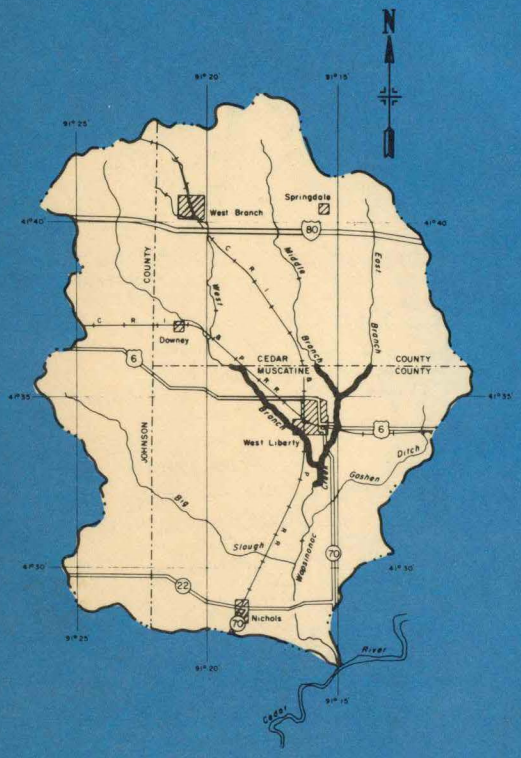
WAPSINONOC CREEK
FLOOD PLAIN INFORMATION

MUSCATINE COUNTY, IOWA



PREPARED FOR THE STATE OF IOWA

IOWA NATURAL RESOURCES COUNCIL

BY

CORPS OF ENGINEERS, U. S. ARMY

ROCK ISLAND DISTRICT

JUNE, 1971

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INTRODUCTION

GENERAL

This report evaluates the flood situation along the Wapsinonoc Creek flood plain at West Liberty, Iowa in Muscatine County. Study limits extend from the county road bridge on the south boundary of Section 24, T78N, R4W to the Muscatine-Cedar County line and includes the West Branch, Middle Branch, and East Branch of Wapsinonoc Creek. Mileage at the county road bridge at the downstream limit of the study was taken from the U. S. Geological Survey open file report titled "Flood of June 7, 1967, in the Wapsinonoc Creek Basin, Iowa" and dated January 1968. Stream mileages upstream to the Muscatine-Cedar County line were measured along the low water channel from 1:4,800 scale topographic maps of the area.

The report was prepared for the Iowa Natural Resources Council at the request of the West Liberty City Council. Topographic maps used in this report were furnished by the Iowa Natural Resources Council and the city of West Liberty.

The report is based on rainfall, runoff, recent flood height information, and other technical data defining the occurrence and size of Wapsinonoc Creek floods. Two significant phases of the flood problem in the study reach are covered in the report. First, it reviews the history of flooding on Wapsinonoc Creek, then, it estimates the possible occurrence of future floods, the Intermediate Regional and Standard Project Floods.

The Intermediate Regional Flood has an average frequency of occurrence of once in 100 years, although it may occur in any year. The magnitude of this flood was determined from a statistical analysis of known floods on gaged streams in the region of the Wapsinonoc Creek basin. The Standard Project Flood represents the

reasonable upper limit of expected flooding. Although a rare event, the conditions producing the Standard Project Flood could occur at any time. Analysis showed that the flow for this type of flood would be considerably larger than the largest known flood on Wapsinonoc Creek. For this reason, logical and practical flood plain development must be made compatible with the flood potential of Wapsinonoc Creek. Appropriate evaluation must be undertaken of the possible recurrence of past floods and the occurrence of the Intermediate Regional and Standard Project Floods.

The maps, profiles, and cross sections in this report indicate the extent of flooding which could occur on the Wapsinonoc Creek flood plain. This information will provide a basis for planning the most practical use of the flood plain consistent with the flood hazard. Likewise, the probable depth of flooding by the Intermediate Regional or the Standard Project Flood may be determined at any location. With this information, structure design criteria may be established or flood proofing measures may be undertaken to eliminate or minimize flood damages.

This report does not include plans for the solution of flood problems. However, it does provide the basis for further study and planning by the local community to minimize vulnerability to flood damages. Local, State, and Federal planning programs may guide developments by managing flood plain use through zoning and subdivision regulations, construction of flood protection works, or a combination of the two approaches.

State regulation of the flood plains of Iowa rivers and streams is provided primarily through administration of Chapter 455A of the Iowa Code by the Iowa Natural Resources Council. This statute assigns to the Resources Council the duty and authority to establish and enforce an appropriate comprehensive statewide program for the control,

utilization, and protection of the surface and ground water resources of the state. Prior approval of the Resources Council is required for any structure, dam, obstruction, deposit, or excavation to be erected, made, used, or maintained in or on the floodway or flood plains of any river or stream. Similarly, works of any nature for flood control may not be constructed or installed unless and until the proposed works are approved by the Resources Council. Chapter 455A was amended by the Sixty-First General Assembly of Iowa, 1965, to authorize the Resources Council to establish and enforce regulations for the orderly development and wise use of the flood plains of any river or stream within the state. The Resources Council is directed to determine the characteristics of floods which reasonably may be expected to occur. In addition, the Resources Council may establish encroachment limits, protection methods and minimum protection levels appropriate to flood characteristics of the stream and reasonable use of the flood plains. Policies and procedures for administration of this Act are being formulated by the Resources Council.

In addition, the authority of local governing bodies to zone land for protection from floods is included in the standard objectives listed in the state enabling statutes, Chapter 358A and Chapter 414 of the Iowa Code 1971, as amended. (See also Chapter 455A of the 1971 Code, as amended.)

Upon request, the Rock Island District of the Corps of Engineers will provide limited technical assistance to Federal, State, and local agencies in interpretation and use of the information contained in this report.

SUMMARY OF THE FLOOD SITUATION

The report covers approximately 17 miles of Wapsinonoc Creek in Muscatine County, Iowa and includes the town of West Liberty.

There are no stream gaging records for the Wapsinonoc Creek basin. However, following a large flood on June 7, 1967 rainfall and runoff data were collected in the basin by the U. S. Geological Survey and the Iowa Natural Resources Council. Indirect discharge measurements were made at several locations in the basin.

From this data together with hydrologic studies of possible future floods, the local flood situation has been developed. The following paragraphs summarize the significant findings.

THE GREATEST KNOWN FLOOD FLOW on Wapsinonoc Creek occurred on June 7, 1967. This flood was the result of a storm of June 6 and 7 that was centered over the Wapsinonoc Creek watershed. The estimated total rainfall within the storm duration of 14 hours was between 4 to 13 inches based from a bucket survey conducted over the area. The estimated runoff resulted in a peak discharge of 27,400 cubic feet per second.

THE INTERMEDIATE REGIONAL FLOOD has an average frequency of occurrence of once in 100 years. The magnitude of this flood was determined from an analysis of past floods on streams in the general area of Wapsinonoc Creek. The flow for this flood on Wapsinonoc Creek downstream from the junction with the West Branch would be 20,800 cubic feet per second. The Intermediate Regional Flood would be 0.8 of a foot lower than the flood of June 1967 at the upstream side of U. S. Highway 6, mile 10.56.

STANDARD PROJECT FLOOD determination indicates that floods could occur on Wapsinonoc Creek from 1 foot to 5 feet higher than the

observed flood of June 1967. The Standard Project Flood would be 4.0 feet higher than the June 1967 flood at the upstream side of U. S. Highway 6.

The heights of the Intermediate Regional and the Standard Project Floods in relation to the height of the flood of June 1967 are shown on Table 1 and plotted on Plates 8 through 10.

FLOOD DAMAGES would result from the recurrence of the June 1967 flood. Extensive damages would be caused by the Standard Project Flood because of its wider extent, greater depths, and higher velocities.

MAIN FLOOD SEASON for Wapsinonoc Creek is in spring and early summer. Most of the larger floods have resulted from heavy general rains during this season. However, intense local thunderstorms may cause floods during other seasons.

VELOCITIES OF WATER during major floods vary widely, depending on location. During an Intermediate Regional Flood, channel and overbank velocities would range up to 6.2 and 5.4 feet per second, respectively. Velocities greater than three feet per second, combined with depths of three feet or greater, are generally considered hazardous.

HAZARDOUS CONDITIONS would occur during large floods as a result of high velocities and deep flows. Floodwaters which overtop roads can cause hazardous conditions for anyone attempting to drive through inundated areas. Health problems often develop when wells become contaminated and when septic tanks become affected. The danger from underestimating the velocity and depth of floodwaters is a problem confronting residents within the flooded areas.

FUTURE FLOOD HEIGHTS during the occurrence of the Intermediate Regional and Standard Project Floods on Wapsinonoc Creek are shown

in Table 1 together with the observed high water marks of the June 7, 1967 flood. The future flood heights are based on existing developments on the flood plain within the study reach assuming no clogging at bridges by debris or ice jams. Future developments, if allowed to encroach into the effective flow area of the flood plain, could cause higher water surface elevations than those shown in the table.

TABLE 1

RELATIVE FLOOD HEIGHTS 2/

Miles Above Mouth of Wapsinonoc Creek 1/	Identification	June 7, 1967 High Water Elevation Feet	Intermediate Regional Flood Elevation Feet	Intermediate Regional Flood Above June 7, 1967 High Water Feet	Standard Project Flood Elevation Feet	Standard Project Flood Above June 7, 1967 High Water Feet
A. Wapsinonoc Creek						
7.12 DS	County Road	645.1	645.4	0.3	647.4	2.3
7.12 US	County Road		645.4		647.4	
7.52			645.6		647.6	
8.04	Junction West Branch		646.5		648.5	
8.82		648.0	648.0	0.0	650.0	2.0
9.35 DS	Highway 70	649.2	649.9	0.7	651.6	2.4
9.35 US	Highway 70	651.7	651.0	-0.7	653.2	1.5
9.86			652.9		655.1	
10.39 DS	C.R.I.&P. RR	656.0	655.2	-0.8	656.9	0.9
10.39 US	C.R.I.&P. RR	658.5	657.2	-1.3	662.0	
10.56 DS	Highway 6	658.8	657.2	-1.6	662.0	
10.56 US	Highway 6	659.0	658.2	-0.8	663.0	4.0
11.00			659.2		664.7	
11.24 DS	Rainbow Drive (Maxson Ave.)	660.4	660.5	0.1	665.3	4.9
11.24 US	Rainbow Drive (Maxson Ave.)	662.8	661.2	-1.6	665.4	2.6
11.62	Junction East Branch		661.5		665.6	
B. Middle Branch						
12.15			663.6		666.8	
12.45 DS	County Highway X-40	665.1	665.1	0.0	667.8	2.7
12.45 US	County Highway X-40	666.1	667.7	1.6	669.5	3.4
12.77			668.9		670.8	
13.18 DS	County Line Road	667.5	669.2	1.7	671.1	3.6
13.18 US	County Line Road	668.0	669.2	1.2	671.1	3.1
C. West Branch						
8.04			646.5		648.5	
8.90			649.1		650.8	
9.41			650.5		652.2	
9.62 DS	C.R.I.&P. RR	651.4	651.1	-0.3	652.8	1.4
9.62 US	C.R.I.&P. RR	652.6	653.0	0.4	654.8	2.2
9.97 DS	County Road		653.3		655.1	
9.97 US	County Road		653.5		655.3	
10.53			654.8		656.9	
10.85 DS	County Road	656.2	655.4	-0.8	657.7	1.5
10.85 US	County Road	657.0	655.6	-0.4	657.9	0.9
11.55			657.0		659.4	
12.05			658.7		661.2	
12.35			659.7		662.3	
12.78			660.1		663.0	
13.22 DS	Highway 6	661.8	662.4	0.6	664.3	1.5
13.22 US	Highway 6	663.0	663.6	0.6	664.5	1.5
13.80			664.7		666.4	
14.48			665.9		667.9	
14.95			666.9		669.0	
16.25			668.8		670.6	
16.85			670.0		671.9	
D. East Branch						
11.62		664.0	661.5	-2.5	665.6	1.5
11.91			662.2		665.8	
12.42			665.2		667.3	
12.84			667.5		668.9	
13.31			669.4		670.5	
13.47 DS	County Line Road		671.2		672.5	
13.47 US	County Line Road		672.4		673.0	

1/ DS - Downstream; US - Upstream

2/ Elevations are based on U.S.C. & G.S. datum 1929 G. A.

GENERAL CONDITIONS AND PAST FLOODS

GENERAL

Wapsinonoc Creek has a drainage area of 108 square miles at mile 7.10, the lower limit of the study reach. It flows generally from north to south. The average flood plain width as defined by the Standard Project Flood varies from 2,000 to 10,000 feet.

Some residential, commercial, and industrial developments in West Liberty are on higher ground. However, there are some residential and commercial developments on or immediately adjacent to the Wapsinonoc Creek flood plain. The principal flood problem areas in the study reach are those near U. S. Highway 6 bridge at mile 10.56, adjacent to the Chicago, Rock Island and Pacific Railroad bridge, at miles 10.39 and 9.63, and developments located on the south side of Prairie Street.

The Stream and Its Valley

Wapsinonoc Creek is a right bank tributary of the Cedar River. The basin is elliptical and oriented with the long axis in the north-south direction. Headwaters begin in Johnson and Cedar Counties and flow is in a generally southern direction. County roads generally follow each section line. At West Liberty, the Chicago, Rock Island and Pacific Railroad radiates in four directions.

State Highways 6, 22, and 70 serves the southern part of the basin and I-80 crosses the basin between West Branch and West Liberty. Plate 1 shows the stream drainage, the watershed, and the reach covered by this report. Table 2 lists the pertinent drainage areas of Wapsinonoc Creek and its tributaries.

TABLE 2

DRAINAGE AREAS IN WATERSHED OF WAPSINONOC CREEK

Stream	Location	Miles above mouth	Drainage Area sq. mi.
Wapsinonoc Creek	County road bridge on south side of Section 24	7.12	108.0
	Downstream from the junction with West Branch	8.12	107.0
	Upstream from the junction with West Branch	8.14	52.2
	Downstream from the junction with East Branch	11.65	45.7
Middle Branch	Upstream from the junction with East Branch	11.67	25.2
	At the Cedar-Muscatine County line road bridge	13.18	23.2
West Branch	Mouth	8.13	54.8
	At the Cedar-Muscatine County line	16.85	42.0
East Branch	Mouth	11.66	20.2

Settlement

The first Wapsinonoc settlement was made in the fall of 1836. It was located just northwest of the present town of West Liberty.

Some of the original settlers who came to Wapsinonoc were from Liberty, Ohio. They changed the name Wapsinonoc to Liberty.

In 1856, West Liberty was surveyed and many buildings were moved to it from Liberty. The Wapsinonoc settlement soon became Wapsinonoc Township which originally consisted of all of Muscatine County west of the Cedar River.

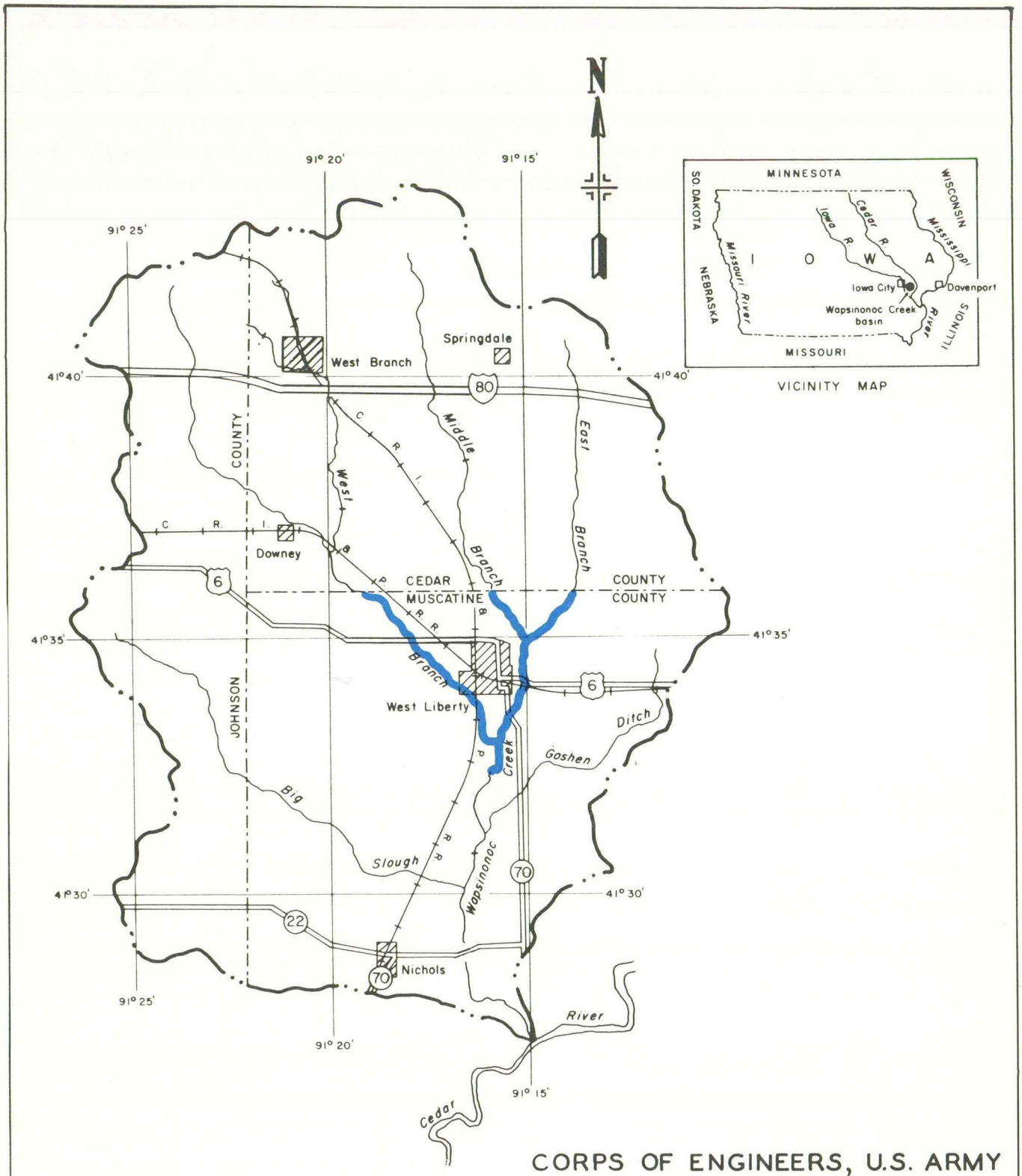

N
91° 20'
91° 15'
91° 25'
41° 40'
41° 35'
41° 30'
91° 25'
91° 20'
91° 15'
Springdale
West Branch
80
COUNTY
Middle
East
West
Branch
Branch
C R I
Downey
6
CEDAR
MUSCATINE
COUNTY
COUNTY
R R
Branch
West Liberty
JOHNSON
Ditch
Goshen
Creek
Big
Slough
Wapsinonoc
70
22
Nichols
River
Cedar
MINNESOTA
SO DAKOTA
NEBRASKA
MISSOURI
WISCONSIN
ILLINOIS
I O W A
Iowa R.
Cedar R.
Mississippi
Missouri River
Iowa City
Davenport
Wapsinonoc Creek basin
VICINITY MAP
REACH COVERED BY THIS REPORT
CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT
WAPSINONOC CREEK
WATERSHED
1 0 1 2 3 4 5
SCALE IN MILES
JUNE 1971

PLATE 1

The town of West Liberty was incorporated in 1868.

