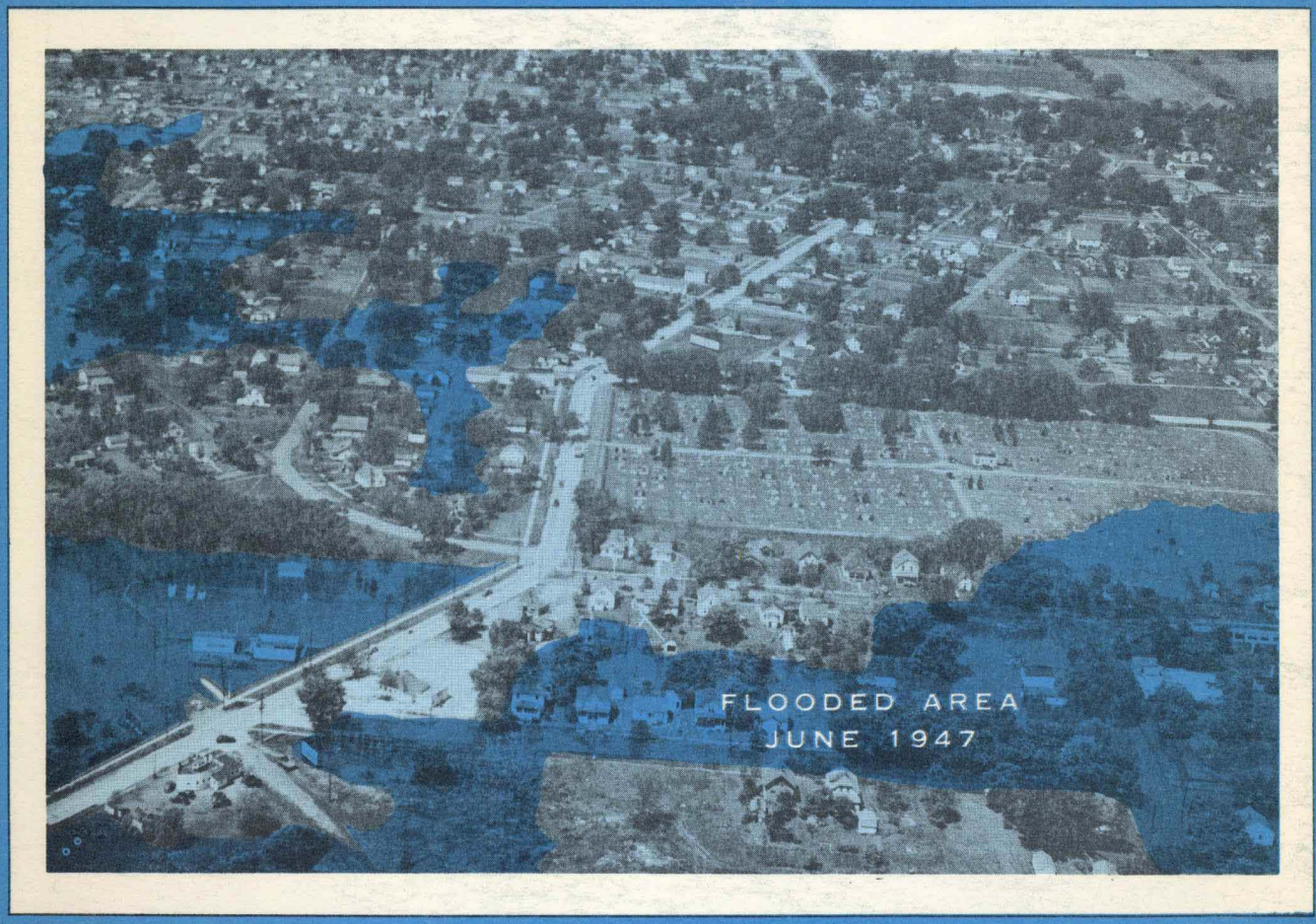
# FLOOD PLAIN INFORMATION
# BLACK HAWK CREEK
# BLACK HAWK COUNTY
# IOWA






PREPARED FOR STATE OF IOWA
IOWA NATURAL RESOURCES COUNCIL
BY
CORPS OF ENGINEERS, U. S. ARMY
ROCK ISLAND DISTRICT
DECEMBER 1968

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## INTRODUCTION

This report evaluates the flood situation along Black Hawk Creek in Black Hawk County, Iowa. The report was prepared at the request of the Waterloo Board of Park Commissioners, City of Waterloo, Iowa, through the Iowa Natural Resources Council, to aid in the solution of local flood problems and in the best use of land subject to overflow. The report covers an area of the Black Hawk Creek flood plain from the mouth to the Grundy County - Black Hawk County line, and includes Waterloo and Hudson. The report presents information on the occurrence and magnitude of Black Hawk Creek floods and is compatible with requirements set forth by the State of Iowa.

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 state-wide program for the control, utilization, and protection of the surface and groundwater 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 1966, as amended. (See also Chapter 455A of the 1966 Code).

The report covers two significant phases of the Black Hawk Creek flood problem in the City of Waterloo, the Town of Hudson, and Black Hawk County. It first reviews the records of the largest known past floods on Black Hawk Creek. Secondly, it estimates probable future floods; namely, the Intermediate Regional Flood and the Standard Project Flood. The Intermediate Regional Flood was determined from an analysis of known floods on Black Hawk Creek. The Standard Project Flood is a flood of rare occurrence and, on most streams, is considerably larger than any past floods. Although the occurrence of a Standard Project Flood is rare, it may happen in any year and should be considered in land use planning for the Black Hawk Creek flood plain.

For problems concerned with the controlled development of the Black Hawk Creek flood plain, decisions must be made on the size of floods to be considered. Appropriate evaluation should be made of the possible recurrence of past floods and the occurrence of the Intermediate Regional Flood and the Standard Project Flood.

The maps, profiles, and cross sections in this report indicate the extent of flooding which could occur on the Black Hawk Creek flood plain in Black Hawk County. From the maps,

profiles, and cross sections, the probable depth of flooding by occurrence of the Intermediate Regional or Standard Project Flood at any location may be determined. With this information, floor levels for buildings may be planned to minimize flood damage or, if at lower elevations, to include flood proofing measures. In addition, the information included in this report provides the affected units of government with a sound basis for flood plain regulations consistent with minimum state standards and local comprehensive land use plans.

The report evaluates the flood hazard along Black Hawk Creek. However, it does not include plans for the solution of flood problems. It does provide the basis for further study and planning by Waterloo and Hudson and Black Hawk County to minimize vulnerability to flood damages. Local planning programs may guide developments by controlling flood plain use through zoning and subdivision regulations, construction of flood protection works, or a combination of the two approaches.

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

## SUMMARY OF FLOOD SITUATION

Black Hawk Creek flows northeasterly through Black Hawk County and joins the Cedar River upstream from the main business district of Waterloo. The report covers the Black Hawk Creek flood plain from the confluence with the Cedar River upstream to the Black Hawk County line at Creek mile 14.57.

Major commercial, industrial, and residential developments occupy the Black Hawk Creek flood plain within the city limits of Waterloo. The principal residential development in the Town of Hudson is on high ground adjacent to the flood plain. Some residential and commercial development in Hudson occupies the flood plain. A considerable portion of the flood plain is occupied by city and county parks. Portions of the flood plain land have been inundated in the past and substantially greater areas are within reach of the potentially greater floods of the future.

The U. S. Geological Survey has maintained a stream gaging station on Black Hawk Creek at Hudson, Iowa, since April 1952. The gage is located on the left bank, thirty-five feet downstream from the bridge on State Highway 58. The water-stage recorder gage datum is 865.03 feet above mean sea level (datum of 1929). All gage heights listed in the report refer to current datum of the gage at Hudson.

Newspaper files and historical documents were searched for information concerning past floods. From these investigations and from studies of possible future floods, the local flood situation has been developed. The following paragraphs summarize the significant findings.

THE LARGEST RECORDED FLOOD FLOW on Black Hawk Creek at the gaging station at Hudson occurred on March 31, 1960. Maximum discharge

was 9,000 cubic feet per second at a gage height of 16.93 feet. During the peak flow period, backwater effect from ice was about 0.4 foot.

THE LARGEST KNOWN FLOOD on Black Hawk Creek occurred on June 3, 1947. Seven bridges across Black Hawk and Miller Creeks were washed out, including the Highway 58 bridge at Hudson. Most rural telephones were out of service at Hudson and loss of livestock was heavy. This flood occurred before the gaging station was installed at Hudson. Although no stage recorder records prior to April 1952 are available to document past floods, the June 3, 1947 flood is the largest remembered by local residents.

ANOTHER LARGE FLOOD occurred on March 27, 1959. This flood was the second highest flood flow recorded at Hudson. Gage height was 0.45 foot lower than the March 31, 1960 flood at the Hudson gage.

OTHER LARGE FLOODS on Black Hawk Creek occurred on April 6, 1965 and March 20, 1959. These floods were 0.58 and 0.37 foot lower, respectively, than the March 1960 flood at the Hudson gage.

INTERMEDIATE REGIONAL FLOOD by definition is a flood that has an average frequency of occurrence in the order of once in 100 years. In the study, the Intermediate Regional Flood was determined from an analysis of floods on Black Hawk Creek. The analysis shows that the Intermediate Regional Flood is 1.9 feet higher than the March 31, 1960 flood at the Hudson gaging station. The Intermediate Regional Flood is 0.6 to 2.4 feet higher than the June 3, 1947 flood. The Intermediate Regional Flood is estimated to be 1.5 feet higher than the 1947 flood under present conditions at the Hudson gaging station. Table 1 shows the relation of observed 1947 flood heights to those of the Intermediate Regional Flood.

STANDARD PROJECT FLOOD determination indicates that floods could occur on Black Hawk Creek between two to six feet higher than the Intermediate Regional Flood. The Standard Project Flood would be 3.9 feet higher than the March 31, 1960 flood and 3.5 feet higher than the June 1947 flood at the Hudson gaging station.

FLOOD DAMAGES from recurrence of major known floods would be substantial. However, the damages would be limited near the mouth of Black Hawk Creek by the proposed local flood protection project. Upstream from the local protection project, damages would be limited to agricultural developments and isolated commercial establishments in the Flood plain. More extensive damages would be caused by the Intermediate Regional and the Standard Project Floods because of wider extent, greater depths, and higher flow velocities.

MAIN FLOOD SEASON for Black Hawk Creek is in the winter and spring. Most of the larger floods have resulted from heavy general rains in combination with snow melt during the winter and spring months. However, intense local thunderstorms may cause floods during other seasons.

VELOCITIES OF WATER during major floods vary widely, depending on location. During any major flood, velocities would be extremely dangerous to life and property. During a Standard Project Flood, velocities would range up to thirteen feet per second in the channel. On the flood plain, they would range up to five feet per second. Velocities greater than three feet per second, combined with depths of three feet or greater, are generally considered hazardous.

FLOOD DURATION is relatively short on Black Hawk Creek. Stages can rise from low flood to extreme flood heights in 48 hours following intense rainfall. During a Standard Project Flood, the stream would rise about 15 feet in approximately 72 hours, with

a maximum rate of rise of 0.5 foot per hour. The stage would equal or exceed bankfull for approximately seven days.

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

FUTURE FLOOD HEIGHTS during occurrence of the Intermediate Regional and Standard Project Floods on Black Hawk Creek are shown in Table 1. The flood elevations for the Standard Project and Intermediate Regional Floods are based on existing developments in the Black Hawk Creek flood plain assuming the local protection project is completed. 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 Table 1. The water surface elevations shown in Table 1 assume no clogging at bridges by debris or ice jams.

TABLE 1

RELATIVE FLOOD HEIGHTS

| Mile | | Identification | Maximum[1] Observed High Water Elevation Feet | Intermediate Regional Flood Elevation Feet | Intermediate Regional Flood Relation to max. High Water Feet | Standard Project Flood Elevation Feet | Standard Project Flood Relation to max. High Water Feet | Design Profile Waterloo Local Protection Elevation Feet |
|---|---|---|---|---|---|---|---|---|
| 0.01 | | Mouth | | 849.09 | | 855.06 | | 858.45 |
| 0.18 | | | | 849.20 | | 855.19 | | 858.48 |
| 0.37 | DS | WCF&N RR & Miles Street | | 849.38 | | 855.38 | | 858.52 |
| 0.37 | US | | | 849.53 | | 856.78 | | 858.85 |
| 0.41 | DS | New Westfield Avenue | | 849.64 | | 856.87 | | 858.87 |
| 0.41 | US | | | 849.64 | | 856.87 | | 858.95 |
| 0.49 | DS | CRI&P RR | | 850.87 | | 858.08 | | 859.22 |
| 0.49 | US | | 851.60 | 852.19 | 0.59 | 858.94 | 7.30 | 859.45 |
| 0.57 | | | | 852.19 | | 858.94 | | 859.45 |
| 0.68 | DS | Falls Avenue | | 852.19 | | 858.94 | | 859.45 |
| 0.68 | US | | 852.50 | 853.38 | 0.88 | 859.63 | 7.13 | 859.65 |
| 0.78 | DS | New U. S. Highway 218 | | 853.54 | | 859.81 | | 859.71 |
| 0.78 | US | | | 853.93 | | 860.62 | | 859.98 |
| 1.01 | | | | 854.07 | | 860.74 | | 860.02 |
| 1.25 | DS | Fletcher Avenue | | 854.24 | | 860.88 | | 860.07 |
| 1.25 | US | | 852.90 | 854.46 | 1.56 | 860.97 | 8.07 | 860.11 |
| 1.59 | | | | 854.81 | | 861.21 | | 860.20 |
| 1.81 | DS | Ansborough Avenue | | 855.19 | | 861.46 | | 860.30 |
| 1.81 | US | | 853.60 | 855.95 | 2.35 | 862.18 | 8.58 | 860.55 |
| 1.96 | | | | 856.33 | | 862.45 | | 860.68 |
| 2.47 | | | | 856.77 | | 862.80 | | 860.85 |
| 3.07 | | | | 858.16 | | 863.49 | | 861.27 |
| 3.63 | | | | 860.44 | | 864.57 | | 862.11 |
| 4.25 | DS | Ridgeway Avenue | | 862.13 | | 865.40 | | 862.95 |
| 4.25 | US | | 862.50 | 863.08 | 0.58 | 866.36 | 3.86 | 863.33 |
| 4.87 | | | | 864.86 | | 867.55 | | 864.98 |
| 5.30 | DS | Ranchero Road | | 866.62 | | 868.97 | | 866.66 |
| 5.30 | US | | 866.40 | 867.25 | 0.85 | 869.29 | 2.89 | 867.27 |
| 5.47 | DS | C&GW RR | | 867.56 | | 869.66 | | 867.57 |
| 5.47 | US | | | 868.67 | | 870.37 | | 868.68 |
| 5.88 | | | | 869.08 | | 870.88 | | 869.09 |
| 6.35 | DS | Shaulis Road | | 870.20 | | 871.90 | | 870.20 |
| 6.35 | US | | 872.30 | 873.19 | 0.89 | 874.20 | 1.90 | 873.19 |
| 6.77 | | | | 873.59 | | 874.83 | | 873.59 |
| 7.71 | | | | 876.10 | | 877.45 | | 876.10 |
| 8.84 | | | | 879.95 | | 881.37 | | 879.95 |
| 9.34 | | | | 881.90 | | 883.51 | | 881.90 |
| 9.64 | DS | State Highway 58 | | 883.85 | | 885.80 | | 883.85 |
| 9.64 | US | (USGS Gage) | | 884.06 | | 886.39 | | 884.06 |
| 10.01 | | | | 886.51 | | 889.09 | | 886.51 |
| 10.95 | | | | 887.49 | | 889.95 | | 887.49 |
| 11.89 | DS | County Road "N" | | 891.17 | | 893.00 | | 891.17 |
| 11.89 | US | | 891.90 | 894.29 | 2.39 | 896.60 | 4.70 | 894.29 |
| 12.46 | | | | 894.63 | | 897.00 | | 894.63 |
| 13.10 | | | | 895.39 | | 897.65 | | 895.39 |
| 13.74 | | | | 897.25 | | 899.16 | | 897.25 |
| 14.09 | | | | 898.28 | | 900.10 | | 898.28 |
| 14.57 | DS | Black Hawk - Grundy | | 899.12 | | 901.00 | | 899.12 |
| 14.57 | US | County Line Road | 901.30 | 901.89 | 0.59 | 904.10 | 2.80 | 901.89 |

1/ June 1947 High Water

## GENERAL CONDITIONS AND PAST FLOODS

### GENERAL

This section of the report is a history of floods on Black Hawk Creek in Black Hawk County, Iowa. The drainage area at the mouth of Black Hawk Creek is 344 square miles. At the gaging station at Hudson, the drainage area is 303 square miles.

Black Hawk Creek flows generally northeast from the Black Hawk County - Grundy County line through Hudson and Waterloo. The creek meanders through a wide flood plain and is bordered by a band of trees and brush on both banks upstream from the Falls Avenue bridge. Channel depths within the study area average five to fifteen feet. In the study area the creek falls at an average rate of 4.2 feet per mile.

Most of the residential, industrial, and commercial developments in the Black Hawk Creek flood plain in the city limits of Waterloo are either on high ground or will be protected by the local protection project. Some commercial development is taking place in the rural flood plain lands. At Hudson nearly all development is on high ground adjacent to the flood plain. A large proportion of the Black Hawk Creek flood plain has been and is continuing to be developed into city and county parks with low damage potential. The remaining area is in agricultural uses or remains undeveloped.

Records of stage and discharge at the U. S. Geological Survey stream gaging station at Hudson are available from April 1952 to the present time. A water-stage recorder has been in continuous use at the present site, thirty-five feet downstream from the Highway 58 bridge over Black Hawk Creek at Hudson, Iowa.

Black Hawk Creek flood history data were collected for the

study. Historical documents and newspaper files were searched for cultural and flood history. From these sources and the gage records which began in 1952, a history of floods on Black Hawk Creek has been developed.

## Settlement

The following paragraphs covering the settlement of Black Hawk County were taken directly from the report, "Land Use Plan", December 1967, prepared by the Metropolitan Planning Commission of Black Hawk County. The report was prepared for the Iowa Development Commission under provisions of Chapter 28, Code of Iowa, as amended, and is Urban Planning Grant Project No. P-41.

Prior to any permanent settlement within the county, a French trapper and explorer named Gervais Paul Sominan (Somaneux) spent the summer of 1837 in the vicinity of the falls of the Cedar (now Cedar Falls). After the Sauk and Fox Indian Cession of 1842 the territory which included Black Hawk County was open to settlement. The county was surveyed during the years of 1845 to 1848.

The first permanent settlement in the county was that of George Hanna in 1845. He built a home on land that was later to become part of the City of Waterloo. In that same year William Sturgis made his first permanent settlement on the site of the present city of Cedar Falls.

Because the settlements of the early pioneers were so close to excellent stream fords and sources of water power on the Cedar River other settlements congregated in the same areas and eventually small towns arose which developed into the present-day cities of Waterloo and Cedar Falls.

In 1850 the county had a population of 135, and the mid-fifties saw the greatest growth years for Black Hawk County.

By 1860 there were 8,244 people residing in the county. During this time a number of smaller settlements arose to service the increasing number of settlers within the county and the many westward-bound pioneers. Other towns, such as Hudson, La Porte City, and Gilbertville were settled during these growth years.

The two most significant factors in the development and urbanization of the county were railroads and factories. The greatest era of railroad construction within the county was during the 1860's. The railroad maintained frequent stations along their tracks to serve as loading points for farmers' crops. The towns of Voorhees, Raymond, and Dunkerton were first settled around this type of railroad terminal.

The continued inrush of settlers added another 14,000 people to the county by 1870. The 1860's and 1870's saw the first significant growth of urban areas of the county. In 1875 Waterloo had a population of 5,508 with 140 commercial businesses, about 20 industries, and 40 professional offices. By 1890 the county had attained a population of 23,913 while Waterloo grew to 6,674 and Cedar Falls to 3,459.

During the next twenty years, from 1890 to 1910, the United States would experience the greatest surge of the "Industrial Revolution" which would cause an equal increase in urbanization. Black Hawk County would be no exception to this. During these years the county received the industrial employment base and the supporting retail and service industries that would pave the way for the development of the metropolitan area that exists in the county today.

The size of Waterloo in 1890 made it the largest city in the region. Because of its size and location in the heart of a prospering agricultural area, the city was an ideal place to develop agriculture related industries. The meat packing industry

got its start in Waterloo in 1891. The manufacturing of farm tractors on a large scale first began in Waterloo during the first decade of the new century. These two decades also saw the beginning of a number of large farm machinery companies who supplemented the tractor works in supplying farmers with the machinery that was responsible for climaxing the "agricultural revolution."

The railroad shops in Waterloo made a significant contribution to the growth of the area at this time, since railroads were becoming a major means of transportation.

The State Normal School at Cedar Falls began in 1876 and was well on its way to becoming an important State College by the early part of the twentieth century. The school was later to be called the Iowa State Teachers College, and in 1967 it was designated as the University of Northern Iowa, with an enrollment of about 7,000 students in the same year.

With this economic base established, the next fifty years would see the expansion of these industries and the addition of many smaller manufacturing firms that presently constitute a significant part of the economic base of the county and urban area. This industrial growth stimulated not only the physical development of the county's urban area but a change in the county's social and economic character. This change is manifested most clearly in the fact that the county was moving toward an urban population rather than the traditional rural population. Between 1890 and 1895 Black Hawk County became urban with better than fifty percent of the population living in the Waterloo-Cedar Falls urban areas. From this time on, more and more of the county's population would be living and working in the urban area and thus acquire the values, traits, and desires of an urban people. While agriculture would still remain a major industry in the county, a smaller percentage

of people would be involved in rural farm operations.

The need for urban development was facilitated at this time by the advent of faster modes of transportation such as the street car and automobile. This evolution in transportation permitted people and business to expand the urban area along street car lines and major highways. Eventually the automobile became the major means of transportation and is the basic factor permitting our urban areas to expand in size.

In retrospect one can sum up the history of Black Hawk County by saying that it has undergone the fundamental change from a strictly rural county to a predominately urban county. This has been a social and economic change, as well as a physical change. It is evident from these facts:

- In 1965, 82 percent of the county's population lived in the urban area that occupies only twelve percent of the county's land area.
- About nine of every ten workers in the county work in the urban area.

It is estimated that by 1990, 88 percent of the people in the county will be living in the metropolitan area which will occupy about 17 percent of the land area of the county.

## Flood Damage Prevention Measures

The Flood Control Act of 1965 (House Document 166, 89th Congress, First Session) authorized construction of levees, floodwalls, pumping plants, and closure structures on both sides of Cedar River and Black Hawk Creek to provide local protection from Cedar River and Black Hawk Creek floods. The General Design Memorandum for the Waterloo local protection project is scheduled for completion in December 1968. Completion of design and specification work and the actual construction are dependent on

continued funding by Congress. Proposed levee alignment for the local protection project will follow the existing levees completed in 1950 for protection of the Galloway-Hagerman addition. Levee heights will be increased to provide protection against the 100-year flood flow from Black Hawk Creek occurring concurrently with the 100-year flood flow on the Cedar River.

## 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 Black Hawk Creek.

In relatively small areas such as the Black Hawk 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 Black Hawk Creek Basin.

