

FLOODS ON FRENCH BROAD RIVER IN NORTH CAROLINA

Tennessee Valley Authority

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IN NORTH CAROLINA

Special Report

Knoxville, Tennessee

June 1973

Tennessee Valley Authority
Division of Water Control Planning
Hydraulic Data Branch

SPECIAL REPORT ON FLOODS

FRENCH BROAD RIVER IN NORTH CAROLINA

This is a special report which relates to past floods and possible future floods on the French Broad River in North Carolina. The report was prepared at the request of the Region B Planning and Economic Development Commission through the North Carolina Office of Water and Air Resources.

The French Broad River basin covers an area of 5,124 square miles in North Carolina and Tennessee. The portion of the basin in North Carolina, shown in Plate 1, is about 70 miles long by an average 24 miles wide, with a total area of 1,664 square miles. The river has its origin along the north and west slopes of the Blue Ridge which divides the Tennessee River Basin from the Atlantic Coast drainage. The mountainous watershed in North Carolina lies within the four counties of Transylvania, Henderson, Buncombe, and Madison. Approximately 75 percent of the area is forest-covered. Elevations in the French Broad River basin range up to 6,400 feet at Potato Knob, and many peaks in the basin are more than one mile above sea level. Near the eastern edge of the basin, several peaks in the Craggy and Black Mountains rise above 6,000 feet. The elevation of the main river at the state line is 1,240 feet, at Asheville it is near 1,960 feet, and at the head of the river above Rosman it is 2,190 feet.

The French Broad River flows in a great semicircle. In the headwaters it flows in a northeasterly direction, but it curves to a northerly direction in the vicinity of Asheville, then northwesterly to the North Carolina-Tennessee state line. From the state line it flows in a general westerly direction past Newport, through Douglas Lake, and on to the confluence with the Holston River to form the Tennessee River at Knoxville, Tennessee.

The French Broad River proper begins at Rosman near the base of the Blue Ridge, 116 river miles above the state line. From Rosman to Asheville, a distance of 69 river miles, it follows a meandering course through a broad flood plain with an average channel slope of about 3 feet per mile, much flatter than is

usual for a mountain area stream. In some reaches the slope is less than one foot per mile. The wide bottoms in this reach provide substantial natural storage of floodwaters which has a significant effect on timing and height of floods at Hot Springs, which is 7 miles above the state line. This is particularly true of the floods resulting from large headwater storms such as those of July 1916, August 1928, and August 1940. The watershed between Asheville and Hot Springs, draining 620 square miles, is more mountainous and the river flows in a narrow gorge with little bottom land and steep channel slopes. The average fall from Asheville to the state line is about 16 feet per mile, with some reaches having a slope in excess of 30 feet per mile.

The character of the French Broad River basin above Hot Springs is such that damaging floods on the river can result not only from general storms which affect the whole basin but also from storms centered primarily on the part of the basin between Asheville and Hot Springs. Because of the influence of this 620-square-mile area from which runoff concentrates rapidly, flood peaks may occur at Hot Springs before they occur at Asheville. On August 30, 1940, when rainfall was heavy over this area, the crest stage at Hot Springs occurred 4 hours before that at Asheville and some 10 to 24 hours before the crest in the flat reach above Asheville. In February 1966, the crest stage occurred at 9:00 a. m. on the 13th at Rosman and at 2:30 p. m. on the 13th at Hot Springs, but at Asheville the crest stage was not reached until 7:45 p. m. on the 14th. The timing of the crest stage at various points along the river is entirely different during floods resulting from heavy rainfall in the extreme headwaters. In October 1964, the flood crested at Rosman at 1:45 p. m. on October 4, at 11:30 p. m. on October 5 at Asheville, and at 5:00 a. m. on October 6 at Hot Springs.

This study covers the entire length of the French Broad River in North Carolina, from the state line at Mile 102.03 to the head of the river at Mile 217.74. Pertinent drainage areas of the French Broad River are given in Table 1.

TABLE 1
DRAINAGE AREAS IN WATERSHED OF FRENCH BROAD RIVER

<u>Stream</u>	<u>Location</u>	<u>Mile above Mouth</u>	<u>Drainage Area sq. mi.</u>
French Broad River	Mouth	0.0	5,124
	Douglas Dam	32.28	4,541
	Tenn. -N. C. state line	102.03	1,664
	Hot Springs, U. S. Hwy. 25 & 70	108.87	1,565
	Marshall, upper bridge	125.21	1,338
	Asheville, below Swannanoa R.	149.01	934
	Brevard, U. S. Hwy. 276	196.51	156
	Rosman, head of river	217.74	66.8
Little Pigeon River	Mouth, Mile 27.40	0.0	381
Nolichucky River	Mouth, Mile 69.15	0.0	1,756
Pigeon River	Mouth, Mile 73.80	0.0	689
Spring Creek	Mouth, Mile 108.50	0.0	72.0
Big Laurel Creek	Mouth, Mile 112.46	0.0	132
Ivy Creek	Mouth, Mile 127.71	0.0	161
Sandymush Creek	Mouth, Mile 131.79	0.0	79.7
Swannanoa River	Mouth, Mile 149.01	0.0	133
Hominy Creek	Mouth, Mile 151.50	0.0	104
Cane Creek	Mouth, Mile 166.89	0.0	87.2
Mud Creek	Mouth, Mile 168.52	0.0	113
Mills River	Mouth, Mile 169.15	0.0	73.8
Little River	Mouth, Mile 187.21	0.0	60.4
Davidson River	Mouth, Mile 191.74	0.0	47.3
East Fork French Broad R.	Mouth, Mile 215.43	0.0	26.4
West Fork French Broad R.	Mouth, Mile 217.74	0.0	29.4
North Fork French Broad R.	Mouth, Mile 217.74	0.0	37.4

Since 1960, TVA has published five reports which present detailed flood investigations on streams in the vicinity of communities along the French Broad River in North Carolina. These reports, and the reach of the French Broad River covered by each, are as follows:

Floods on French Broad River and Spring Creek in Vicinity of Hot Springs, North Carolina
Mile 103.0 to Mile 111.0
July 1960

Floods on French Broad River in Vicinity of Marshall, North Carolina
Mile 124.4 to Mile 126.8
May 1960

Floods on French Broad and Swannanoa Rivers in Vicinity of Asheville, North Carolina
Mile 142.2 to Mile 151.5
December 1960

Floods on French Broad and Davidson Rivers and King, Nicholson, and Tucker Creeks in Vicinity of Brevard, North Carolina
Mile 186.8 to Mile 208.4
May 1964

Floods on French Broad River and Tributaries in Vicinity of Rosman, North Carolina
Mile 208.4 to Mile 217.7
April 1971

In addition to the above, two reports have been published covering reaches of the French Broad River in Tennessee. One for Knoxville covers the river from the mouth to Mile 21.4, and one for Newport covers the river from Mile 71.0 to Mile 84.0.

Past Floods

Records of river stages on the French Broad River began on September 2, 1895, when the U. S. Geological Survey established a gage at Asheville. A number of gages were installed at later dates at other sites, and at the present time there are stream gages on the river at six locations in North Carolina and three locations in Tennessee. Table 2 shows the period of record for all of the gages which have been maintained in North Carolina and for the gage near Newport, Tennessee, located 25 miles downstream from the state line. As shown, most of the gages have been maintained by the U. S. Geological Survey, but the U. S. Weather Bureau (now the National Weather Service) has maintained several of the gages. At the present time the National Weather Service publishes records from their gages at Asheville and Hot Springs. At Marshall, observations are made during periods of high stages only. Continuous records are available for the gages operated by the Geological Survey.

TABLE 2
STREAM GAGES ON THE FRENCH BROAD RIVER

<u>Gage</u>	<u>Maintained By</u>	<u>River Mile</u>	<u>Drainage Area sq. mi.</u>	<u>Period of Record</u>
at Rosman	USGS	216.45	67.9	1907-1909, 1936-
at Calvert	USGS	214.02	103	1924-1955
at Penrose	USWB	186.62	291	1917-1924
at Blantyre	USGS	183.72	296	1920-
at Bent Creek	USGS	157.75	676	1934-
at Asheville	USGS	147.33	937	1903-1922
	USWB	147.33	937	1903-1958
	USGS	145.75	945	1895-1901, 1922-
	USWB	145.75	945	1958-
at Marshall	USGS	126.70	1,332	1942-
	USWB	125.21	1,338	1902-1903, 1917-1931, 1934-
at Hot Springs	USGS	109.20	1,563	1934-1949
	USWB	108.92	1,565	1934-
nr Newport, Tenn.	USGS	77.48	1,858	1900-1905, 1920-

To supplement the records from the stream gages, a flood history investigation was made by TVA in 1937. Local residents were interviewed for dates and heights of floods, and newspaper files were searched as were historical documents and records. Additional investigations were made following the large floods which have occurred since 1937. These investigations have developed a knowledge of floods on the French Broad River extending back to 1791.

In April 1791, a flood occurred on the Swannanoa River which exceeded the greatest flood on that stream since then by as much as 5 feet. Since a flood in April is likely to be caused by general rains, it is reasonable to assume that the French Broad River was also unusually high and that it may have been as high as the highest known flood on that river.

From 1791 until gage records began at Asheville in 1895, at least 10 floods occurred on the French Broad River. The greatest of the 10 occurred in 1876 and is often called the "June Freshet." It is the largest known flood on some of the tributary streams and is one of the great floods along the upper reaches of the French Broad River. In the vicinity of Brevard, it was exceeded only by the floods of July 1916 and October 1964. At Asheville, only the 1916 flood is known to be greater.

Since 1895 there have been many floods on the river, but because of the peculiar watershed characteristics mentioned previously and the variation in the distribution of rainfall, the number of floods and the order of magnitude vary at the gaging stations. When lists of the highest five floods during the period from 1895 to 1971 are compiled for each of eight stream gages from Rosman to Newport, a total of twelve different floods is listed. Only the flood of July 1916 is among the top five floods on all eight lists. At Rosman it was exceeded by the flood of October 1964, and at Newport it was exceeded by the flood of February 1902. From the mouth of East Fork French Broad River, just 2.3 miles below the head of the river, to the state line, the 1916 flood is the highest known flood on the French Broad River. Upstream from Asheville it rose 6 to 18 feet above flood stage, and at Asheville, Marshall, and Hot Springs it was 15 feet above flood stage.

Floods in August 1928 and October 1964 are listed among the top five floods at six and five stations, respectively. Both floods resulted from heavy rainfall in the upper watershed, and drop out of the top five in the lower reaches of the river. There were two floods in August 1940. The mid-August flood was similar to the 1928 and 1964 floods and was a major flood downstream to Asheville. The late August flood resulted from general heavy rainfall over the watershed and was a major flood downstream from Asheville. At Marshall and Hot Springs it was exceeded only by the 1916 flood. Floods in March 1963 and March 1965 also resulted from general rains and are among the top five floods which have occurred since 1895 at Marshall, Hot Springs, and Newport.

Detailed descriptions of most of the major floods on the French Broad River are available in the local flood reports which have been listed previously.

Flood Occurrences

In the extreme headwaters of the French Broad River and in the flat reaches upstream from Asheville, there have been about 100 floods since 1895. This is an average of six floods in five years; however, in many years no flooding occurs, while in other years flood stages may be exceeded four or five times. Floods have occurred in every month of the year in this reach of the river, and the number of floods which have occurred in the four months of July through October is about the same as the number occurring during the five winter and spring months, December through April.

At Asheville, where the slope of the stream is greater and the banks are higher, only 32 floods have occurred since 1895. Half of the floods occurred during the winter and spring months and less than 40 percent occurred during the July through October period.

From Marshall to the state line, there have been about 50 floods during the same period. About 75 percent occurred during the winter and spring months and less than 20 percent occurred during the summer and fall months. Floods rarely occur in this reach of the river during the months of May, June, September, and November.

Velocities

In the reach of the French Broad River from Asheville to the state line, it is estimated that during large floods the velocity in the channel ranges up to 15 feet per second, and in the overbank areas velocities range up to 6 feet per second. In the flat reach upstream from Asheville, velocities in the channel and overbank areas ranged up to 10 and 4 feet per second, respectively.

At Rosman and in the reach from Asheville to the state line, large floods may rise at a maximum rate of 4 to 5 feet per hour, but in the flat reach at the Blantyre gage the maximum rate of rise seldom exceeds one foot per hour. In October 1964 the river was above bankfull stage at Blantyre for almost five days. At Rosman the duration of flooding is generally less than one day, and below Asheville large floods remain above bank stage between one and two days.

Stream Profiles

Profiles of the streambed, low water surface, and for various floods have been developed for the entire length of the French Broad River. The profiles for the reach from the state line at Mile 102 to the head of the river are shown on eight plates included in this report. The reaches covered by each plate are as follow:

<u>Plate No.</u>	<u>River Miles Covered</u>
3	102 - 111
6	111 - 130
9	130 - 143
11	142 - 153
14	151 - 170
17	170 - 188
20	187 - 210
22	208 - 217.7

Maps of the reach accompany each profile plate. Because of the meandering of the river, it was necessary to use two maps to show some reaches so that 13 map plates are included.

No single flood profile extends the full length of the river in North Carolina. The profiles shown and the reach covered are as follow:

<u>Flood</u>	<u>River Miles</u>
July 16, 1916	102.0 - 195.4
August 13 and 14, 1940	151.5 - 188.0
August 30 and 31, 1940	102.0 - 153.0
October 4 to 6, 1964	142.2 - 217.7

A large number of cross sections have been made on the French Broad River. Some were obtained by the Soil Conservation Service and others by TVA in connection with special studies and investigations, for local flood reports, and some especially for this report. The locations of all of the sections are shown on both the maps and the profile plates. A complete set of these cross sections is available in the files of the Hydraulic Data Branch of TVA.

100-Year Floods

The 100-year flood is defined as a flood which would be equaled or exceeded on an average of once in a 100-year period. It would have a one percent chance of occurring in any given year. Floods of this magnitude are often used as a guide in developing flood plain areas.

