UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HYDRAULIC ANALYSIS, PAINT CREEK AT STATE ROUTE 772, CHILLICOTHE, OHIO

by Ronald I. Mayo and William P. Bartlett, Jr.

U.S. Geological Survey

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UNITED STATES DEPARTMENT OF THE INTERIOR

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GEOLOGICAL SURVEY

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METRIC CONVERSION FACTORS

Conversion factors for inch-pound system to SI metric units

To convert from	To	Multiply by
	Length	
foot (ft)	meter (m)	0.3048
mile (mi)	kilometer (km)	1.609
	Area	
acre	hectare^2 (ha^2)	0.4047
mile^2 (mi^2)	kilometer^2 (km^2)	2.590
	Volume	
acre-foot (acre-ft)	hectometer^3 (hm^3)	0.001233
	Volume per unit time	
foot^3 per second (ft^3/s)	meter^3 per second (m^3/s)	0.02832

HYDRAULIC ANALYSIS, PAINT CREEK AT STATE ROUTE 772

Chillicothe, Ohio

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ABSTRACT

The Ohio Department of Transportation, Division of Highways, proposes to replace a three-span arch bridge across Paint Creek on South Paint Street in Chillicothe, Ohio with a new deck-type structure resting on four sets of piles and four piers. Profiles of the 10-, 25-, 50-, and 100-year floods under present conditions and under conditions modified by construction of the new bridge are presented in this report. The results indicate that the construction of the new bridge will not cause significant changes in the flood profiles or the areas inundated.

INTRODUCTION

The Ohio Department of Transportation, Division of Highways (ODOT) proposes to replace a 320-foot long three-span arch bridge on State Route 772 (South Paint Street) in Chillicothe with a 590-foot long deck-type bridge resting on four sets of piling and four piers. A hydraulic analysis of the effect of this project on the elevation of flood waters on Paint Creek upstream from the bridge was requested by ODOT. Profiles of the 10-, 25-, 50-, and 100-year frequency floods under present and modified conditions were requested for a reach of Paint Creek between the bridge and a point about 3 miles upstream (fig. 1).

The purpose of this report is to present the results of the analysis of flood profile elevations under present and modified conditions in the designated reach. All elevations in the report are referenced to the National Geodetic Vertical Datum of 1929 (NGVD of 1929).

This investigation is part of a continuing cooperative program between the Ohio Department of Transportation, Division of Highways (ODOT) and the U.S. Geological Survey (USGS).

