are present in some parts of the formation. Ground water usually occurs in openings along joints, fractures, and bedding planes (Culbertson, 1964).

The more permeable Coker Formation of Cretaceous age crops out in the southern and western parts of the study area. Although the upper 300 feet of the Coker Formation consists chiefly of clay (Metzger, 1965), the permeable sand and gravel beds in the lower 100 feet provide significant quantities of base flow to streams and are the principal source of water from wells in much of the Lake Tuscaloosa area (Cole, 1985).

SEDIMENTATION

Sediment movement and deposition in Lake Tuscaloosa is a continuing process. Sediment supply rates are influenced by physiography, soils, precipitation, and land use. Areas with steep slopes and soils with high erosion potential have rapid runoff and increased sediment yield. Areas with dense vegetation cover have reduced erosion rates.

Logging, agriculture, construction, and activities associated with surface coal mining, such as removal of the vegetative cover, building and maintaining haul roads, and creation of spoil piles subject to weathering and erosion, can increase sediment yields and reduce reservoir storage capacity.

Bottom profiles were measured annually at 17 locations in Lake Tuscaloosa from 1982 to 1986. For brevity, only the 1982 and 1986 profiles are shown in figures 2 through 18. (See Data-Collection Methods section.) The maximum sediment deposition values from 1982 to 1986 reported in table 1 were calculated by assuming that profiles of troughs were the most accurate and that maximum deposition occurred in troughs. The reader is cautioned that the value for maximum sediment deposition was calculated for a single point in each cross section and does not necessarily represent the changes in sedimentation upstream or downstream. Because of the variability of boat speed and angle, uncertainty of water level at a given location, and inconsistency of measurement error, it is not possible to determine exactly how much deposition is occurring in the lake.

The rate of sediment deposition in Lake Tuscaloosa is low. The maximum sediment deposition at the 17 lake cross sections between 1982 and 1986 was about 3.5 feet (or about 0.9 foot per year) for a lake cross section that receives drainage from Brush Creek (table 1). The second-largest amount of sediment deposition (3.0 feet) also occurred in Brush Creek basin. The maximum sediment deposition rate during 1982-86 was the same as that reported by Cole (1985) for preimpoundment (1969). Cole reported that the maximum sediment deposition between preimpoundment and 1982 at the 17 cross sections was 20 feet--also at a cross section that receives drainage from Brush Creek. If the 20 feet of sediment deposition occurred in equal amounts annually between 1969 (when the preimpoundment topographic survey was performed) and 1982, this also would be equivalent to about 0.9 foot per year.

Brush Creek is an unmined basin with steep overland and channel slopes. Cole (1985) reported that the average overland slope and mean channel slope for the Brush Creek basin are greater than those for any other basin in the study area. Cole concluded that the steeper overland and channel slopes in Brush Creek basin increase the velocity of runoff and cause more erosion and sediment delivery to Lake Tuscaloosa.

Table 1.--Estimated maximum sediment depositions at Lake Tuscaloosa cross sections from 1969 to 1982 and from 1982 to 1986
[Basin disturbed (D) or undisturbed (U) by mining]

Lake cross section[a]	Contributing basin	Principal formation drained	Land use effects	Maximum sediment deposition, in feet 1969-82[b]	Maximum sediment deposition, in feet 1982-86[c]	Profiles shown on figure
BC2	Binion Creek	Coker	D	2	1.0	2
BC5	Binion Creek	Coker	D	2	-1.8	3
BRC1	Brush Creek	Pottsville	U	3	3.5	4
BRC4	Brush Creek	Pottsville	U	13	3.0	5
BRC7	Brush Creek	Pottsville	U	20	-1.0	6
CC2	Carroll Creek	Coker	U	3	0.8	7
CC5	Carroll Creek	Coker	U	<1	0.0	8
CC8	Carroll Creek	Coker	U	4	-1.2	9
DC2	Dry Creek	Pottsville	U	2	0.0	10
NR2	North River	Pottsville	D	8	-1.0	11
NR5	North River	Pottsville	D	11	1.8	12
NR8	North River	Pottsville	D	8	-1.5	13
TC1	Tierce Creek	Pottsville	U	4	1.0	14
TC4	Tierce Creek	Pottsville	U	-2	-1.2	15
TC7	Tierce Creek	Pottsville	U	-2	-1.0	16
TRC2	Turkey Creek	Pottsville and Coker	D	7	-0.1	17
TRC5	Turkey Creek	Pottsville and Coker	D	15	0.4	18

[a]Locations of cross sections are shown on figure 1.
[b]From Cole (1985).
[c]Estimated from figures 2-18, assuming that maximum deposition occurred in troughs.

At 15 of the 17 lake cross sections the maximum sediment deposition from 1982 to 1986 was less than 2 feet (or less than 0.5 foot per year). Scour and fill processes (redistribution of the sediment further downstream) appear to be taking place at many of the cross sections on the basis of annual measurements. The large sediment deposition in Lake Tuscaloosa from North River and Turkey Creek basins from 1969 to 1982 did not reoccur during 1982 to 1986.

The low sediment deposition rates at the 17 lake cross sections are not surprising, though, in consideration of the fathometric profiles performed at 39 cross sections in Lake Tuscaloosa in April 1975 by E.F. Hubbard. Hubbard (1975) reported that, as of 1975, there was no widespread formation of visible sand bars or mud flats in the lake and that it may take more than 3,000 years to fill the lake at present sediment loads.

SUMMARY

Lake Tuscaloosa, created in 1969 by the impoundment of North River, provides the primary water supply for Tuscaloosa, Alabama, and surrounding areas. The rate of sediment at the 17 cross sections in the lake is low. Because of the variability of boat speed and angle, uncertainty of water level at a given location, and measurement error, it is not possible to determine exactly how much deposition is occurring in the lake. There is, however, some indication that sediment has filled the deepest part of the channel at locations on Brush Creek to depths as much as 3.5 feet, about 0.9 foot annually since 1982. Average annual sedimentation rate in the other cross sections was about 0.5 foot annually.

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Hubbard, E.F., 1975, Fathometer survey of Lake Tuscaloosa, Alabama: U.S. Geological Survey Open-File Report, 94 p.

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Metzger, W.J., 1965, Pennsylvanian stratigraphy of the Warrior basin, Alabama: Geological Survey of Alabama Circular 30, 80 p.

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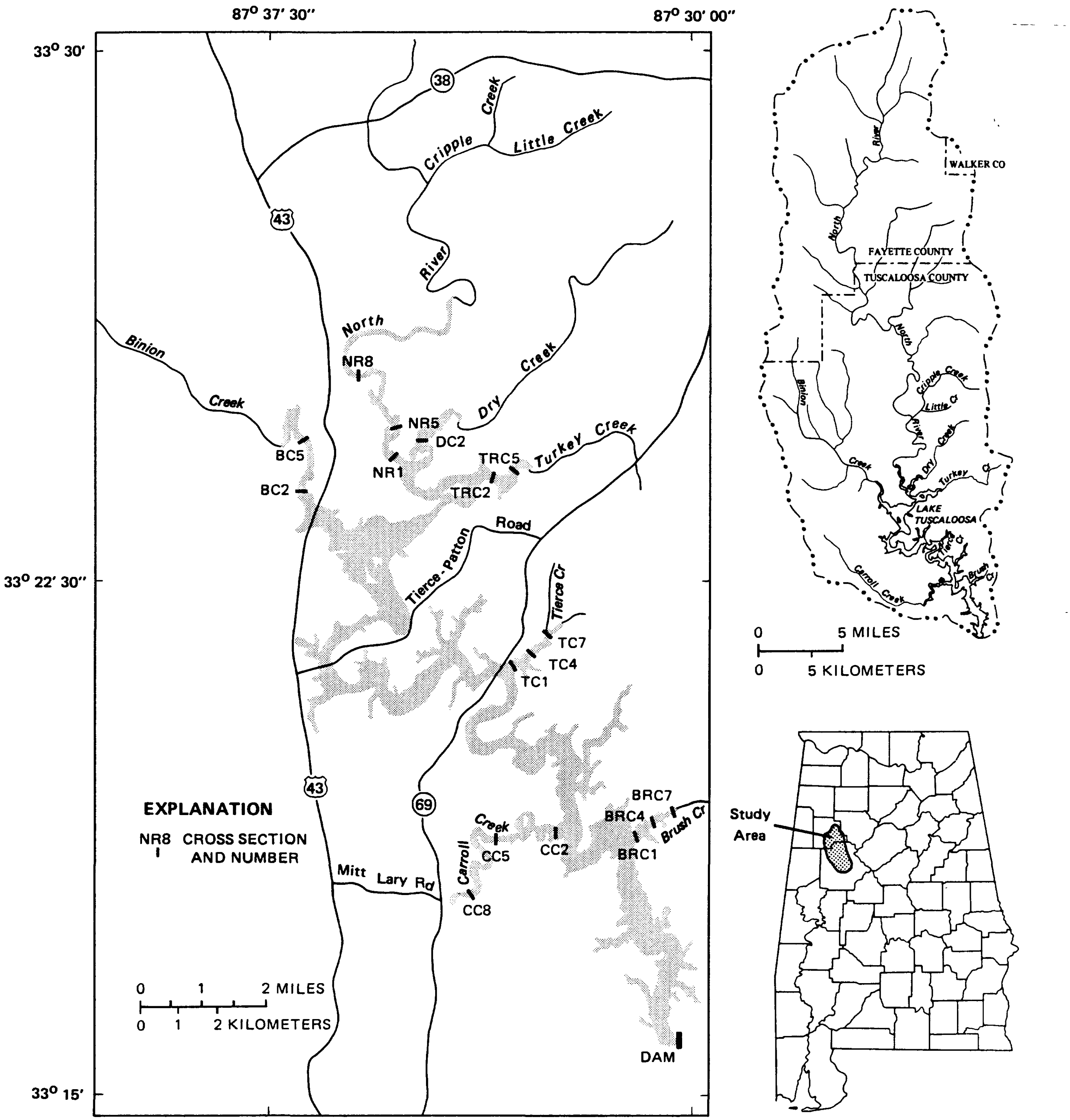

Figure 1.--Location of study area and lake cross sections.

