FLOOD PLAIN INFORMATION REPORT

INDIAN AND DRY CREEKS

LINN COUNTY, IOWA

TECHNICAL APPENDIX

PREPARED FOR

STATE OF IOWA

IOWA NATURAL RESOURCES COUNCIL

BY

U. S. ARMY ENGINEER DISTRICT, ROCK ISLAND

CORPS OF ENGINEERS

ROCK ISLAND, ILLINOIS

DECEMBER 1964

Flood Plain Information Report
on
Indian and Dry Creeks
Linn County, Iowa

The initial step in the development of a flood problem.

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TABLE OF CONTENTS

TABLES

PLATES

PHOTOGRAPHS

FLOOD PLAIN INFORMATION REPORT

ON

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SUMMARY

1. GENERAL

The Flood Plain Information Report on Indian and Dry Creeks, Linn County, Iowa, has been prepared at the request of the State of Iowa, through the Iowa Natural Resources Council, Des Moines, Iowa. The study covers 13.4 and 5.3 miles of Indian and Dry Creek respectively. The report is divided into a brief main report which presents generalized data and the findings of the study, and the technical appendix which contains the detailed engineering and technical data used in the preparation of the main report.

2. AUTHORIZATION

This report has been prepared and distributed in accordance with Section 206, Public Law 86-645 (Flood Control Act of 1960) which authorizes the Corps of Engineers to compile and disseminate information on floods and flood damages upon the request of responsible local governmental agencies. The text of Section 206 states "(a) That, in recognition of the increasing use and development of the flood plains of the rivers of the United States and of the need for information on flood hazards to serve as a guide to such development, and as a basis for avoiding future flood hazards by regulation of use by States and municipalities, the Secretary of the Army, through the Chief of Engineers, Department of the Army, is hereby authorized to compile and disseminate information on floods and flood damages, including identification of areas subject to inundation by floods of various magnitudes and frequencies, and general criteria for guidance in the use of flood plain areas; and to provide engineering advice to local interests for their use in planning to ameliorate the flood hazard: Provided, that the necessary surveys and studies will be made and such information and advice will be provided for specific localities only upon the request of a State or a responsible local governmental agency and upon approval by the Chief of Engineers. (b) The Secretary of the Army is hereby authorized to allot, from any appropriations, hereafter made for flood control, sums not to exceed $1,000,000 in any one fiscal year for the compilation and dissemination of such information."

3. On 21 March 1963, the Iowa Natural Resources Council submitted a formal request to the District Engineer, U. S. Army Engineer District, Rock Island, to prepare a series of flood plain information studies for Cedar River, Indian, Prairie and Otter Creeks in Linn County, Iowa. The rapid urban expansion of the cities of Cedar Rapids and Marion is expected to engulf the area within a few years. First study priority was assigned to the Indian Creek watershed by the Iowa Natural Resources Council. A series of conferences between representatives of the Corps of Engineers, Iowa Natural Resources Council, Linn County, City of Cedar Rapids and City of Marion, established the study limits and the extent of data to be furnished by the local interests. Assurances were given that the results of the study would be publicized and that the findings would be used as a basis for future regulated development of the flood plain. The request was forwarded by the District Engineer through the Division Engineer, North Central Division, to the Chief of Engineers, Washington, D. C., by letter dated 17 May 1963. The completed report has been reviewed and approved for release by the Iowa Natural Resources Council and the Chief of Engineers, Department of the Army. The Iowa Natural Resources Council will disseminate this flood plain information to local interests in the study area. The Council will provide assistance to local agencies in formulating flood plain permissive-use regulations. Specific requests for additional information on floods or flood plain planning should be directed to the Council. Copies of letters from local governmental agencies which are pertinent to the study are included as part of this appendix.

4. PURPOSE OF STUDY

It is the intention of this study to provide specific information regarding hydrologic features of the study area and to relate this information in terms of relative frequency of occurrence of future floods to flooded-area maps and flood-flow profiles. With this information, local and State agencies may work toward the achievement of the following objectives:

a. To publicize information for the guidance of public agencies, private interests, and citizens on use and hazards of flood plain occupancy;

b. to preserve adequate channel and floodway to satisfy the requirements of the Iowa Code regarding the establishment of a designated floodway;

c. to reduce future flood damage in this area through regulation and/or permissive-use zoning of the flood plain, allowing maximum use of the flood plain which may be accomplished without detriment to the other objectives;

d. to incorporate the findings of this study in the over-all City-County planning, specifically as guides to the establishment of "green-belt" areas for recreation and/or other purposes; and

e. to reduce future expenditures of tax money (local, State, or Federal) for projects to protect developments which, in the absence of the flood plain information study, would have taken place.

5. SCOPE OF THE STUDY

This flood plain information study covers Indian Creek from its mouth at the Cedar River in Section 30, Township 83 R6, Linn County, Iowa, to a point 2.5 miles upstream from the confluence with Dry Creek in Section 30, Township 84 R6, Linn County, Iowa, or about 1 mile northeast of the present city limits of Marion. The study also continues from the mouth of Dry Creek to the center of Section 33, Township 83 R7, in the Town of Hiawatha, Linn County, Iowa. The study area covers approximately 13.4 river miles on Indian Creek and approximately 5.3 river miles on Dry Creek. The backwater effect from the Cedar River is shown in this study for the lower reaches of Indian Creek.

6. The flood plain is almost completely undeveloped at the present time and as a result very few flood records or descriptive newspaper accounts of floods have been made in conjunction with the study area. Those that have been kept indicate basin-wide floods occurred in 1929, 1937, 1945, 1946, 1947, 1959, 1960, 1961, and 1962. One of the larger recorded floods in the Indian Creek basin occurred during June 1947 and was produced by the combination of a series of heavy rainfalls during the month. The flood inundated most of the agricultural flood plain. The flood of January 12, 1960 rampaged through the Dry and Indian Creek basins, causing one resident along Indian Creek to be evacuated. The flood of September 13-14, 1961 was slightly higher than the July 3, 1962 high water on Indian Creek; however, on Dry Creek the July 3, 1962 high water exceeded the September 13-14, 1961 flood by one foot. The November 17, 1961 flood on Indian Creek inundated Thomas Park in the City of Marion but did very little damage. The 1945 and 1946 floods were less in magnitude than the 1947 flood and did very little damage. Because of the amount of elapsed time since the 1929 and 1937 floods, it was possible to obtain only a few high water records. There are no available accurate descriptions of these floods in the newspapers or other available sources; however, it is known that the damages were restricted to agricultural areas.

7. It is probable that a flood much larger than those of record will occur in the Indian Creek basin. Such a flood is described as the Standard Project Flood as shown on Plate 8. If future residential, commercial, and industrial development is generally kept above the elevation reached by the Standard Project Flood, the frequency of damaging flooding would be rare. Floods which have occurred in the study area caused such minor damage, except to some agricultural land, that

residents recalled very few flood elevations. Consequently, it has not been possible to obtain many high-water marks from the more moderate floods. Sufficient information was obtained, however, to reproduce the profiles of the September 1961 and July 1962 floods. These flows, however, are of such low magnitude that they are not shown on Plates 4/1 through 4/3.

8. The general guidelines set forth in this report can be used as a basis for zoning ordinances and other regulatory action to permit optimum usage of an area without increasing potential flood damage. The data should also be of assistance in determining the type of regulating legislation of the kind of remedial action which would be most suitable for the area in question. The guidelines are general suggestions based on past flood occurrences in the study area and do not preclude additions or modifications which may be desirable based on future experience at a particular location.

9. USE OF THE REPORT

The information and suggestions contained in this study are presented for consideration and use by the Iowa Natural Resources Council, the Cities of Cedar Rapids and Marion, Linn County, and various county, municipal and other agencies. A brief report of the information contained in this study has also been prepared to acquaint the general public with the existing flood problems and the need for immediate action in regulating the development of areas subject to flooding. The report in no way extends Federal authority over zoning or other regulations of flood plain use. The Iowa Natural Resources Council will make the results of the study available to other local interests or persons who have use for such information. Copies of the report and technical appendix may be obtained directly from their offices at the State House, Des Moines, Iowa, 50319. A limited number of copies for consultation will be available at the following locations:

(a) Linn County Engineer, Linn County Court House, Cedar Rapids, Iowa.

(b) City of Cedar Rapids Engineer, City Hall, Cedar Rapids, Iowa.

(c) City Manager, City of Marion, City Hall, Marion, Iowa.

10. This flood plain information study does not commit the Federal Government to investigating, planning, designing, constructing, operating, or maintaining any facilities, or imply any intent to undertake such activity if not authorized by Congress.

11. ACKNOWLEDGMENTS

The cooperation and assistance given by the following agencies in the accumulation of data for this report is greatly appreciated:

Iowa Natural Resources Council
U. S. Geological Survey
Linn County
U. S. Weather Bureau
City of Marion
City of Cedar Rapids

Specifically, the detailed topographic maps and cross-sections for this report were furnished by Linn County and the Cities of Marion and Cedar Rapids.

DESCRIPTION OF PROBLEM

12. GENERAL DESCRIPTION OF STUDY AREA

The Indian and Dry Creek flood plain study areas lie completely within Linn County, Iowa, and include portions of Monroe, Marion, Rapids and Bertram townships, and the municipalities of Hiawatha, Marion and Cedar Rapids. The Indian and Dry Creek basins and study area are shown on Plate 1. The study area extends from the mouth of Indian Creek to a point 2.5 miles upstream from the confluence with Dry Creek or about one mile northeast of the present city limits of Marion. The Dry Creek study area extends from the mouth of Dry Creek through the town of Hiawatha. The lower portion of the Indian Creek study area is affected by the entire Indian Creek watershed, an area of approximately 93 square miles. This portion is also affected by backwater flooding from the Cedar River.

13. The watershed has a maximum width of roughly 8 miles and maximum length of 17 miles. Squaw Creek enters Indian Creek about three-fourths of a mile above the mouth and drains about 15 square miles. Dry Creek enters Indian Creek about 11 miles above the mouth and has a drainage area of about 31 square miles. The Dry Creek basin has a maximum width of 4 miles and maximum length of about 15 miles. It originates in the northern part of Maine township near the Town of Central City. The Indian Creek flood plain study area above the mouth of Dry Creek drains a watershed of approximately 36 square miles with a maximum length of 11 miles and maximum width of 5 miles. The watershed lies parallel to the Dry Creek watershed in the north-south direction.

14. From the mouth of Indian Creek to approximately 11 miles upstream to the confluence with Dry Creek, the creek channel has a width of from 60 to 130 feet and a depth of 6 to 10 feet. The banks of the channel are relatively low in this reach but the creek flows in a meandering course within a much wider flood plain as shown on Plate 10. In this reach the

creek passes through portions of Linn County, and the Cities of Marion and Cedar Rapids. The existing flood plain developments are few with only a few residential developments and some park areas. The Indian Creek channel, above the confluence of Indian and Dry Creeks, has a width of from 30 to 80 feet and a depth of 4 to 10 feet. The banks are generally quite low with some high banks of 12 to 18 feet, on one side of the channel, near 10th Street within the City of Marion. The existing flood plain developments are relatively few; however, this reach is expected to become highly developed in the near future. From the confluence of Dry and Indian Creeks through the Town of Hiawatha, the creek channel has a width of from 30 to 80 feet and a depth of 3 to 9 feet. The banks are generally very low with some high banks of 15 to 20 feet in the Town of Hiawatha. During some hot summer months with below normal rainfall, the creek will become dry in the area around Hiawatha. The creek is fed by underground springs about a mile above the confluence with Indian Creek and thus never becomes completely dry in this area, which at one time was a source of water supply for the City of Marion. Residential developments are just beginning in this reach and if not controlled could become a major flood damage potential.

15. Within the study area, there are two small dams on Indian Creek, 5 to 7 feet high. To facilitate location on the accompanying maps, the initial reference to dams, bridges and other points of interest discussed in this report will be to creek channel mileage from the mouth of Indian Creek. Channel mileage is shown on Table 1. The Cedar Rapids Country Club dam and pumphouse is located at mile 6.2. The primary function of the dam is the storage of water for the golf course irrigation system during periods of low flow in Indian Creek. The old East Star Mill Dam on Indian Creek, within the City of Marion, at mile 10.90, has been abandoned. A section of the dam has been removed and has little effect upon the flow on Indian Creek.

16. The channel bed of both creeks is essentially glacial drift. Adjacent flood plains are generally agricultural land. Much of this land is covered with timber which restrict flood flows in the flood plain. Many of these timbered areas are planned for parks and recreational developments with the probability of much brush and timber cleanout. A number of bridges on both creeks play a significant role in flood stages within the study area. With the rapid urbanization of the rural areas and expansion of urban areas, some of these bridges are being removed and reconstructed. In general, the new bridges provide more waterway capacity. Ice jams are frequent in early spring floods and have caused excessively high stages in certain reaches along the study area.

17. LAND USE WITHIN THE FLOOD PLAIN

Since Indian and Dry Creek flood plains are relatively low and flat throughout many of the reaches, and much of the area is susceptible to overland flow, land usage should be confined to certain types of developments. Fortunately, at the present time the flood plain has not been

TABLE 1

FLOOD PLAIN MILEAGES

Profile Thalweg Mileage	Flood Plain Mileage	Profile Thalweg Mileage	Flood Plain Mileage
0.04	0.04	3.44	3.19
0.12	0.12	3.65	3.39
0.18	0.18	4.11	3.80
0.33	0.33	4.42	4.11
0.62	0.59	4.48	4.17
0.75	0.72	4.82	4.48
0.81	0.78	5.05	4.71
1.01	0.97	5.32	4.98
1.07	1.03	5.52	5.14
1.08	1.04	5.66	5.29
1.32	1.24	5.71	5.34
1.54	1.42	5.74	5.37
1.75	1.60	5.80	5.43
1.98	1.81	6.04	5.66
2.21	2.03	6.24	5.86
2.45	2.24	6.32	5.94
2.53	2.30	6.38	6.00
2.68	2.44	6.71	6.30
3.00	2.76	6.87	6.46
3.21	2.96	7.05	6.64

TABLE 1 contd.

FLOOD PLAIN MILEAGES

Profile Thalweg Mileage	Flood Plain Mileage	Profile Thalweg Mileage	Flood Plain Mileage
7.31	6.90	10.90	10.07
7.34	6.93	10.97	10.14
7.39	6.98	11.05	10.22
7.49	7.08	11.18	10.37
7.76	7.32	11.25	10.46
7.89	7.42	11.37	10.60
8.10	7.63	11.51	10.74
8.45	7.88	11.89	10.96
8.80	8.18	12.01	11.07
9.27	8.60	12.12	11.29
9.45	8.75	12.28	11.46
9.69	8.91	12.53	11.70
9.75	8.97	12.74	11.89
9.89	9.10	12.99	12.11
10.17	9.38	13.21	12.31
10.43	9.61	13.33	12.43
10.56	9.74	13.44	12.53
10.65	9.82	*	
10.75	9.92	11.20 D	10.37 D
10.81	9.98	11.34 D	10.51 D

TABLE 1 contd.

FLOOD PLAIN MILEAGES

Profile Thalweg Mileage	Flood Plain Mileage	Profile Thalweg Mileage	Flood Plain Mileage
11.59 D	10.76 D	14.09 D	13.04 D
11.76 D	10.92 D	14.42 D	13.24 D
11.94 D	11.08 D	14.57 D	13.38 D
12.15 D	11.28 D	14.77 D	13.56 D
12.39 D	11.49 D	15.10 D	13.86 D
12.69 D	11.79 D	15.45 D	14.19 D
12.88 D	11.94 D	15.91 D	14.61 D
13.22 D	12.24 D	16.05 D	14.74 D
13.37 D	12.40 D	16.32 D	15.00 D
13.74 D	12.73 D		

* Dry Creek Mileages "D" from Mouth of Indian Creek

extensively developed and consists mainly of agricultural land and recreational areas. Cedar Rapids is experiencing rapid industrial expansion. Considerable pressure is evident toward utilization of the flood hazard area by commercial and residential developers. Because the flood plain has remained undeveloped, very little monetary damage has occurred from past floods. The location of streets, highways and utilities which may be affected by flooding are shown on Plates 1, 2 and 3. The elevation of lowest steel or highest crown of arch for all bridges crossing Indian and Dry Creeks within the study area is shown on profile plates numbered 4. Additional bridge information is shown by photographs on plates numbered 5. Bridge descriptions are given in Table 2. Service and footbridges across Indian Creek along the Cedar Rapids Country Club golf course, about mile 6.0, are not tabulated in the data because these bridges are not measurably restrictive to flow.

a. <u>Confluence of Indian Creek with the Cedar River to Mt. Vernon Road, Mile 1.08</u>.

The broad flood plain of Indian Creek in Linn County, Iowa, from the confluence with the Cedar River to Mt. Vernon Road is usually inundated during Cedar River flood stages. The flood plain within this reach is characterized mostly by agricultural land use and some residential development. A small residential development located near Mt. Vernon Road is within the flood plain and has experienced damages from Cedar River floods. Just upstream from this residential development south of Mt. Vernon Road, Squaw Creek enters Indian Creek at mile 0.85 from the east contributing runoff waters from about 15 square miles of drainage area.

b. <u>Mt. Vernon Road to East Post Road, Mile 1.08 to Mile 4.42.</u>

Proceeding upstream from Mt. Vernon Road to East Post Road, approximately four and one-half miles along Indian Creek from its confluence with Cedar River, the flood plain becomes quite narrow. Within this reach of Indian Creek the flood plain is generally densely wooded and in a wilderness state with the exception of a small amount of land cleared for agricultural use. This undeveloped area provides natural habitat for wildlife. One dwelling within the flood inundation limits in this reach is located just south of East Post Road.

c. <u>East Post Road to Cottage Grove Avenue, Mile 4.42 to Mile 5.32.</u>

(1) Upstream from East Post Road the flood plain becomes wider, the natural wilderness state of the flood plain vanishes and agricultural use of the flood plain generally prevails. Although this reach is essentially cultivated land, residential developments and potential developments appear to be encroaching on the flood plain. An attractive subdivision, Sun Valley Addition to the City of Cedar Rapids, approximately mile 4.5 to mile 5.0, is presently being developed on the east side of Indian Creek and west of Fox Meadow Drive north of East Post Road.

TABLE 2

FLOOD PLAIN INFORMATION STUDY - INDIAN CREEK

BRIDGE DATA

Name of Bridge	Channel Mile	Description	Clear Ht., Feet	Total Clear Width, Ft.	Skew Angle, Degrees	Low Steel El., Ft. (2)	Approximate Roadway El., Ft. (1)	Approximate Waterway Area Square Feet
C & NW RR Br.	0.04	4-Span Plate Girder	17	165	12°	707	714	1,850
Otis Road Br.	0.18	3-Span Plate Girder	18	169	0°	710	713	2,150
County Road "GG" Br.	0.75	Single Span Steel Truss	17	175	20°	709	711	1,835
Abandoned RR Br.	1.07	Abandoned RR Br. Pier & Abutments	-	-	-	-	-	-
Mt. Vernon Road Br.	1.08	Single Span Steel Truss	13	122	0°	710	713	1,045
County Road Br.	2.21	Single Span Steel Truss	14	100	0°	718	719	1,025
East Post Road Br.	4.42	3-Span Concrete Girder	22	166	10°	742	745	2,500
Cottage Grove Ave. Br.	5.32	3-Span Continuous Steel Girder	14	145	0°	746	749	1,675
Suspension Footbridge	5.71	Wood Deck Suspension Footbridge	--Negligible Flow Restriction---			-	-	-
Maintenance Br.	5.80	Wood Deck Steel I-Beam Br.	--Negligible Flow Restriction---			-	-	-
Suspension Br.	6.32	Wood Deck Suspension Footbridge	--Negligible Flow Restriction---			-	-	-
Service Br.	6.38	Wood Deck Steel I-Beam Br.	--Negligible Flow Restriction---			-	-	-
30th St. Drive SE Br.	6.87	Single Span Steel Truss	13	140	0°	758	759	1,450
Thomas Park Br.	10.65	Single Span Steel Truss	10	61	0°	776	775	475
Marion Boulevard	10.81	3-Span Concrete Arch	21	162	0°	790	792	2,350
C. M. & St. P. RR Br.	10.97	2-Span Plate Girder	35	216	0°	807	815	5,300
8th Avenue Br.	11.05	2-Span Concrete Arch	16	187	0°	788	791	2,070
Central Avenue Br.	11.51	Single Span Concrete Arch	19	100	20°	794	796	1,280
10th Street Br.	12.12	2-Span Plate Girder	13	114	40°	791	793	1,355
"C" Avenue Br.	13.37 D(3)	Single Span Plate Girder	11	60	0°	801	804	450
Council Street Br.	15.10 D(3)	3-Span Wood Beam	9	56	0°	809	811	350

(1) at bridge
(2) highest elevation on the underside of bridge or crown of arch
(3) Dry Creek

(2) Although most of the present residences in Sun Valley subdivision are located just outside the flood inundation limits, the rear portion of a few developed lots may experience occasional flooding. Proposed additions to Sun Valley subdivision are located adjacent to Indian Creek entirely within the potential flood damage area and may experience frequent flooding.

d. Cottage Grove Avenue to 30th Street Drive, SE, Mile 5.32 to Mile 6.87.

(1) The Indian Creek flood plain between Cottage Grove Avenue and 30th Street Drive SE is contrasted by flood plain developments having minor and severe flood damage potentials. Cedar Rapids Country Club, a private golf course, occupies most of Indian Creek's flood plain between Cottage Grove Avenue and 30th Street Drive SE. A minor flood damage potential is usually associated with a golf course development on a flood plain.

(2) However, the developed residential areas in the reach near 30th Street Drive SE and on both sides of Indian Creek are among the most critical areas studied in this report. Since the natural valley near 30th Street Drive SE becomes quite narrow and restricted, higher flood stages may be expected within this reach. Abutting Indian Creek within the flood hazard area are residential developments consisting of older homes, recently constructed homes, and apartment buildings. As shown on the flood profiles on Plate 4, flood stages may be several feet above the present 30th Street Drive SE bridge and above ground floor levels of many houses and a few apartment buildings. In addition to the flood damage potential to residential developments 30th Street Drive SE is a primary road and one of the few crossings over Indian Creek. Its accessibility for emergency situations which generally increase during major floods is vital to the community.

e. 30th Street Drive SE to Marion Boulevard (U. S. Highway 151), Mile 6.87 to Mile 10.81.

(1) Proceeding upstream from the residential developments in the flood plain near 30th Street Drive SE to Marion Boulevard in the City of Marion, a variety of land uses may be seen, including a cemetery, a partially constructed residential area, an undeveloped wooded area, scenic parks and recreational areas.

(2) North of 32nd Street Drive adjacent to the west bank of Indian Creek is Mount Calvary Cemetery, mile 7.2, the lower portion of which may experience frequent flooding. Upstream from Mount Calvary Cemetery through a short undeveloped wooded reach, Indian Creek makes a sharp reversal in direction. Near the east city limits of Cedar Rapids at the extension of the present 40th Street Drive, mile 7.8, fill material is currently being dumped in the flood plain extending from the west bluff to the channel. This indiscriminate dumping materially

restricts the floodway, thereby increasing natural flood stages and velocities. Further upstream is a partially developed addition to the City of Marion known as Glenbrook Cove, mile 8.0. Although some of the recently completed homes in this attractive addition are constructed at elevations above any serious flood damage potential, several new homes north and one home south of 40th Street Drive SE are constructed on the flood plain and may experience frequent flooding. In addition to the serious flood damage potential attributable to the construction of new homes on the flood plain, the downstream filling and encroachment on the floodway will increase flood stages and flood damages. Impending construction of more homes on Indian Creek flood plain in this area is evidenced by recently constructed streets, filling, and grading. Upstream from Glenbrook Cove, almost to Marion Boulevard, the flood plain is generally wooded and undeveloped. East of Indian Creek north of the extension of Grand Avenue in the City of Marion, mile 10.2, an abandoned sewage treatment plant is currently being filled for a proposed park development. A short distance upstream from the abandoned sewage treatment plant, Oakshade Cemetery, mile 10.3, occupies a portion of the flood plain near the east bluff line. Farther upstream east of Indian Creek is the City of Marion's High School athletic field, mile 10.6. The essentially wooded undeveloped west side of Indian Creek south of Marion Boulevard is Thomas Park. This city park, a popular tourist stop, includes many recreational facilities including a large swimming pool.

f. Marion Boulevard to West 8th Avenue at the Confluence of Indian and Dry Creeks in the City of Marion, Mile 10.81 to Mile 11.05.

(1) The heavily traveled U. S. Highway 151 and State Highway 64, (Marion Boulevard), crosses Indian Creek about 10.8 channel miles upstream from its confluence with the Cedar River. Less than a half mile upstream from Marion Boulevard, Dry Creek enters Indian Creek at the West 8th Avenue bridge. At this point Indian Creek has a drainage area of approximately 67 square miles, of which Dry Creek drainage basin contributes about 31 square miles.

(2) The Chicago, Milwaukee, St. Paul, and Pacific Railroad bridge, mile 10.97, homes, and current filling encroachments on the flood plain are included in this reach of Indian Creek. A prominent landmark in the City of Marion is the remains of the old East Star Mill dam (Bale's Mill), mile 10.90, which is located midway between Marion Boulevard and the railroad bridge. The dam has deteriorated and sedimentation has almost filled the old impoundment area. There is presently some local interest in rejuvenating the old mill dam for a recreation area. South of West 8th Avenue on the east side of Indian Creek is the City of Marion's water works facilities, mile 11.00.

(3) Homes and buildings that may experience flood damages are located on the west side of Indian Creek north of Blairs Ferry Road, mile 10.91, and on both sides of West 8th Avenue west of Indian Creek.