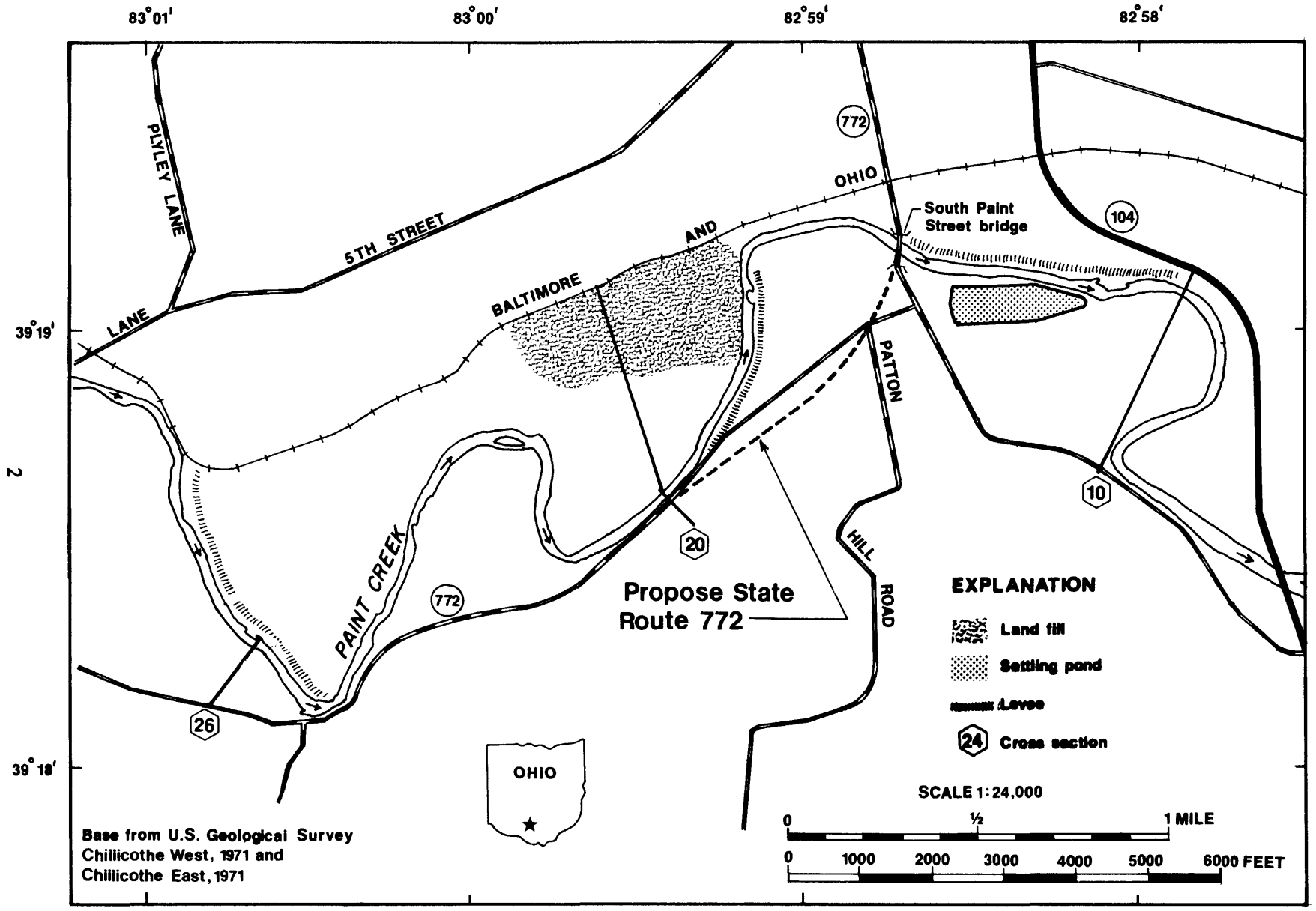

Figure 1.--Study area, Paint Creek at State Route 772, Chillicothe, Ohio.

Available Data

Cross sections at selected sites in the designated reach and a map showing the stream channel and structures were provided by ODOT from aerial and ground surveying. ODOT also furnished plans for the proposed bridge (fig. 2) and approach roadway. Cross-section data at the present three-span arch bridge were available from a study made in 1966 by the U.S. Geological Survey. The underwater cross-section elevations for sections downstream from the bridge were obtained from a low-flow study made by the Meade Paper Co. (1978).

DESCRIPTION OF AREA

The area investigated includes a reach of Paint Creek together with its adjoining flood plain in the vicinity of the South Paint Street (State Route 772) bridge in Chillicothe, Ohio. The step-backwater model used starts at a rating section (section 10), 4,000 feet downstream from the bridge, and ends at section 26, about 21,000 feet upstream from the bridge (fig. 1). In this reach the channel makes long gentle meanders in a 3,000-foot wide flood plain. The last meander upstream from the bridge encompasses a flood plain on the right bank of about 260 acres which has been lightly developed for residential use. This flood plain segment is partly protected by a levee along an arc of the channel between river distance 10,160 feet (section 20) and river distance 6,600 feet (fig. 1). Only lower magnitude floods (those having less than a 10-year frequency) are diverted from the flood plain by this levee. Prior to the operation of Paint Creek dam (fig. 3), for flood-control in 1974, this area was flooded every few years.

The road leading to the present bridge and that designed for the new structure are low-level roads generally at about the elevation of the land they cross.

The right bank flood plain downstream from the bridge contains large settling ponds built by the Meade Paper Co. A landfill of about 80 acres extends along the left bank flood plain between points 2,000 feet and 5,000 feet upstream from (west of) the bridge.