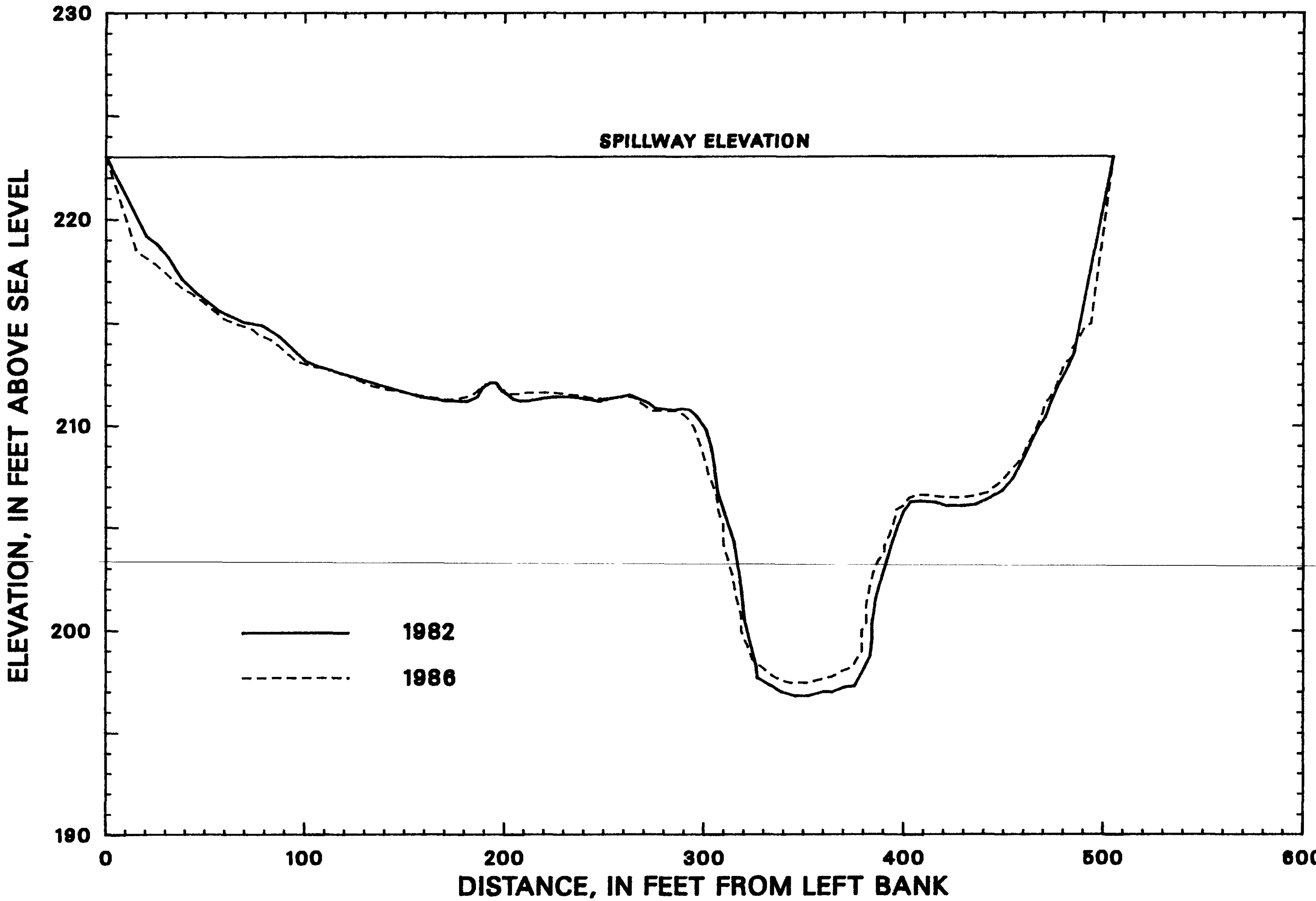

Figure 2.--Cross section BC2 in Binion Creek basin.

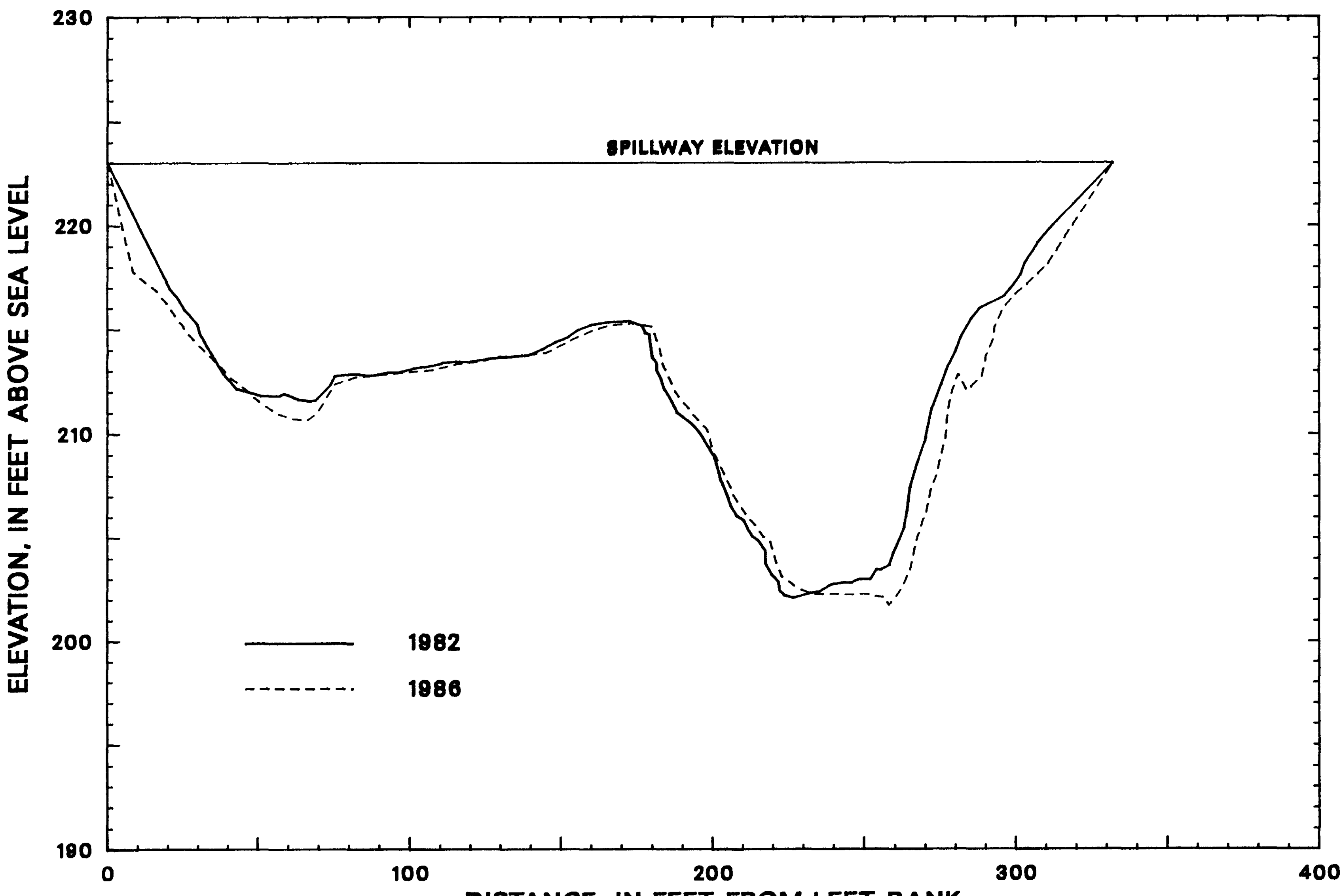

Figure 3.--Cross section BC5 in Binion Creek basin.