In 1841, the first saw mill was erected on the West Branch Wapsinonoc Creek near Prairie Street. In 1866 a grist mill was in operation about two miles east of town on U. S. Highway 6.

Flood Damage Prevention Measures

There are no proposed or authorized flood control projects for West Liberty.

Flood Warning and Forecasting Services

The Environmental Science Services Administration Weather Bureau provides a flood forecasting service for the major river basins in Iowa including the Cedar River basin. However, there is no specific service for Wapsinonoc Creek.

In relatively small areas such as the Wapsinonoc Creek basin, procedures using radar or local flash flood reporting networks are the most practical means for issuing flood warnings. The Weather Bureau radar facilities in Des Moines, Iowa, have effective range to cover the basin. Commercial radio and television stations have 24 hour telephone warning service from the Weather Bureau in Des Moines and can provide immediate general broadcasts to identify intense storm areas and potential flooding in the Wapsinonoc Creek basin.

Developments in the Flood Plain

Extensive flood plain development has not taken place in West Liberty. However, some developments were damaged or threatened by the June 7, 1967 flood. Several barns in the east part of town were flooded by Wapsinonoc Creek. In the southwest corner of town, three houses were threatened and two saved from damage by hastily installed plastic sheeting over doors and windows.

Plates 3 through 7 show the areas that would be affected by the occurrence of the Standard Project Flood and the Intermediate Regional Flood.

Bridges Across Wapsinonoc Creek

In the study reach the following bridges span the creek: Wapsinonoc Creek and Middle Branch - County Road at mile 7.12, Highway 70 at mile 9.35, C.R.I.&P. Railroad at mile 10.39, Highway 6 at mile 10.56, Rainbow Drive (Maxson Avenue) at mile 11.24, County Road X-40 at mile 12.45, and a County Road at mile 13.18; West Branch - C.R.I.&P. Railroad at mile 9.62, County Road at mile 9.97, County Road at mile 10.85 and Highway 6 at mile 13.22; and East Branch - County Road at mile 13.47.

The Intermediate Regional Flood would inundate roadways or approaches to all bridges except the C.R.I.&P. Railroad on Wapsinonoc Creek.

Table 3 lists and describes existing bridges and shows the approximate relation of average low steel elevation to the Intermediate Regional Flood crest elevation. Figures 1 through 12 are photographs of the bridges listed in Table 3.

Obstructions to Flood Flow

The high water profiles shown on Plates 8, 9, and 10 indicate the effect of bridges on flood flows. For flows of the magnitude of the Intermediate Regional and Standard Project Floods, the bridges are not serious obstructions since the flows overtop the approach fills. Only the C.R.I.&P. Railroad bridges on Wapsinonoc Creek and the West Branch and the Highway 70 bridge on Wapsinonoc Creek severely restrict flood flows resulting in head losses of up to 5.0 feet between the upstream and downstream side of the bridges.

The current level of development in the flood plain does not constitute a serious degree of encroachment. However, present trends and projected growth patterns indicate urban developments will encroach into areas subject to inundation by flows of the magnitude of the Intermediate Regional and Standard Project Floods. Careful flood plain management, including the establishment of encroachment limit lines, should be considered to assure preservation of an adequate floodway to accommodate the flow of the Intermediate Regional Flood without adverse effects on existing facilities.

TABLE 3

BRIDGES ACROSS WAPSINONOC CREEK

Miles Above Mouth of Wapsinonoc Creek	Identification	Type	Spans and Length in Feet	Intermediate Regional Flood Crest Elev. Feet	Streambed Elev. Feet	Average Floor Elev. Feet	Low Steel Elev. Feet	Underclearance: Low Steel Above Intermediate Regional Flood Feet	Underclearance: Low Steel Below Intermediate Regional Flood Feet
A. Wapsinonoc Creek									
7.12	County Road Bridge on South Side of Section 24	Pony Truss	2 at 16; 1 at 70	645.4	624.9	637.7	636.7		8.7
9.35	Iowa State Highway 70	Concrete Girder	2 at 40; 1 at 80	651.0	633.5	655.2	651.4	0.4	
10.39	C.R.I.&P. RR	Steel Plate Girder	2 at 56	657.2	640.9	664.9	657.3	0.1	
10.56	U. S. Highway 6	Concrete Girder	2 at 27	658.2	642.0	655.0	653.6		4.6
11.24	Rainbow Drive (Maxson Ave.)	Steel Plate Girder	2 at 44; 1 at 57	661.2	643.0	661.0	658.0		3.2
B. Middle Branch									
12.45	County Road X-40	Pony Truss	1 at 61	667.7	651.7	665.7	663.9		3.8
13.18	Cedar-Muscatine County Line Road	Pony Truss	1 at 40	669.2	655.2	665.5	664.3		4.9
C. West Branch									
9.63	C.R.I.&P. RR	Steel Plate Girder	3 at 32	653.0	635.9	652.9	647.8		5.2
9.97	County Road	Pony Truss	2 at 14; 2 at 48	653.5	635.2	651.0	649.8		3.7
10.85	County Road	Pony Truss	1 at 88	655.6	640.1	655.6	653.1		2.5
13.22	U. S. Highway 6	Steel Plate Girder	2 at 32; 2 at 43	663.6	646.1	665.6	663.2		0.4
D. East Branch									
13.47	Cedar-Muscatine County Line Road	Steel Plate Girder	1 at 52	672.4	658.2	673.8	670.9		1.5

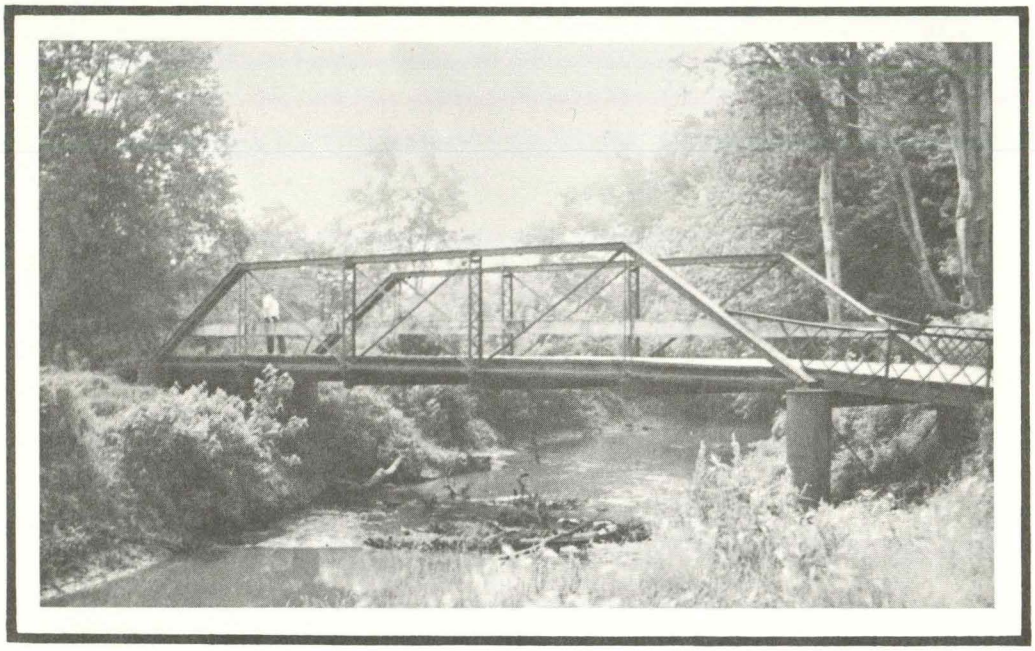


Figure 1. County Road bridge at mile 7.12 (Wapsinonoc Creek), looking downstream.

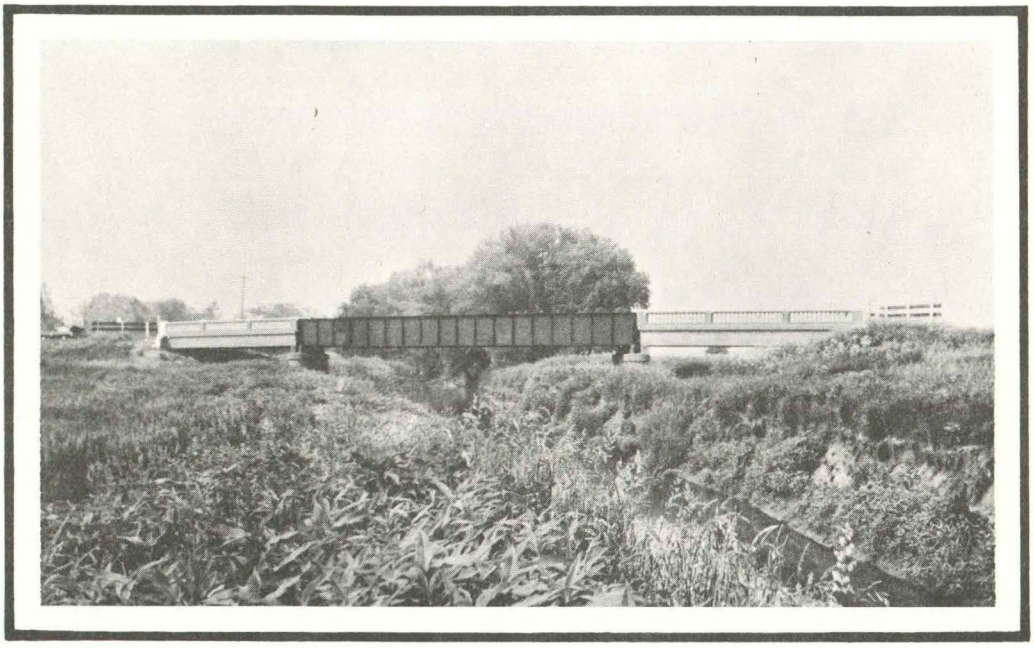


Figure 2. Iowa Highway 70 bridge at mile 9.35 (Wapsinonoc Creek), looking downstream.

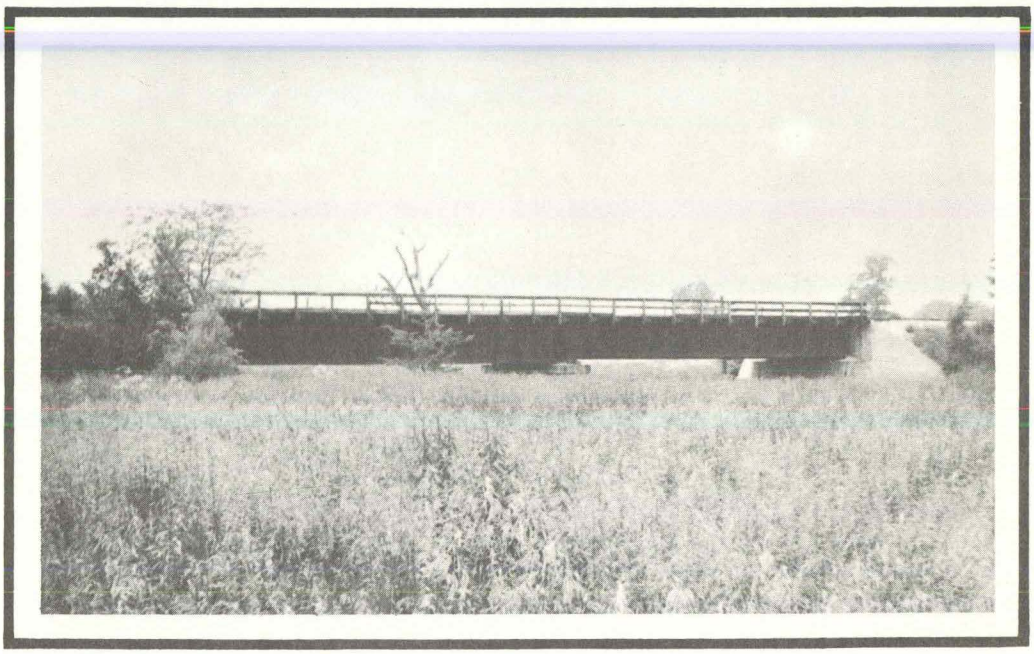


Figure 3. C.R.I.&P. RR bridge at mile 10.39 (Wapsinonoc Creek), looking downstream.

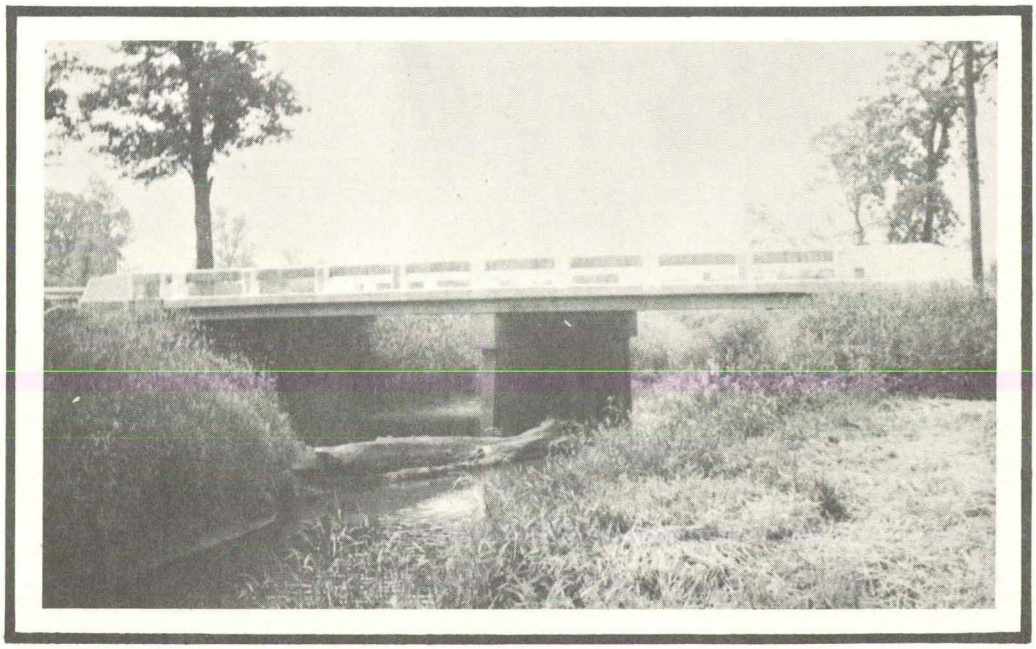


Figure 4. U. S. Highway 6 bridge at mile 10.56 (Wapsinonoc Creek), looking downstream.

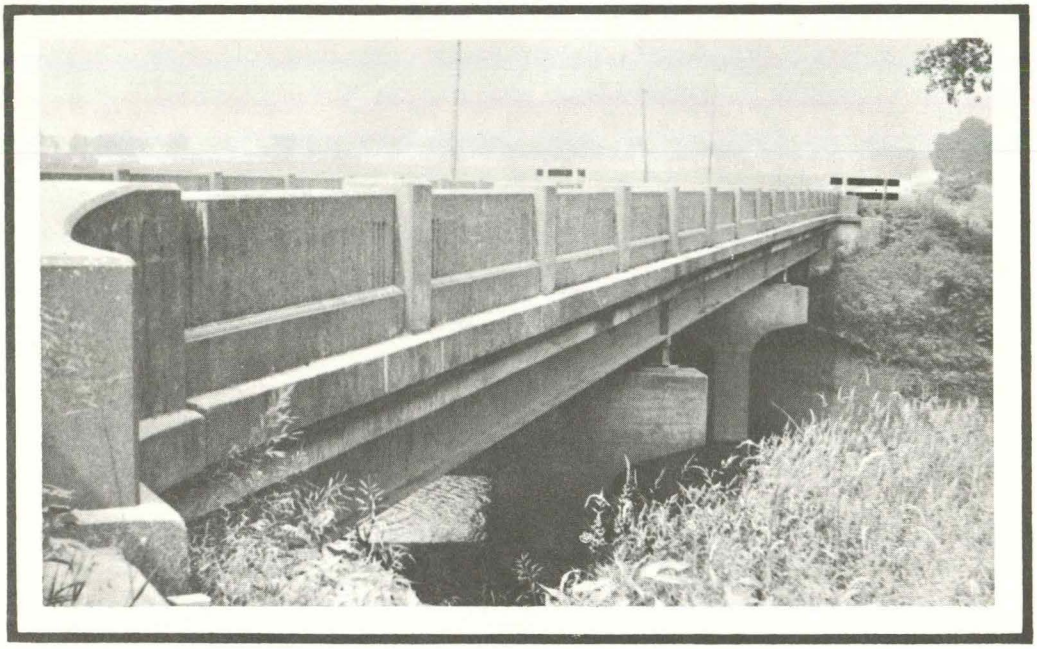


Figure 5. Upstream side of Rainbow Drive (Maxson Ave.) bridge at mile 11.24 (Wapsinonoc Creek), looking west.

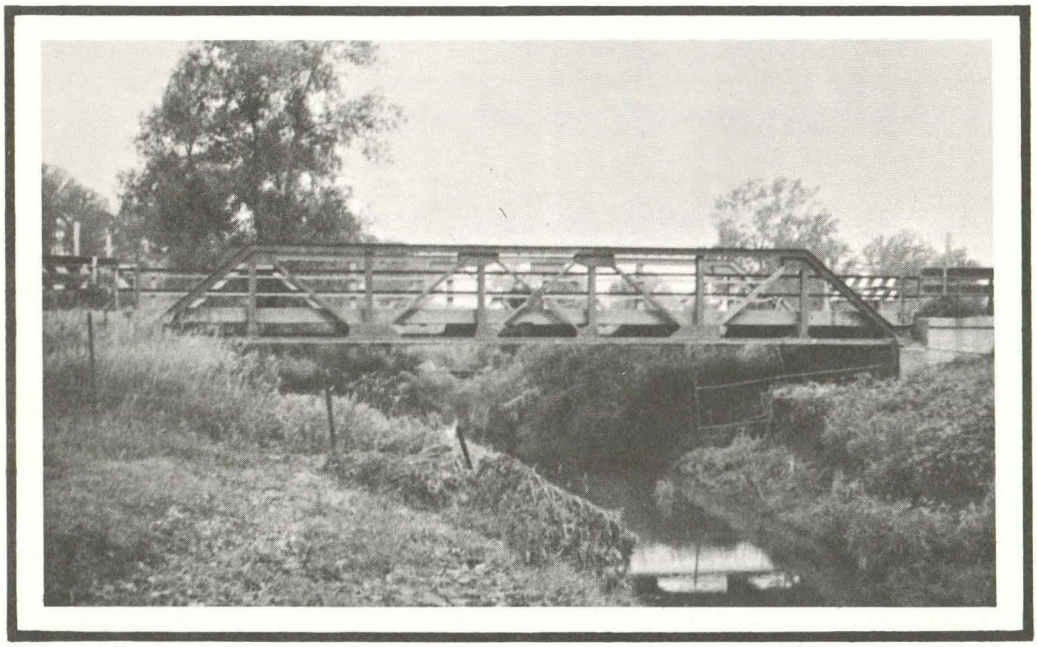


Figure 6. County Road X-40 bridge at mile 12.45 (Middle Branch), looking upstream.

