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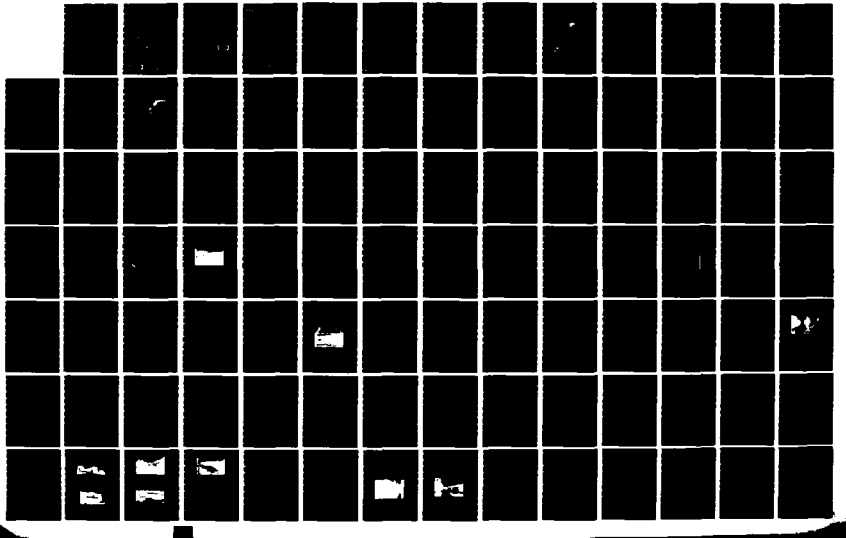

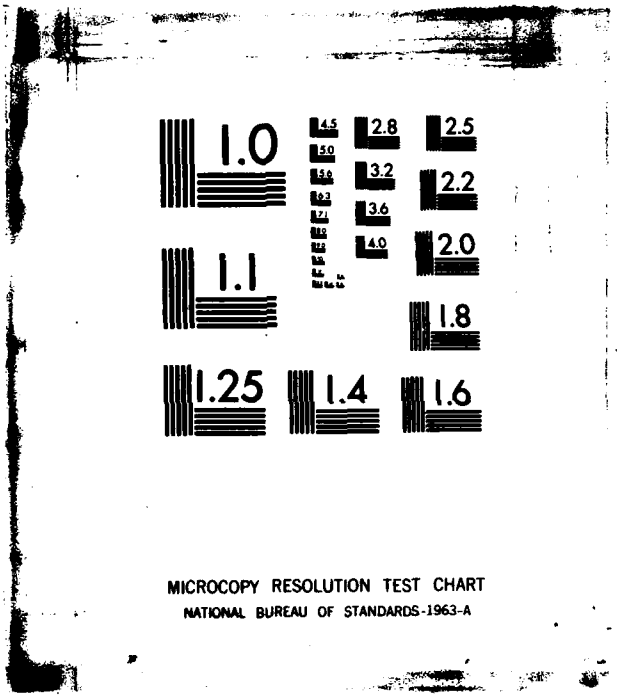
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Report on

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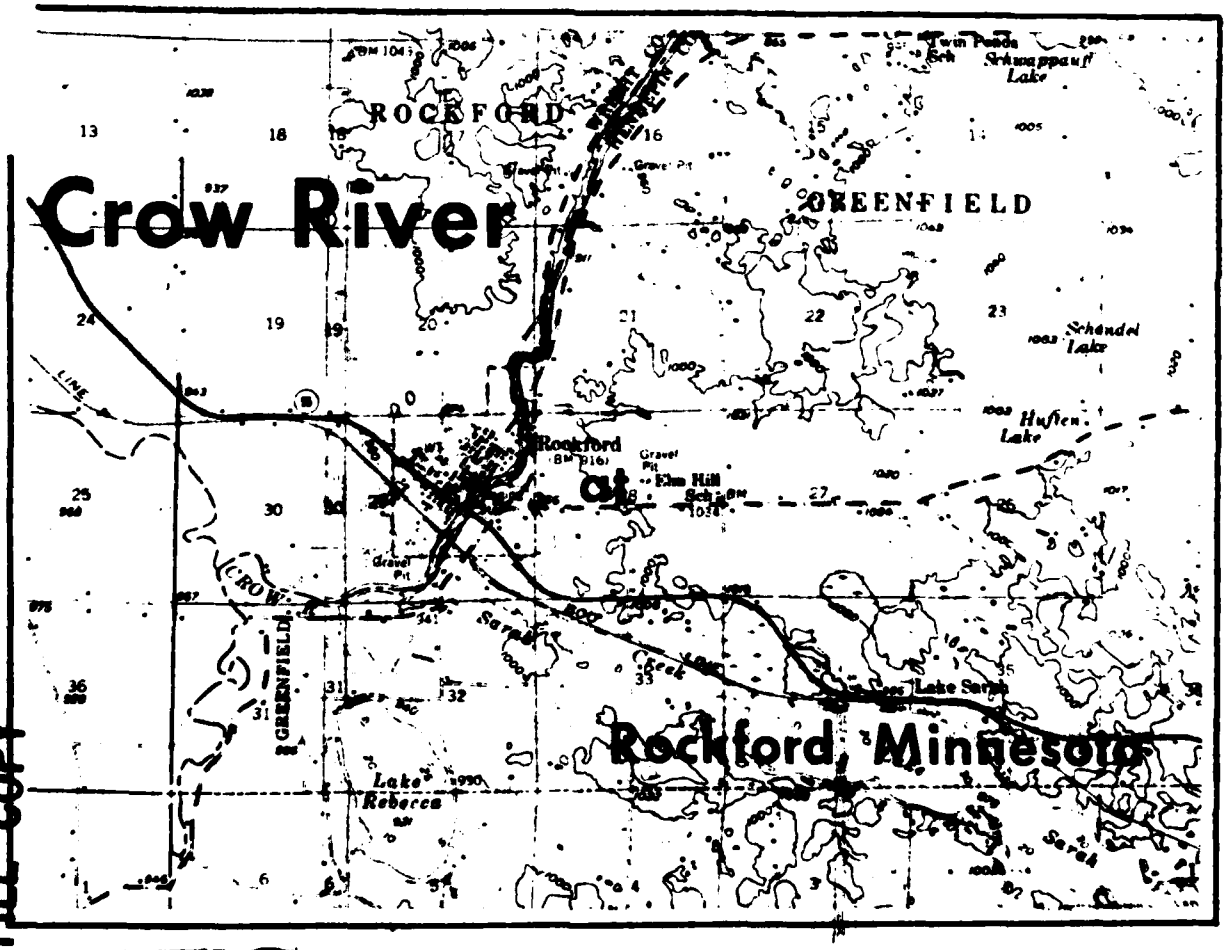