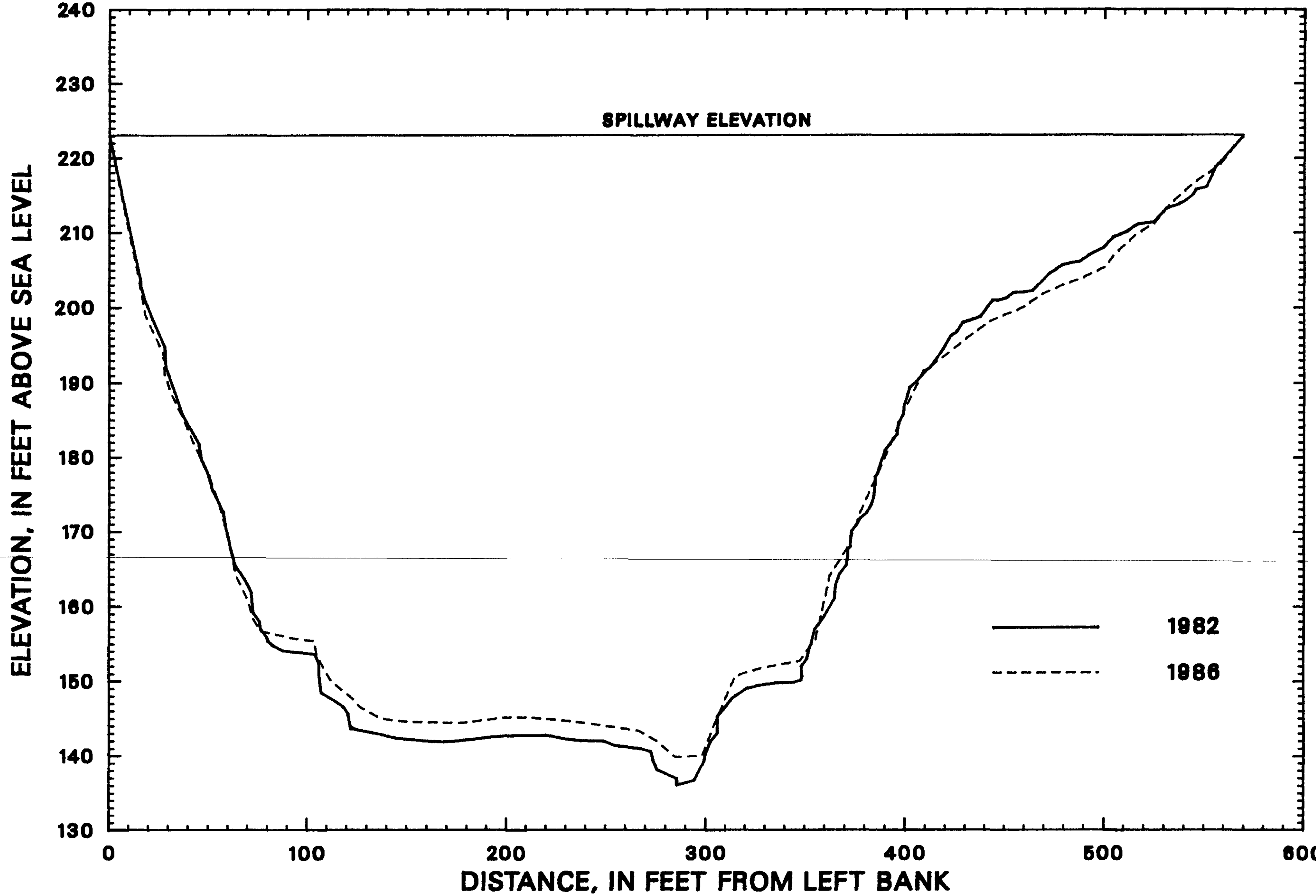

Figure 4.--Cross section BRC1 in Brush Creek basin.

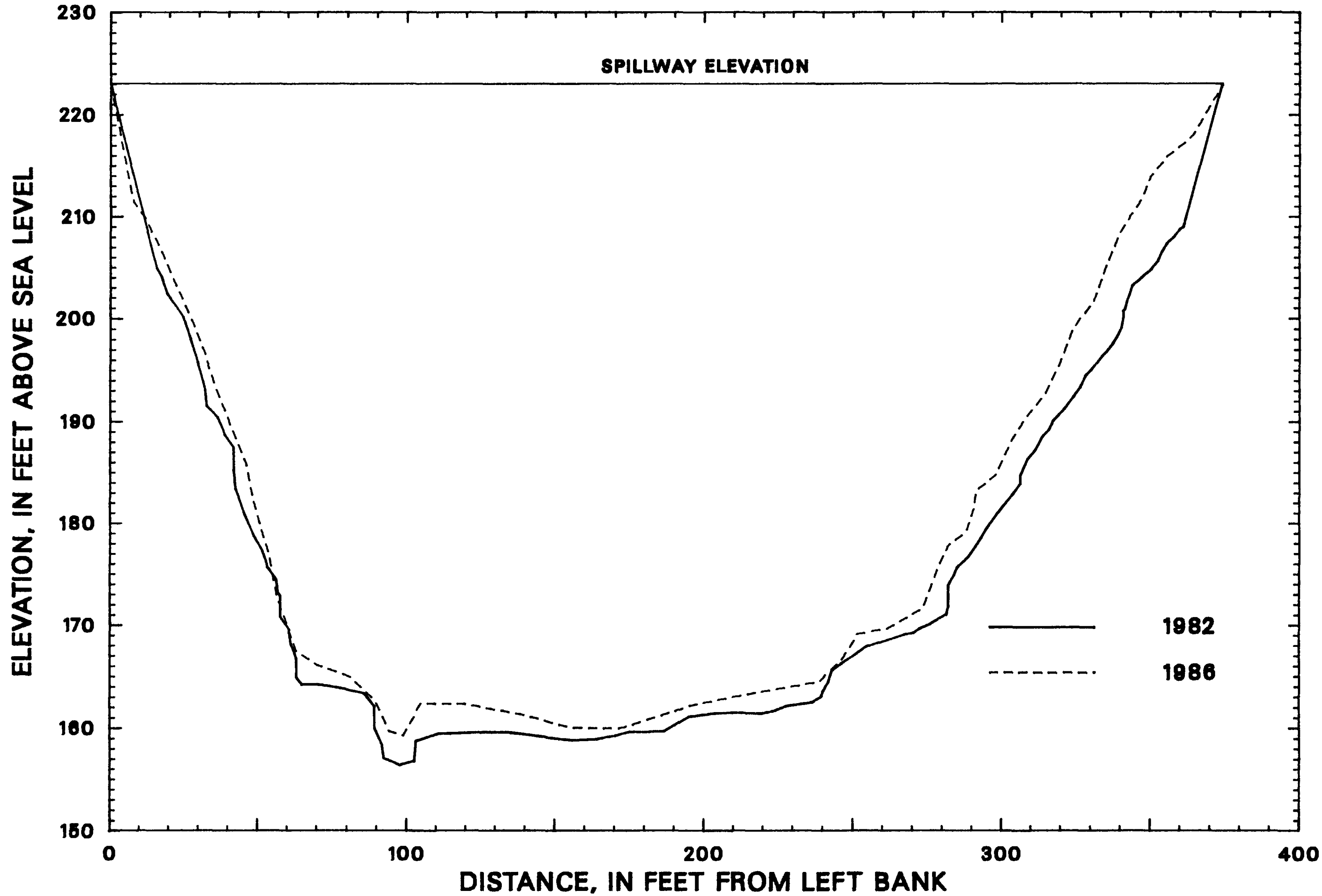

Figure 5.--Cross section BRC4 in Brush Creek basin.

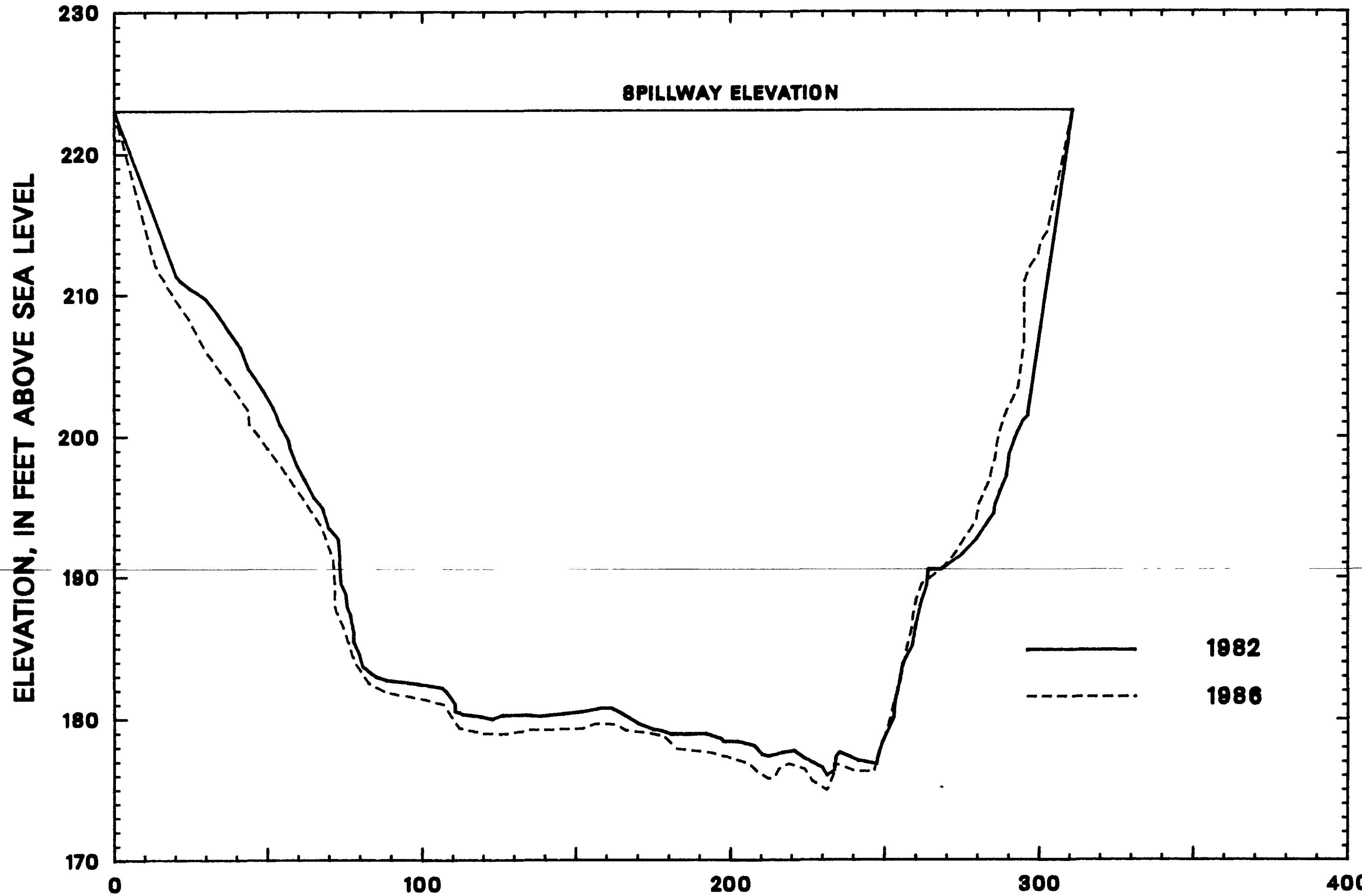

Figure 6.--Cross section BRC7 in Brush Creek basin.