In addition to existing buildings on the flood plain current land filling is encroaching upon the floodway north of Blairs Ferry Road on the west side of Indian Creek.

g. Indian Creek from West 8th Avenue within the City of Marion to a Point Approximately 2.4 Miles Upstream, in Section 30, Township 84 R6, Linn County, Iowa, Mile 11.05 to Mile 13.44.

(1) Much of the area is susceptible to overland flow and land usage is confined mainly to certain types of developments. The flood plain has not been extensively developed and consists mostly of agricultural land and recreational areas. In the lower half of the reach some residential homes have been built on the flood plain and will be subject to flooding during the higher floods. Marion is experiencing rapid residential growth and considerable pressure is evident toward utilization of the flood hazard area by commercial and residential developers.

(2) The City of Marion has been filling and shaping the flood plain, as shown by Photos No. 16 and 17 on Exhibit No. 7 in the development of a new recreational park area about 300 feet above the confluence with Dry Creek. Upstream from this park area and below Central Avenue some residential development has occurred, within the flood plain, along the left bank. The right bank flood plain is predominantly agricultural land. This land may be developed in the future. From Central Avenue upstream to 10th Street the flood plain is mostly agricultural along the right bank with some residential homes just upstream from Central Avenue. Most of these homes are above the flood plain; however, a few are susceptible to backwater flooding on the lower floor levels. Above 10th Street the flood plain is almost entirely agricultural with the Indian Creek Country Club and a public school located on the left bank, both of which are above existing flood limits. An athletic field which is located along the left bank of the flood plain at approximately mile 13.2 will be subject to frequent flooding; however, monetary damage will be small due to good flood plain planning.

h. Dry Creek from West 8th Avenue through the Town of Hiawatha, Mile 11.05 to Mile 16.32D.

(1) At the present time the flood plain within this reach of Dry Creek is primarily devoted to agricultural use. A few exceptions are a park area and some residential encroachments on the flood plain.

(2) Directly upstream from West 8th Avenue along both sides of Dry Creek, is the City of Marion's Donnelly Park, mile 11.1D to mile 11.2D. This scenic wooded area is essentially undeveloped.

(3) Adjacent to Donnelly Park and extending a short distance upstream, residential encroachment again is apparent. In the area

between Parkview Drive, mile 11.16D, and Dry Creek, some flood damage potential exists for a few recently constructed homes.

(4) Concerning the City's water supply, prior to the early 1950's, Marion's municipal source of water supply came from natural springs in this reach of Dry Creek commonly known as Linwood Knolls Springs. Continuing upstream agricultural land dominates the flood plain. Within this farm area two north-south roads cross Dry Creek, C Avenue, mile 13.37D, and the extension of Council Street, mile 15.10D. Less than a half mile upstream from Council Street, near the present corporate limits of the City of Cedar Rapids and the Town of Hiawatha, the flood plain turns to the north. In this area two sewage stabilization ponds for the Town of Hiawatha are located in the flood plain, near mile 15.80D. Near the upper limit of the area included in this report, is the Hiawatha Trailer Court, mile 16.00D, which occupies land at elevations that are above expected flood stages.

(5) The present agricultural use in the flood plain of Dry Creek between West 8th Avenue and the Hiawatha Trailer Court results in a relatively low flood damage. Presently, plans are underway to abandon the Town of Hiawatha sewage treatment facilities and to provide for a joint sanitary sewer system serving the Town of Hiawatha and the Cities of Cedar Rapids and Marion. The topography and location of this area adjacent to Dry Creek with respect to the Cities of Cedar Rapids and Marion and the availability of sanitary sewer and other facilities all support a rapid growth potential. Should this area be developed without regard to flood hazards, the relatively low flood damage potential will increase many times.

18. FLOOD WARNING AND FORECASTING SERVICES

At present there is no specific flood warning or forecasting service for the Indian Creek basin. The Cedar Rapids area is well within the effective range of the Weather Surveillance Radar, operating continuously at Des Moines, Iowa. Strong echoes observed by this equipment are an indication of heavy precipitation. This makes possible immediate radio and television broadcasts of information on areas of intense precipitation and possible flash flooding.

19. FLOOD FIGHTING AND EMERGENCY EVACUATION PLANS

There is no prearranged plan for flood fighting or evacuation in the Indian Creek basin. The absence of a flood warning system for the basin is simply a reflection of how little damage has been done to public and private property during previous floods.

20. The U. S. Weather Bureau provides a flood forecasting service for many of the river basins in Iowa. One forecast point is for the mainstem of the Cedar River at Cedar Rapids. The system involves the Weather Bureau making a prediction of a given stage at a particular gage or

gages in the basin based on observed precipitation and flows at upstream points as well as anticipated weather conditions. The flood forecast is transmitted to newspapers, radio and television stations in the basin which disseminate the information to the residents of the flood plain in the form of a flood warning. Even though the anticipated flood may be of moderate proportions, such forewarning permits industrial plants, public utilities, municipal officials and individual homeowners with property in the lowlands to take protective measures.

21. Residents of the study area may wish to set up a flood warning system for Indian and Dry Creeks sometime in the future. There are a number of possible gage sites on both creeks that could be used as a part of the forecasting program. Gages could be installed at any of the locations for which rating curves were developed, as shown on Plate 9.

22. NATURE AND EXTENT OF FLOOD PROBLEMS

Floods of varying magnitude occurred on Indian and Dry Creeks in the years 1929, 1937, 1945, 1946, 1947, 1959, 1960, 1961, and 1962. High-water marks recovered at certain locations for the floods of 1946, 1959, and 1961 have been plotted on the profiles shown on Plate 4. Because of the scarcity of high water information, profiles for the historic floods have not been plotted.

23. As stated previously, the historic floods on Indian and Dry Creeks have produced relatively light damages, particularly to residential property. There is no record of loss of life due to past floods. Information from newspaper accounts, Linn County records, libraries, and personal interviews has been condensed to give the following descriptions of the most notable floods.

a. June 1947 - This was a month which saw major floods in much of Iowa. Cedar Rapids received heavy damage from flooding, particularly from the Cedar River. The floods were produced by a series of intermittent periods of heavy rainfall during the month of June. Flood damage was present throughout the Indian and Dry Creek watersheds. The lower reaches of Indian Creek were hardest hit. Flooding in this area resulted from a combination of high flows on Indian Creek and backwater from the high stage on Cedar River. Because of the absence of large scale residential development at the time only a few homes were damaged by flood waters. The agricultural losses in the present flood plain were large and reflect the large increase in damages that would occur today with the expansion of residential development. There was considerable damage to the county road system, railroads, and utilities. Mt. Vernon Road, mile 1.08, and Otis Road, mile 0.18, were overtopped by flood waters which restricted and hampered flood operations in those areas. A large portion of the Cedar Rapids Country Club golf course was flooded, however relatively light damage was suffered in the area.

In large measure this accounts for the proposed local interests plan for "green belt" zoning throughout much of Indian and Dry Creeks flood plains.

b. January 1960 - In Cedar Rapids, Marion, and Linn County, a thousand basements were flooded, overflowing ditches and creek bridge damage plagued the area, all due to record January rains. Several streets had to be closed because of drainage ditch flooding or sunken service ditches. Inadequate storm drainage was the cause of much of the damage to the streets and basements. The ground was generally free of frost and fully saturated from 3.11 inches of rain in two days. It was estimated that 95 percent runoff occurred. Indian Creek overflowed its banks and flooded lowlands from Marion to the Cedar River. A resident near 30th Street Drive along Indian Creek had to be evacuated when floodwater covered the yard and broke through the foundation of his home. An estimated $2,500 in damage to the home resulted.

c. April 1960 - In this flood most of the damage at Cedar Rapids was due to Cedar River flooding; however, Indian and Dry Creek basins recorded some damage. Most of the flooding occured in the lower reaches of Indian Creek where backwater from the Cedar River contributed to the flooded conditions of Indian Creek. A number of homes were flooded and residences along County Road "GG" had water on the first floor as shown by photos numbered 1 and 2, Exhibit 1. Rowboats were used between houses and other buildings in the area. The C. & N. W. Railroad and Otis Road bridges were just out of water (see photo No. 3, Exhibit 2) with Otis Road submerged just west of the bridge. No record of estimated damages was made; however, losses exceeded several thousands of dollars.

d. March 1961 - As in the previous year, the major flood damage occurred on the Cedar River flood plain within the City of Cedar Rapids. Most of the available historic records, news articles, and photographs covered that area. However, Indian and Dry Creeks suffered flooding in many reaches and relatively large damages occurred. The major flooding and associated damage occurred on the lower reaches of Indian Creek. During this particular March flood, much of the damage along Indian Creek was attributed to Cedar River backwater. Many homes and buildings were flooded, a typical example is shown by photo 4, Exhibit 2. County Road "GG" was submerged by flood water (see photo No. 5, Exhibit 2) hampering emergency operations by restricting transportation. Some homes were protected by sandbag levees, requiring pumping operations similar to that shown on photo 6, Exhibit 3. Agricultural damage was relatively small because most of the spring field operations had not begun. Some farm buildings were inundated, causing grain spoilage. Photos 7 and 8, Exhibit 3, illustrate typical areas where new developments may be expected to occur and the possible consequence that may result during flood periods. Otis Road was again flooded as shown on photo 9, Exhibit 3, damage to the road was minor because of low water velocities in the overbank areas. The total damage from this flood is unknown but the problems incurred are evident.

e. November 1961 - This unusual flash flood on Dry and Indian Creeks occurred in late fall. The total damage was light because most agricultural crops had been harvested and many summer activities had ceased in the park areas. The flood was not severe enough to inundate any residential homes although some smaller buildings were partially covered by flood water. Flooding was most obvious within the City of Marion, at Thomas Park. The footbridge across Indian Creek was isolated by flood waters as shown on photo 10, Exhibit 4. Water covered much of the park, surrounded the Legion swimming pool, and inundated the Legion baseball field, surrounding the park service bridge as shown on photo 11, Exhibit 4. Water rose to within a few feet of the Legion swimming pool but caused very little damage as shown by photos 12 and 13, Exhibit 5. This again shows the advantage or reserving the flood plain for park and recreational areas.

24. DEVELOPMENTAL FACTORS WHICH AFFECT FLOOD FLOWS

The many natural or man-made conditions which have a detrimental effect on the capacity of a river to carry high discharges possess one or all of the following characteristics; they reduce vertically and/or horizontally the cross-section of the flow area, or they force the flow to change direction, or increase the watershed runoff rate. Some of the factors most commonly found are bridges, dams, ice jams, debris jams, fills, fences, sedimentation, vegetation, sharp bends in the channel, utility lines which are suspended below the low steel on bridges crossing the flood plain, underwater utility lines which cross rivers on or above the channel bottom, boat houses, docks and other structures lying in the flood plain. The watershed yield or runoff rate may be increased, thus producing more flood water in the flood plain and increasing damages. The yield is increased by decreasing the infiltration rate and/or the temporary available storage in the watershed. Some of the factors affecting this criteria are the developments of streets, parking lots, land filling, roof areas and many types of land usage. The following paragraphs discuss some of these developmental factors which are most significant within the limits of the study area.

25. Floods in the Indian and Dry Creek basins are often the result of rain falling on frozen soils and are frequently augmented by melting snow. As a result, creek stages are often affected by ice jams throughout the study area. Indian and Dry Creeks are relatively winding creeks with a number of sharp bends, and jams occur at these sharp turns. However, since most of the flood plain is undeveloped, the resulting backwater has caused very little damage. One developmental factor which has altered flood profiles is the gradual filling within the flood plain which has taken place in a number of locations along Indian Creek as previously described in paragraph 18. There has also been recent filling in the reach just downstream from 30th Street bridge in Cedar

Rapids. This filling within the flood plain has caused restrictions to flow which will result in higher water surface elevations. Present-day profiles of high discharge floods are undoubledly higher upstream from these fill areas than they were before the area was filled. Photos Nos. 14 and 15, Exhibit 6, are typical examples of these land fill areas.

26. Many of the bridges over Indian Creek, within the study area are single-span truss bridges as shown on Plate 5. The waterway opening under this type of bridge usually offers a good conveyance factor until the high water profile reaches low steel elevation. These bridges are submerged by the 50-year profile and are constrictive to high flows as shown by the profiles on Plate 4. At high stages debris lodges against the truss and creates more impedence to flow. There are two arch bridges over Indian Creek which have relatively long spans with good channel clearance. Further bridge descriptions are listed in Table 2 and shown on Plate 5.

27. The photo on Plate 5/9, mile 11.05, 8th Avenue Bridge, illustrates another condition which tends to aggravate flood stages. This bridge was constructed recently and sometime after its completion fill was deposited and compacted along the west pier just upstream and downstream from the bridge. The fill encroaches into the channel and has reduced the effective waterway opening. The situation at this bridge is more severe than many of the bridges along the creek because the site lies just below the confluence of Indian and Dry Creeks. Future flood stages will undoubtedly be raised on the upstream side of this bridge as a result of this unregulated flood plain encroachment.

28. PROSPECTIVE DEVELOPMENTS AFFECTING THE FLOOD PLAIN

Linn County and the Cities of Cedar Rapids and Marion have active planning programs carried out through their various governing bodies. These planning agencies have made comprehensive studies of present growth trends and have made forecasts of future economic and population growth and the resulting needs for housing, recreation facilities, schools, parks and major streets. At the present time there are no specific residential, commercial or industrial developments anticipated in the flood plain which would affect flood hydrology and damages in the immediate future. According to estimates of the Cedar Rapids City Planning Commission, considerable growth can be expected in the vicinity of Dry Run and Indian Creeks over the next 15 to 20-year period. In a report prepared for Linn County entitled "Background for Planning", it is estimated that Linn County's population will grow to approximately 185,600 by 1980. This represents an increase of almost 50,000 people over the 1960 population of 136,899. The bulk of this increase is expected to take place in the urban area of Cedar Rapids and Marion. History has shown that such growth in areas bordering on a stream's flood plain will produce a considerable increase in future flood damages if allowed to occur without sufficient flood plain management practices.

Photo 1 - Mt. Vernon Road Bridge during the April 1960 Flood. Looking downstream at Mile 1.08.

Photo 2 - County Road "GG" bridge and flooded homes in the area during the April 1960 flood. Looking downstream at Mile 0.75.

EXHIBIT 1

Photo 3 - Otis Road Bridge in foreground and C. & N.W. Railroad bridge in background during the April 1960 flood. Looking downstream at Mile 0.18.

Photo 4 - Flooded homes and building near County Road "GG" during the March 1961 Flood. Near Mile 0.72.

Photo 5 - Boating on County Road "GG" looking south toward the Indian Creek main channel during the March 1961 Flood at Mile 0.75.

EXHIBIT 2

Photo 6 - Pumping operations from one of many residential homes along Indian Creek during the March 1961 Flood at Mile 0.73.

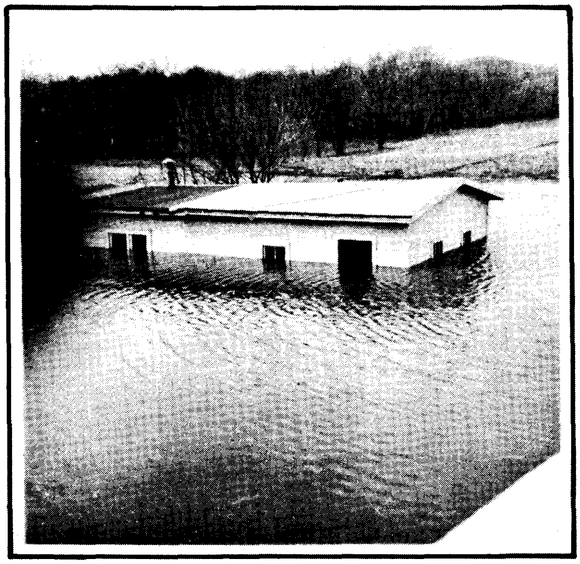

Photo 7 - Flooding along Indian Creek during the March 1961 Flood at approximately Mile 0.72.

Photo 8 - Flooding in the vicinity of Mt. Vernon Road showing flooded house and emergency operations during the March 1961 Flood at Mile 0.95.

Photo 9 - Otis Road during the 1961 Flood showing the submerged road for approximately 3000 feet at Mile 0.18.

EXHIBIT 3

Photo 10 - Isolated Thomas Park footbridge in foreground looking upstream. Marion Boulevard in background - November 1961 flash flood at Mile 10.75.

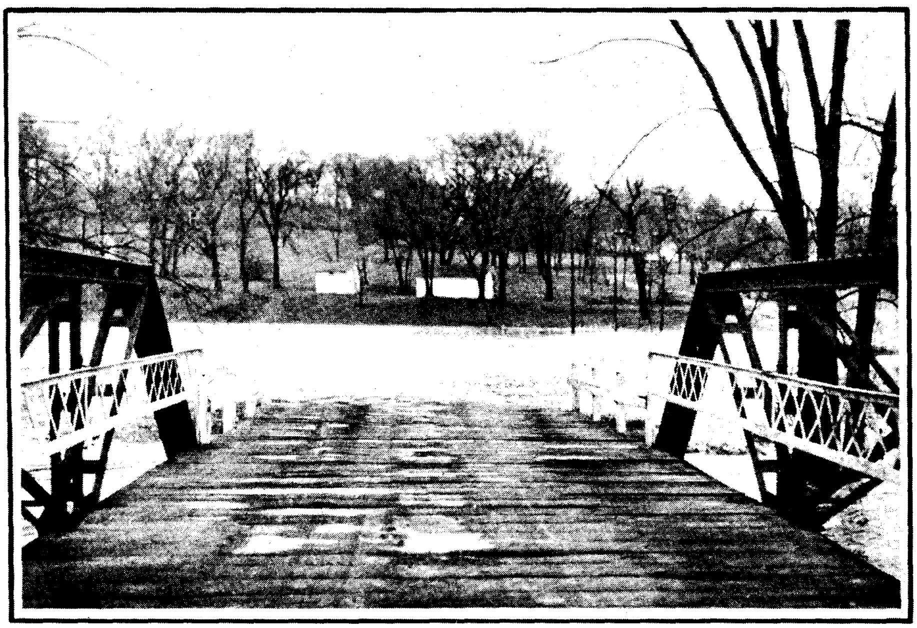

Photo 11 - Thomas Park in Marion looking at right bank as viewed from the lower vehicular service bridge - November 1961 flood at Mile 10.65.

EXHIBIT 4

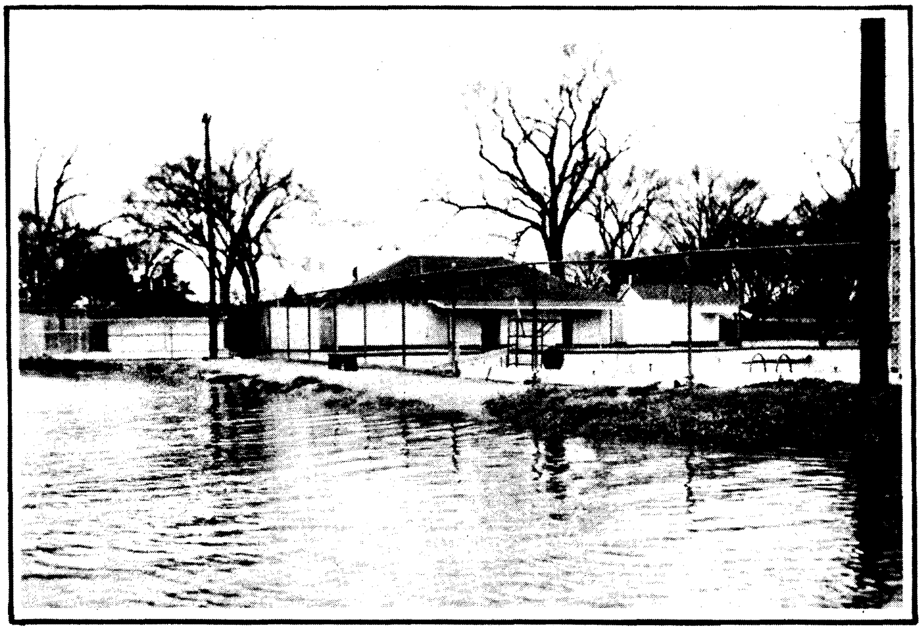

Photo 12 - Thomas Park swimming pool right bank - November 1961 flood at Mile 10.7.

Photo 13 - Thomas Park showing flooded park and nearby areas right bank - November 1961 flood at Mile 10.7.

EXHIBIT 5

Photo 14 - Filling on Indian Creek flood plain at end of 40th Street Drive S.E. projected. Photo taken from right bank of Indian Creek located in Cedar Rapids, adjacent to Marion-Cedar Rapids Corporate City limits at Mile 7.80.

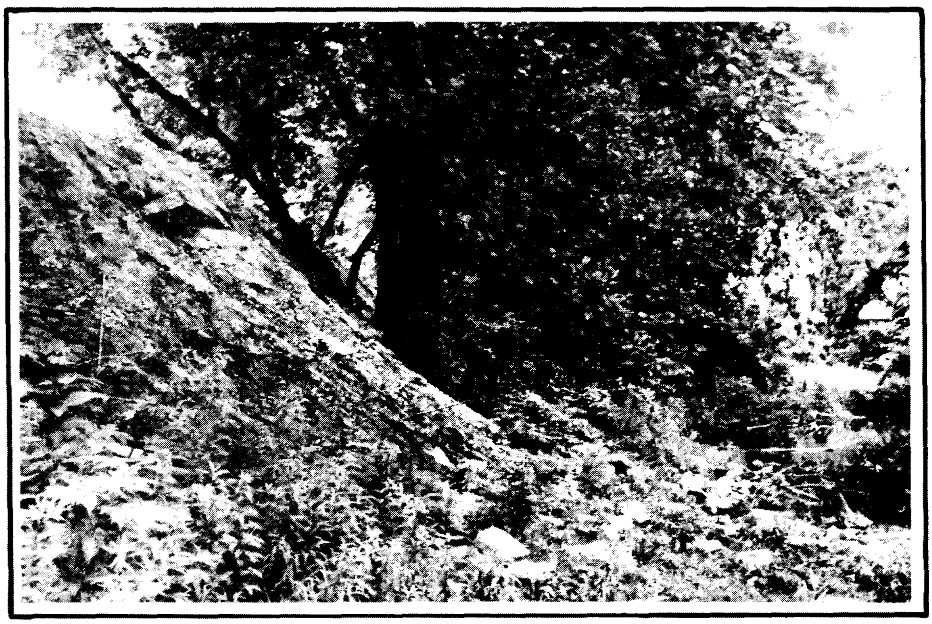

Photo 15 - Photo taken 2 July 1964, looking upstream from right bank of Indian Creek near 29th Street Drive S.E. at Mile 6.70.

EXHIBIT 6

Photo 16 - Looking West from present flood plain land fill area across Indian Creek with Dry Creek in the background. Fill area about to be closed and converted to Park Area at Mile 11.18.

Photo 17 - Looking Northwest at city flood plain fill area Southeast of Indian Creek about 500 feet above the junction with Dry Creek. Fill area about to be closed and shaped into a City Park at Mile 11.25.

EXHIBIT 7

29. There are several points along Indian and Dry Creeks with pronounced constriction, and the channel banks are very low in much of the flood plain. In such reaches it is easy for people to unknowingly move into a development that is subject to frequent flooding. Such developments will probably occur on both creeks if minimum elevations for future development are not established by local and State agencies.

30. EXISTING AND AUTHORIZED FLOOD CONTROL AND RELATED PROJECTS

There have been no Federal flood control or allied projects constructed or anticipated at this time within the Indian and Dry Creek basins.

31. EXISTING REGULATIONS

The zoning ordinance adopted by Linn County in 1959 regulates construction on the flood plain in unincorporated areas of the county. The flood plain, with reference to the zoning ordinance, is defined as land areas known to have been flooded previously or that are reasonably expected to be flooded by a 50-year frequency flood, as determined by the county engineer. Buildings intended for permanent occupancy may not be moved onto or constructed on flood plain areas and the lowest floor of summer cottages must be at least one foot above flood crest elevation. The ordinance exempts from its operation all farmland and structures, in terms very similar to those used in the enabling statute, Section 358A.2, Iowa Code 1962.

32. Although the Cities of Cedar Rapids and Marion have prepared comprehensive plans and enacted zoning ordinances, it appears that there are no subdivision regulations, building codes or zoning ordinances adopted by either city with provisions which affect or regulate the use of land with respect to flood risk. The authority of local governing bodies to zone for protection from floods appears to be included in the standard objectives listed in the state enabling statutes even though not specifically set out.

33. 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 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 any floodway. 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. Other statutes affecting activities on the flood plain but less directly concerned with flood plain regulation are listed in the bibliography.

34. REFERENCES

A bibliography of references used in the preparation of this report is presented at the conclusion of this technical appendix.

RAINFALL AND FLOODS

35. GENERAL

Flooding in the Indian and Dry Creek basins is most often caused by rainfall on snow-covered or saturated ground and occurs most often in the late winter or early spring. Creek stages are sometimes affected by debris and ice jams, particularly at sharp bends and bridges. Storms oriented principally over the upper portion of Indian Creek appear to peak earlier and somewhat higher than corresponding peaks on Dry Creek. The time lag between the two peaks at the confluence is normally short and tends to produce a single peak flood at the City of Marion and below.

36. PRECIPITATION

Precipitation records for the study area are available from the Cedar Rapids station which has a record of 81 years. The station has a record of temperatures for 80 years and snowfall for 21 years. Central Iowa and southern Minnesota have a number of operating stations which have records that are useful to the study area, some of which have records back to 1871. The annual precipitation is well distributed over the basin and averages 33.33 inches at the Cedar Rapids station. Snowfall averaging 29.9 inches annually is included in the precipitation amounts. More detailed data on stations and records are shown in Table 3.