A study was made of gage records maintained on the French Broad River and a statistical determination was made of the 100-year flood discharge. Table 3 lists the stream gages on the river and the 100-year flood discharge at each gage. For comparison, the discharges, known or estimated, are also shown for the floods of 1916, 1940, and 1964.

As shown in the table, the peak discharge of the 100-year flood is greater than the peak discharge of the historical floods at the Rosman and Calvert gages, but at the gages farther downstream in North Carolina, the peak discharge of the 1916 flood is greater than that of the 100-year flood. At Newport, Tennessee, the 100-year flood is slightly greater than the 1916 flood, but it is less than the 1902 flood.

TABLE 3

100-YEAR FLOOD DISCHARGE ON FRENCH BROAD RIVER

<u>Stream Gage</u>	<u>River Mile</u>	<u>Flood Peak Discharge in cfs</u>				
		<u>100-Year</u>	<u>July 1916</u>	<u>Mid-Aug. 1940</u>	<u>Late Aug. 1940</u>	<u>Oct. 1964</u>
at Rosman	216.45	18,000	11,000	9,040	9,410	13,500*
at Calvert	214.02	21,500	18,000*	12,300	9,380	16,800
at Blantyre	183.72	35,000	50,700*	20,800	10,900	30,000
at Bent Creek	157.75	47,000	95,000*	23,600	18,900	30,600
at Asheville	145.75	68,000	110,000*	31,800	34,800	36,200
at Marshall	126.70	78,000	110,000*	36,500	70,000	34,100
at Hot Springs	108.92	98,000	110,000*	37,100	75,900	36,000
nr Newport, Tenn.	77.48	100,000	97,000	38,000	76,300	37,800

*Maximum known flood since 1895. At Newport, the flood on February 28, 1902, had a peak discharge of 101,000 cfs.

The profile of the 100-year flood is shown on the profile plates, and the areas that would be inundated by the 100-year flood are shown on the map plates. The profile is higher than historical flood profiles from the head of the river at Mile 217.7 downstream to the mouth of Little River at Mile 187.2 by amounts ranging up to 4 feet, but averaging 2 feet. From the mouth of Little River to the Tennessee state line at Mile 102.0, the profile of the 100-year flood is lower than the 1916 flood profile, but higher than the second highest historical flood profile. It averages a little more than 3 feet below the 1916 flood, but ranges from one foot lower in the vicinity of Marshall and near the state line up to 9 feet lower in the vicinity of Long Shoals bridge near Mile 159.

The relationships between the height of the 100-year flood, the 1916 flood, and the late August 1940 flood or the October 1964 flood are shown below at important points along the river.

	Height of 100-Year Flood in Feet		
	Above or Below July 1916	Above Aug. 30, 1940	Above Oct. 1964
Rosman	+1.5		0.5
Brevard	+1		3
Asheville	-4 to -7		6
Marshall	-1	2.5	
Hot Springs	-1.5	3	

Floodways

A study of the available flood data suggests that there is a need for maintaining at least minimum "floodways" for the French Broad River. The purpose of such floodways is to assure that the waters of future high floods will be accommodated within the limits of the river and its flood plains. This suggestion is based upon two major considerations.

First, land fill, structures, and other restrictions to the flow of water placed in the river or on the flood plain could cause increased flood elevations upstream. A second consideration on the need for a floodway is that areas subject to flood are hazardous for life and property. Authorities agree that the really dangerous flood areas are those covered by 2 or more feet of water and located near the main stream where water velocities are likely to be high.

Studies have been made to delineate floodways which would be necessary to pass the waters of the 100-year flood should it occur today or in the near future. Assuming that structures and/or earth fills would be built to cover the entire fringe area just outside these floodways, a most unlikely condition, the 100-year flood could be contained without increasing the height of the flood more than about one foot. These floodways are shown on the 13 flooded area maps.

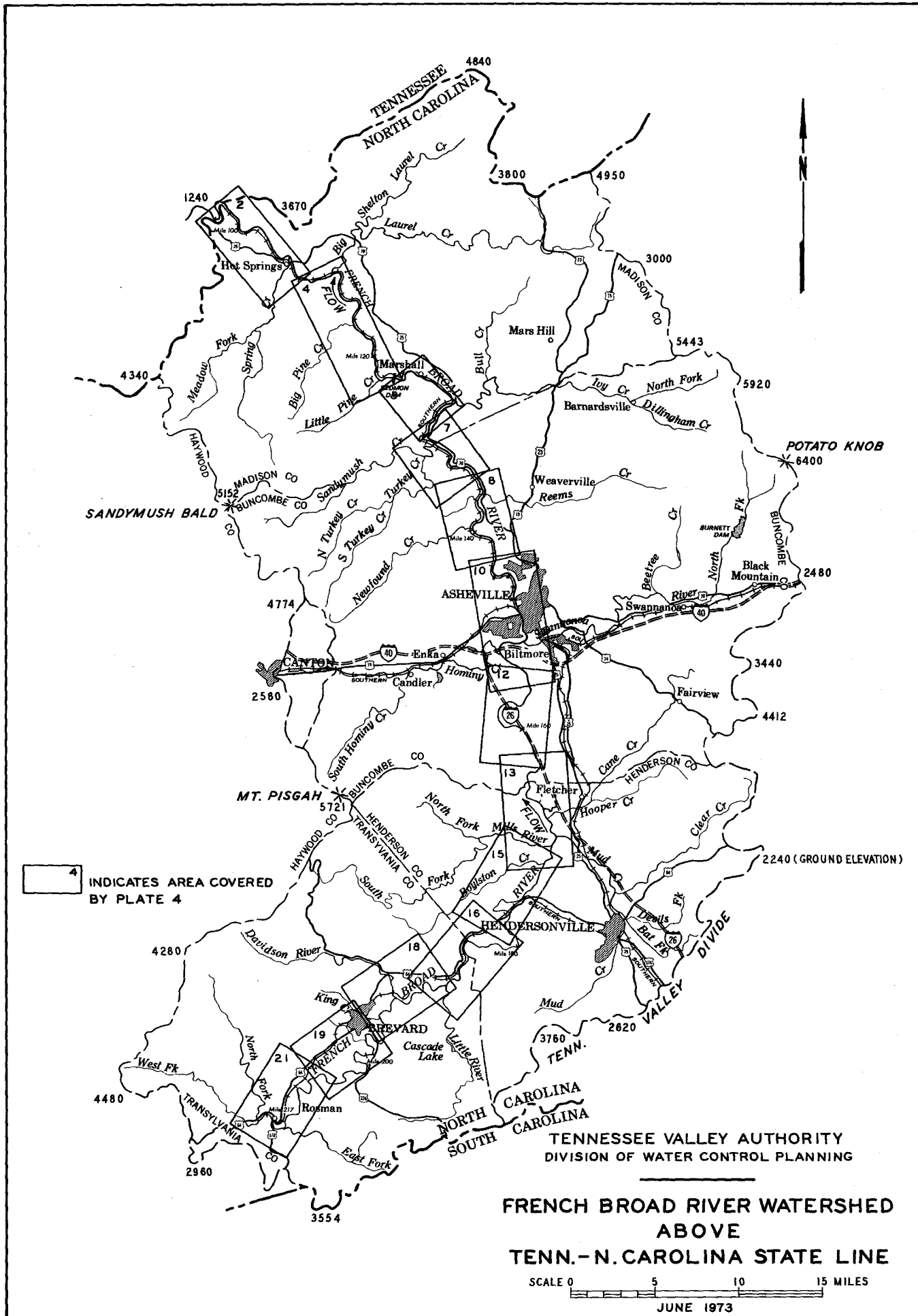
Possible Larger Floods

Although the 100-year flood is frequently used for planning purposes, it should be remembered that larger floods are possible and could occur at any time.

As discussed previously, the 1916 flood exceeds the 100-year flood by amounts ranging up to 9 feet in the reach from the mouth of Little River downstream to the state line.

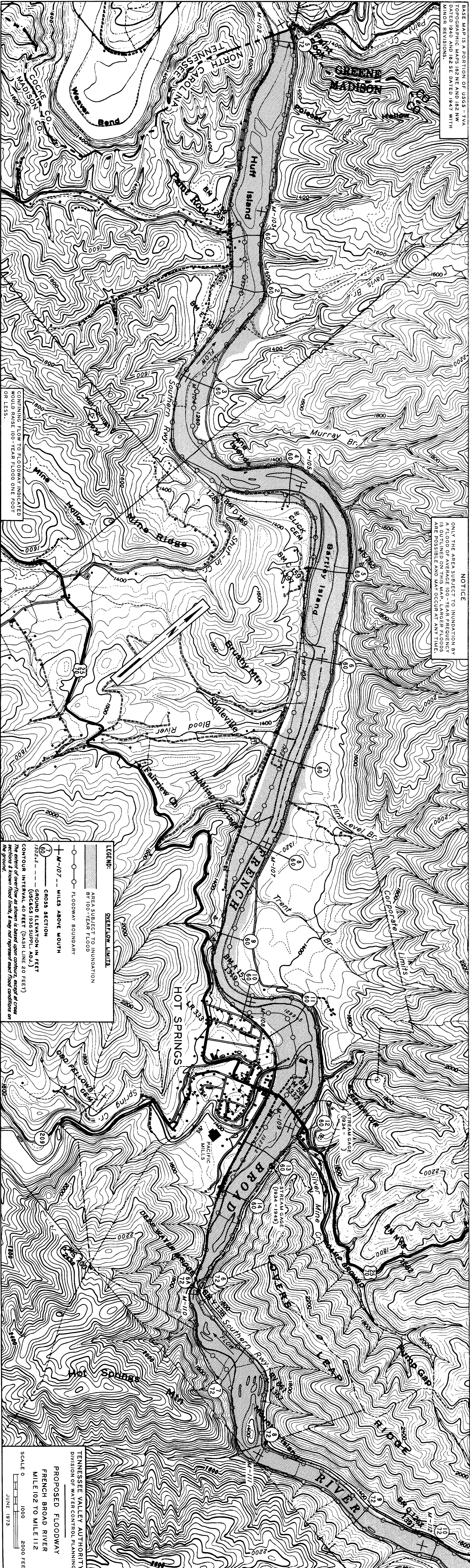
Regional Floods are computed on the basis of known floods that have occurred on a stream or nearby streams with similar watersheds. They are discussed in detail in the local flood reports which have been published for communities along the French Broad River. At Asheville, Marshall, and Hot Springs, the Regional Flood is the same or slightly greater than the 1916 flood, but is 1 to 8 feet higher than the 100-year flood. At Rosman and Brevard the Regional Flood is 3 and 5 feet, respectively, higher than the 1916 flood.

Maximum Probable Floods are also discussed in the local flood reports. Such a flood represents the reasonable upper limits of expected flooding, and along the French Broad River, it would exceed the 100-year flood by amounts ranging from 6 feet at Rosman to 17 feet at Marshall.



BASE MAP IS A PORTION OF USGS - TVA TOPOGRAPHIC MAPS 182 NE AND 182 NW DATED 1940 AND 182 SE DATED 1947 WITH MINOR REVISIONS.

NOTICE
 ONLY THE AREA SUBJECT TO INUNDATION BY FLOOD OF AVERAGE 100-YEAR FREQUENCY IS OUTLINED. OTHER FLOOD FREQUENCIES ARE POSSIBLE AND MAY OCCUR AT ANY TIME.



CONFINING FLOW TO FLOODWAY INDICATED WOULD RAISE 100-YEAR FLOOD ONE FOOT OR LESS.

LEGEND:

- OVERTFLOW LIMITS
- AREA SUBJECT TO INUNDATION BY 100-YEAR FLOOD
- FLOODWAY BOUNDARY
- M-107 — MILES ABOVE MOUTH
- CROSS SECTION
- GROUND ELEVATION IN FEET (USG&S 1936 SUPPL. ADJ.)
- CONTOUR INTERVAL 40 FEET (DASH LINE 20 FEET)

The extent of overflow as shown is based upon contours, except at cross sections & known flood limits & may not represent exact flood conditions on the ground.