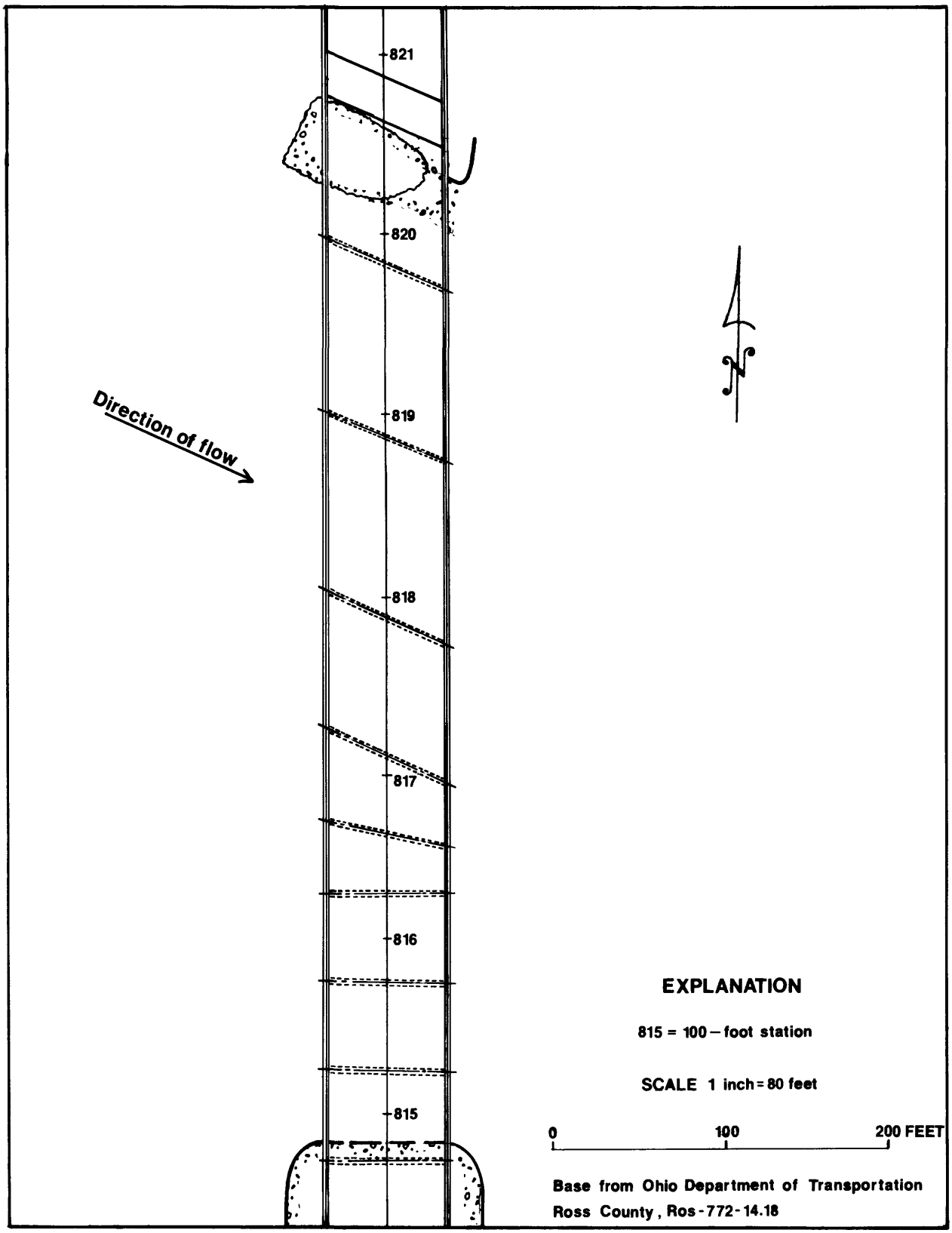

Figure 2.--Plan of proposed bridge and approach roadway, Paint Creek at State Route 772, Chillicothe, Ohio.