37. RAINFALL

The highest monthly average precipitation, 4.85 inches, occurs during the month of June. The minimum monthly average, 1.10 inches, occurs in February. Maximum and minimum months for central Iowa are also June and February. The rainfall intensity-duration frequency curve for the study area is shown on Plate 11. From this curve, a 24-hour storm having a frequency of about once in 50 years has an average intensity of 0.25 inches per hour.

38. TEMPERATURE

The monthly means for seven stations recording temperature are shown in Table 3. The average annual temperature at Cedar Rapids is 49.3 degrees Fahrenheit and is considered to be representative of the basin. July is the warmest month and January the coldest, with average temperatures of 74.9 and 21.5 degrees, respectively.

39. SNOWFALL

Records of snowfall at seven stations in or adjacent to the basin are shown on Table 3. The average annual snowfall is 29.9 inches. The highest monthly mean is 7.7 inches in March at Cedar Rapids.

40. STREAM FLOW RECORDS

There are two U.S.G.S. crest stage gages within the study area as shown on Plates 3/2 and 3/5. The Dry Creek gage is located on a concrete deck bridge, mile 13.37, two miles west and 3/4 mile north of Marion in SE 1/4 Section 34, T84N, R7W, Linn County, Iowa. The Indian Creek gage is located on a county road bridge, mile 2.21, 3 miles east of Cedar Rapids in NE 1/4 Section 19, T83N, R6W, Linn County, Iowa. Three other crest stage gages are located in the Indian Creek watershed. One gage is on Squaw Creek about one mile above the mouth, with a drainage area of 13.8 square miles, another gage on Dry Creek, about nine miles above the mouth, has a drainage area of 14 square miles, and a gage on Indian Creek about two miles above the confluence with Dry Creek, measures a 32 square mile area. These five gages were established in 1961 and the records obtained from them will provide valuable information for future studies. There are no recording gages in the basin at this time. Because of the relatively short record from the crest stage gages it was not possible to develop rating curves from actual current meter measurements; however, theoretical rating curves were developed at many locations from the extensive backwater study. These rating curves are shown on Plate 9.

41. FLOOD FREQUENCIES

Floods are random occurrences dependent on a combination of natural climatological factors and channel conditions and there is no method of accurately predicting the time of occurrence or magnitude of any future flood event. However, an analysis of past floods and/or floods in a similar basin within a given area can give an indication of the probability of occurrence of a given stage or discharge. In connection with flood damages and flood control planning, it is customary to estimate the frequency (or probability) with which specific flood stages or discharges may be equalled or exceeded, rather than the frequency of an exact value of stage or discharge. When expressed correctly, frequency can be stated in two ways; as once in a specified number of years, or as a percent--the percentage being numerically equal to the estimated number of occurrences in 100 years. Another term, recurrence interval, is defined as the average interval of time in years over a long period, which can be expected to elapse between floods equalling or exceeding the specified flood. Therefore, a flood having a frequency of once in 20 years can also be expressed as having a five percent frequency (five occurrences in 100 years) or as having a recurrence interval of 20 years. A discharge frequency curve was developed at the mouth of Indian Creek as shown on Plate 7. The curve was computed in accordance with

TABLE 3

CLIMATOLOGICAL DATA

Station	Length of Record (Years)	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average Annual Precipitation (Inches)	Maximum Yearly Precipitation	Minimum Yearly Precipitation
		Average Monthly Precipitation in Inches														
Albert Lea	72	0.77	0.81	1.70	2.21	4.09	4.39	3.80	3.56	3.05	1.90	1.49	0.91	28.68	41.93	15.43
Mason City	71	0.88	0.86	1.70	2.40	3.81	5.17	3.55	4.08	3.20	1.89	1.56	0.89	29.99	45.18	15.27
Charles City	88	1.19	1.06	2.21	2.70	4.00	4.51	3.49	3.94	3.37	1.93	1.88	1.19	31.47	45.81	15.88
Waterloo	81	1.15	0.92	2.05	2.70	3.74	4.83	3.79	3.42	3.80	2.12	1.83	1.13	31.48	41.76	17.35
Marshalltown	85	1.27	1.08	2.22	2.83	4.62	4.89	3.42	3.42	3.39	2.19	1.93	1.18	32.44	52.91	17.47
Cedar Rapids	81	1.44	1.10	2.34	3.17	3.90	4.85	3.70	3.16	3.71	2.46	2.13	1.37	33.33	48.23	18.74
Washington	88	1.49	1.29	2.56	3.15	3.75	4.89	3.81	3.51	2.92	2.25	2.23	1.62	33.47	45.16	16.56
AVERAGE	81	1.17	1.02	2.11	2.74	3.99	4.79	3.65	3.58	3.35	2.11	1.86	1.18	31.55	45.85	16.67

Mean Monthly Temperatures

Station	Length of Record (Years)	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average Yearly Temperature	Maximum Temperature	Minimum Temperature
Albert Lea	74	15.9	19.2	30.0	46.1	58.7	68.6	73.6	71.4	62.4	51.1	33.4	21.0	46.0	106	-41
Mason City	65	16.3	19.8	30.4	46.2	58.4	68.3	73.0	71.0	62.0	50.9	33.8	21.7	46.0	107	-35
Charles City	72	17.3	20.8	31.6	47.3	59.3	69.0	73.7	71.6	62.6	51.6	34.7	22.5	46.8	108	-34
Waterloo	67	18.4	21.9	32.5	47.8	59.9	69.6	74.3	72.2	63.4	52.2	35.2	23.2	47.6	112	-33
Marshalltown	67	20.3	23.9	34.4	49.1	60.7	70.6	75.2	73.0	64.3	53.2	36.6	25.1	48.9	112	-32
Cedar Rapids	80	21.5	25.1	35.1	49.5	60.7	70.3	74.9	72.8	64.6	53.5	37.6	26.2	49.3	110	-36
Washington	81	23.8	27.2	37.2	51.2	62.3	72.0	76.4	74.5	66.5	55.4	39.3	28.1	51.2	113	-29
AVERAGE	72	19.1	22.6	33.0	48.2	60.0	69.8	74.4	72.4	63.7	52.6	35.8	24.0	48.0	110	-34

Mean Monthly Snowfall

Station	Length of Record (Years)	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean Yearly Snowfall Inches
Albert Lea	57	8.7	7.3	7.2	2.6	0.1	.0	.0	.0	0.1	0.6	3.8	7.5	37.9
Mason City	53	7.8	7.7	7.9	2.3	0.2	.0	.0	.0	0.1	0.5	3.9	7.3	37.7
Charles City	61	9.3	9.0	8.2	2.2	0.1	.0	.0	.0	.0	0.3	3.9	8.2	41.2
Waterloo	55	6.9	6.0	5.3	1.3	0.1	.0	.0	.0	T	0.3	3.0	6.1	29.0
Marshalltown	55	7.7	6.7	6.1	1.1	T	.0	.0	.0	.0	0.3	2.4	6.2	30.5
Cedar Rapids	21	7.2	5.6	7.7	1.2	T	.0	.0	.0	.0	0.1	2.3	5.8	29.9
Washington	51	7.0	6.2	4.7	0.9	T	.0	.0	.0	.0	0.1	1.4	5.9	26.2
AVERAGE	50	7.8	6.9	6.7	1.7	0.1	.0	.0	.0	T	0.3	3.0	6.7	33.2

"Statistical Methods in Hydrology" by Leo R. Beard. The statistical approach assumes that the logarithms of flood discharges follow a normal distribution. Since the properties of the normal probability curve have been well defined, it is possible to estimate with some justification the frequencies of occurrence of future floods of varying magnitudes. The longer the period of record, the more reliable the estimates of future flood frequencies. Therefore, as additional years of record are added to a frequency study, the frequencies of floods, as previously determined, may change. Because no flow records were available for Indian Creek, the frequency curve was developed in the following manner. By plotting the mean annual flood discharge vs. drainage area on log-log paper for seven similar watersheds within the central Iowa area each having about 25 years of flow records, it was determined that the mean annual flood discharge (two-year frequency) for the 93 square mile drainage area was 3,160 c.f.s. The discharge frequency curve was then defined by using this point and computing the standard deviation (and therefore the slope on log-probability paper) of the frequency curve by averaging the standard deviations for the similar watersheds. For comparison purposes the peak flood discharge resulting from estimated run-off from the 100 year-24 hour storm from the U. S. Weather Bureau Technical Paper No. 25 (Plate 11) was routed through the Indian Creek basin. The peak discharge was found to agree satisfactorily with the 100-year discharge as shown on the frequency curve.

42. The computed floods in Tables 4 and 5 have been developed to show the stages and discharges which would be produced at various points along Indian and Dry Creeks by floods of various frequencies. The stages shown on Table 5 are those which would result from the given discharges under free flow conditions, i.e., no ice or debris jams. The flow frequency values shown in Table 4 were obtained by the following relationship which was found to agree with the observed data from the seven watersheds studied:

$$\sqrt{\frac{D.A._{\text{given location}}}{D.A._{\text{mouth}}}}\ (\text{Computed discharge at mouth})$$

The frequency relationships summarized in Table 4 should not be regarded as a prediction of when or how often a specified flood might occur, but only as an indication or index of the possibility of occurrence. Assigning a 50-year frequency to a particular discharge does not mean that this discharge can be expected to occur every 50 years. However, over a period of 200 years, this flood should be equalled or exceeded about four times. The longer the period of record of past flood occurrences, the more reliable are the frequency data. Since there are no past flood records on Indian and Dry Creeks, information gathered in the future will improve the reliability of the frequency data.

TABLE 4

DISCHARGES FOR FLOODS OF VARIOUS RECURRENCE INTERVALS

Mile	Drainage Area Square Miles	Discharge of Computed Floods 50-year flood	100-year flood	standard project flood
0.00	93.0	17,400	22,000	31,100
0.62	92.7	17,370	21,960	31,040
1.01	77.6	15,900	20,110	28,425
2.21	76.2	15,750	19,910	28,150
3.00	75.3	15,660	19,800	27,990
3.44	74.7	15,590	19,710	27,870
3.65	74.2	15,540	19,650	27,770
4.11	73.7	15,490	19,580	27,680
4.42	73.4	15,470	19,560	27,650
4.82	72.7	15,380	19,450	27,490
5.32	72.1	15,330	19,380	27,400
5.66	71.7	15,280	19,320	27,305
6.87	71.3	15,240	19,270	27,240
8.10	69.8	15,070	19,050	26,930
9.27	68.9	14,980	18,940	26,780
9.89	68.3	14,910	18,850	26,650
10.43	67.8	14,860	18,790	26,560
11.05	66.8	14,750	18,650	26,370
11.18	35.8	10,790	13,650	19,290

TABLE 4 (contd)

DISCHARGES FOR FLOODS OF VARIOUS RECURRENCE INTERVALS

Mile	Drainage Area Square Miles	Discharge of Computed Floods 50-year flood	100-year flood	standard project flood
11.51	35.4	10,740	13,580	19,200
12.01	34.7	10,630	13,440	18,990
12.28	34.1	10,540	13,330	18,840
12.74	33.6	10,450	13,220	18,680
13.33	32.6	10,300	13,020	18,410
*				
11.20D	31.0	10,040	12,690	17,940
11.94D	26.6	9,310	11,770	16,640
12.15D	26.4	9,270	11,730	16,580
12.88D	26.1	9,220	11,660	16,480
13.37D	25.6	9,140	11,550	16,330
14.57D	24.8	8,980	11,350	16,050
14.77D	24.4	8,910	11,260	15,920
15.10D	24.2	8,870	11,220	15,860
15.91D	23.9	8,820	11,150	15,770
16.32D	23.7	8,790	11,110	15,710

* Dry Creek Mileage "D" from Mouth of Indian Creek.

TABLE 5

FLOOD PROFILE INFORMATION

Mile	Location	Elevation of flood profile - feet		
		50-year flood	100-year flood	standard project flood
C & NW Railroad 0.04	Downstream	708.2	708.9	710.2
	Upstream	708.9	710.1	712.8
0.12		709.0	710.2	712.8
Otis Road 0.18	Downstream	709.3	710.5	713.2
	Upstream	710.0	711.3	713.6
0.33		710.2	711.5	713.9
0.62		710.8	712.1	714.5
County Rd. "GG" 0.75	Downstream	711.2	712.5	714.8
	Upstream	712.4	714.1	716.7
0.81		712.5	714.2	716.7
1.01		713.0	714.6	717.2
1.07		713.0	714.6	717.2
Mt. Vernon Road 1.08	Downstream	715.0	717.0	719.4
	Upstream	716.0	717.7	720.1
1.32		716.9	718.5	720.8
1.54		717.6	719.0	721.4
1.75		718.0	719.5	721.8
1.98		719.0	720.4	722.7
County Road 2.21	Downstream	720.0	721.4	723.7
	Upstream	720.0	721.4	723.7
2.45		723.2	724.1	725.7
2.53		724.5	725.9	728.2

TABLE 5 (contd)

FLOOD PROFILE INFORMATION

Mile	Location	Elevation of flood profile - feet: 50-year flood	100-year flood	standard project flood
2.68		724.9	726.2	728.5
3.00		727.3	728.6	730.8
3.21		728.2	729.6	732.0
3.44		729.4	730.8	733.1
3.65		731.1	732.5	734.8
4.11		734.7	736.2	738.9
East Post Road	Downstream	736.1	737.5	739.9
4.42	Upstream	736.5	738.1	740.9
4.48		737.3	738.9	741.8
4.82		739.6	741.3	744.4
5.05		740.5	742.0	744.8
Cottage Grove Ave.	Downstream	743.8	744.9	746.9
5.32	Upstream	745.8	747.6	750.7
5.52		746.2	747.8	750.8
5.66		746.9	748.3	751.1
Golf Course Service Branch	Downstream	747.2	748.6	751.3
5.71	Upstream	747.2	748.6	751.3
5.74		747.4	748.7	751.4
Golf Course Service Branch	Downstream	747.8	749.0	751.5
5.80	Upstream	747.8	749.0	751.5
6.04		749.4	750.2	752.2

TABLE 5 (contd)

FLOOD PROFILE INFORMATION

Mile	Location	Elevation of flood profile - feet 50-year flood	100-year flood	standard project flood
Golf Course Dam	Downstream	751.2	751.9	753.5
6.24	Upstream	751.2	752.0	753.5
Golf Course Service Branch	Downstream	752.3	753.0	754.3
6.32	Upstream	753.1	753.7	754.6
Golf Course Service Branch	Downstream	754.5	755.2	756.3
6.38	Upstream	754.6	755.3	756.5
6.71		757.4	758.2	759.6
30th St. Drive SE	Downstream	760.5	761.4	762.9
6.87	Upstream	762.9	764.7	766.2
7.05		764.9	766.3	768.1
7.31		765.8	767.3	769.4
7.34		765.8	767.3	769.4
7.39		767.0	768.8	771.2
7.49		767.3	769.0	771.5
7.76		768.0	769.6	772.1
7.89		768.4	770.0	772.4
8.10		769.0	770.5	772.9
8.45		770.0	771.5	773.9
8.80		771.6	773.1	775.6
9.27		773.2	774.8	777.5
9.45		773.7	775.2	777.9

TABLE 5 (contd)

FLOOD PROFILE INFORMATION

Mile	Location	Elevation of flood profile - feet: 50-year flood	100-year flood	standard project flood
9.69		774.7	776.2	778.8
9.75		775.6	777.1	779.7
9.89		776.4	777.8	780.4
10.17		777.9	779.2	781.7
10.43		779.8	781.1	783.3
10.56		781.1	782.2	784.3
Thomas Park Road	Downstream	783.4	784.8	787.4
10.65	Upstream	783.4	784.8	787.4
Thomas Park Foot Br.	Downstream	784.2	785.6	787.9
10.75	Upstream	784.2	785.6	787.9
Marion Boulevard	Downstream	784.5	785.9	788.2
10.81	Upstream	784.9	786.7	789.7
Marion Waterworks Dam	Downstream	785.8	787.4	790.2
10.90	Upstream	785.9	787.5	790.3
CM & St. Paul RR	Downstream	786.7	788.2	791.0
10.97	Upstream	787.4	789.2	792.4
8th Avenue	Downstream	788.2	789.9	793.0
11.05	Upstream	788.4	790.5	793.5
11.18		789.9	791.6	794.4
11.25		789.9	791.7	794.4
11.37		790.0	791.8	794.5
Central Avenue Bridge	Downstream	790.1	791.8	794.6
11.51	Upstream	791.5	793.7	796.3
11.89		791.7	793.9	796.4
12.01		791.9	794.0	796.5

TABLE 5 (contd)

FLOOD PROFILE INFORMATION

Mile	Location	Elevation of flood profile - feet: 50-year flood	100-year flood	standard project flood
10th Street Bridge	Downstream	792.2	794.2	796.8
12.12	Upstream	792.4	794.3	796.8
12.28		792.9	794.6	797.0
12.53		793.6	795.1	797.3
12.74		794.2	795.5	797.6
12.99		795.5	796.5	798.3
13.21		796.8	797.6	799.2
13.33		797.7	798.5	800.0
13.44		798.7	799.6	801.2
*				
11.20 D		789.9	791.6	794.4
11.34 D		790.0	791.7	794.5
11.59 D		790.5	792.1	794.8
11.76 D		792.0	793.2	795.4
11.94 D		793.8	794.7	796.4
12.15 D		794.9	795.7	797.3
12.39 D		796.2	797.1	798.7
12.69 D		798.4	799.3	801.0
12.88 D		799.4	800.3	802.0
13.22 D		802.5	803.2	804.6
"C" Avenue NE	Downstream	803.3	804.0	805.5
13.37 D	Upstream	807.4	808.0	809.0
13.74		807.6	808.2	809.3

TABLE 5 (contd)

FLOOD PROFILE INFORMATION

Mile	Location	Elevation of flood profile - feet 50-year flood	100-year flood	standard project flood
14.09 D		808.0	808.7	809.9
14.42 D		809.2	810.0	811.3
14.57 D		810.7	811.6	813.0
14.77 D		811.5	812.4	813.8
Council Street	Downstream	813.9	814.8	816.2
15.10 D	Upstream	814.7	815.5	816.6
15.45 D		816.5	817.4	818.9
15.91 D		818.5	819.4	820.9
16.01 D		819.4	820.3	821.9
16.32 D		821.0	822.1	823.8

* Dry Creek Mileages "D" from Mouth of Indian Creek.

43. RATING CURVES

Curves relating stage to discharge were developed at various points along Indian and Dry Creeks as shown on Plate 9. These curves were developed from the backwater profiles computed by the Manning equation, $Q=\frac{1.486}{n} AR^{2/3} s^{1/2}$, the most widely used equation for open channel flow. "Q" is expressed as discharge in cubic feet per second, "A" as the cross-sectional area of the waterway in square feet to the water surface, "s" as the slope of the water surface, "n", as a friction factor, is an index of the relative resistance to flow of water in an area, and "R" as the hydraulic radius. The hydraulic radius is the ratio of the cross-sectional area of the waterway to the perimeter of the channel or overbank which comes in contact with the water. For this study the values of "n" ranged from 0.030 to 0.040 in the channel and 0.040 to 0.100 in the overbank areas. The frequency lines shown on Plate 9 indicate the elevation and discharge that may be expected at the given recurrence intervals. Future verification could be obtained by the establishment of gages to record peak stages, and by making actual discharge measurements on each branch during future flood occurrences.

44. BENCH MARKS

A list of bench marks and locations from which these elevations were determined is shown on Table 6. The list is presented as an aid to local interests in establishing crest gages, setting minimum elevations for future development or establishing other elevations necessary to flood plain planning. All elevations in this report are referred to U. S. Coast and Geodetic Survey Datum. These bench marks should be suitably marked and preserved. The elevations of bench marks which may be destroyed by proposed construction should be transferred to another permanent base.

45. HYDROLOGIC CHARACTERISTICS

The hydrologic characteristics of Indian and Dry Creek basins cannot be expected to remain as they are today. As residential development absorbs rural land, ditches and storm sewers will be constructed to convey runoff from these areas to Indian Creek and its tributaries. These practices can be expected to produce a gradual change in the flow characteristics of future floods. In the earlier phases of development, land tile and storm sewer drainage in the lower reaches of the basin may actually decrease flood peaks in these lower reaches. By conveying the runoff from adjacent land to the creek well ahead of the flood crest from the upper reaches, the peak discharge may be lower than it would have been under natural conditions. In the future, however, the effect of development is to produce higher discharges for a given rainfall by conveying increased runoff more rapidly to the river. Marshy lowlands which formerly stored runoff and released it slowly to the water table will be drained to the river. Rainfall which previously "soaked" into

TABLE 6

Descriptions and Elevations of Benchmarks

Mile 0.04 - 8306-30 SE (3) (Indian Creek) - On south edge of Cedar Rapids, on C & NW RR bridge over Indian Creek, about 200 feet above mouth of Indian Creek. Chiselled square on top of upstream end of upstream landward corner of first concrete pier from right abutment. Elevation 707.65.

Mile 0.78 - 8306-30 SE (2) (Indian Creek) - 1.5 miles east of Cedar Rapids on Mt. Vernon Road (old Highway 30) and 0.5 mile south on county road "GG" to E-W county road "BB", 400 feet west of "T" intersection, in top right downstream concrete handrail post of concrete bridge over Indian Creek. Bronze tablet stamped Linn County Engineering Department 1031 Indian Creek. Elevation 715.28.

Mile 0.80 - 8306-30 NE (2) (Indian Creek) - 1.5 miles east of Cedar Rapids on Mt. Vernon Road (old Highway 30) and 0.25 mile south on N-S county road "GG", about 400 feet south of "T" road west and EM 8306-30 NE (1), in top left downstream abutment of through truss bridge over Indian Creek; bronze tablet stamped Linn County Engineer Department - Indian Creek - 1053. Elevation 710.85.

Mile 0.81 - 8306-30 NE (1) (Indian Creek) - 1.5 miles east of Cedar Rapids on Mt. Vernon Road (old Highway 30) and 0.25 mile south on N-S county road "GG" on east line section 30, at road "T" intersection west. On top downstream headwall 4' x 6' culvert. Bronze tablet stamped Linn County Engineer Department 877-1922. Elevation 712.36.

Mile 1.07 - 8306-29 NW (1) (Indian Creek) - 1.5 miles east of Cedar Rapids on Mt. Vernon Road (old Highway 30), on bridge over Indian Creek. On left downstream concrete wing wall; chiselled X. Elevation 712.74.

Mile 1.08 - 8306-20 SW (2) (Indian Creek) - 1.5 miles east of Cedar Rapids on Mt. Vernon Road (old Highway 30) and 0.5 mile north on N-S county road on east line of section 19. In last transmission pole on east side of road; pole spike and collar. Elevation 758.46.

Mile 2.21 - 8306-20 NW (1) (Indian Creek) - 1.5 miles east of Cedar Rapids on Mt. Vernon Road (old Highway 30), 0.75 mile north on N-S county road on east line of section 19. At bridge over Indian Creek, chiselled X in downstream rivet head on top of left downstream steel pier. Elevation 718.17.

TABLE 6

Descriptions and Elevations of Benchmarks - (contd)

Mile 4.42 - 8307-24 NE (1) (Indian Creek) - In SE Cedar Rapids on East Post Road, on upstream SW corner of concrete bridge over Indian Creek. Bronze tablet stamped Linn County Engineering Department No. 2346. Elevation 745.86.

Mile 5.30 - 8307-13 SW (2) (Indian Creek) - In SE Cedar Rapids, 3/8 mile downstream from intersection of Cottage Grove Avenue SE and 34th Street SE. In 30-inch Elm trees (biggest tree) on left bank of Indian Creek, 100 feet streamward from E-W fence and 10 feet upstream from N-S fence prolonged 1 foot above ground; pole spike and collar. Elevation 733.53.

Mile 5.32 - 8307-13 SW (1) (Indian Creek) - In SE Cedar Rapids near intersection of Cottage Grove Avenue SE and 34th Street SE. Bronze tablet stamped Linn County Engineer Department No. 2342, on SW corner of bridge over Indian Creek. Elevation 751.30.

Mile 5.80 - 8307-14 NE (1) (Indian Creek) - In SE Cedar Rapids on Country Club Golf Course. Near east end of suspension bridge walkway over Indian Creek. Chiselled square in NW corner of concrete well cover. Elevation 743.90.

Mile 6.87 - 8307-11 SW (1) (Indian Creek) - In SE Cedar Rapids at 30th Street Drive SE and Sidney Street SE intersection, on right bank, on downstream landward corner of concrete wing wall of bridge over Indian Creek. Chiselled square. Elevation 759.64.

Mile 7.15 - 8307-11 SE (1) (Indian Creek) - In NE Cedar Rapids, in SE corner of Mt. Calvary Cemetery, on right bank of Indian Creek near 32nd Street NE. In NW side of 24-inch elm tree; pole spike and collar. Elevation 756.12.

Mile 7.80 - 8307-2 SE (1) (Indian Creek) - In NE Cedar Rapids at intersection of 1st Avenue and Glen Brook Drive, at SW corner, on top curbing, 18 feet NE of fire hydrant and 4.5 feet from street marker; chiselled square. Elevation 803.68.

Mile 7.89 - 8307-11 NE (1) (Indian Creek) - In Marion near SW city limits, 150 feet SE of intersection of 40th Street Drive SE and Glen Brook Drive SE. Chiselled square in center of 4' high, 4' diameter, concrete cylinder. Elevation 761.81.