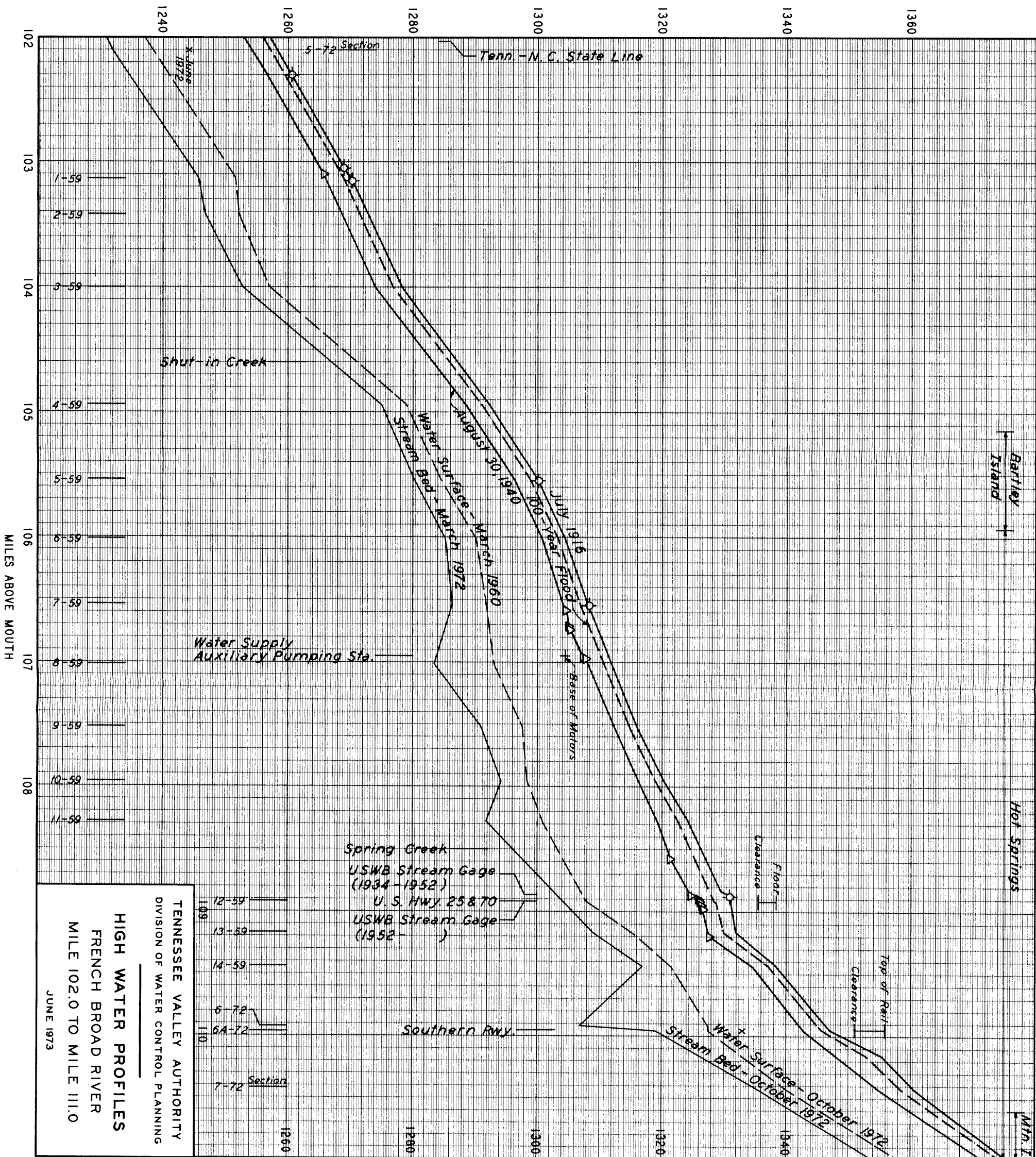
TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING

PROPOSED FLOODWAY
 FRENCH BROAD RIVER
 MILE 102 TO MILE 112

SCALE 0 1000 2000 FEET

JUNE 1973

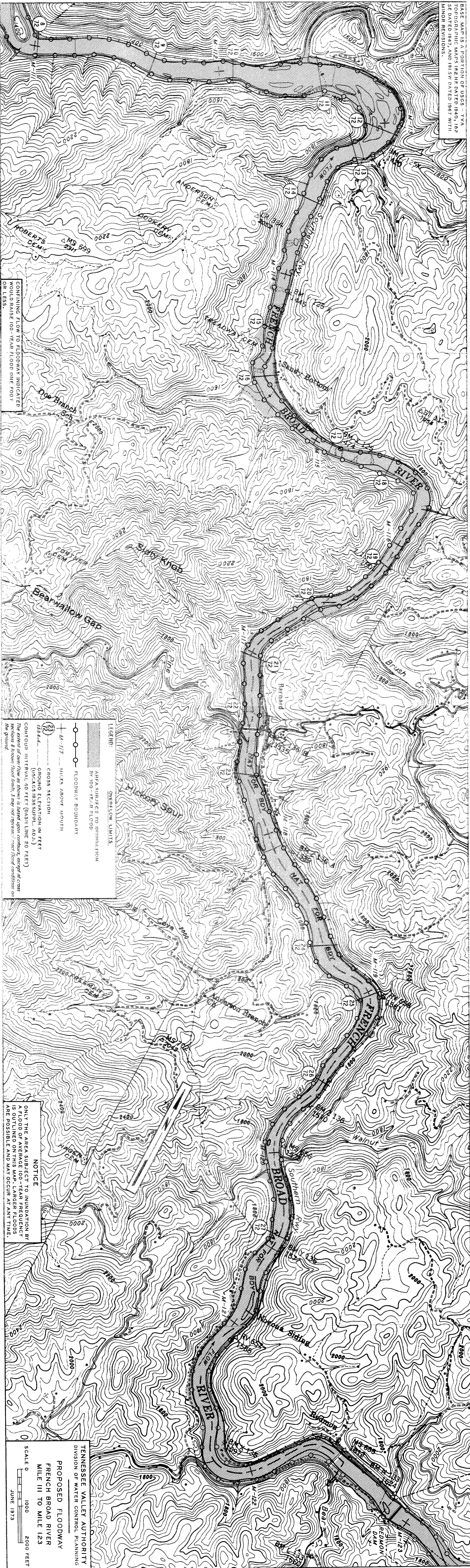
ELEVATION IN FEET (USC&GS 1936 SUPPL. ADJ.)



MILES ABOVE MOUTH

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
HIGH WATER PROFILES
 FRENCH BROAD RIVER
 MILE 102.0 TO MILE 111.0
 JUNE 1973

BASE MAP IS A PORTION OF USGS 7.5' X 7.5' TOPOGRAPHIC MAPS IN 2" SERIES DATED 1940, 1925 DATED 1947, AND 1915 DATED 1967 WITH MINOR REVISIONS.



LEGEND:

— OVERFLOW LIMITS

▨ AREA SUBJECT TO INUNDATION BY 100-YEAR FLOOD

--- FLOODWAY BOUNDARY

○—○ MILES ABOVE MOUTH

— CROSS SECTION

— GROUND ELEVATION IN FEET (USGAS 1936 SUPPL. ADJ.)

--- CONTOUR INTERVAL 40 FEET (DASH LINE 20 FEET)

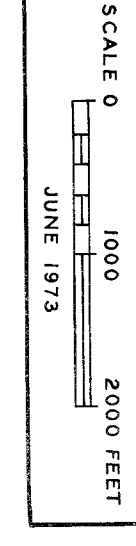
The extent of over flow as shown is based upon contours, except at curve sections & known flood plains, it may not represent exact flood conditions on the ground.

NOTICE

ONLY THE AREA SUBJECT TO INUNDATION BY A FLOOD OF AVERAGE 100-YEAR FREQUENCY IS OUTLINED ON THIS MAP. LARGER FLOODS ARE POSSIBLE AND MAY OCCUR AT ANY TIME.

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

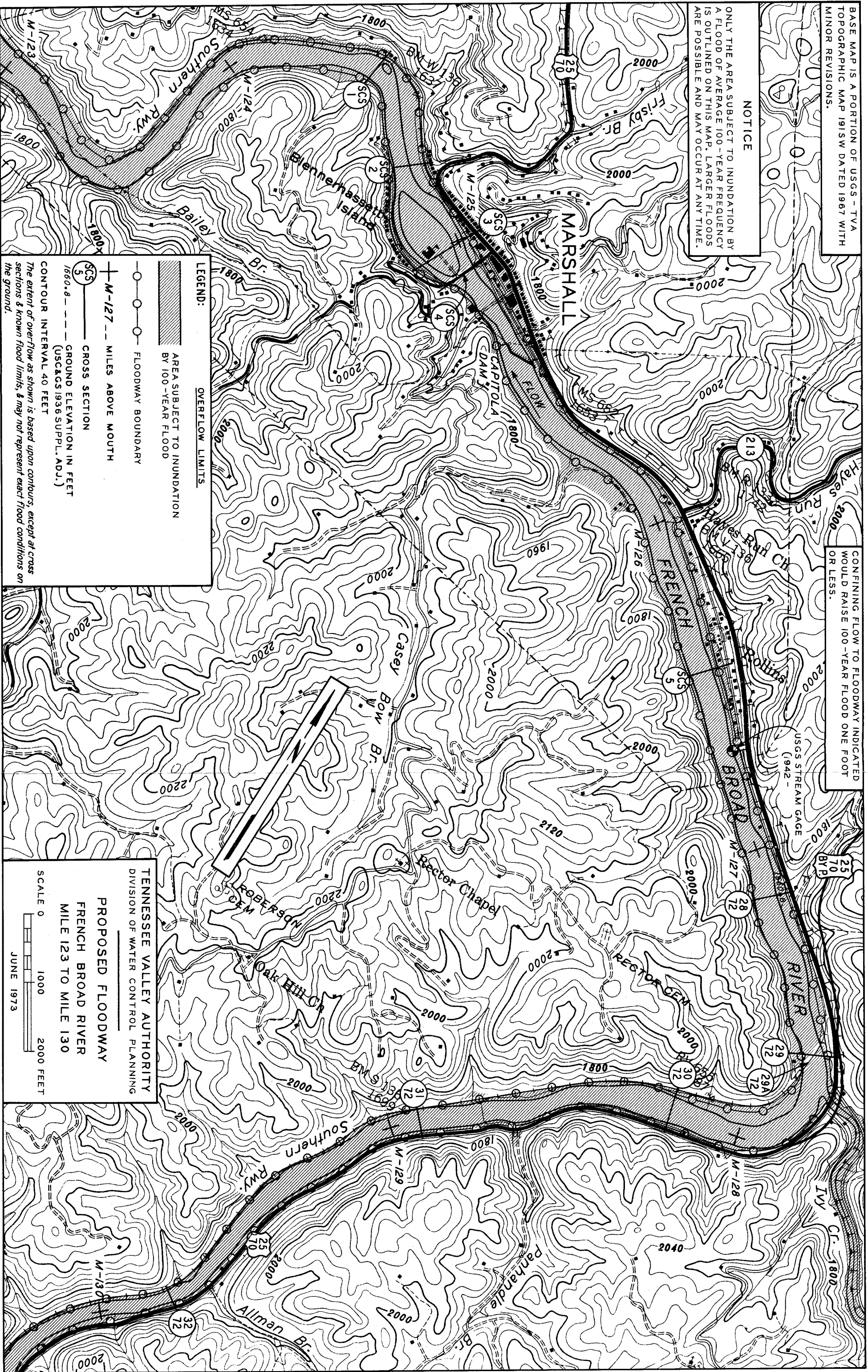
PROPOSED FLOODWAY
FRENCH BROAD RIVER
MILE III TO MILE 123



BASE MAP IS A PORTION OF USGS - TVA
 TOPOGRAPHIC MAP 1915W DATED 1967 WITH
 MINOR REVISIONS.

NOTICE
 ONLY THE AREA SUBJECT TO INUNDATION BY
 A FLOOD OF AVERAGE 100-YEAR FREQUENCY
 IS OUTLINED ON THIS MAP. LARGER FLOODS
 ARE POSSIBLE AND MAY OCCUR AT ANY TIME.

CONFINING FLOW TO FLOODWAY INDICATED
 WOULD RAISE 100-YEAR FLOOD ONE FOOT
 OR LESS.



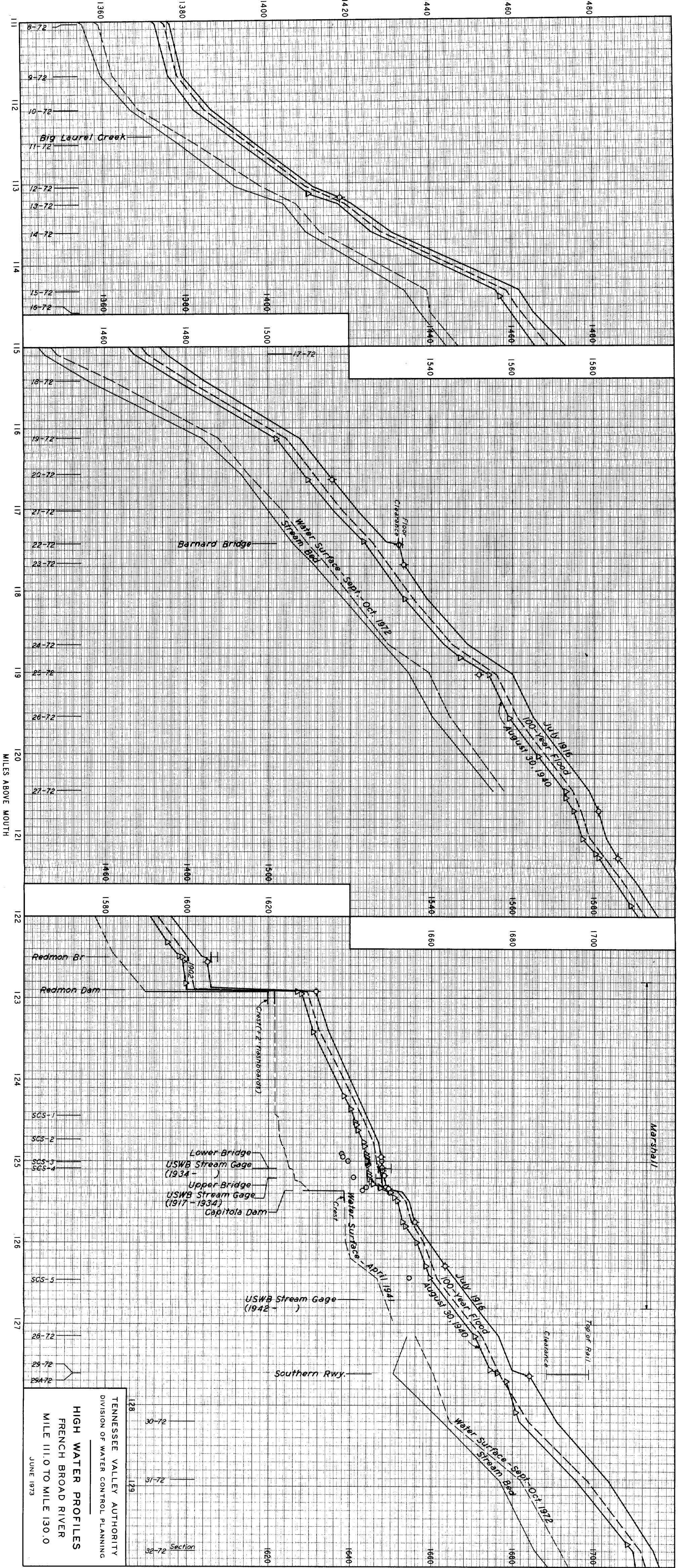
LEGEND:
 OVERFLOW LIMITS
 AREA SUBJECT TO INUNDATION
 BY 100-YEAR FLOOD
 FLOODWAY BOUNDARY
 M-127 - MILES ABOVE MOUTH
 CROSS SECTION
 GROUND ELEVATION IN FEET
 /660-8 - (USC&GS 1936 SUPPL. ADJ.)
 CONTOUR INTERVAL 40 FEET
 The extent of overflow as shown is based upon contours, except at cross
 sections & known flood limits, & may not represent exact flood conditions on
 the ground.