ST. PAUL DISTRICT
CORPS OF ENGINEERS
SEPT. 1975

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FLOODPLAINS
LEVEES
FLOOD PROOFING

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Following major flooding at Rockford, Minnesota in 1965 and 1969, the village council requested the Corps of Engineers to study the feasibility of implementing permanent flood damage reduction measures. The report investigates structural and nonstructural flood reduction alternatives. The report includes a nontechnical summary and a technical appendix of detailed information on the study and report, environmental setting and resources, problems and needs, and plan formulation.

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ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

IN REPLY REFER TO
NCSED-PB

26 November 1975

SUBJECT: Section 205, Detailed Project Report for Flood Control, Crow River at Rockford, Minnesota

Division Engineer, North Central

1. Subject report is submitted in accordance with Engineering Regulation 1105-2-50.

2. The comparative evaluation of alternative solutions to flood problems at Rockford, Minnesota, indicates that a continuation of existing policies and programs is the best plan for flood damage reduction at Rockford. Therefore, I recommend that Rockford enact a floodplain zoning ordinance, maintain its eligibility for federally subsidized flood insurance, maintain its existing emergency levee, and develop a flood emergency plan.

3. Funds in the amount of $85,000 have been made available and expended for preparation of the detailed project report. Further Federal expenditures and studies do not appear warranted.

1 Incl
Rept (cys 1-16)

MAX W. NOAH
Colonel, Corps of Engineers
District Engineer

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THE STUDY AND REPORT

Following major flooding at Rockford, Minn., in 1965 and 1969, the village council passed a resolution on 28 June 1972 requesting the Corps of Engineers to study the feasibility of implementing permanent flood damage reduction measures under its small project authority. The purpose of this report is to comply with that request and to evaluate the alternatives for flood damage reduction under the authority of Section 205 of the Flood Control Act approved 30 June 1948, as amended.

This study assesses the water and related land resource problems and needs with emphasis on the flood problems along the Crow River at and in the vicinity of Rockford. The general area is illustrated in the following figure.