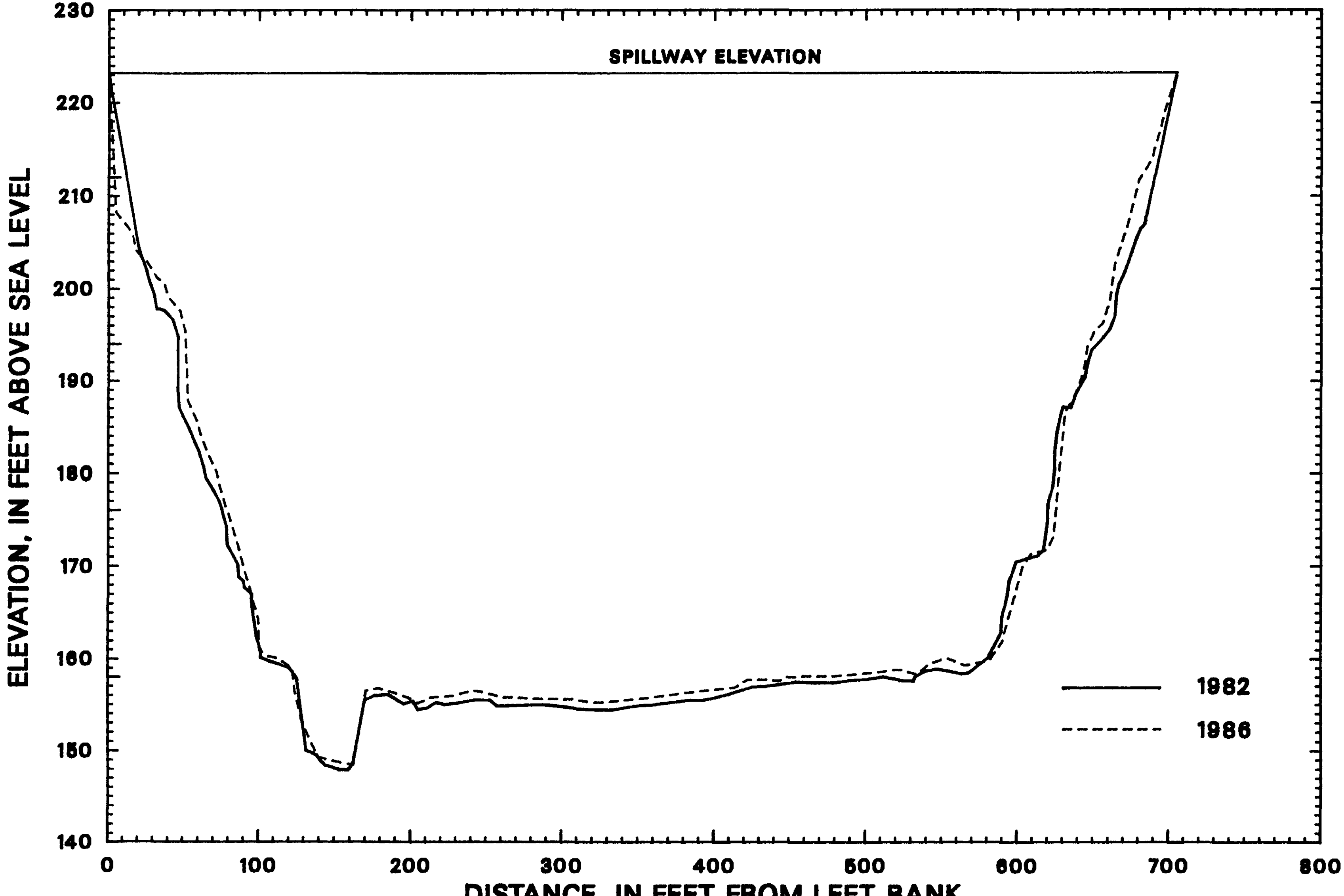

Figure 7.--Cross section CC2 in Carroll Creek basin.

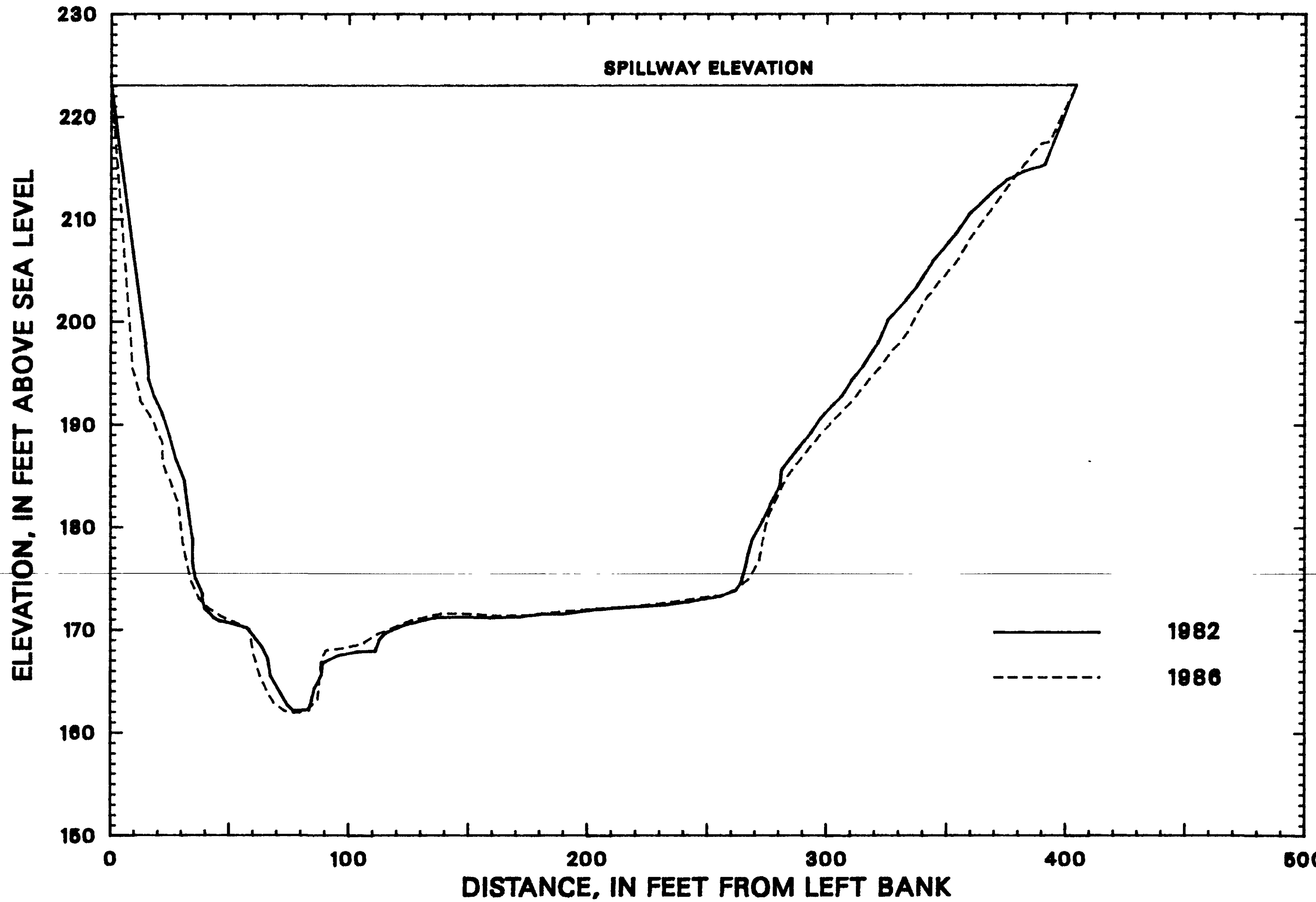

Figure 8.--Cross section CC5 in Carroll Creek basin.