Figure 7. Cedar-Muscatine County Line Road bridge at mile 13.18 (Middle Branch), looking downstream.

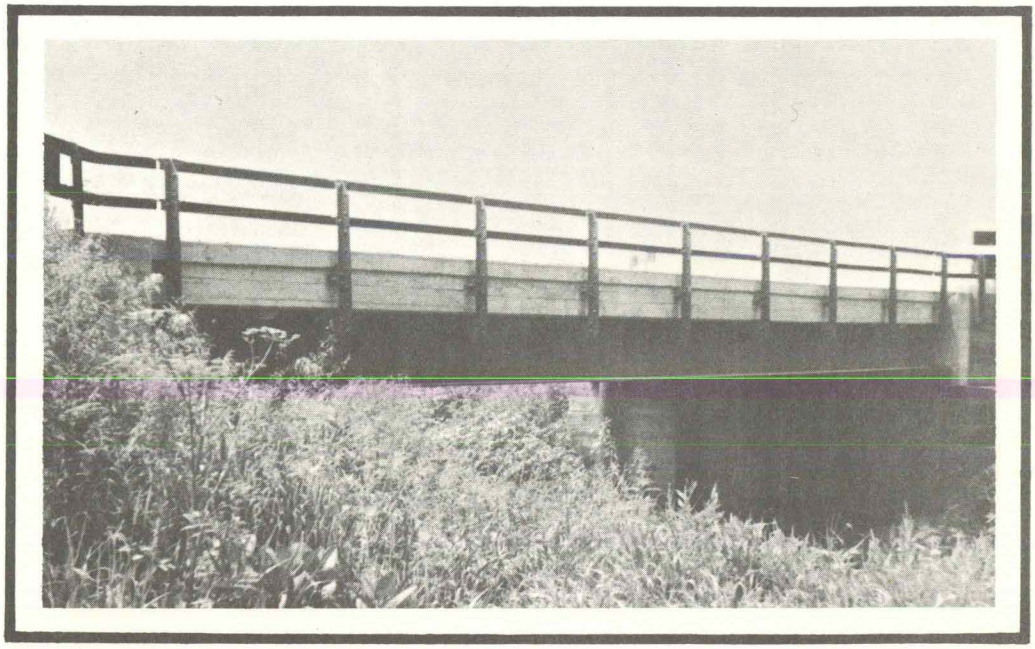


Figure 8. Upstream side of Cedar-Muscatine County Line Road bridge at mile 13.47 (East Branch), looking west.

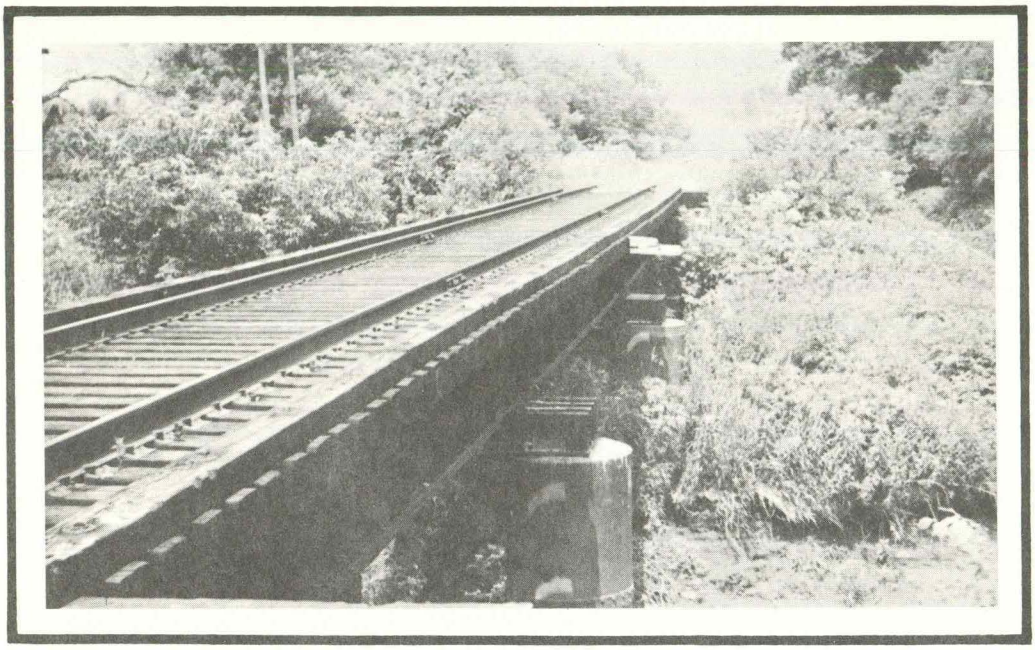


Figure 9. Downstream side of C.R.I.&P. RR bridge at mile 9.62 (West Branch), looking north.

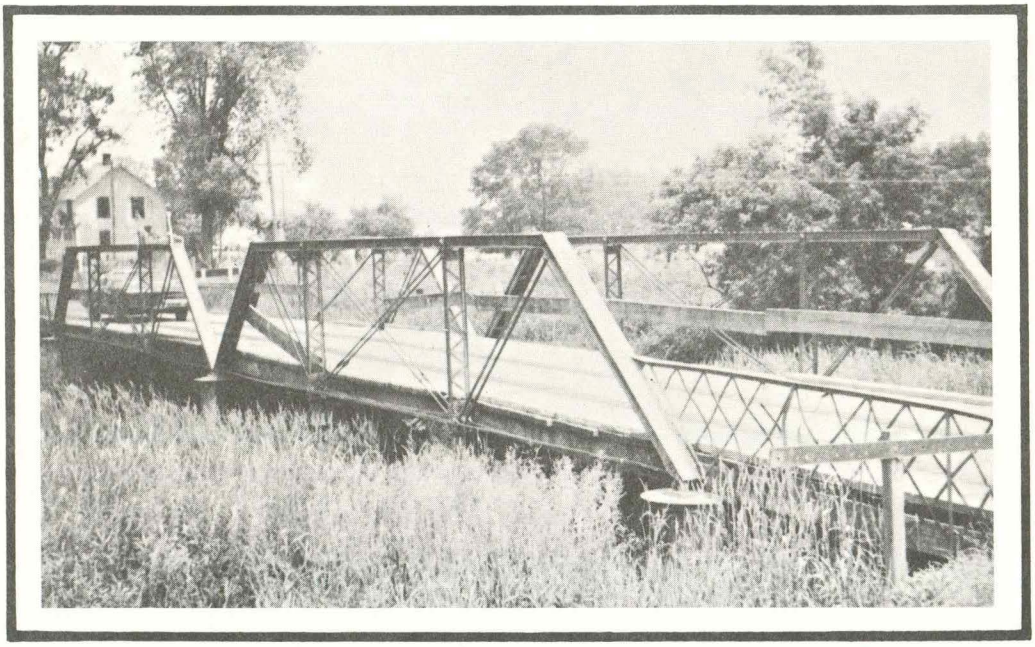


Figure 10. Upstream side of County Road bridge at mile 9.97 (West Branch), looking northeast.

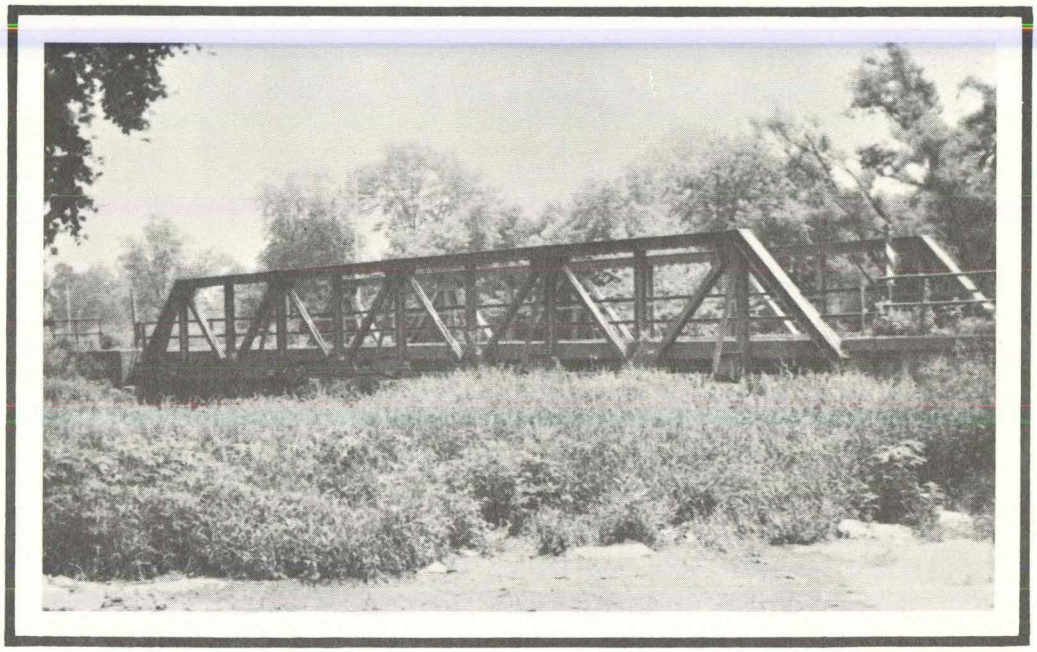


Figure 11. County Road bridge at mile 10.85 (West Branch), looking downstream.

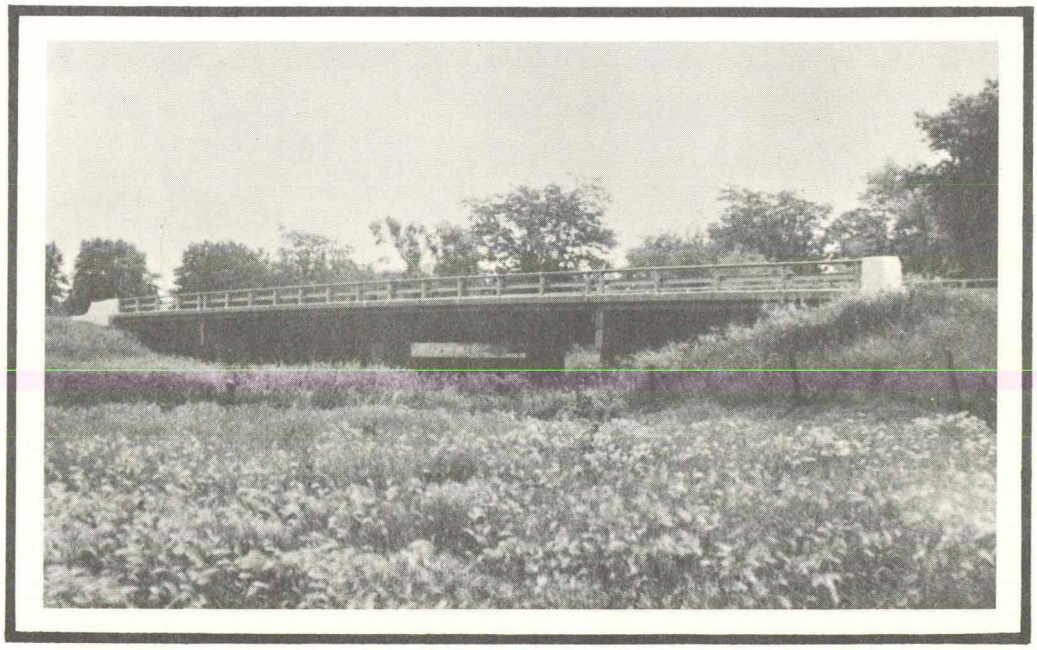


Figure 12. U. S. Highway 6 bridge at mile 13.22 (West Branch), looking downstream.

FLOOD SITUATION

Flood Records

Gaging stations to measure river stages and discharges have not been installed on the streams in the Wapsinonoc Creek basin. However, following the flood of June 7, 1967, the U. S. Geological Survey and the Iowa Natural Resources Council collected rainfall and runoff data and recovered the high water elevations along Wapsinonoc Creek, the West Branch, and the Middle Branch. Indirect flow measurements were made at many locations by the USGS. The data was published in the USGS open file report titled "Flood of June 7, 1967, in the Wapsinonoc Creek Basin, Iowa" Iowa City, Iowa, January 1968.

Velocities

Maximum channel velocities range up to 6.2 feet per second and 6.0 feet per second respectively for the Standard Project and Intermediate Regional Floods. The associated overbank velocities are 3.5 feet per second and 3.1 feet per second respectively. These velocities are representative of open river conditions, but would be greater at flow constrictions such as bridges.

Flooded Areas, Flood Profiles, and Cross Sections

Plates 3 through 7 show the approximate areas along the Wapsinonoc Creek that would be inundated by the Intermediate Regional and Standard Project Floods. The actual limits of these overflow areas on the ground may vary from those shown on the maps. The contour interval, scale of the maps, and changes in topography since mapping was completed, do not permit precise plotting of flooded area boundaries. However, the water surface profile elevations shown in Plates 8, 9, and 10 may be used at specific locations.

High water marks observed during the June 7, 1967 flood are also shown on Plates 8, 9, and 10.

Plates 11 and 12 show cross sections that are typical of the sections obtained for Wapsinonoc Creek in the reach investigated. The locations of cross sections are shown on Plates 3 through 10.

FLOOD DESCRIPTIONS

Flood of June 7, 1967

The following excerpts were taken from the USGS open file report titled "Flood of June 7, 1967, in the Wapsinonoc Creek Basin, Iowa":

"An outstanding flood occurred in the Wapsinonoc Creek basin in east central Iowa on June 7, 1967. The flood was the result of rainfall totalling from 4 to 13 inches in about 14 hours on the night of June 6 and the morning of June 7. The storm was nearly centered over the 180 square mile basin. A peak discharge of 27,400 cubic feet per second was measured from 161 square miles of the basin. This and other peak discharges for areas larger than 40 square miles were among the greatest recorded in the last 50 years in eastern Iowa."

"According to residents the rainfall occurred in two or more heavy showers. One account stated that 4.6 inches accumulated between 1930 and 2030 hours on June 6 in the area north of West Liberty and south of I-80. A second intense burst of rainfall occurred from 0200 to 0500 hours on June 7, and a third substantial amount fell between 0800 and 1100 hours on the same day. This type of distribution is believed to have been basinwide and resulted in two or more peaks for the flood in the upper basin reaches."

"West Liberty was affected to some extent by flooding from the main creek and from the West Branch. Several barns near the east side of town were flooded by Wapsinonoc Creek. Three houses were threatened at the southwest corner of town by the West Branch of Wapsinonoc Creek and two were saved from damage by hastily installed plastic sheeting over doors and windows."

"The effect on county roads and highways was generally limited to brief periods of traffic interruption by overflow. One small county bridge in the downstream part of the basin was washed out.

Highways and roads were universally overflowed at the peak of the flood and West Liberty was virtually isolated by floodwaters for a short time. Interstate 80 was overflowed by the Middle Branch near the community of Springdale. However, there was no damage to the highway and no known interruption to traffic. South of West Liberty, the low relief and the Highway 76 (now Highway 70) fill permitted floodwater to flow south in the reach upstream (east) of the highway. This water eventually returned to the creek at some distance downstream through culverts under the highway, principally those for Goshen Ditch."

Figures 13 through 22 show typical scenes in West Liberty during the June 7, 1967 flood.

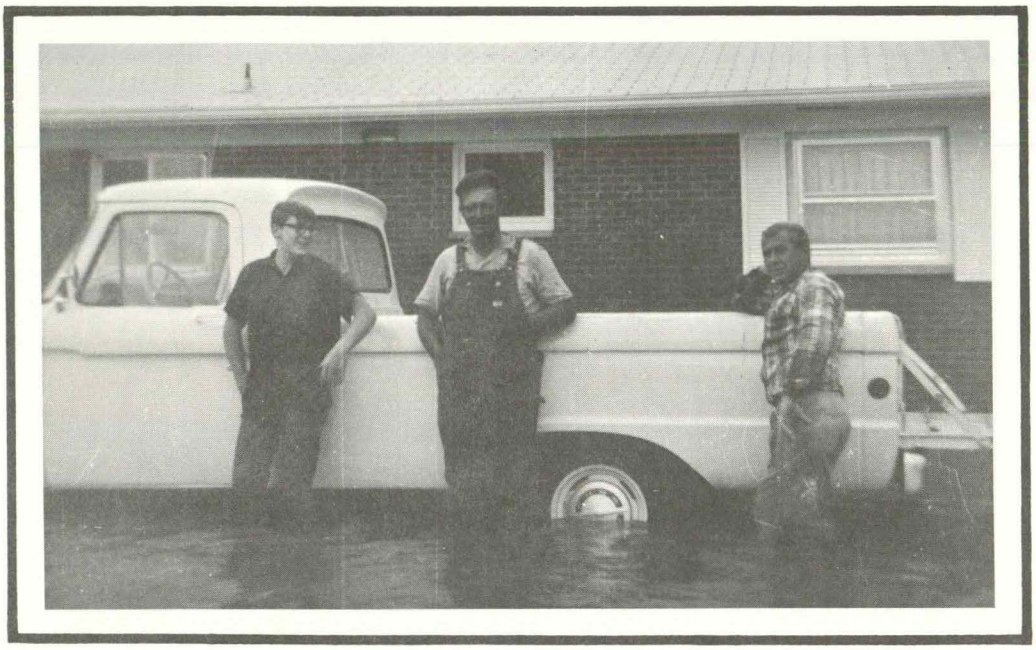


Figure 13. The third home from the West Branch Wapsinonoc Creek on Prairie Street during the flood of June 1967, looking south.