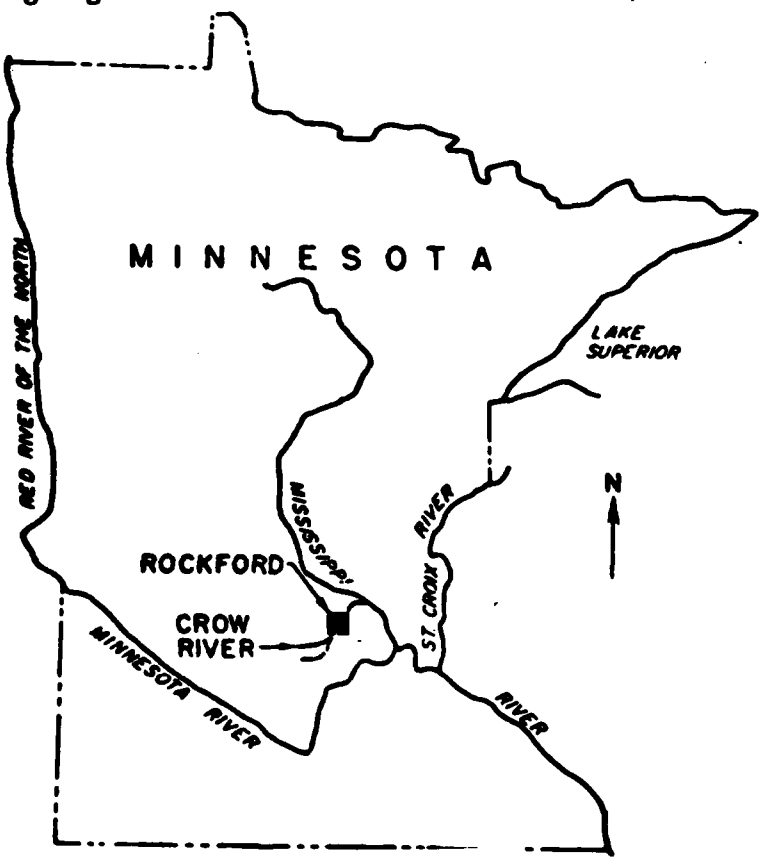

Figure 1 - Location map, Crow River at Rockford, Minnesota

The investigations are based on field instrument surveys, aerial topographic maps, flood damage appraisals, and analyses of the engineering, economic, environmental, and social factors involved. Floodplain information studies included the delineation of the intermediate regional floodplain and preparation of water surface profiles for various levels of floods. Investigations were made in sufficient detail to permit adequate evaluation of the positive and negative aspects of possible alternatives and to determine if a feasible and practicable solution to the flood problems at Rockford exists.

This report has been arranged into a main report and a technical appendix. The main report is a nontechnical summary of the overall study. The technical appendix contains detailed information compiled and utilized during report preparation including detailed information on the study and report, environmental setting and resources, problems and needs, and plan formulation. The technical report is available for review from the St. Paul District, Corps of Engineers.

PROBLEMS AND NEEDS

An assessment of the water and related land resource needs of the Rockford area indicated that flood damage reduction is a major need. Rockford has experienced an average of about one flood every 4 years. Since 1950, Rockford has been inundated by four major floods. An emergency levee constructed in 1969 protected the city from two other floods. Under present conditions of development, the floods of 1952, 1957, 1965, and 1969 would each cause damages of more than $200,000.

The highest recorded peak discharge was 22,400 cfs (cubic feet per second) and occurred in 1965. Damages attributed to the 1965 flood in 1965 prices and conditions totaled $233,000. A recurrence of the 1965 flood under 1975 prices and conditions would cause damages of about $508,000. Portions of the residential areas would again be inundated to a depth of 4 to 5 feet on the first floor. Potential damages for a recurrence of the six most recent floods are shown in the following table.

Table 1 - Estimated flood damages for historic floods, Rockford, Minn., 1975 conditions and January 1975 price levels

Date of flood peak	Instantaneous peak (cfs)	Potential damages under 1975 conditions
16 April 1951	7,720	$18,000
13 April 1952	13,900	239,000
26 June 1957	13,500	215,000
16 April 1965	22,400	508,000
13 April 1969	15,100	287,000
25 March 1972	7,410	15,000

The intermediate regional flood discharge is estimated at 30,600 cfs. Potential damages at current development conditions for a flood of this magnitude are estimated at $734,200. Occurrence of the intermediate regional flood would adversely affect about 50 homes, 23 businesses, 3 public buildings, and 232 mobile homesites in Rockford. The area of Rockford adversely affected by the intermediate regional flood is illustrated in the following figure.