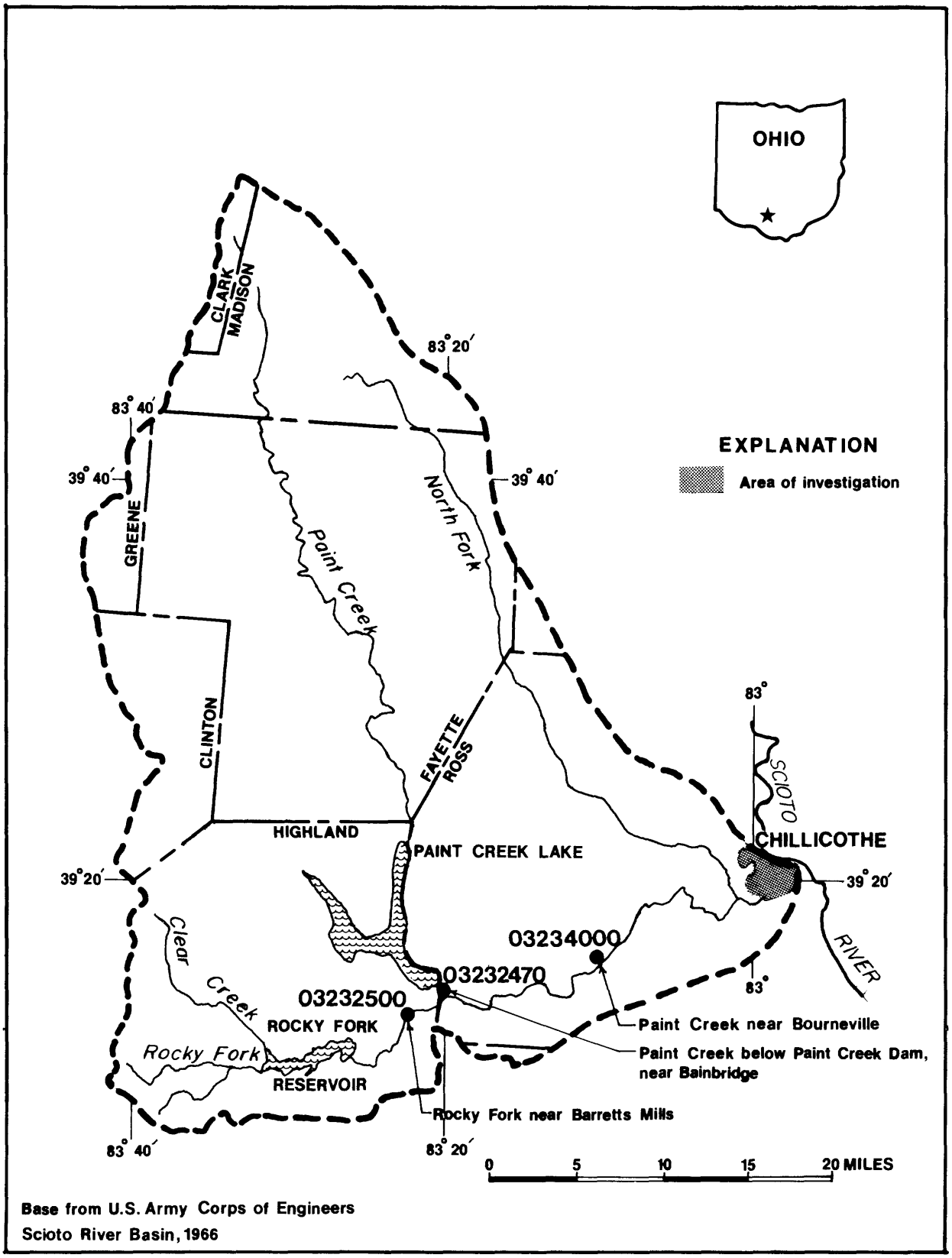

Figure 3.--Paint Creek drainage basin.

FIELD RECONNAISSANCE

A field reconnaissance was made to inspect the channel and flood plain, determine levee locations and to estimate their effects on the flow, and select cross-section locations and roughness coefficients for use in the step-backwater model. Interviews with local residents and officials at Meade Paper Co. were made to gather information on past flooding. Several high-water marks to confirm profile elevations determined by the profile model were obtained. Since the completion of Paint Creek dam in 1974, flood flows have been confined by flood-control levees, and no serious flooding has occurred.

MAGNITUDE AND FREQUENCY OF FLOODS

Records of stage and discharge are available for the gaging station "Paint Creek near Bourneville" (drainage area, 807 mi^2) from October 1921 to January 1937, and from January 1938 to September 1979. Paint Creek has been regulated by Rocky Fork Lake (drainage area, 114 mi^2, capacity 34,100 acre-feet) since 1952; and by Paint Creek Lake (drainage area, 570 mi^2, flood storage capacity 145,000 acre-feet) since 1974. The highest recorded peak flow at the Bourneville gage prior to 1974 was 56,900 ft^3/s in 1964; since that date, the maximum peak flow has been 10,800 ft^3/s.

Flood Frequency

The U.S. Army Corps of Engineers, developed stage-discharge and stage-frequency relations for a gage at South Paint Street with a drainage area of 1,136 mi^2, for conditions modified by Paint Creek Lake and Rocky Fork Lake. Curves showing these relationships were published by the Corps in a flood plain information report (U.S. Army Corps of Engineers, 1966). Because the capacity of the completed flood control structure was essentially the same as the design capacity, the flood-frequency discharges for conditions modified by Paint Creek Lake and Rocky Fork Lake were used in this report. The 10-, 25-, 50-, and 100-year frequency discharges are 37,000, 51,000, 62,000, and 75,000 ft^3/s, respectively. These magnitude and frequency relationships are shown in figure 4.