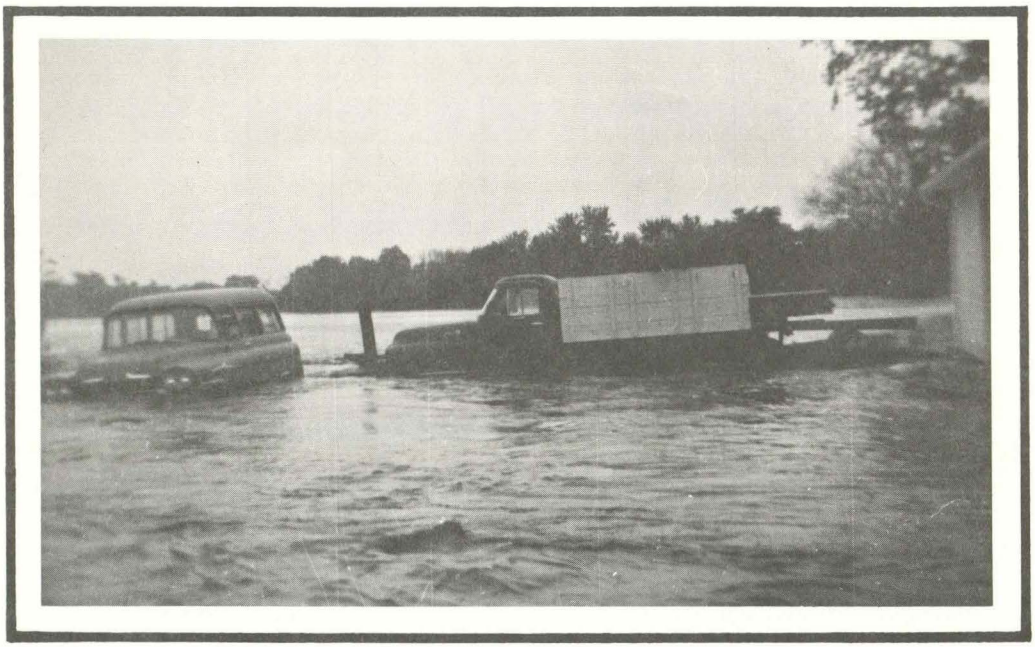


Figure 14. Looking south from Prairie Street during the flood of June 1967.

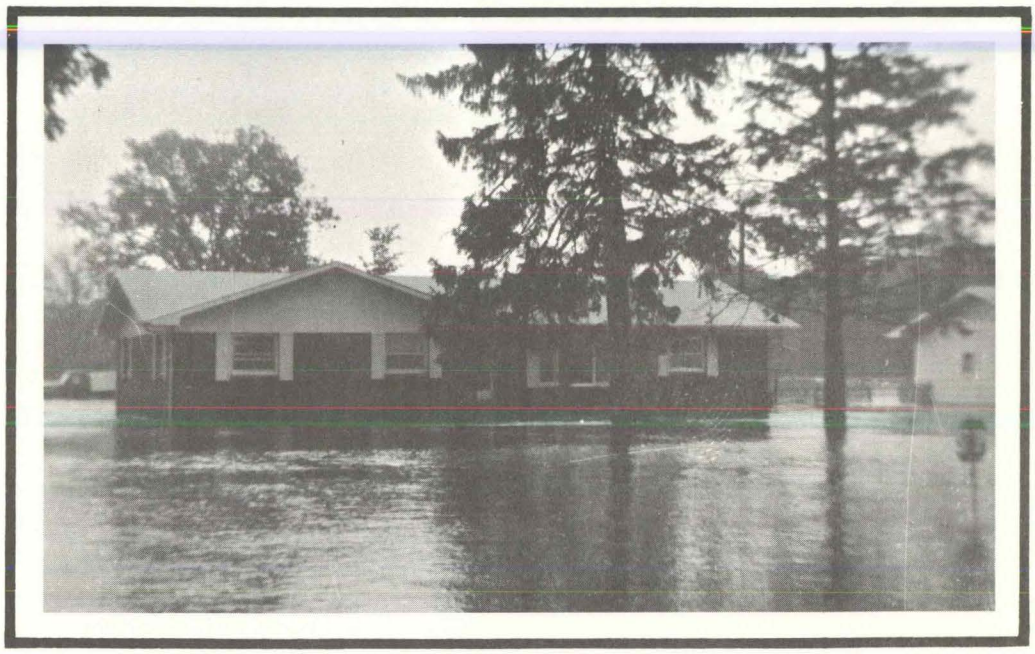


Figure 15. Looking south from Prairie Street during the flood of June 1967.

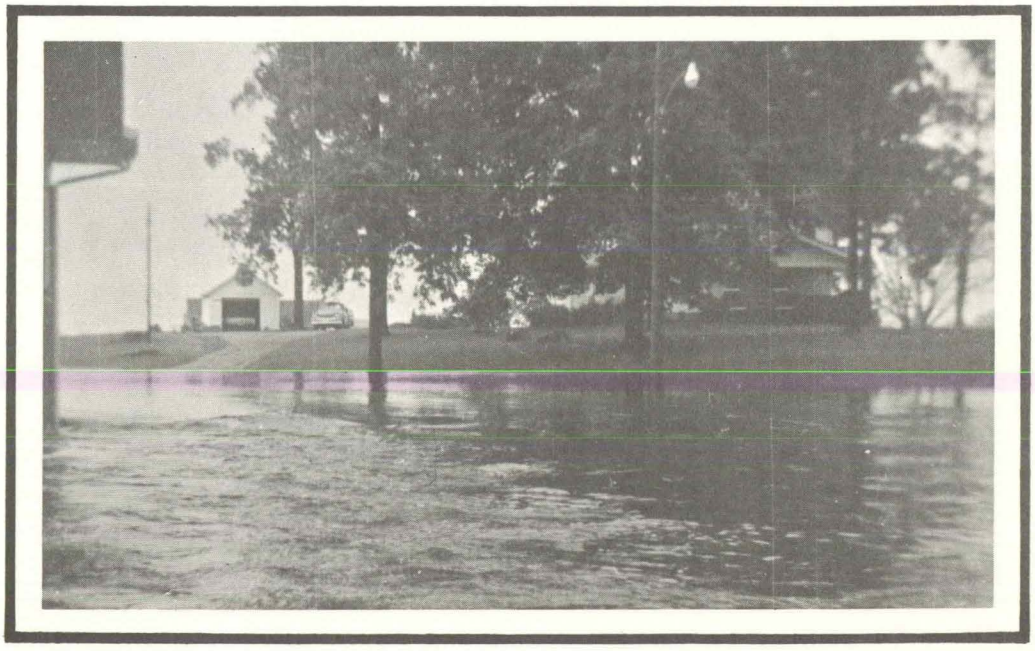


Figure 16. Looking north from Prairie Street during the flood of June 1967.

Figure 17. Looking southwest from Prairie Street during the flood of June 1967.

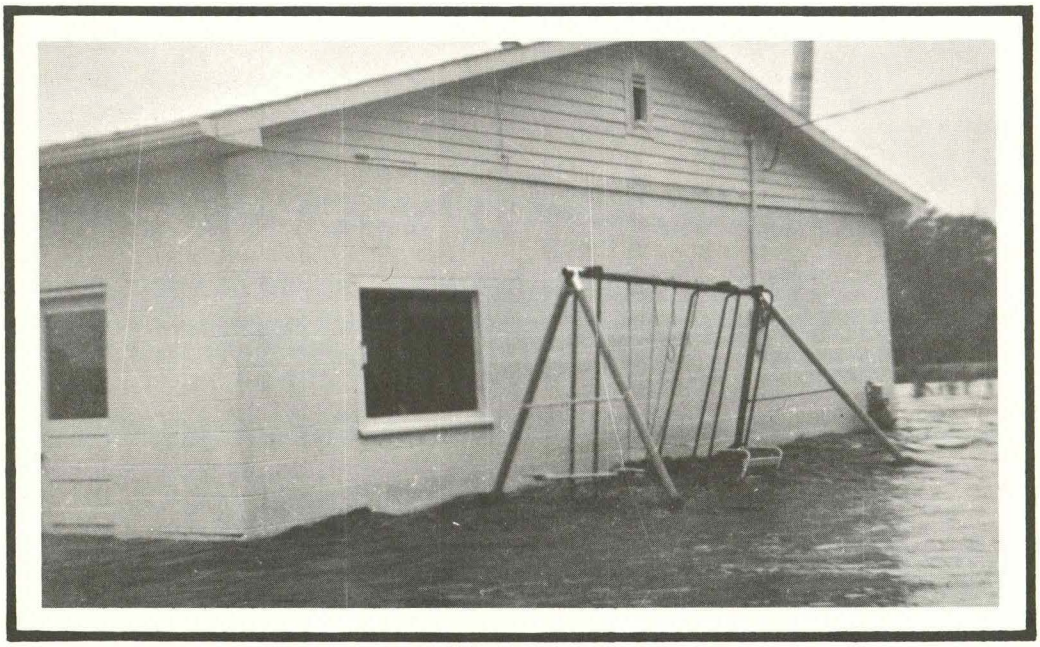


Figure 18. Looking southwest at a garage-office 100 feet south of Prairie Street during the flood of June 1967.

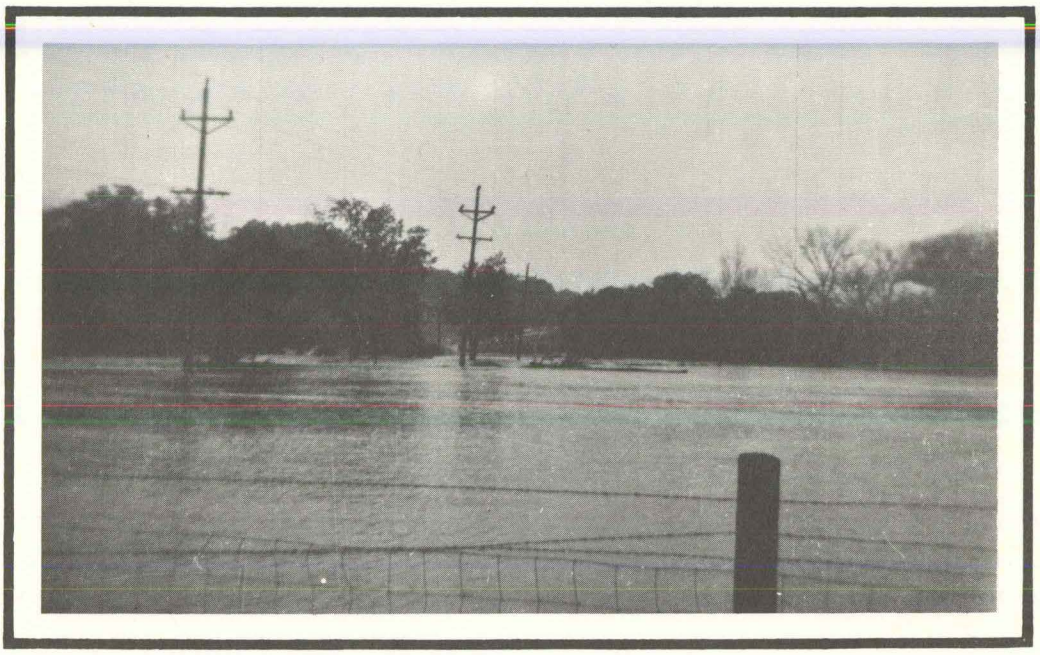


Figure 19. Looking west on Prairie Street during the flood of June 1967.

Figure 20. The third house west from Walnut Street during the flood of June 1967, looking southeast.

Figure 21. Looking northeast from corporate limits on Prairie Street during the flood of June 1967.

Figure 22. Looking northeast on Prairie Street during the flood of June 1967.

FUTURE FLOODS

This section of the report discusses the Standard Project Flood and the Intermediate Regional Flood on the Wapsinonoc Creek in the study area. The Standard Project Flood represents reasonable upper limits of expected flooding with the existing conditions of development and encroachment in the flood plain area. The Intermediate Regional Flood represents a flood that may reasonably be expected to occur more frequently.

Large floods from heavy general storms have occurred on streams in the general geographical and physiographical region of West Liberty. Similar heavy storms could occur over the Wapsinonoc Creek watershed that would result in floods comparable to those on neighboring streams. It is, therefore, desirable to consider storms and floods that have occurred in the region on watersheds whose topography, watershed cover, and physical characteristics are similar to those of Wapsinonoc Creek. Table 4 lists maximum known flood discharges that have occurred on watersheds in the region of West Liberty.

DETERMINATION OF INTERMEDIATE REGIONAL FLOOD

The Intermediate Regional Flood is defined as a flood having an average frequency of occurrence in the order of once in one hundred years, at a designated location, although the flood may occur in any year. Probability estimates are based on analysis of rainfall and runoff characteristics in the general region of the study area. The Intermediate Regional Flood represents a major flood which can occur on Wapsinonoc Creek. Peak discharges of this flood are shown in Table 5.

TABLE 4

MAXIMUM KNOWN FLOOD DISCHARGES ON

STREAMS IN THE REGION OF WEST LIBERTY, IOWA

Stream	Location	Drainage Area Sq. Mi.	Date	Peak Discharge Amount cfs	Peak Discharge Per Sq. Mi. cfs
Wapsipinicon River	At Independence, Iowa	1,048	June 14, 1947	21,500	20.5
Boyer River	At Logan, Iowa	871	June 16, 1957	23,600	27.1
Boone River	Near Webster City, Iowa	844	June 22, 1954	20,300	24.1
Nodaway River	At Clarinda, Iowa	762	June 13, 1947	31,100	40.8
Maple River	At Mapleton, Iowa	669	June 20, 1954	15,600	23.3
Upper Iowa River	At Decorah, Iowa	511	March 27, 1961	20,200	39.5
Middle Raccoon River	At Panora, Iowa	440	July 2, 1958	9,150	20.8
Beaver Creek	At New Hartford, Iowa	347	June 13, 1947	18,000	52.0
Little Cedar River	Near Ionia, Iowa	306	March 27, 1961	10,800	35.3
Pecatonica River	Near Darlington, Wisconsin	274	July 16, 1950	22,000	80.0
Turkey River	Near Spillville, Iowa	177	March 29, 1962	7,380	41.7
Little Maquoketa River	Near Durango, Iowa	130	June 13, 1947	23,000	176.9
Timber Creek	Near Marshalltown, Iowa	118	May 14, 1970	5,940	50.3
Big Creek	Near Mount Pleasant, Iowa	106	September 21, 1965	6,150	58.0
Weldon River	Near Leon, Iowa	104	August 6, 1959	48,600	467.3
East Fork One Hundred and Two River	Near Bedford, Iowa	92.1	April 26, 1969	7,160	77.7
Fox River	At Bloomfield, Iowa	87.7	May 6, 1960	8,600	98.1
Big Cedar Creed	Near Varina, Iowa	80.0	August 31, 1962	2,080	26.0
Walnut Creek	Near Hartwick, Iowa	70.9	September 3, 1958	4,930	69.5
Bear Creek	Near Monmouth, Iowa	61.3	September 21, 1965	7,340	119.7
Richland Creek	Near Haven, Iowa	56.1	March 30, 1960	3,650	65.1
Elk Creek	Near Decatur City, Iowa	52.5	July 9, 1969	7,710	146.8
Paint Creek	At Waterville, Iowa	42.8	July 29, 1970	5,010	117.0
Davids Creek	Near Hamlin, Iowa	26.0	July 2, 1958	22,700	873.1

TABLE 5

INTERMEDIATE REGIONAL FLOOD

PEAK DISCHARGES ON WAPSINONOC CREEK

Stream	Location	River Mile	Drainage Area sq. mi.	Discharge cfs
Wapsinonoc Creek	Downstream from junction with West Branch	8.12	107	20,800
	Upstream from junction with West Branch	8.14	52.2	14,600
	Downstream from junction with East Branch	11.65	45.7	13,700
Middle Branch	Upstream from junction with East Branch	11.67	25.2	10,200
West Branch	Mouth	8.13	54.8	14,900
East Branch	Mouth	11.66	20.2	9,100

DETERMINATION OF STANDARD PROJECT FLOOD

Only in rare instances has a specific stream experienced the largest flood that is likely to occur. Severe as the maximum known flood may have been on any given stream, it is commonly accepted that a larger flood can and probably will occur. The Corps of Engineers, in cooperation with the Weather Bureau, has made broad and comprehensive studies and investigations based on records of known storms and floods, and has evolved generalized procedures for estimating the flood potential of streams. These procedures have been used to determine a Standard Project Flood. It is defined as the largest flood that can be expected from the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical region involved excluding extremely rare combinations.

Standard Project Flood estimates have been made for Wapsinonoc Creek at the junction with the West Branch. Peak discharges of this flood are shown in Table 6.

TABLE 6

STANDARD PROJECT FLOOD

PEAK DISCHARGES ON WAPSINONOC CREEK

Stream	Location	River Mile	Drainage Area sq. mi.	Discharge cfs
Wapsinonoc Creek	Downstream from junction with West Branch	8.12	107	38,000
	Upstream from junction with West Branch	8.14	52.2	26,600
	Downstream from junction with East Branch	11.65	45.7	24,900
Middle Branch	Upstream from junction with East Branch	11.67	25.2	18,500
West Branch	Mouth	8.13	54.8	27,200
East Branch	Mouth	11.66	20.2	16,500

Frequency

The occurrence of the Standard Project Flood would be an extremely rare event; however, it could occur in any given year. This flood is a hypothetical event representing the critical flood volume and peak discharge that may be expected. Assignment of a frequency to this flood is considered impractical.

Possible Larger Floods

Floods larger than the Standard Project Flood are possible; however, the combination of factors necessary to produce such floods

would seldom occur. The consideration of floods of this magnitude depends on the consequences should the flood occur. Extensive damage may be avoided by consideration of the Standard Project Flood in the regulation of flood plain development.

HAZARDS OF GREAT FLOODS

The damage caused by any flood depends, in general, on the area flooded, the height of flooding, the velocity of flow, rate of rise, duration of flooding, and amount and character of the flood plain development. The melting of the winter accumulation of snow, with or without additional runoff from rainfall, produces late winter and early spring floods. Late spring and early summer floods are the result of heavy general rainfall over the basin.

Ice jams may occur on Wapsinonoc Creek and produce higher stages than would be obtained with open river conditions assumed for this report. However, ice jams are unpredictable and their occurrence is mentioned as a potential flood risk.

Areas Flooded and Heights of Flooding

The areas flooded along Wapsinonoc Creek by the Standard Project Flood and the Intermediate Regional Flood are shown in Plates 3 through 7. Depths of flow can be estimated from the water surface profiles shown on Plates 8, 9, and 10 and the cross sections shown on Plates 11 and 12.

The water surface profiles were computed using stream characteristics determined from topographic maps and valley cross sections. The elevations shown in Plates 8, 9, and 10 and the overflow areas shown in Plates 3 through 7 have been determined with an accuracy consistent with the purpose of this study and the accuracy of the basic data.