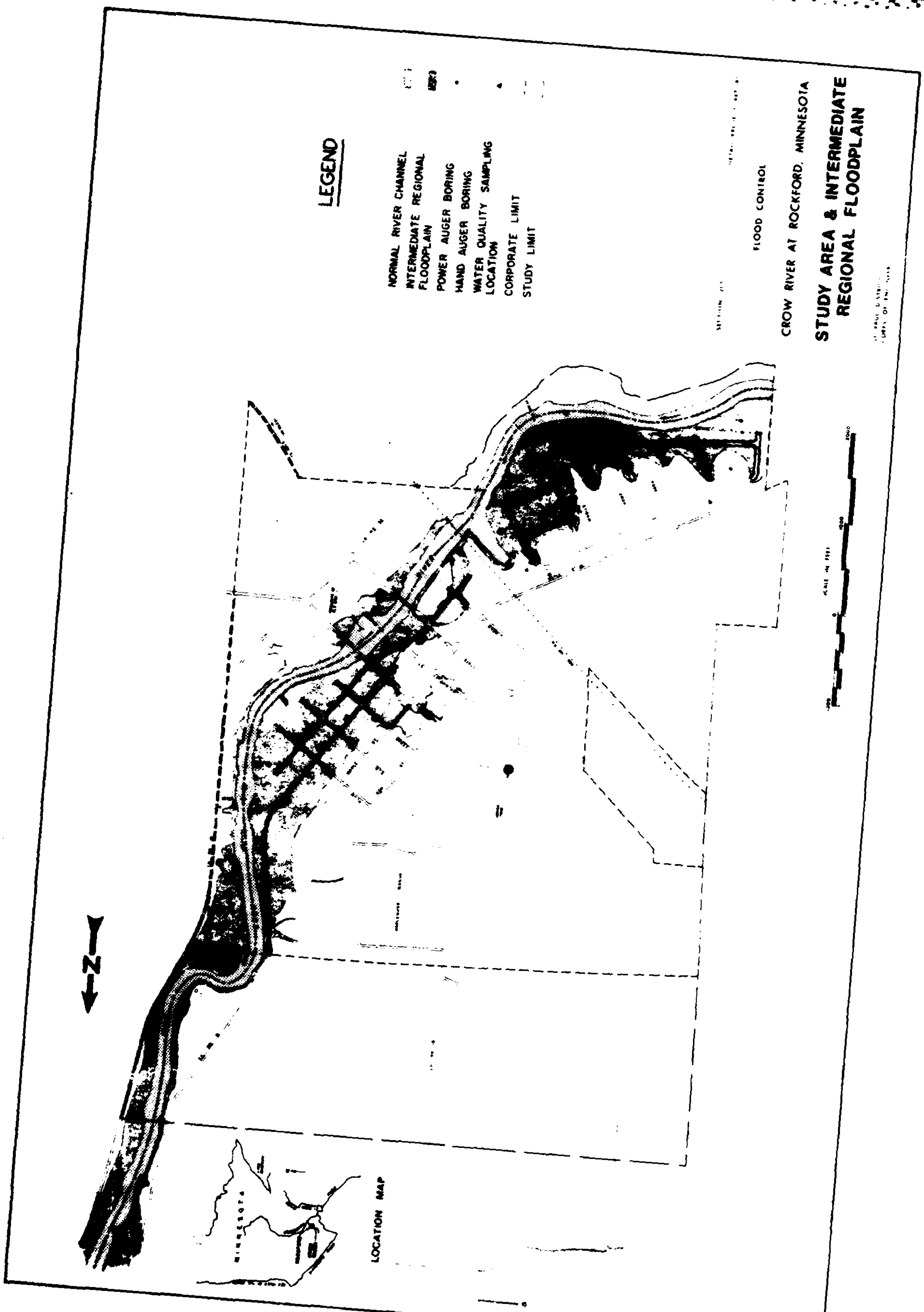

Figure 2 - Study area and intermediate regional floodplain

ALTERNATIVES EVALUATION

Potential solutions to the flood damage problems at Rockford were evaluated in accordance with accepted principles and standards for planning involving water and related land resources. Criteria under the categories of technical feasibility and completeness, economic efficiency, environmental quality, and social well-being were utilized to measure the advantages and disadvantages of each potential solution. The base condition, or "no action" alternative, was also evaluated to form a base upon which to measure the effectiveness of the other alternative solutions.

The alternative solutions investigated included the following:

Nonstructural

- No action.
- Flood proofing.
- Floodplain evacuation.

Structural

- Levee system.
- Channel modification.
- Upstream reservoir storage.

A brief summary of the pertinent features of each alternative is presented in the following paragraphs and illustrated in the following table.

Table 2 - Summary evaluation of economic, environmental, and social well-being aspects of flood damage reduction alternatives, Crow River at Rockford, Minn

Item	Plan 1 Flood proofing	Plan 2 Floodplain evacuation	Plan 3 Permanent levees	Plan 4 Channel modification	Plan 5 Upstream reservoir storage
Economic					
First cost	$2,470,000	$3,330,000	$1,310,000	$2,640,000	$6,000,000
Benefit-cost ratio	0.6	0.5	0.4	0.1	<0.1
Environmental					
Woodland gained or lost (acres)	+40	+45	-0.7	-7	-500
Miles of stream modified	0	0	0	1	15
Social well-being					
Present flood damage reduction (percent)	91	93	75	46	45
Residences relocated	36	50	16	6	35

NOTE: Prices are based on July 1974 levels.

BASE CONDITION

The base condition, or "no action" alternative, would consist of continuation of policies and programs which are currently in existence or for which enabling legislation exists. These programs, policies, and actions include implementation of floodplain regulations, participation in the federally subsidized flood insurance program, maintenance of the existing emergency levee system, and prediction of the time and level of flood flows.

FLOOD PROOFING

The flood proofing alternative emphasizes use of structural modifications to existing buildings to make them less vulnerable to flood damages. The majority of structures in the floodplain at Rockford cannot be adequately flood proofed; therefore, it would be necessary to supplement flood proofing measures with other flood damage reduction measures. The plan evaluated would consist of flood proofing about 28 percent of the houses, 28 percent of the businesses, 33 percent of the public buildings, and that segment of the mobile home park that lies in the floodplain; a levee plan to protect the area between Highway 55 and the Soo Line Railroad; and evacuation of the remainder of the floodplain structures. As indicated in table 1 (page 3), this plan has a first cost estimated at $2,470,000, a benefit-cost ratio of 0.6, and solves about 91 percent of the flood damage reduction needs.

FLOODPLAIN EVACUATION

The floodplain evacuation alternative would consist of relocation of all residences, businesses, and public buildings located in the flood prone area as outlined on figure 2 (page 4). The buildings would be relocated to nonflood prone locations in the Rockford area. The first cost of this alternative plan is estimated at $3,334,000 with a benefit-cost ratio of 0.5.

PERMANENT LEVEES

The permanent levee plan would include improvement and upgrading of the existing emergency levee system with some minor alterations in its alignment. Interior drainage facilities including ditches, ponding areas, and pumping stations would be provided. The existing levee would be raised by an average height of about 3 feet. As indicated in the previous table, the first cost of this plan is estimated at about $1,310,000 with a benefit-cost ratio of 0.4. The alignment and pertinent features of the levee plan are illustrated on the following figure, as labeled under the alternate levee alignment.