## The Stream and Its Valley

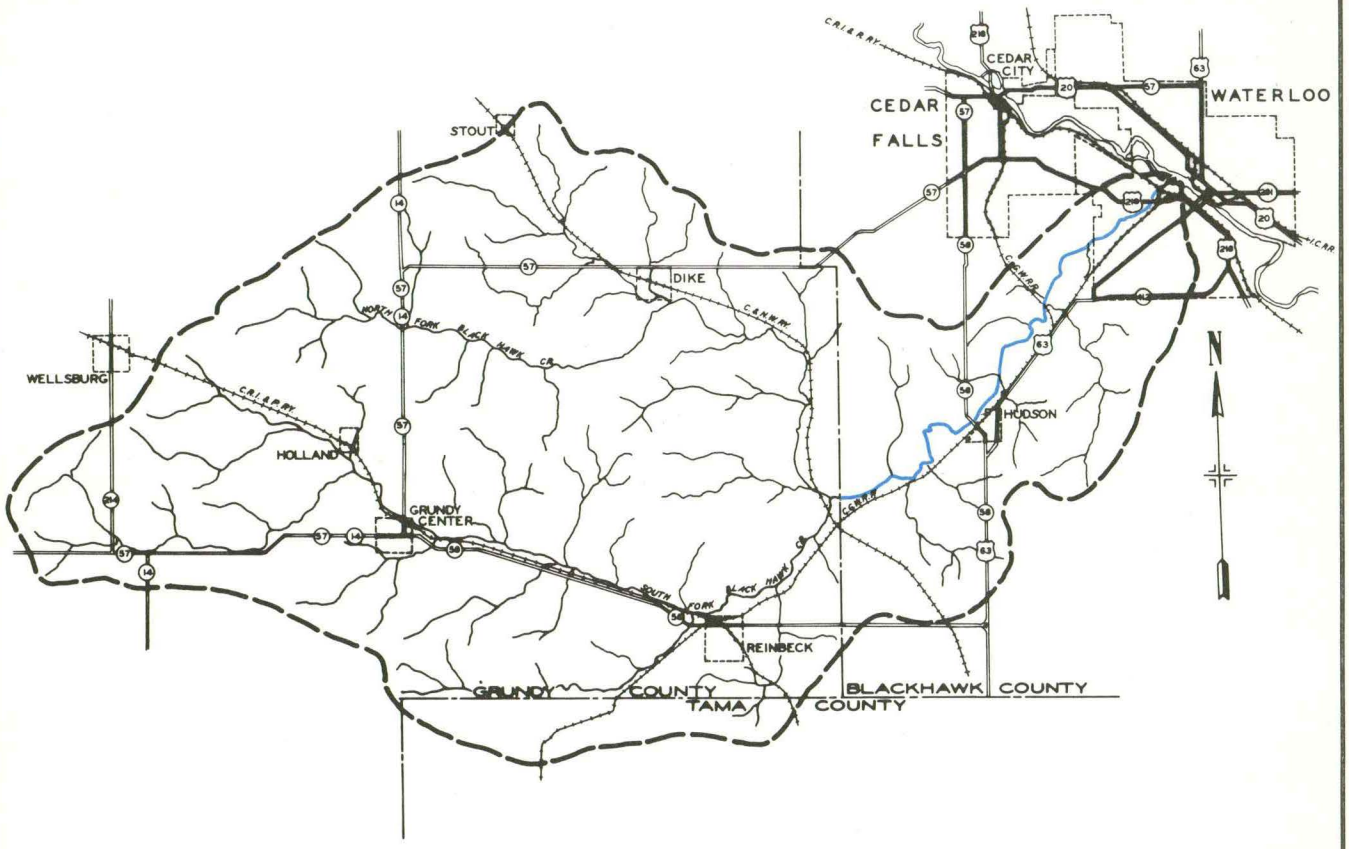
Black Hawk Creek headwaters begin in the western part of Grundy County, Iowa. Flow is generally northeast in Black Hawk County. A short distance upstream from the Black Hawk County line, Black Hawk Creek branches to the North Fork and South Fork. Plate 1 shows the watershed, the stream drainage, and the Black Hawk Creek reach covered by this report.

Drainage area of Black Hawk Creek is 344 square miles at the mouth and 278 square miles at the west county line. The

creek meanders across timber bordered farm land. The creek bottom is primarily sand with heavy deposits of silt in some areas. Average slope of the creek bottom is about four feet per mile in Black Hawk County.

The topography of the area varies from gently rolling ridges to broad, flat flood plain areas. The flood plain of Black Hawk Creek averages between 3,000 and 4,000 feet in width upstream from the developed area of Waterloo.

Pertinent drainage areas of Black Hawk Creek are given in Table 2.




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

# BLACK HAWK CREEK WATERSHED

REACH COVERED BY THIS REPORT

2 1 0 2 4 6 8 10
SCALE IN MILES

DECEMBER 1968

PLATE 1

TABLE 2

DRAINAGE AREAS IN WATERSHED OF BLACK HAWK CREEK

| Stream | Location | Mile Above Mouth | Drainage Area Sq. Mile |
|---|---|---|---|
| Black Hawk Creek | At Mouth | 0 | 344 |
| | Ridgeway Avenue Bridge | 4.25 | 332 |
| | Shaulis Road Bridge | 6.35 | 313 |
| | State Highway 58 (Gage at Hudson) | 9.64 | 303 |
| | West County Line Bridge | 14.57 | 278 |
| Prescotts Creek | At confluence with Black Hawk Creek | | 13 |
| Wilson Creek | At confluence with Black Hawk Creek | | 8 |
| North Black Hawk Creek | At confluence with Black Hawk Creek | | 119 |
| Mosquito Creek | At confluence with Black Hawk Creek | | 24 |
| Munns Creek | At confluence with Black Hawk Creek | | 7 |
| Minnehaha Creek | At confluence with Black Hawk Creek | | 11 |
| Holland Creek | At confluence with Black Hawk Creek | | 22 |

Developments in the Flood Plain

Plates 5 and 6 are index maps of eight sheets showing the flooded areas of Black Hawk Creek in the study reach. Plates 7 through 14 show the flooded areas covered by this report. Detailed topographic maps were not available from the Black Hawk County line to the center of Section 32, T88N, R14W; therefore,

the flood delineation for this area is not shown. Near the mouth of Black Hawk Creek, the flood plain is highly developed with industrial and commercial establishments and residences. This developed area will be protected by the Waterloo local protection project. Hope Martin Memorial Park occupies a considerable portion of the unprotected area. Upstream from the protected area some commercial developments are taking place in the flood plain. Most of the remaining flood plain land is in agricultural or low damage potential use. At Hudson, most development is outside the inundation limits of the Standard Project and Intermediate Regional Floods. However, the sewage treatment plant is subject to periodic flooding.

Bridges Across the Stream

Fourteen bridges span Black Hawk Creek in the study reach. Of the fourteen bridges, three are railroad bridges, one is a U. S. Highway bridge, two are state highway bridges, and eight are city street or county road bridges. Table 3 lists and describes the bridges across Black Hawk Creek and shows the relation of floor and low steel elevations to the Intermediate Regional Flood crest elevations. Figures 1 through 19 show the Black Hawk Creek bridges. Figure 20 shows channel realignment near the mouth of Black Hawk Creek.

The following bridges are subject to inundation by the Intermediate Regional Flood: Chicago, Rock Island and Pacific Railroad at mile 0.49; Falls Avenue bridge at mile 0.68; Fletcher Avenue bridge at mile 1.25; Ranchero Road (State Highway 42) bridge at mile 5.30; Chicago Great Western Railway bridge at mile 5.47; and, Shaulis Road bridge at mile 6.35. The Intermediate Regional Flood crest is above low steel of the Waterloo, Cedar Falls and Northern Railroad (Waterloo Railroad) bridge and the old Westfield Avenue bridge at mile

0.37, the County road "N" bridge at mile 11.89, and the County Line road bridge at mile 14.57. The Standard Project Flood inundates entirely or reaches low steel on all bridges except the Ansborough Avenue bridge under construction at the present time at mile 1.81 and the State Highway 58 bridge at mile 9.64.

U. S. Highway 20 is being relocated south of the metropolitan area of Waterloo, will be renamed Highway 520 and is proposed to cross Black Hawk Creek at approximately mile 4.7. In addition, the report, "Land Use Plan", prepared by the Metropolitan Planning Commission of Black Hawk County, proposes a freeway crossing of Black Hawk Creek upstream from Hudson, Iowa, at approximately mile 10.2.

Obstructions to Flood Flow

Some of the bridges across Black Hawk Creek are serious obstructions to flood flows in the order of magnitude of the Intermediate Regional and Standard Project Flood flows. The seriousness of the obstructions is shown on Plates 15 and 16. Head losses at bridges vary up from 0.2 to 3.5 feet depending on flood flows and elevations and configuration of bridge openings and approach fills.

TABLE 3

BRIDGES ACROSS BLACK HAWK CREEK

| Mile | Identification | Type | Spans and Length in Feet | Stream Bed Elev. Feet | Floor Elev. Feet | Intermediate Regional Flood Crest Elev. Feet | Low Steel Elev. Feet | Underclearance Above Inter. Regional Flood Feet | Underclearance Below Inter. Regional Flood Feet |
|---|---|---|---|---|---|---|---|---|---|
| 0.37 | WCF&N RR & Miles Street | Steel Deck Girder and Concrete Deck Girder | 4 @ 27.5, 3 @ 30.5 | 830.0 | 853.2 | 849.5 | 849.2 | | 0.3 |
| 0.41 | New Westfield Avenue | Concrete Continuous Girder | 4 @ 67.5 | 832.0 | 858.3 | 849.6 | 854.2 | 4.6 | |
| 0.49 | CRI&P RR | Steel Deck Girder on Pile Bents and Trestle | 33 @ 15.4 | 832.0 | 851.6 | 852.2 | 846.5 | | 5.7 |
| 0.68 | Falls Avenue | Concrete Deck Girder | 3 @ 35 | 832.5 | 850.9 | 853.4 | 846.7 | | 6.7 |
| 0.78 | U. S. Highway 218 | Steel Continuous Girder | 4 @ 100 | 833.0 | 861.5 | 853.9 | 857.5 | 3.6 | |
| 1.25 | Fletcher Avenue | Concrete Deck Girder | 2 @ 30, 2 @ 25 | 834.0 | 851.4 | 854.5 | 849.8 | | 4.7 |
| 1.81 | Ansborough Avenue | Steel Continuous Girder | 6 @ 80 | 835.0 | 869.3 | 856.0 | 864.5 | 8.5 | |
| 4.25 | Ridgeway Road | Steel Continuous Girder | 2 @ 93, 1 @ 110 | 846.0 | 868.4 | 863.1 | 863.4 | 0.3 | |
| 5.30 | Ranchero Road | Wood on Pile Bents and Trestle | 5 @ 30, 1 @ 20 | 849.0 | 864.5 | 867.3 | 863.0 | | 4.3 |
| 5.47 | C&GW RR | Steel Deck Girder on Pile Bents and Trestle | 17 @ 14.5 | 851.5 | 868.0 | 868.7 | 866.0 | | 2.7 |
| 6.35 | Shaulis Road | Steel Deck Girder on Pile Bents and Trestle | 3 @ 34, 2 @ 27 | 856.8 | 871.0 | 873.2 | 869.7 | | 3.5 |
| 9.64 | State Highway 58 (USGS Gage) | Steel Continuous Girder | 2 @ 74, 1 @ 94 | 866.5 | 891.0 | 884.1 | 887.5 | 3.4 | |
| 11.89 | County Road "N" | Steel Continuous Girder | 2 @ 74, 1 @ 94 | 881.0 | 896.9 | 894.3 | 893.4 | | 0.9 |
| 14.57 | Black Hawk - Grundy County Line Road | Steel Truss | 2 @ 15, 1 @ 100 | 889.8 | 902.4 | 901.9 | 899.8 | | 2.1 |

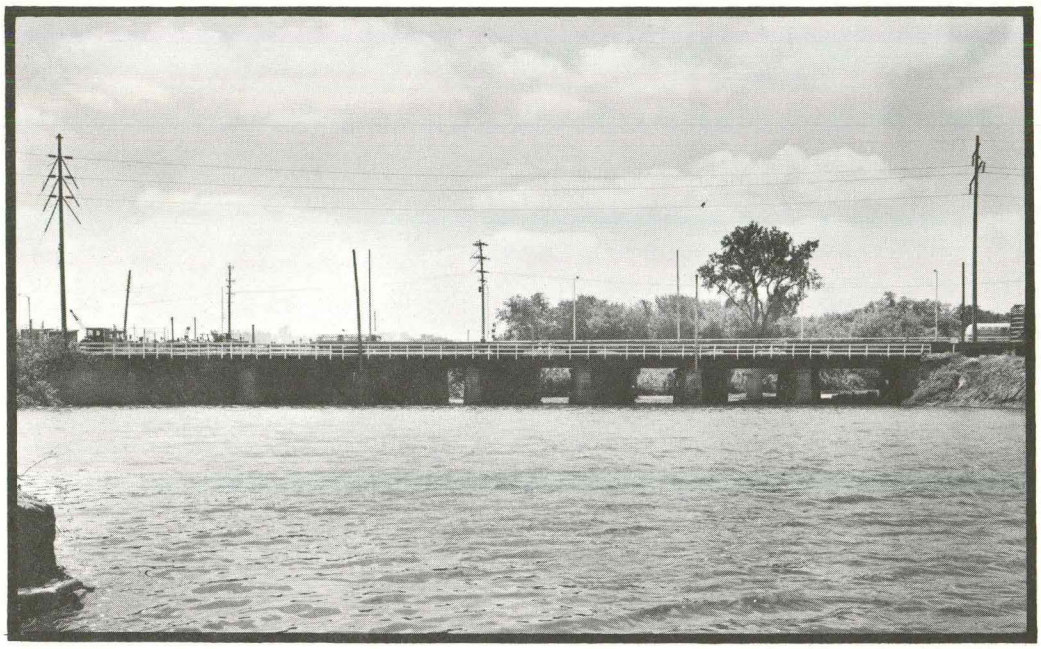


Figure 1. Downstream side of the Waterloo, Cedar Falls and Northern Railroad (Waterloo Railroad) bridge at Mile 0.37.

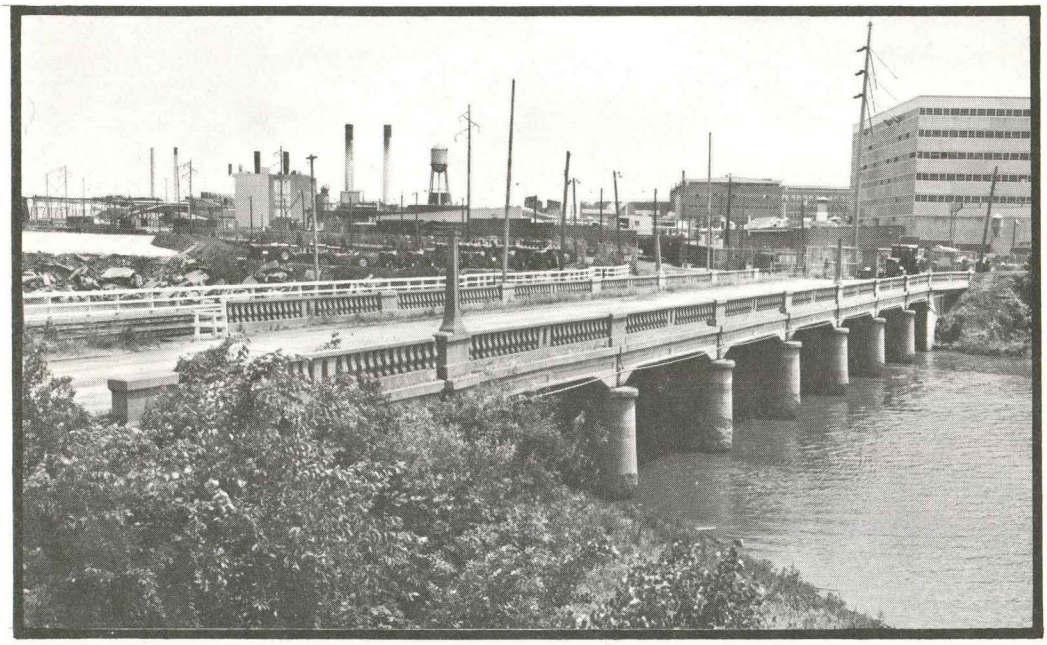


Figure 2. Upstream side of the old Miles Street bridge at Mile 0.37.

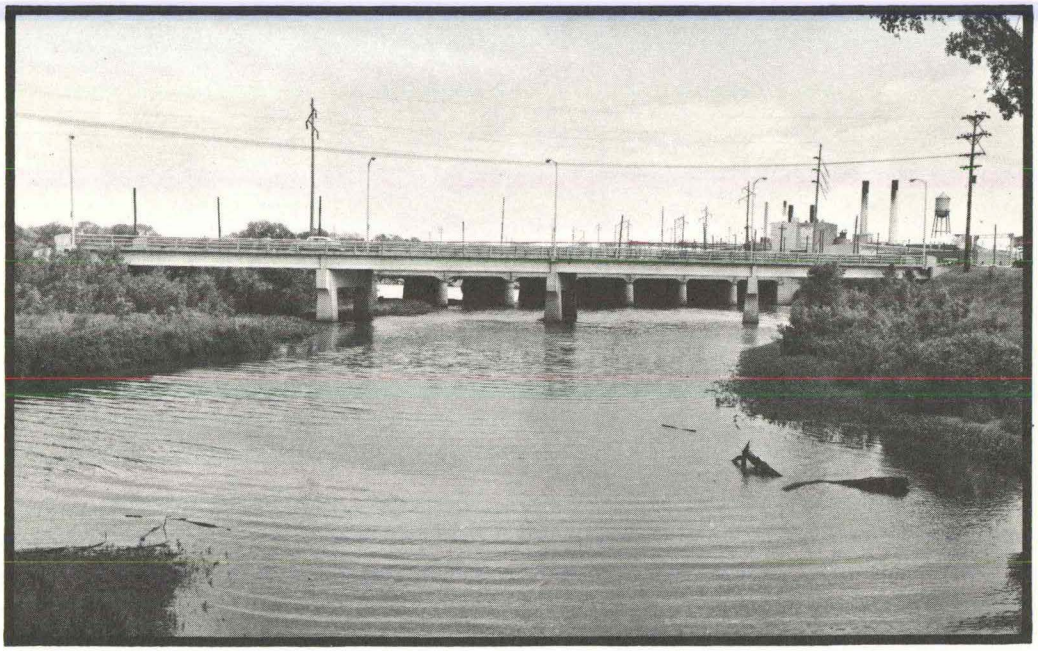


Figure 3. Upstream side of the new Westfield Avenue bridge at Mile 0.41.

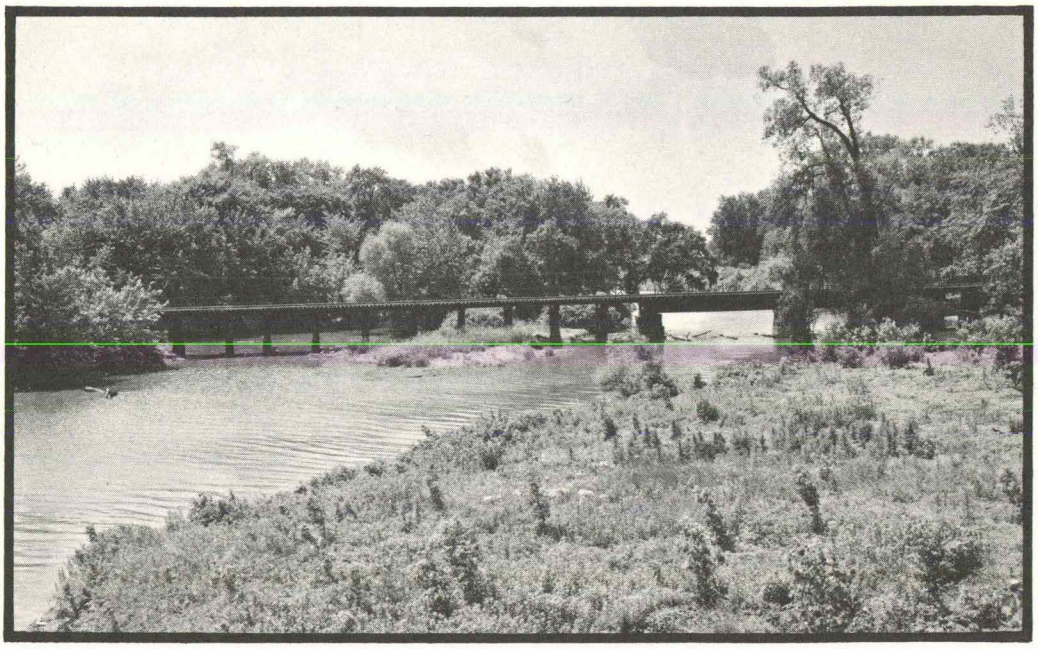


Figure 4. Upstream side of the Chicago, Rock Island and Pacific Railroad bridge at Mile 0.49.

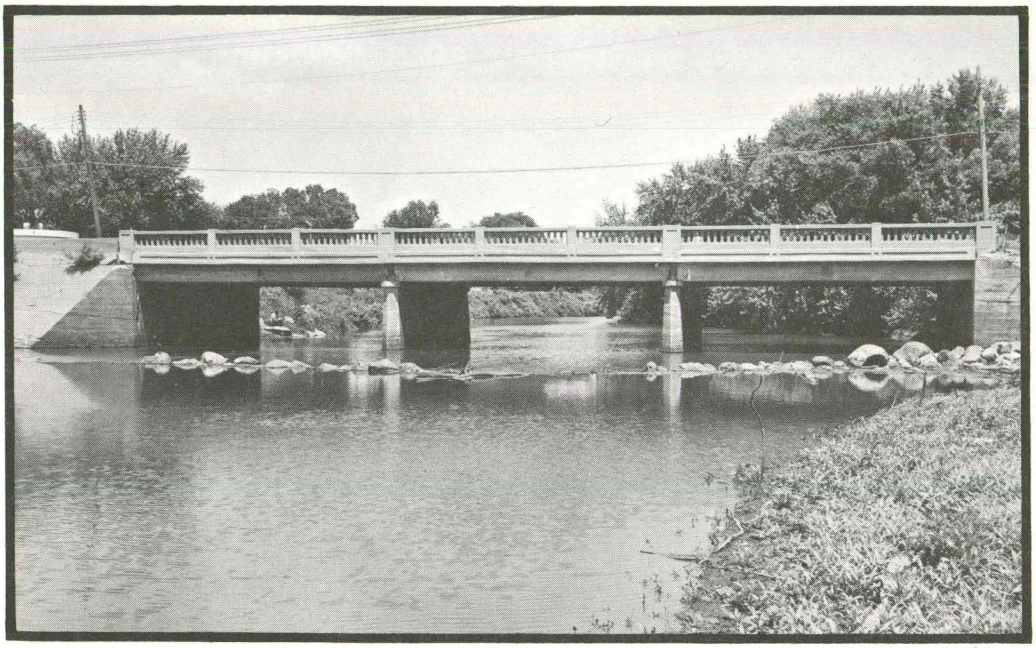


Figure 5. Upstream side of Falls Avenue bridge at Mile 0.68.

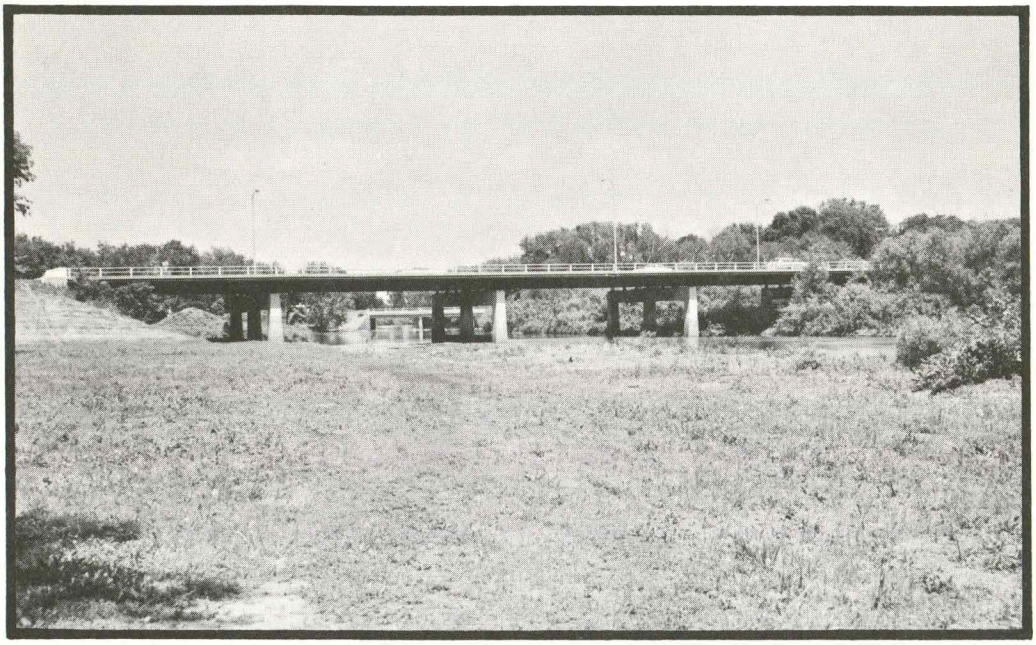


Figure 6. Upstream side of the Main Channel bridge, U. S. Highway 218 at Mile 0.78.

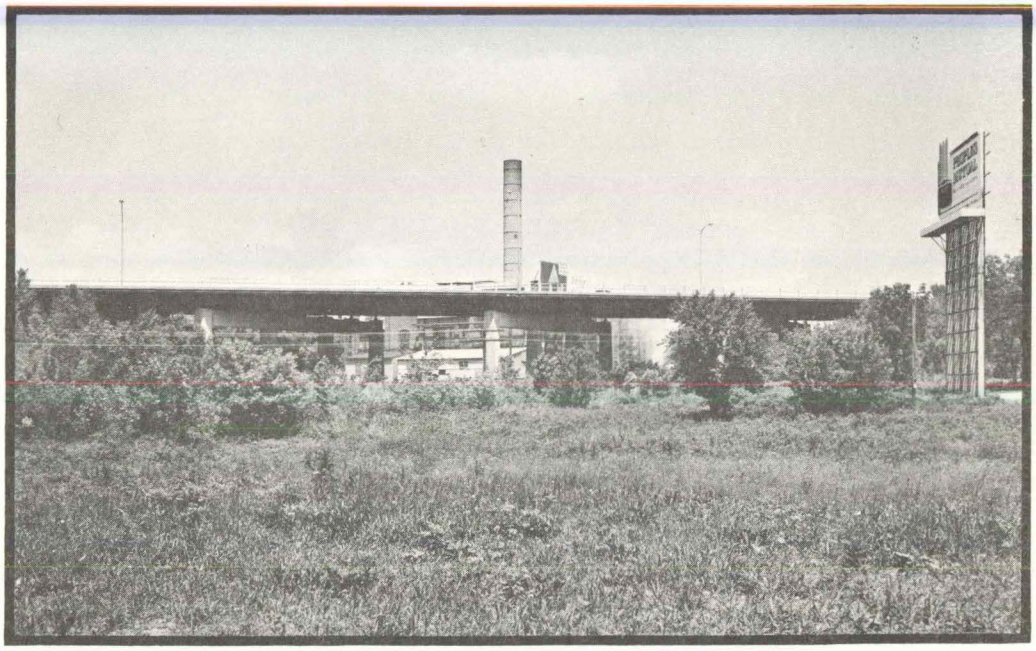


Figure 7. Upstream side of U. S. Highway 218 bridge over the tracks of the Chicago and Great Western Railroad at Mile 0.78.