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING

PROPOSED FLOODWAY
 FRENCH BROAD RIVER
 MILE 123 TO MILE 130

SCALE 0 1000 2000 FEET
 JUNE 1973

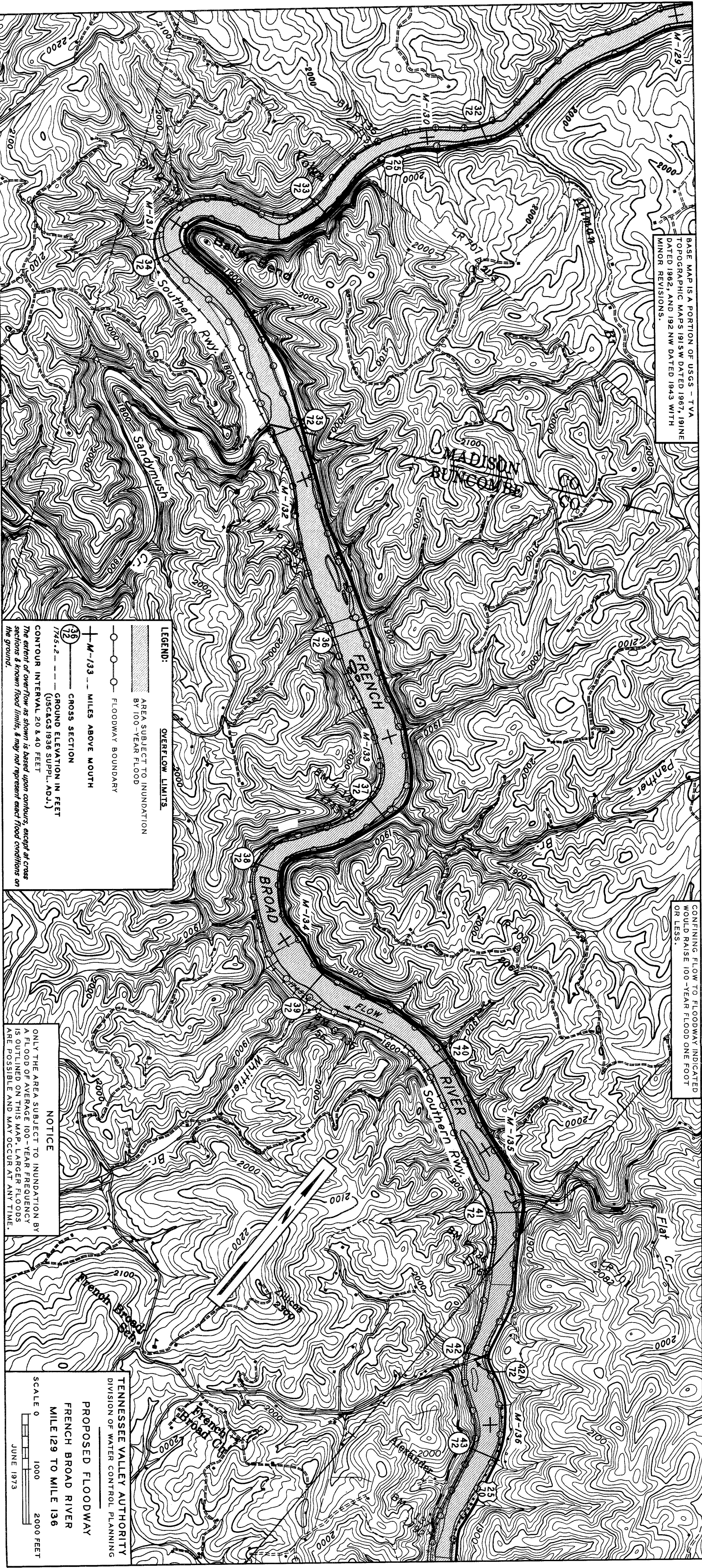
ELEVATION IN FEET (USC&GS 1936 SUPPL. ADJ.)



TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
HIGH WATER PROFILES
 FRENCH BROAD RIVER
 MILE 111.0 TO MILE 130.0
 JUNE 1973

BASE MAP IS A PORTION OF USGS - TVA
TOPOGRAPHIC MAPS 1915W DATED 1967, 191NE
DATED 1962, AND 192 NW DATED 1943 WITH
MINOR REVISIONS.

CONFINING FLOW TO FLOODWAY INDICATED
WOULD RAISE 100-YEAR FLOOD ONE FOOT
OR LESS.



LEGEND:

- OVERFLOW LIMITS
- ▨ AREA SUBJECT TO INUNDATION BY 100-YEAR FLOOD
- FLOODWAY BOUNDARY
- M-133 — MILES ABOVE MOUTH
- CROSS SECTION
- GROUND ELEVATION IN FEET (USCGS 1936 SUPPL. ADJ.)

NOTICE

ONLY THE AREA SUBJECT TO INUNDATION BY A FLOOD OF AVERAGE 100-YEAR FREQUENCY IS OUTLINED ON THIS MAP. LARGER FLOODS ARE POSSIBLE AND MAY OCCUR AT ANY TIME.

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

PROPOSED FLOODWAY
FRENCH BROAD RIVER
MILE 129 TO MILE 136

SCALE 0 1000 2000 FEET
JUNE 1973

BASE MAP IS A PORTION OF USGS - TVA TOPOGRAPHIC MAPS 192 NE DATED 1962 AND 192 NW DATED 1943 WITH MINOR REVISIONS.

LEGEND:

OVERFLOW LIMITS

AREA SUBJECT TO INUNDATION BY 100-YEAR FLOOD

FLOODWAY BOUNDARY

M-139 - MILES ABOVE MOUTH

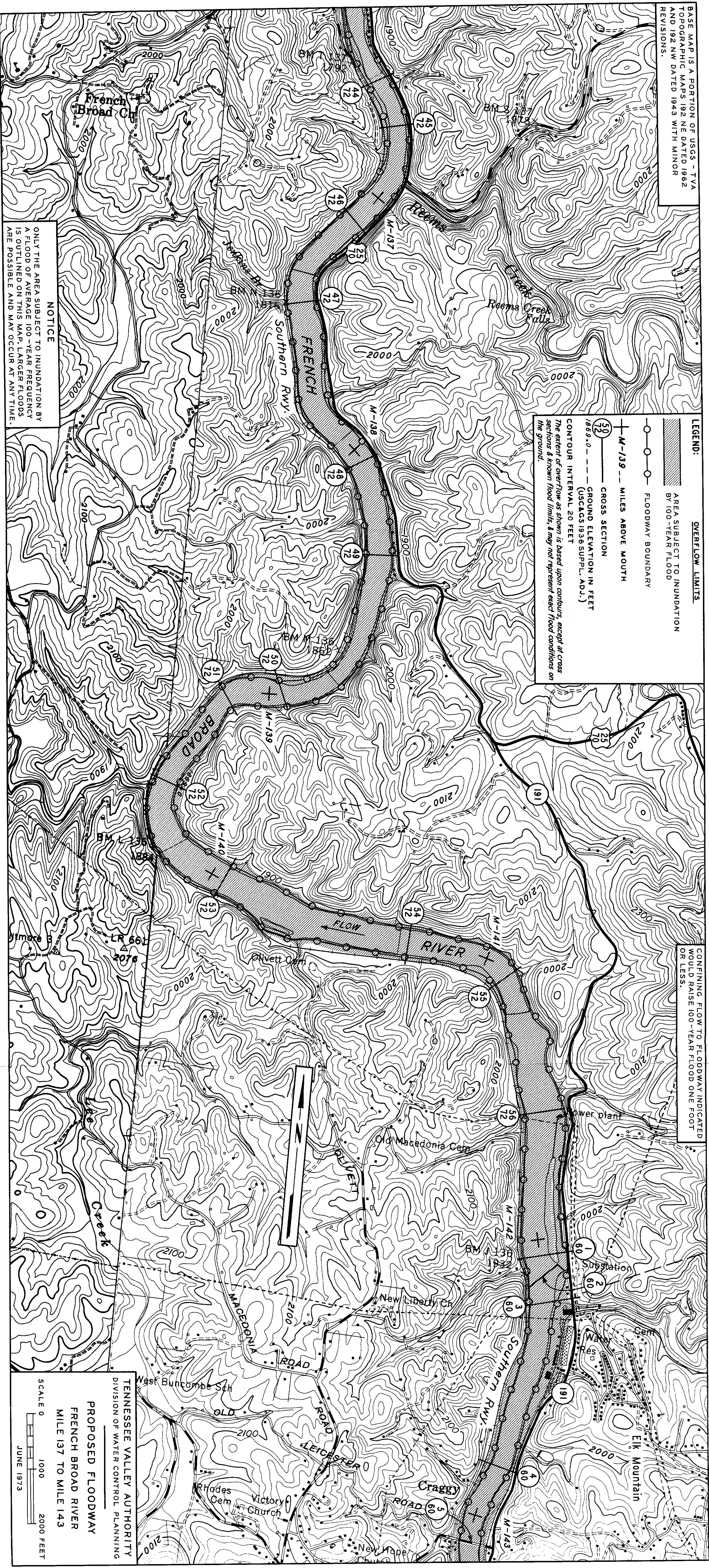
CROSS SECTION

GROUND ELEVATION IN FEET (USCGS 1936 SUPPL. ADJ.)

CONTOUR INTERVAL 20 FEET

The extent of over-flow as shown is based upon contours, except at cross sections & known flood limits, & may not represent exact flood conditions on the ground.

CONFINING FLOW TO FLOODWAY INDICATED WOULD RAISE 100-YEAR FLOOD ONE FOOT OR LESS.

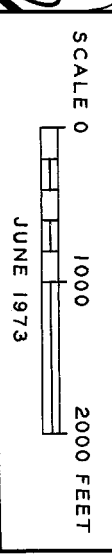


NOTICE

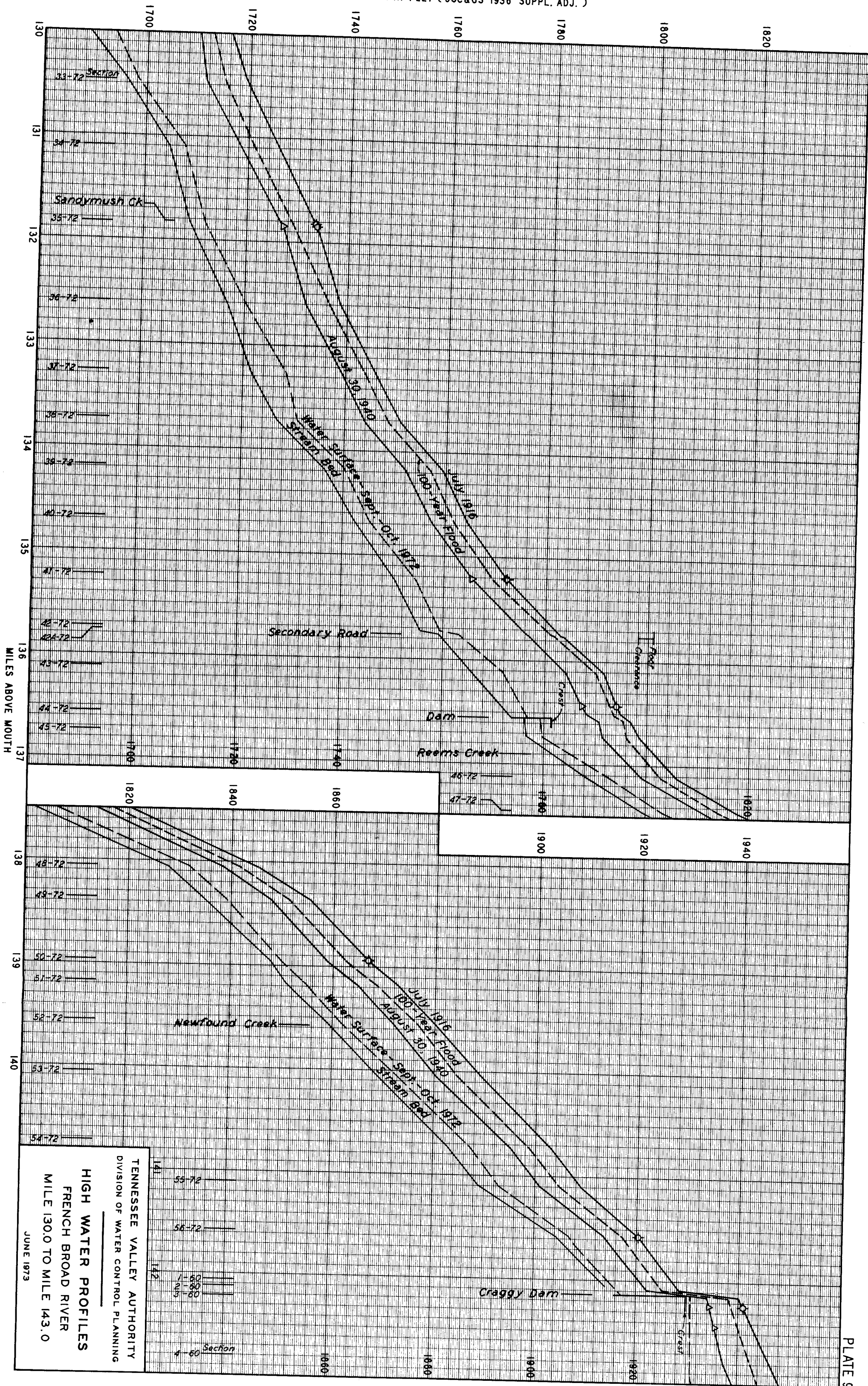
ONLY THE AREA SUBJECT TO INUNDATION BY A FLOOD OF AVERAGE 100-YEAR FREQUENCY IS OUTLINED ON THIS MAP. LARGER FLOODS ARE POSSIBLE AND MAY OCCUR AT ANY TIME.