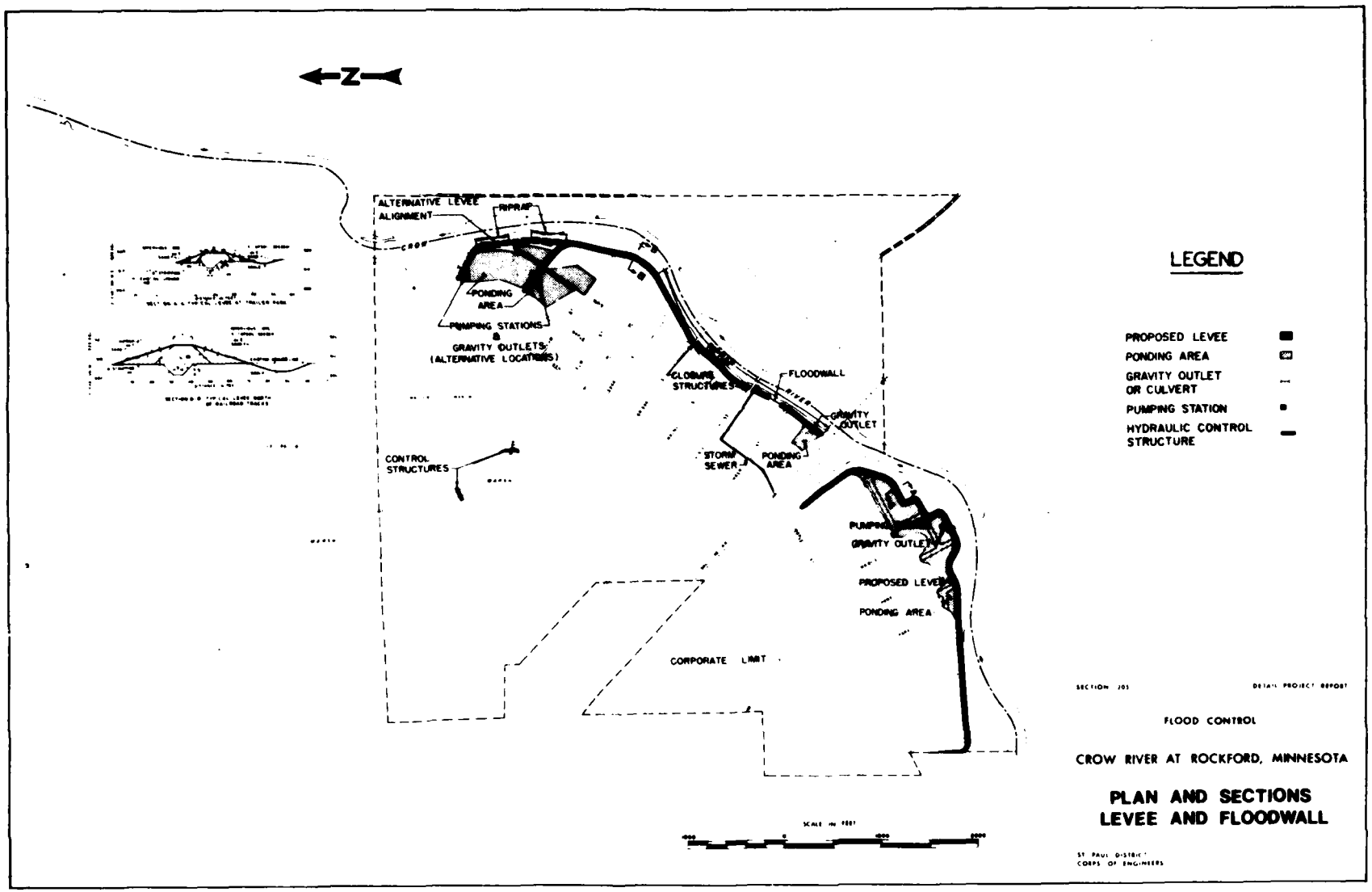

Figure 3 - Plan and sections - levee and floodwall

CHANNEL MODIFICATION

The channel modification alternative would include enlargement and straightening of the Crow River from the Highway 55 bridge downstream about 1 1/4 miles. The modified channel would contain discharges up to and including about the 40-year flood, and would result in lowering the level of the intermediate regional flood by only about 1.2 feet. The estimated cost of this plan would be about $2,640,000 with a benefit-cost ratio of about 0.1. The reach of the Crow River that would be modified is illustrated in the following figure.