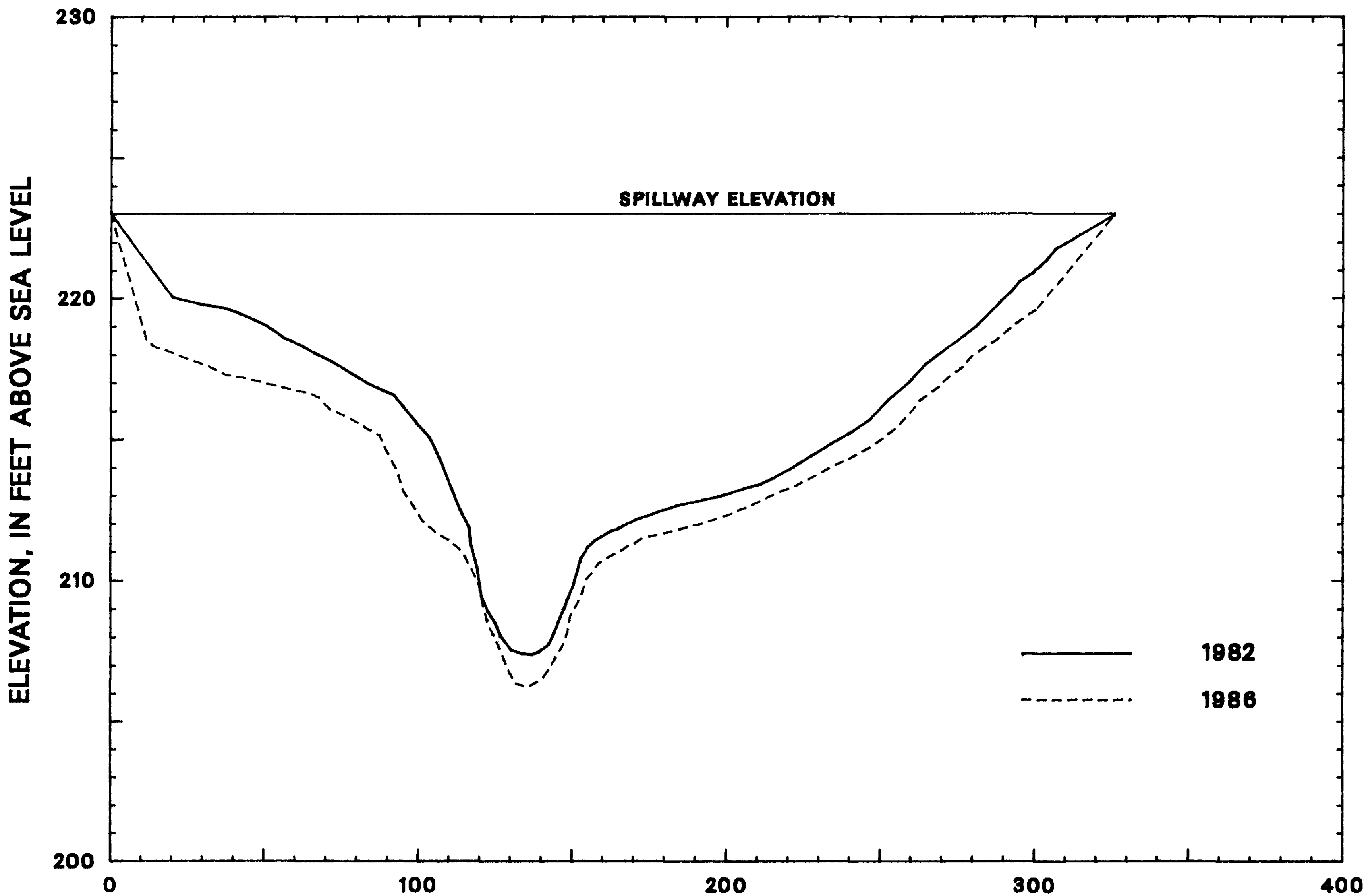

Figure 9.--Cross section CC8 in Carroll Creek basin.

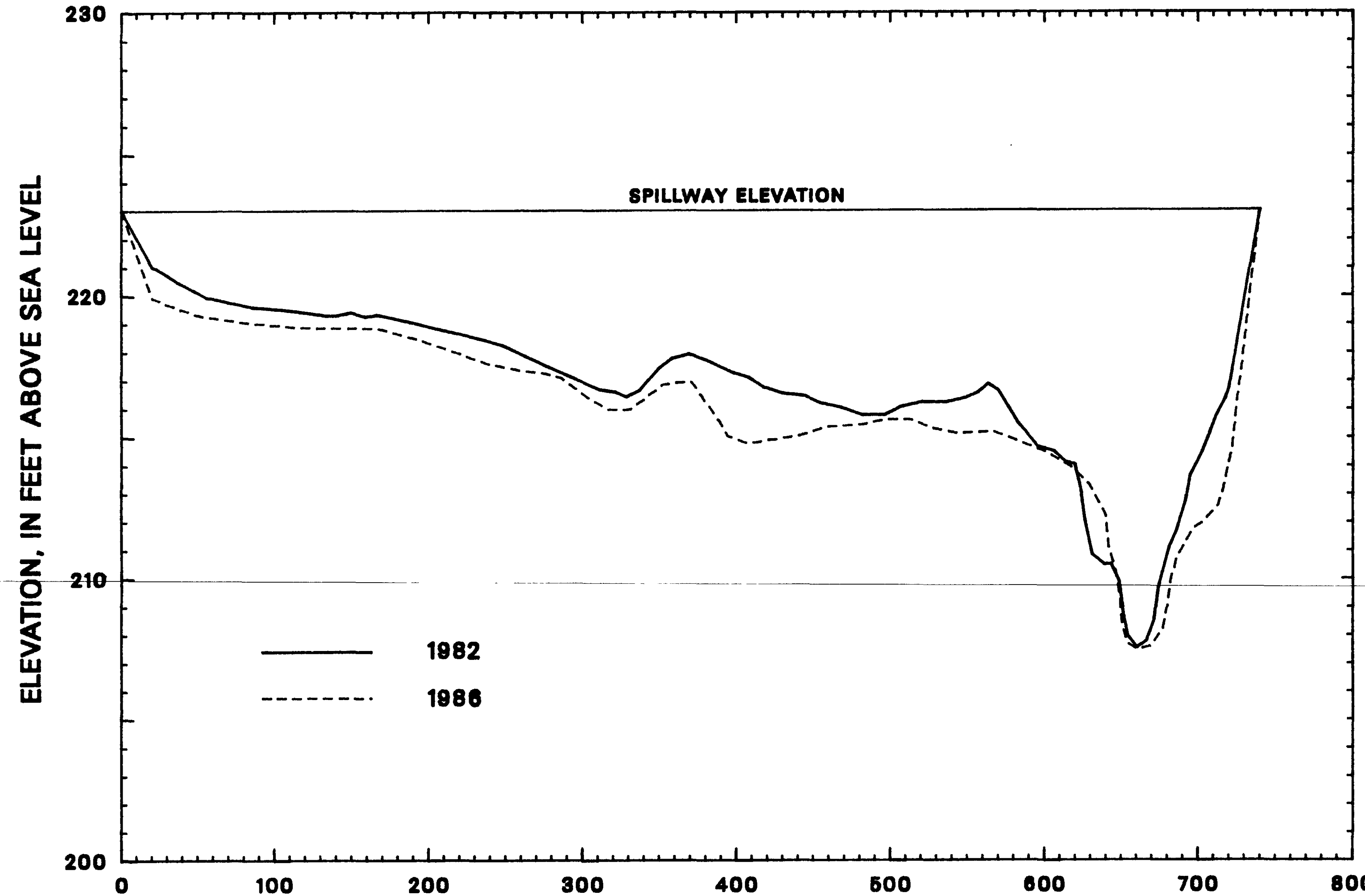

Figure 10.--Cross section DC2 in Dry Creek basin.

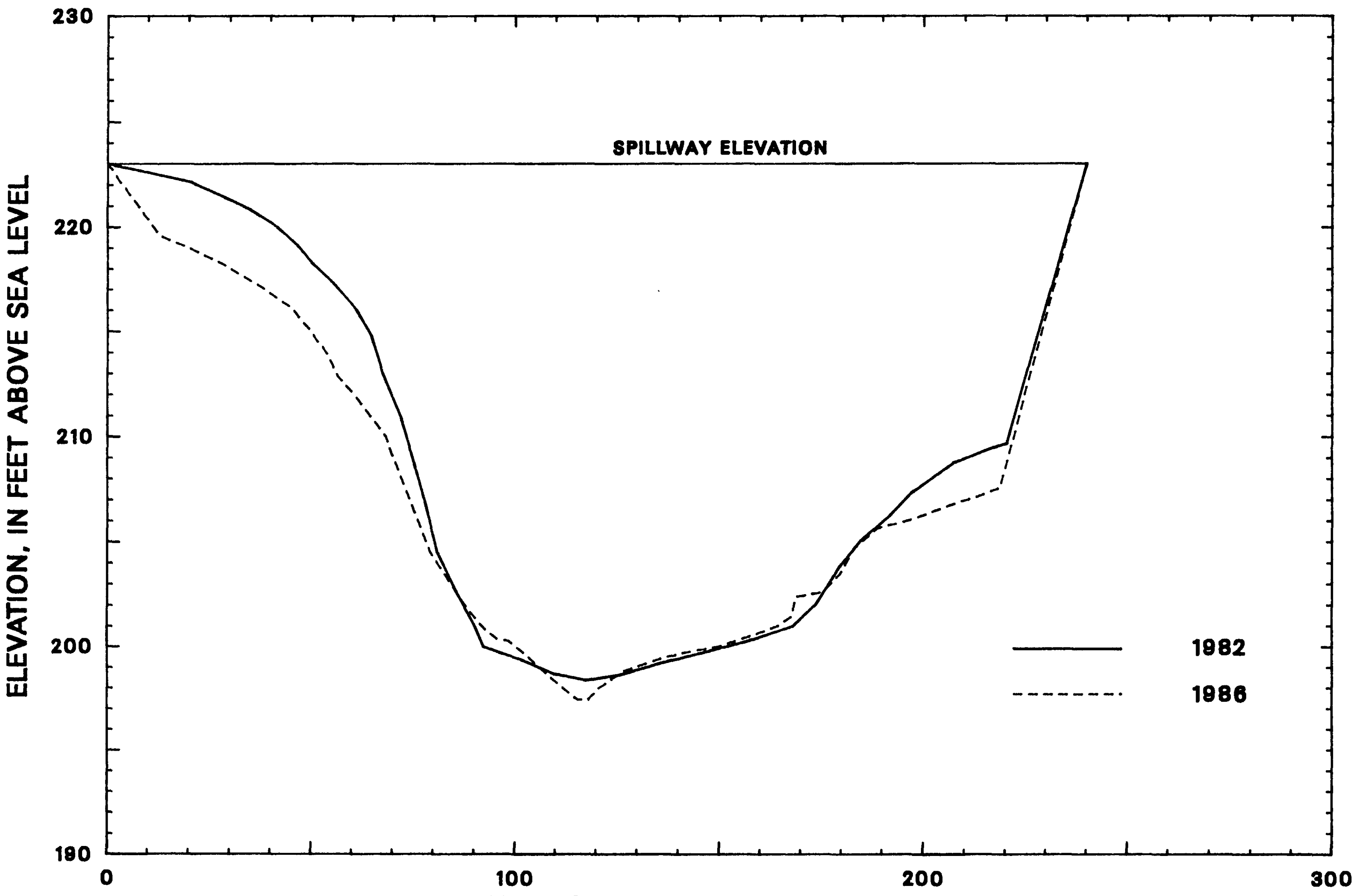

Figure 11.--Cross section NR2 in North River basin.