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

PROPOSED FLOODWAY
FRENCH BROAD RIVER
MILE 137 TO MILE 143

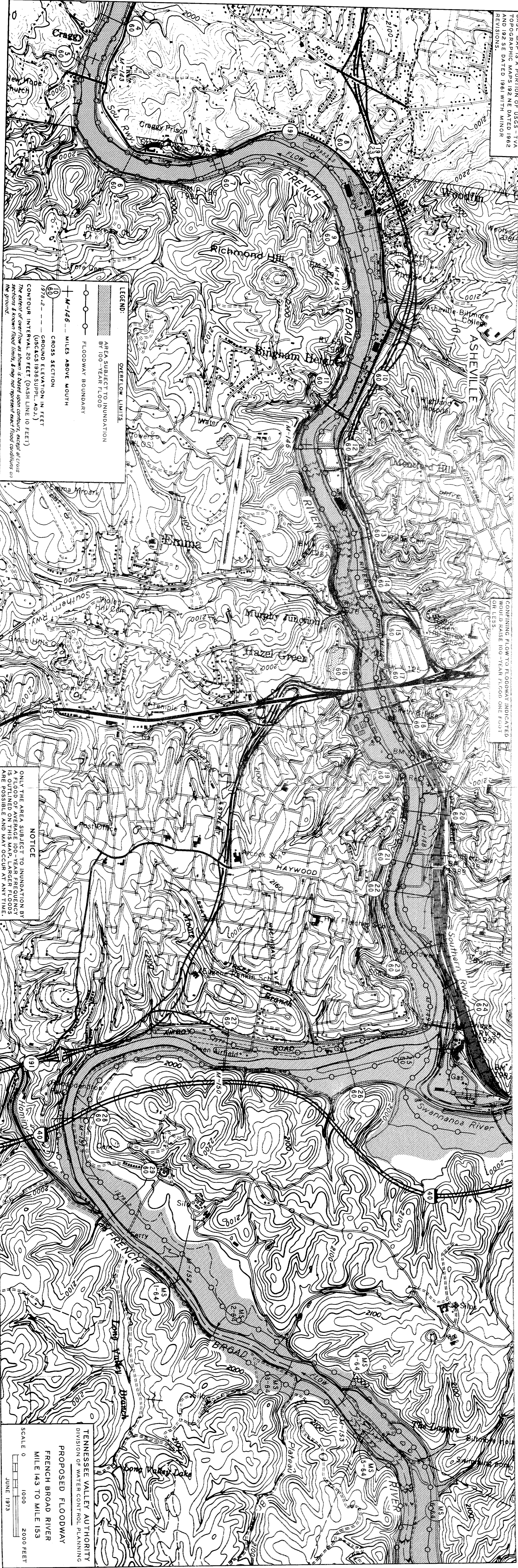


ELEVATION IN FEET (USC&GS 1936 SUPPL. ADJ.)



BASE MAP IS A PORTION OF USGS - TVA
 TOPOGRAPHIC MAPS 192 NE DATED 1982
 AND 192 SE DATED 1961 WITH MINOR
 REVISIONS.

CONFINING FLOW TO FLOODWAY INDICATED
 WOULD RAISE 100-YEAR FLOOD ONE FOOT
 OR LESS.



LEGEND:

OVERFLOW LIMITS
 AREA SUBJECT TO INUNDATION
 BY 100-YEAR FLOOD

FLOODWAY BOUNDARY

M-146 --- MILES ABOVE MOUTH

CROSS SECTION

GROUND ELEVATION, IN FEET
 1978-2 (USGS 1986 SUPPL. ADJ.)

CONTOUR INTERVAL, 20 FEET (DASH LINE 10 FEET)

The extent of overflow as shown is based upon contours, except at cross sections & known flood limits, & may not represent exact flood conditions on the ground.

NOTICE

ONLY THE AREA SUBJECT TO INUNDATION BY
 A FLOOD OF AVERAGE 100-YEAR FREQUENCY
 IS OUTLINED ON THIS MAP. LARGER FLOODS
 ARE POSSIBLE AND MAY OCCUR AT ANY TIME.

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING

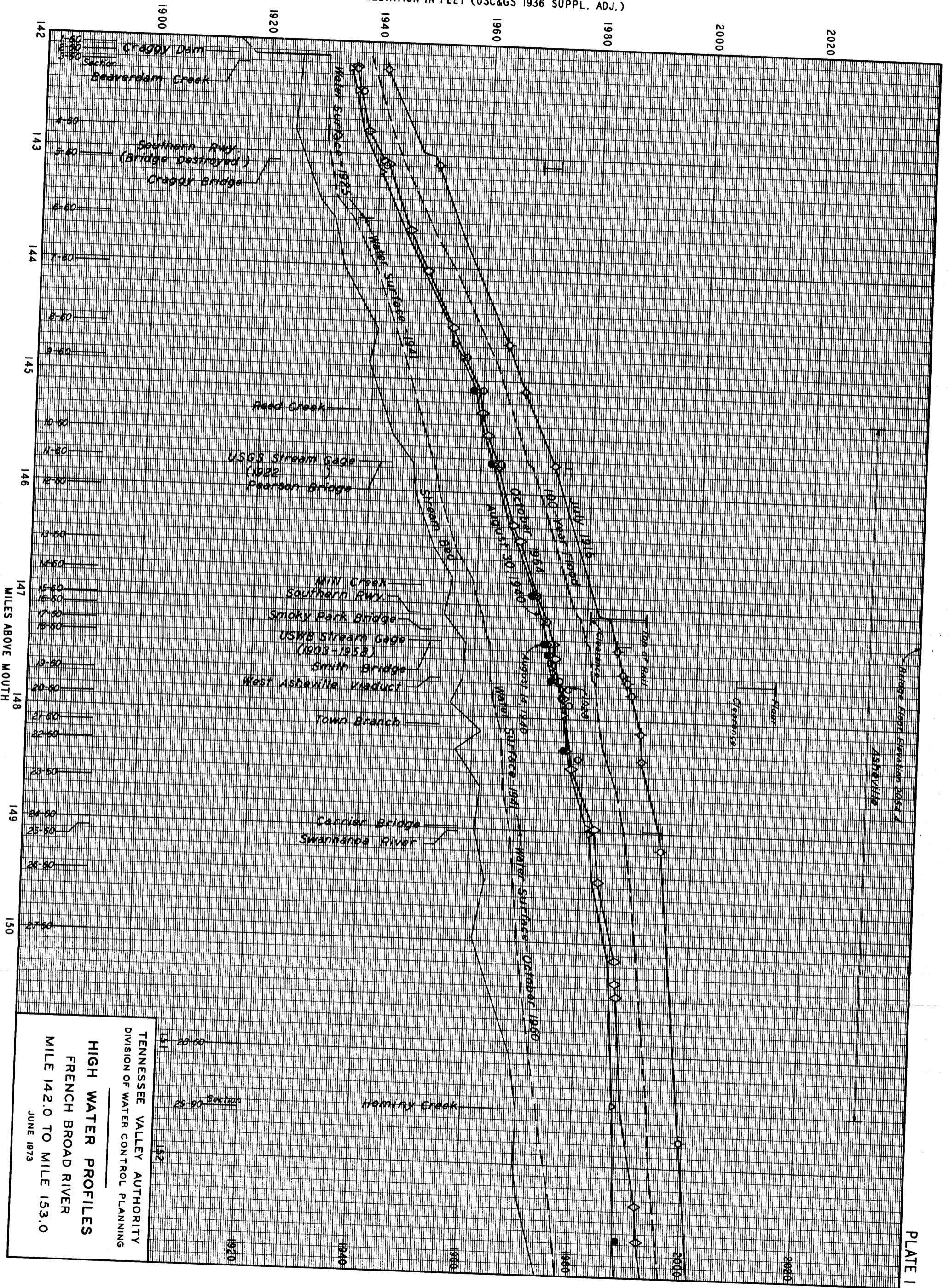
PROPOSED FLOODWAY

FRENCH BROAD RIVER
 MILE 143 TO MILE 153

SCALE 0 1000 2000 FEET

JUNE 1973

ELEVATION IN FEET (USC&GS 1936 SUPPL. ADJ.)



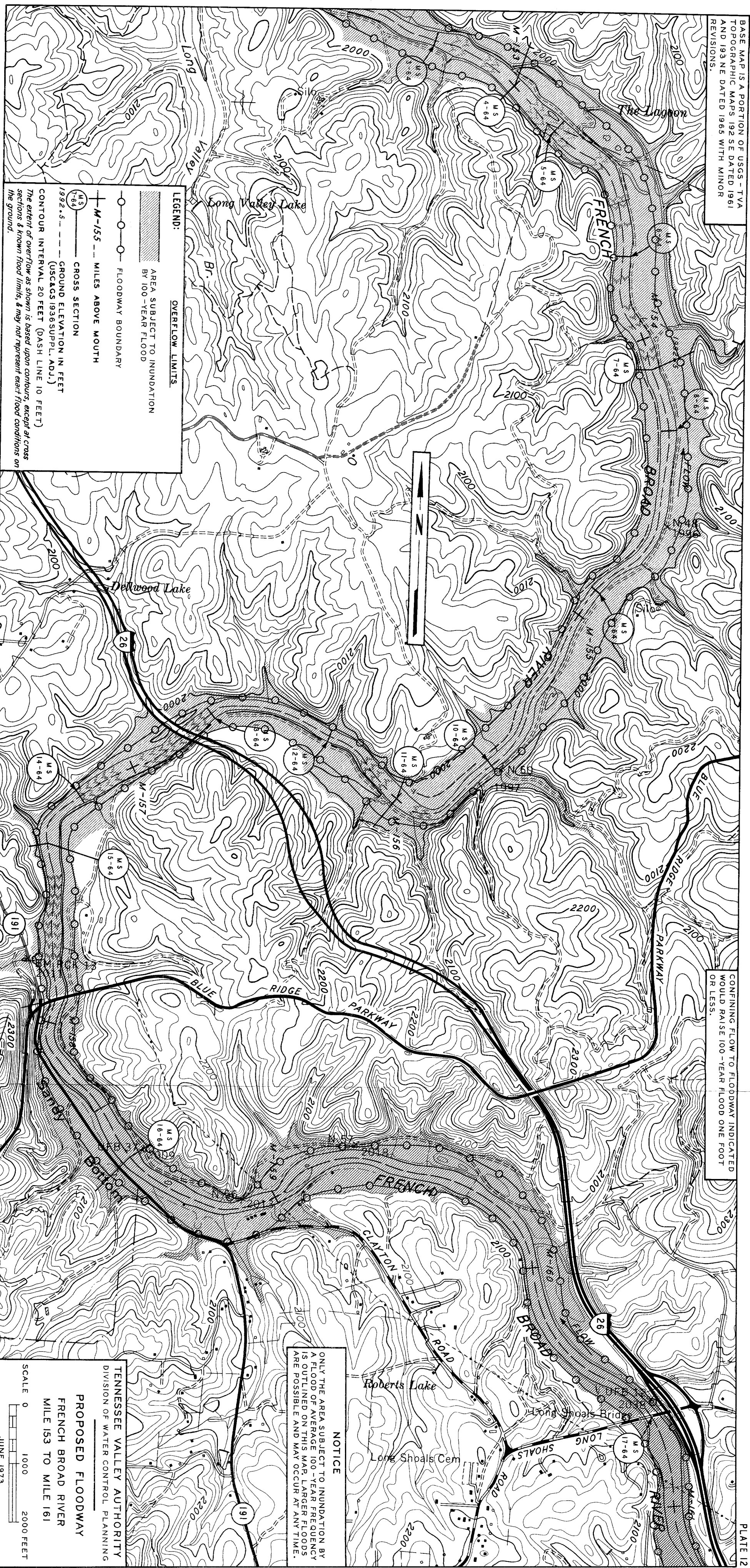
TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING

HIGH WATER PROFILES
FRENCH BROAD RIVER
 MILE 142.0 TO MILE 153.0

JUNE 1973

BASE MAP IS A PORTION OF USGS - TVA
 TOPOGRAPHIC MAPS 192 SE DATED 1961
 AND 193 NE DATED 1965 WITH MINOR
 REVISIONS.

CONFINING FLOW TO FLOODWAY INDICATED
 WOULD RAISE 100-YEAR FLOOD ONE FOOT
 OR LESS.



LEGEND:

AREA SUBJECT TO INUNDATION
 BY 100-YEAR FLOOD

OVERFLOW LIMITS

FLOODWAY BOUNDARY

M-155 - MILES ABOVE MOUTH

CROSS SECTION

GROUND ELEVATION IN FEET
 (USCGCS 1936 SUPPL. ADJ.)

CONTOUR INTERVAL 20 FEET (DASH LINE 10 FEET)

The extent of overflow as shown is based upon contours, except at cross sections & known flood limits, & may not represent exact flood conditions on the ground.

NOTICE

ONLY THE AREA SUBJECT TO INUNDATION BY
 A FLOOD OF AVERAGE 100-YEAR FREQUENCY
 IS OUTLINED ON THIS MAP. LARGER FLOODS
 ARE POSSIBLE AND MAY OCCUR AT ANYTIME.