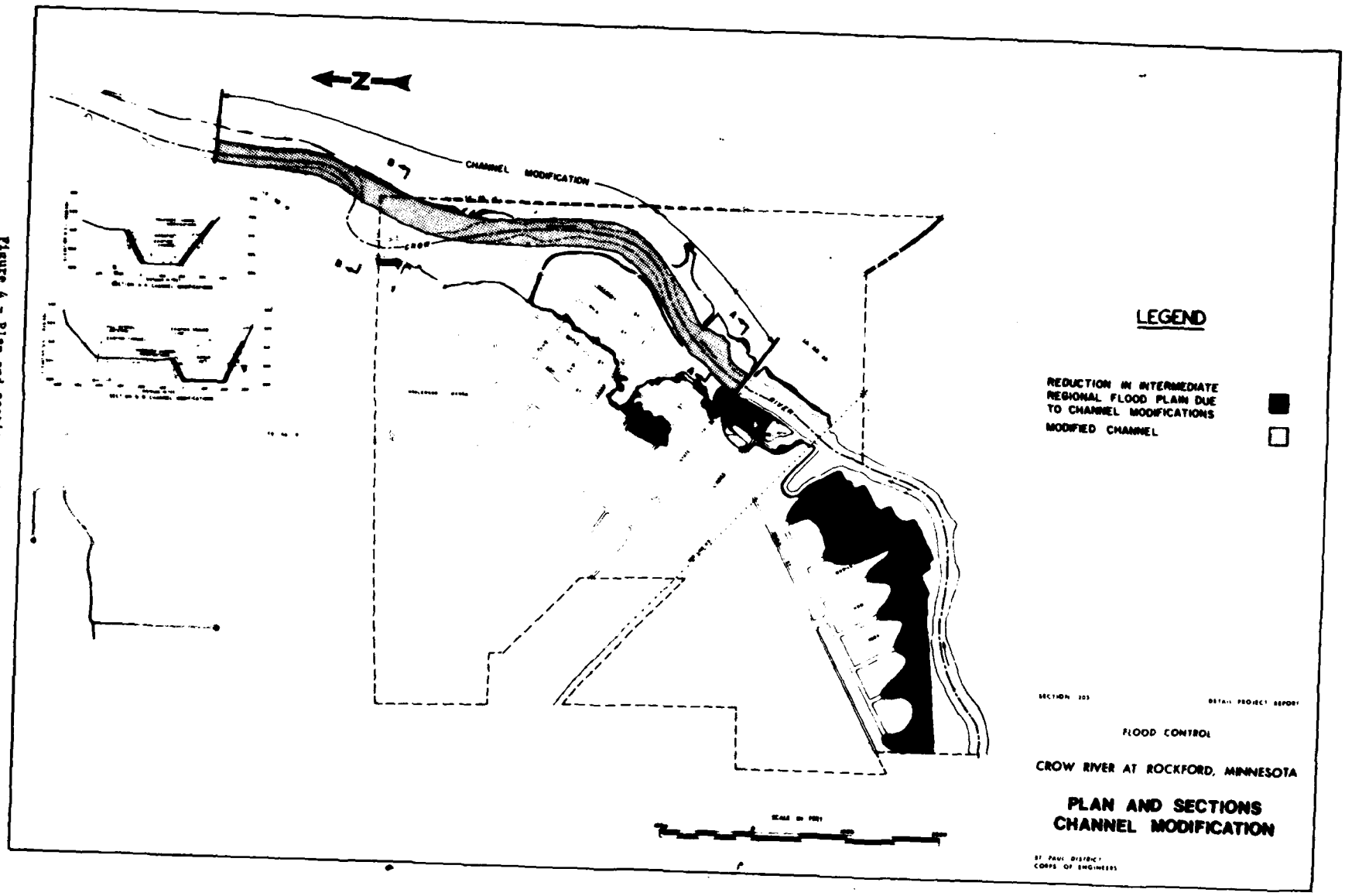

Figure 4 - Plan and sections - channel modification

UPSTREAM RESERVOIR STORAGE

The upstream reservoir storage plan for retarding floodwaters would consist of two reservoirs, one on the North Fork Crow River and one on the South Fork Crow River. These two reservoirs would provide a total of about 40,000 acre-feet of floodwater retention volume. This would result in flood stage reductions for the intermediate regional flood at Rockford of only about one-half foot. The cost of the reservoirs would be in excess of $6 million and the benefit-cost ratio would be less than 0.1.

CONCLUSIONS

The comparative evaluation of the alternative solutions to flood damage problems at Rockford under current conditions indicates that none of the alternatives demonstrates sufficient benefits to justify expenditure of the costs of implementation. A minimum benefit-cost ratio of 1.0 is necessary to meet the economic evaluation criteria for potential plan implementation. Since no major alternative action plan for reduction of flood damages at Rockford meets implementation criteria, continuation of existing policies and programs is considered to be the best plan for flood damage reduction at Rockford.

COORDINATION

A public meeting was held on 26 November 1973 at which the results of preliminary studies were discussed. No firm positive or negative local reactions to any of the alternative plans was indicated. Subsequent coordination with a citizens advisory committee comprised of representatives of the city most affected by flood problems, indicated that the local acceptability of various alternative plans was, from most to least acceptable:

a. Floodplain regulations and flood insurance (most acceptable).

b. Upstream reservoir storage.

c. Channel modifications.

d. Do nothing.

e. Levees and/or floodwalls.

f. Floodplain evacuation (least acceptable).

The completed results of this evaluation were presented on 10 June 1975 to the citizens advisory committee, elected officials of Rockford, and the interested public. Since none of the major potential immediate solutions to flood damage problems at Rockford was economically feasible, additional study on any of these alternatives was deemed unjustifiable. Local interests concurred in the conclusions reached, although they still indicated their desire to have a positive solution to their flood problem implemented. Representatives of the Minnesota Department of Natural Resources agreed with our study findings and indicated they would continue to provide assistance to Rockford in implementing a comprehensive floodplain management program. The National Weather Service commented that floodplain zoning in conjunction with adequate flood warning and a community action plan provides for a substantial reduction in flood damage. The Weather Service will continue to provide flood forecasts and warnings to the residents of Rockford. Letters from the Weather Service and the Department of Natural Resources are contained in Section V.