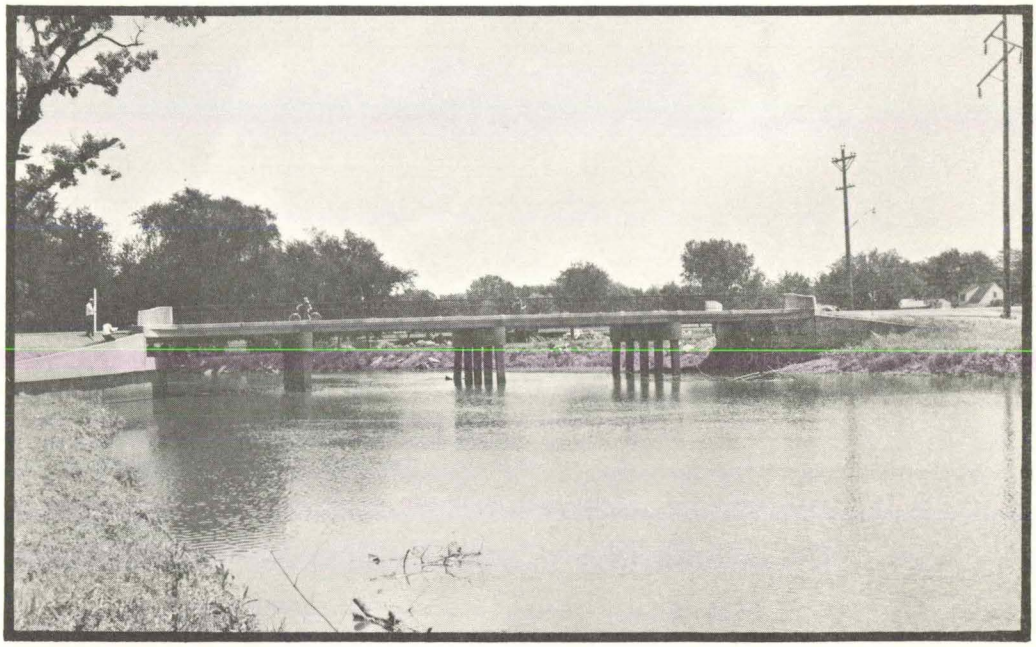


Figure 8. Upstream side of Fletcher Avenue bridge at Mile 1.25.

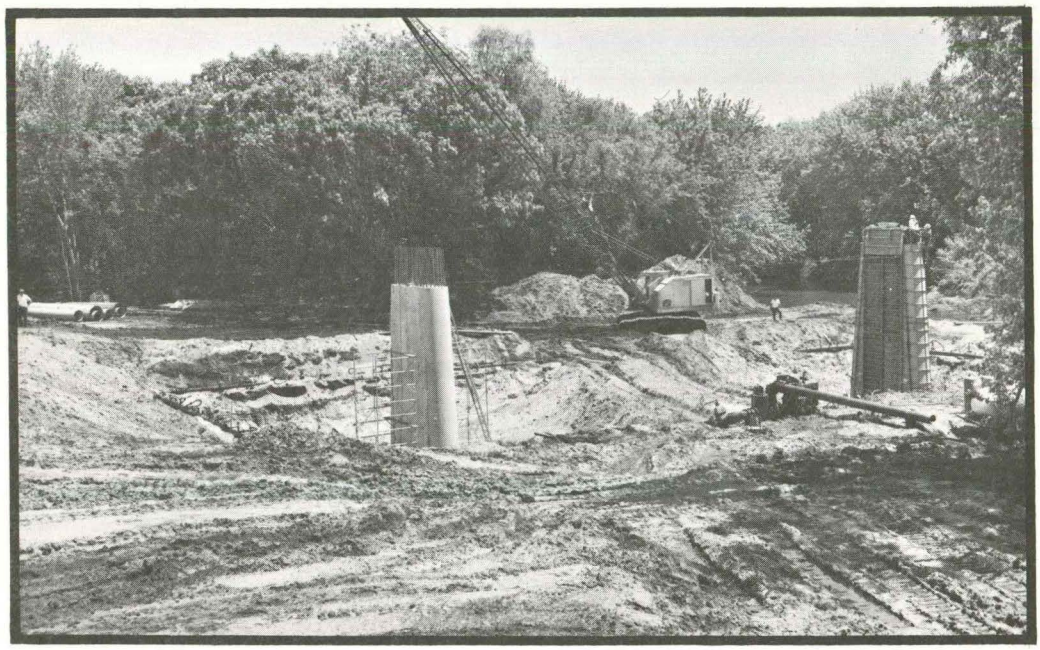


Figure 9. The Ansborough Avenue bridge construction at Mile 1.81 looking downstream.

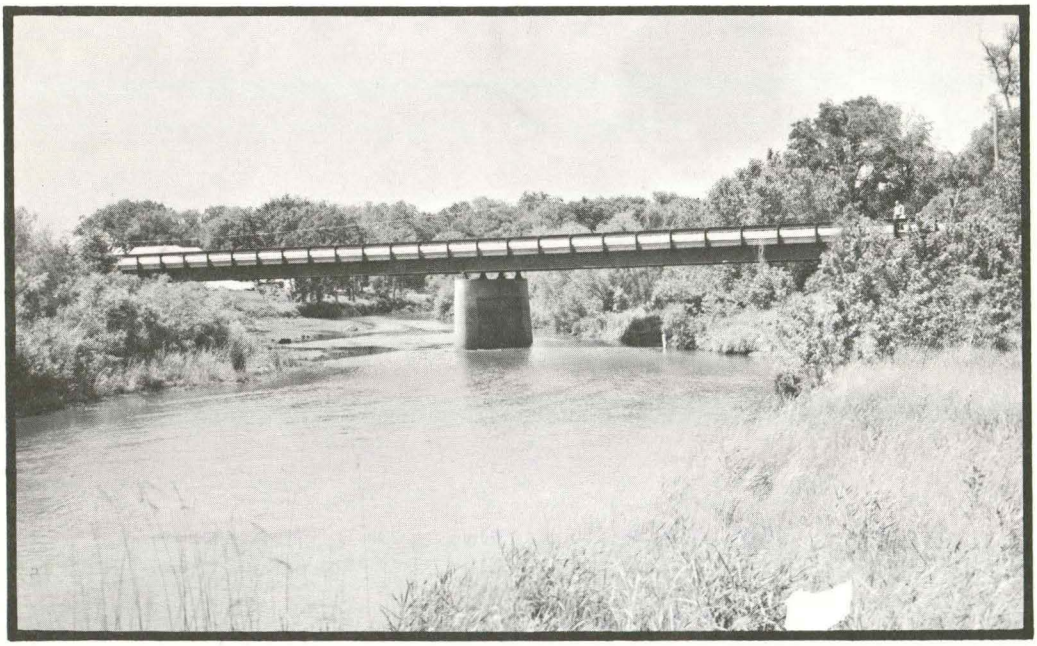


Figure 10. Upstream side of Ridgeway Avenue bridge at Mile 4.25.

Figure 11. Upstream side of Ranchero Road (State Highway 412) bridge at Mile 5.30.

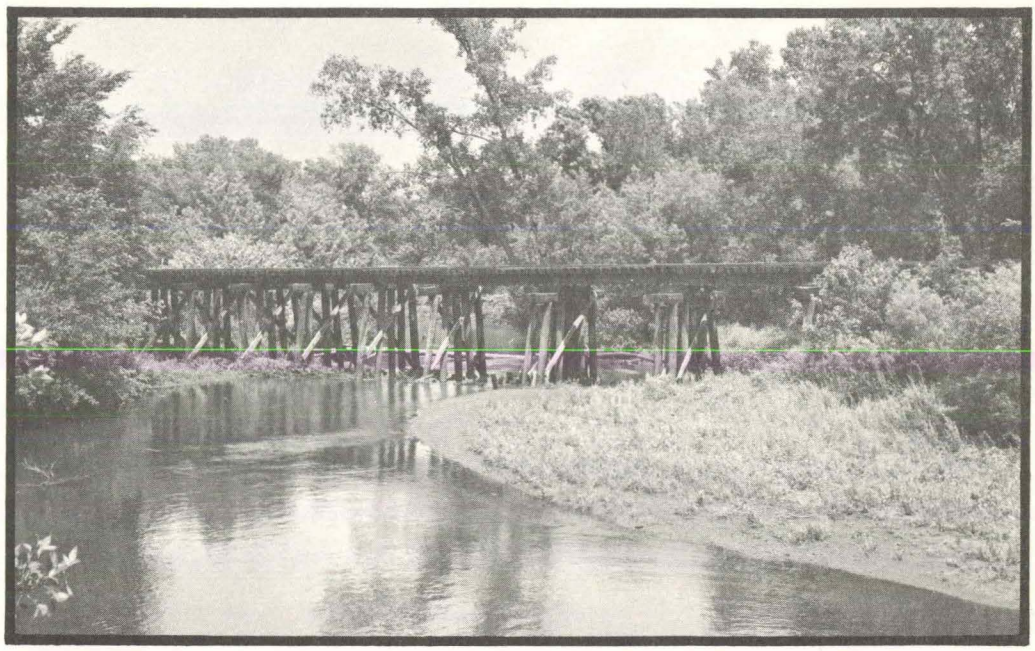


Figure 12. Upstream side of the Chicago, Great Western Railway bridge at Mile 5.47.

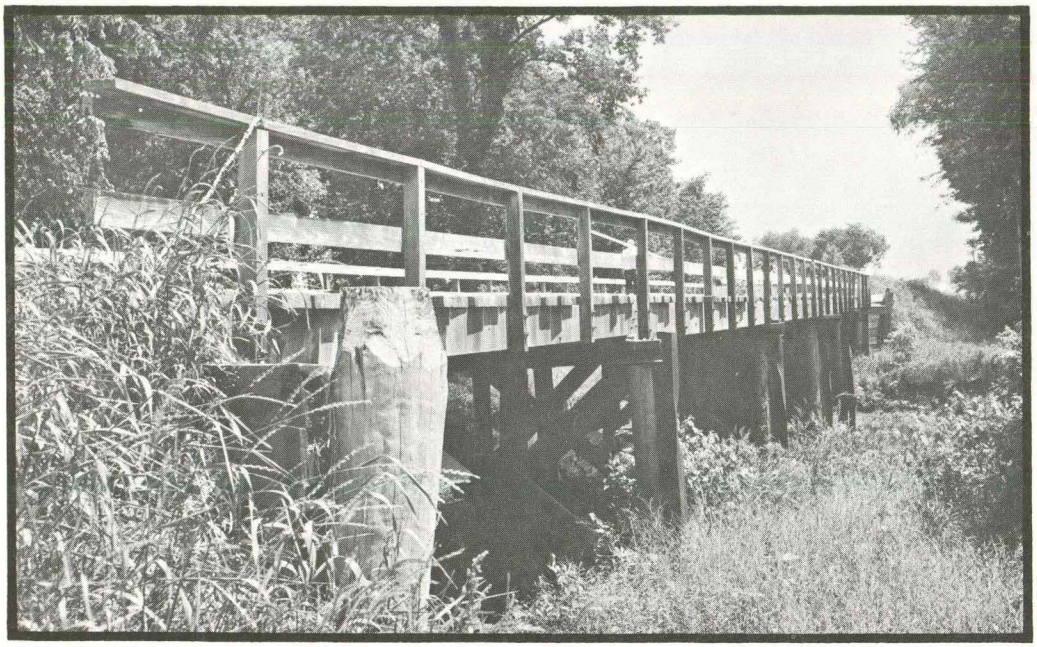


Figure 13. Upstream side of Shaulis Road bridge at Mile 6.35.

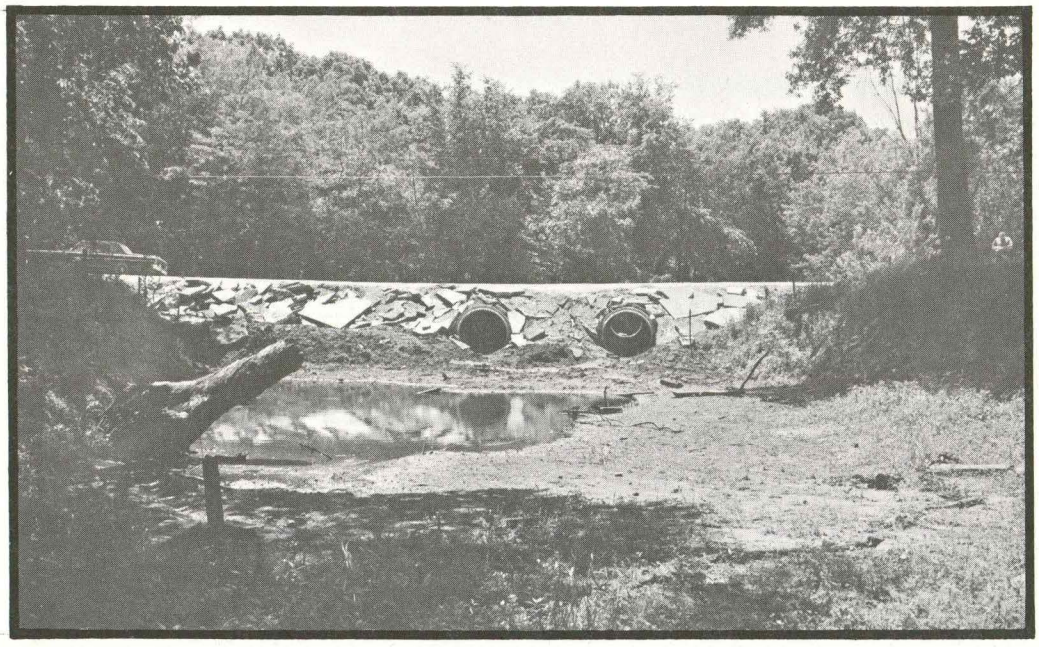


Figure 14. Downstream side of the Shaulis Road culverts at Mile 6.35.

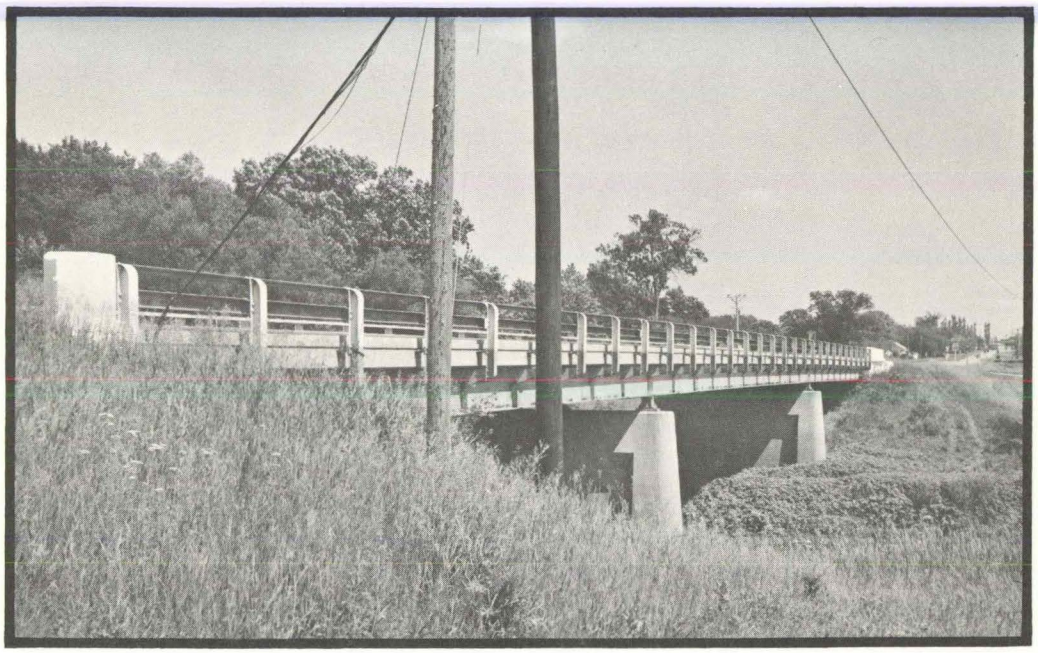


Figure 15. Upstream side of the Main Channel bridge of State Highway 58 at Mile 9.64.

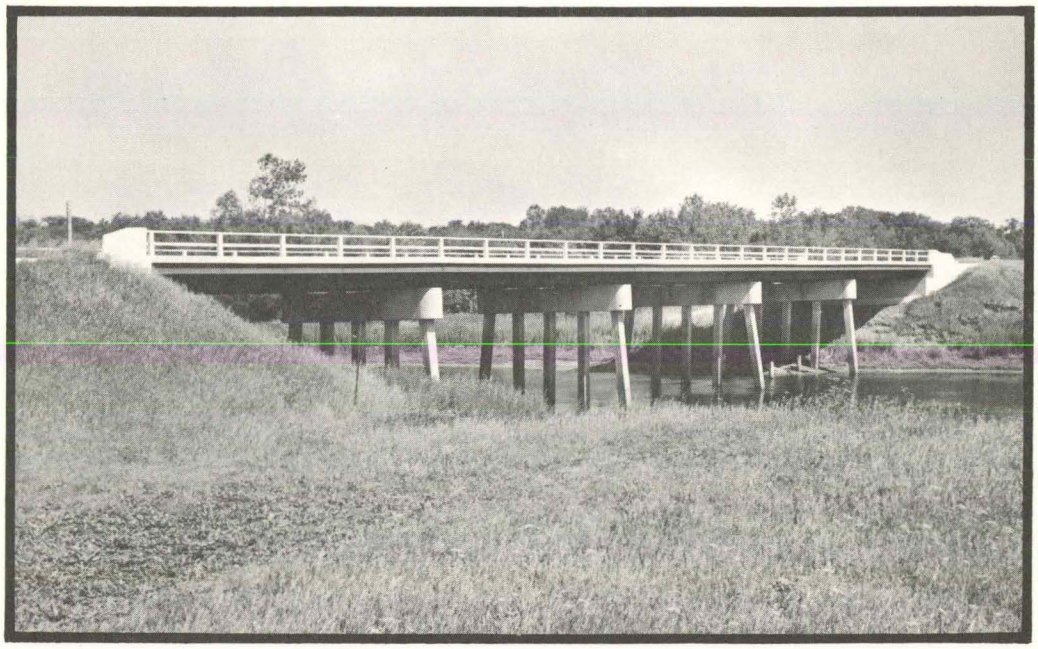


Figure 16. Upstream side of the cutoff channel bridge on State Highway 58 at Mile 9.64.

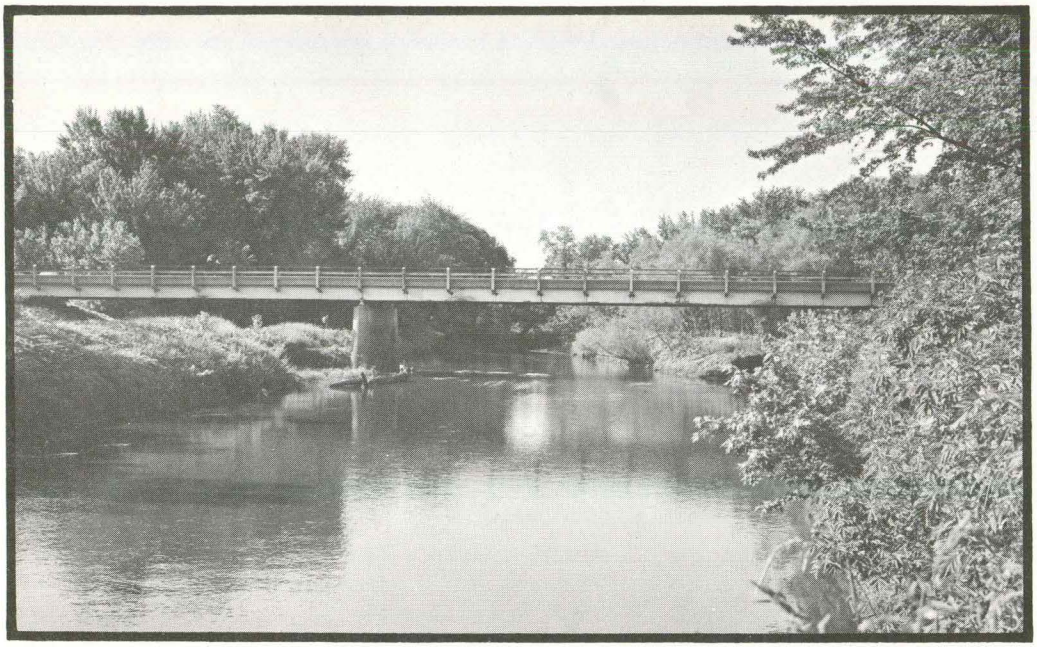


Figure 17. Downstream side of the County Road "N" bridge at Mile 11.89.

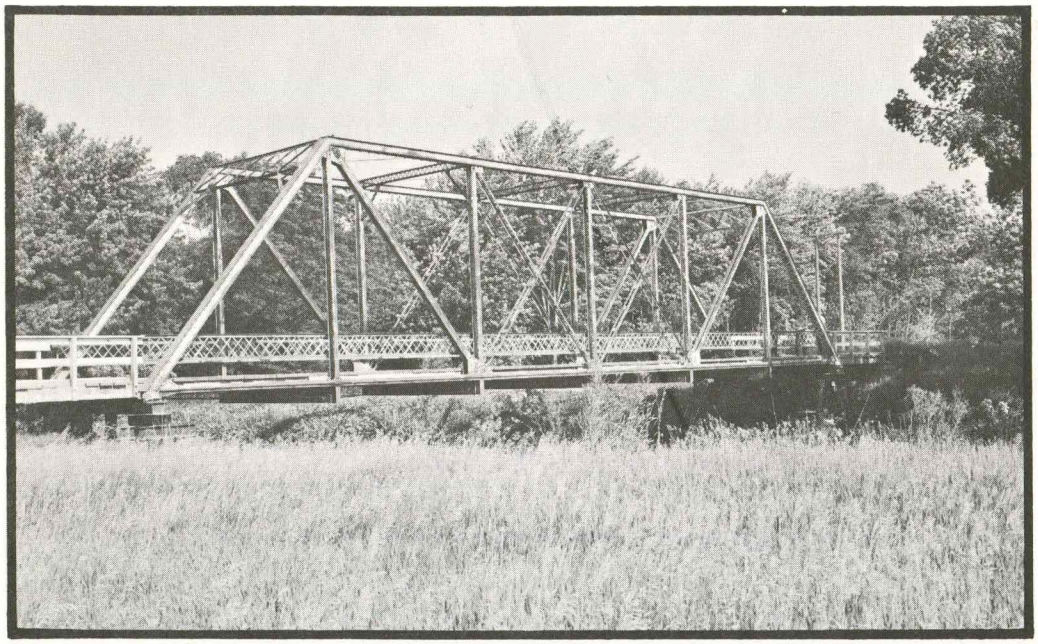


Figure 18. Downstream side of the Main Channel bridge on West County line road at Mile 14.57.