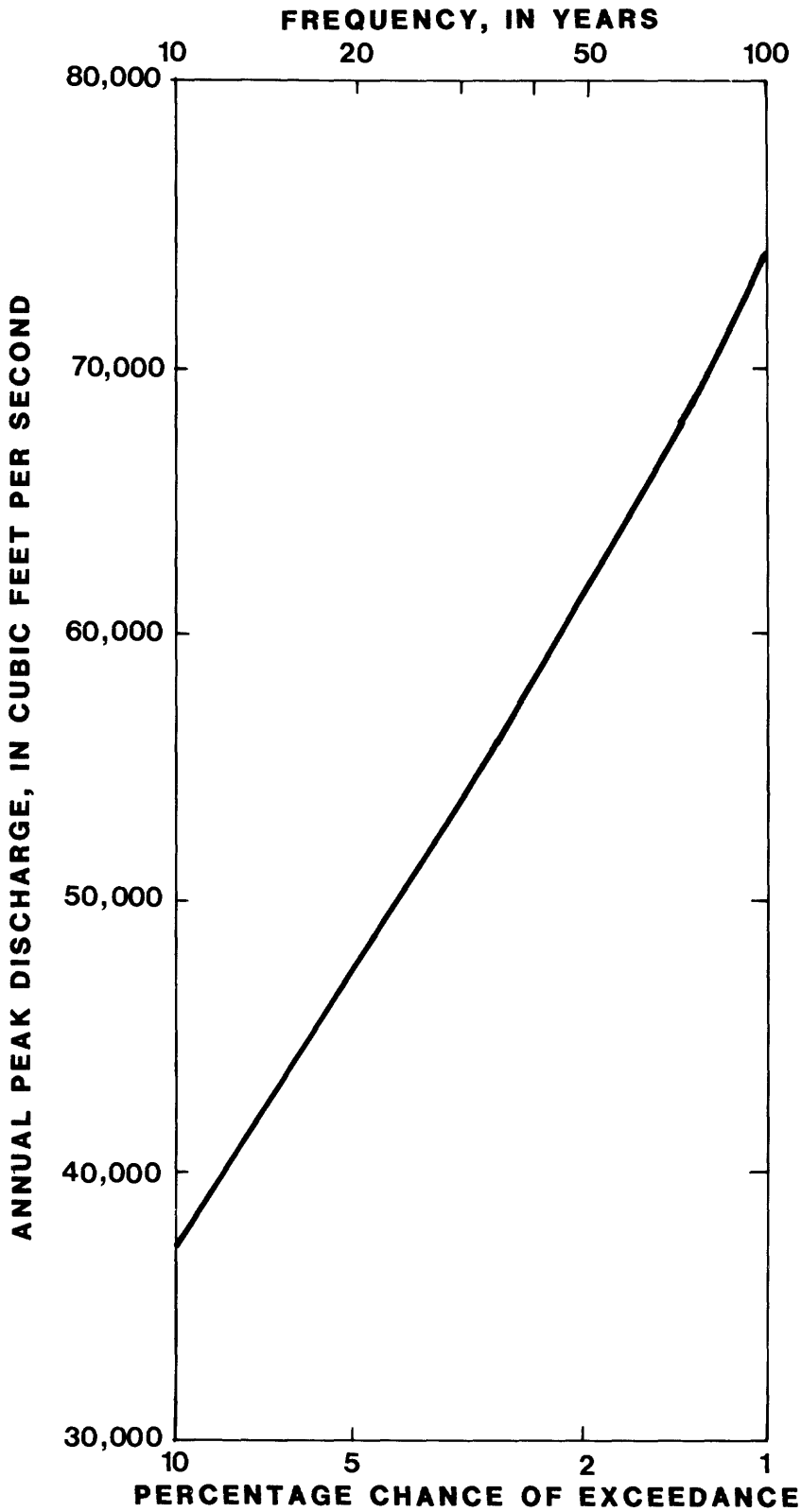

Figure 4.--Flood frequency curve, Paint Creek at Chillicothe, Ohio.

HYDRAULIC ANALYSIS

Stage-discharge relationships used for the initial section were developed from a discharge rating for a gage at South Paint Street bridge and profiles published in the U.S. Army Corps of Engineers Flood Plain Information report (1966). This initial section is 4,000 feet downstream from the bridge. It is also downstream from changes made in the flood channel between the time of the Flood Plain Information report and the present study. The changes consisted of the construction of a levee along the left bank and of large settling ponds in the middle of the right bank flood plain. Profiles were developed in the reach between the initial section and South Paint Sreet bridge through use of the U.S. Geological Survey's E431 step-backwater program (Shearman, 1976), for the 10-, 25-, 50-, and 100-year frequency floods.

At the site of the present and proposed bridges flow equal to or greater than a 10-year flood partly bypasses the present bridge and will bypass the proposed bridge by flow across the right bank flood plain. Flood profiles were determined by distributing flow through and around the bridges, using the distribution of conveyance in the approach sections and configuration of the ground as guides.

Profiles between the bridge and section 26 were computed by use of the Geological Survey's E431 step-backwater program (Shearman, 1976). River distances were measured along the thalweg of the meandering channel. A roughness coefficient (Manning's $\underline{n}$) of 0.040 was used for the main channel and $\underline{n}$'s ranging from 0.050 to 0.100 were used for the flood plain parts at the cross sections. The roughness coefficients were selected in the field and verified from aerial photos.

A typical cross section is shown in figure 5. Elevation data for the profiles of the 10-, 25-, 50-, and 100-year frequency floods in the reach between the downstream side of the South Paint Sreet bridge and the upstream end of the designated reach are presented in figure 6 and listed in table 1. Area inundated by the 100-year flood is shown in figure 7. Data and computations supporting analysis given in this report are available for inspection at the U.S. Geological Survey office in Columbus, Ohio.