RECOMMENDATIONS

To provide for proper implementation of the best plan for reduction of flood damages at Rockford, I recommend that the following actions be taken.

* When requested by the Minnesota Department of Natural Resources, Rockford should enact a floodplain zoning ordinance to replace the existing floodplain land use resolution. The objective of this ordinance should be to preclude any further residential, business, or other development in flood prone areas which would be subject to damage by the 100-year flood. The guidelines furnished by the Minnesota Department of Natural Resources should be followed in the preparation of an appropriate floodplain zoning ordinance. This ordinance should be effective in meeting the objective of reducing the potential for flood damages. Under the continuing authority of section 206 of the 1960 Flood Control Act, the Corps of Engineers, at the request of the city, will provide technical information and planning assistance that may be needed for the implementation of the floodplain zoning ordinance and flood proofing measures.

* Rockford should maintain its eligibility for participation in the federally subsidized flood insurance program. Individual property owners and businesses that have property subject to damages by floods should participate in the flood insurance program to assure that they will recover for damages suffered due to flooding.

* Rockford should have a flood emergency plan which sets forth procedures to be followed in the event of an impending flood. These procedures should include a description of the activities to be accomplished, a time and priority schedule for their accomplishment, and the predicted flood stage level at which they would be required. Sandbag closures in the levee, pumping needs for interior drainage, and evacuation of residents should be covered by the flood emergency plan. Individual task responsibilities also should be designated. During flood emergencies, representatives of the Corps of Engineers will be available to offer technical assistance in preventing flood damages. Other flood fighting services of the Corps of Engineers, such as portable pumps, sandbags, and emergency construction capability, will also be available as necessary.

* Public agencies, individual property owners, and businesses should undertake, where feasible, structural modifications to flood proof their properties. These flood proofing measures would be most applicable to properties located along the edges of the floodplain where the depths of flooding from the 100-year flood would generally be less than 2 feet and where velocities would be relatively slow. The mobile home park would be a principal candidate for implementation of flood proofing measures.

* The National Weather Service should continue to provide the timely prediction of flood crests for the Crow River at Rockford. The predicted date and the height of the flood crest would continue to provide Rockford with valuable lead time to prepare for an impending flood.

FORREST T. GAY, III
Colonel, Corps of Engineers
District Engineer

Technical Report on

Flood Control Alternatives

Crow River

at

Rockford, Minnesota

ST. PAUL DISTRICT
CORPS OF ENGINEERS
SEPT. 1975

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SECTION I

THE STUDY AND REPORT

SECTION I

THE STUDY AND REPORT

PURPOSE AND AUTHORITY

Following major flooding at Rockford, Minn., in 1965 and 1969, the village council of Rockford passed a resolution on 28 June 1972 requesting the Corps of Engineers to study the feasibility of implementing permanent flood damage reduction measures under its small project authority. The purpose of this report is to comply with that request, and to evaluate the alternatives for flood damage reduction under the authority of Section 205 of the Flood Control Act approved 30 June 1948, as amended, which reads as follows:

> "The Secretary of the Army is authorized to allot from any appropriations heretofore or hereafter made for flood control, not to exceed $30,000,000 for any one fiscal year, for the construction of small projects for flood control and related purposes not specifically authorized by Congress, which come within the provisions of Section 1 of the Flood Control Act of June 22, 1936, when in the opinion of the Chief of Engineers such work is advisable. The amount allotted for a project shall be sufficient to complete Federal participation in the project. Not more than $1,000,000 shall be allotted under this section for a project at any single locality, except that not more than $2,000,000 shall be allotted under this section for a project at a single locality if such project protects an area which has been declared to be a major disaster area pursuant to the Disaster Relief Act of 1966 or the Disaster Relief Act of 1970 in the five-year period immediately preceding the date the Chief of Engineers deems such work advisable.

The provisions of local cooperation specified in section 3 of the Flood Control Act of June 22, 1936, as amended, shall apply. The work shall be complete in itself and not commit the United States to any additional improvements to insure its successful operation, except as may result from the normal procedure applying to projects authorized after submission of preliminary examination and survey reports."

SCOPE OF THE STUDY

This study assesses the water and related land resource problems and needs with emphasis on the flood problems along the Crow River at and in the vicinity of Rockford. The general area is illustrated in the following figure.