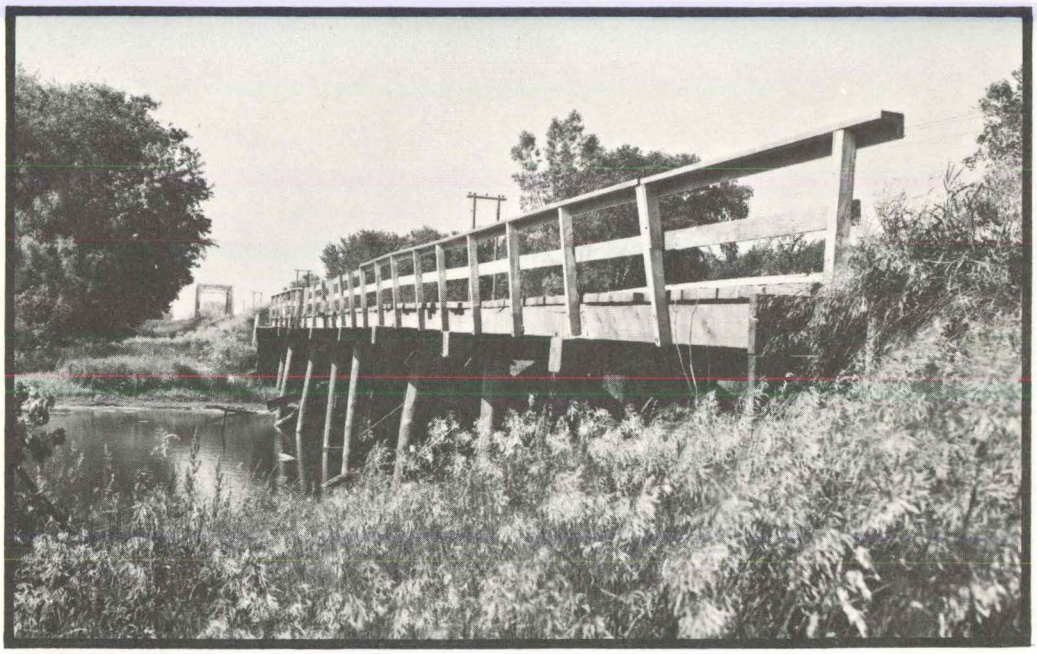


Figure 19. Downstream side of the bayou bridge on the west County line road at Mile 14.57.

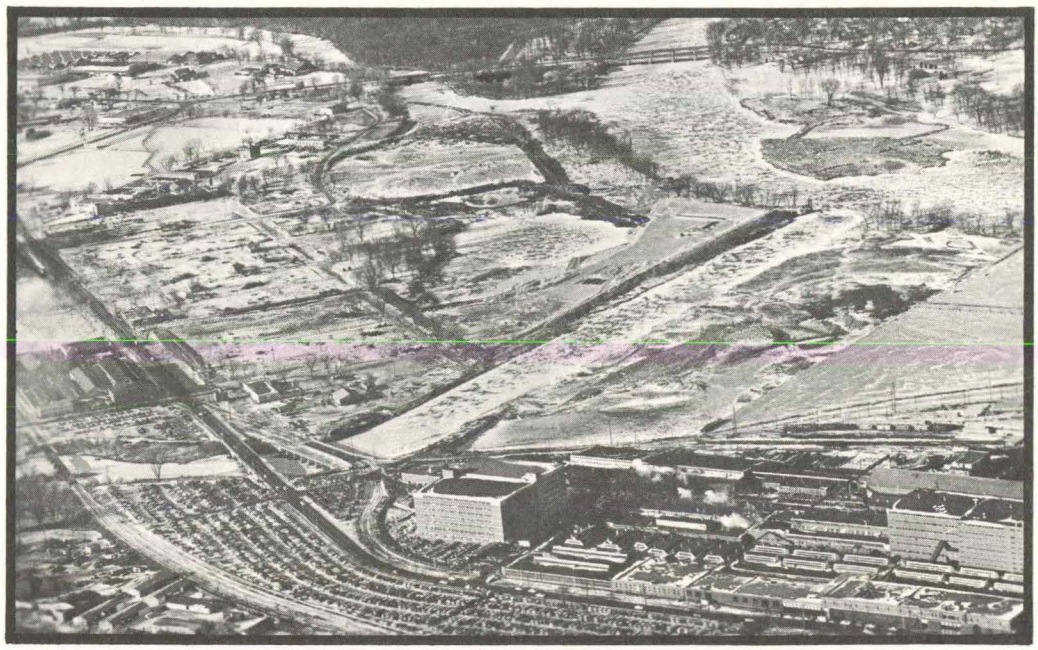


Figure 20. The straightened channel of Black Hawk Creek at its confluence with Cedar River.

## FLOOD SITUATION

### Flood Records

Records of river stages and discharges on Black Hawk Creek have been maintained since April 1952, when a water-stage recording gage was installed by the U. S. Geological Survey. The gage is located 35 feet downstream from the State Highway 58 bridge over Black Hawk Creek at mile 9.64.

To supplement the gage record obtained at this gaging station, local people were interviewed for information on dates and heights of floods. Newspaper files and historical records and documents were searched. Through these searches and investigations, a knowledge of floods on Black Hawk Creek has been developed.

### Flood Stages and Discharges

Table 4 lists crest stages and discharges for the known floods exceeding bankfull stage of 11.3 feet at the gaging station at Hudson, Iowa. The bankfull stage at the gaging station was related to damaging stages assuming no destruction of bridges or clogging by debris or ice jams. Table 5 lists the ten highest recorded floods in order of magnitude.

Five of the ten highest floods in Table 5 occurred in February or March. During these months snow melt and ice cover are generally greatest. This combination of conditions indicates the potential for ice jams at bridges during each late winter and early spring period of high water. Newspaper articles on past floods on Black Hawk Creek describe the occurrence of ice jams and emphasize potential ice jams in the future.

TABLE 4

FLOOD CREST ELEVATIONS ABOVE BANKFULL STAGE

BLACK HAWK CREEK, BLACK HAWK COUNTY, IOWA

1952 - 1968

The table includes all recorded floods above bankfull stage of 11.30 feet at the U. S. Geological Survey gaging station on the left bank, 35 feet downstream from bridge on State Highway 58 and 0.2 mile northeast of Chicago, Great Western Railway tracks in the west edge of Hudson. Drainage area at this gage = 303 square miles. Zero of gage = 865.03 feet above mean sea level, datum of 1929.

| Date of Crest | Gage Heights Stage feet | Elevation feet | Discharge cfs |
|---|---|---|---|
| June 13, 1953 | 12.57 | 877.60 | 1550 |
| June 28, 1953 | 11.32 | 876.35 | 1090 |
| July 7, 1953 | 13.71 | 878.74 | 2100 |
| June 2, 1954 | 12.73 | 877.76 | 1590 |
| June 11, 1954 | 13.58 | 878.61 | 2040 |
| August 28, 1954 | 11.98 | 877.01 | 1310 |
| May 30, 1957 | 14.57 | 879.60 | 2490 |
| June 18, 1957 | 13.92 | 878.95 | 2100 |
| June 15, 1958 | 12.58 | 877.61 | 1330 |
| July 16, 1958 | 14.57 | 879.60 | 2450 |
| March 20, 1959 | - | - | 7250 |
| March 27, 1959 | 16.48 | 881.51 | 8750 |
| January 14, 1960 | 12.77 | 877.80 | 1520 |
| March 31, 1960 | 16.93 | 881.96 | 9000 |
| April 18, 1960 | 14.97 | 880.00 | 2960 |
| May 8, 1960 | 14.75 | 879.78 | 2710 |

TABLE 4 (continued)

| Date of Crest | Gage Heights Stage feet | Elevation feet | Discharge cfs |
|---|---|---|---|
| June 19, 1960 | 11.36 | 876.39 | 1040 |
| February 20, 1961 | 13.52 | 878.55 | 1400 |
| February 23, 1961 | 14.93 | 879.96 | 2950 |
| March 7, 1961 | 14.09 | 879.12 | 2310 |
| March 15, 1961 | 12.35 | 877.38 | 1480 |
| March 26, 1961 | 11.88 | 876.91 | 1320 |
| March 28, 1962 | 15.70 | 880.73 | 5400 |
| May 12, 1962 | 11.99 | 877.02 | 1360 |
| March 17, 1963 | 13.69 | 878.72 | 2080 |
| July 20, 1963 | 12.00 | 877.03 | 1360 |
| March 1, 1965 | - | - | 2000 |
| April 1, 1965 | 16.01 | 881.04 | 5640 |
| April 6, 1965 | 16.35 | 881.38 | 7500 |
| October 1, 1965 | 12.67 | 877.70 | 1580 |
| February 9, 1966 | 14.82 | 879.85 | 3080 |
| June 13, 1966 | 14.68 | 879.71 | 3030 |
| August 22, 1966 | 13.98 | 879.01 | 2240 |
| *August 6, 1968 | 15.27 | 880.30 | 3490 |

*Preliminary report subject to revision.

TABLE 5

HIGHEST TEN RECORDED FLOODS IN ORDER OF MAGNITUDE

BLACK HAWK CREEK, BLACK HAWK COUNTY, IOWA

| Order No. | Date of Crest | Gage Heights | | Estimated Peak Discharge |
|---|---|---|---|---|
| | | Stage feet | Elevation feet | cfs |
| 1 | March 31, 1960 | 16.93 | 881.96 | 9000 |
| 2 | March 27, 1959 | 16.48 | 881.51 | 8750 |
| 3 | April 6, 1965 | 16.35 | 881.38 | 7500 |
| 4 | March 20, 1959 | 16.56 | 881.59 | 7250 |
| 5 | April 1, 1965 | 16.01 | 881.04 | 5640 |
| 6 | March 28, 1962 | 15.70 | 880.73 | 5400 |
| 7 | August 6, 1968 | 15.27 | 880.30 | 3490* |
| 8 | February 9, 1966 | 14.82 | 879.85 | 3080 |
| 9 | June 13, 1966 | 14.68 | 879.71 | 3030 |
| 10 | April 18, 1960 | 14.97 | 880.0 | 2960 |

*Preliminary report subject to revision

## Flood Occurrence

Plate 2 shows crest stages and years during which known floods exceeded the bankfull stage of 11.3 feet at the USGS stream gaging station at Hudson, Iowa.

## Duration and Rate of Rise

Plates 3 and 4 show the recorded stage hydrographs at the Hudson gaging station for the floods of March and April of 1960, the flood of March and April 1965, and the flood of June 1966. During the March 1960 flood, the creek rose to its crest stage in eighty hours at an average rate of 0.2 foot per hour. The maximum rate of rise for an eight-hour period was 0.3 foot per hour. This flood remained out of banks for three days.

## Velocities

A recurrence of the March 1960 flood would result in velocities of 5.9 feet per second and 1.1 feet per second in the channel and overbanks, respectively, in the reach between Ridgeway and Ansborough Avenues. Velocities in this reach are representative of open river conditions for flows of the magnitude of the March 1960 flood, but would be greater at flow constrictions. During larger floods, channel and overbank velocities would be greater.

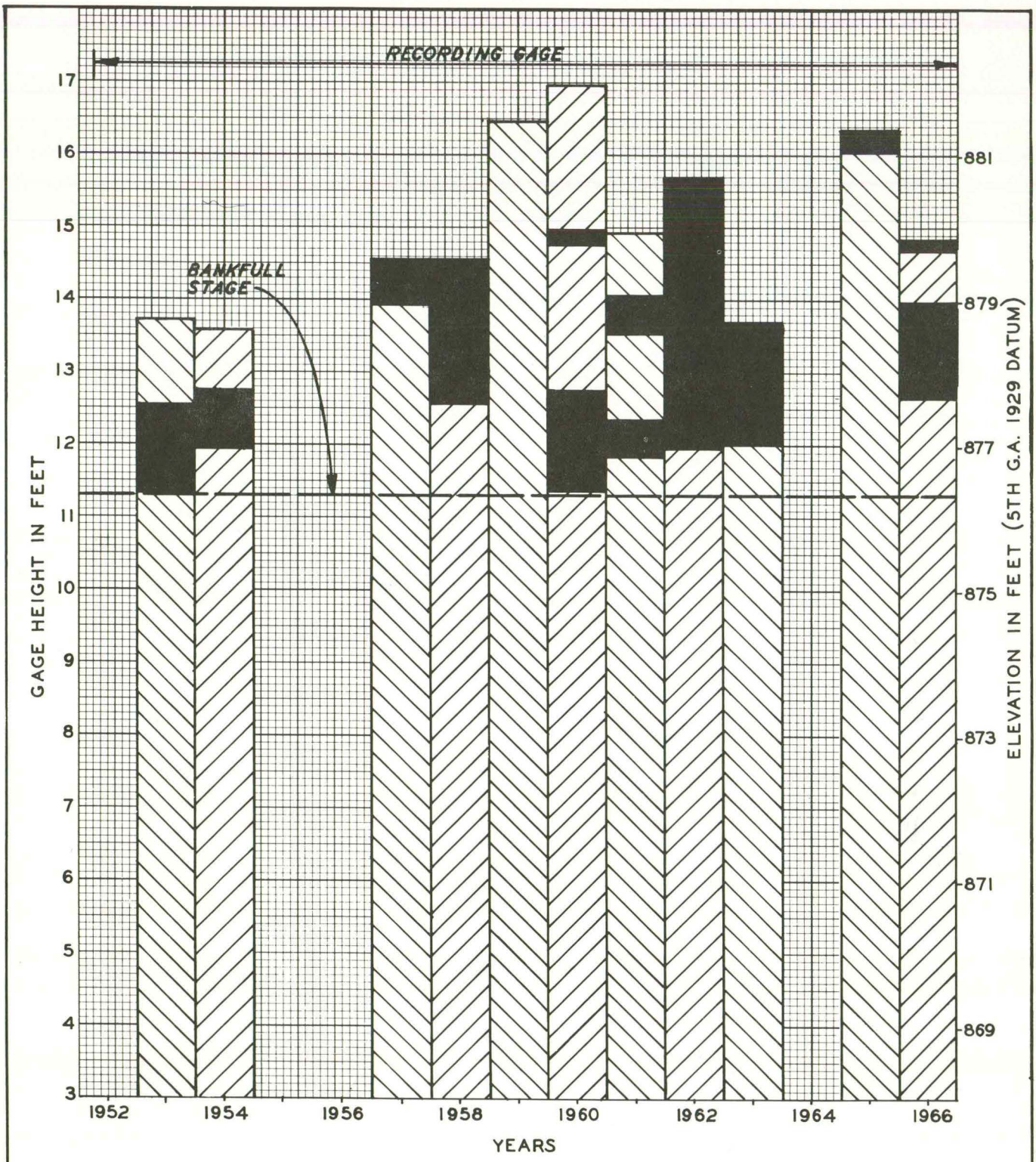
## Flooded Areas, Flood Profiles, and Cross Sections

Plates 7 through 14 show the approximate area along Black Hawk Creek that would be inundated by the Intermediate Regional and Standard Project Floods and the observed flood of June 1947. The actual limits of these overflow areas on the ground may vary from those shown on the maps. For specific locations, water surface elevations for the Standard Project and Intermediate

Regional Floods should be determined from the profiles on Plates 15 and 16. Detailed topographic maps were not available from the west Black Hawk County line downstream to the center of Section 32, T88N, R14W. Therefore, the flooded area in this reach is not shown in the report.

Plates 15 and 16 show the high water profiles for the Intermediate Regional and the Standard Project Floods in addition to the design water surface profile for the Waterloo Local Protection Project. Water surface elevations at the mouth of Black Hawk Creek were determined assuming the ten-year flood flow on the Cedar River occurred concurrently with the Intermediate Regional Flood flow from Black Hawk Creek and the fifty-year flood flow on the Cedar River occurred concurrently with the Standard Project Flood flow from Black Hawk Creek. The Waterloo Local Protection Project design profile assumes the 100-year flood flow on the Cedar River occurred concurrently with the 100-year flood flow from Black Hawk Creek. The profiles shown in Plates 15 and 16 are based on conditions which will exist after completion of the Waterloo Local Protection Project. The profiles present the effects of confining the flows through Evansdale and Waterloo on the Cedar River, and through West Waterloo on Black Hawk Creek.

Plate 17 shows five cross sections that are typical of the 35 cross sections obtained for Black Hawk Creek in the reach investigated. The locations of the cross sections are shown on Plates 7 through 14. The elevation and extent of overflow of the Intermediate Regional and Standard Project Floods are indicated on the typical sections.




STREAM GAGE AT CREEK MILE 9.64

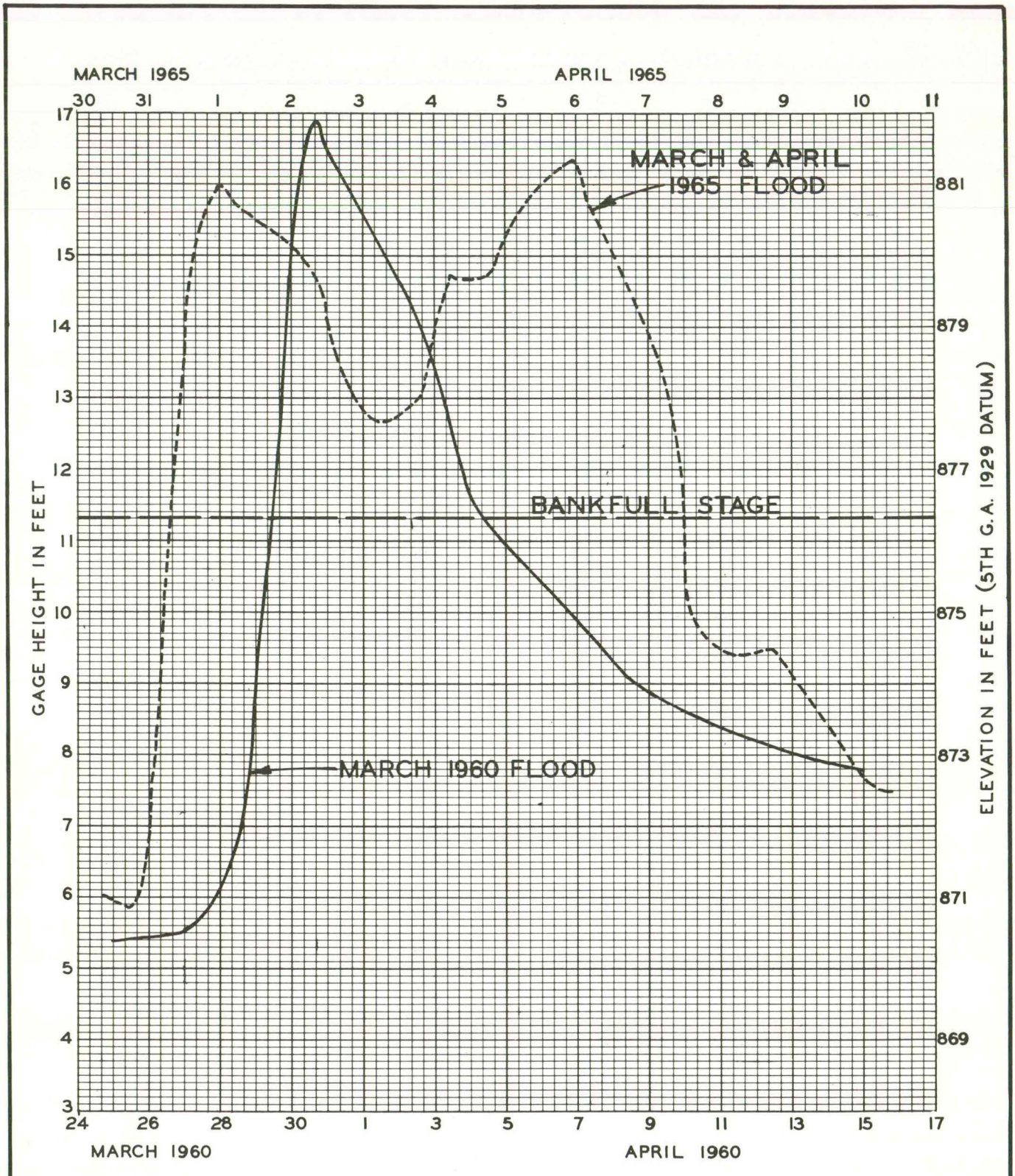
VARIATION IN SHADING ON BAR GRAPH INDICATES MORE THAN ONE FLOOD DURING THE WATER YEAR. FOR EXAMPLE, IN 1960 THERE WERE 5 FLOODS; GAGE HEIGHTS WERE 16.93, 14.97, 14.75, 12.77, AND 11.36 FEET.

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

# FLOODS ABOVE BANKFULL STAGE

BLACK HAWK CREEK
HUDSON, IOWA
DECEMBER 1968

PLATE 2




STREAM GAGE
AT CREEK MILE 9.64

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

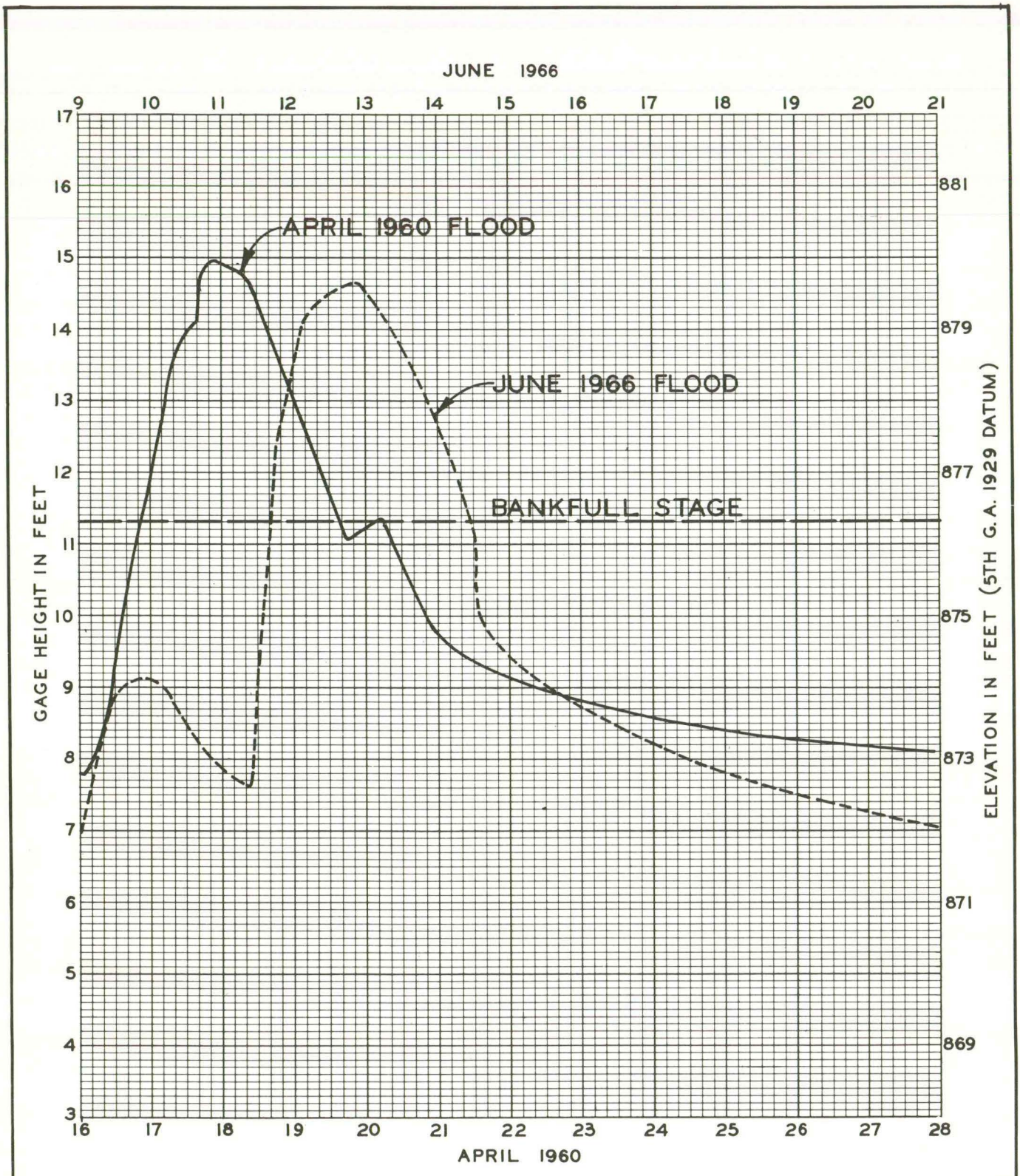
## STAGE HYDROGRAPHS

BLACK HAWK CREEK

HUDSON, IOWA

DECEMBER 1968

PLATE 3




STREAM GAGE
AT CREEK MILE 9.64

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

## STAGE HYDROGRAPHS

BLACK HAWK CREEK

HUDSON, IOWA
DECEMBER 1968

PLATE 4

## FLOOD DESCRIPTIONS

Descriptions of large floods that have occurred on Black Hawk Creek at Waterloo, Iowa, are based on newspaper accounts and historical records.

### Flood of March 1929

This flood was caused by conversion of heavy ice and snow cover to runoff by a sudden rise in temperature in combination with rainfall. A newspaper account reads as follows:

"Black Hawk Creek backed up during the night to flood new sections along Westfield Avenue, Avalon Avenue, Briggs, Witry, and Duryea Streets. Westfield Avenue, for a stretch of 500 feet near the Galloway plant, was covered with water from one to three feet in depth. Some motorists were driving through this water this morning, but several machines were stalled when the water reached their engines."

### Flood of June 18, 1944

A newspaper article describes this flood as follows:

"Both the Cedar (River) and Black Hawk (Creek) began their rampage early Saturday, carrying away the drainage from heavy downpours early Friday morning."

"Black Hawk Creek, breaking out of its banks at many spots southwest of Waterloo during Saturday, had quieted down last night. It was running full but not out of control. The creek's waters almost reached the bottom of Fall's Avenue bridge, near the John Deere Tractor Company, Saturday morning. Many tracts of farmland along the creek were inundated Saturday."