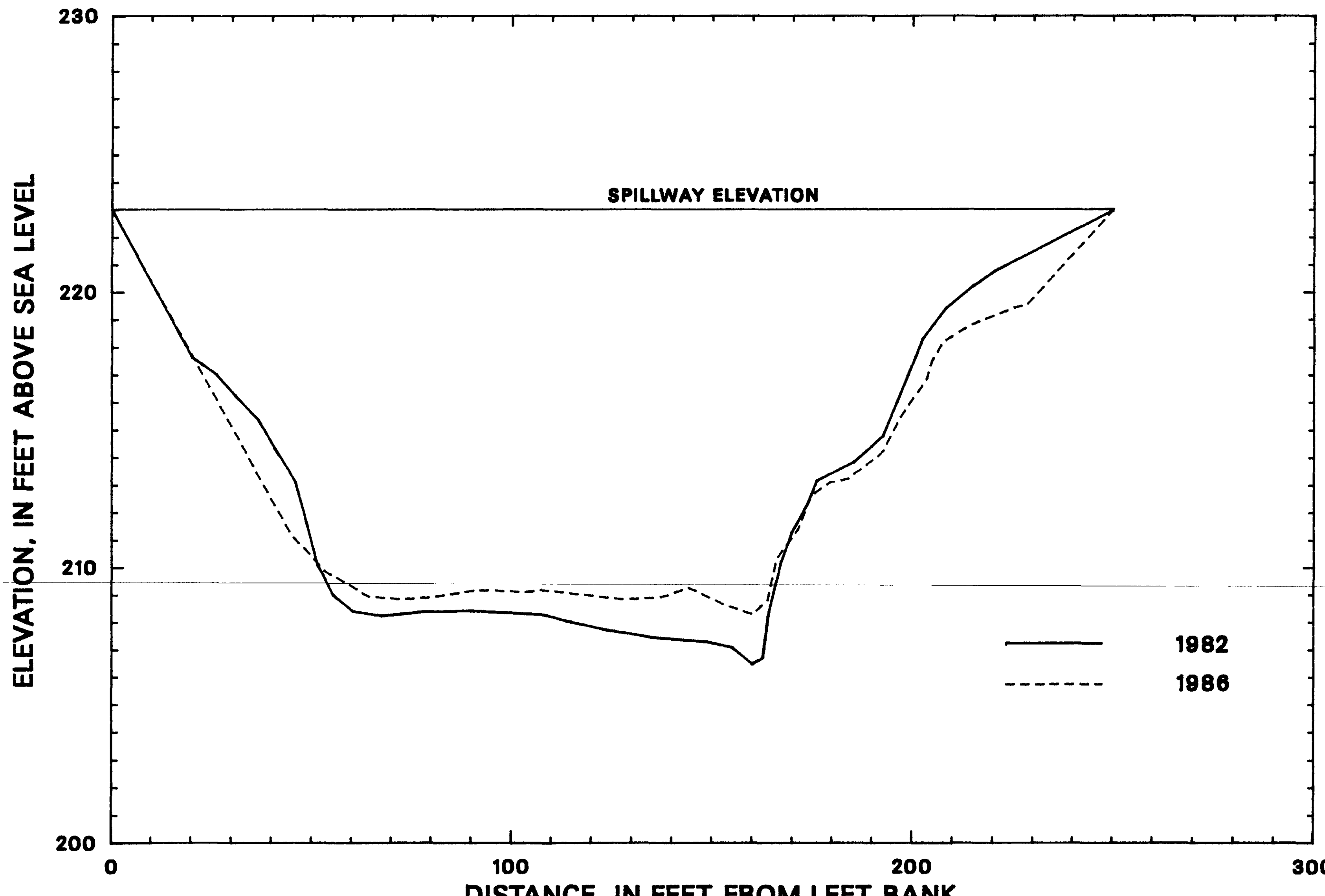

Figure 12.--Cross section NR5 in North River basin.

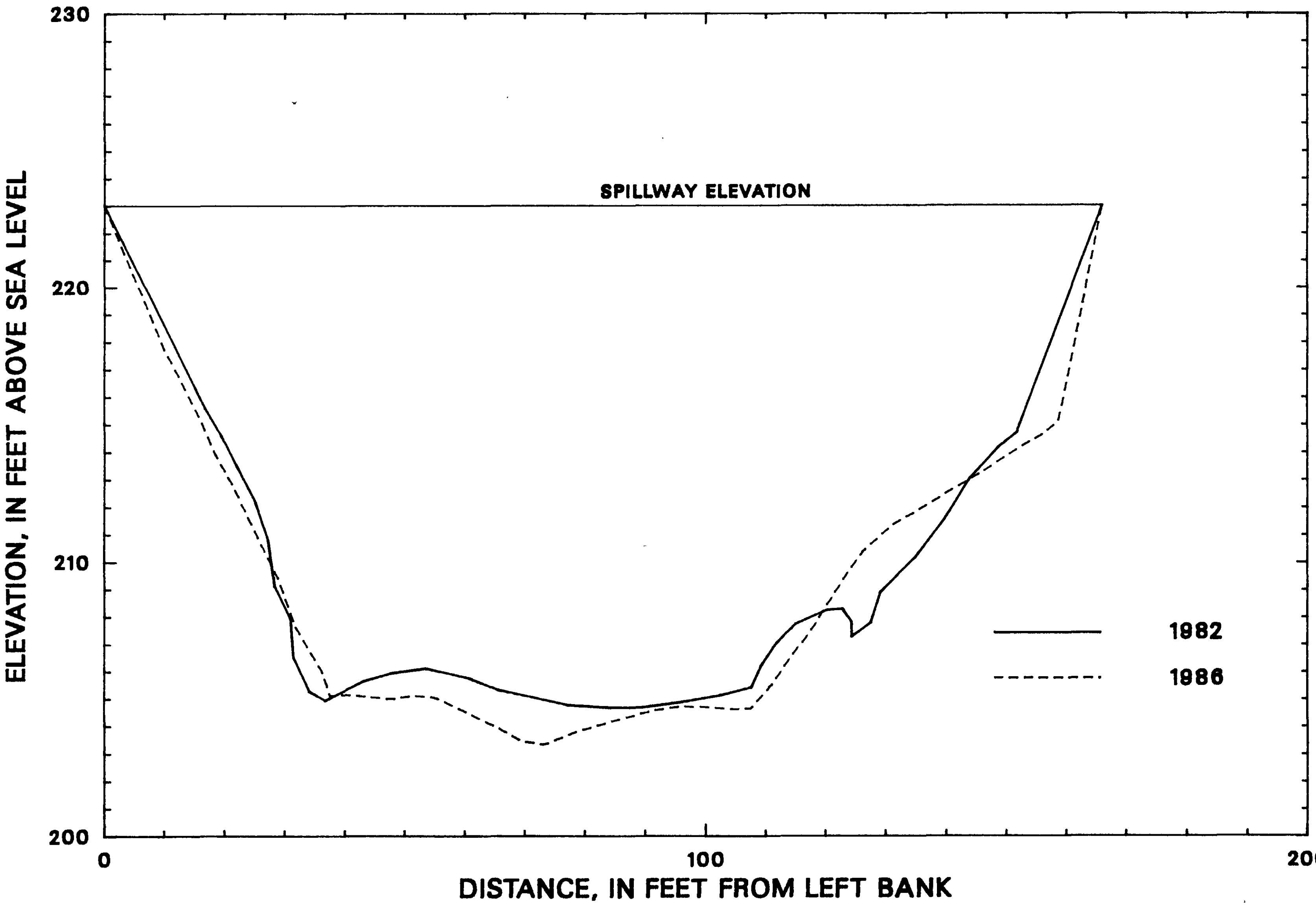

Figure 13.--Cross section NR8 in North River basin.