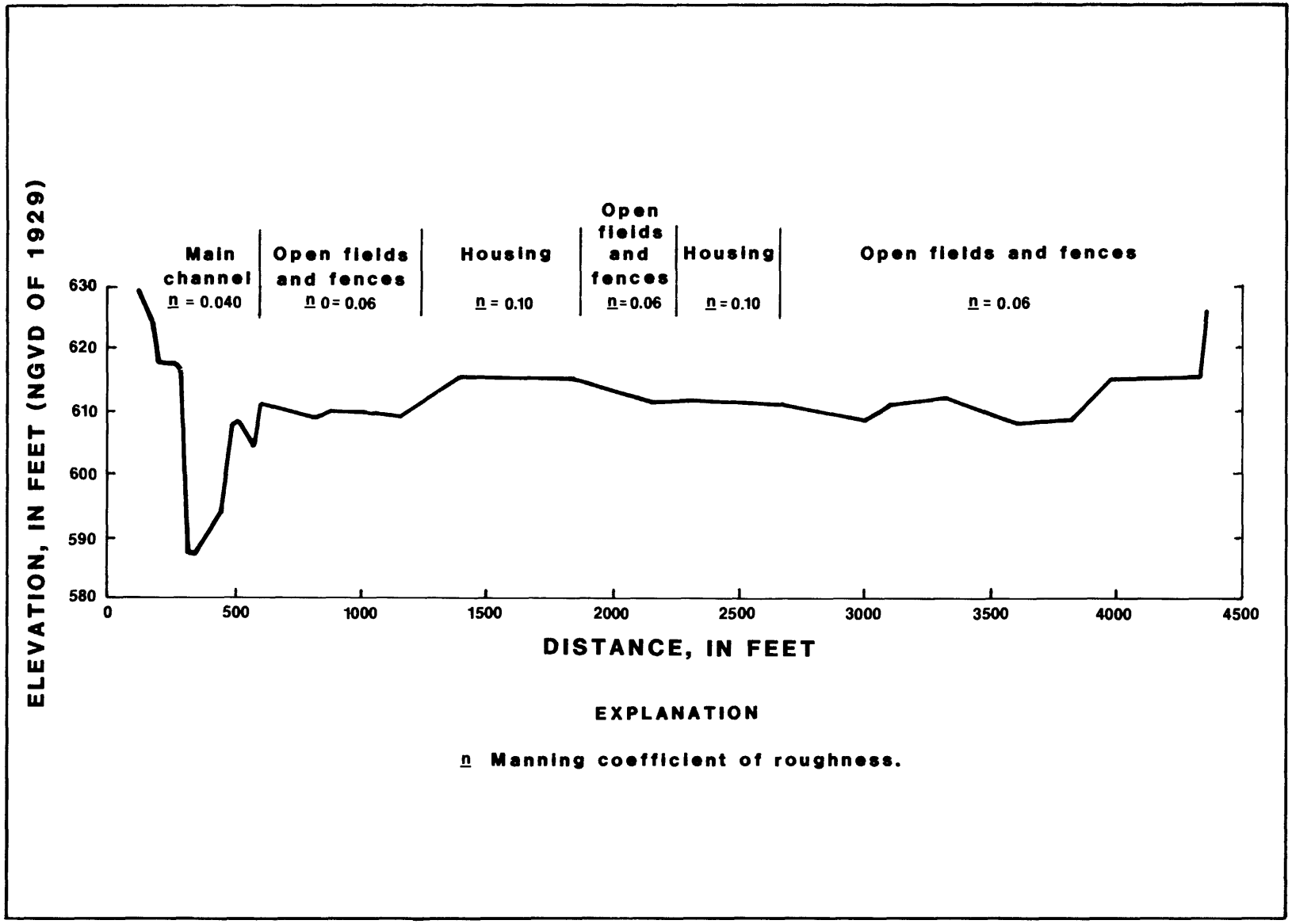

Figure 5.--Typical valley cross section, Section 17, Paint Creek at State Route 772, Chillicothe, Ohio.