Flood of June 3, 1947

The account of this flood was recorded as follows:

"Swollen by 2.92 inches of rain over a 24-hour period, the Cedar River, Black Hawk and Virden Creeks spread into the basements of homes and caused evacuation of at least twenty Waterloo families."

"County Engineer Raymond Stevenson reported Black Hawk Creek at an all-time high flood stage."

"The rain swollen waters of Black Hawk Creek swept away the north end of the small concrete bridge a half-mile west of Hudson, Iowa, on Highway 58, Sunday night and washed out approximately 1,500 feet of paving approaching the bridge."

"Farmers near Hudson reported flood conditions were the worst in years. Most rural telephones were out of commission at Hudson and loss of livestock was believed to be heavy. Many basements were flooded."

"Raymond Stevenson, Black Hawk County Engineer, said Monday that seven county bridges and numerous county roads were washed out by the swollen waters of Black Hawk and Miller Creeks."

Subsequent to this flood, the Highway 58 bridge was repaired, and a second bridge built to effectively double the flow area. As a result, flood heights upstream from the bridges are lower for a given flow than those previous to and during the 1947 flood.

Flood of February 29, 1948

Black Hawk Creek swept out of its banks and forced evacuation of twelve families during this flood. The Waterloo fire department evacuated twelve families from the area near Howery and Joder Streets. Black Hawk Creek crested about four feet below the record flood of 1947 and Duryea and Falls Avenue escaped flooding."

Flood of March 6, 1949

This flood was described in a newspaper article as follows:

"Black Hawk Creek, whose waters were washing about two feet deep through Black Hawk Road, apparently reached its crest at

about eight o'clock last night and was starting down."

"Earlier in the day, Mrs. Thelma V. MacLennan and her children and roomers - seven persons in all - were evacuated from their home at 840 Black Hawk Road by the Waterloo Fire Department. It appeared last night that they would be the only Waterloo evacuees of the present high water."

Flood of March 7, 1950

The following account of this flood appeared in Waterloo newspapers:

"Flood waters of Black Hawk Creek, an estimated eight feet above normal Tuesday noon, had forced ten families in the area to evacuate their homes."

"However, the city engineer's office said the stream had apparently crested at noon and that the flood crest was dropping at the rate of two inches an hour at Hudson, Iowa."

"Flood waters of Black Hawk Creek were flowing several feet deep over the new Fletcher Avenue cutoff and this short-cut from Falls Avenue to the west side residential area is closed to traffic."

Flood of February 26, 1951

The following are excerpts from newspaper accounts of the 1951 flood:

"The Black Hawk Creek flood control project Monday was getting its first real test after melting snow and 0.67 of an inch of rain sent the stream out of its banks for the first time since the dike, designed to protect Galloway-Hagerman addition, was completed last fall."

"The stream, up approximately six feet above normal level Monday morning, had leveled off at Hudson, Iowa, at about 10 A.M."

"In Waterloo, employees of the city engineer's office, street department, and of John Rooff and Son Construction Company, worked all night to close a sluiceway through the Black Hawk Creek dike.

The sluiceway, constructed to permit surface water to drain through the dike and into the creek is to be equipped with an automatic flap gate and a sluice gate."

"An ice jam piled up against the Chicago, Rock Island and Pacific Railroad trestle across Black Hawk Creek during this flood. A truck-mounted dragline moved out on the trestle to break up the ice jam and reduce flood heights upstream from the bridge."

"The Fletcher Avenue cutoff was closed to traffic late Sunday and remained closed Monday as flooded Black Hawk Creek covered the low-lying road. The flood gates were installed at the closure structure on Fletcher Avenue to prevent the flood waters from flowing over the Galloway-Hagerman addition."

Flood of April 2, 1965

A newspaper article described this flood as follows:

"....the water of Black Hawk Creek, which crested into the Cedar River at the creek's mouth near the John Deere Waterloo Tractor works Friday, had already brought the (Cedar) river up to more than eleven feet by Thursday evening."

"....because of an ice jam in Black Hawk Creek, water poured through the opening of the dike at Fletcher Avenue and Black Hawk Road at about 6 P.M. Thursday."

"Dallas Sanders, (Superintendent of the Waterloo Sewer Department) and Carl Fagerlind, city street commissioner, arranged for the immediate sandbagging of the opening with approximately 200 sandbags. Sanders said the height of the Black Hawk at Hudson had not indicated the sudden two-foot rise."

"Street Commissioner Fagerlind and Sanders utilized a huge crane of the Jens Olesen and Sons Construction Company to break the ice jam on the Black Hawk Thursday evening."

Additional large floods are tabulated in Table 5. Figures 21 through 26 show typical flood scenes for selected floods in the reach of Black Hawk Creek covered by this report.

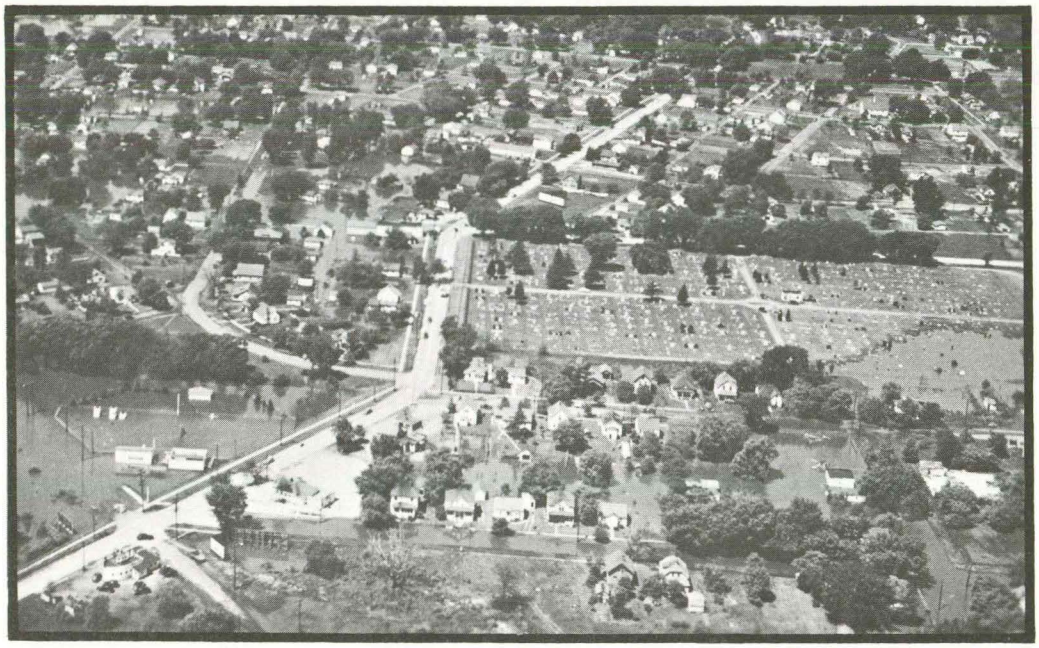


Figure 21. A view of Duryea Street, foreground, Calvary Cemetery, and Janney Avenue, the road directly above the Schoitz Memorial swimming pool in the center foreground, during the flood of June 1947.

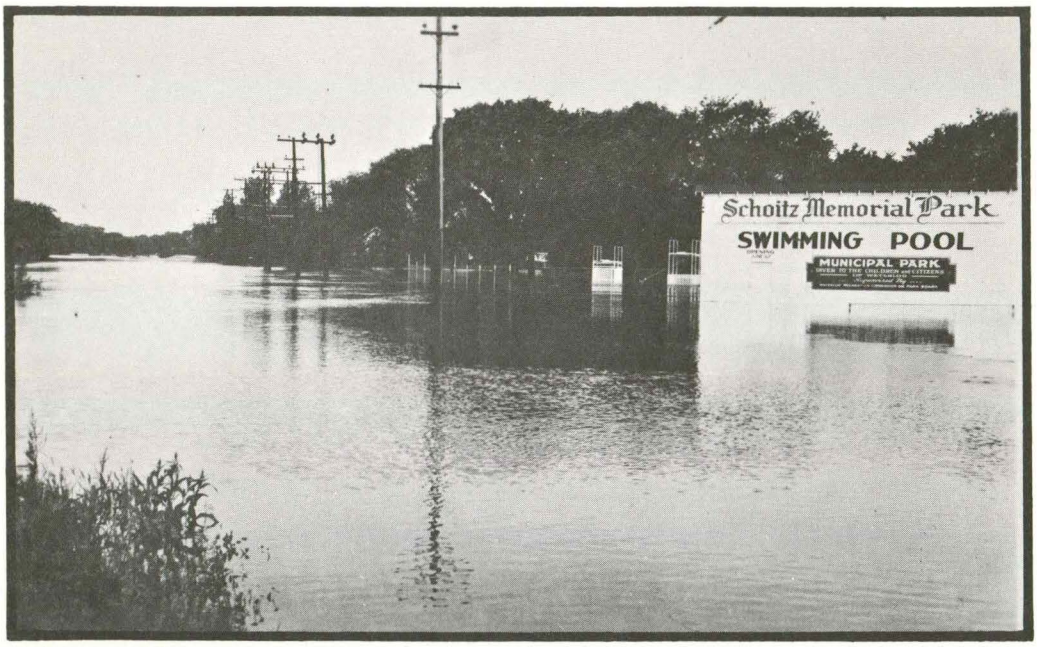



Figure 22. Black Hawk Road at Schoitz Memorial Park during the flood of June 1947.

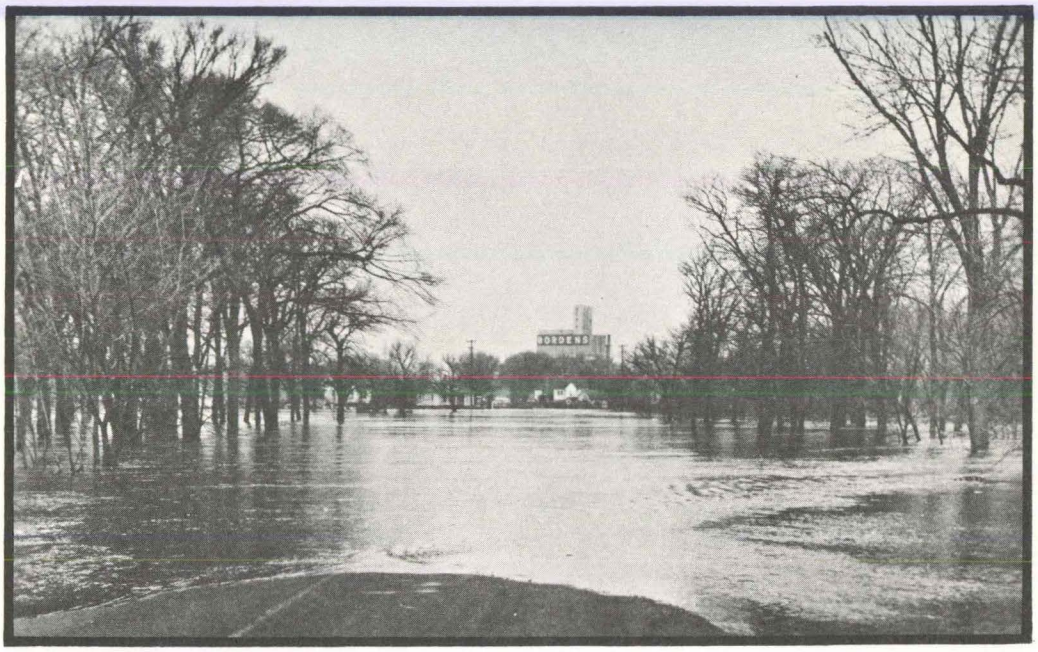


Figure 23. A view of Black Hawk Road from Fletcher Avenue bridge during the flood of March 1950.

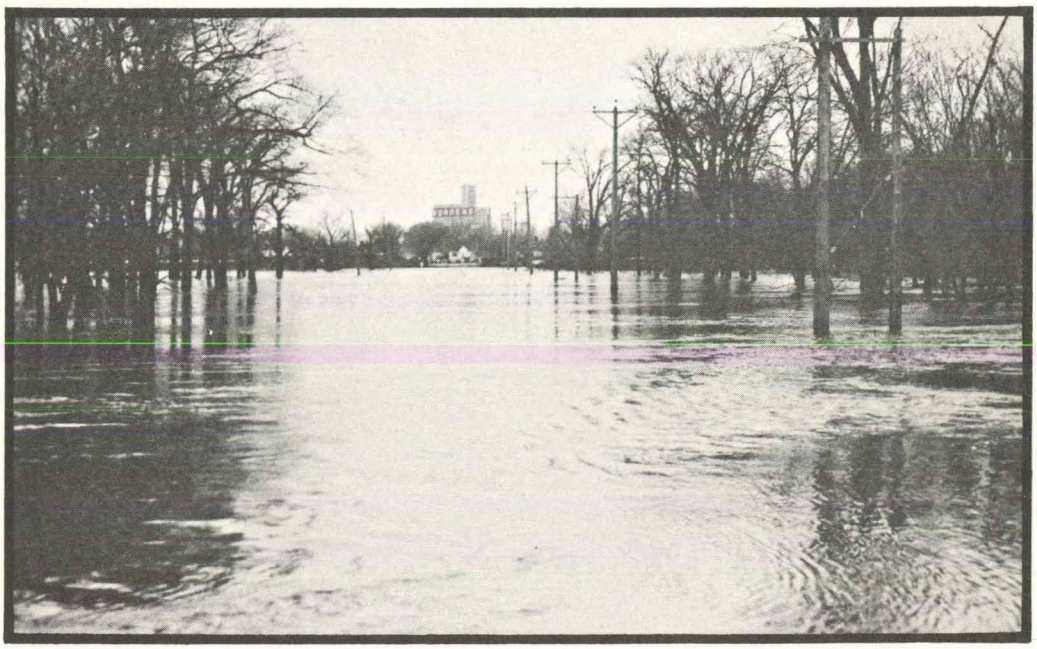


Figure 24. A view past the barricades on Fletcher Avenue extension during the flood of March 1957.


Figure 25. Looking upstream from Fletcher Avenue bridge during the flood of April 1965.

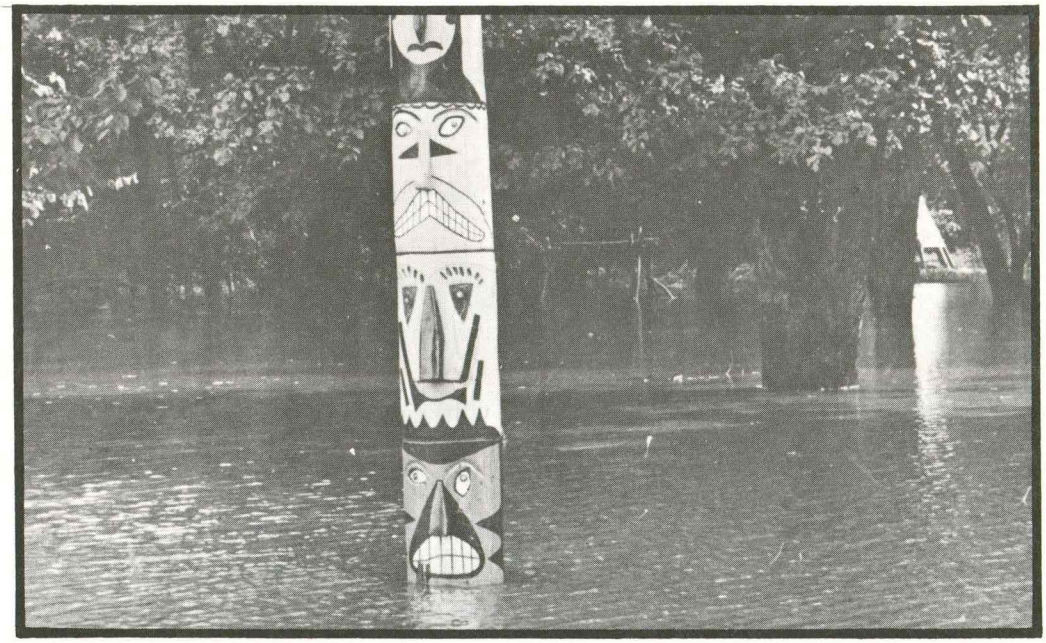


Figure 26. The June 1966 flood was almost up to the chin of Chief Tillamook, low man on the Hope Martin Park totem pole.

## FUTURE FLOODS

This section of the report discusses the Standard Project Flood and the Intermediate Regional Flood on Black Hawk Creek in the vicinity of the City of Waterloo. The Standard Project Flood represents reasonable upper limits of expected flooding. The Intermediate Regional Flood represents a flood that may reasonably be expected to occur more frequently, although it is not as high as the infrequent Standard Project Flood.

Large floods from heavy storms have occurred on streams in the general geographical and physiographical region of Waterloo. Heavy storms similar to those causing these floods could occur over the watershed of Black Hawk Creek. In this event, floods comparable to those on neighboring streams would occur on Black Hawk Creek. 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 Black Hawk Creek.

### 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 100 years, at a designated location, although the flood may occur in any year. Probability estimates are based on statistical analyses of stream flow records available for the watershed under study. The Intermediate Regional Flood represents a major flood, although it is much less severe than the Standard Project Flood.

In order to determine the Intermediate Regional Flood for Black Hawk Creek, statistical studies were made using the 16-year record of known flood data for Black Hawk Creek at the gaging station at Hudson, Iowa. Table 6 lists the maximum known floods that have occurred on watersheds within the same geographical region.

## TABLE 6

## MAXIMUM KNOWN FLOOD DISCHARGES ON

## STREAMS IN THE REGION OF WATERLOO, IOWA

| Stream | Location | Drainage Area Sq. Mi. | Date | Peak Discharge Amount cfs | Peak Discharge Per Sq. Mi. cfs |
|---|---|---|---|---|---|
| Shell Rock River | At Shell Rock, Iowa | 1746 | March 28, 1961 | 33500 | 19 |
| Iowa River | At Marshalltown, Iowa | 1564 | June 4, 1918 | 42000 | 27 |
| Turkey River | At Garber, Iowa | 1545 | February 23, 1922 | 32300 | 21 |
| West Fork Des Moines River | At Estherville, Iowa | 1372 | June 8, 1953 | 10800 | 8 |
| Cedar River | At Charles City, Iowa | 1054 | April 7, 1965 | 21000 | 20 |
| Wapsipinicon River | At Independence, Iowa | 1048 | June 14, 1947 | 21500 | 21 |
| West Fork Cedar River | At Finchford, Iowa | 846 | June 27, 1951 | 31900 | 38 |
| Boone River | Near Webster City, Iowa | 844 | June 22, 1954 | 20300 | 24 |
| Middle Raccoon River | At Panora, Iowa | 440 | July 2, 1958 | 9150 | 21 |
| Cedar River | Near Austin, Minnesota | 425 | March 29, 1962 | 9530 | 22 |
| LaCrosse River | Near West Salem, Wisconsin | 398 | August 6, 1935 | 8200 | 21 |
| Beaver Creek | At New Hartford, Iowa | 347 | June 13, 1947 | 18000 | 52 |
| Skunk River | Near Ames, Iowa | 315 | June 10, 1954 | 8630 | 27 |
| Little Cedar River | Near Ionia, Iowa | 306 | March 27, 1961 | 10800 | 35 |
| Black Hawk Creek | At Hudson, Iowa | 303 | March 31, 1960 | 9000 | 30 |
| Shell Rock River | Near Northwood, Iowa | 300 | April 8, 1965 | 3400 | 11 |
| Indian Creek | Near Mingo, Iowa | 276 | June 12, 1966 | 7380 | 27 |
| South Fork Root River | Near Houston, Minnesota | 275 | March 29, 1962 | 8420 | 31 |
| Pecatonica River | Near Darlington, Wisconsin | 274 | July 16, 1950 | 22000 | 80 |
| Kickapoo River | At LaFarge, Wisconsin | 266 | February 9, 1966 | 9910 | 37 |
| Turkey River | At Spillville, Iowa | 177 | March 29, 1962 | 7380 | 42 |

Peak discharge of the Intermediate Regional Flood is 26,000 cubic feet per second at the gaging station at Hudson, Iowa. Peak discharges of the Intermediate Regional Flood at various locations on Black Hawk Creek are shown on Table 7.

TABLE 7

INTERMEDIATE REGIONAL FLOOD

PEAK DISCHARGES ON BLACK HAWK CREEK

| Location | River Mile | Drainage Area Sq. Mile | Discharge cfs |
|---|---|---|---|
| Mouth | 0.01 | 344 | 27600 |
| Downstream side of Ridgeway Avenue bridge | 4.25 | 332 | 27100 |
| Downstream side of Shaulis Road bridge | 6.35 | 313 | 26400 |
| USGS Gage at Hudson | 9.64 | 303 | 26000 |
| Downstream side of County line bridge | 14.57 | 278 | 24800 |

The Intermediate Regional Flood on Black Hawk Creek in the reach investigated would be up to 1.0 foot higher than the June 1947 flood.

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

experienced 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 may be expected from the most severe combination of meteorological and hydrological conditions considered reasonably characteristic of the geographical region involved, excluding extremely rare combinations.

Standard Project Flood estimates have been made on Black Hawk Creek at the stream gaging station at Hudson, Iowa. The storm rainfall used is 13.55 inches in 96 hours. Peak discharges at selected locations for the Standard Project Flood on Black Hawk Creek are shown on Table 8.

TABLE 8

STANDARD PROJECT FLOOD

PEAK DISCHARGES ON BLACK HAWK CREEK

| Location | River Mile | Drainage Area Sq. Mile | Discharge cfs |
|---|---|---|---|
| Mouth | 0.01 | 344 | 48000 |
| Downstream side of Ridgeway Avenue bridge | 4.25 | 332 | 47300 |
| Downstream side of Shaulis Road bridge | 6.35 | 313 | 46000 |
| USGS Gage at Hudson | 9.64 | 303 | 45300 |
| Downstream side of County line bridge | 14.57 | 278 | 43200 |

Frequency

The occurrence of the Standard Project Flood would be a rare

event; however, it could occur in any 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 that would be necessary to produce such floods would seldom occur. The consideration of floods of this magnitude is more important in some problems than in others depending on the consequences should this 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, upon how much area is flooded, the height of flooding, the velocity of flow, the rate of rise, and the duration of flooding. Black Hawk Creek floods are developed by two sets of conditions. The melting of the winter accumulation of snow, with or without additional runoff due to rainfall, results in the later winter and early spring floods. The spring and summer floods are due to heavy rainfall over the Black Hawk Creek Basin.

Ice jams do occur on Black Hawk Creek and produce higher stages than would be obtained with open river conditions assumed for this report. However, ice jams are difficult to evaluate and their occurrence is mentioned as a potential flood risk.

### Areas Flooded and Height of Flooding

The areas flooded along Black Hawk Creek by the Standard Project Flood and the Intermediate Regional Flood are shown in Plates 7 through 14. Depths of flow can be estimated from the crest profiles shown in Plates 15 and 16 and cross sections in Plate 17.

The water surface profiles for Black Hawk Creek were computed using stream characteristics determined from topographic maps and valley cross sections. The elevations shown in Plates 15 and 16 and the overflow areas shown in Plates 7 through 14 have been determined with an accuracy consistent with the purposes of this study and the accuracy of the basic data.

The 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 27 through 36 show the heights that would be reached by the Standard Project Flood and the Intermediate Regional Flood on the facilities existing on the flood plain of Black Hawk Creek.

Velocities, Rates of Rise and Duration

Water velocities during floods depend largely upon 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 the different locations on the stream.

Table 9 lists the maximum velocities that would occur in the main channel of Black Hawk Creek during the Intermediate Regional and Standard Project Floods.

TABLE 9

MAXIMUM CHANNEL VELOCITIES

| Stream | Location | Maximum Velocities | |
|---|---|---|---|
| | | Int. Reg. Flood Ft. Per Sec. | Std. Proj. Flood Ft. Per Sec. |
| Black Hawk Creek | Mile 1.81 | 12.4 | 13.2 |

Table 10 lists the maximum velocities that would occur in the overbank areas of Black Hawk Creek during the Standard Project and Intermediate Regional Floods.

TABLE 10

MAXIMUM OVERBANK VELOCITIES

| Stream | Location | Maximum Velocities | |
|---|---|---|---|
| | | Int. Reg. Flood Ft. Per Sec. | Std. Proj. Flood Ft. Per Sec. |
| Black Hawk Creek | Mile 4.25 | 4.6 | 4.9 |

Table 11 lists the total rise above low water to the crest of the Intermediate Regional Flood, the maximum rate of rise, and the duration above bankfull stage of the Intermediate Regional Flood for Black Hawk Creek.

Table 11 also lists similar information for the Standard Project Flood.