Mile 8.00 - 8307-11 NE (2) (Indian Creek) - In SW Marion at intersection of 40th Street Drive SE and Pepperwood Hill SE, on pavement 15 feet SW from fire hydrant and 2 feet from edge of curb; chiselled X. Elevation 761.29.

TABLE 6

Descriptions and Elevations of Benchmarks - (contd)

Mile 8.50 - 8307-12 NW (1) (Indian Creek) - In Marion at south dead end of Tama Street, north of Indian Creek, in power pole 100 feet south of entrance to George N. Banning farm on east side of road. Power pole No. 3093. Pole spike and collar on SW side of power pole near ground level. Elevation 766.66.

Mile 9.75 - 8307-1 SW (1) (Indian Creek) - In Cedar Rapids in fourth high voltage power pole east of Tama Street (power pole line is extension of farm lane), on right bank of Indian Creek. Pole spike and collar on SW side of pole near ground level. Elevation 778.15.

Mile 10.17 - 8307-1 SE (1) (Indian Creek) - In SW Marion at rodeo grounds, on right bank of Indian Creek, in power pole with transformer. Nail and tin about 1 foot above ground. Elevation 778.15.

Mile 10.30 - 8307-1 SE (2) (Indian Creek) - In SW Marion on left bank of Indian Creek at city dump near Sewage Disposal Plant and cemetery; on power pole with transformer near sewage lift station. Pole spike and collar. Elevation 777.99.

Mile 10.65 - 8307-1 NW (3) (Indian Creek) - In SW Marion, in Thomas Park, on steel truss bridge over Indian Creek, about 600 feet downstream from 1st Avenue bridge. Chiselled cross on rivet head of fifth set of upstream horizontal stringer rivets from left upstream end of truss. May be used as RP. Elevation 777.05.

Mile 10.75 - 8307-1 NW (2) (Indian Creek) - In SW Marion on pedestrian bridge over Indian Creek in Thomas Park, about 200 feet downstream from 1st Avenue bridge. Chiselled square on top of right upstream abutment. Elevation 777.52.

Mile 10.81 - 8307-1 NW (1) (Indian Creek) - In SW Marion at Indian Creek bridge on 1st Avenue, downstream right abutment bridge seat; chiselled square. Elevation 788.16.

Mile 10.90 - 8307-1 NW (4) (Indian Creek) - In SW Marion on old broken concrete waterworks dam about 300 feet upstream from 1st Avenue bridge over Indian Creek. Chiselled square on top of downstream edge of crest of dam, about 1 foot right of left abutment. Elevation 777.51.

Mile 11.05 - 8307-1 NW (5) (Indian Creek) - In Marion on 8th Avenue bridge over Indian Creek. Linn County Engineer Department bronze tablet No. 934 on right downstream SW corner of bridge, on sidewalk near handrail. Elevation 792.11.

TABLE 6

Descriptions and Elevations of Benchmarks - (contd)

Mile 11.51 - 8407-36 SE (1) (Indian Creek) - In Marion, at Central Avenue (county road "I") bridge over Indian Creek. Chiselled square on left downstream (SE corner on concrete ledge at base of handrail.) Elevation 799.15.

Mile 11.51 - 8407-36 SE (2) (Indian Creek) - In Marion, at Central Avenue (county road "I") bridge over Indian Creek. Linn County Engineer Department bronze tablet No. 985 on top center of downstream handrail. Elevation 800.88.

Mile 11.90 - 8407-36 SE (3) (Indian Creek) - In Marion, on power pole about 80 feet west of 8th Street on south side of 17th Avenue extended. Pole spike and collar on south side of pole about 1 foot above ground level. Elevation 784.69.

Mile 12.12 - 8407-36 NE (1) (Indian Creek) - On north edge of Marion, on 10th Street bridge over Indian Creek. Linn County Engineer Department bronze tablet No. 2406 on top of left downstream (SW) wingwall of bridge. Elevation 795.54.

Mile 12.12 - 8406-31 NW (3) (Indian Creek) - On north edge of Marion, about 300 feet south of 10th Street bridge over Indian Creek, about 150 feet north of intersection of 10th Street and McGowan Boulevard, 21 paces SE of F22 and 22 sign post and 4 feet east of east curb of 10th Street. USC & GS & SS bronze tablet stamped 57-135, about 8 inches below ground level on slope. Elevation 797.70.

Mile 12.28 - 8406-31 NW (2) (Indian Creek) - 1/8 mile north of Marion, on NE-SW gravel road 400 feet east of Indian Creek, 100 feet SW of entrance to Indian Creek Country Club, on concrete box culvert. Linn County Engineer bronze tablet No. 1146 on top center of east headwall. Elevation 793.66.

Mile 12.36 - 8406-31 NW (1) (Indian Creek) - 3/8 mile north of Marion, on NE-SW gravel road 1,000 feet east of Indian Creek on concrete box culvert. Also about 1,000 feet NE of Indian Creek Country Club entrance. Linn County Engineer bronze tablet No. 1147 on top center of west headwall. Elevation 796.26.

Mile 12.62 - 8406-30 SW (1) (Indian Creek) - 0.5 mile north of Marion, at a county road "T" intersection (Linn County F22 and 67). Pole spike and collar near bottom of NE side of power pole on west side of intersection, 1,000 feet east of Indian Creek. Elevation 796.66.

TABLE 6

Descriptions and Elevations of Benchmarks - (contd)

Mile 13.31 - 8406-30 SE (1) (Indian Creek) - One mile north of Marion, on top center of south headwall of concrete box culvert on E-W road at NE corner of intersection triangle (intersection of Linn County F66 and 23). Linn County Engineer bronze tablet No. 228. Elevation 811.97.

Mile 13.57 - 8406-30 NE (2) (Indian Creek) - One mile north of Marion, on small plank bridge over small tributary to Indian Creek, at NW corner of intersection triangle. Pole spike and collar in NW wingwall support piling, on SW side of piling near ground level. Elevation 800.79.

Mile 13.59 - 8406-30 NE (3) (Indian Creek) - One mile north of Marion, on bridge-type concrete culvert on N-S road, at NE corner of intersection triangle (intersection of Linn County F66 and 23). Linn County Engineer bronze tablet No. 1150 on top center of west concrete guardrail. Elevation 813.47.

Mile 13.62 - 8406-30 NE (4) (Indian Creek) - One mile north of Marion, on top of NW wingwall of concrete box culvert on E-W road at NE corner of intersection triangle (intersection of Linn County F66 and 23). Chiselled cross on NW end of wingwall. Elevation 811.77.

Mile 13.71 - 8406-30 NE (1) (Indian Creek) - 1-1/8 miles north of Marion, on small truss bridge over Indian Creek (gage bridge). Linn County Engineer bronze tablet No. 2408 on left downstream top of concrete bridge seat. Elevation 796.62.

Mile 11.86 - 8407-35 SE (1) (Dry Creek) - About 0.75 mile NW of Marion, on E-W county road paralleling and north of Dry Creek, on bridge-type concrete culvert over small tributary. Linn County bronze tablet No. 1085 on top center of downstream guardrail. Elevation 795.09.

Mile 13.37 - 8407-34 SE (1) (Dry Creek) - Two miles west and 3/8 mile north of Marion on county road bridge over Dry Creek, on SW corner of bridge on concrete wheel guard. Bronze marker No. 2334 of Linn County Engineer Department. Elevation 805.20.

Mile 15.10 - 8407-33 SE (1) (Dry Creek) - Three miles west and 0.25 mile north of Marion on county road bridge over Dry Creek. Linn County Engineer Department bronze tablet No. 2301 dated 1931 on right upstream pile cap. Elevation 809.45.

the ground will be intercepted by rooftops, parking areas, and paved roads and conveyed be sewers and ditches directly to the river. The result of these changes is that, as development progresses, a given flood will have an ever shortening recurrence interval, i.e., a discharge that is a 100-year flood now, may become a 50-year flood in the future.

GUIDE LINES FOR USE OF FLOOD PLAIN AND FOR REDUCING FLOOD DAMAGES

46. GENERAL

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

47. Streams in flood may carry thousands of times more flow than during low flow periods. These vast quantities of water 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. Over the years, reservoirs, channel improvements, levees and other flood protection works have been constructed to protect the works of man against the force of nature's floods. Unfortunately, the construction of these protection works is extremely expensive. In addition, encroachment on the flood plains has taken place faster than flood protection works have been constructed with the result that flood hazard areas and flood damages have been steadily increasing in Iowa and across the nation.

48. Historically, man has tried to reduce flood damages through the <u>exercise of control over the river</u> in time of flood. Many different types of control works can be constructed for this purpose. Dams and reservoirs can be constructed to store water for gradual release after the threat of flooding has passed. Channel improvements are 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 flood walls can be 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. There should be a history or an existing potential of heavy flood damage to justify the cost of these measures.

49. 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, the exercise of control over the land lying adjacent to the river through the planned management and development of flood hazard areas. The flood plain plan, if fully integrated into the comprehensive land use and development plan of an area and enforced by means of appropriate zoning, subdvision and building regulation, can prevent the creation of new flood hazard areas. While flood plain areas probably never can be considered flood free, planning will allow selection of a flood risk commensurate with the type of development desired and allow a reasonable level of protection to be built into a project during initial construction.

50. Regulation 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 within the purpose of this report to recommend the specific technique to be used. Flood plain regulations are the responsibility of State and local governments and these report data are provided to furnish a basis for appropriate regulatory action. It is hoped that the basic data in this report will be used in conjunction with comprehensive plans to develop a reasonable and desirable plan for use of the Indian Creek flood plain.

51. Fortunately, the need for flood plain planning on Indian Creek has been recognized by local interests before extensive flood plain development has taken place. This means that future damages in the study area can be reduced now, at little or no cost to the taxpayer, by the enactment and enforcement of flood plain regulations. The Linn County Zoning Commission and the Cedar Rapids Planning Commission have done extensive research on the present and projected growth in the areas of land use, population, economy, recreation and transportation, and have published comprehensive planning reports. Planning in these areas also has been undertaken by the City of Marion. The flood data in this report, together with the planning program for future land use, will enable State and local interests to minimize flood damage risks.

52. 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. Discussion of these methods is given later in this report.

53. 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 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 flood water 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.

54. The profiles shown on Plate 4, combined with the information contained in this report, will provide a basis which will allow formulation of flood plain regulations. Such regulations will be consistent with both minimum State requirements and the overall comprehensive plan of local authorities.

55. CRITERIA FOR ESTABLISHING CHANNEL AND FLOODWAY REQUIREMENTS

As stated previously, a 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 flood water 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, and between these lines no construction or filling should be permitted which will cause an impedance to flow. If possible, encroachment limits should be established before extensive development has taken place, in order that costly clearance of existing structures may be avoided. Final choice of the magnitude of the flood, which will determine the size of the floodway, is a matter for State and local decision because in the final analysis, it is determined by consideration of local land use plans and comprehensive statewide flood control plans.

56. The data contained in this report are being 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. For the present time, problems or situations regarding encroachment at specific points in the study area should be referred to the Iowa Natural Resources Council at Des Moines.

57. Flood plain regulations dealing with the maintenance of the required floodway should also include restrictions on filling and dumping. In areas where these operations are proposed or are taking place now,

the required floodway width should be determined and the encroachment lines defined. No subsequent filling or dumping should be permitted within these encroachment lines. At present there are some dumping areas within the flood plain which should not be permitted to continue without regulation. Recently, filling and dumping on Indian Creek flood plain was noted at the east end of the existing 40th Street Drive in the City of Cedar Rapids and near the corporate limits of the City of Marion. This encroachment materially restricts overbank flood flow conveyances on the west side of Indian Creek. The current filling and dumping on Indian Creek flood plain near 40th Street Drive is in violation of Chapter 455A, Code of Iowa. This points up to the fact that flood plain regulations can only be as effective as their enforcement.

58. In addition to establishing floodway limits, it is imperative that adequate criteria be set up to regulate vertical and horizontal clear openings and minimum low steel elevations for bridges crossing the flood channel. It is also important that channel bottom profiles be well defined. Restrictions should be established so that future sewers, utility lines or bridge pier foundations will not interfere with flood flows, suffer damage by floods, or cause expensive modifications if channel improvement is undertaken at a later date.

59. Other factors which adversely affect flood flows are highway embankments crossing the flood plain, extensive earth fills within the flood plain and sharp bends in the river channel. Highway and railroad embankments frequently act as levees or dams producing higher water surfaces upstream. Other extensive earth fills, if permitted within the floodway will have the same result. Sometimes these fills are necessary but the benefits derived should be balanced against the possible flood damages which may result, before construction is permitted. Minor filling within the flood plain outside the floodway should have little effect on upstream water elevations. Flood plain regulations may permit a limited amount of filling in these areas in order that proposed structures may be built above the regulatory minimum elevations. On the other hand, extensive filling in these areas will result in a reduction of valley storage capacity which may produce higher peak discharges downstream. Sharp bends in the river channel are a form of restriction to flow. As such they tend to raise upstream stages as well as provide potential trouble spots for the occurrence of ice jams. These bends are usually produced by nature, but any man-made modifications to the flood plain, which tend to increase the sharpness of these bends, should be avoided.

60. 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 as well as a supplement to them. Thus, designated floodways may be zoned for the purpose of passing flood waters 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 Chapter 414 and 358A, respectively, of the Iowa Code 1962 as amended.

61. The late Francis C. Murphy carried out an extensive research program on the status and effectiveness of flood plain regulation in many areas in the United States. His treatise entitled, "Regulating Flood Plain Development," University of Chicago Press, November 1958, is an excellent reference for those concerned with flood plain planning. Murphy's suggestions on developing zoning ordinances are considered of such value that they are quoted below:

> "For zoning ordinances to be more widely used and more favorably received, the following points deserve consideration in drafting new ordinances:
>
> a. A statement to the effect that designation of the area that is subject to flooding, and so zoned by the planning agency, does not in any way imply that areas outside this district are free from flood.
>
> b. Provisions allowing economically warranted development to take place provided that certain necessary requirements to reduce flood losses are met. If flood control is desired for the area, then the ordinance should state that the area is to be furnished flood protection and that a permit requiring approval of the method of protection proposed by the developer needs to be obtained from a designated agency, preferably a state flood control organization.
>
> c. Where possible, a double-zoning technique is desirable. In preparing a master plan for a city, all areas should be zoned for their most appropriate use. This would be the pattern of development that

planners and municipal officials envision for the city. Then, because of the flood problem, flood zone restrictions for the appropriate area could be superimposed on the regular zoning map and provisions written into the ordinance specifying the kind of improvement necessary to have these restrictions removed. For a proposed residential zone, this would appear as FP:RI (flood plain: residential first-class district).

d. Detailed provisions enumerating the allowable and also the conditional uses that may be made of the land.

e. Provisions for increased lot size and greater rear setback line for building on property abutting a river, if flood plain zoning provisions cannot be included in the ordinance."

62. OPEN SPACE, PARKS, AND RECREATIONAL LAND NEEDS

The cities of Cedar Rapids and Marion and Linn Conty have made extensive studies of existing recreational facilities and needs for the future based upon population projections and general plan objectives. At the time of publication in 1961, the Cedar Rapids Parks and Schools Report indicated that there were 33 city park areas totalling nearly 1,300 acres of land in Cedar Rapids. Since that time, Cedar Rapids has acquired 14 additional park areas totalling approximately 420 acres, bringing the existing total to 47 park areas containing more than 1,700 acres. The Open Space Plan prepared for the Linn County Board of Supervisors indicates that there are 18 existing county park areas containing nearly 1,500 acres of land, all acquired since 1959. Most of these park areas are located along stream frontages of the Cedar and Wapsipinicon Rivers and their tributaries. The Open Space Plan adopted by the City of Marion in 1964 provides for acquisition of 11 new neighborhood park areas and one new community park.

63. All three reports suggest the need for the conservation of stream frontages for public and private recreational uses and for flood plain management purposes. The reports outline a program of stream frontage acquisition for public recreational needs where demand justifies this approach.

64. 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.

65. 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:

a. Prevent flotation of buildings from their foundations by specifying anchorage.

b. Establish basement elevations and minimum first floor elevations consistent with potential flood occurrences.

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

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

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

66. FLOOD PROOFING

Flood proofing is the use of structural modifications and adjustments to properties subject to flooding, specifically for the reduction of flood damages. Although flood proofing should not be substituted for regulation of new construction in the flood plain, it may be useful in developed areas where flood control has proven infeasible or where the possibilities of flood control measures are in the distant future. Some of the possible flood proofing measures are listed below.

a. Seepage control. This method involves the use of asphalt or quick set hydraulic compounds to seal walls which are subjected to water pressure. This approach is often complemented with sump pits and pumping. Floor and wall systems for buildings so treated must be constructed to withstand the external water pressures generated by rising water levels.

b. Prevention of sewer backup. In many areas not subject to direct overflow, considerable damage occurs from backup of sanitary or combined sewers that are overloaded by high storm water runoff, flooded manholes or high tailwater at the sewer outlets. Various types of automatic and manually operated valves and checks have been installed on house sewers as well as on lateral and trunk sewers to prevent flooding from sewer backup. In the absence of these measures, a section of pipe screwed in place over basement drains is a cheap effective means of coping with this problem. It allows water to rise up in the pipe, but prevents overflow up to the limit of the length of pipe. It is recommended that whenever possible the storm and sanitary sewers be separate systems to prevent backup from the combined system into residences from overloaded storm sewers.

c. Permanent closure. In a relatively watertight structure, unnecessary openings may be permanently sealed. If the passage of light is desirable, glass bricks or other translucent materials having adequate structural strength should be considered.

d. Openings protected. Sandbagging of doorways and other openings in structures has been used as a temporary emergency protection for many years. Removable bulkheads or flood gates are usually a more efficient means of accomplishing the same purpose. These devices can be bolted against a frame containing a neoprene gasket which provides a watertight seal. Operating procedures should be developed to assure placement of the closure devices with minimum confusion during periods of unexpected flash flooding.

e. Protective coverings. The rapid development of new types of plastics with various specific properties should be considered in connection with sealing and protecting machinery and mechanical equipment from silt and rust damage.

f. Fire protection. The possibility of fire from electrical short circuiting is a potential hazard during flooding. Power shut-off on a large scale is generally not practical because it usually would affect areas outside the flooded zone. Proper attention to fuse protection for individual structures would reduce the possibility of fire when power is not disrupted.

g. Utilities service. Considerable financial loss has resulted in the past when power failures caused disruption of refrigeration or heat. Disruption of gas and water supplies has also incurred loss. Rerouting of utilities to supply the affected area can only be achieved by the utility companies. However, combining a general knowledge of the flood problem with foresight and good planning may simplify and expedite such rerouting procedures when flooding does occur. In specific cases bottled gas has been used to supply heat, and gasoline driven generators have been utilized to supply minimum essential power.

h. Elevation. The regulation of the minimum elevations above which future structures must be built has been mentioned previously in connection with zoning and subdivision regulations. However, for existing structures in flood risk areas, provisions can be made for hoisting instrument panels, machinery or other valuable equipment above floor level. Some residential property owners have protected their household furnishings in past floods by suspending them from hooks in the ceiling.

i. Watertight covers. Storage tanks with contents which are damageable by flood waters should be protected by gaskets and watertight caps. Watertight covers should also be installed on manholes in the flood area, if flood entry to these manholes could overcharge sewers or pumping stations outside the flood area.

j. Deliberate flooding. Occasionally an area is deliberately flooded in order to increase the degree of protection for a more valuable area. Fuse plug levees and floodways are sometimes designed for this purpose. This method is also used to prevent the loss of a main levee. Deliberate flooding of basements, storage tanks, and other structures is sometimes undertaken to minimize the potential for greater damage which may result through structural failure or flotation.

k. Structural design. Sometimes specific features are incorporated into the design or orientation of a new structure so that potential damages are minimized. For example, a stadium may be erected on a flood plain with open ends parallel to the direction of flow, so that little impedance is offered to flood flows. Concrete pilings have sometimes been beautifully integrated into the architectural design of a structure, while simultaneously raising the structure several feet above the flood plain.

67. OTHER METHODS

The following approaches to flood plain regulation may be adaptable to special situations or may serve as supplemental measures to a large overall regulation program.

a. Tax reductions. As population expands, the increased development on the periphery of the urban areas absorbs more and more of the available agricultural and open land. The increased property values in the formerly rural area often bring about such a rise in tax assessments that it becomes unprofitable for the remaining adjacent farms to continue to operate. Special tax adjustments for flood plain land dedicated to agriculture, conservation, recreation and other open space uses may permit these businesses to continue to operate and thereby help to preserve an adequate floodway.

b. Building financing. Very little building is carried on without financing. Therefore, lending institutions, both Federal and private, are in a position to exercise some control over flood plain development.

c. Evacuation temporary and permanent. Temporary evacuation is ultimately the only way to reduce flood damage in some areas. Even in protected areas, evacuation will be necessary when a flood occurs of greater magnitude than that for which the protection was designed. Such emergency measures taken immediately prior to and during a flood, help materially to reduce flood damage. However, it should be pointed out that this method will reduce risks only to people and to that property which can be easily transported out of the flood area. Permanent evacuation or clearance, a very costly approach, is sometimes warranted where the risk to life is too great, or the recurrence of damage too frequent. In some instances, clearance of blighted areas in the flood plain has been achieved with Federal aid as a part of an urban renewal program.

d. Rescheduling. In some instances, it may be possible to reduce flood losses by hastening the shipment of outgoing goods and delaying the delivery of incoming goods to an industry or commercial establishment in the flood plain.

e. Warning signs. A method which may be used to discourage development is the erection of flood warning signs in the flood plain area. These signs carry no enforcement but simply serve to inform prospective buyers that a flood hazard exists. There may be other methods of flood plain regulation in existence. The fact that they have not been mentioned here does not preclude them from consideration in future planning.

68. POSSIBLE DIRECT FLOOD CONTROL MEASURES

Flood damages on Indian Creek have been so light within the study area that there has been no need to consider direct flood control measures to the present time. If adequate flood plain regulations are instituted and effectively enforced now, flood control measures may not be necessary in the near future, in any case plans for flood control measures can be developed concurrently with plans for flood plain construction.

69. NEED FOR CONTINUING OBSERVATION

Through the cooperation of State and local governments, agencies and planning boards, sufficient material was obtained to provide a general presentation of the flood problem. Although it was not possible to reconstruct past floods from actual highwater marks obtained in the field, hydraulic and hydrologic analyses were used to provide information on expected frequencies and stages of future floods. It is suggested that local interests continue to gather information on future flood stages along Indian Creek and Dry Creek. Since these are such promising areas for future development they are, of course, the areas in which people are most apt to unknowingly build in the flood plain. In addition to the crest stage gages discussed in paragraph 40, it is suggested that gages be established on Indian Creek at East Post Road, and at 30th Street, and at Marion Boulevard. Observation of the peak stages of future floods at all gage locations will be especially helpful in more accurately defining the flood hazard throughout the study area.

70. CONTINUING ASSISTANCE OF CORPS OF ENGINEERS

The technical assistance of the Corps of Engineers will be available to State and local agencies to interpret and explain information contained in this report. Requests for assistance or additional hydrologic and flood data should be directed to the Iowa Natural Resources Council at Des Moines. The Corps of Engineers will offer assistance upon the request of the Iowa Natural Resources Council.

GLOSSARY OF SELECTED TERMS

A. HYDROLOGIC TERMS

1. Channel. A natural or artificial watercourse of perceptible extent, with definite bed and banks to confine and conduct continuously or periodically flowing water. Channel flow thus is that water which is flowing within the limits of the defined channel.

2. Crest gage. A device which provides visible evidence of the highest stage occurring during a particular flood event. Various types are in current use.

3. Design flood. A selected flood, generally expressed in terms of recurrence interval or frequency, for which the associated flows, stages and backwater profiles have been ascertained. In flood control studies, the design flood against which protection is provided, or eventually will be provided by means of flood protection works.

4. Flood. A temporary rise in stream flow or stage that results in significant adverse effects in the areas adjacent to the stream.

5. Flood stage. A term commonly used by the U. S. Weather Bureau and others to designate that stage, on a particular river gage, at which overflow of the natural banks of the stream results in significant damage in any portion of the reach for which the gage is a representative index.

6. Flood frequency. A means of expressing the probability of flood occurrences as determined from a statistical analysis of representative stream flow records. It is customary to estimate the frequency with which specific flood stages or discharges may be equaled or exceeded, rather than the frequency of an exact stage or discharge. Such estimates by strict definition are designated "exceedence frequency" but in practice the term "frequency" is used. The frequency of a particular stage or discharge is usually expressed as occurring once in a specified number of years. Also see: Recurrence interval.

7. Flood peak. The highest value of stage or discharge attained during a flood event; thus peak stage or peak discharge.

8. Flood record. Records of flood events for which there is reasonably reliable data useful in technical analysis. The highest recorded stage or discharge is often referred to as "Maximum flood of record" as differentiated from "historic highwater marks" which may not be well defined.

9. Flood plain. The relatively flat lowlands adjoining a watercourse or other body of water subject to overflow therefrom during flood periods.

10. Flood profile. The longitudinal profile traced by the crest of a flood event expressed in elevation.

11. Gage. See: Recording, Staff, and Wire-weight gage.

12. Historical flood. A known flood which occurred before systematic record keeping was begun for the stream or area under consideration.

13. Natural 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 flow of the flood.

14. Rating curve. See: Stage-discharge curve.

15. Recording gage. A gage which records stages continuously such that a permanent record is produced indicating river stage versus time. The mechanism usually consists of a chart on a constant speed revolving drum on which an inking pen traces the stages as activated by the fluctuating stages of the stream.

16. Recurrence interval. The average interval of time, based on a statistical analysis of actual or representative stream flow records, which can be expected to elapse between floods equal to or greater than a specified stage or discharge. Recurrence interval is generally expressed in years. Also see: Flood frequency.