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING

PROPOSED FLOODWAY

FRENCH BROAD RIVER
 MILE 153 TO MILE 161

SCALE 0 1000 2000 FEET

JUNE 1973

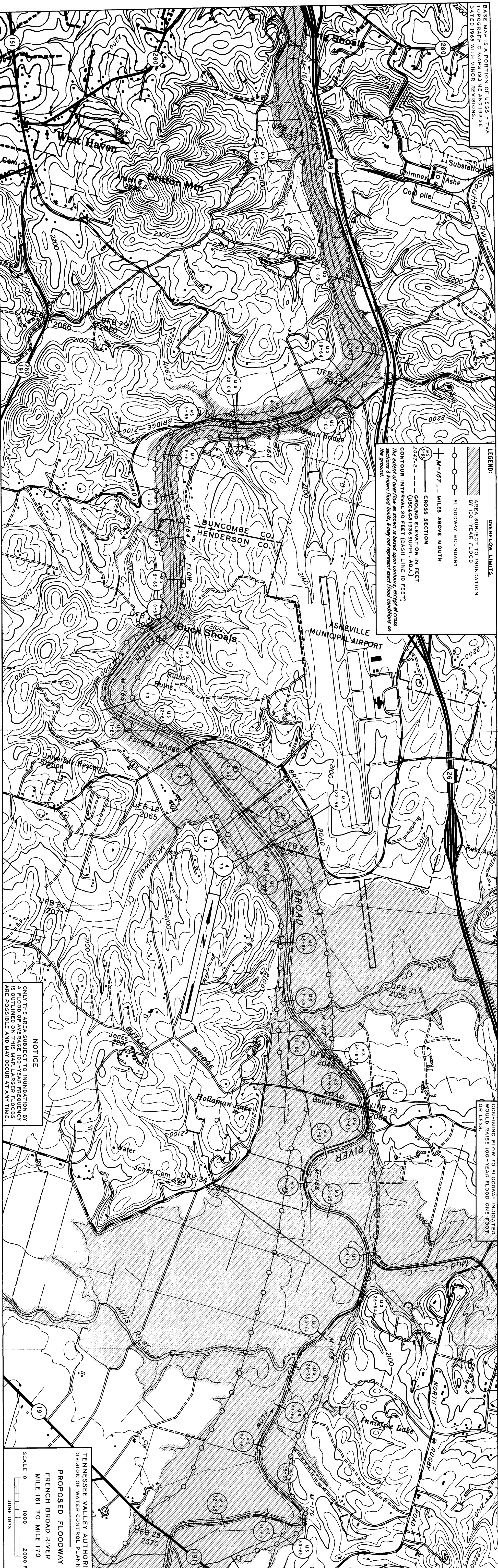
BASE MAP IS A PORTION OF USGS - TVA
 TOPOGRAPHIC MAPS 1936 AND 1935
 DATED 1965 WITH MINOR REVISIONS.

LEGEND:

- OVERFLOW LIMITS
- ▨ AREA SUBJECT TO INUNDATION BY 100-YEAR FLOOD
- FLOODWAY BOUNDARY
- M-167 — MILES ABOVE MOUTH
- CROSS SECTION
- GROUND ELEVATION IN FEET (USCGS 1936 SUPPL. ADJ.)
- CONTOUR INTERVAL 20 FEET (DASH LINE 10 FEET)

The extent of overflow as shown is based upon contours, except at cross sections & known flood limits, & may not represent exact flood conditions on the ground.

CONFINING FLOW TO FLOODWAY INDICATED
 WOULD RAISE 100-YEAR FLOOD ONE FOOT
 OR LESS.



NOTICE

ONLY THE AREA SUBJECT TO INUNDATION BY
 A FLOOD OF AVERAGE 100-YEAR FREQUENCY
 IS OUTLINED ON THIS MAP. LARGER FLOODS
 ARE POSSIBLE AND MAY OCCUR AT ANY TIME.

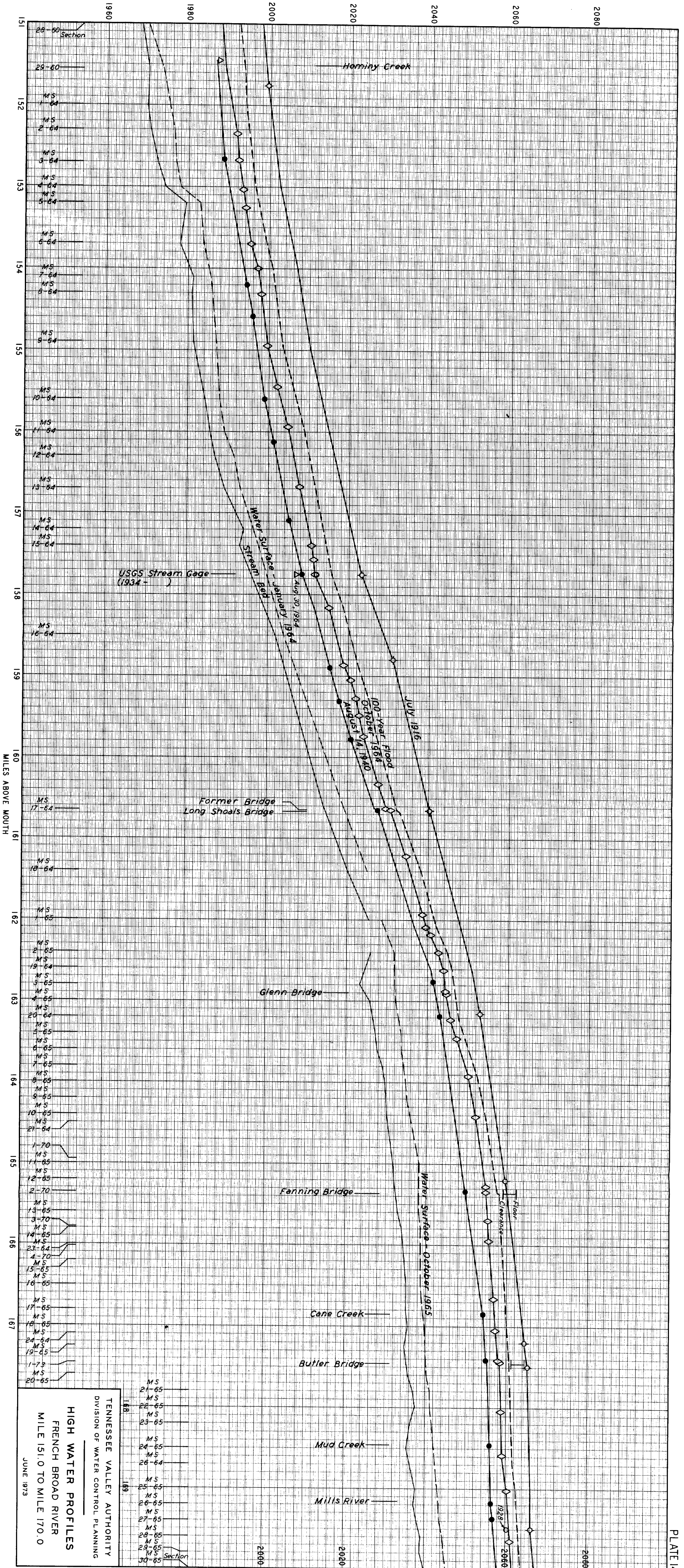
TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING

PROPOSED FLOODWAY
 FRENCH BROAD RIVER
 MILE 161 TO MILE 170

SCALE 0 1000 2000 FEET

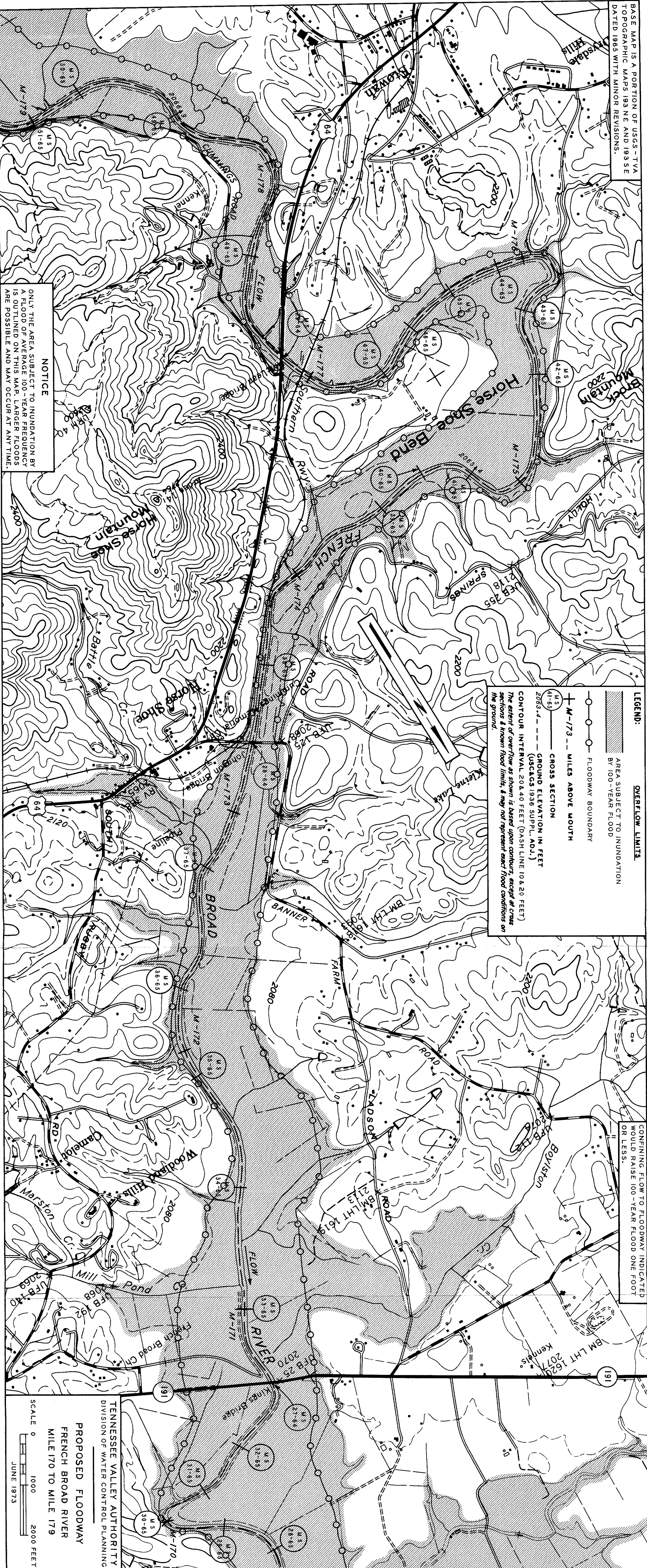
JUNE 1973

ELEVATION IN FEET (US&GS 1936 SUPPL. ADJ.)



TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
 HIGH WATER PROFILES
 FRENCH BROAD RIVER
 MILE 151.0 TO MILE 170.0
 JUNE 1973

BASE MAP IS A PORTION OF USGS - TVA
 TOPOGRAPHIC MAPS 193 NE AND 193 SE
 DATED 1965 WITH MINOR REVISIONS.



NOTICE
 ONLY THE AREA SUBJECT TO INUNDATION BY
 A FLOOD OF AVERAGE 100-YEAR FREQUENCY
 IS OUTLINED ON THIS MAP. LARGER FLOODS
 ARE POSSIBLE AND MAY OCCUR AT ANY TIME.

LEGEND:

- OVERFLOW LIMITS
- ▨ AREA SUBJECT TO INUNDATION BY 100-YEAR FLOOD
- FLOODWAY BOUNDARY
- M-173 — MILES ABOVE MOUTH
- CROSS SECTION
- GROUND ELEVATION IN FEET (USCGS 1936 SUPPL. ADJ.)
- CONTOUR INTERVAL 20 & 40 FEET (DASH LINE 10 & 20 FEET)

The extent of overflow as shown is based upon contours, except at cross sections & known flood limits, & may not represent exact flood conditions on the ground.

CONFINING FLOW TO FLOODWAY INDICATED
 WOULD RAISE 100-YEAR FLOOD ONE FOOT
 OR LESS.

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING

PROPOSED FLOODWAY
 FRENCH BROAD RIVER
 MILE 170 TO MILE 179

SCALE 0 1000 2000 FEET
 JUNE 1973

BASE MAP IS A PORTION OF
USGS - TVA TOPOGRAPHIC MAPS
193 SE AND 193 SW DATED 1965
WITH MINOR REVISIONS.

LEGEND:

- AREA SUBJECT TO INUNDATION BY 100-YEAR FLOOD
- FLOODWAY BOUNDARY
- M-182 --- MILES ABOVE MOUTH
- CROSS SECTION
- GROUND ELEVATION IN FEET (USGCS 1988 SUPPL. ADJ.)
- CONTOUR INTERVAL 40 FEET (DASH LINE 20 FEET)

The extent of overflow as shown is based upon contours, except at cross sections & known flood limits, & may not represent exact flood conditions on the ground.

CONFINING FLOW TO FLOODWAY INDICATED WOULD RAISE 100-YEAR FLOOD ONE FOOT OR LESS.