TABLE 11

BLACK HAWK CREEK

RATES OF RISE AND DURATION

| Flood | Location | Height of Rise Feet | Time of Rise Hours | Maximum Rate of Rise Ft./Hr. | Duration Above Bankfull Stage Days |
|---|---|---|---|---|---|
| Intermediate Regional | USGS Gage @ Hudson, Iowa | 12 | 54 | 0.4 | 5 |
| Standard Project | USGS Gage @ Hudson, Iowa | 15 | 72 | 0.5 | 7 |

The duration of flooding shown in Table 11 in combination with the overbank velocities shown in Table 10 would create a hazardous situation in developed areas. Velocities greater than three feet per second combined with a depth of flow of three feet or greater, are generally considered hazardous.

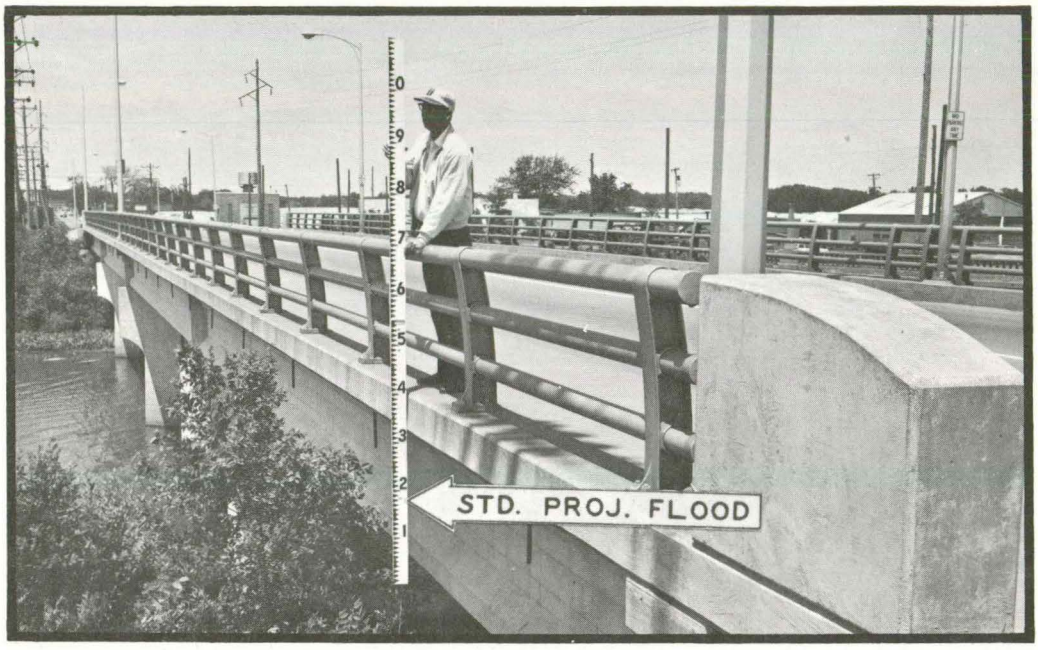



Figure 27. Upstream side of the new Westfield Avenue bridge at Mile 0.41.

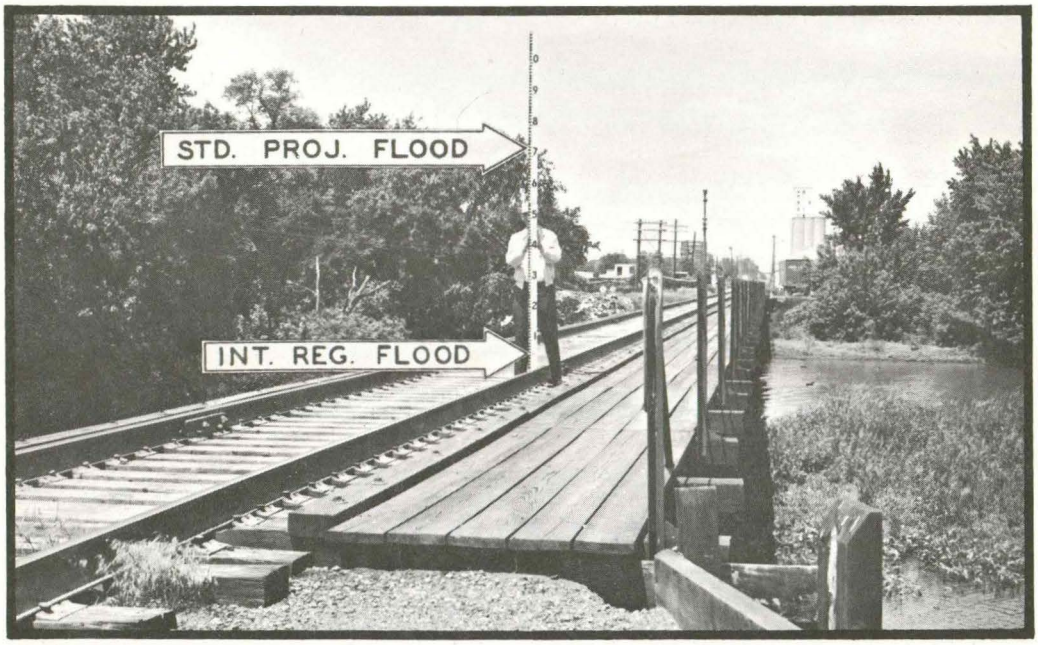



Figure 28. Downstream side of the Chicago, Rock Island and Pacific Railroad bridge at Mile 0.49.

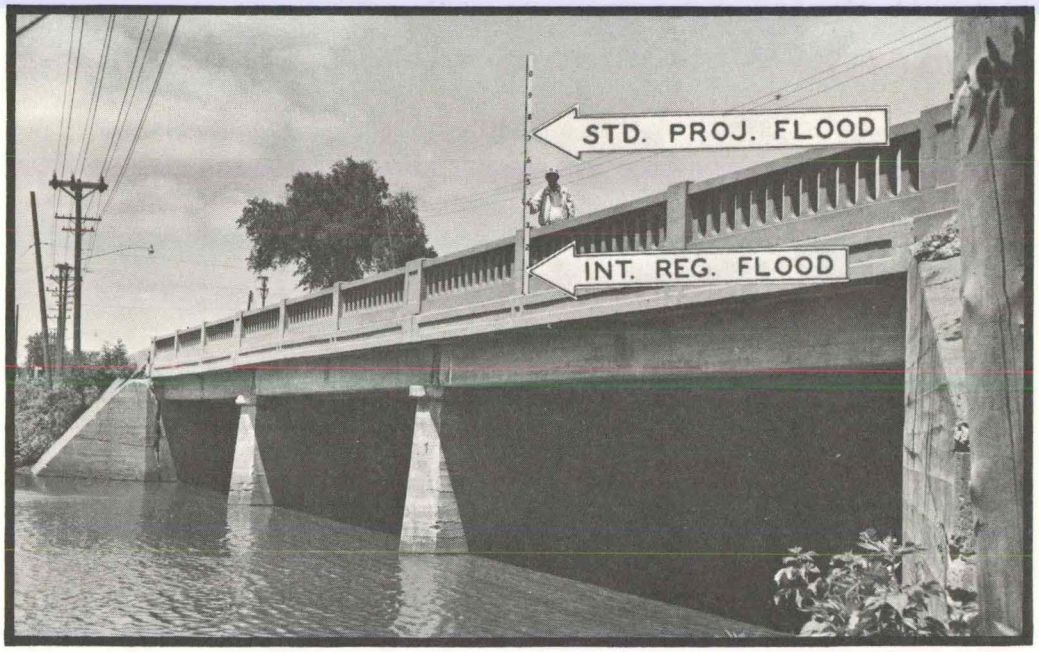



Figure 29. Upstream side of Falls Avenue bridge at Mile 0.68.

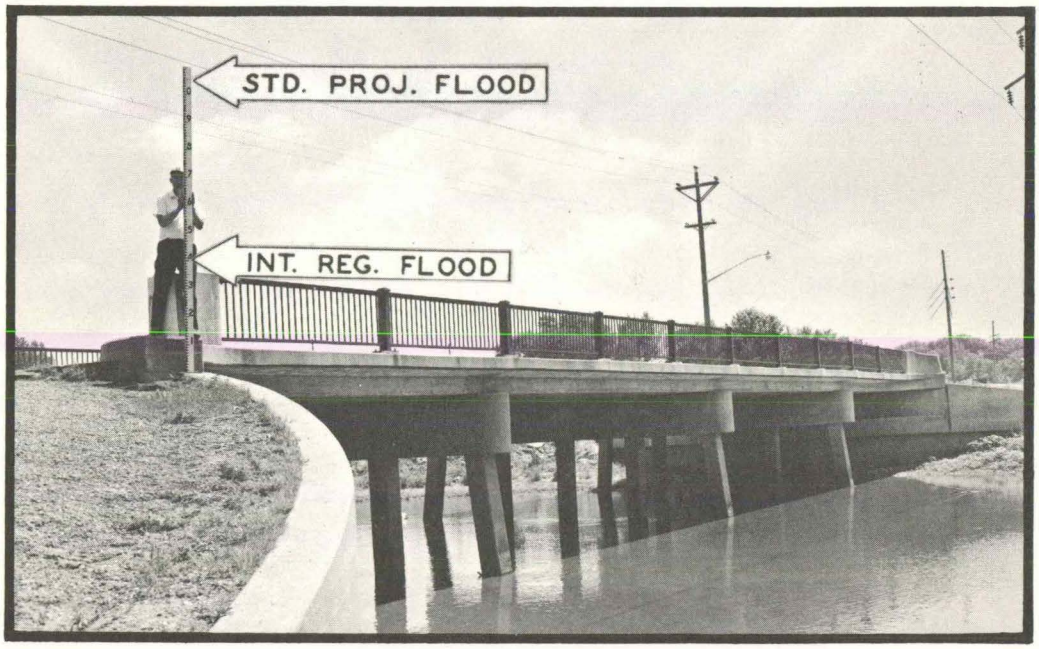



Figure 30. Upstream side of Fletcher Avenue bridge at Mile 1.25.

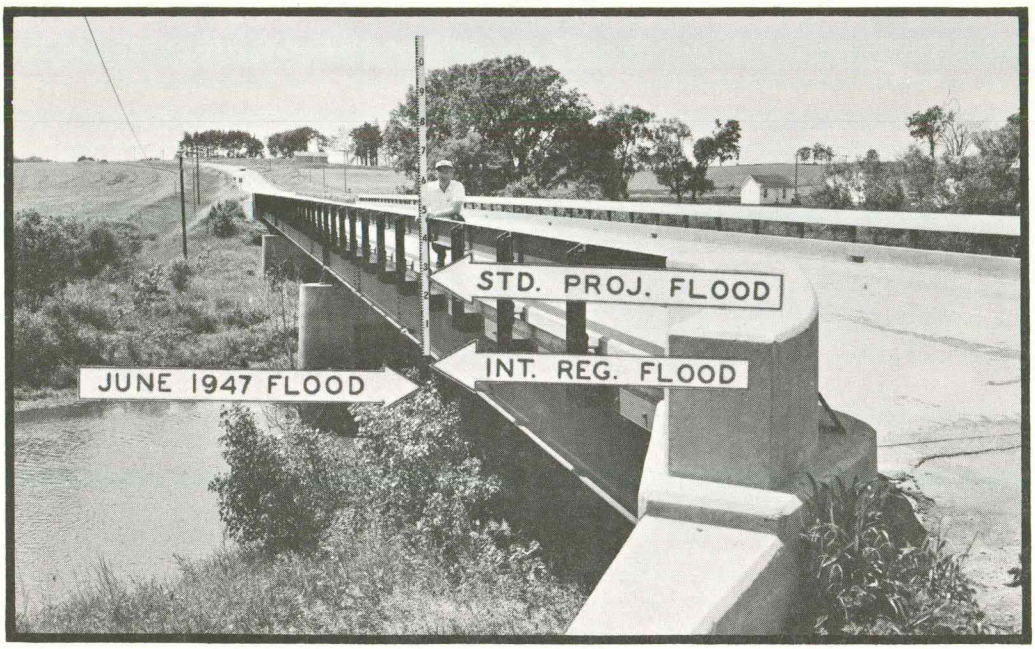



Figure 31. Upstream side of Ridgeway Avenue bridge at Mile 4.25.

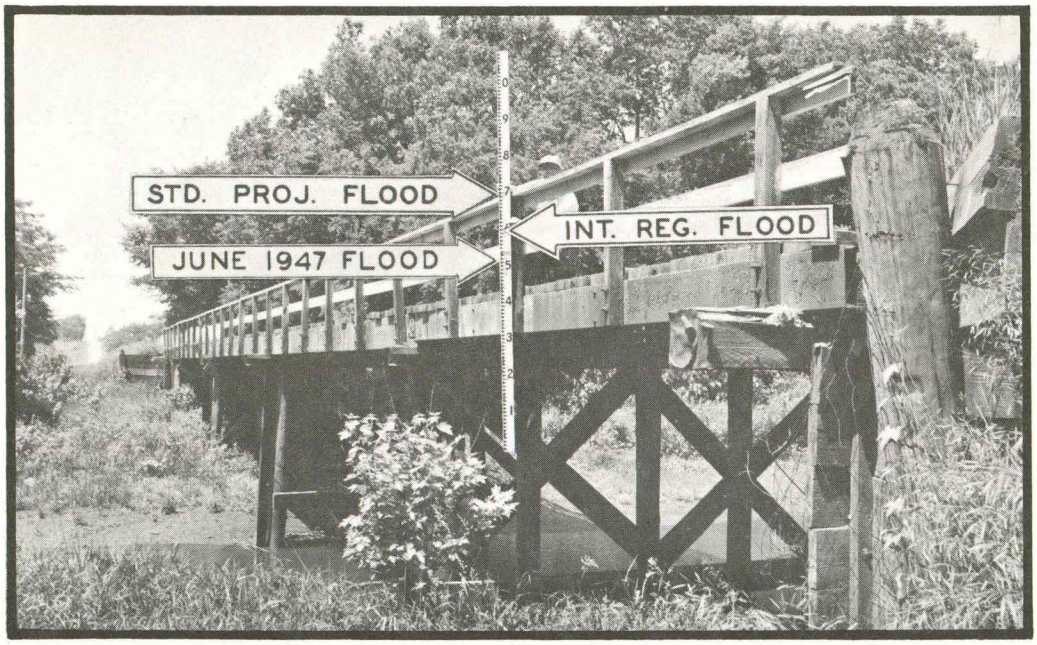



Figure 32. Downstream side of Ranchero Road bridge at Mile 5.30.

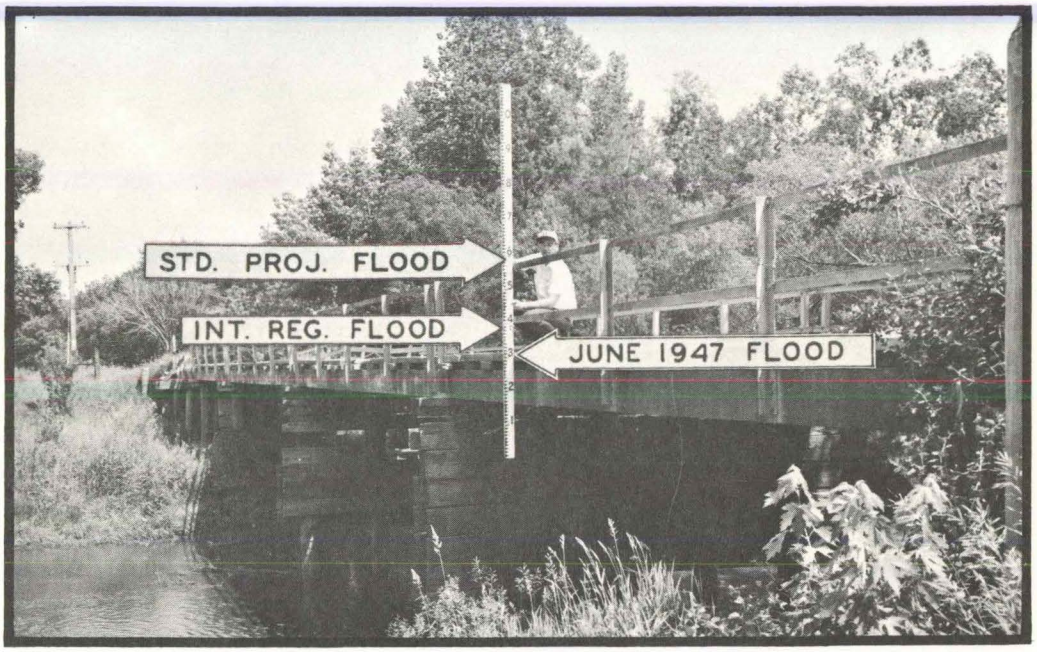



Figure 33. Upstream side of Shaulis Road bridge at Mile 6.35.

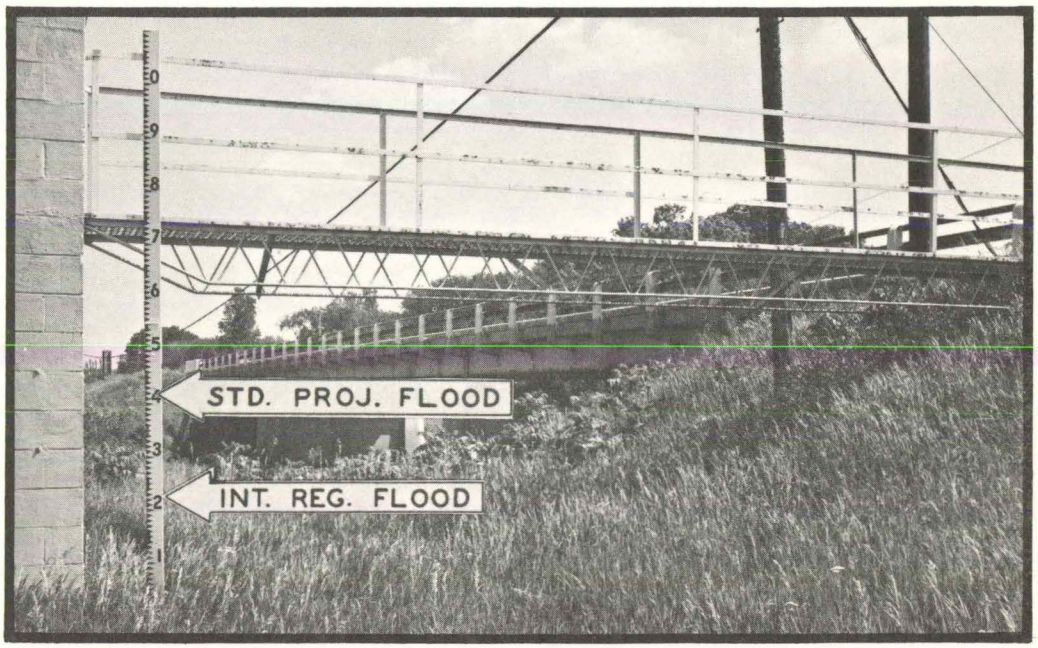



Figure 34. Downstream side of State Highway 58 bridge at Hudson Gaging Station - Mile 9.64.

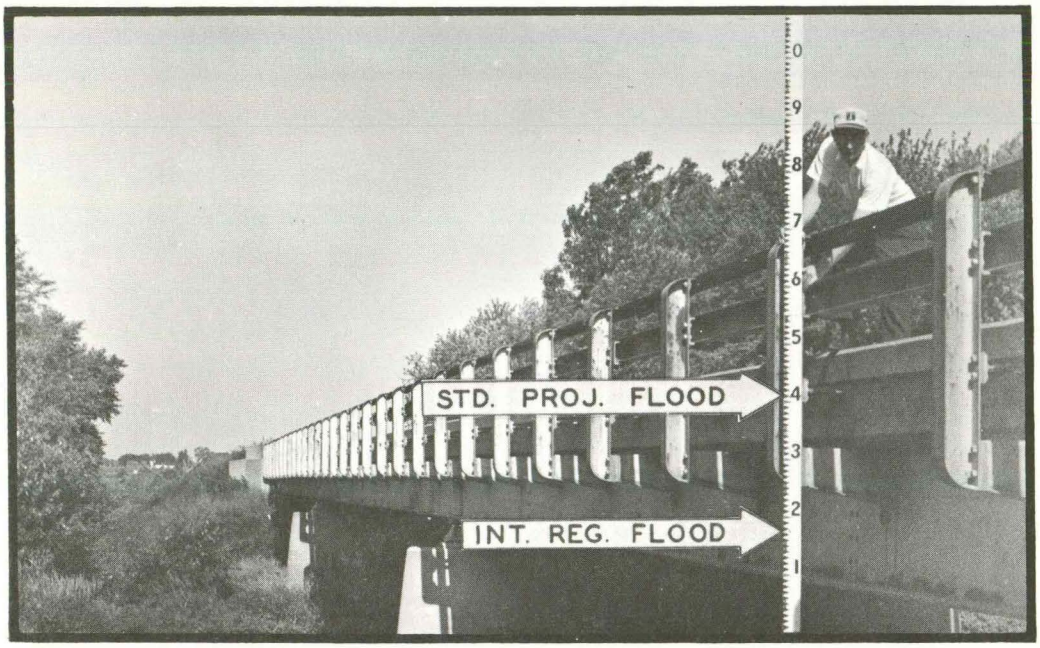



Figure 35. Downstream side of County Road "N" bridge at Mile 11.89.

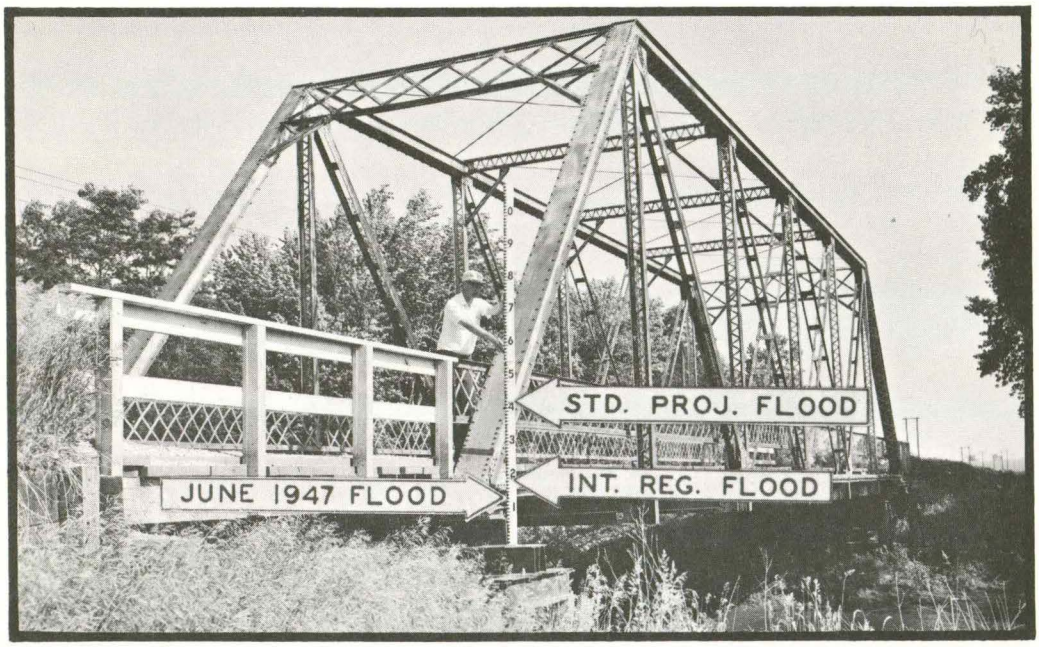



Figure 36. Downstream side of Black Hawk - Grundy county line bridge at Mile 14.57.

## 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 stream flow 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 stream flow, 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 low lands 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 flood water.

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.

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 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 of 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 organizations and numerous private citizens, in accumulation of information used in this report, is greatly appreciated.