17. Staff gage. A graduated scale, generally enamelled steel, anchored permanently in a vertical position such that the height (stage or elevation) of the water surface can be read directly on the scale.

18. Stage-discharge curve. (Rating curve.) A graph showing the relation between the gage height and quantity of water flowing in the stream, generally plotted on rectangular co-ordinate paper. The gage height is plotted as the ordinate, while the amount of water in cubic feet per second is plotted as the abscissa. A rating curve is applicable only to the specific location on the stream for which it is developed and only for that period during which no channel or overbank encroachments or enlargements have been made.

19. Standard project flood. A hypothetical flood, estimated by the Corps of Engineers, representing the critical flood runoff volume and peak discharge that may be expected from the most severe combination of meteorological and hydrologic conditions that are considered reasonably characteristic of the geographical region involved, excluding extremely rare combinations.

20. Thalweg. The elevation of the deepest part of a stream channel at a particular section. Thalweg elevations, when determined for many sections along the length of a stream, provide a profile of the bottom from mouth to source.

21. Unit hydrograph. A plot of the flow hydrograph (discharge vs time) for a specific point on a stream, resulting from the generation of one inch of runoff from the drainage area above the specified point. Less frequently, presented as a stage-time plot.

22. Wire-weight gage. A gage, with a fixed elevation, and located on a bridge, from which the vertical distance to the water surface is manually taped to determine the corresponding stage or elevation of the water surface. Provides useful data until the bridge or its approaches are inundated by flood waters.

B. REGULATORY TERMS

1. Building code. A collection of regulations adopted by a local governing body setting forth standards for the construction of buildings and other structures for the purpose of protecting the health, safety and general welfare of the public.

2. Designated floodway. The channel of a stream and that portion of the adjoining flood plain designated by a regulatory agency (Iowa Natural Resources Council) to provide for reasonable passage of flood flows.

3. Encroachment lines. Lateral limits or lines along streams or other bodies of water, within which no structure or fill may be added. Their purposes are to preserve the flood carrying capacity of the stream or other body of water and its flood plain, and to assure attainment of the basic objective of improvement plans that may be considered or proposed. Their location, if along a stream, should be such that the floodway between them including the channel, will handle a designated flood flow or condition. These lines are set by regulatory agencies and may be changed by them.

4. Flood plain regulations. A general term applied to the full range of codes, ordinances, and other regulations relating to the use of land and construction within flood plain limits. The term encompasses zoning ordinances, subdivision regulation, building and housing codes, encroachment laws and open area regulations.

5. Flood proofing. A combination of structural provisions, changes, or adjustments to properties subject to flooding primarily for the reduction or elimination of flood damages.

6. Green belt. A term related to the development and retention of stream frontages and flood plains as "green belts." Permissive use of these public or private lands for pasture or grazing, parks, golf courses and similar uses would materially reduce or regulate the damage potential in the high-hazard flood plain area. The "green belt" is an integral part of overall planning and open-space plans of Linn County, City of Cedar Rapids and City of Marion.

7. Subdivision regulations. Regulations and standards established by a local public authority, generally the local planning agency, with authority from a State enabling law, for the subdivision of land in order to secure coordinated land development, including adequate building sites and land for vital community services and facilities such as streets, utilities, schools and parks.

8. Zoning ordinance. An ordinance adopted by a local governing body, with authority from a State zoning enabling law, which under the police power divides an entire local governmental area into districts and, within each district, regulates the use of land, the height, bulk, and use of buildings or other structures, and the density of population.

C. OTHER TERMS

Urban renewal. The over-all program of public and private action, growing out of the National Housing Act of 1954 as amended, designed to prevent the spread of blight, to rehabilitate and conserve urban areas that can be economically restored, and to clear and redevelop areas that cannot be saved.

BIBLIOGRAPHY

A. TECHNICAL

1. *U. S. Geological Survey Water-Supply Paper 1526, "Hydraulic and Hydrologic Aspects of Flood Plain Planning", 1961.

2. *U. S. Department of Commerce, Weather Bureau Technical Paper No. 40, "Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years", May 1961.

3. *Corps of Engineers, U. S. Army Engineer District, Sacramento, California, "Statistical Methods in Hydrology", January 1962.

4. *Corps of Engineers, U. S. Army Engineering and Design Manual EM1110-2-1409, "Backwater Curves in River Channels", December 1959.

5. Corps of Engineers, U. S. Army, Civil Works Engineer Bulletin 52-B, "Standard Project Flood Determination".

*Available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

B. PLANNING

1. Iowa Natural Resources Council, "A Study of Flood Problems and Flood Plain Regulation, Iowa River and Local Tributaries of Iowa City, Iowa", Des Moines, Iowa: Iowa Natural Resources Council, June 1960, (mimeographed).

2. City Planning Commission, Cedar Rapids, Iowa, "Parks and Schools", October 1961.

3. Linn County Zoning Commission, "Background for Planning, Linn County, Iowa", March 1961.

4. Linn County Board of Supervisors, "Open Space Plan, Linn County, Iowa", August 1963.

5. City of Marion, "Open Space Plan, Marion, Iowa", January 1964.

6. *American Society of Civil Engineers, "Guide for Development of Flood Plain Regulations", Task Force on Flood Plain Regulations, Committee on Flood Control, Hydraulics Division, September 1962.

7. *Miller, Harold V., "Flood Damage Prevention for Tennessee", Nashville: Tennessee State Planning Commission, Publication 309, November 1960.

8. Morse, Henry F., "Role of the States in Guiding Land Use in Flood Plains", Special Report No. 38, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, 1962.

9. *Murphy, Francis C., "Regulating Flood Plain Development", Chicago: University of Chicago, Department of Geography, Research Paper No. 56, 1958.

10. Tennessee Valley Authority, James E. Goddard, Chief, Local Flood Relations Branch, Division of Water Control Planning.

a. "Floods on Tuckasegee River, Bryson City, N. C.", 1960.

b. "Floods on Tennessee River, South Pittsburg and Richard City, Tenn.", 1960.

c. "Floods on Richland Creek, Pulaski, Tennessee", 1957.

11. White, Gilbert F., et al., "Changes in Urban Occupancy of Flood Plains in the United States", University of Chicago, Department of Geography Research Paper No. 57, Chicago, 1958.

12. *White, Gilbert F., et al., "Papers on Flood Problems", University of Chicago, Department of Geography Research Paper No. 70, Chicago, 1961.

* Contains detailed reading bibliography.

C. REGULATION

1. State of Iowa, Code 1962, as amended.

a. Chapter 455A, "Iowa Natural Resources Council".

b. Chapter 358A, "County Zoning Commission".

c. Chapter 414, "Municipal Zoning".

d. Chapter 111, "Conservation and Public Parks", Sections 111.4, 111.5, and 111.18.

e. Chapter 368, "General Powers of Municipal Corporations", Sections 368.3 and 368.26.

f. Chapter 657, "Nuisances", Section 657.2(3).

g. Chapter 716, "Injuries to Internal Improvements and Common Carriers", Sections 716.3 and 716.4.

STATE OF IOWA
IOWA NATURAL RESOURCES COUNCIL
STATE HOUSE
DES MOINES 19, IOWA

OTHIE R. McMURRY, DIR
R. G. BULLARD, WATER COMMISSIONER

March 21, 1963

Colonel Richard L. Hennessy
District Engineer
U. S. Corps of Engineers
Clock Tower Building
Rock Island, Illinois

Dear Colonel Hennessy:

The Iowa Natural Resources Council, at a meeting held on November 29, 1962, considered an application by Linn County, Iowa, for approval and submission to the District Engineer, Rock Island District, U. S. Corps of Engineers. Application was made for a flood plain information study to be provided by the Corps of Engineers, U. S. Army, under the provisions of Section 206, Public Law 86-645 (Flood Control Act of 1960). The Iowa Natural Resources Council has studied this application and has reached the following conclusions:

1. That flood plain information is needed by Linn County, Iowa, to allow the formulation of regulations for the wise use of flood plain areas.

2. That Linn County, Iowa, is presently developing a comprehensive plan for the general development of the City and that flood plain information is needed as part of this comprehensive plan.

3. That Linn County, Iowa, has the desire and the ability to make optimum use of flood plain information which may become available.

4. That the flood plain information study program can be of significant value in providing information which can be integrated into the comprehensive flood control and water use plan of the state.

2. Linn County, Iowa, "Rural Zoning Ordinance", July 1959.

3. City of Iowa City, Iowa, "Zoning Ordinance", July 1962. (Article VI - Flood Plain Use Regulations.)

4. Beuchert, Edward W., "A Legal View of the Flood Plain", Harvard Law School, 1961.

5. Cooter, Harriet Holt, "To Stay Out of Floods", National Civic Review, Vol. L. No. 10, pp. 534-539, November 1961.

6. Dunham, Allison, "Flood Control Via the Police Power", 107 University of Pennsylvania Law Review, 1098-1132, 1959.

7. *American Society of Civil Engineers, "Guide for the Development of Flood Plain Regulations", Task Force on Flood Plain Regulations, Committee on Flood Control, Hydraulics Division, September 1962.

8. *Murphy, Francis C., "Regulating Flood Plain Development", Chicago: University of Chicago, Department of Geography, Research Paper No. 56, 1958.

* Contains detailed reading bibliography.

STATE OF IOWA
IOWA NATURAL RESOURCES COUNCIL
STATE HOUSE
DES MOINES 19, IOWA

OTHIE R. McMURRY, DIRECTOR
M. G. BULLARD, WATER COMMISSIONER

March 22, 1963

Colonel Richard L. Hennessy
District Engineer
U. S. Corps of Engineers
Clock Tower Building
Rock Island, Illinois

Dear Colonel Hennessy:

In accordance with a meeting with representatives of your office held on March 6, 1963, concerning flood plain information studies under provisions of Section 206, Public Law 86-645, the following information is presented concerning applications for studies which have been approved and submitted to your office to date.

I. a. Indian Creek, Linn County
   b. Duck Creek, Scott County
   c. Prairie Creek, Linn County

II. Cedar River, Cedar Rapids

III. Cedar River, Cedar Rapies North to Linn County Line, Linn County
     Cedar River, Cedar Rapids South to Linn County Line, Linn County
     Otter Creek, Linn County

In conclusion, the Iowa Natural Resources Council approves the application of Linn County, Iowa, for a flood plain information study under the provisions of Section 206, Public Law 86-645, submitted herewith, to the District Engineer, Rock Island District, Corps of Engineers. It is requested that this application be considered at the earliest possible date. Every effort will be made to furnish such additional information in support of this application as the Corps of Engineers should require.

FOR THE IOWA NATURAL RESOURCES COUNCIL

Othie R McMurry

OTHIE R. MC MURRY
DIRECTOR

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STATE OF IOWA
IOWA NATURAL RESOURCES COUNCIL
STATE HOUSE
DES MOINES, IOWA 50319

OTHIE R. McMURRY, DIRECTOR
R. G. BULLARD, WATER COMMISSIONER

October 9, 1964

Jackson Graham
Major General U.S.A.
Director of Civil Works
Office of the Chief of Engineers
Washington, D. C.

Dear General Graham:

The proposed report and technical appendix for the flood plain information study on Indian and Dry Creeks, Linn County, Iowa, has been reviewed by the Iowa Natural Resources Council.

The Iowa Natural Resources Council approves the report and recommends its release.

The Council also wishes to express its appreciation for the able and continuing service and cooperation with this study.

FOR THE IOWA NATURAL RESOURCES COUNCIL

Othie R. McMurry
Director

ORM/sbh

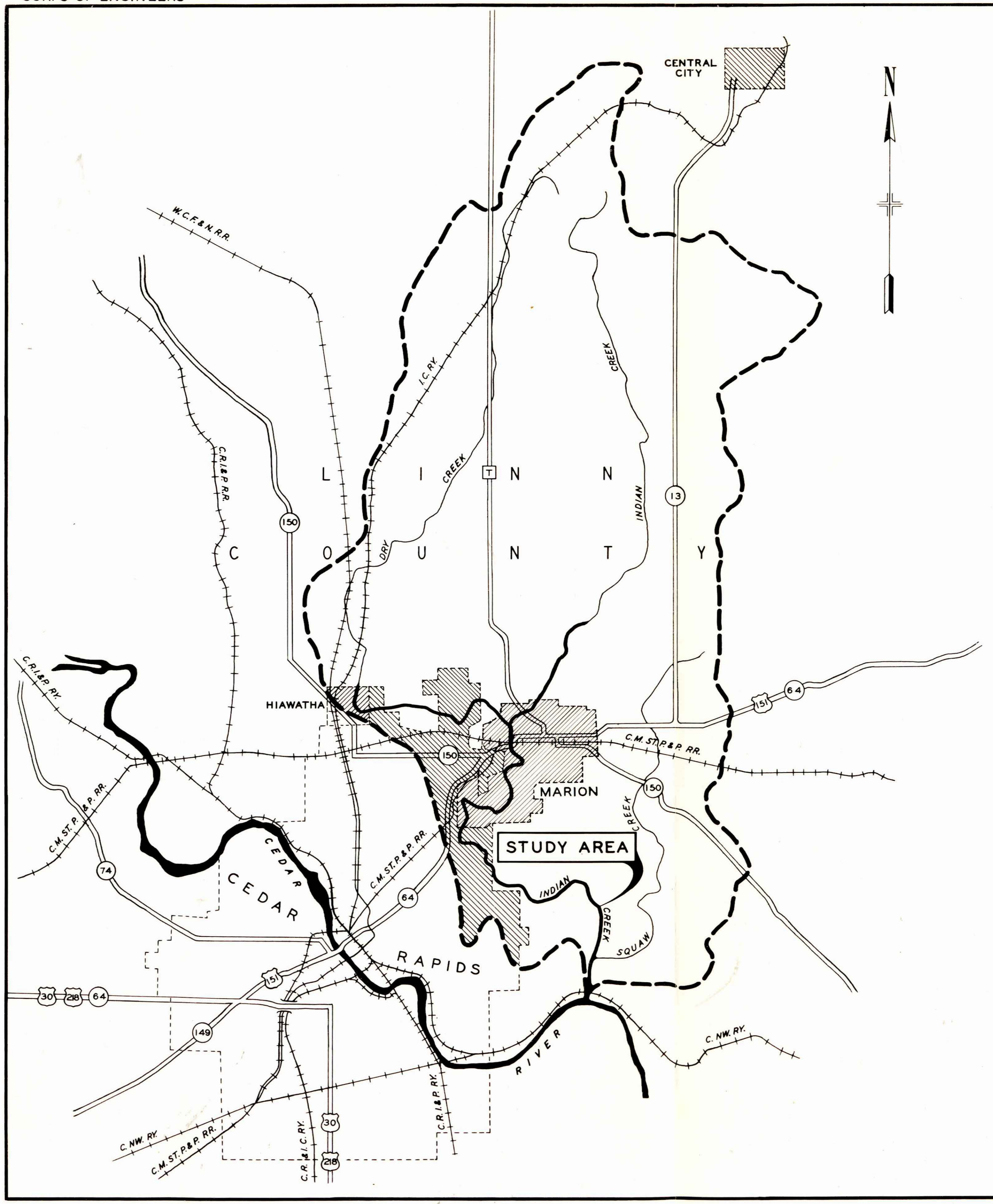
In regard to the applications of the City of Cedar Rapids and Linn County, it is our understanding that the applicants will acquire contour maps of Prairie Creek and Indian Creek, at a contour interval of five feet. In addition the applicants will provide such valley and channel cross sections of the creek as will be needed for the proposed studies. This information should be available within approximately two to three months after approval of a study by the Corps of Engineers.

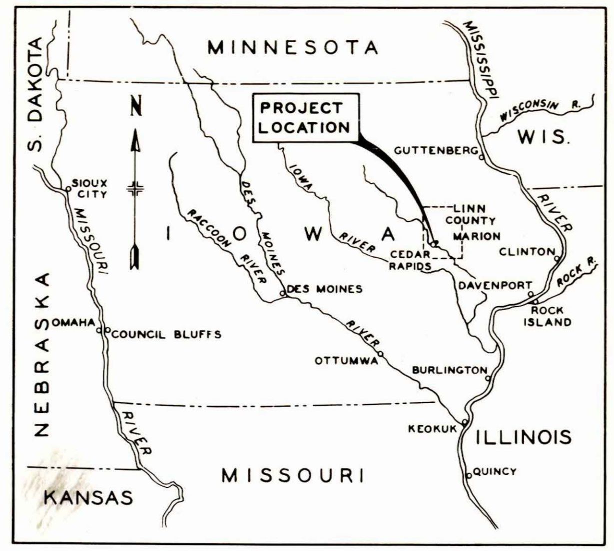
FOR THE IOWA NATURAL RESOURCES COUNCIL

Othie R McMurry

OTHIE R. MC MURRY
DIRECTOR

ORM/er/db





VICINITY MAP

25 0 25 50 75
SCALE IN MILES

LEGEND:

WATERSHED

CITY LIMITS

FEDERAL HIGHWAYS

STATE HIGHWAYS

COUNTY ROAD

FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA
BASIN MAP
INDIAN AND DRY CREEKS

1 0 1 2
SCALE IN MILES

U. S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

LEGEND

PLATE 3/4	CORRESPONDING TOPOGRAPHIC MAP OF FLOODED AREA.
—12.0	DISTANCE IN MILES ON INDIAN CREEK FROM MOUTH OF INDIAN CREEK.
—12.0D	DISTANCE IN MILES ON DRY CREEK FROM MOUTH OF INDIAN CREEK.

FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA

INDEX SHEET
FOR
FLOODED AREA MAPS

INDIAN CREEK
MOUTH TO SEC. 30. MARION TOWNSHIP
DRY CREEK
CONFLUENCE WITH INDIAN CREEK TO HIAWATHA

1000 0 1000 2000 3000
APPROX. SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

LEGEND

- 50 YEAR FLOOD
- 100 YEAR FLOOD
- STANDARD PROJECT FLOOD
- 8.0 DISTANCE FROM MOUTH OF INDIAN CREEK IN MILES
- ⊗ U.S.G.S. REFERENCE POINT

NOTE: ELEVATIONS BASED ON U.S.C.&G.S.

FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

INDIAN CREEK
MOUTH TO SEC. 30, MARION TOWNSHIP

DRY CREEK
CONFLUENCE WITH INDIAN CREEK TO HIAWATHA

100 0 500 1000
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

LEGEND

50 YEAR FLOOD

100 YEAR FLOOD

STANDARD PROJECT FLOOD

8.0 DISTANCE FROM MOUTH OF INDIAN CREEK IN MILES

⊗ U.S.G.S. REFERENCE POINT

NOTE:
ELEVATIONS BASED ON U.S.C.&G.S. SHOWN IN VERTICAL LETTERING.

FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA

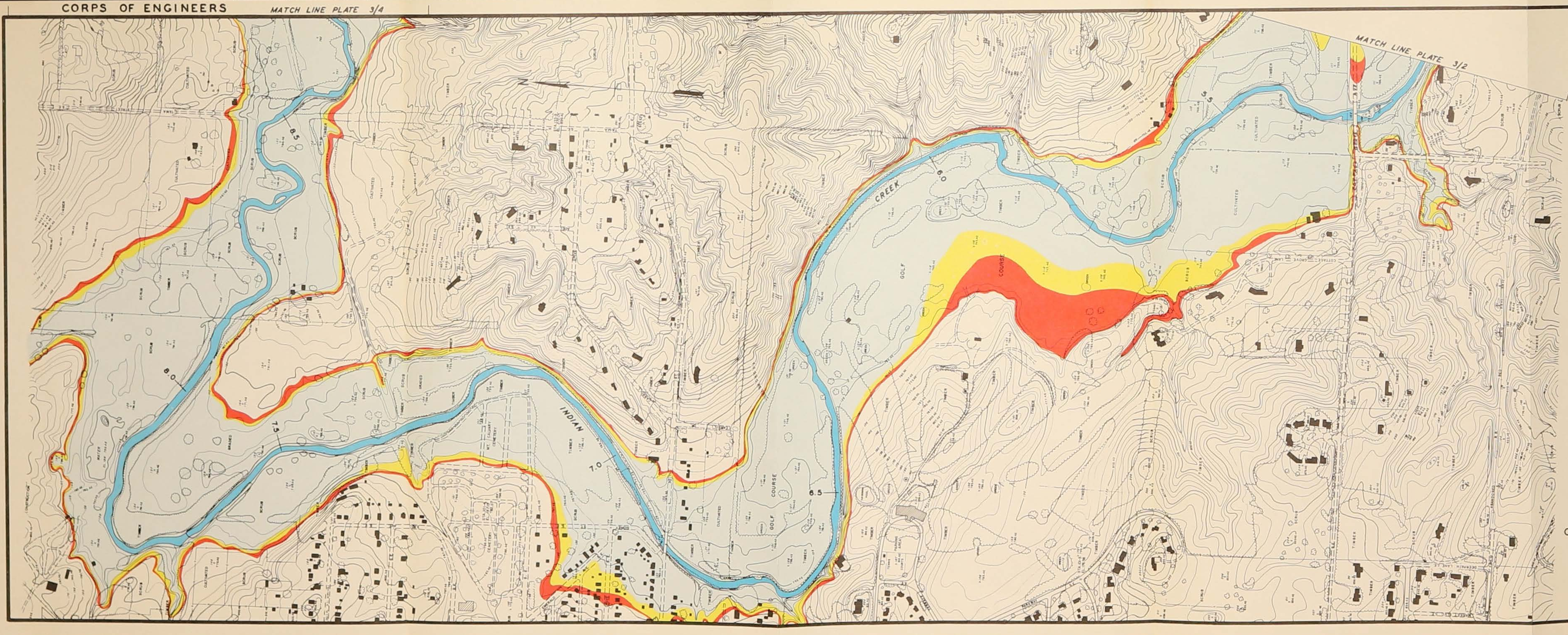
TOPOGRAPHIC MAP OF FLOODED AREA

INDIAN CREEK
MOUTH TO SEC. 30, MARION TOWNSHIP

DRY CREEK
CONFLUENCE WITH INDIAN CREEK TO HIAWATHA

100 0 500 1000
SCALE IN FEET

U. S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964



LEGEND

- 50 YEAR FLOOD
- 100 YEAR FLOOD
- STANDARD PROJECT FLOOD
- 8.0 DISTANCE FROM MOUTH OF INDIAN CREEK IN MILES
- ⊗ U.S.G.S. REFERENCE POINT

NOTE:
ELEVATIONS BASED ON U.S.C.&G.S. SHOWN IN VERTICAL LETTERING.

FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

INDIAN CREEK
MOUTH TO SEC. 30, MARION TOWNSHIP

DRY CREEK
CONFLUENCE WITH INDIAN CREEK TO HIAWATHA

100 0 500 1000
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

CORPS OF ENGINEERS U. S. ARMY

FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA
TOPOGRAPHIC MAP OF FLOODED AREA
INDIAN CREEK
MOUTH TO SEC. 30, MARION TOWNSHIP
DRY CREEK
CONFLUENCE WITH INDIAN CREEK TO HIAWATHA

U. S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

MATCH LINE PLATE 3/6 MATCH LINE PLATE 3/3 PLATE 3/4


LEGEND
50 YEAR FLOOD
100 YEAR FLOOD
STANDARD PROJECT FLOOD
8.0 DISTANCE FROM MOUTH OF INDIAN CREEK IN MILES
U.S.G.S. REFERENCE POINT
NOTE: ELEVATIONS BASED ON U.S.C.&G.S.
MATCH LINE PLATE 3/4
INDIAN
CREEK
END OF STUDY AREA
N
FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA
TOPOGRAPHIC MAP OF FLOODED AREA
INDIAN CREEK
MOUTH TO SEC. 30, MARION TOWNSHIP
DRY CREEK
CONFLUENCE WITH INDIAN CREEK TO HIAWATHA
100 0 500 1000
SCALE IN FEET
U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

CORPS OF ENGINEERS

U.S. ARMY

LEGEND

- 50 YEAR FLOOD
- 100 YEAR FLOOD
- STANDARD PROJECT FLOOD
- 8.0 DISTANCE FROM MOUTH OF INDIAN CREEK IN MILES
- ⊗ U.S.G.S. REFERENCE POINT

NOTES:
1. ELEVATIONS BASED ON U.S.C.&G.S. SHOWN IN VERTICAL LETTERING.
2. D INDICATES MILEAGE ALONG DRY CREEK FROM THE MOUTH OF INDIAN CREEK.

FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA

TOPOGRAPHIC MAP OF FLOODED AREA

INDIAN CREEK
MOUTH TO SEC. 30, MARION TOWNSHIP

DRY CREEK
CONFLUENCE WITH INDIAN CREEK TO HIAWATHA

100 0 500 1000
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

PLATE 3/6

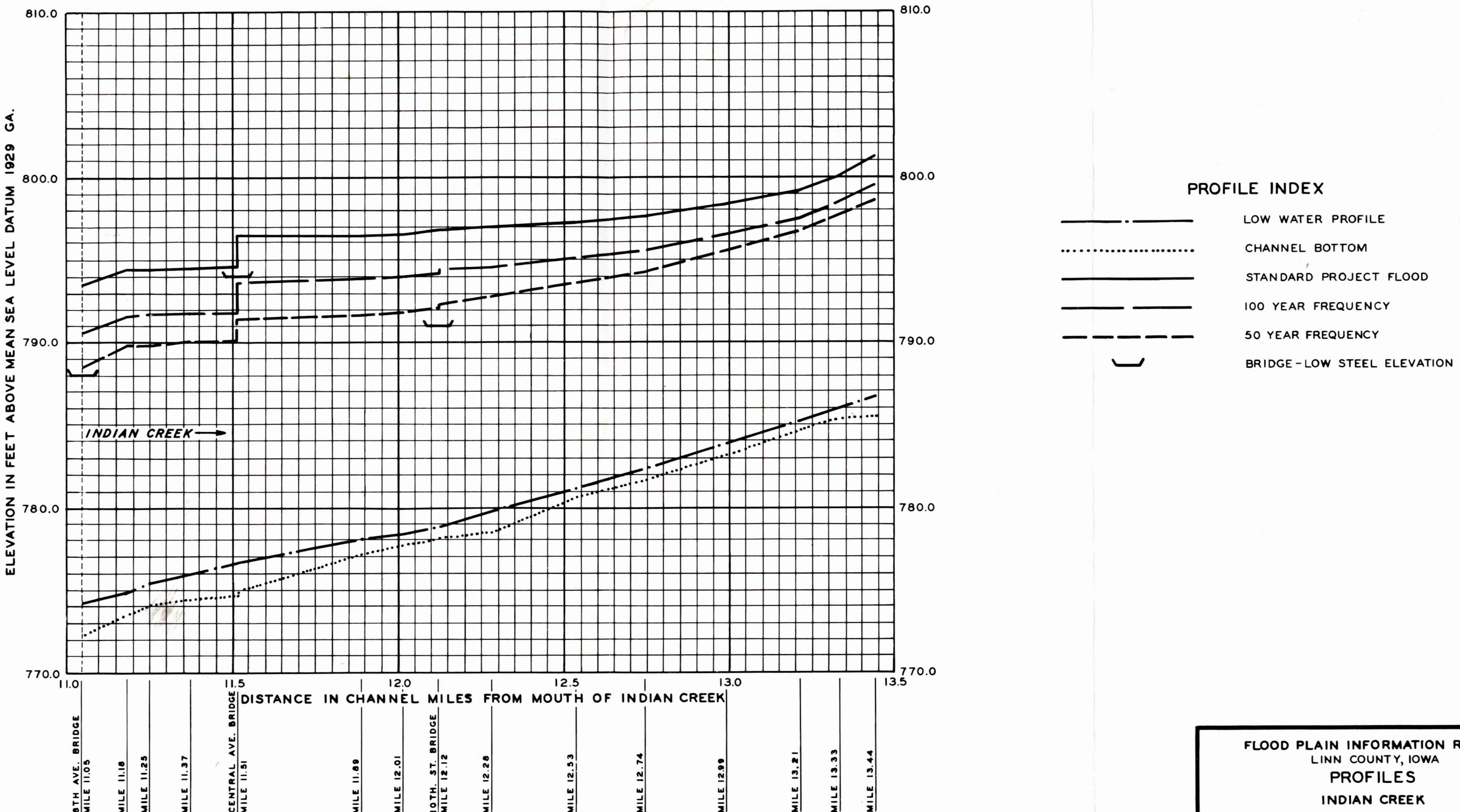
FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA
PROFILES
INDIAN CREEK
MOUTH TO SEC. 30, MARION TOWNSHIP
DRY CREEK
CONFLUENCE WITH INDIAN CREEK TO HIAWATHA
U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

PLATE 4/1

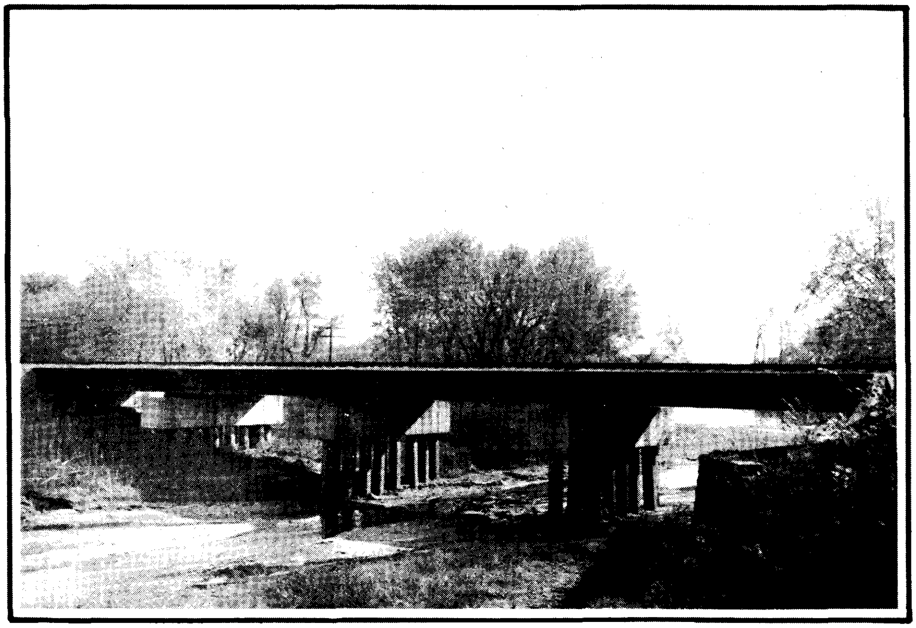
FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA
PROFILES
INDIAN CREEK
MOUTH TO SEC. 30, MARION TOWNSHIP
DRY CREEK
CONFLUENCE WITH INDIAN CREEK TO HIAWATHA
U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

PLATE 4/2

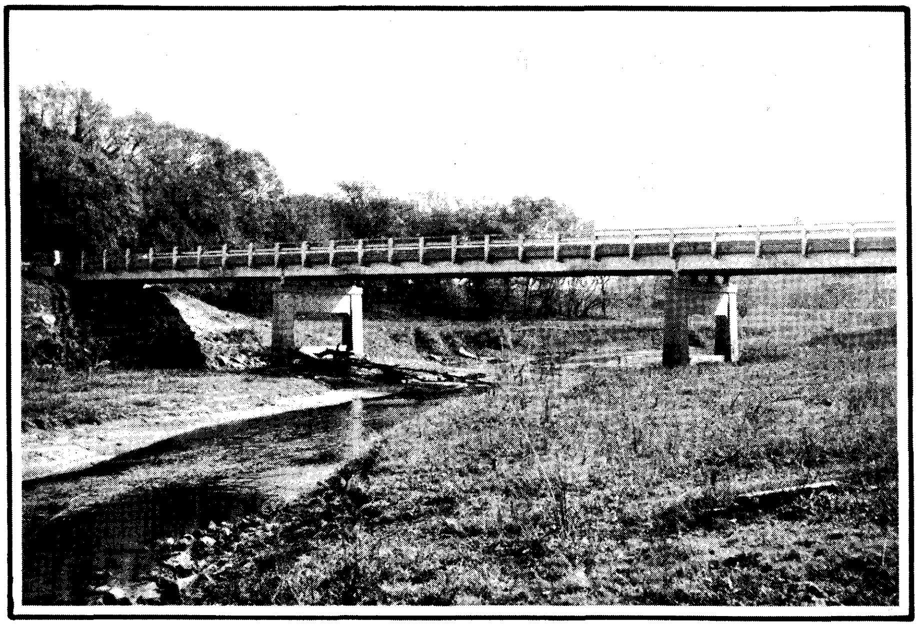
FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA
PROFILES
INDIAN CREEK
MOUTH TO SEC. 30, MARION TOWNSHIP
DRY CREEK
CONFLUENCE WITH INDIAN CREEK TO HIAWATHA
U. S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964



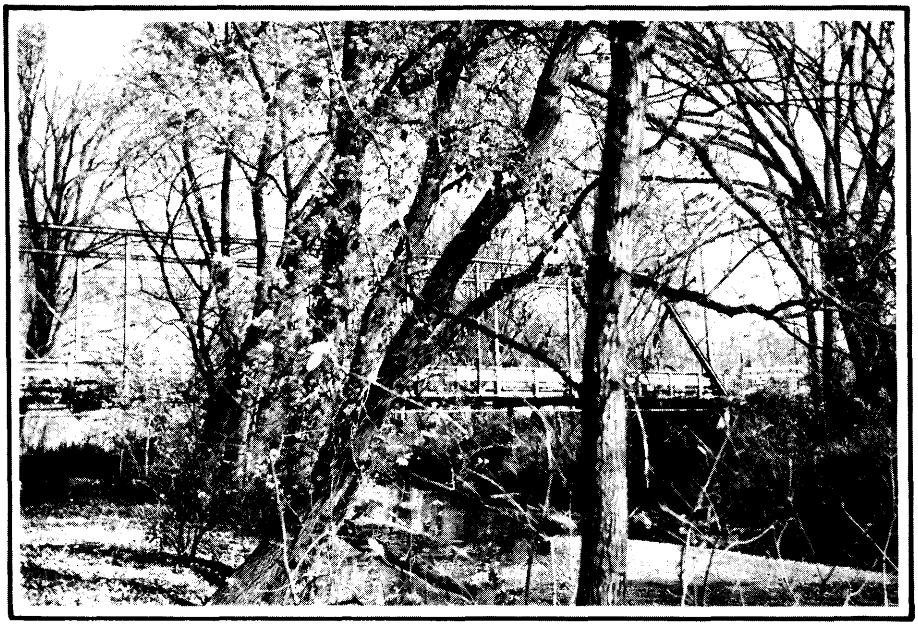
FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA
PROFILES
INDIAN CREEK
MOUTH TO SEC. 30, MARION TOWNSHIP
DRY CREEK
CONFLUENCE WITH INDIAN CREEK TO HIAWATHA
U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964



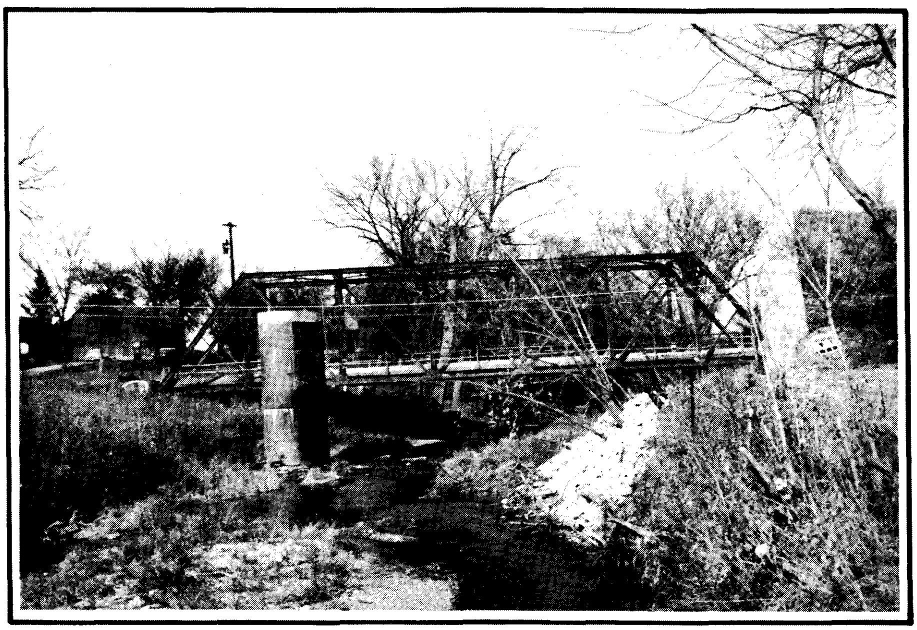
C&NW RR Bridge Mile 0.04.
Looking Downstream with Cedar River in background.
Note old bridge abutments.



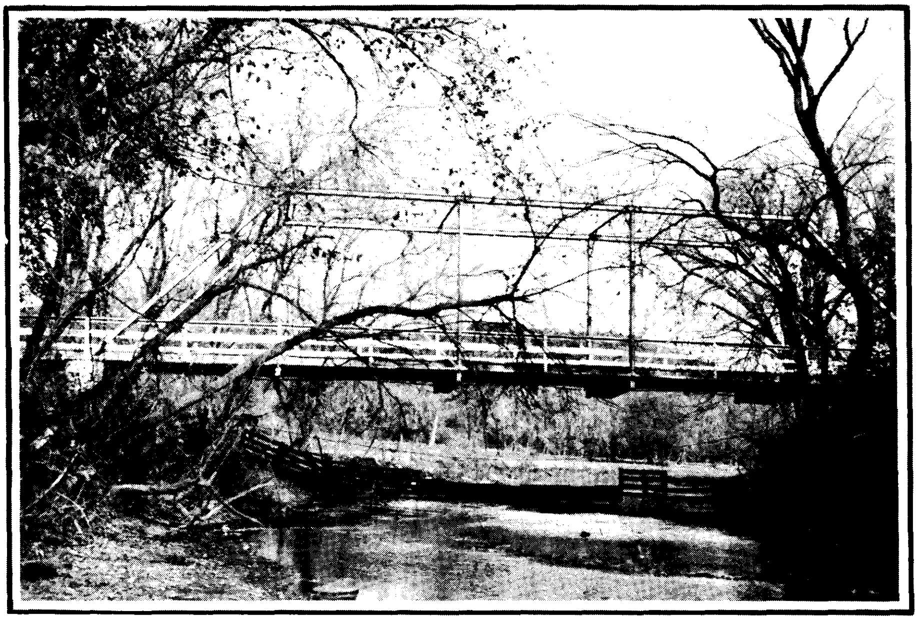
Otis Road Bridge Mile 0.18.
Looking Downstream.



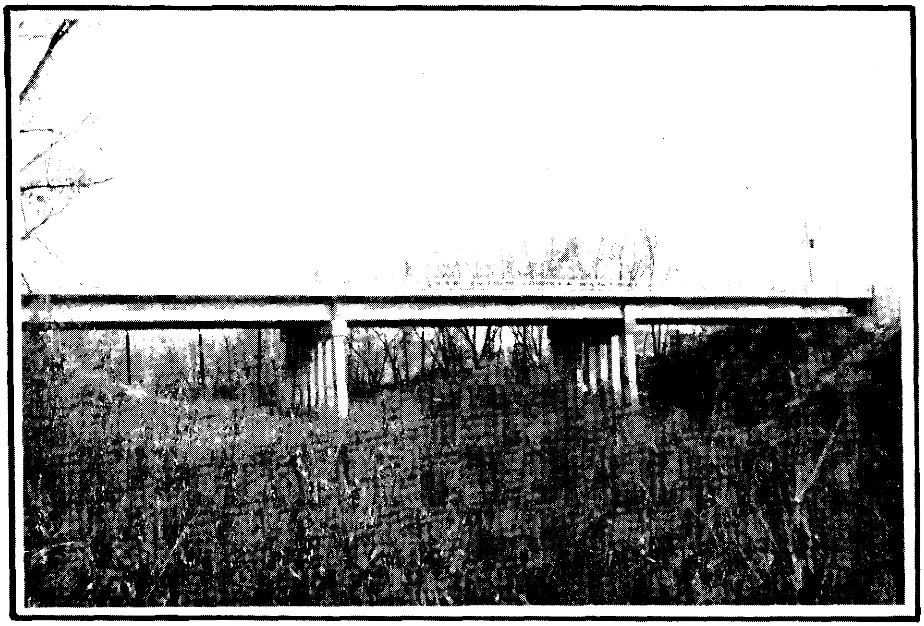
County Road "GG" Bridge Mile 0.75.
Looking Upstream at Bridge with
approach span on Right Bank on wood piling.



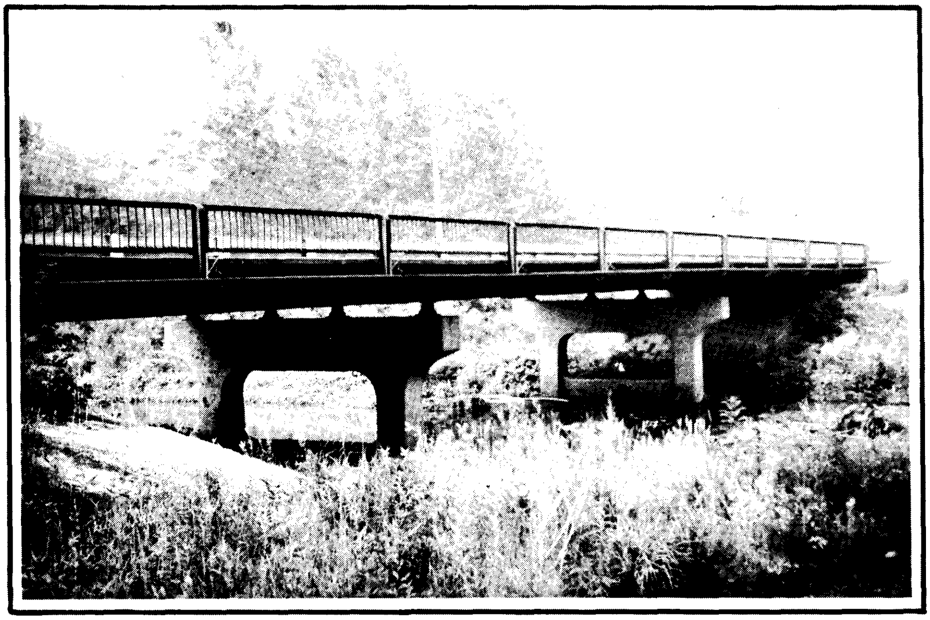
Abandoned RR Bridge Pier and Abutment Mile 1.07 and looking
Upstream at Mt. Vernon Road Bridge (Old #30) Mile 1.08.



County Road Bridge Mile 2.21.
Looking Downstream at Bridge and cattle guard.



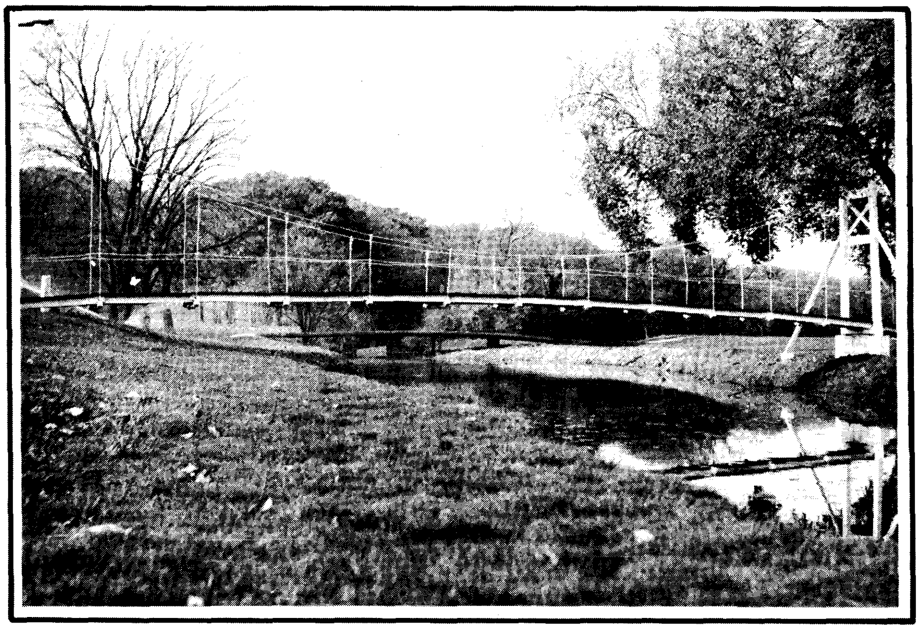
East Post Road Mile 4.42.
Looking Downstream at Bridge and
vertical timbers supporting a cattle guard.



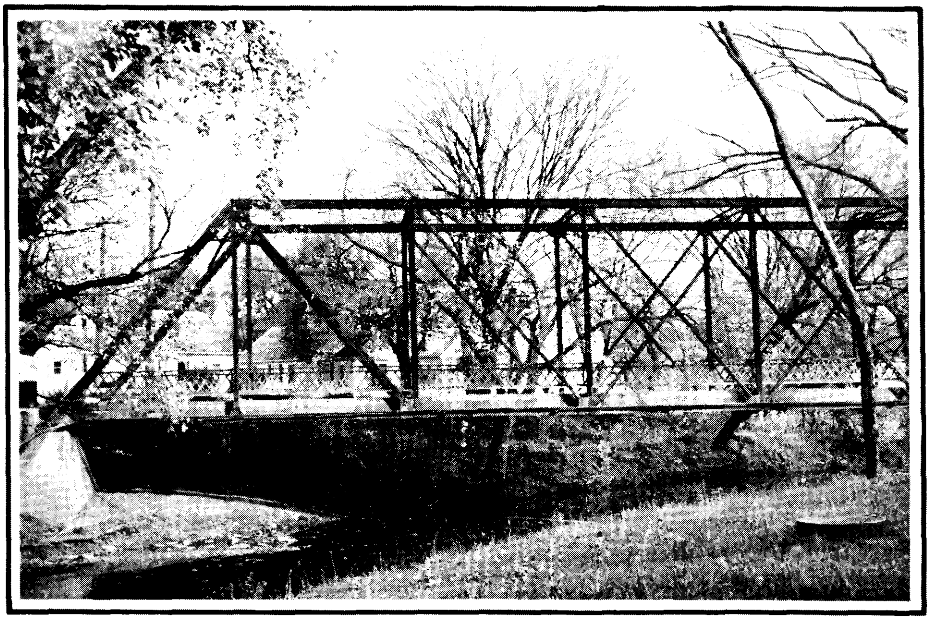
Cottage Grove Ave. Mile 5.32.
Looking Upstream from Right Bank.

Cedar Rapids Country Club Maintenance Bridge Mile 5.80.
Looking Downstream with suspension footbridge in background.

Cedar Rapids Country Club Dam Mile 6.20.
Looking Upstream at Dam and Pump House for Sprinkler System.

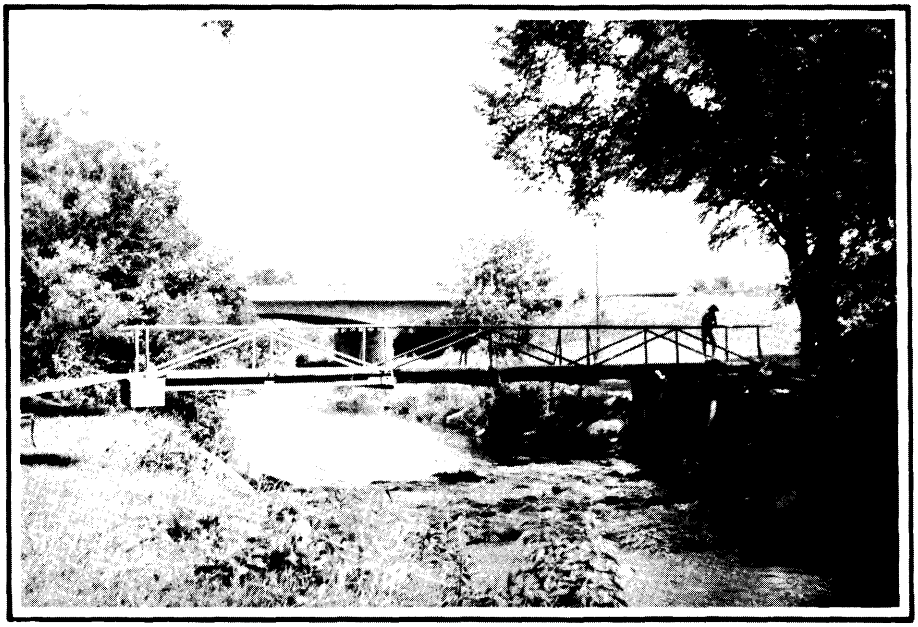


Cedar Rapids Country Club Suspension Foodbridge Mile 6.35.
Looking Upstream with Service Bridge in background.



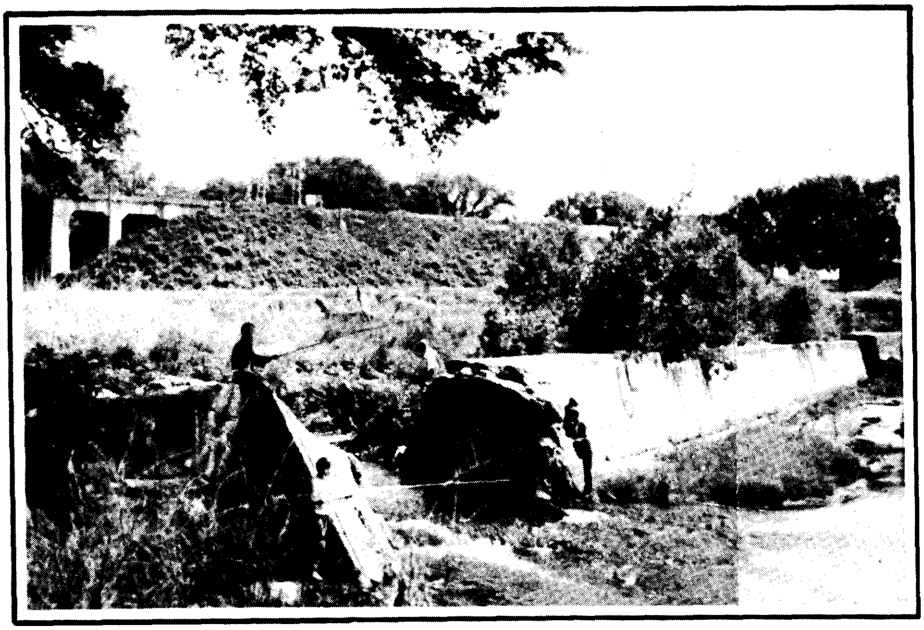
30th Street Drive S.E. Bridge Mile 6.87.
Looking Upstream at Bridge scheduled for replacement with several houses in downstream left overbank area.

Thomas Park Bridge Mile 10.65.
Looking Upstream at lower vehicular bridge within the City Park, swimming pool upstream on right bank.