NOTICE

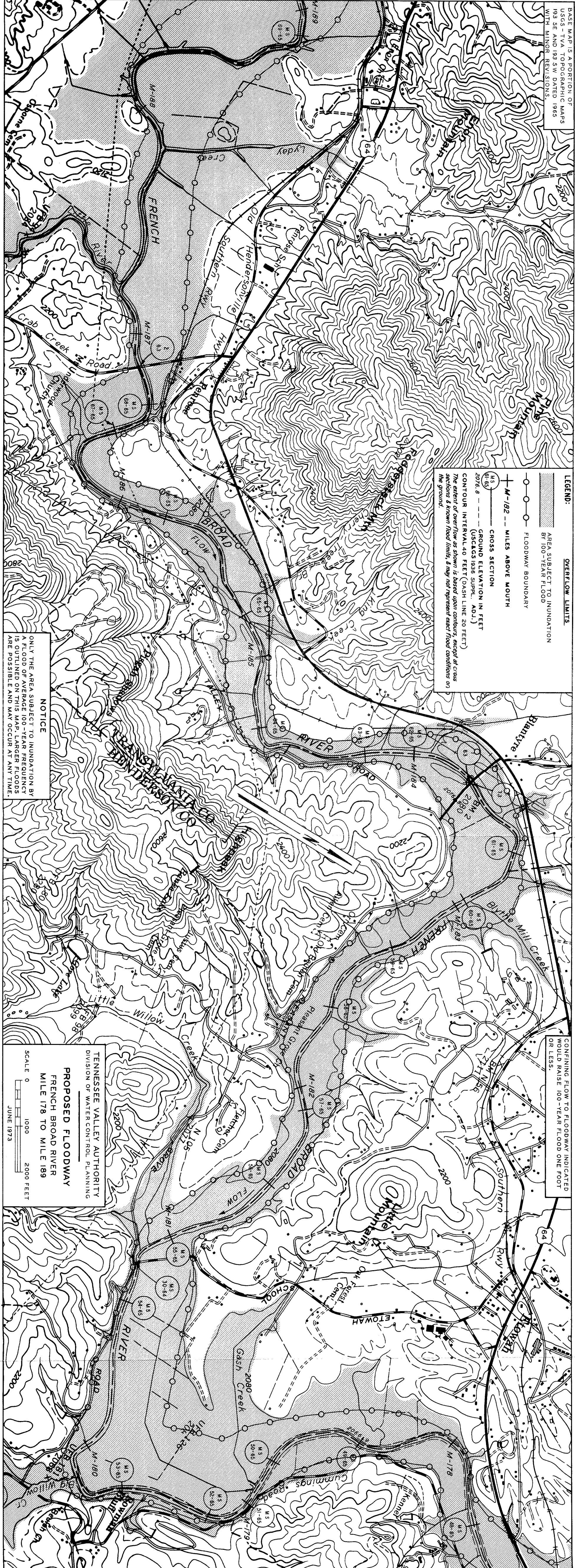
ONLY THE AREA SUBJECT TO INUNDATION BY A FLOOD OF AVERAGE 100-YEAR FREQUENCY IS OUTLINED ON THIS MAP. LARGER FLOODS ARE POSSIBLE AND MAY OCCUR AT ANY TIME.

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

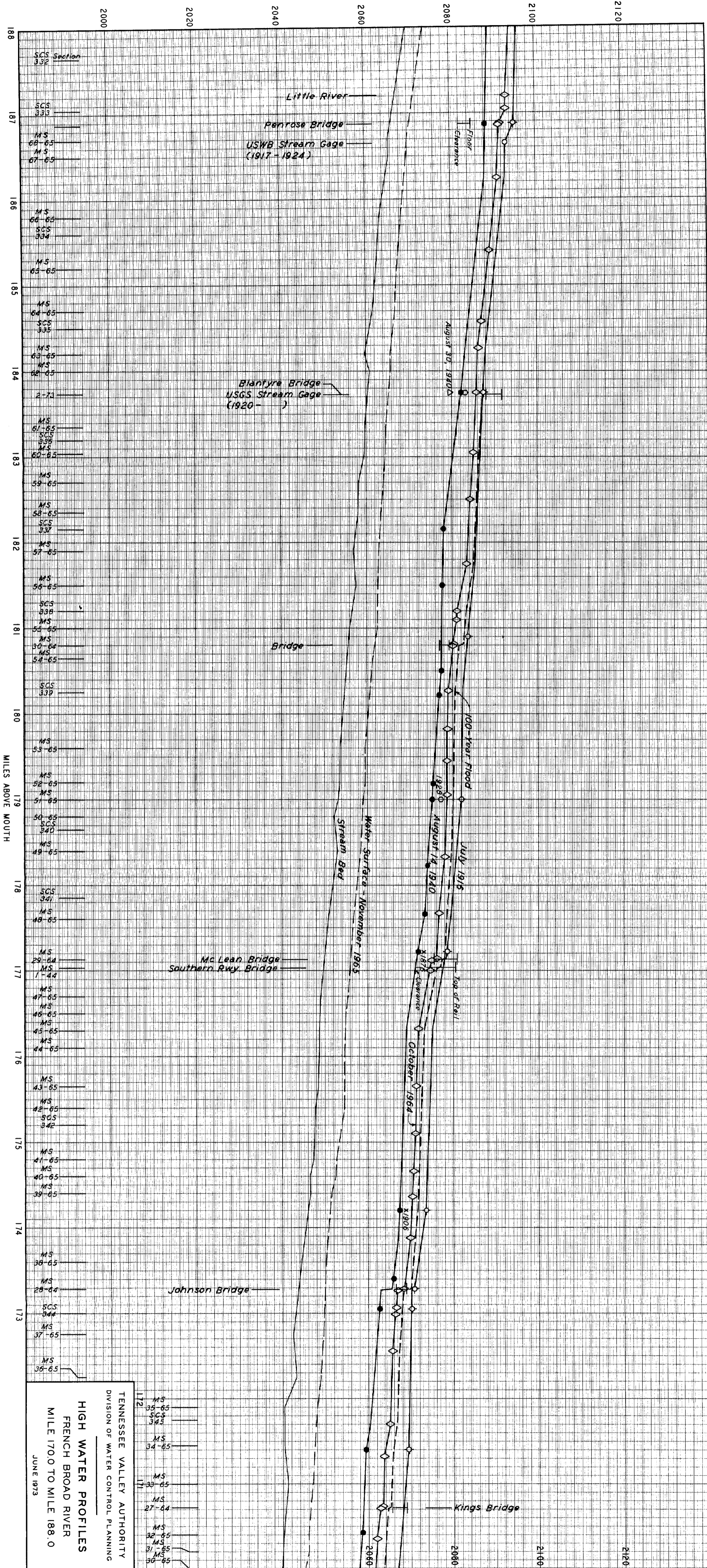
PROPOSED FLOODWAY
FRENCH BROAD RIVER
MILE 178 TO MILE 189

SCALE 0 1000 2000 FEET

JUNE 1973



ELEVATION IN FEET (USC&GS 1936 SUPPL. ADJ.)



TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
HIGH WATER PROFILES
 FRENCH BROAD RIVER
 MILE 170.0 TO MILE 188.0
 JUNE 1973

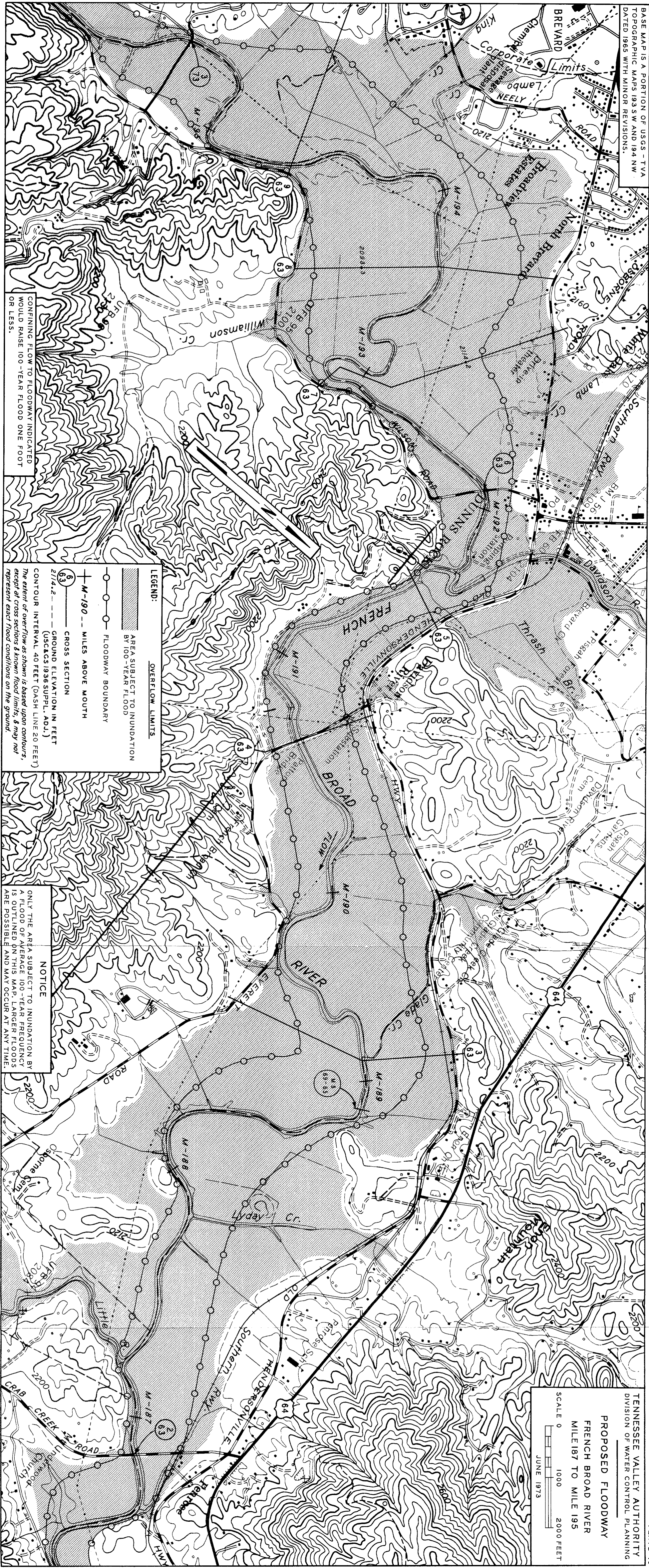
172	MS	35-65
	SCS	345
	MS	34-65
171	MS	33-65
	MS	27-64
	MS	32-65
	MS	31-65
	MS	30-65

BASE MAP IS A PORTION OF USGS - T-VA
 TOPOGRAPHIC MAPS 193 SW AND 194 NW
 DATED 1965 WITH MINOR REVISIONS.

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING

**PROPOSED FLOODWAY
 FRENCH BROAD RIVER
 MILE 187 TO MILE 195**

SCALE 0 1000 2000 FEET
 JUNE 1973



LEGEND:

OVERFLOW LIMITS
 AREA SUBJECT TO INUNDATION
 BY 100-YEAR FLOOD

FLOODWAY BOUNDARY

M-190 -- MILES ABOVE MOUTH

CROSS SECTION
 27/4.2 --- GROUND ELEVATION IN FEET
 (USGACS 1936 SUPPL. ADJ.)

CONTOUR INTERVAL 40 FEET (DASH LINE 20 FEET)
 The extent of overflow as shown is based upon contours,
 except at cross sections & known flood limits, & may not
 represent exact flood conditions on the ground.

NOTICE

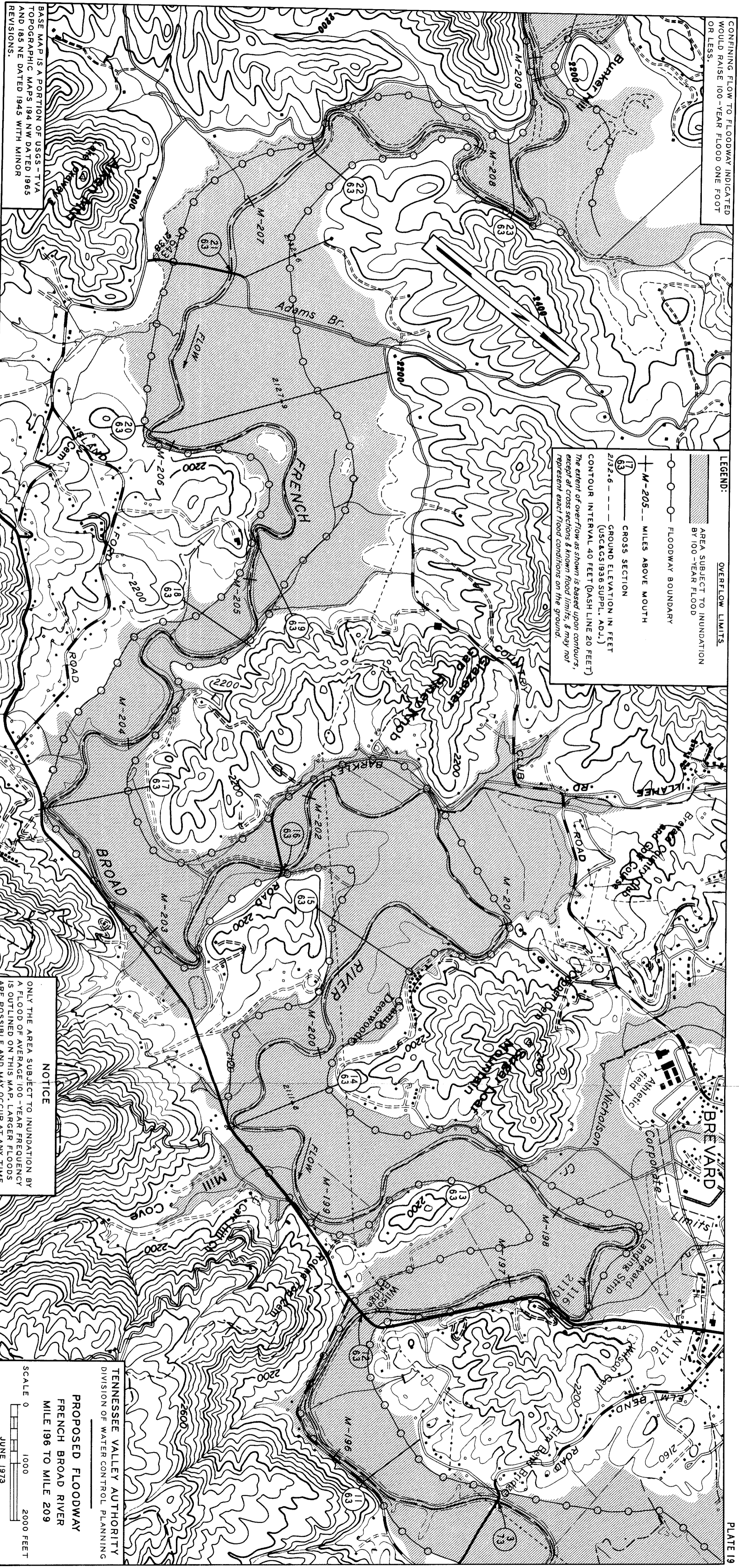
ONLY THE AREA SUBJECT TO INUNDATION BY
 A FLOOD OF AVERAGE 100-YEAR FREQUENCY
 IS OUTLINED ON THIS MAP. LARGER FREQUENCIES
 ARE POSSIBLE AND MAY OCCUR AT ANY TIME.