The water surface profiles of the Standard Project Flood and the Intermediate Regional Flood depend in part upon the degree of destruction or clogging of various bridges during the flood. Because it is impossible to forecast these events, it was assumed that all bridge structures would stand and that no clogging by debris or ice would occur.

Figures 23 through 34 show the heights that would be reached by the Standard Project Flood and the Intermediate Regional Flood on the facilities existing on the Wapsinonoc Creek flood plain.

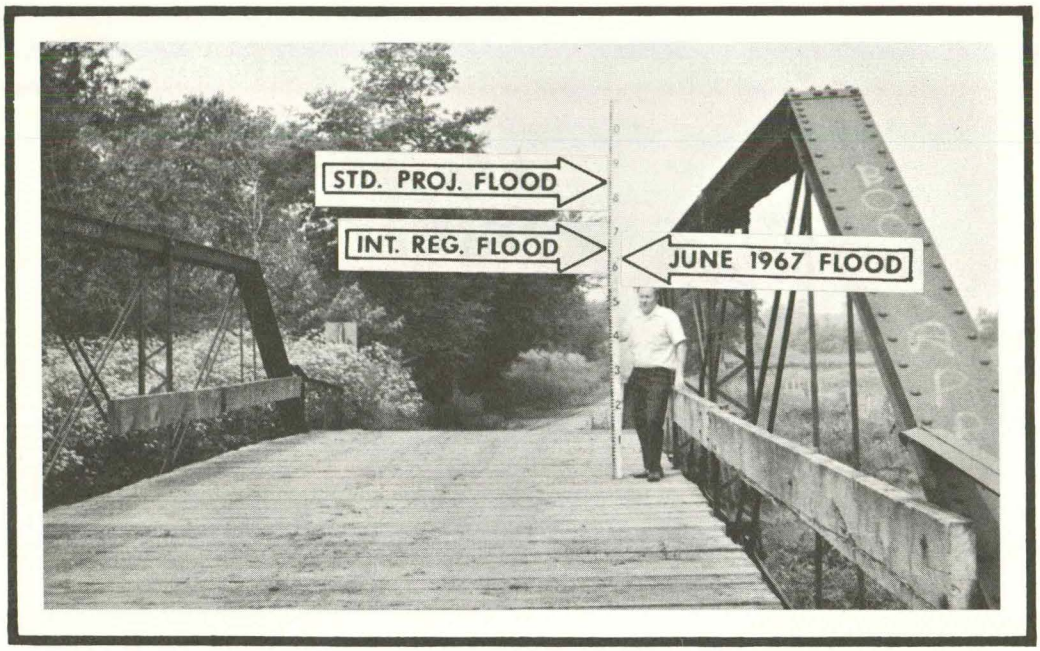


Figure 23. Upstream side of County Road bridge at mile 7.12 (Wapsinonoc Creek), looking West.

Figure 24. Upstream side of Iowa Highway 70 bridge at mile 9.35 (Wapsinonoc Creek), looking north.

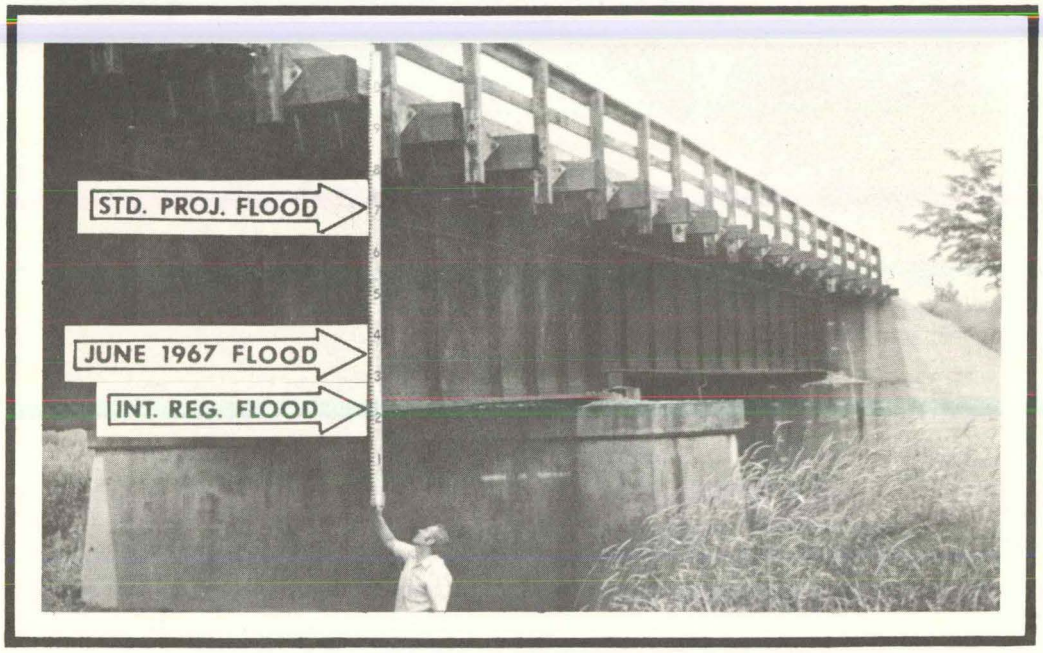


Figure 25. Upstream side of C.R.I.&P. RR bridge at mile 10.39 (Wapsinonoc Creek), looking west.

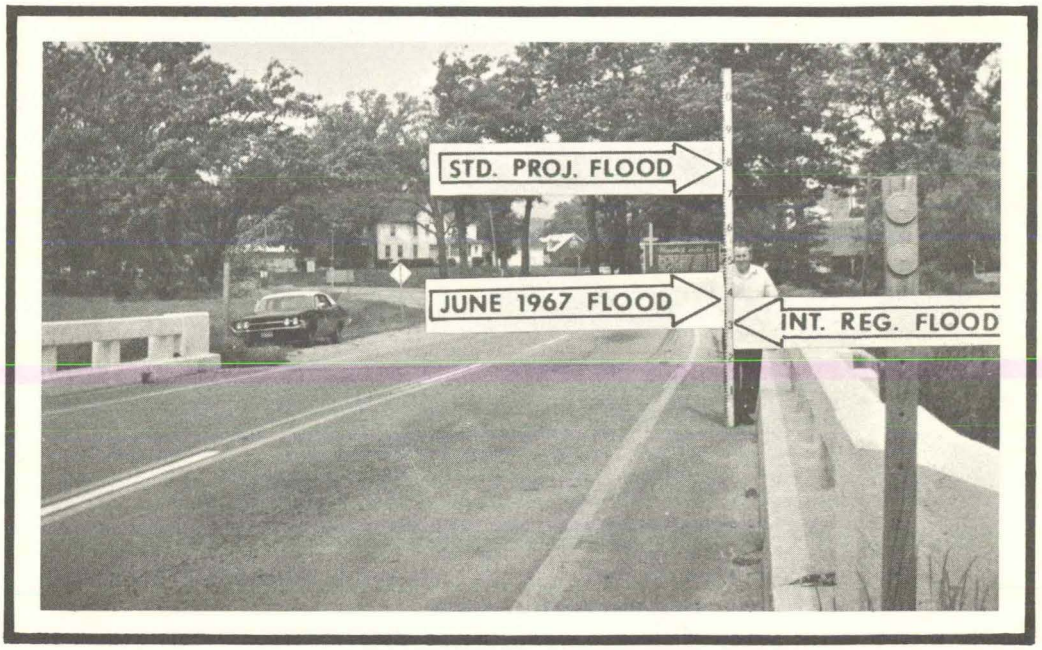


Figure 26. Upstream side of U. S. Highway 6 bridge at mile 10.56 (Wapsinonoc Creek), looking west.

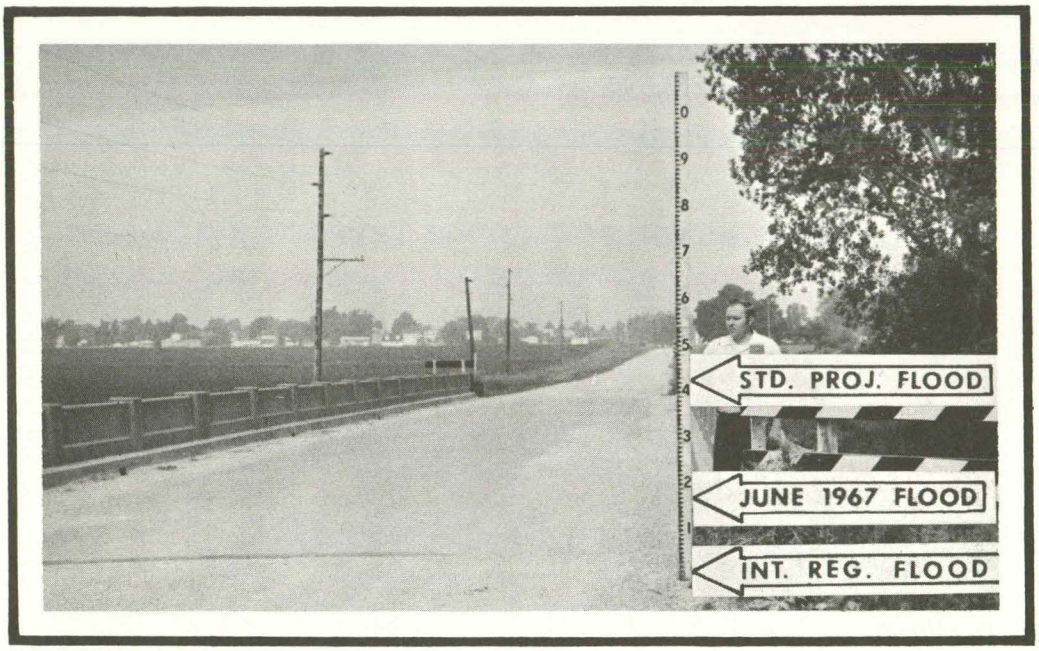


Figure 27. Upstream side of Rainbow Drive(Maxson Ave.)bridge at mile 11.24 (Wapsinonoc Creek), looking west.

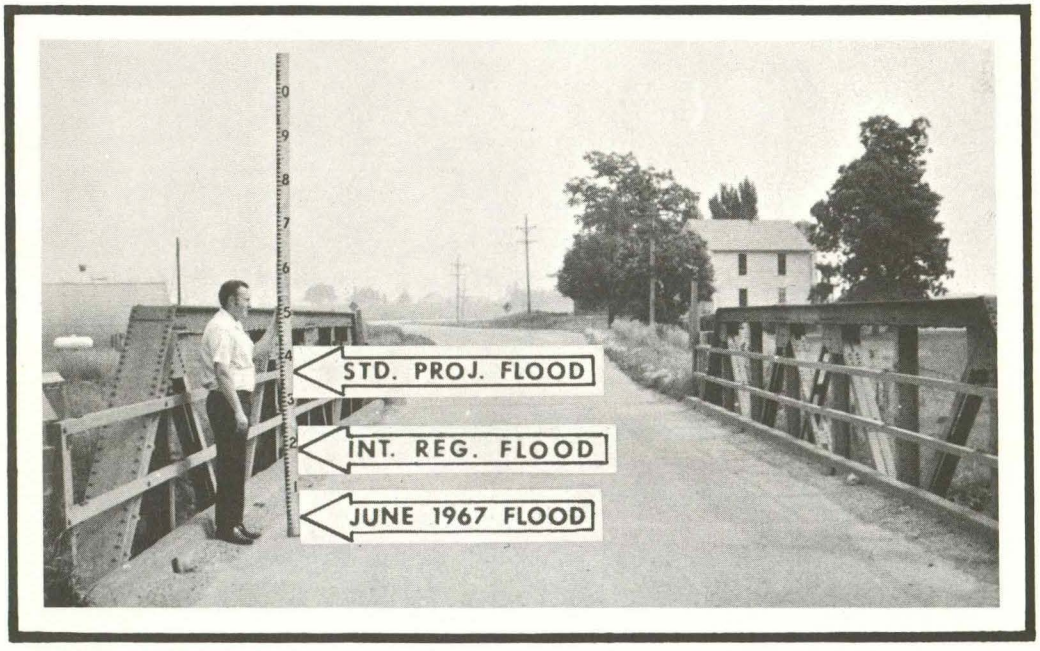


Figure 28. Upstream side of County Road X-40 bridge at mile 12.45 (Middle Branch), looking north.

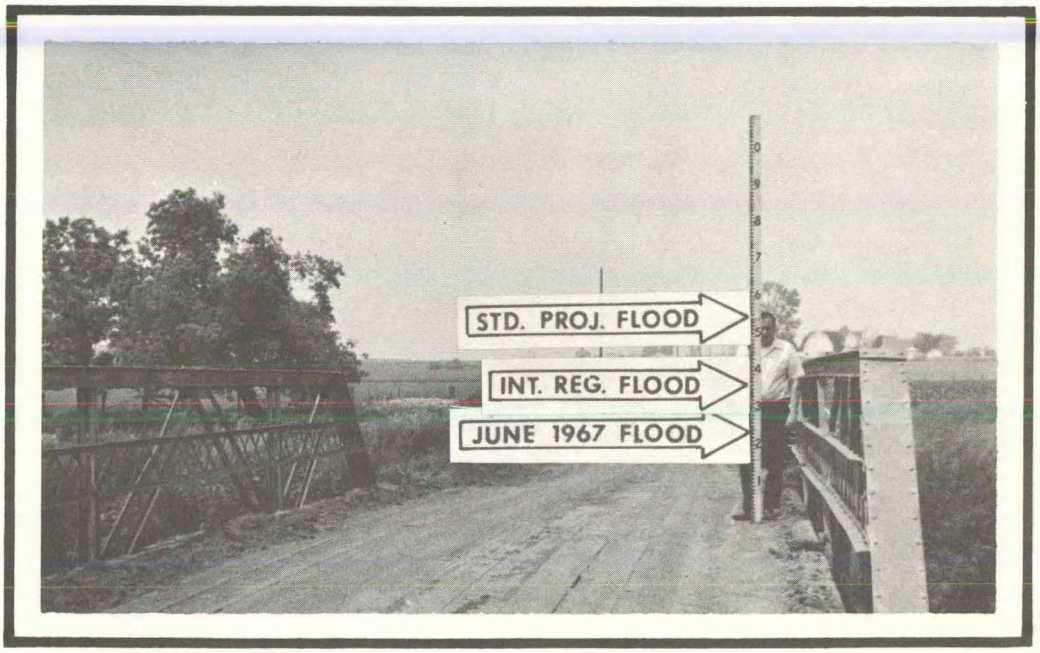


Figure 29. Upstream side of Cedar-Muscatine County Line Road bridge at mile 13.18 (Middle Branch), looking west.

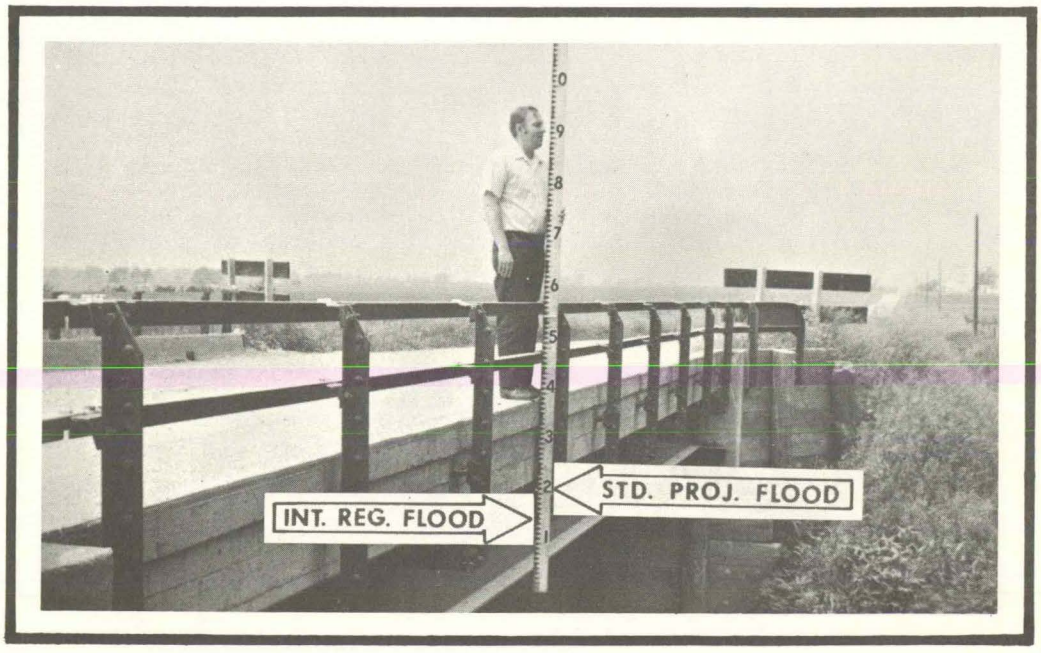


Figure 30. Upstream side of Cedar-Muscatine County Line Road bridge at mile 13.47 (East Branch), looking west.

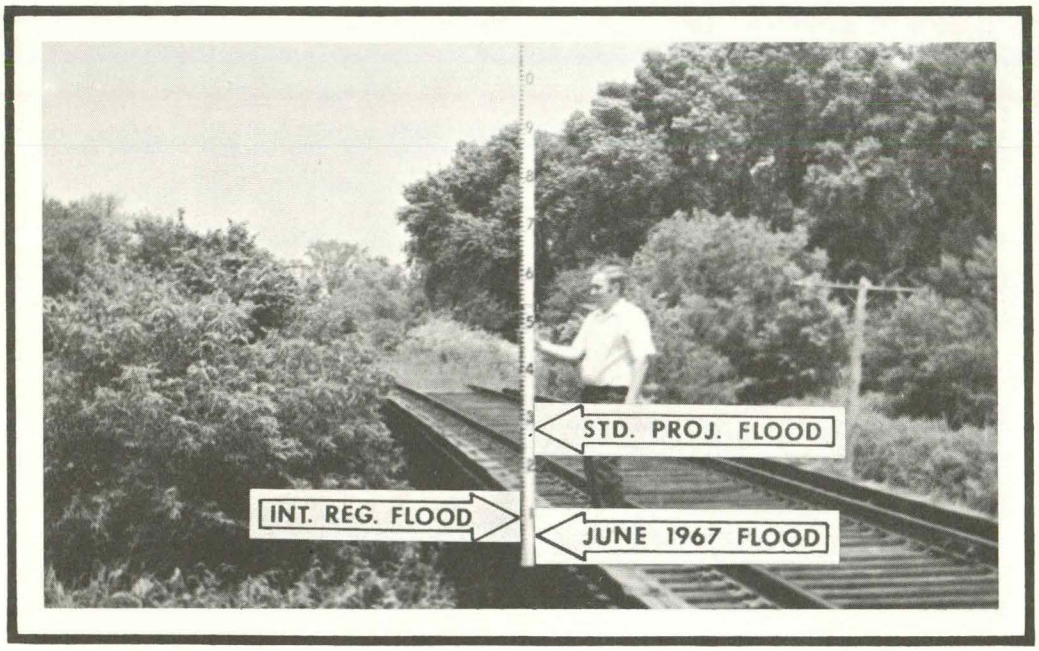


Figure 31. Upstream side of C.R.I.&P. RR bridge at mile 9.62 (West Branch), looking north.