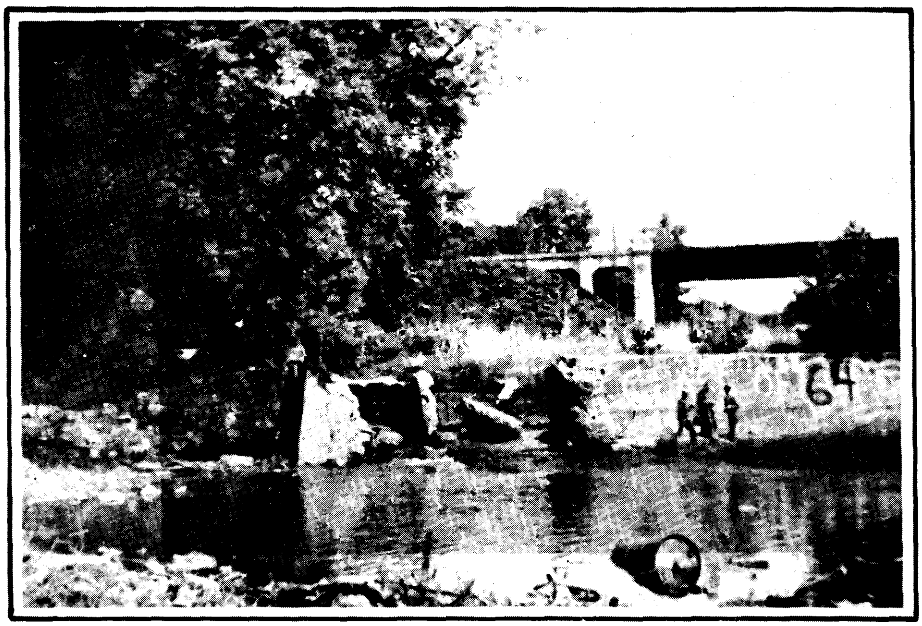


Thomas Park Footbridge in Foreground Mile 10.75.
Looking Upstream with Marion Boulevard in Background.

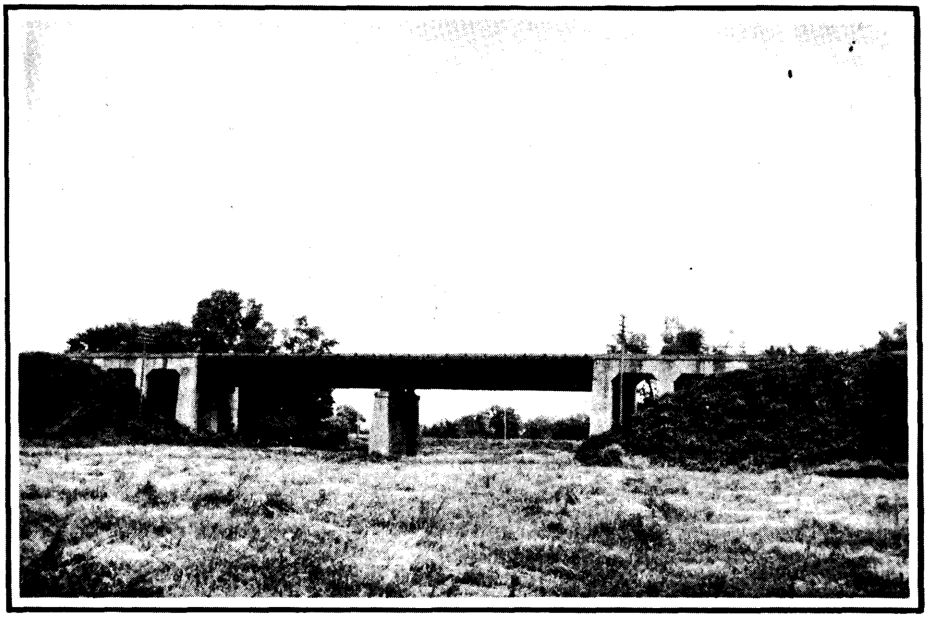
Marion Boulevard Bridge Mile 10.81.
Looking Upstream at Bridge which carries
Highway 151, 64 and 94 traffic.



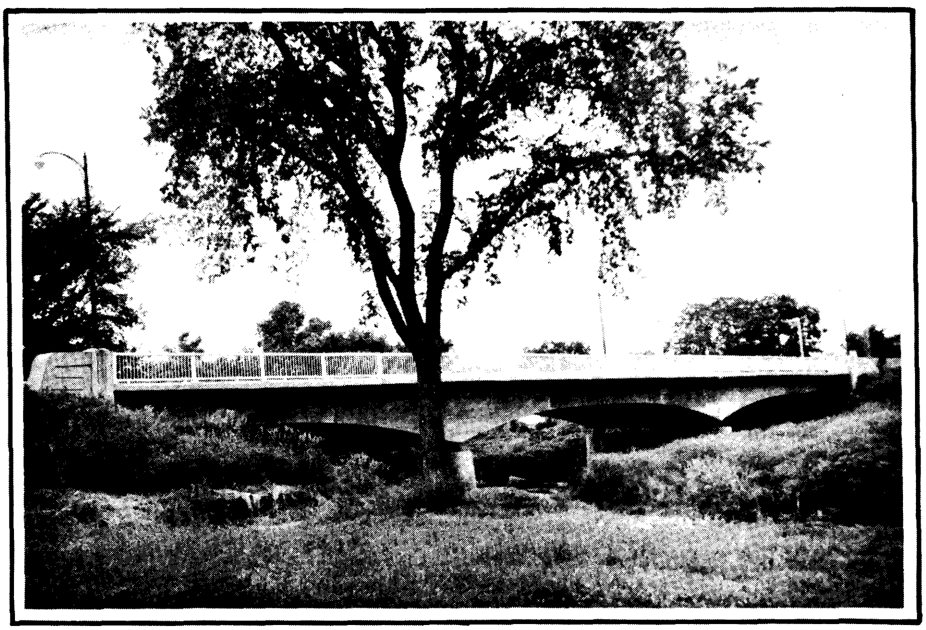
Old East Star Mill Dam Mile 10.90.
Looking Upstream at toe of dam showing
profile of removed section.



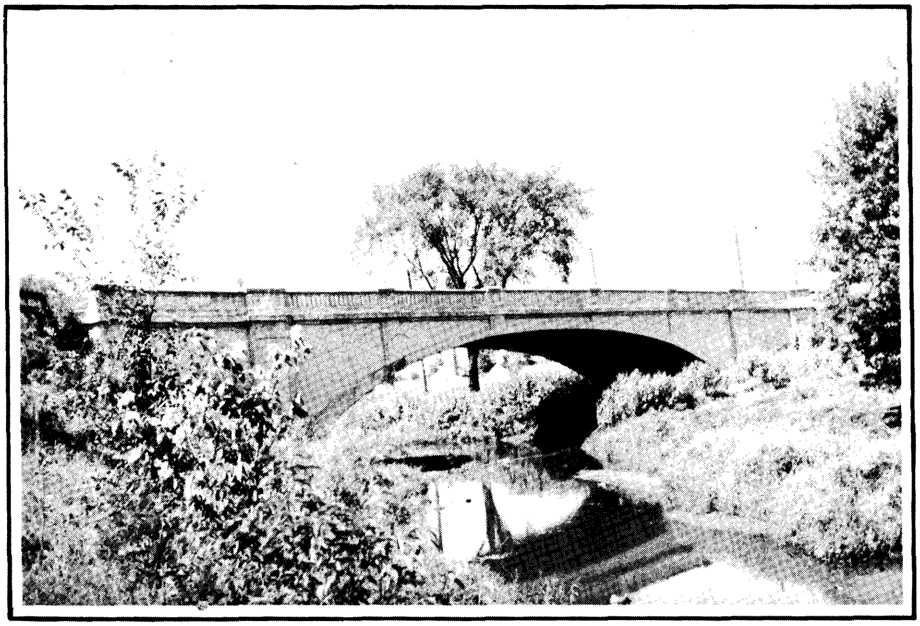
Old East Star Mill Dam Mile 10.90.
Looking Upstream at right abutment.



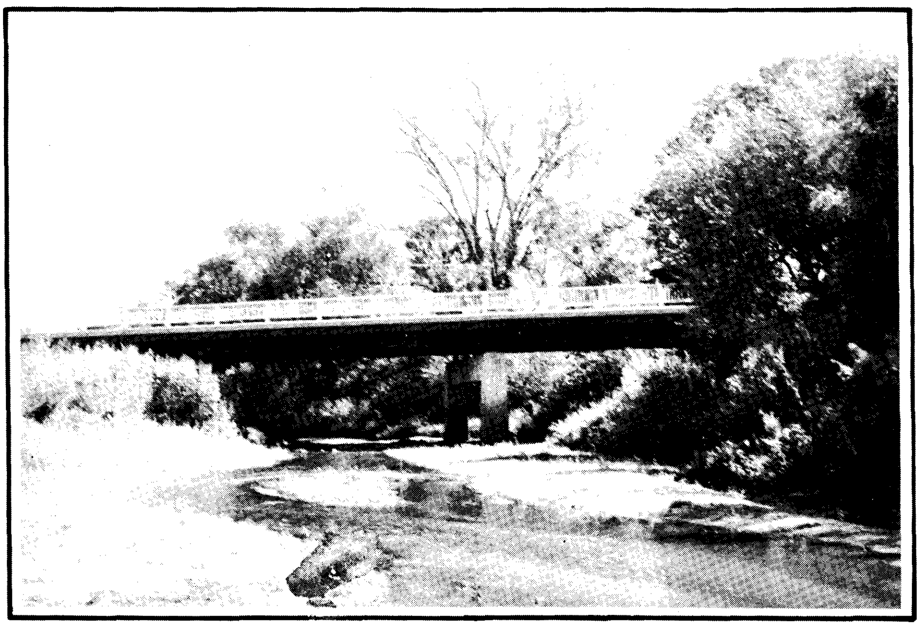
C. M. St. P. & P. RR Bridge Mile 10.97.
Looking Upstream.



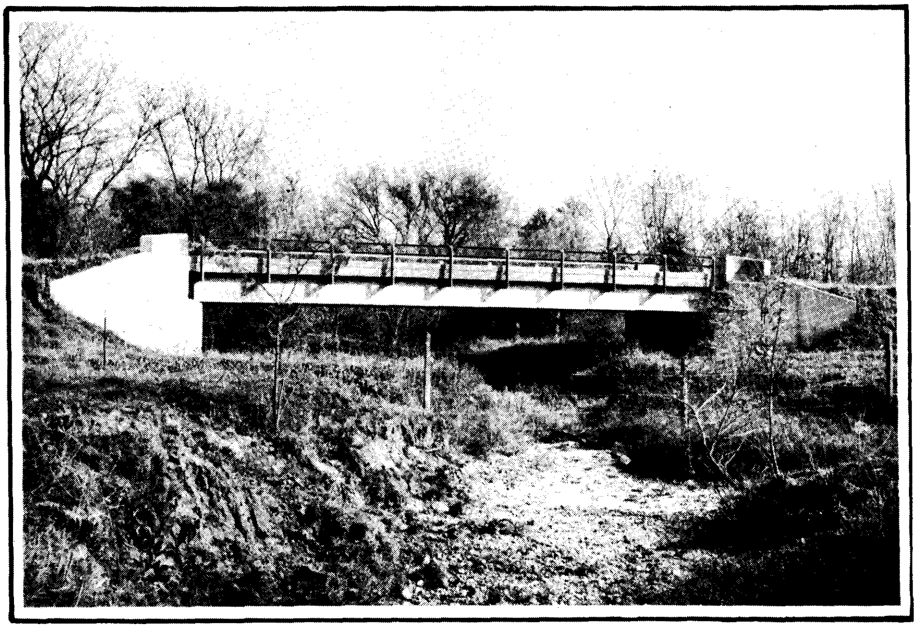
8th Avenue Bridge Mile 11.05.
Looking Downstream at the Bridge which is
below the Confluence of Indian and Dry Creeks.



Central Avenue Bridge Mile 11.51.
Looking Downstream from left bank.



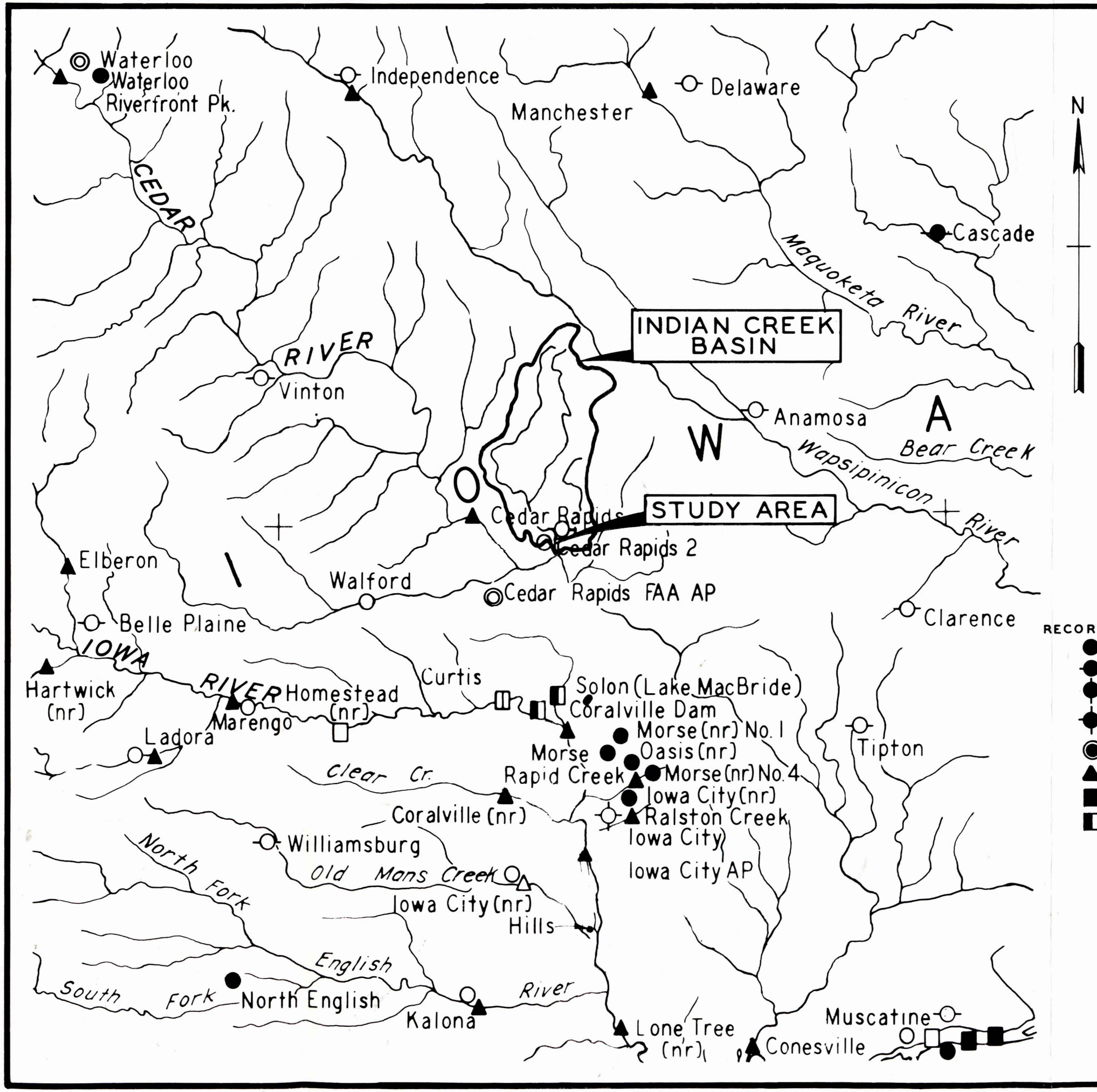
10th Street Bridge Mile 12.12.
Looking Upstream from right bank.

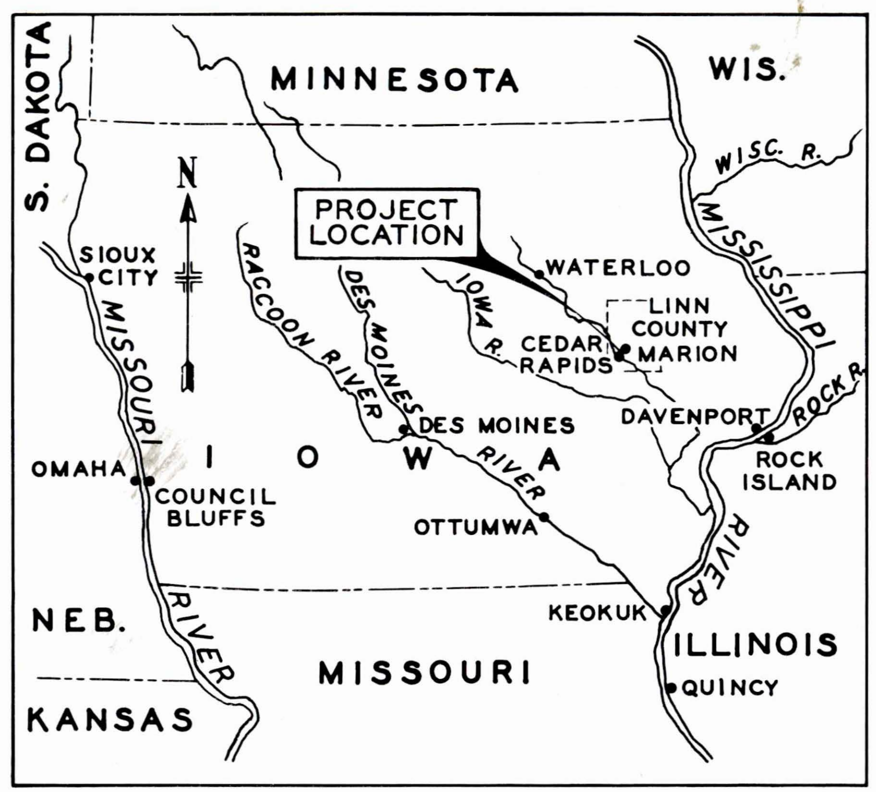


"C" Avenue Bridge Mile 13.37.
Looking Downstream from the center of Dry Creek.

Council Street Bridge Mile 15.10.
Looking Downstream from the center of Dry Creek.

Plate 5/11





VICINITY MAP

25 0 25 50 75

SCALE IN MILES

GAGES

RECORDING	NON-RECORDING	
●	○	PRECIPITATION STATION
		PRECIPITATION AND TEMPERATURE
		PRECIPITATION AND EVAPORATION
		PRECIPITATION, TEMPERATURE, AND EVAPORATION
◉	◎	COMPLETE WEATHER BUREAU METEOROLOGICAL STA.
▲	△	RIVER GAGE, RATED
■	□	RIVER GAGE, STAGE ONLY
◧	◫	RESERVOIR OR LAKE GAGE