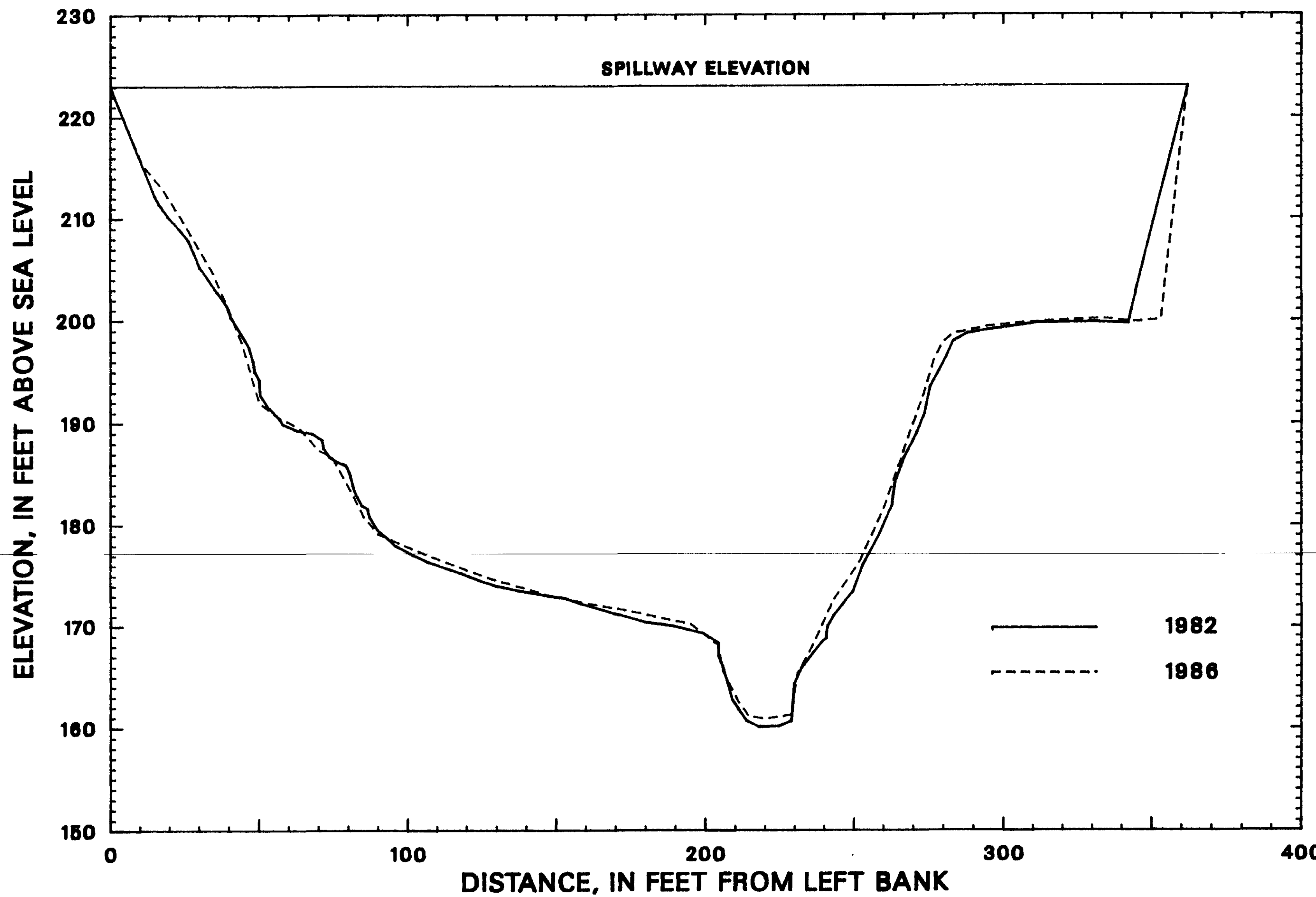

Figure 14.--Cross section TC1 in Tierce Creek basin.

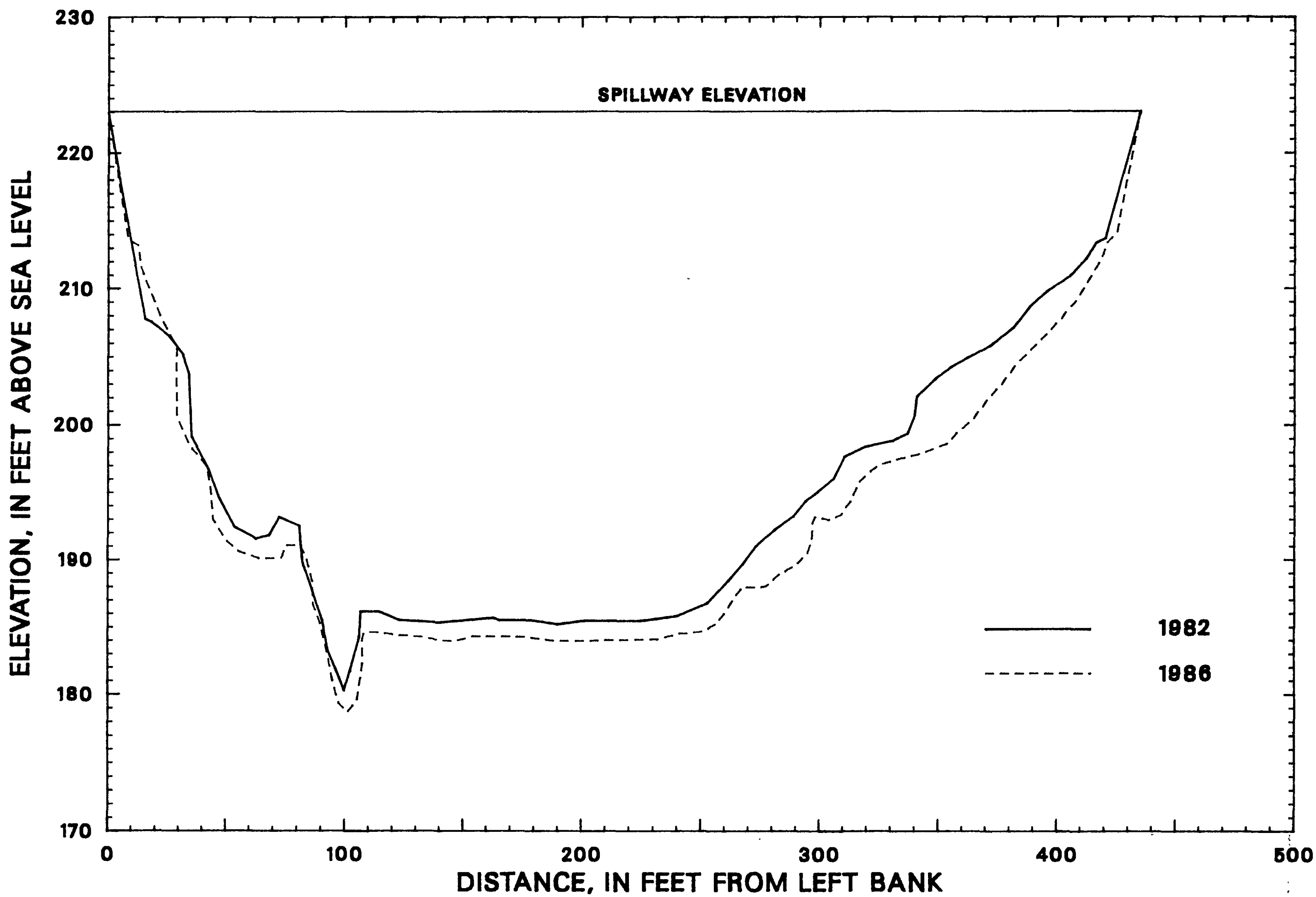

Figure 15.--Cross section TC4 in Tierce Creek basin.