Figure 32. Upstream side of County Road bridge at mile 9.97 (West Branch), looking north.

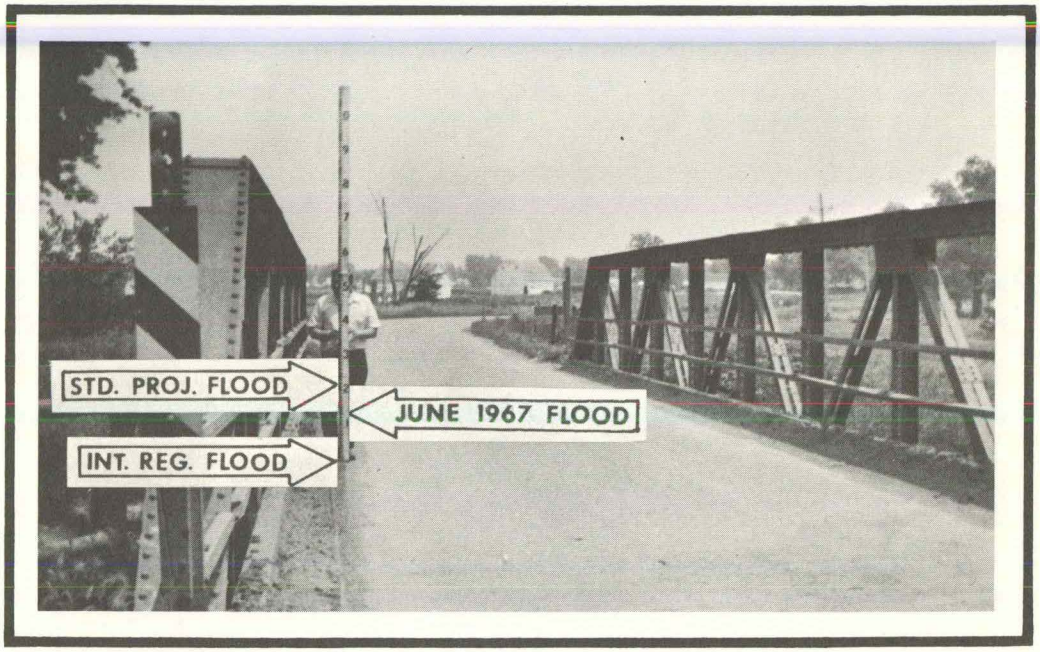


Figure 33. Upstream side of County Road bridge at mile 10.85 (West Branch), looking east.

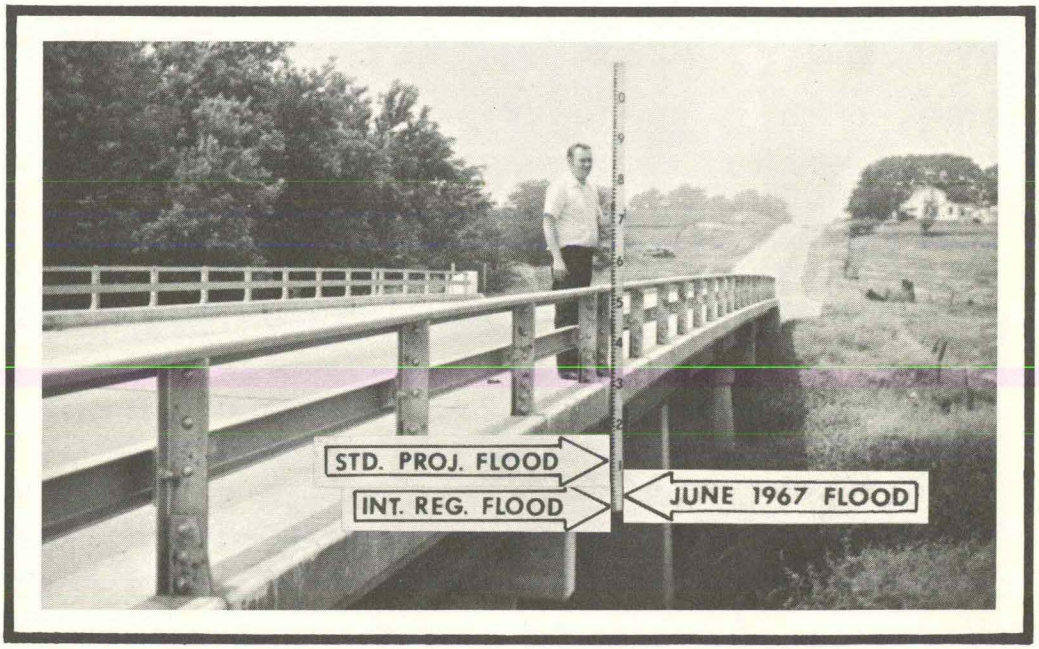


Figure 34. Upstream side of U. S. Highway 6 bridge at mile 13.22 (West Branch), looking west.

Velocities

Water velocities during floods depend largely on the size and shape of the cross section, the condition of the stream, and the bed slope, all of which vary on different streams and at different locations on a single stream.

Tables 7 and 8 list the maximum velocities that would occur in the main channel and overbank areas of Wapsinonoc Creek during the Intermediate Regional and Standard Project Floods. Velocities listed are representative of open river conditions and may be higher at flow constrictions.

TABLE 7

MAXIMUM CHANNEL VELOCITIES

Stream	Location Mile	Maximum Velocities: Int. Reg. Flood ft. per sec.	Maximum Velocities: Std. Proj. Flood ft. per sec.
Wapsinonoc Creek	8.04	-	5.7
	12.15	5.4	-
West Branch	12.05	5.1	-
	10.53	-	6.2
East Branch	12.42	6.0	5.1

TABLE 8

MAXIMUM OVERBANK VELOCITIES

Stream	Location Mile	Maximum Velocities: Int. Reg. Flood ft. per sec.	Maximum Velocities: Std. Proj. Flood ft. per sec.
Wapsinonoc Creek	11.00	3.1	3.5
West Branch	9.41	2.5	-
	10.53	-	3.1
East Branch	12.42	2.6	2.5

GUIDELINES FOR FLOOD DAMAGE REDUCTION

General

Man has been building on and occupying the flood plains of Iowa rivers and streams since the arrival of the pioneer settlers. The streams first provided transportation and water supply. Later, milldams were built and early highways and railroads were constructed along the gentle valley grades. Today the continuing growth of river cities results in ever increasing encroachment on the flood plains.

Streams in flood may carry thousands of times more flow than during low flow periods. These vast quantities of floodwater caused little damage until the works of man invaded the flood plain. Man has learned through bitter experience that floods periodically inundate portions of the flood plain, damaging or sweeping away roads, buildings, and homes. In addition to these property damages, floods often pose a severe threat to human life and health.

Historically, man has tried to reduce flood damages through structural measures to confine floods within the riverbanks. Many different types of control works have been constructed for this purpose. Dams and reservoirs have been constructed to store water for gradual release after the threat of flooding has passed. Channel improvements have been used to remove constrictions and improve flow characteristics so that future flood stages are reduced. Watershed treatment involves the regulation of the rate of runoff to the main stem and tributaries. Levees, dikes, and floodwalls have been constructed to confine the river to a definite course at stages which may be well above the adjacent flood plain. These methods are generally very costly and therefore are more often used in areas where development has already heavily encroached on the

flood plain, or where future plans call for extensive use of the flood plain. However, continued uncontrolled encroachment on the flood plain has taken place faster than construction of flood control works, with the result that development in flood hazard areas with their associated flood damages have been steadily increasing across the nation.

The increase in flood hazards and flood damages, despite the expenditure of billions of dollars of tax funds for the construction of flood control works, has led to a new approach to the reduction of these hazards and damages; namely the planned management and development of land adjacent to rivers by establishing land use patterns compatible with the flood hazards. The flood plain management plan, if fully integrated into the comprehensive land use and development plan of an area and implemented by means of appropriate zoning, subdivision and building regulations, can prevent the creation of new flood hazard areas. While flood plain areas can probably never be considered entirely flood free, comprehensive planning allows selection of the type of development desired consistent with the flood risk. A reasonable level of flood protection and flood damage prevention can be built into a project during initial construction.

Management of the flood plain can be carried out by a variety of means: encroachment lines, zoning ordinances, subdivision regulations, and modifications or additions to building codes. These methods will be described subsequently in some detail. However, it is not the purpose or intent of this report to recommend the specific technique to be used. Implementation of flood plain management techniques is the responsibility of State and local governments. This report is provided to furnish the State and local governments with an engineering basis for their appropriate action. The data in this report can be used in conjunction with

comprehensive land use plans to develop a reasonable and desirable plan for managing the Wapsinonoc Creek flood plain in the study reach.

Fortunately, the need for flood plain planning on Wapsinonoc Creek has been recognized by local interests. This means that future damages in the study area can be reduced, at little or no cost to the taxpayer, by developing and enacting flood plain regulations. The flood data in this report, together with a planning program for future land use, will enable State and local interests to minimize flood damage risks.

Flood plain management may also include other methods which are helpful, particularly in special localized areas. These include park and open space developments, evacuation, urban redevelopment, flood proofing, tax reductions, and warning signs.

Encroachment Lines

A designated floodway is the area of channel and those portions of the flood plains adjoining the channel which are reasonably required to carry and discharge the floodwater or flood flow of a flood of a specific size without unduly raising upstream water surface elevations. Encroachment lines or limits are the lateral boundaries of this floodway. They are two definitely established lines, one on each side of the river. Between these lines no construction or filling should be permitted which could cause an impedance to flow. If possible, encroachment limits should be established before extensive development has taken place to avoid costly clearance of existing structures. Final choice of the magnitude of the flood, which will determine the size of the floodway, is a matter for State and local decision. In the final analysis, the flood magnitude is determined by consideration of local land use plans and comprehensive statewide flood control plans.

The data contained in this report can be used by State and local interests to determine the size of the regulatory flood, and to establish floodway encroachment lines or limits and land use districts. Problems or situations regarding encroachment at specific points in the study area should be referred to the appropriate State agency. In Iowa, the responsible agency is the Iowa Natural Resources Council at Des Moines.

Zoning

Zoning is a legal tool used by cities, towns, and counties to control and direct the use and development of land and property within their jurisdiction. Division of a municipality or county into various zones should be the result of a comprehensive planning program for the entire area, with the purpose of guiding its growth. The planning program as such has no legal status. Zoning, as described above, is a legal tool that is used to implement and enforce the details of the planning program. Its objectives are the conservation of property value and the achievement of the most appropriate and beneficial use of available land. Flood plain zoning is not a special type of ordinance, but merely another set of provisions which can be incorporated into a comprehensive zoning ordinance so that flood damage can be minimized. Zoning regulations may be used in lieu of encroachment laws or as a supplement to them. Thus, designated floodways may be zoned for the purpose of passing floodwaters and for other limited uses that do not conflict with that primary purpose. The ordinance may also establish regulations for the flood plain areas outside the floodway. These include designating elevations above which certain types of development must be constructed. The enabling statutes which authorize municipalities and counties in Iowa to adopt zoning regulations are Chapters 358A and 414, respectively, of the Iowa Code 1971, as amended.

Subdivision Regulations

A subdivision can be defined in a broad sense as a tract or parcel of land divided into two or more lots or other units for the purpose of sale or building development. Subdivision regulations are used by local governments to specify the manner in which land may be subdivided within the entire area under their jurisdiction. Regulations may state the required width of streets, requirements for curbs and gutters, size of lots, elevation of land, freedom from flooding, size of floodways, and other points pertinent to the welfare of the community. It has been found that responsible subdividers favor such regulations because they discourage land speculation and prevent unscrupulous competition from other subdividers who might develop flood hazard land with less than minimum desirable standards. Experience has also shown that various municipal costs are reduced during flood periods and that the annual maintenance required for streets and utilities is minimized. Subdivision regulations provide an efficient means of controlling development in areas which are presently undeveloped. By introducing such regulations early in these areas, planned flood plain development can take place without being hampered by nonconforming uses.

Building Codes

The primary purpose of building codes is to set up minimum standards for controlling the design, construction, and quality of materials used in buildings and structures within a given area, so that life, health, property, and public welfare are safeguarded. Since it may not be practical to prevent the location of any building in all areas subject to flooding, building codes can be used to minimize structural and consequential damages resulting from flood velocities and inundation. Some of the methods adaptable to building codes are:

(1) Prevent flotation of buildings from their foundations by specifying anchorage.

(2) Establish basement elevations and minimum first floor elevations consistent with potential flood occurrences.

(3) Prohibit basements in those areas subject to very shallow, infrequent flooding where filling and slab construction would prevent virtually all damage.

(4) Require reinforcement to withstand water pressure or high velocity flow and restrict the use of materials which deteriorate rapidly in the presence of water.

(5) Prohibit equipment that might be hazardous to life when submerged. This includes chemical storage, boilers, or electrical equipment.

Flood Plain Regulations

Flood plain regulation involves the establishment of legal tools with which to control the extent and type of future development which will be allowed to take place within the flood plain. The regulations must be definitive enough so that there is general public understanding of the problem and the choices of action which the regulations provide. Regulations must be specific enough so that criteria, such as minimum first floor elevations, type of construction, or encroachment limits, are known for the area in question. There are basically two main objectives of regulation. The first is to assure and guarantee the retention of an adequate floodway for the river - floodway being defined as the channel and those portions of the flood plains adjoining the channel, which are reasonably required to carry and discharge the floodwater or flood flow of a flood of a specific size without unduly raising upstream water surface elevations. Its size is based on sound economic and hydraulic criteria. Development and use of the areas

lying on either side of the floodway, and which may become inundated by the regulatory flood, should be planned and controlled. The second objective of regulation is to encourage sound land use consistent with the flood hazard and the community land use needs.

The water surface profiles combined with the detailed information contained in this report, provide a basis for formulation of flood plain regulations.

GLOSSARY OF TERMS

Flood. An overflow of lands not normally covered by water and that are used or useable by man. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river or stream or an ocean, lake, or other body of standing water.

Normally, a "flood" is considered as any temporary rise in streamflow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased streamflow, and other problems.

Flood Crest. The maximum stage or elevation reached by the waters of a flood at a given location.

Flood Peak. The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest.

Flood Plain. The relatively flat area or lowlands adjoining the channel of a river, stream or watercourse, or ocean, lake, or other body of standing water, which has been or may be covered by floodwater.

Flood Profile. A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage. The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

Floodway. The channel of the stream or body of water and that portion of the flood plain that is inundated by a flood and used to carry the flood flow.

Head Loss. The effect of obstructions, such as narrow bridge openings or buildings that limit the area through which water must flow, raising the surface of the water upstream from the obstruction.

Intermediate Regional Flood. A flood having an average frequency of occurrence in the order of once in 100 years, although the flood may occur in any year. It is based on statistical analyses of rainfall and runoff characteristics in the "general region of the watershed".

Left Bank. The bank on the left side of a river, stream, or watercourse, looking downstream.

Low Steel (or Underclearance). See "Underclearance".

Right Bank. The bank on the right side of a river, stream, or watercourse, looking downstream.

Standard Project Flood. The flood that may be expected from the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. Peak discharges for these floods are generally about forty percent to sixty percent of the Probable Maximum Floods for the same basins. Such floods, as used by the Corps of Engineers, are intended as practicable expressions of the degree of protection that should be sought in the design of flood control works, the failure of which might be disastrous.

Thalweg. The line following the deepest part of the bed or channel of a stream.

Underclearance. The lowest point of a bridge or other structure over or across a river, stream, or watercourse, that limits the opening through which water flows. This is referred to as "low steel" in some regions.

AUTHORITY, ACKNOWLEDGMENTS, AND INTERPRETATION OF DATA

This report has been prepared in accordance with the authority granted by the Flood Control Act of 1960 (PL 86-645), as amended.

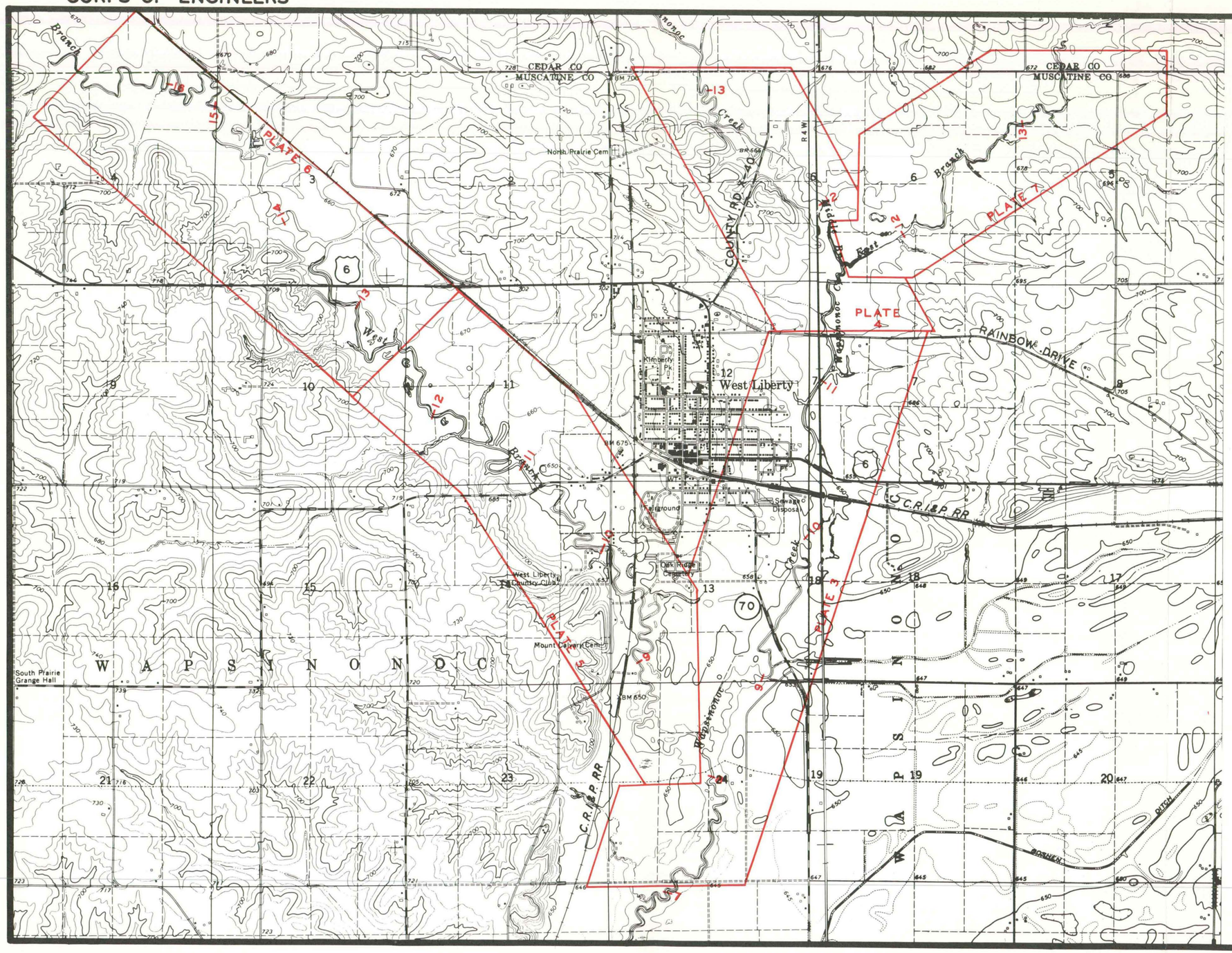
The cooperation and assistance given by the following agencies and numerous private citizens, in the accumulation of the information used in this report is greatly appreciated.