CONFINING FLOW TO FLOODWAY INDICATED
 WOULD RAISE 100-YEAR FLOOD ONE FOOT
 OR LESS.

CONFINING FLOW TO FLOODWAY INDICATED WOULD RAISE 100-YEAR FLOOD ONE FOOT OR LESS.

LEGEND:

- OVERFLOW LIMITS
 - ▨ AREA SUBJECT TO INUNDATION BY 100-YEAR FLOOD
 - FLOODWAY BOUNDARY
 - M-205— MILES ABOVE MOUTH
 - CROSS SECTION
 - 2132+6 — GROUND ELEVATION IN FEET (USCGS 1936 SUPPL. ADJ.)
 - CONTOUR INTERVAL 40 FEET (DASH LINE 20 FEET)
- The extent of overflow as shown is based upon contours, except at cross sections & known flood limits, & may not represent exact flood conditions on the ground.



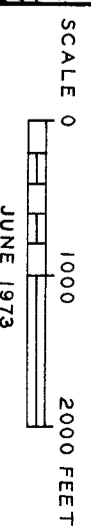
BASE MAP IS A PORTION OF USGS-TVA TOPOGRAPHIC MAPS 194 NW DATED 1965 AND 185 NE DATED 1945 WITH MINOR REVISIONS.

NOTICE

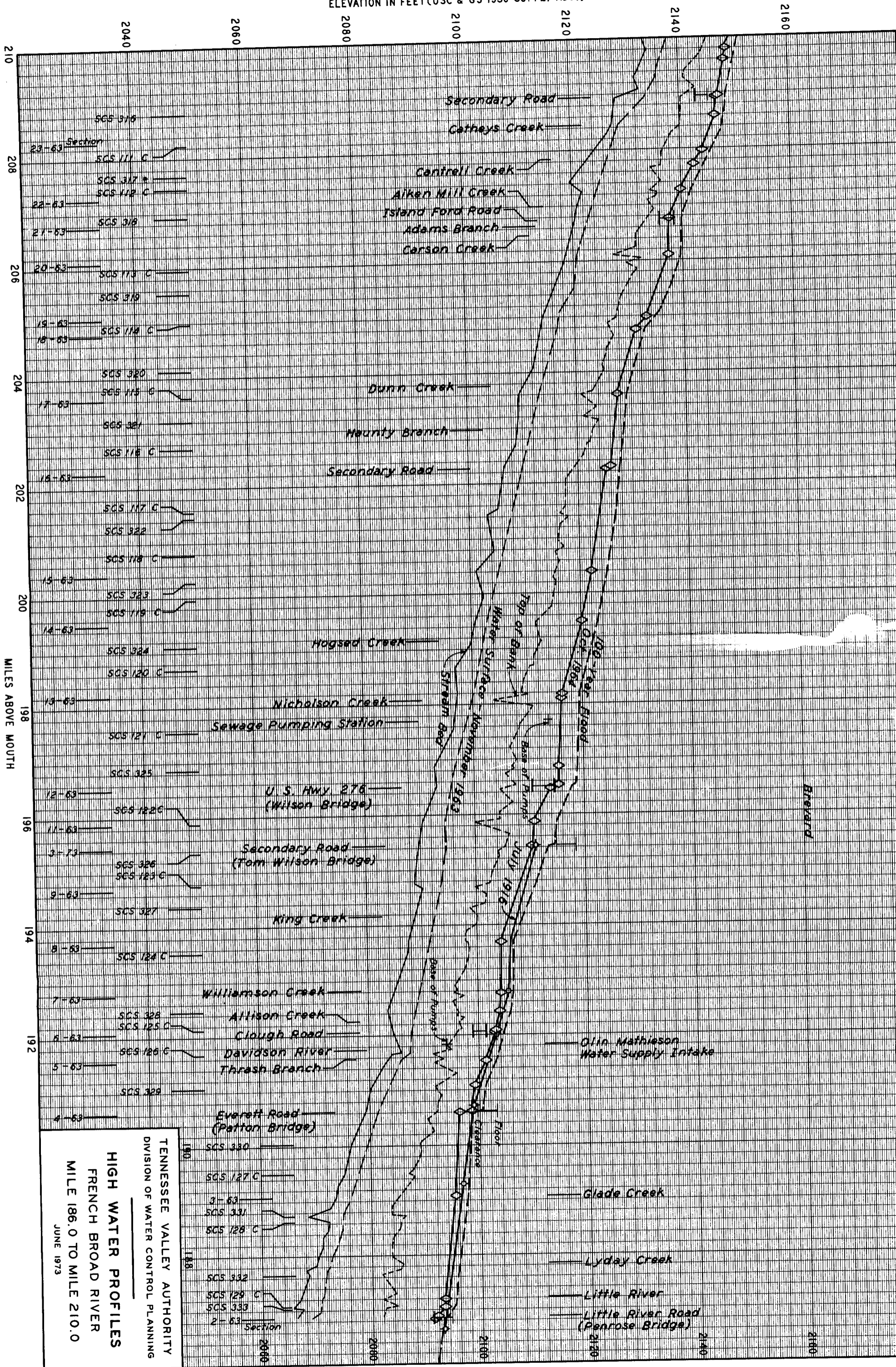
ONLY THE AREA SUBJECT TO INUNDATION BY A FLOOD OF AVERAGE 100-YEAR FREQUENCY IS OUTLINED ON THIS MAP. LARGER FLOODS ARE POSSIBLE AND MAY OCCUR AT ANY TIME.

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

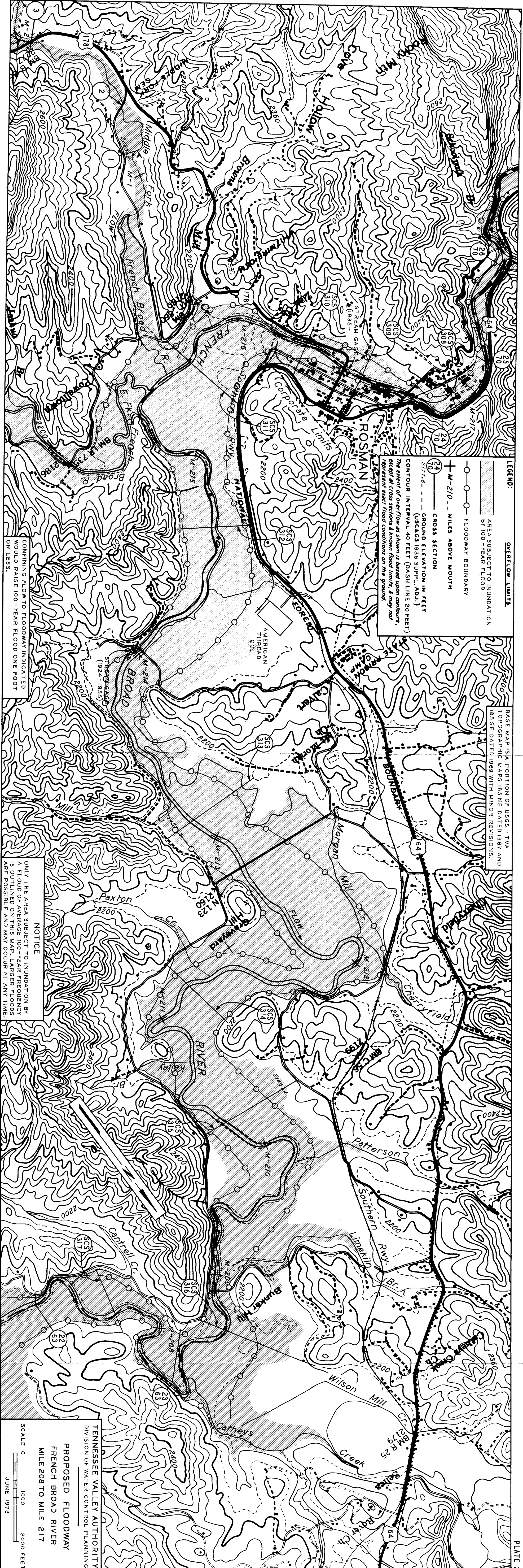
PROPOSED FLOODWAY
FRENCH BROAD RIVER
MILE 196 TO MILE 209



ELEVATION IN FEET (USC & GS 1936 SUPPL. ADJ.)



TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
HIGH WATER PROFILES
 FRENCH BROAD RIVER
 MILE 186.0 TO MILE 210.0
 JUNE 1973



LEGEND:

- OVERFLOW LIMITS
- AREA SUBJECT TO INUNDATION BY 100-YEAR FLOOD
- - - FLOODWAY BOUNDARY
- M-210 - MILES ABOVE MOUTH
- CROSS SECTION
- GROUND ELEVATION IN FEET (USC&GS 1936 SUPPL. ADJ.)
- CONTOUR INTERVAL 40 FEET (DASH LINE 20 FEET)

The extent of over-flow as shown is based upon contours, except at cross sections & known flood limits, & may not represent exact flood conditions on the ground.

BASE MAP IS A PORTION OF USGS - TVA TOPOGRAPHIC MAPS 185 NE DATED 1967 AND 185 SE DATED 1969 WITH MINOR REVISIONS.

CONFINING FLOW TO FLOODWAY INDICATED WOULD RAISE 100-YEAR FLOOD ONE FOOT OR LESS.

NOTICE

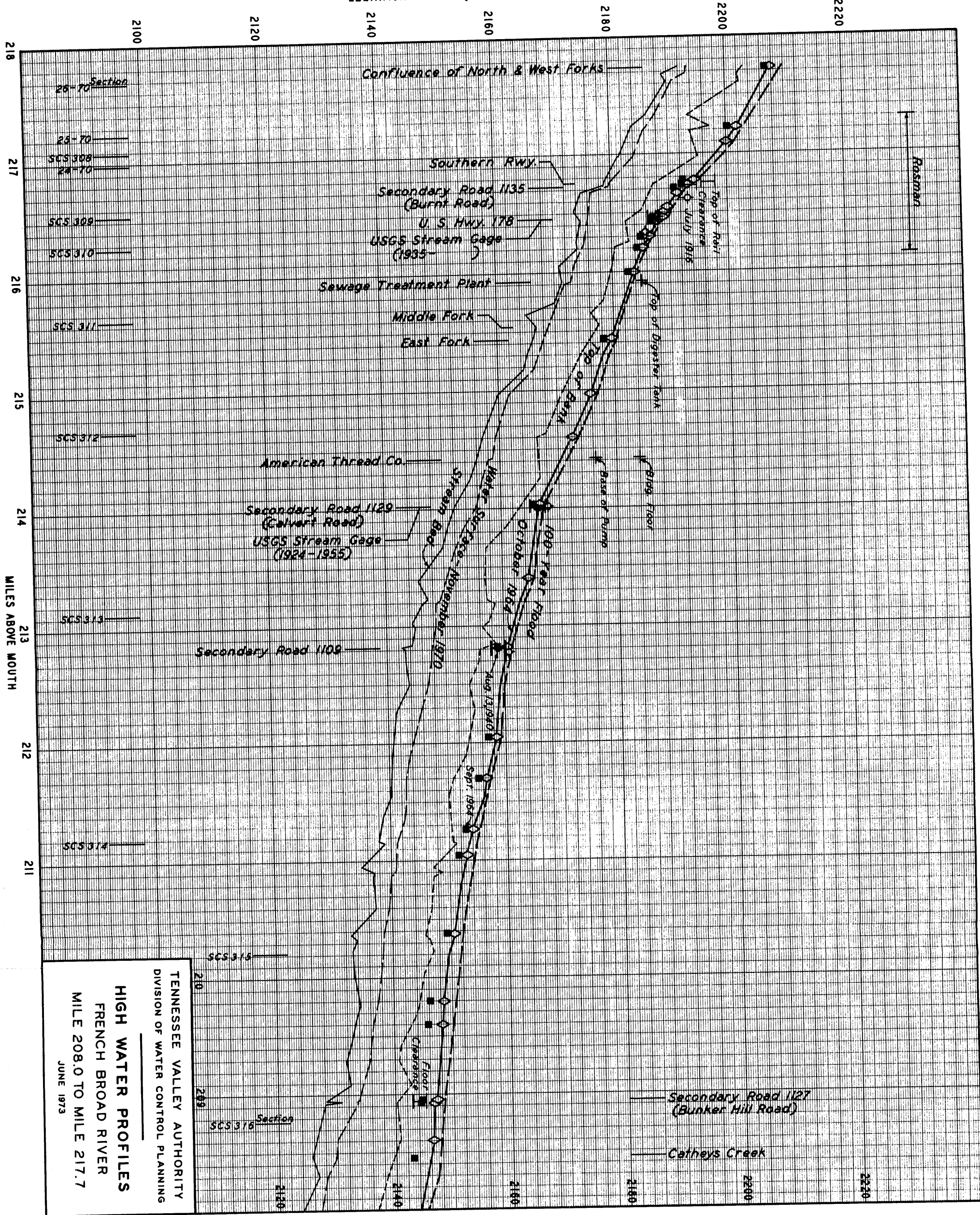
ONLY THE AREA SUBJECT TO INUNDATION BY A FLOOD OF AVERAGE 100-YEAR FREQUENCY IS OUTLINED ON THIS MAP. LARGER FLOODS ARE POSSIBLE AND MAY OCCUR AT ANY TIME.

TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

PROPOSED FLOODWAY
FRENCH BROAD RIVER
MILE 208 TO MILE 217

SCALE 0 1000 2000 FEET
JUNE 1973

ELEVATION IN FEET (USC&GS 1936 SUPPL. ADJ.)



MILES ABOVE MOUTH

TENNESSEE VALLEY AUTHORITY
 DIVISION OF WATER CONTROL PLANNING
HIGH WATER PROFILES
 FRENCH BROAD RIVER
 MILE 208.0 TO MILE 217.7
 JUNE 1973