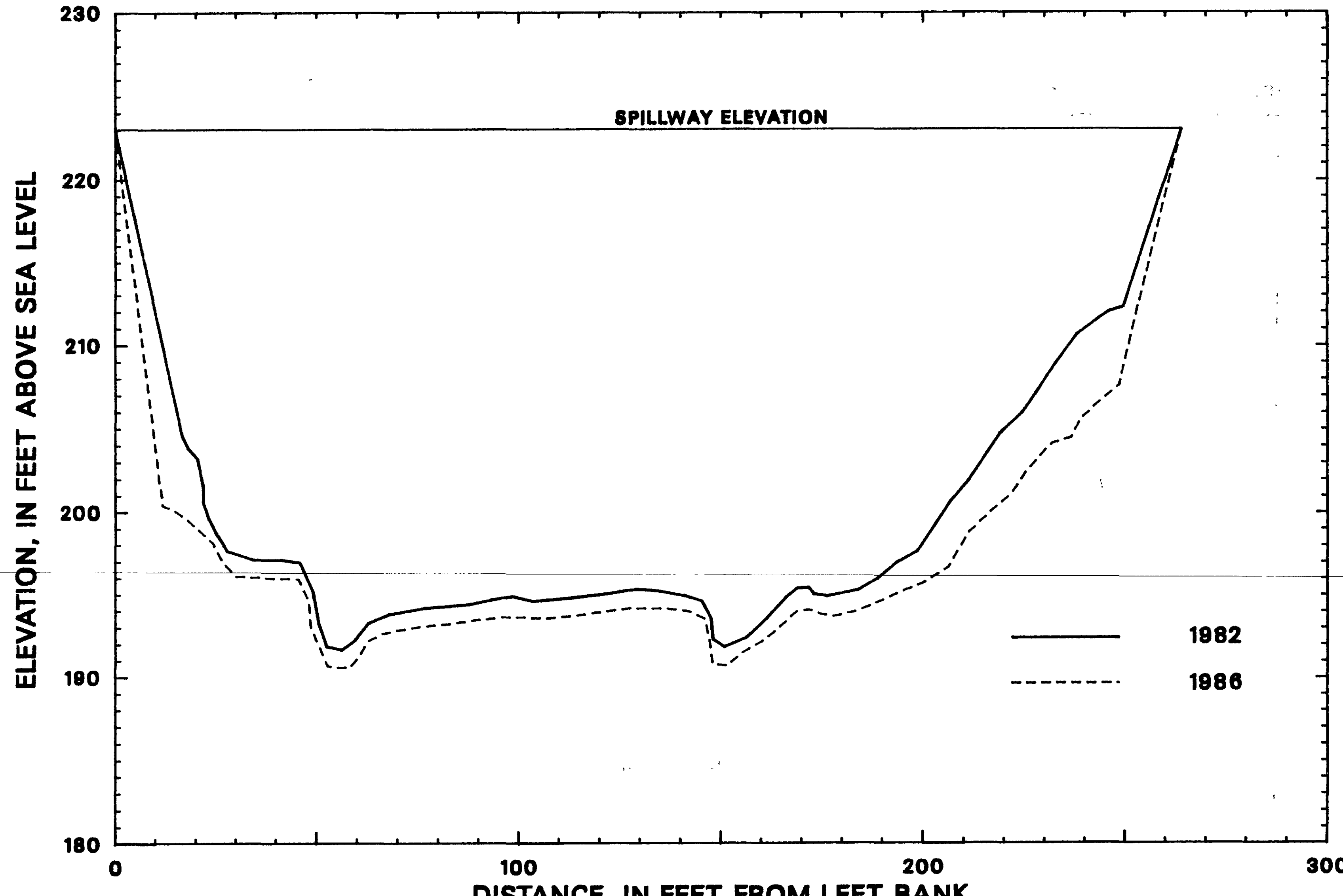

Figure 16.--Cross section TC7 in Tierce Creek basin.

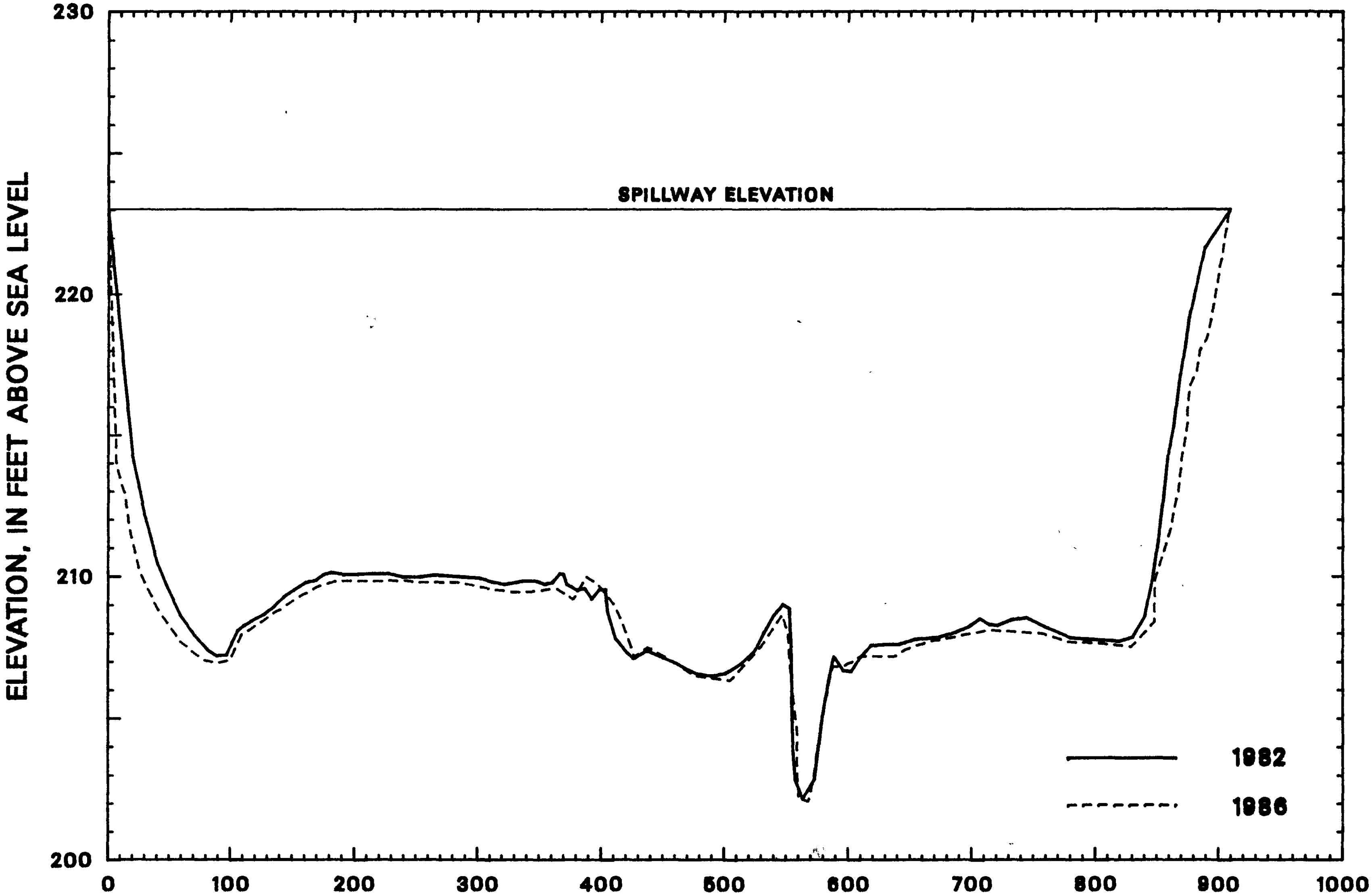

Figure 17.--Cross section TRC2 in Turkey Creek basin.

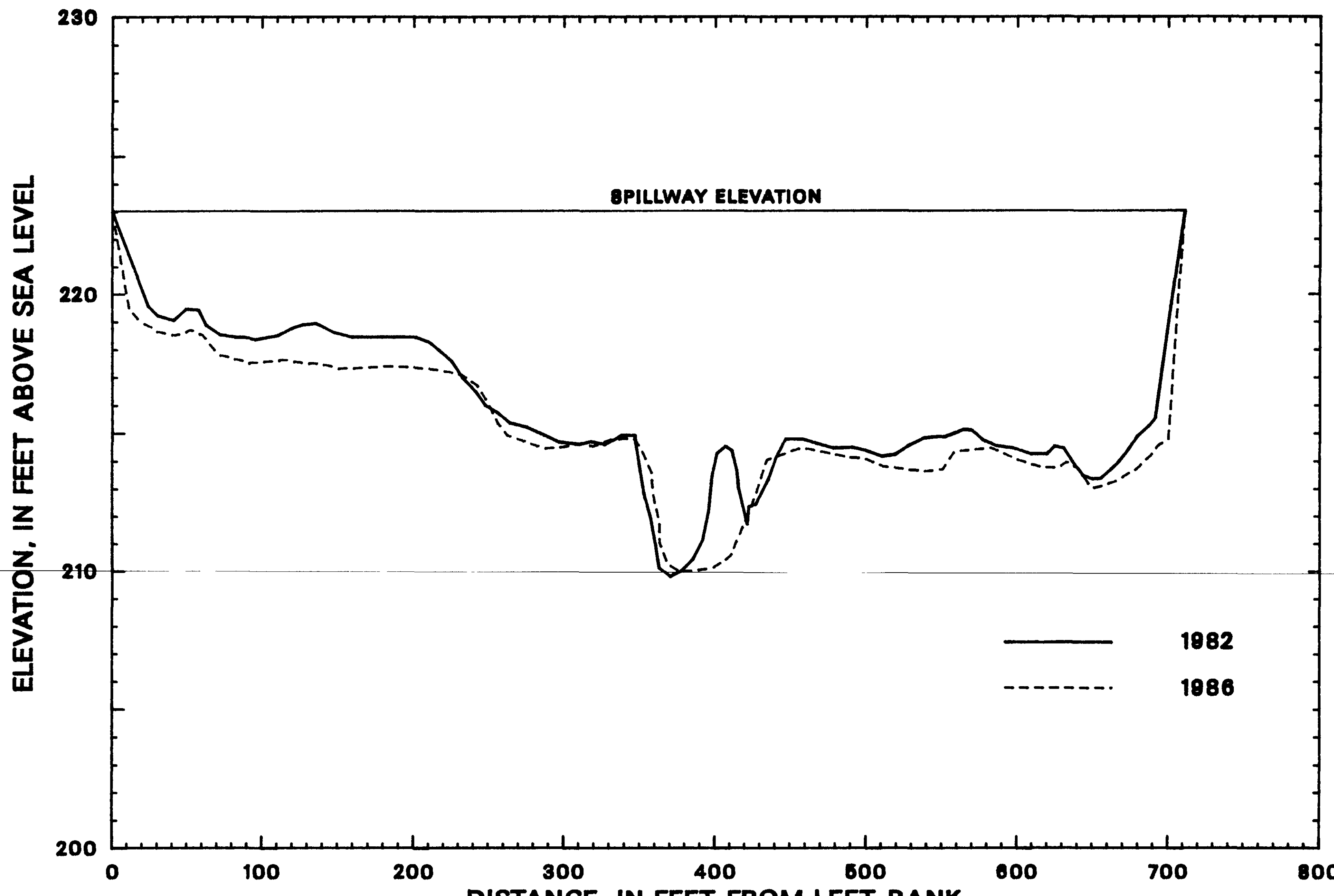

Figure 18.--Cross section TRC5 in Turkey Creek basin.