FLOOD PLAIN STUDY
LINN COUNTY, IOWA

HYDROLOGIC STATION MAP

INDIAN AND DRY CREEK

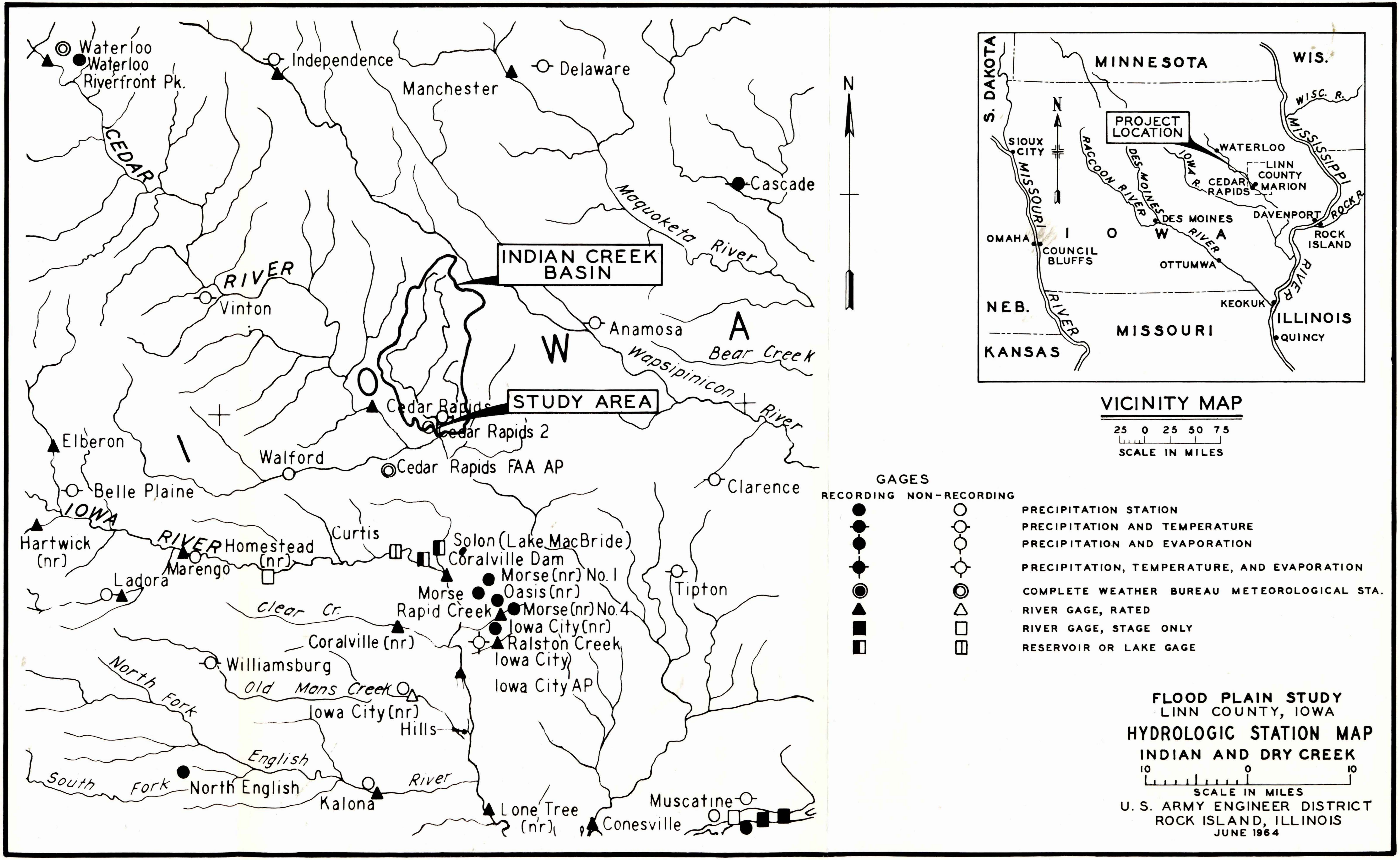
10 0 10

SCALE IN MILES

U. S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

CORPS OF ENGINEERS

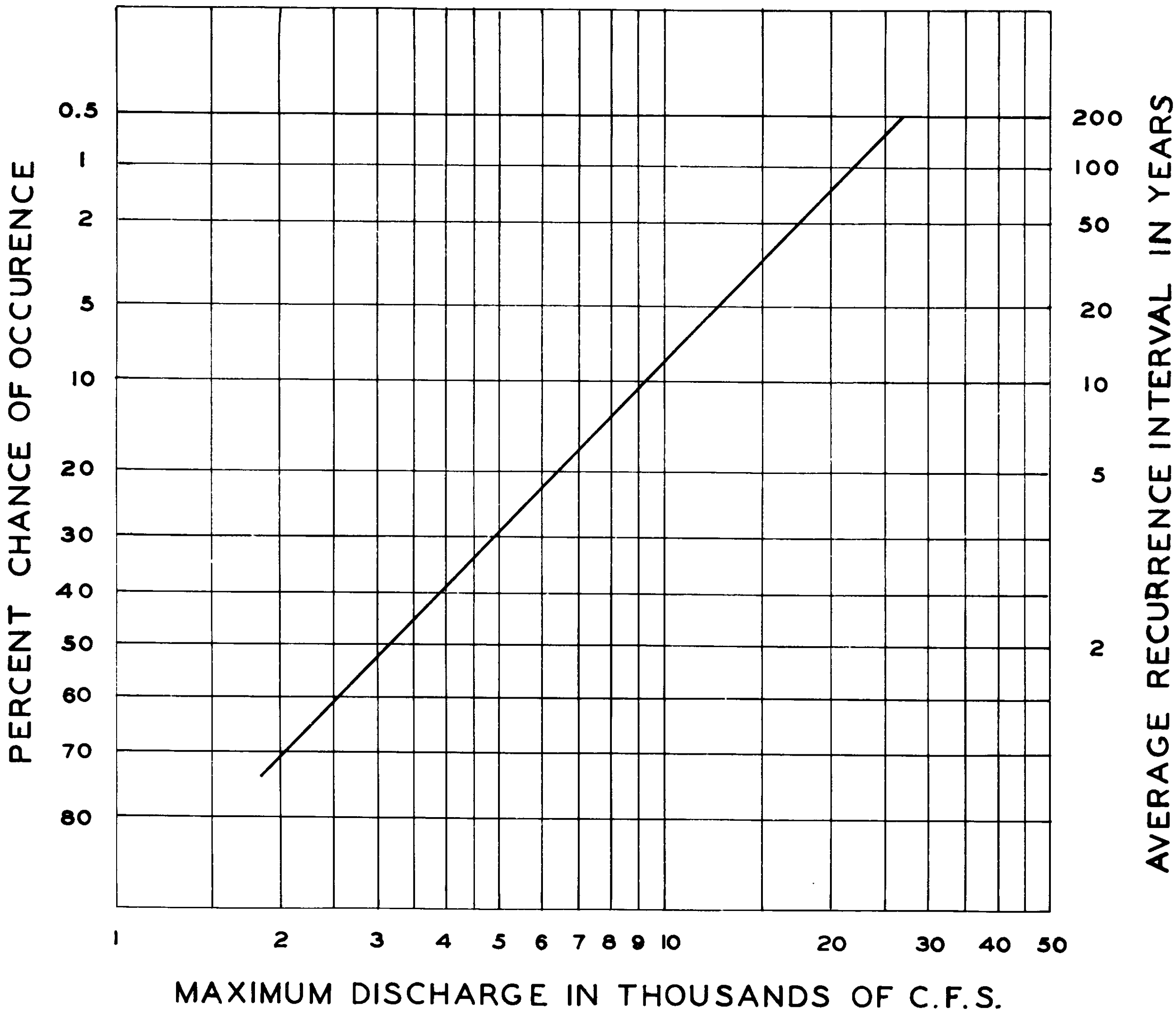
U. S. ARMY



FLOOD PLAIN STUDY
LINN COUNTY, IOWA
HYDROLOGIC STATION MAP
INDIAN AND DRY CREEK

U. S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

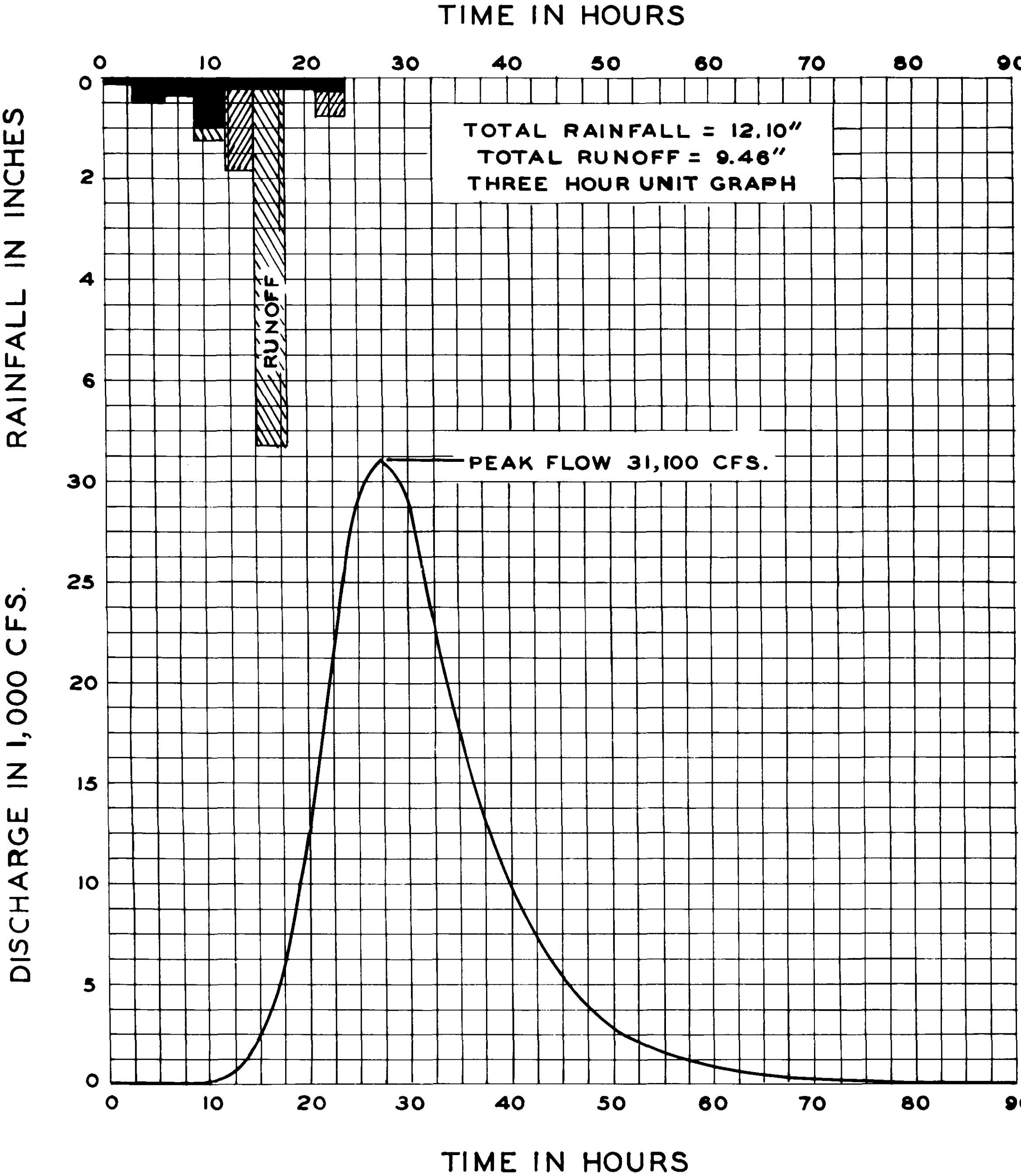
PLATE 6



FLOOD PLAIN STUDY
INDIAN AND DRY CREEKS
LINN COUNTY, IOWA

SYNTHETIC FREQUENCY CURVE
MOUTH OF INDIAN CREEK

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE, 1964

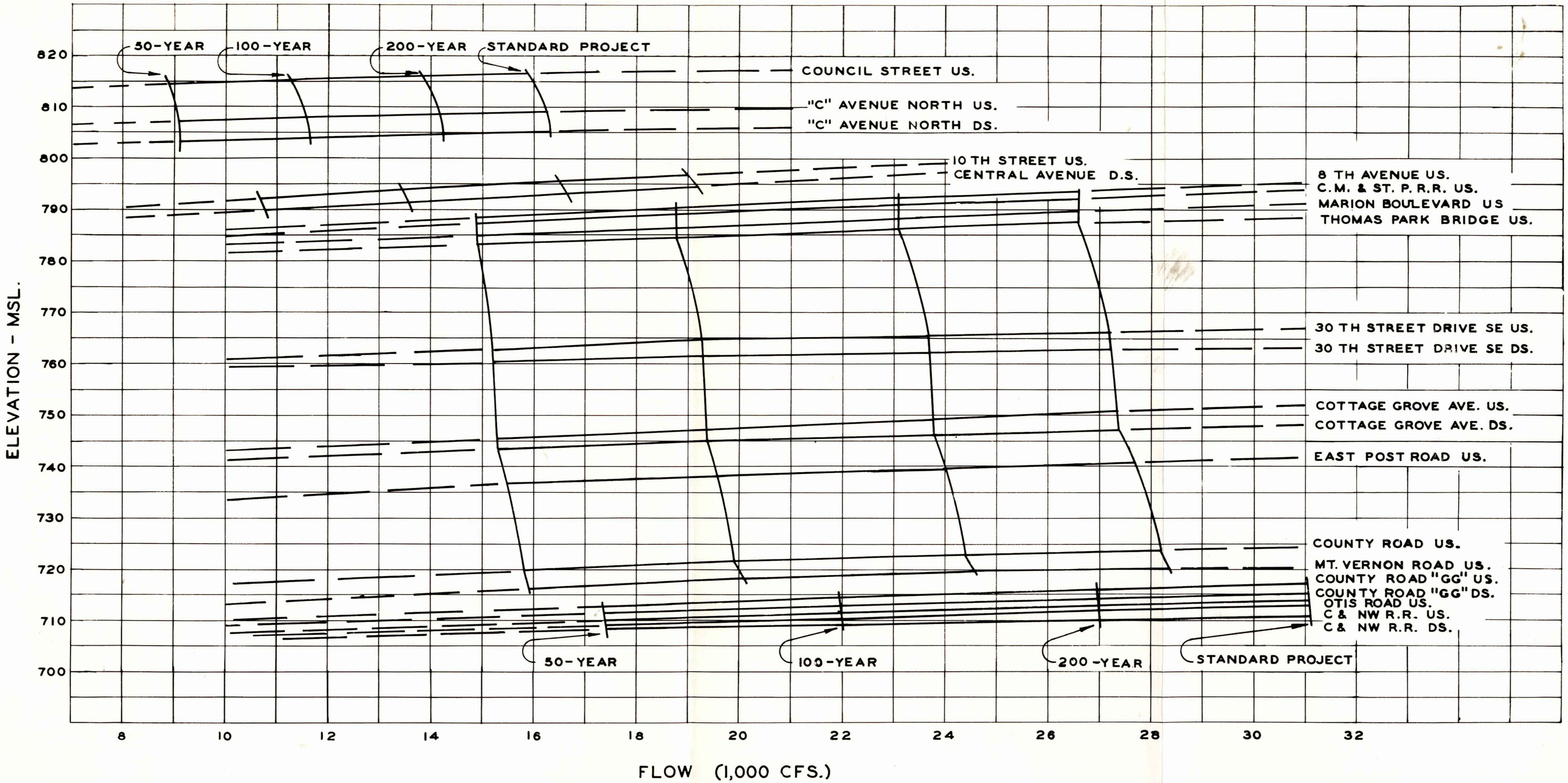


NOTE:
RAINFALL DISTRIBUTED IN ACCORDANCE WITH THE METHOD DESCRIBED IN CIVIL WORKS BULLETIN 52-8.

FLOOD PLAIN STUDY
INDIAN AND DRY CREEKS
LINN COUNTY, IOWA

STANDARD PROJECT FLOOD
24 - HOUR STORM

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

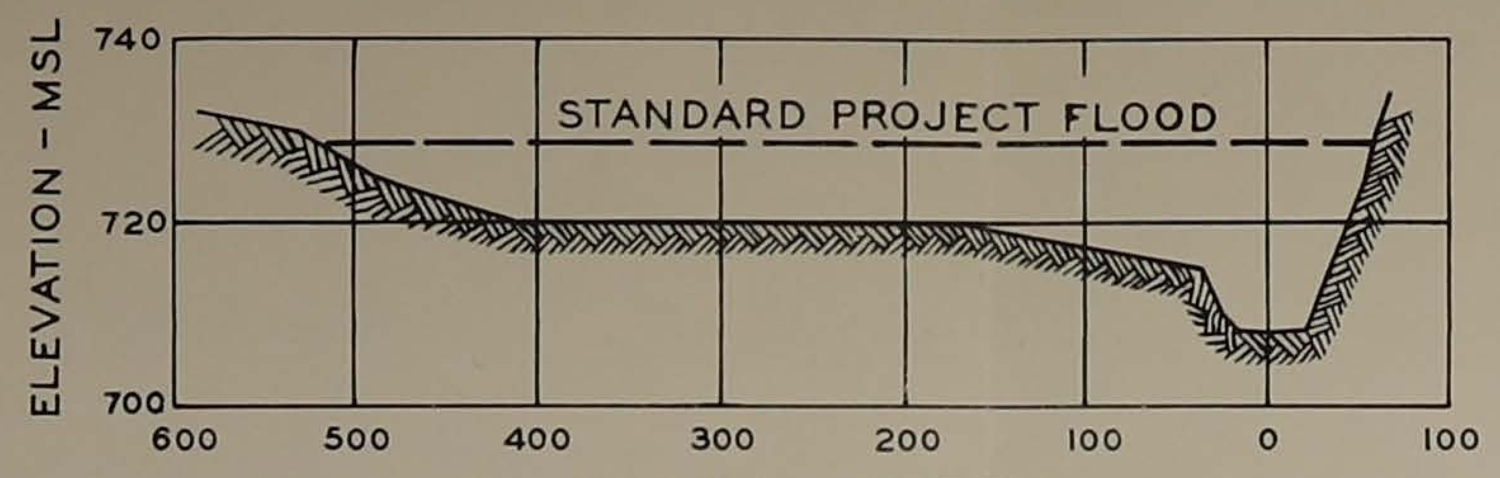


FLOOD PLAIN STUDY
INDIAN AND DRY CREEKS
LINN COUNTY, IOWA

ELEVATION - DISCHARGE
FREQUENCY RELATIONS

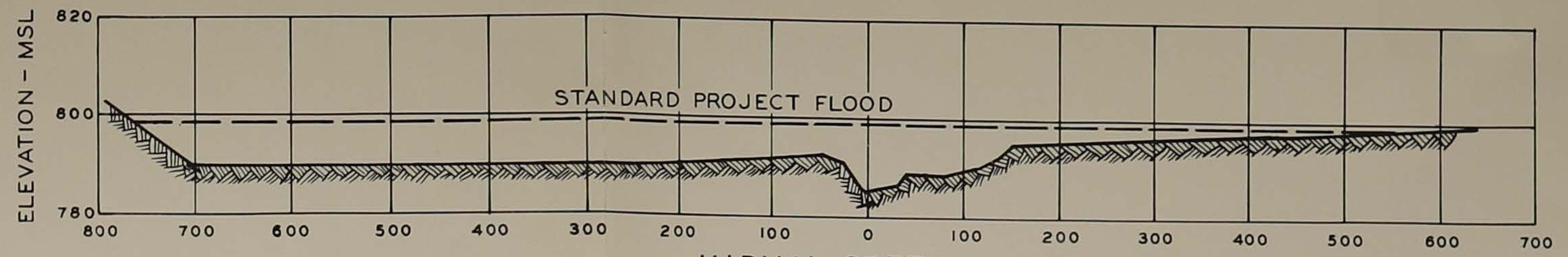
U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964

PLATE 9



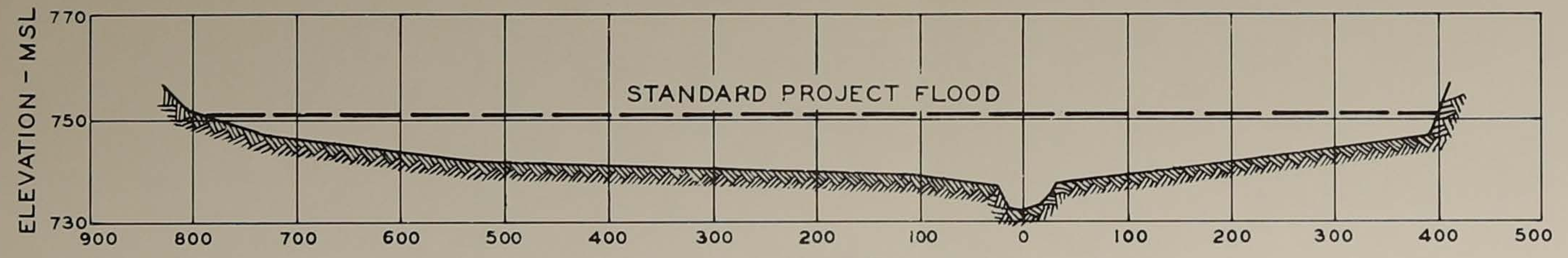
INDIAN CREEK

MILE 2.68



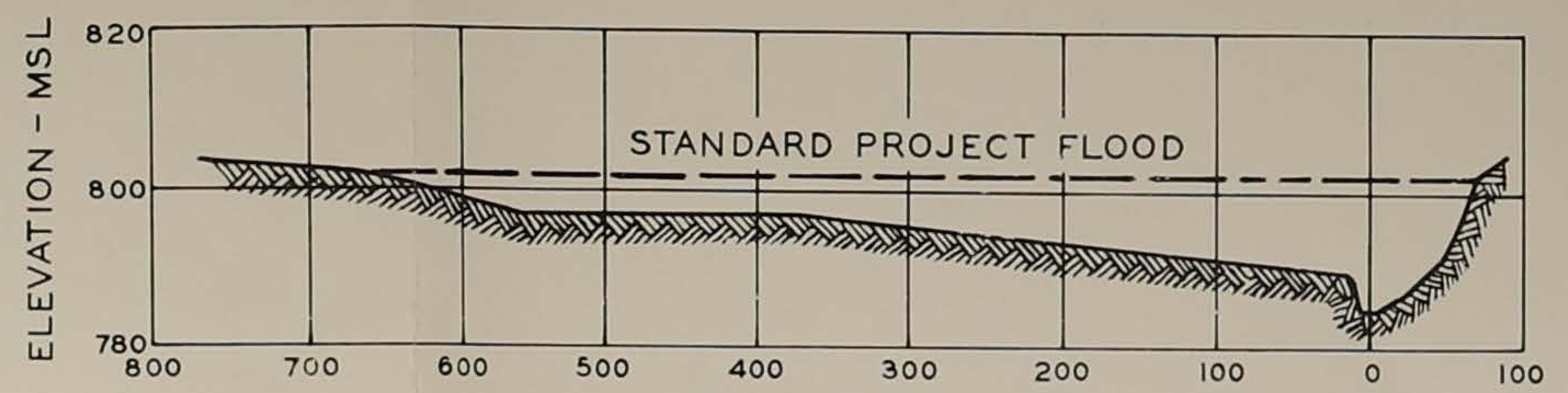
INDIAN CREEK

MILE 12.99



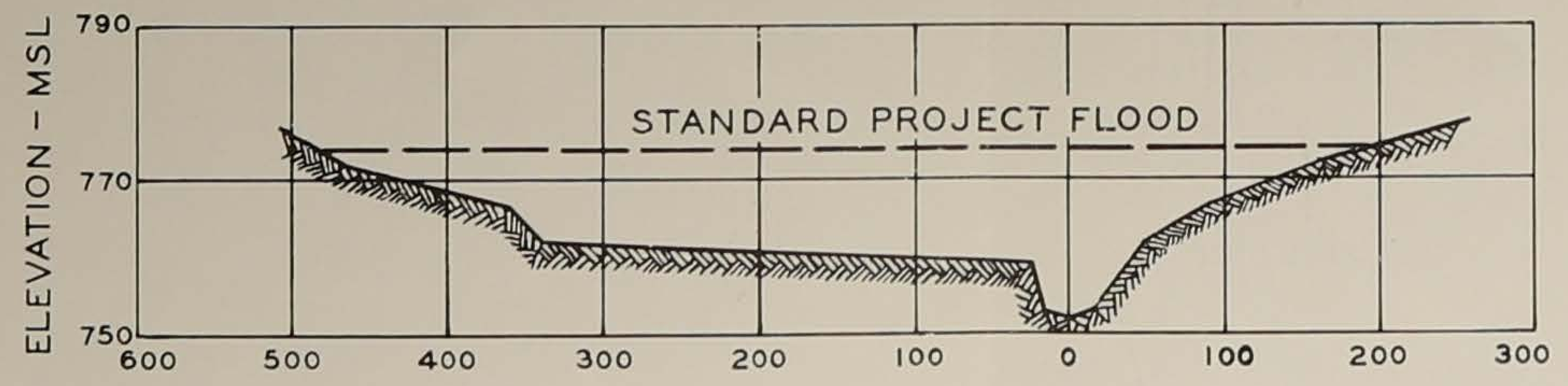
INDIAN CREEK

MILE 5.52



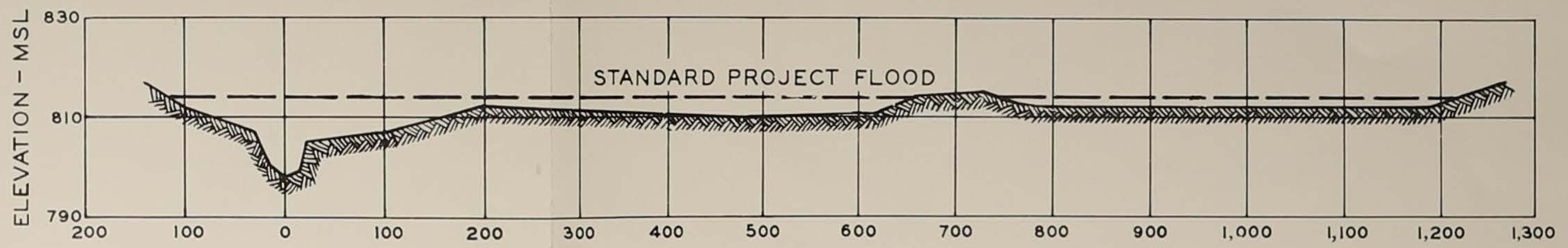
DRY CREEK

MILE 12.88D



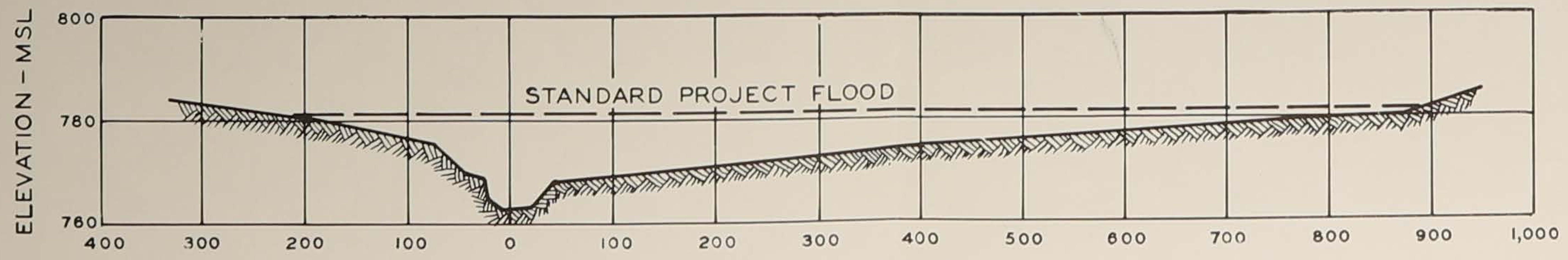
INDIAN CREEK

MILE 8.45



DRY CREEK

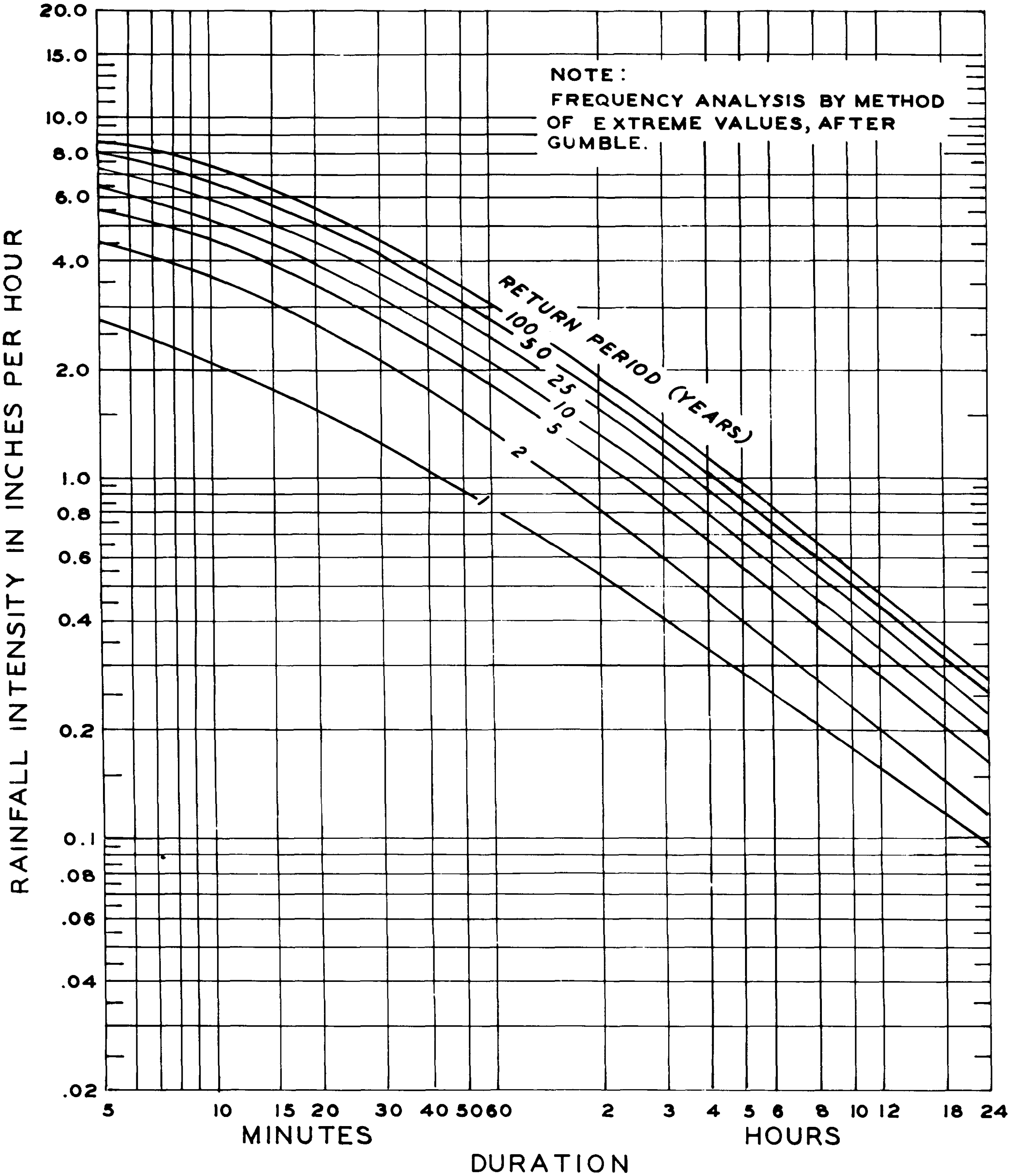
MILE 14.77 D



INDIAN CREEK

MILE 10.71

FLOOD PLAIN INFORMATION REPORT
LINN COUNTY, IOWA
TYPICAL CROSS SECTIONS
INDIAN AND DRY CREEKS
U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964



FLOOD PLAIN STUDY
INDIAN AND DRY CREEKS
LINN COUNTY, IOWA

RAINFALL INTENSITY - DURATION FREQUENCY CURVES

FROM U.S. WEATHER BUREAU
TECHNICAL PAPER NO. 25
RAINFALL INTENSITY - DURATION
FREQUENCY CURVES
(DAVENPORT, IOWA)

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1964