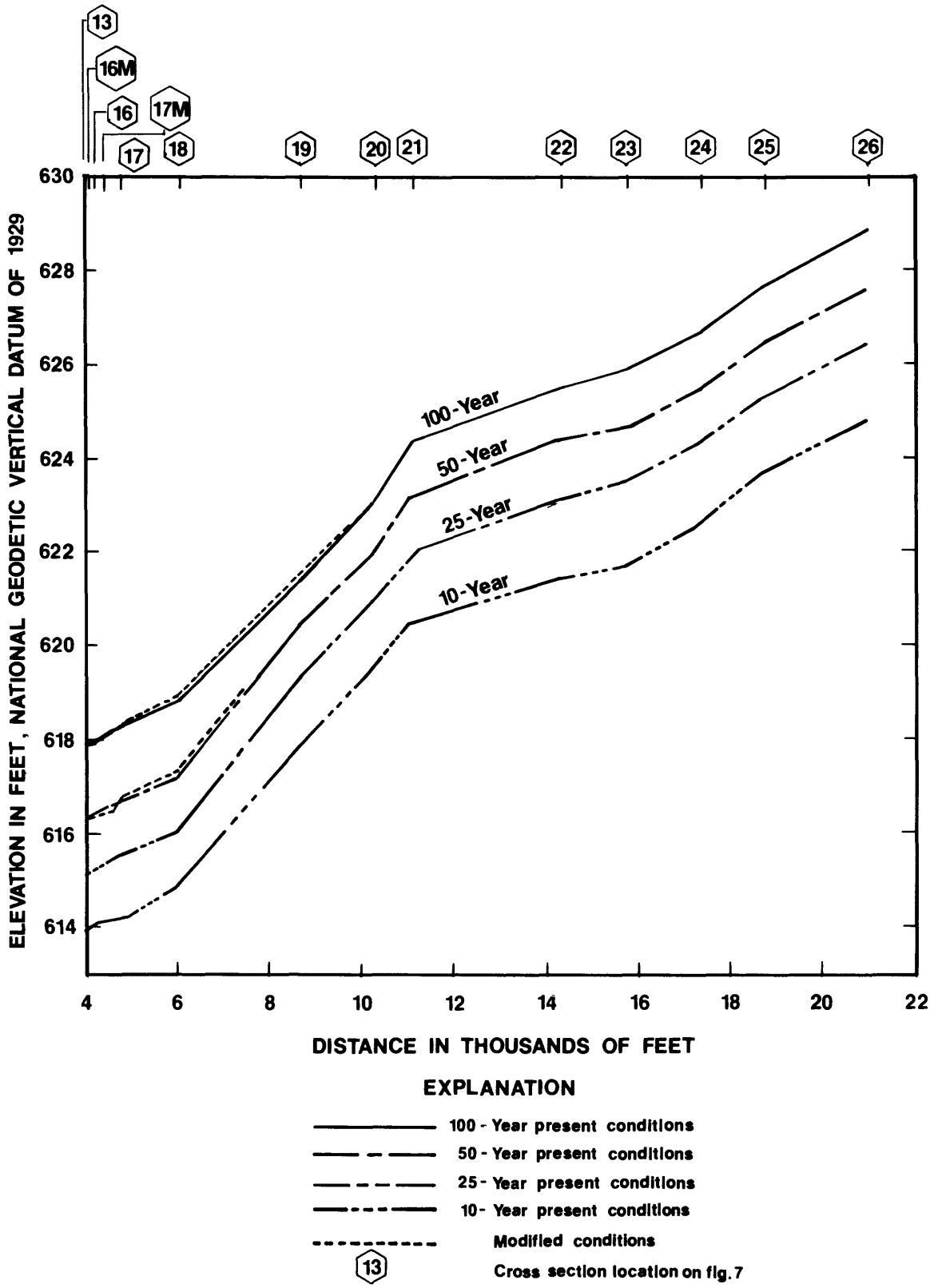

Figure 6.--Profiles for present and modified conditions, Paint Creek at Chillicothe, Ohio.

Table 1.--Profile elevations, Paint Creek at Chillicothe, Ohio
(Elevations in feet, National Geodetic Vertical Datum of 1929)

Section	Distance upstream from initial section (in feet)	Flood recurrence interval							
		10-year flood		25-year flood		50-year flood		100-year flood	
		Conditions		Conditions		Conditions		Conditions	
		Present	Modified	Present	Modified	Present	Modified	Present	Modified
13	4,000	613.9	613.9	615.1	615.1	616.3	616.3	617.9	617.9
16M	4,055	--	614.0	--	615.1	--	616.3	--	617.9
16	4,330	614.1	--	615.3	--	616.5	--	618.0	--
17M	4,465	--	614.0	--	615.4	--	616.5	--	618.1
17	4,860	614.2	614.2	615.6	615.6	616.7	616.8	618.3	618.4
18	5,950	614.8	614.8	616.0	616.1	617.2	617.3	618.8	618.9
19	8,580	617.8	617.8	619.5	619.5	620.5	620.5	621.4	621.5
20	10,180	619.5	619.5	621.0	621.0	622.0	622.0	623.1	623.1
21	10,960	620.5	620.5	622.1	622.1	623.2	623.2	624.4	624.4
22	14,260	621.2	621.2	622.9	622.9	624.1	624.1	625.2	625.2
23	15,660	621.6	621.6	623.3	623.3	624.5	624.5	625.7	625.7
24	17,210	622.6	622.6	624.3	624.3	625.3	625.3	626.5	626.5
25	18,560	623.8	623.8	625.3	625.3	626.3	626.3	627.5	627.5
26	20,230	624.6	624.6	626.1	626.1	627.1	627.1	628.2	628.2