City of West Liberty
Iowa Natural Resources Council
U. S. Geological Survey
U. S. Weather Bureau (E.S.S.A.)

The Rock Island District, Corps of Engineers, upon request, will provide limited technical assistance in the interpretation and application of the data presented in this report.

CORPS OF ENGINEERS

U. S. ARMY



NOTES:

1. PLATE NUMBERS CORRESPOND TO TOPOGRAPHIC MAP OF FLOODED AREAS.
2. STATIONING IS MEASURED IN MILES FROM THE MOUTH OF WAPSINONOC CREEK.

FLOOD PLAIN INFORMATION REPORT

WEST LIBERTY, IOWA

INDEX SHEET FOR FLOODED AREA MAPS

WAPSINONOC CREEK

2500 1500 500 0 2500 5000

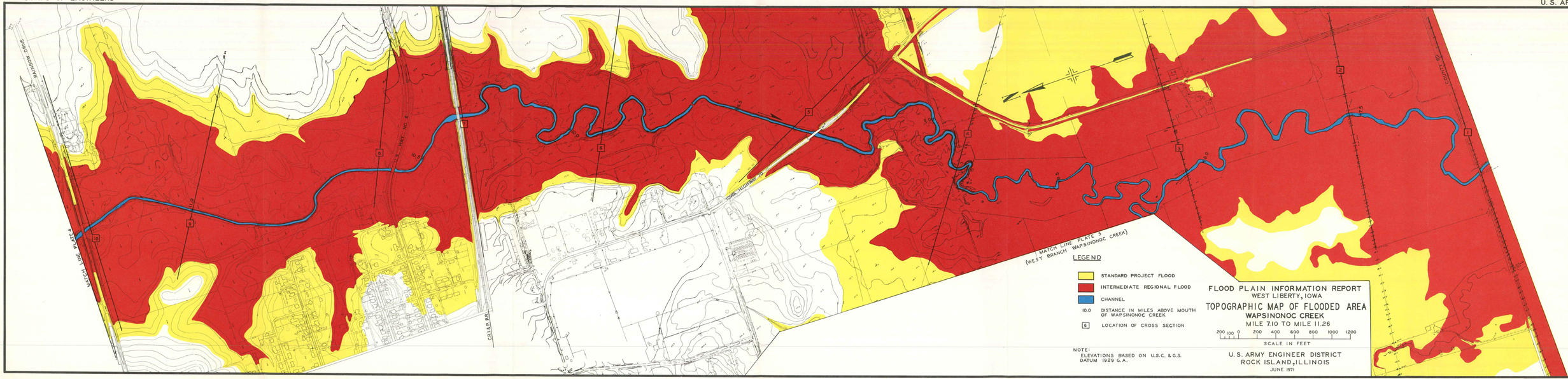
APPROX. SCALE IN MILES

U. S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1971

PLATE 2

CORPS OF ENGINEERS

U. S. ARMY



LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- 10.0 DISTANCE IN MILES ABOVE MOUTH OF WAPSINONOC CREEK
- [6] LOCATION OF CROSS SECTION

NOTE:
ELEVATIONS BASED ON U.S.C. & G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT
WEST LIBERTY, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA
WAPSINONOC CREEK
MILE 7.10 TO MILE 11.26

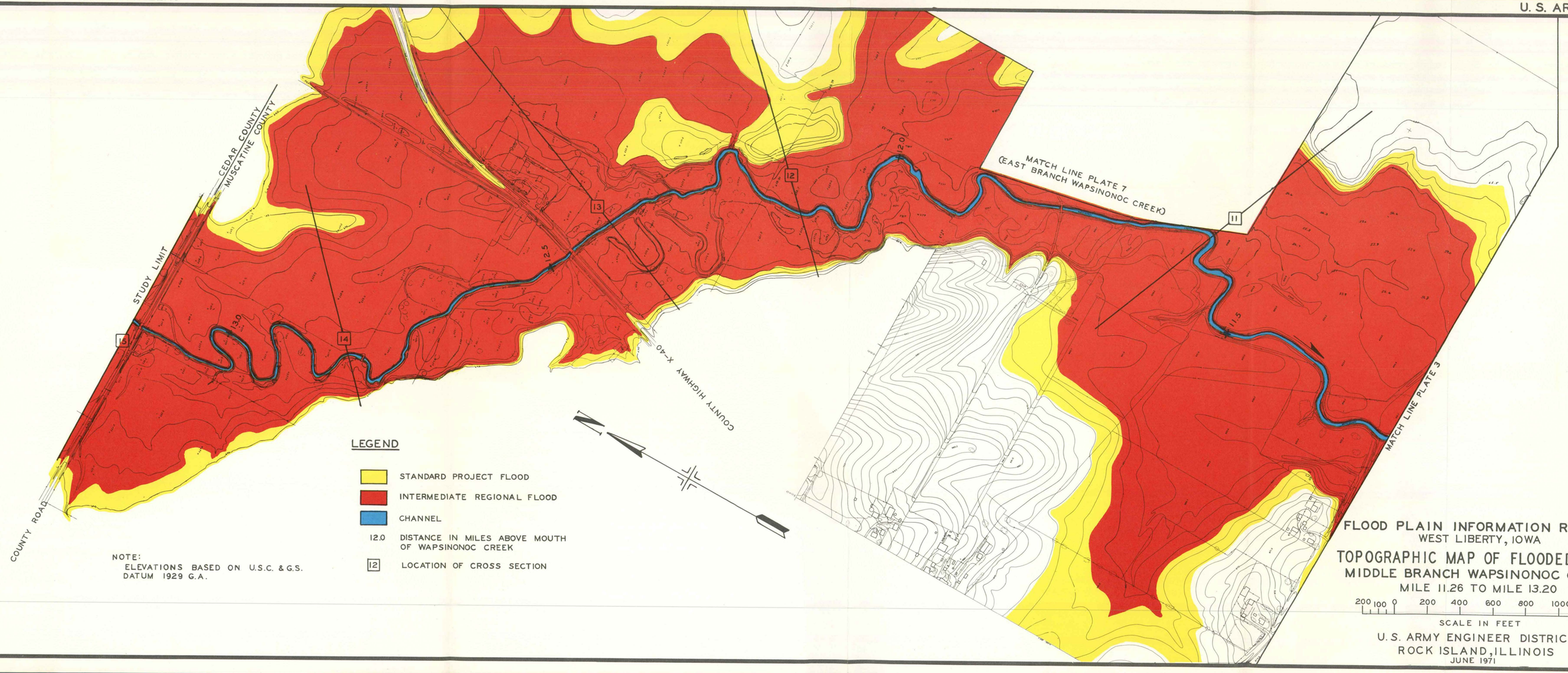
200 100 0 200 400 600 800 1000 1200
SCALE IN FEET

U. S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1971

PLATE 3

CORPS OF ENGINEERS

U. S. ARMY



FLOOD PLAIN INFORMATION REPORT

WEST LIBERTY, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

MIDDLE BRANCH WAPSINONOC CREEK

MILE 11.26 TO MILE 13.20

200 100 0 200 400 600 800 1000 1200

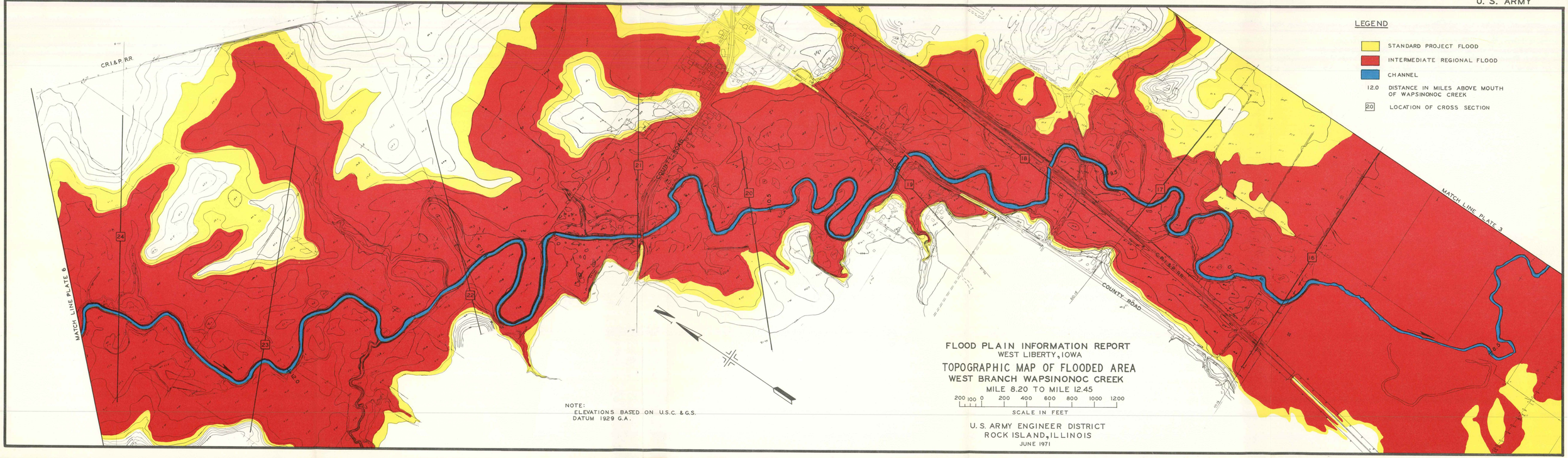
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1971

PLATE 4

CORPS OF ENGINEERS

U. S. ARMY



NOTE:
ELEVATIONS BASED ON U.S.C. & G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT
WEST LIBERTY, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA
WEST BRANCH WAPSINONOC CREEK
MILE 8.20 TO MILE 12.45

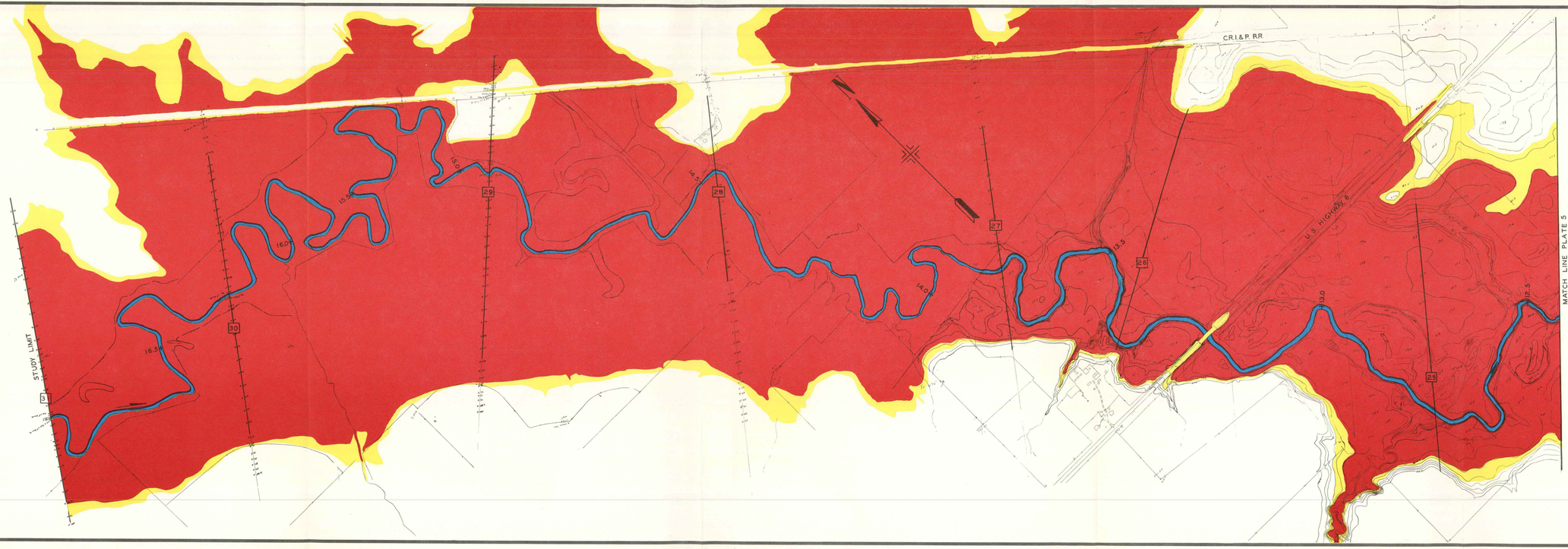
200 100 0 200 400 600 800 1000 1200
SCALE IN FEET

U. S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1971

PLATE 5

CORPS OF ENGINEERS

U.S. ARMY



LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- 13.5 DISTANCE IN MILES ABOVE MOUTH OF WAPSINONOC CREEK
- 26 LOCATION OF CROSS SECTION

NOTE:
ELEVATIONS BASED ON U.S.C. & G.S. DATUM 1929 G.A.

FLOOD PLAIN INFORMATION REPORT
WEST LIBERTY, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA
WEST BRANCH WAPSINONOC CREEK
MILE 1245 TO MILE 16.85

200 100 0 200 400 600 800 1000 1200
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1971

PLATE 6

CORPS OF ENGINEERS

U. S. ARMY

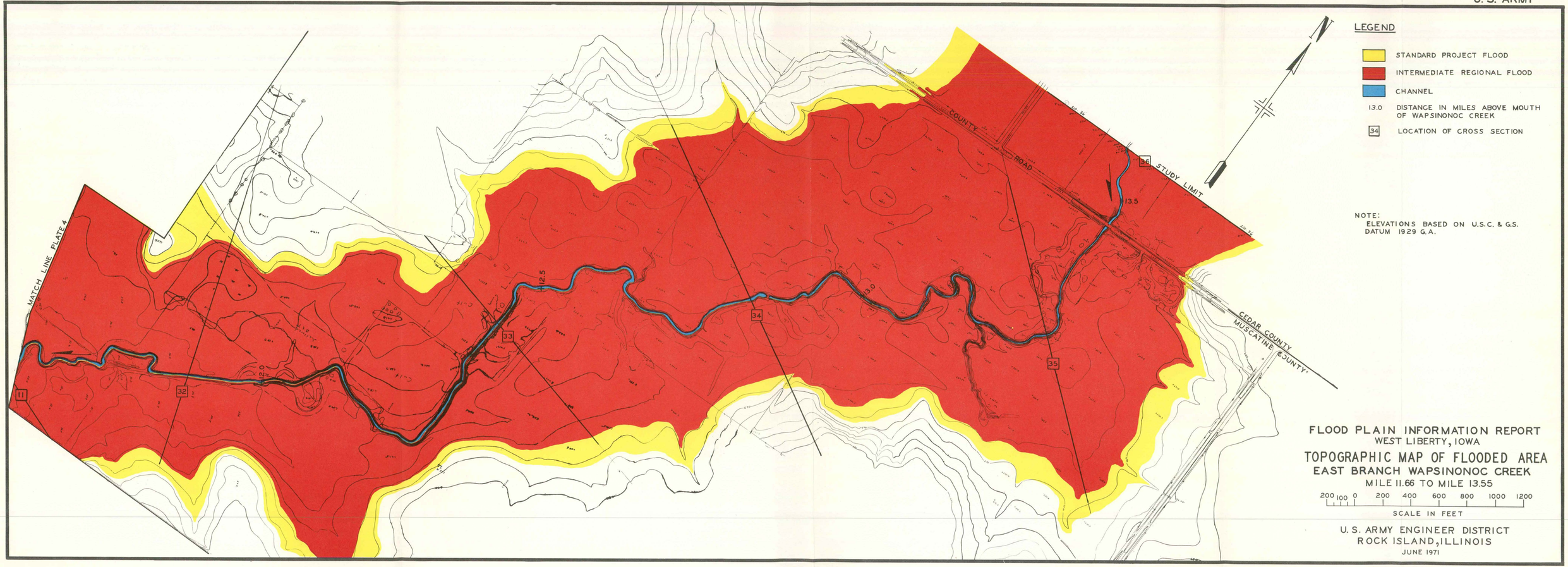
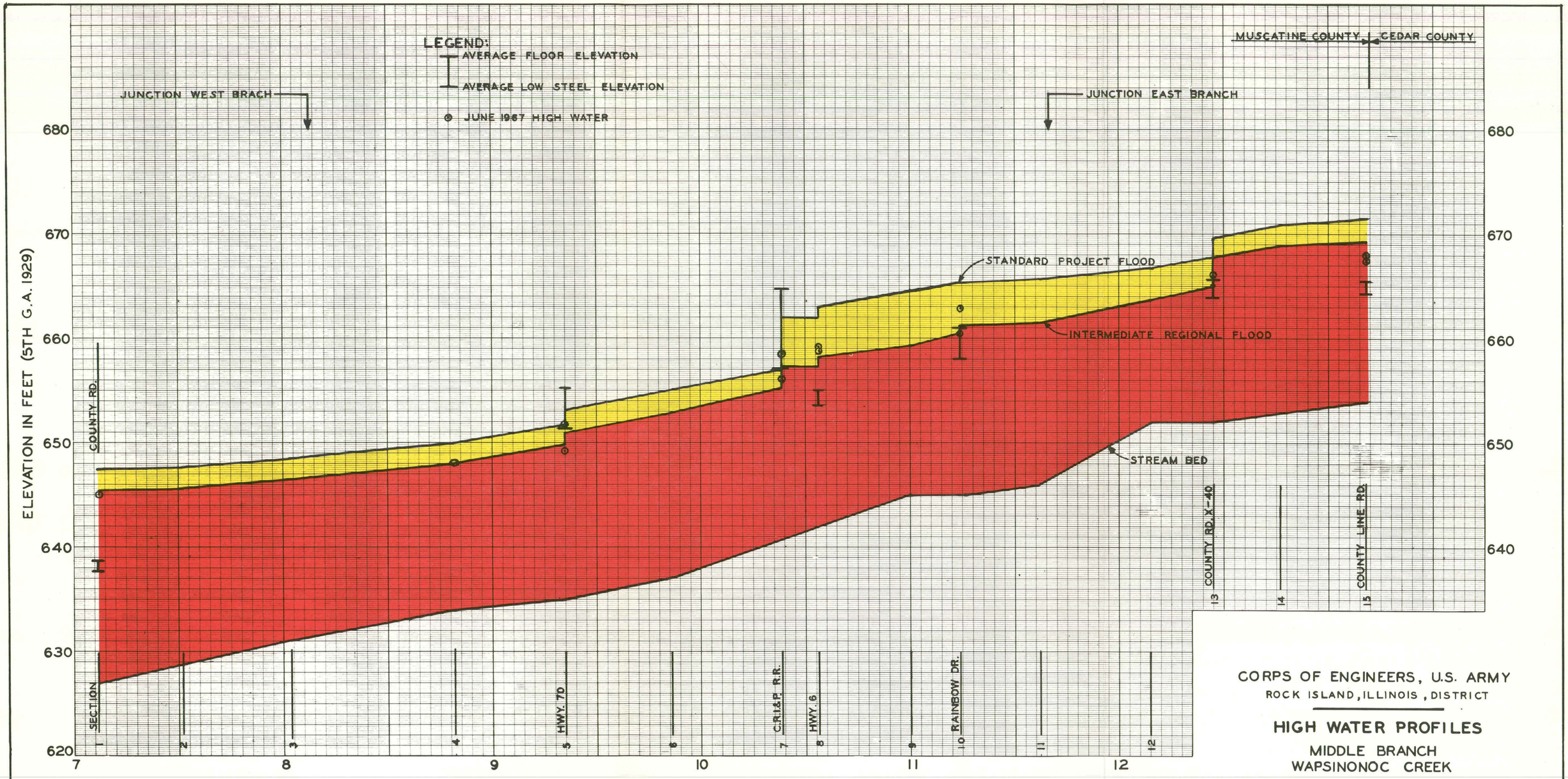