Black Hawk County Conservation Board

Black Hawk County Engineer and Staff

Chicago, Great Western Railway Company, Oelwein, Iowa
(E. R. Bowman, Office Engineer)

Iowa Natural Resources Council

Metropolitan Planning Commission of Black Hawk County
(particularly Clarence Baldwin)

U. S. Geological Survey

U. S. Weather Bureau (E.S.S.A.)

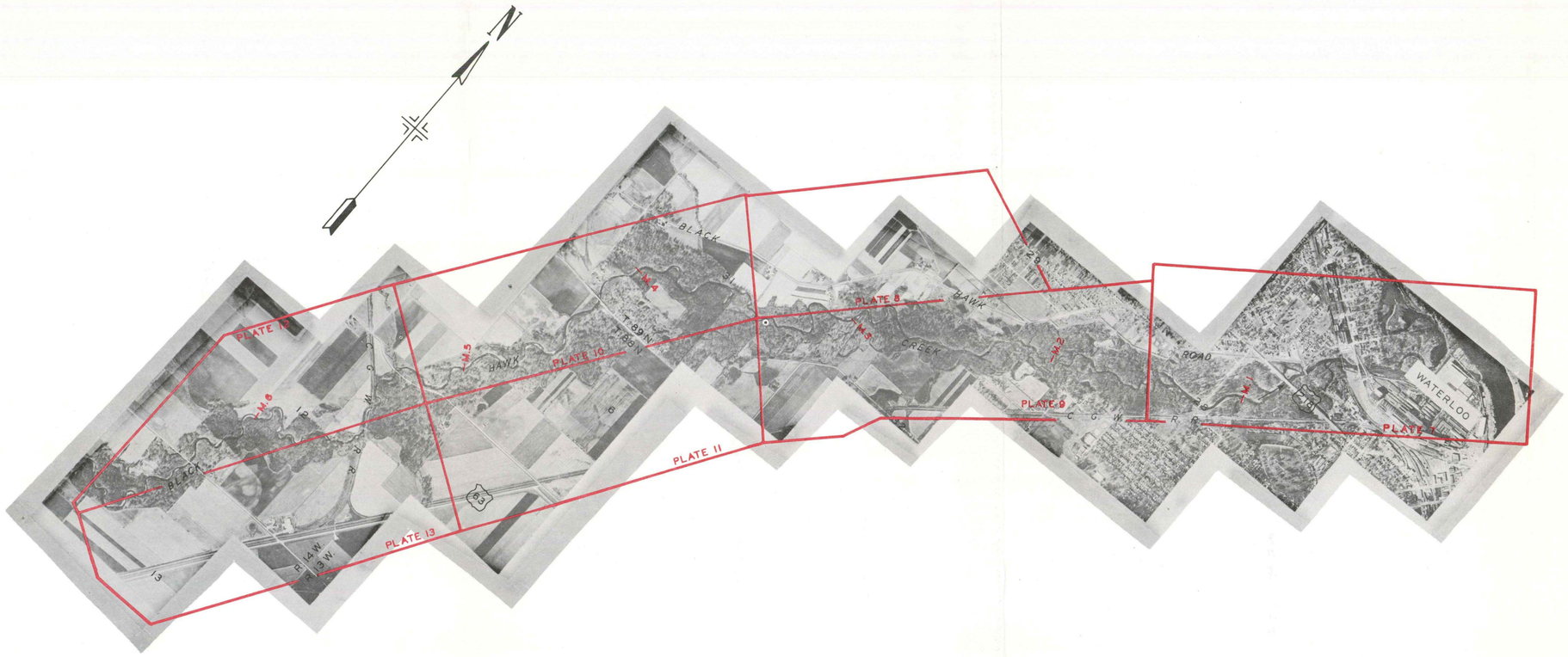
Waterloo Board of Park Commissioners

Waterloo City Council

Waterloo City Engineer and Staff

Waterloo Daily Courier

This report evaluates the flood situation in Black Hawk County, Iowa, caused by Black Hawk Creek and its tributaries. The Rock Island District of the Corps of Engineers, upon request, will provide limited technical assistance in the interpretation and application of the data presented in this report.




NOTES:

1. PLATE NUMBERS CORRESPOND TO TOPOGRAPHIC MAPS OF FLOODED AREA.
2. STATIONING IS MEASURED IN MILES FROM THE MOUTH OF BLACK HAWK CREEK.
3. AERIAL MOSAIC OF JANUARY 1966.

# FLOOD PLAIN INFORMATION REPORT

BLACK HAWK COUNTY, IOWA

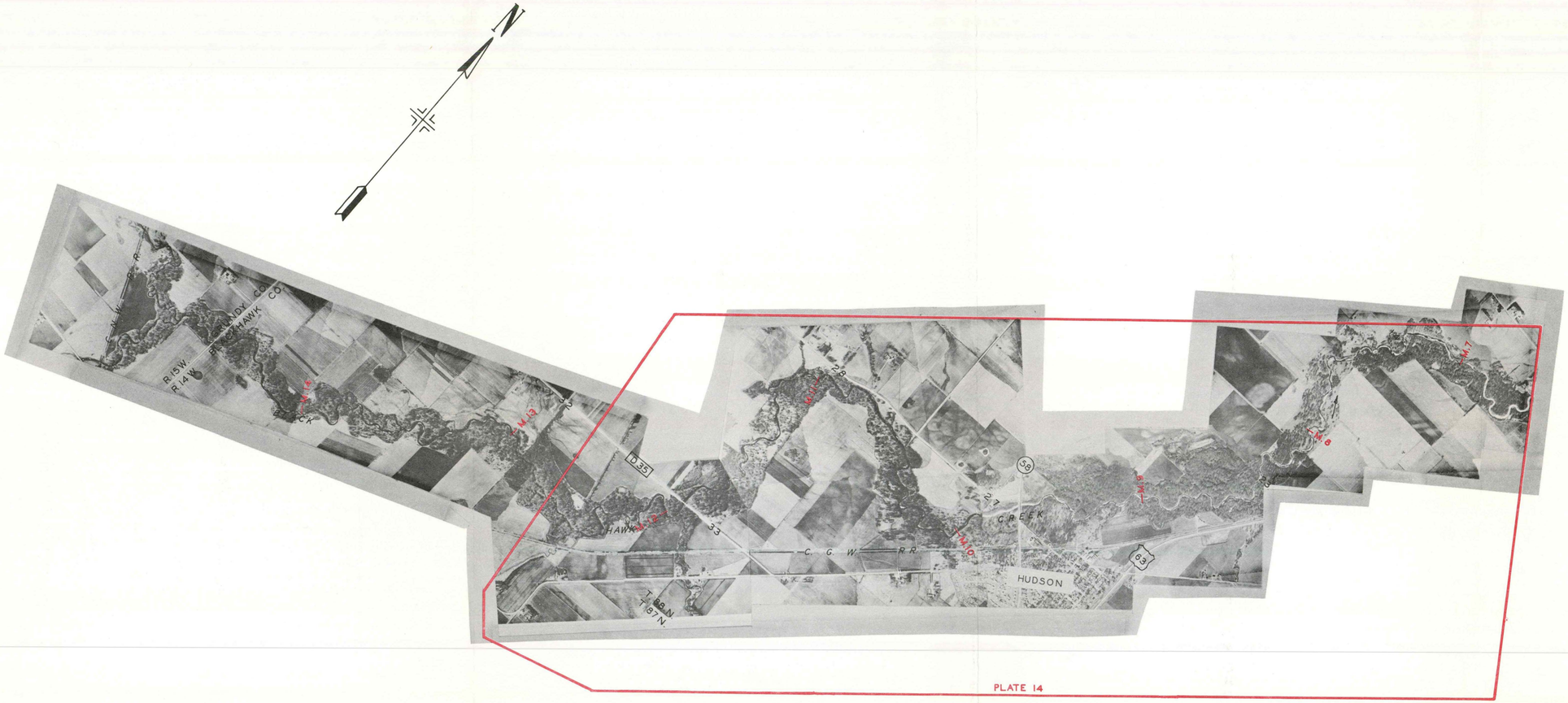
## INDEX SHEET FOR FLOODED AREA MAPS

BLACK HAWK CREEK

1/4 0 1/2 1

APPROX. SCALE IN MILES

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
DECEMBER 1968




NOTES:

1. PLATE NUMBERS CORRESPOND TO TOPOGRAPHIC MAPS OF FLOODED AREA.
2. STATIONING IS MEASURED IN MILES FROM THE MOUTH OF BLACK HAWK CREEK.
3. AERIAL MOSAIC OF MARCH 1968.

# FLOOD PLAIN INFORMATION REPORT

BLACK HAWK COUNTY, IOWA

## INDEX SHEET FOR FLOODED AREA MAPS

BLACK HAWK CREEK

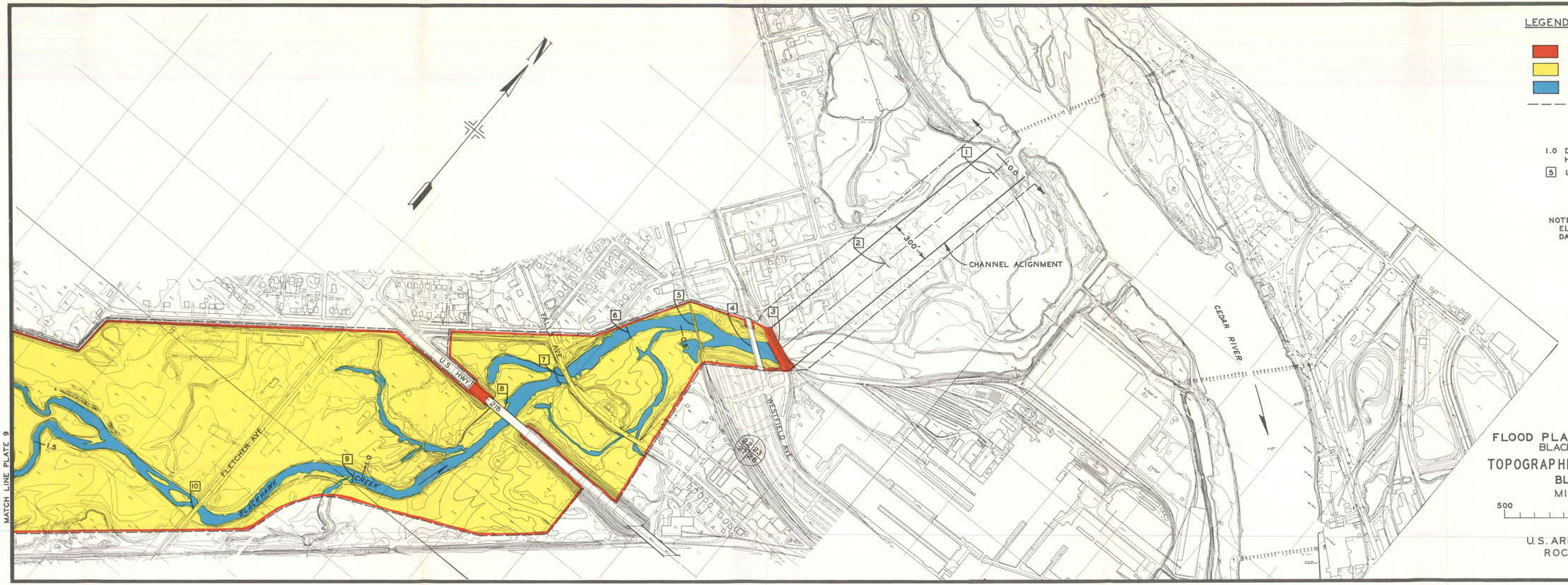
1/4 0 1/2 1

APPROX. SCALE IN MILES

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
DECEMBER 1968

CORPS OF ENGINEERS

U. S. ARMY




# FLOOD PLAIN INFORMATION REPORT
BLACK HAWK COUNTY, IOWA

## TOPOGRAPHIC MAP OF FLOODED AREA
BLACK HAWK CREEK
MILE 0.0 TO MILE 1.5

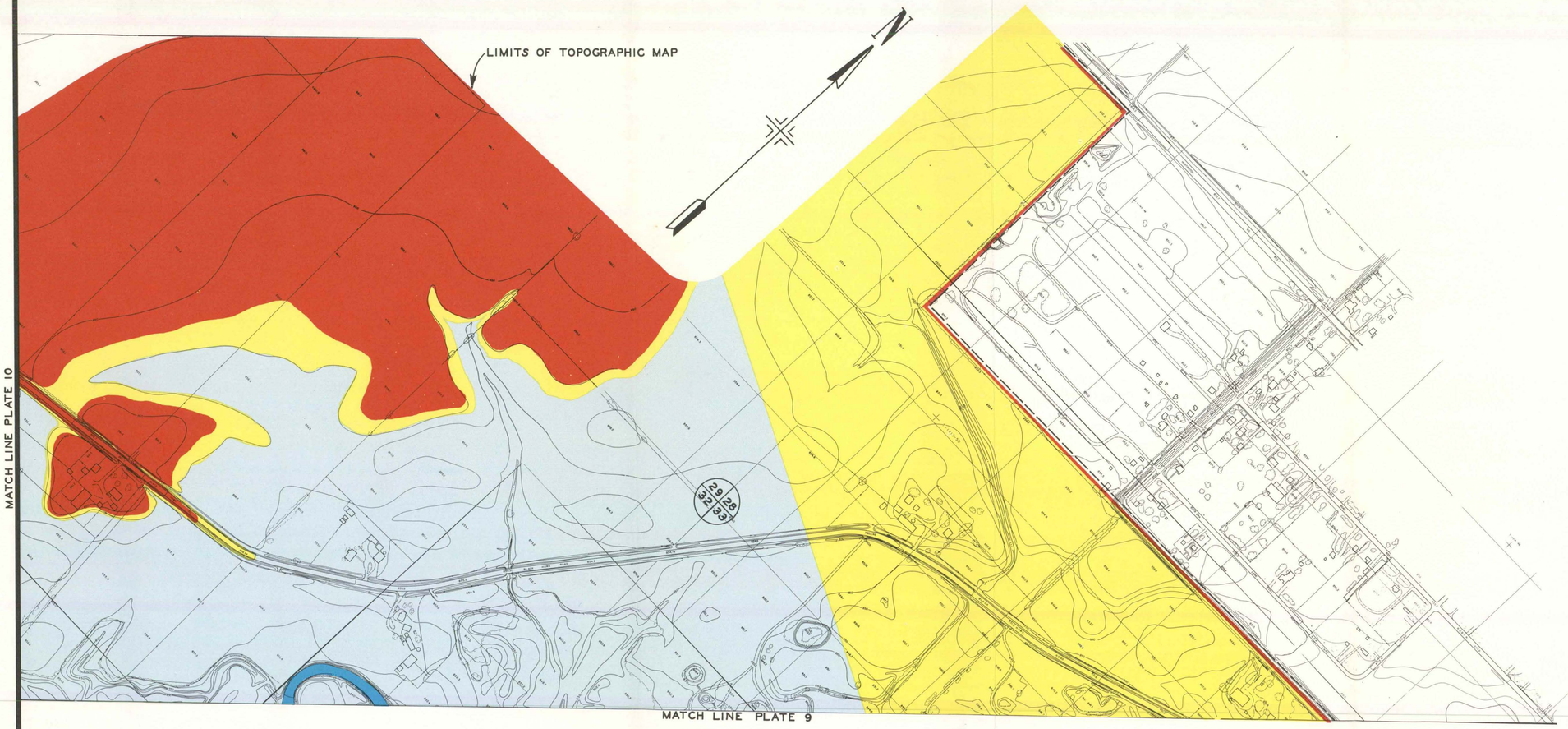
500 0 500 1000
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
DECEMBER 1968

PLATE 7

CORPS OF ENGINEERS

U.S. ARMY




LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- 1947 HIGH WATER
- CHANNEL
- — — — WATERLOO LOCAL PROTECTION LEVEE ALIGNMENT

NOTE:

1. ELEVATIONS BASED ON U.S.C. & G.S. DATUM 1929 G.A.
2. THE 1947 FLOOD OUTLINE IS SHOWN UPSTREAM OF THE EXISTING LEVEE SYSTEM ONLY.

# FLOOD PLAIN INFORMATION REPORT

BLACK HAWK COUNTY, IOWA

## TOPOGRAPHIC MAP OF FLOODED AREA

BLACK HAWK CREEK

MILE 1.5 TO MILE 3.4

500 0 500 1000

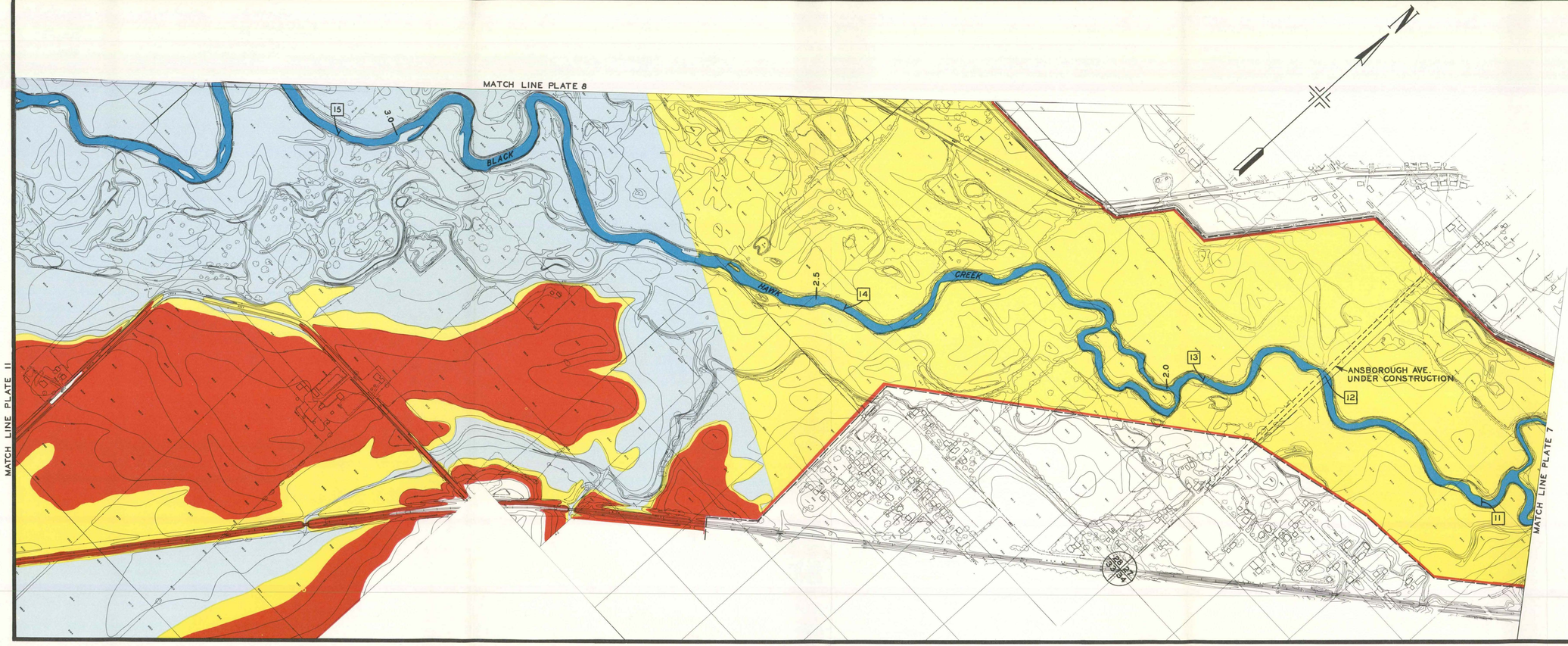
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
DECEMBER 1968

PLATE 8

CORPS OF ENGINEERS

U.S. ARMY




LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- 1947 HIGH WATER
- CHANNEL
- — — — WATERLOO LOCAL PROTECTION LEVEE ALIGNMENT
- 2.5 DISTANCE FROM MOUTH OF BLACK HAWK CREEK IN MILES.
- [12] LOCATION OF CROSS SECTION

NOTE:

1. ELEVATIONS BASED ON U.S.C. & G.S. DATUM 1929 G.A.
2. THE 1947 FLOOD OUTLINE IS SHOWN UPSTREAM OF THE EXISTING LEVEE SYSTEM ONLY.

# FLOOD PLAIN INFORMATION REPORT

BLACK HAWK COUNTY, IOWA

## TOPOGRAPHIC MAP OF FLOODED AREA

BLACK HAWK CREEK

MILE 1.5 TO MILE 3.4

500 0 500 1000

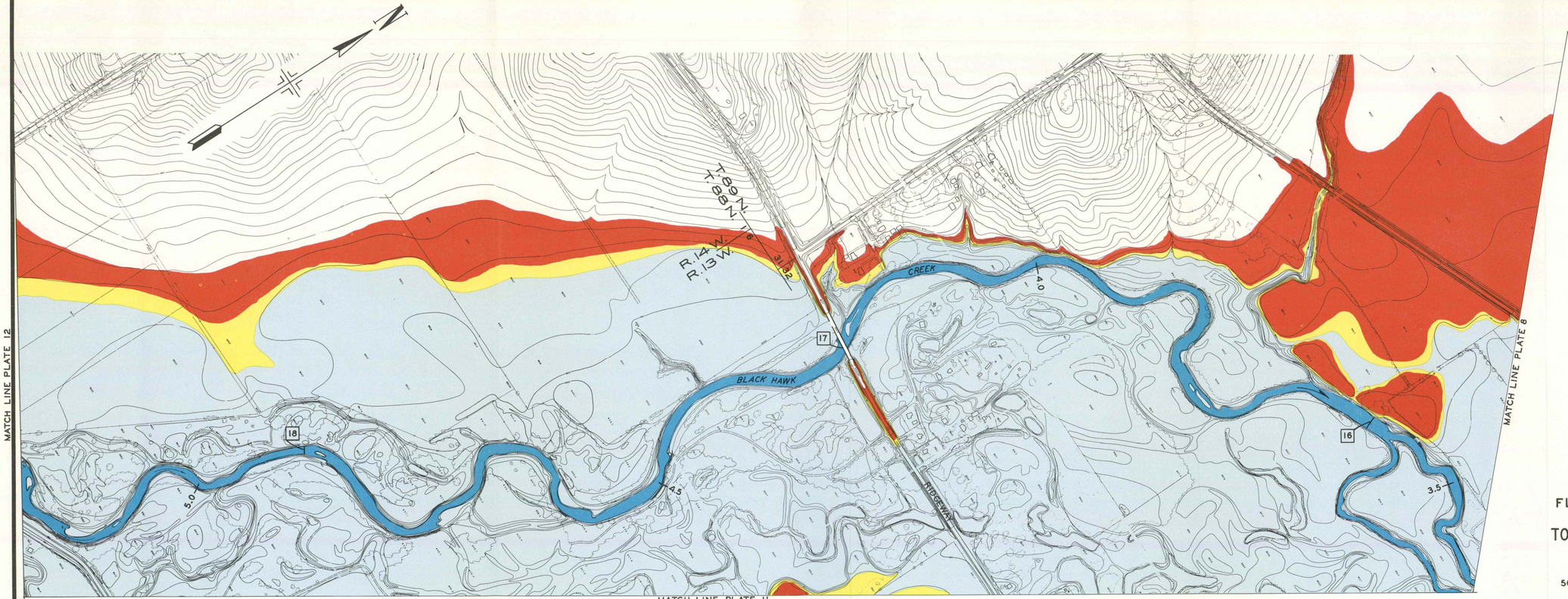
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
DECEMBER 1968

PLATE 9

CORPS OF ENGINEERS

U. S. ARMY




LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- 1947 HIGH WATER
- CHANNEL

5.0 DISTANCE FROM MOUTH OF BLACK HAWK CREEK IN MILES.

17 LOCATION OF CROSS SECTION

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

# FLOOD PLAIN INFORMATION REPORT
BLACK HAWK COUNTY, IOWA

## TOPOGRAPHIC MAP OF FLOODED AREA
BLACK HAWK CREEK
MILE 3.4 TO MILE 5.2

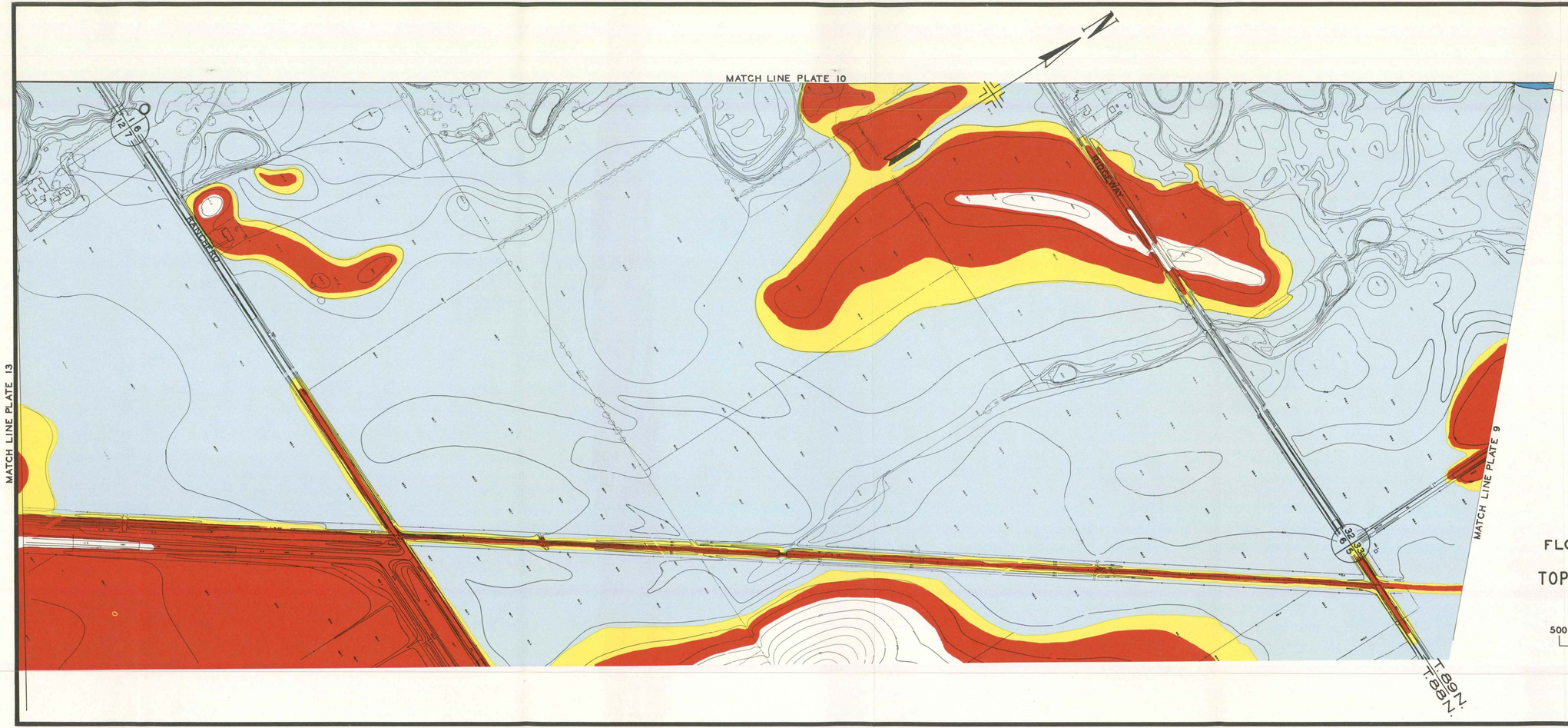
500 0 500 1000
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
DECEMBER 1968