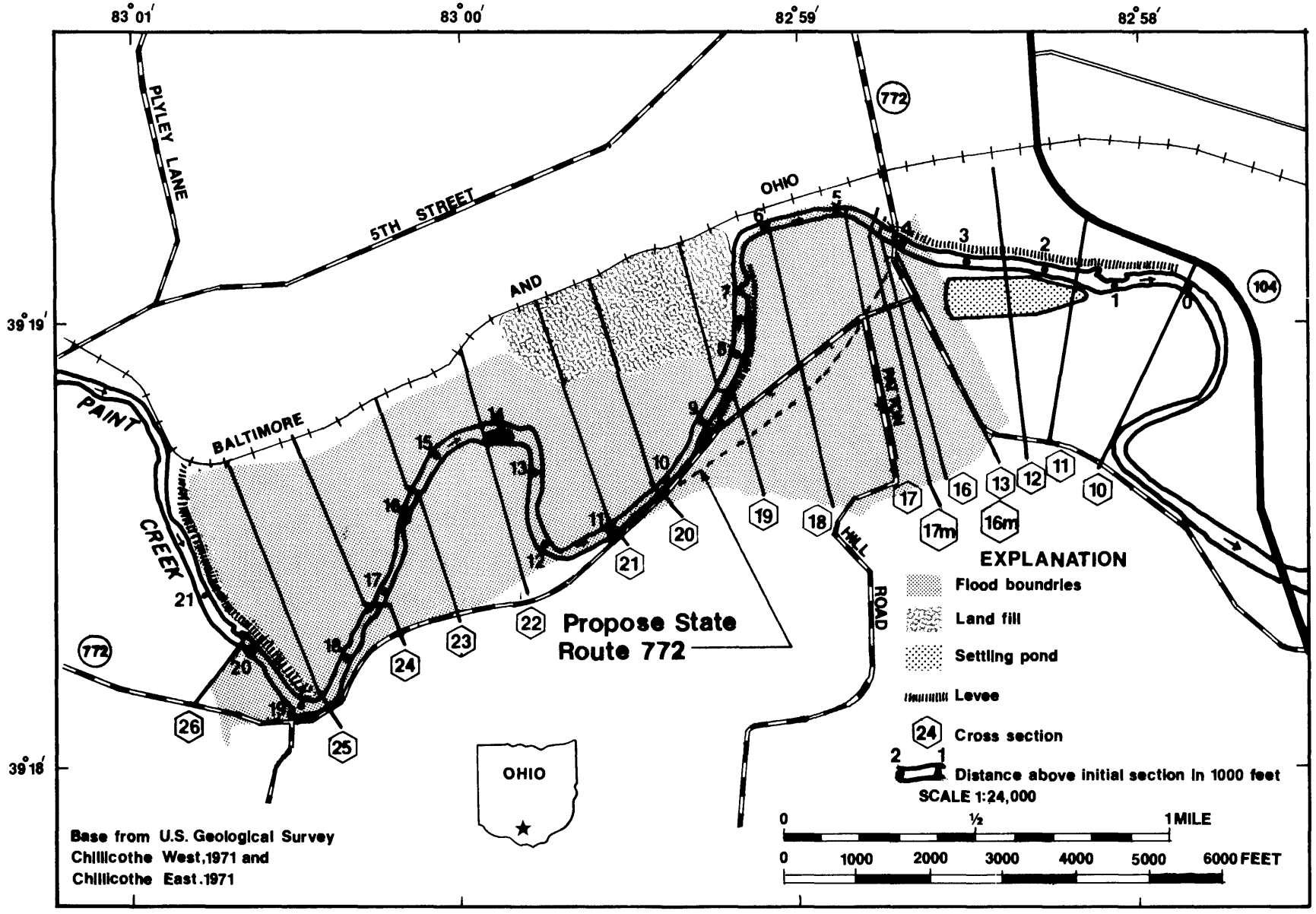

Figure 7.--Cross-section location and flood boundaries, Paint Creek at State Route 772, Chillicothe, Ohio

SUMMARY AND CONCLUSIONS

A summary of water-surface profile elevations for the 10-, 25-, 50-, and 100-year frequency floods under present and modified conditions is presented in table 1, and shown graphically in figure 6. Because neither the present nor the proposed roadways restrict flow to the main channel, there is considerable flow that bypasses the present bridge and will bypass the proposed bridge for all discharges investigated. The effect is to reduce backwater effects of bridge contraction. The maximum difference between the downstream and approach section elevations is 0.3 foot for the present bridge and 0.2 foot for the proposed bridge.

The proposed bridge and connecting roadway will not cause an increase in upstream flood elevations for the 10-, 25-, 50-, or 100-year flood discharges. The profiles for these discharges are essentially the same for the proposed bridge as for the present bridge.

SELECTED REFERENCES

Mead Paper Co., 1978, Low-flow study Paint Creek downstream from South Paint Street: Cross section data, August 1978.

Shearman, James O., 1976, Computer applications for step backwater and floodway analyses: U.S. Geological Survey Open-File Report 76-499, 103 p.

U.S. Army, Corps of Engineers, 1966, Flood plain information report, Scioto and Olentangy Rivers: Buffalo District, October, 59 p.

U.S. Geological Survey, 7.5 minute series topographic maps, scale 1:24,000, contour interval 20 feet; Chillicothe East 1961 (photorevised 1975), and Chillicothe West 1961 (photorevised 1971).

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