PLATE 7



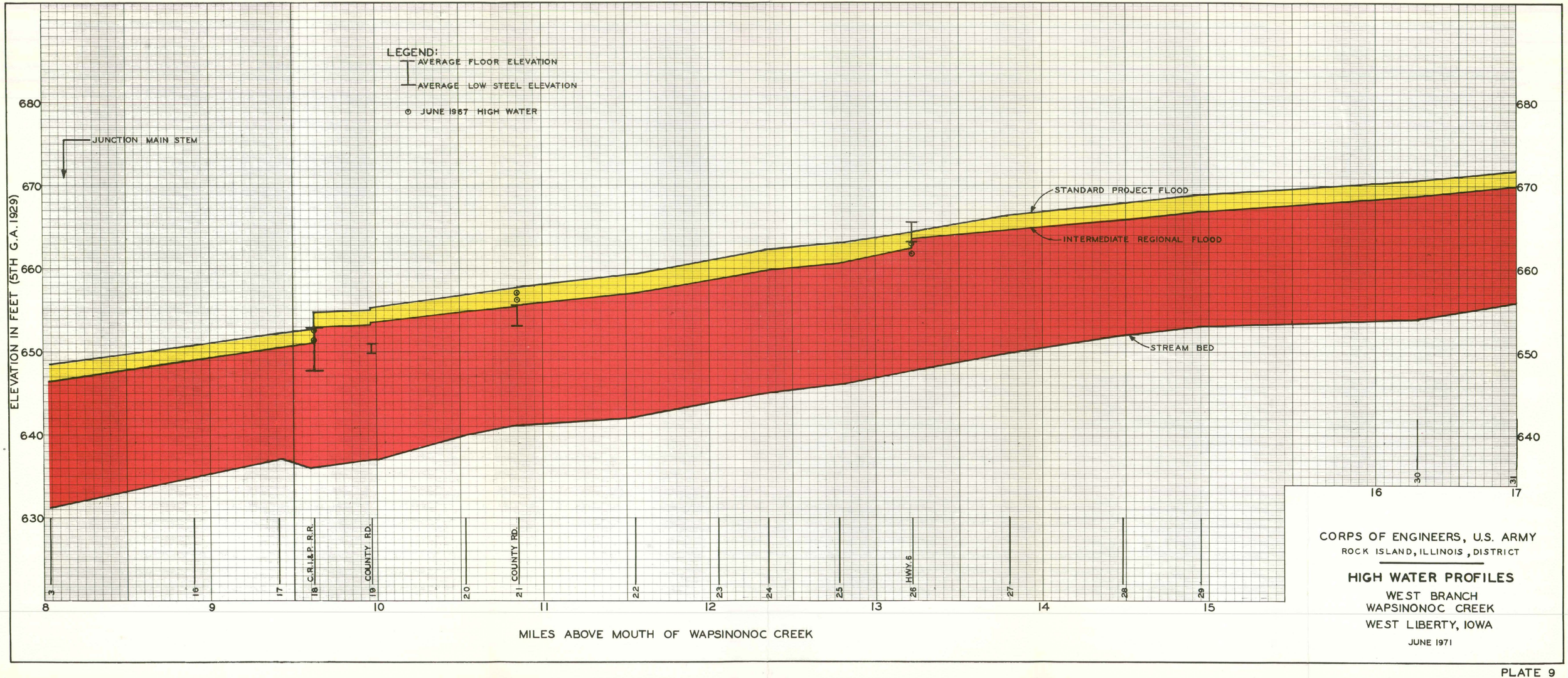
CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

HIGH WATER PROFILES

MIDDLE BRANCH
WAPSINONOC CREEK
WEST LIBERTY, IOWA

JUNE 1971

PLATE 8



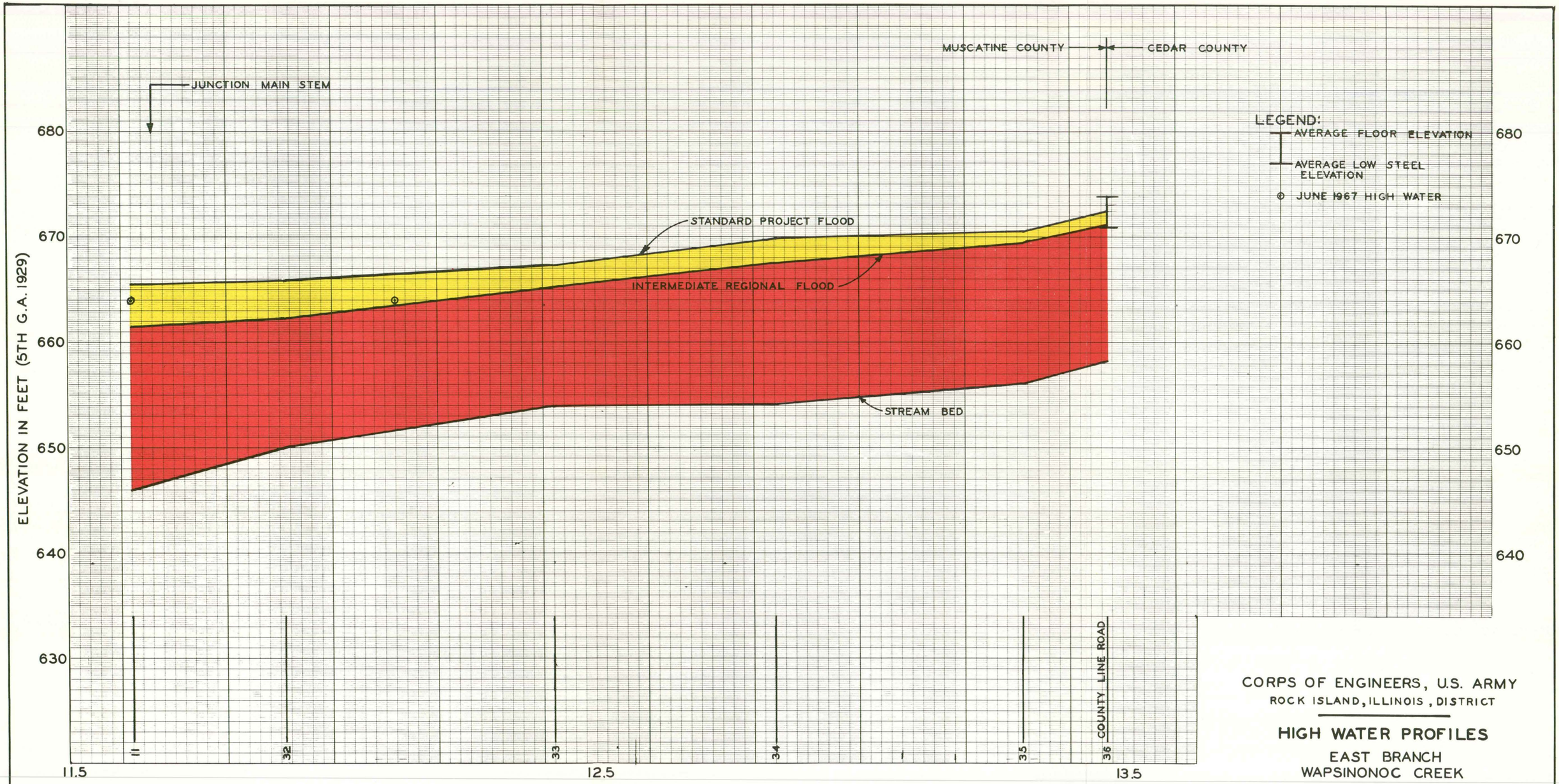
CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

HIGH WATER PROFILES

WEST BRANCH
WAPSINONOC CREEK
WEST LIBERTY, IOWA

JUNE 1971

PLATE 9



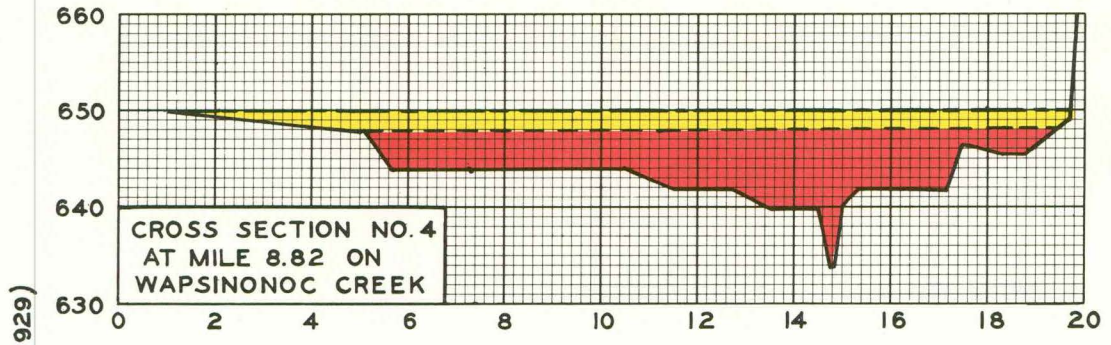
CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

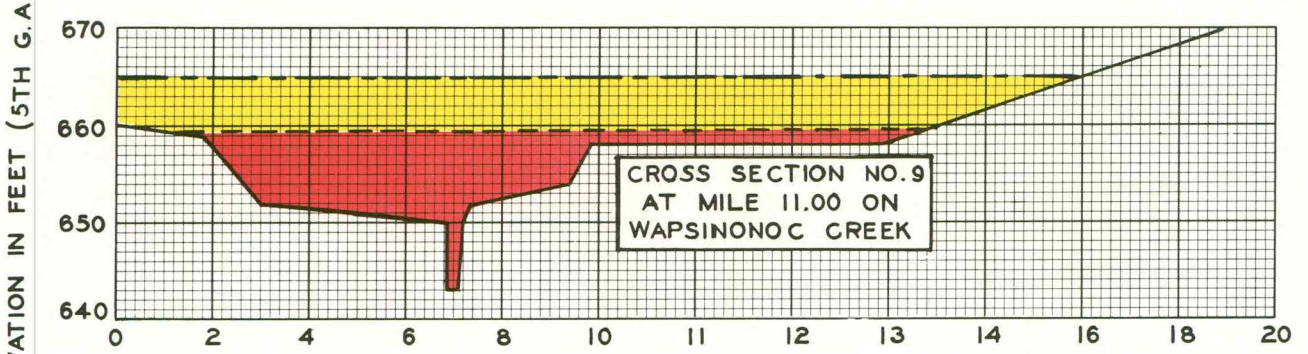
HIGH WATER PROFILES

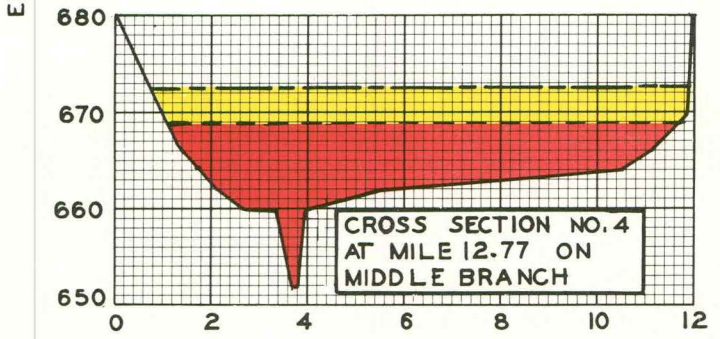
EAST BRANCH
WAPSINONOC CREEK
WEST LIBERTY, IOWA

JUNE, 1971

PLATE 10







ELEVATION IN FEET (5TH G.A. 1929)

HORIZONTAL DISTANCE, HUNDRED FEET

LEGEND

STANDARD PROJECT FLOOD

INTERMEDIATE REGIONAL FLOOD

GROUND LINE

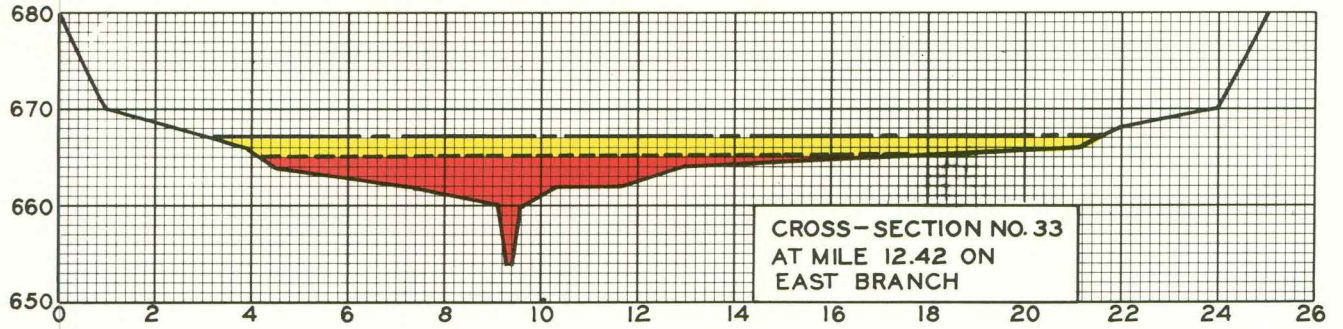
CROSS SECTIONS ARE PLOTTED LOOKING UPSTREAM

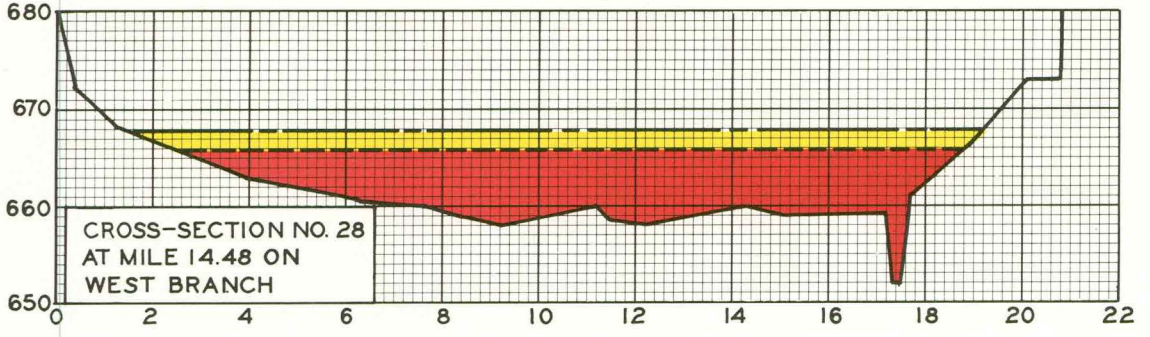
CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

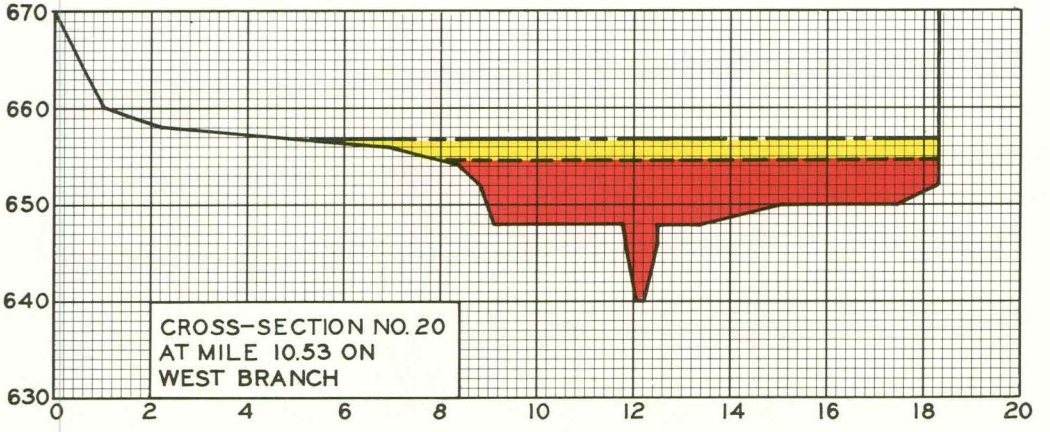
CROSS SECTIONS
WAPSINONOC CREEK
WEST LIBERTY, IOWA

JUNE 1971

PLATE 11







ELEVATION IN FEET (5TH G.A. 1929)

HORIZONTAL DISTANCE, HUNDRED FEET

LEGEND:

STANDARD PROJECT FLOOD

INTERMEDIATE REGIONAL FLOOD

GROUND LINE

CROSS SECTIONS ARE PLOTTED LOOKING UPSTREAM

CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

CROSS SECTIONS
WAPSINONOC CREEK
WEST LIBERTY, IOWA

JUNE 1971

PLATE 12