PLATE 10

CORPS OF ENGINEERS

U. S. ARMY




LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- 1947 HIGH WATER
- CHANNEL

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

# FLOOD PLAIN INFORMATION REPORT

BLACK HAWK COUNTY, IOWA

## TOPOGRAPHIC MAP OF FLOODED AREA

BLACK HAWK CREEK

MILE 3.4 TO MILE 5.2

500 0 500 1000

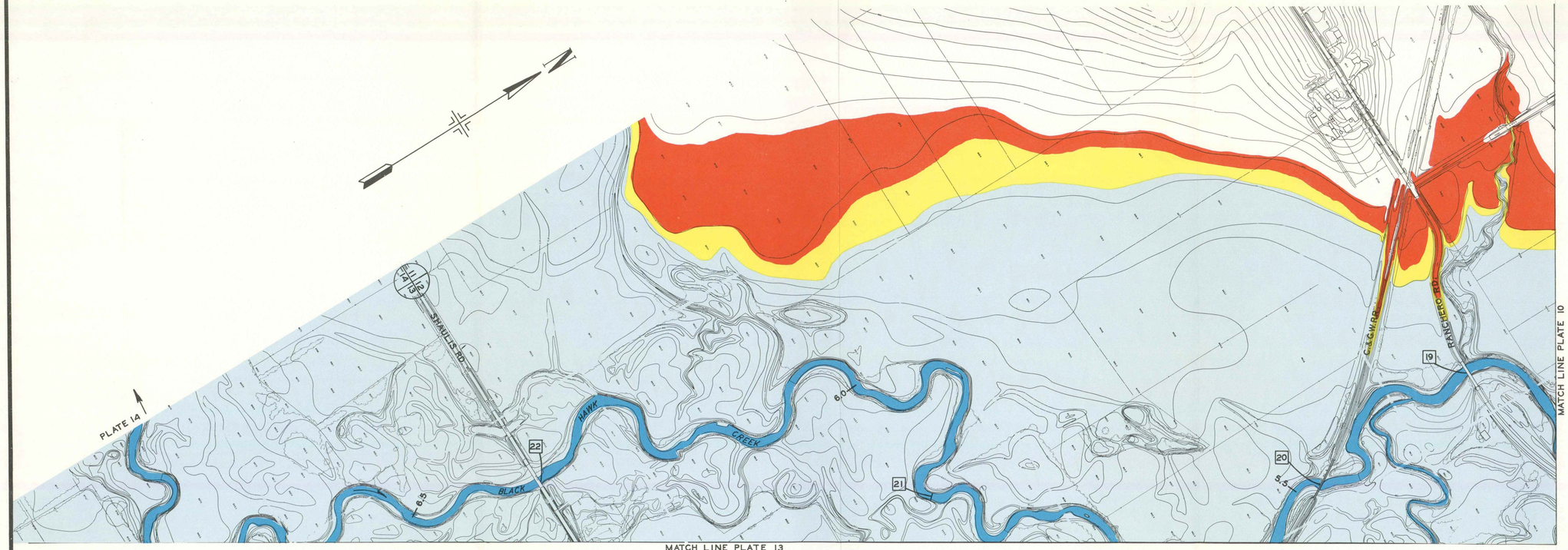
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
DECEMBER 1968

PLATE 11

CORPS OF ENGINEERS

U. S. ARMY




LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- 1947 HIGH WATER
- CHANNEL

6.0 DISTANCE FROM MOUTH OF BLACK HAWK CREEK IN MILES.

22 LOCATION OF CROSS SECTION

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

# FLOOD PLAIN INFORMATION REPORT
BLACK HAWK COUNTY, IOWA

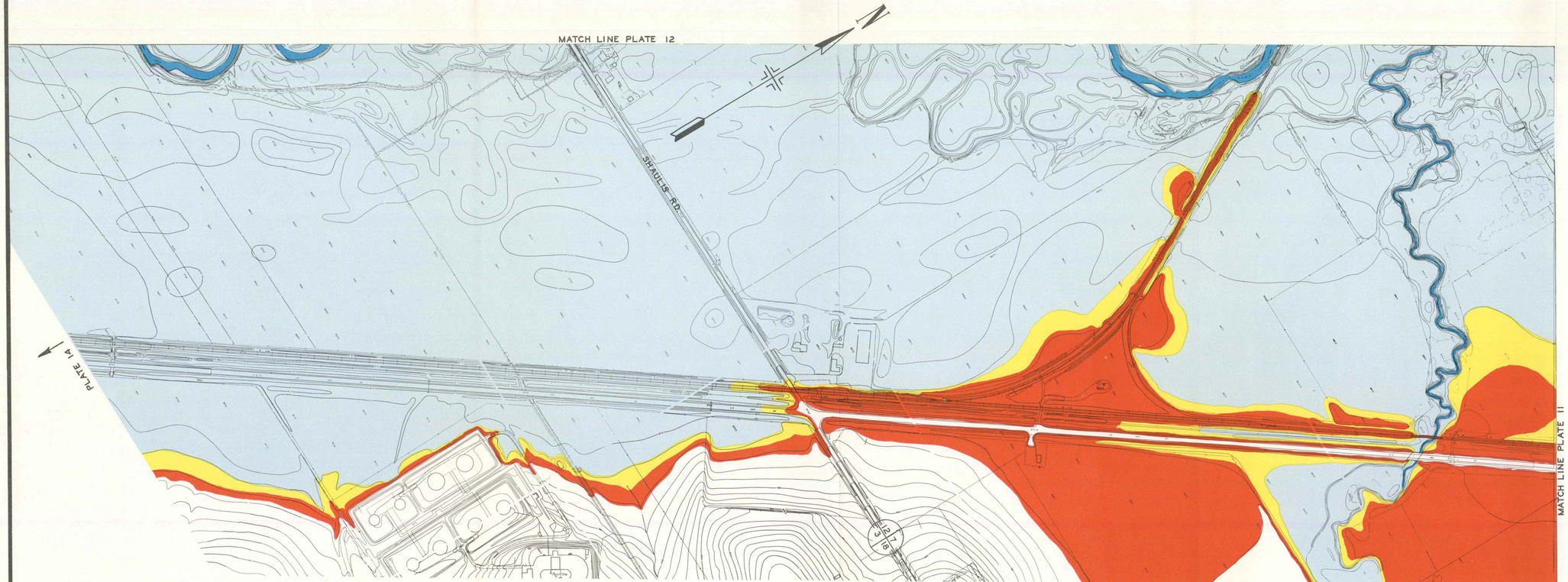
## TOPOGRAPHIC MAP OF FLOODED AREA
BLACK HAWK CREEK
MILE 5.2 TO MILE 6.9

500 0 500 1000
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS

DECEMBER 1968

PLATE 12




LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- 1947 HIGH WATER
- CHANNEL

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

# FLOOD PLAIN INFORMATION REPORT

BLACK HAWK COUNTY, IOWA

## TOPOGRAPHIC MAP OF FLOODED AREA

BLACK HAWK CREEK

MILE 5.2 TO MILE 6.9

500 0 500 1000

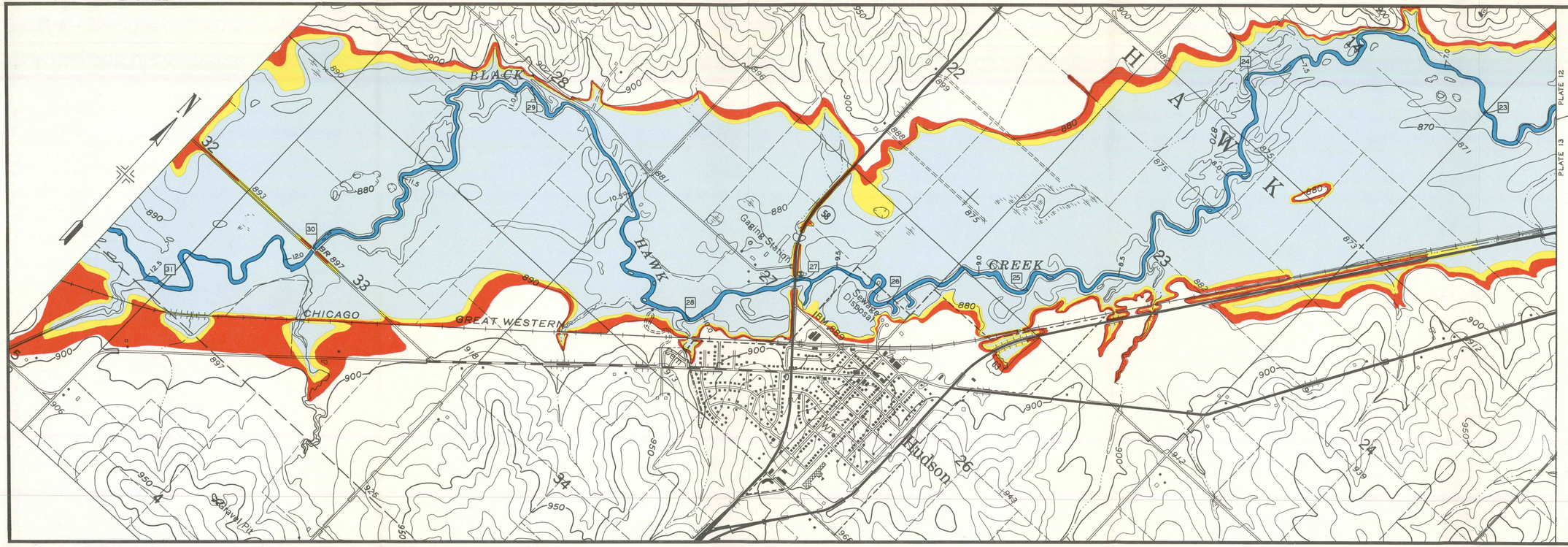
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS

DECEMBER 1968

CORPS OF ENGINEERS

U. S. ARMY




LEGEND

- STANDARD PROJECT FLOOD
- INTERMEDIATE REGIONAL FLOOD
- 1947 HIGH WATER
- CHANNEL

8.5 DISTANCE FROM MOUTH OF BLACK HAWK CREEK IN MILES.

24 LOCATION OF CROSS SECTION

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

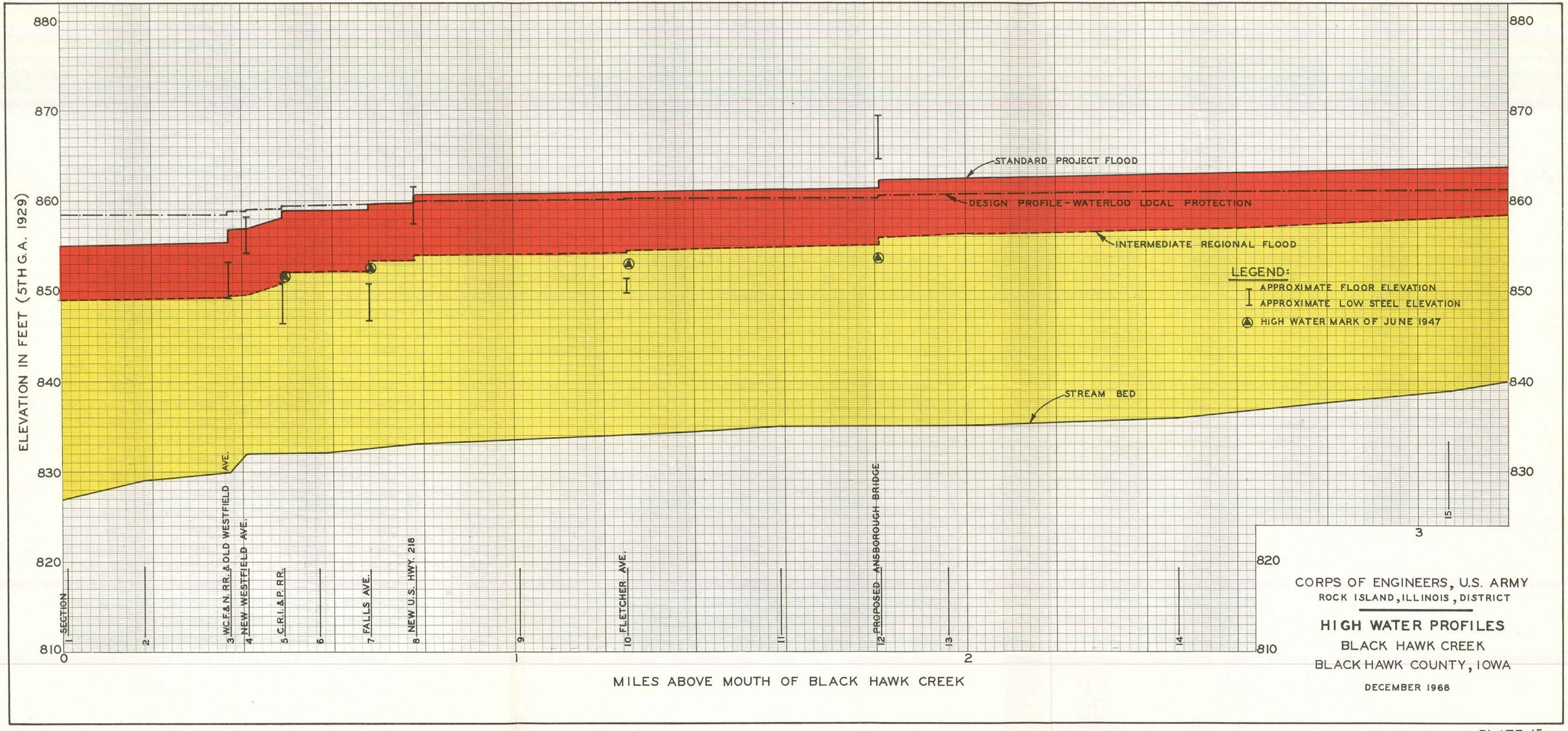
# FLOOD PLAIN INFORMATION REPORT
BLACK HAWK COUNTY, IOWA

## TOPOGRAPHIC MAP OF FLOODED AREA
BLACK HAWK CREEK
MILE 6.5 TO MILE 12.7

500 0 1000 2000 3000
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
DECEMBER 1968

PLATE 14



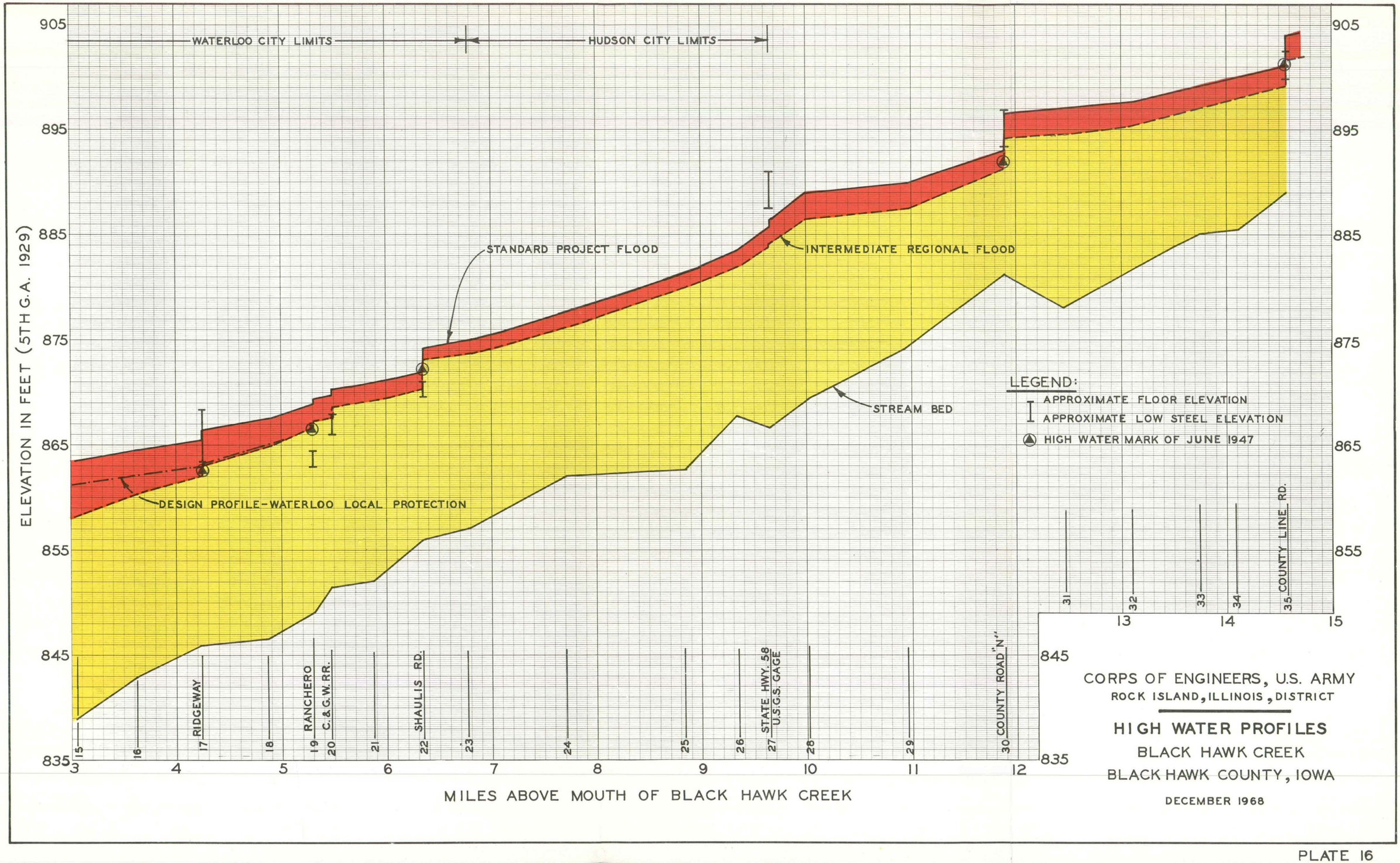

CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

# HIGH WATER PROFILES

BLACK HAWK CREEK
BLACK HAWK COUNTY, IOWA

DECEMBER 1968

PLATE 15



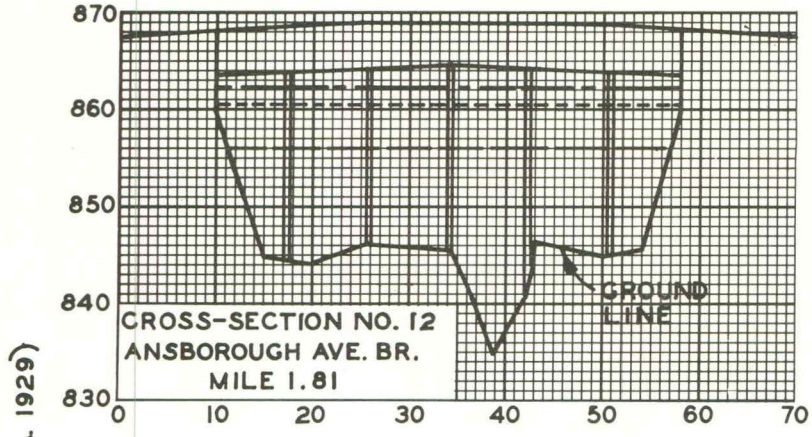

CORPS OF ENGINEERS, U.S. ARMY
ROCK ISLAND, ILLINOIS, DISTRICT

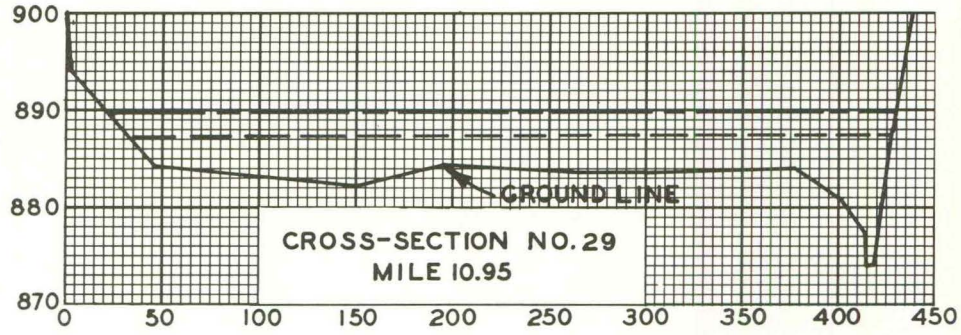
# HIGH WATER PROFILES

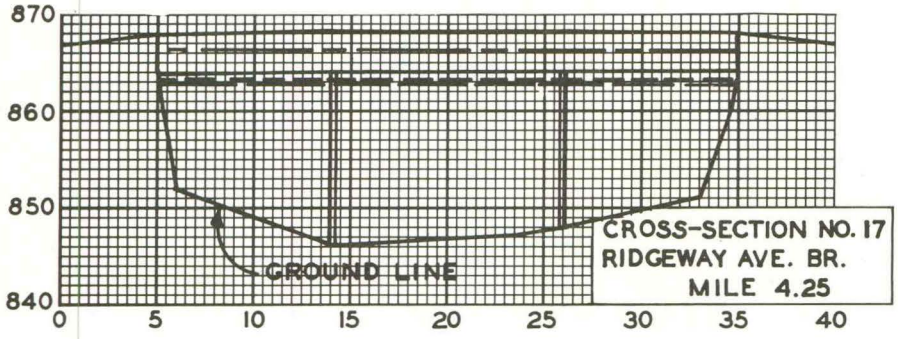
BLACK HAWK CREEK
BLACK HAWK COUNTY, IOWA

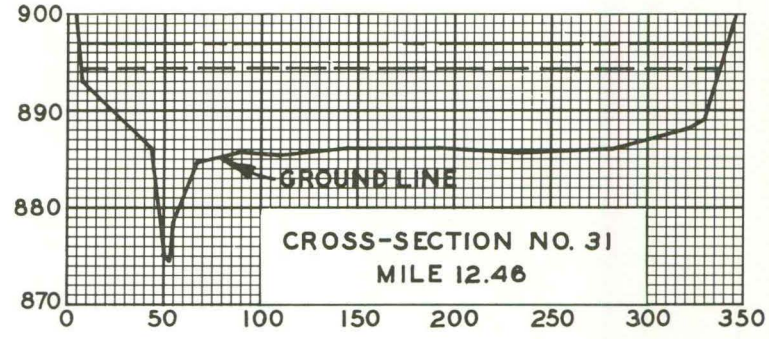
DECEMBER 1968

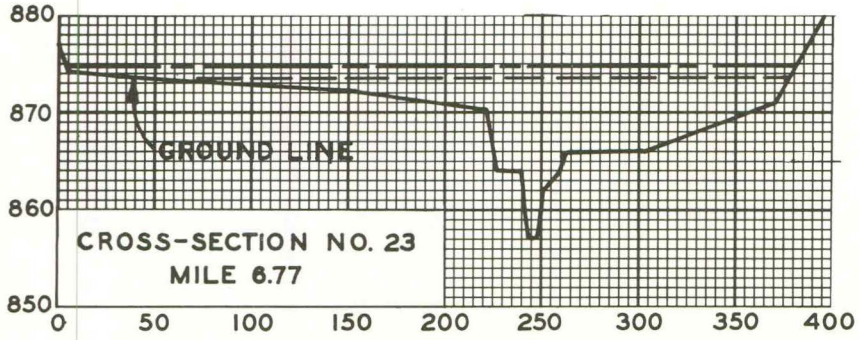
PLATE 16




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

LEGEND:

——— — ——— STANDARD PROJECT FLOOD

— — — — — — WATERLOO LOCAL PROTECTION DESIGN FLOOD

——— ——— ——— INTERMEDIATE REGIONAL FLOOD

SECTIONS TAKEN LOOKING UPSTREAM

HORIZONTAL DISTANCE, TEN FEET

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

# CROSS SECTIONS
## BLACK HAWK CREEK
## BLACK HAWK COUNTY, IOWA
DECEMBER 1968

PLATE 17