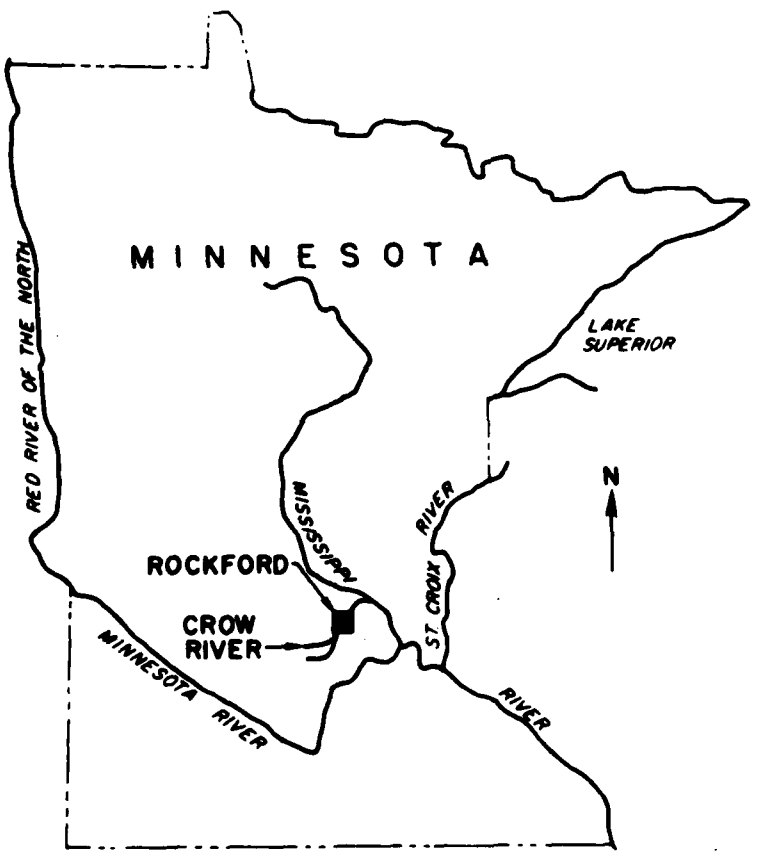


Figure A-1 - Location map, Crow River at Rockford, Minnesota

The investigations are based on field instrument surveys, aerial topographic maps, flood damage appraisals, and analyses of the engineering, economic, environmental, and social factors involved. Floodplain information studies included the delineation of the intermediate regional floodplain and preparation of water surface profiles for various levels of floods. Investigations were made in sufficient detail to permit adequate evaluation of the positive and negative aspects of possible alternatives and to determine if a feasible and practicable solution to the flood problems at Rockford exists.

STUDY PARTICIPANTS AND COORDINATION

The Corps of Engineers has the principal responsibility for conducting the study, compiling information from local interests and other agencies, evaluating alternatives, and preparing this report. The St. Paul District contracted with Barr Engineering Company, a consulting hydraulic engineering firm, for an assessment of the engineering, economic, social, and environmental aspects of the alternatives for flood damage reduction. Agencies and governmental units providing input to the study include the U.S. Fish and Wildlife Service, the Minnesota Department of Natural Resources, the Minnesota Department of Highways, and the city of Rockford.

Input from the general public was obtained via a public meeting held on 26 November 1973 and through several meetings with a citizens advisory committee composed of interested citizens of the Rockford area.

THE REPORT

This report has been arranged into a main report and technical appendix. The main report is a nontechnical summary of the overall study. The technical appendix contains detailed information

compiled and utilized during report preparation, including detailed information on the study and report, environmental setting and resources, problems and needs, and plan formulation.

PRIOR REPORTS

The following prior studies and reports contain valuable information regarding water and related land resource problems and needs in the area.

The Upper Mississippi River Comprehensive Basin Study, prepared under the supervision of the Upper Mississippi River Basin Coordinating Committee, was completed in June 1972. This report presents data for a framework program for development and management of water and related land resources of the Upper Mississippi River basin. The Crow River is included in this study.

Section 205, Flood Control Reconnaissance Report, Crow River at Rockford, Minnesota, was completed 20 August 1973. This report evaluated the flood problems at Rockford on a preliminary basis and found that a feasible solution to the problem might exist. Preparation of the section 205 detailed project report was recommended.

Floodplain Information, Crow River at Rockford, Minnesota, describes the flood history and extent of the intermediate regional and standard project floods, including water surface profiles, flood outline maps, and pictorial representation of potential water depths at key points in Rockford for these two floods. The study was completed in February 1968 and was instrumental in identifying the flood hazards at Rockford.

SECTION II

ENVIRONMENTAL SETTING AND RESOURCES

SECTION II

ENVIRONMENTAL SETTING AND RESOURCES

INTRODUCTION

An understanding of the present environmental setting, the natural, human, and economic resources; and the future developmental trends of the study area is essential to the understanding of the present and projected problems and needs and development of possible solutions. The following paragraphs discuss the environmental setting and natural resources, the human resources, the development and economy, and the publications which describe the study area.

The study area is described essentially by the corporate limits of the city of Rockford, Minn., with some additional area included to the north, west, and south, and is illustrated on plate 1. Rockford is located on the Crow River about 25 miles west-northwest of downtown Minneapolis, Minn. The Crow River in the vicinity of Rockford forms the boundary between eastern Wright County and western Hennepin County, Minn. Rockford is located in both Wright and Hennepin Counties, with the largest portion located in Wright County.

ENVIRONMENTAL SETTING AND NATURAL RESOURCES

TOPOGRAPHY, GEOLOGY, AND SOILS

The city of Rockford is located in the valley of the Crow River approximately 23.5 miles upstream from the confluence of the Crow River with the Mississippi River. Gently rolling to steep topography characterizes most of the surrounding area.

The study area is underlain by glacial drift in the form of glacial till, glacial outwash, and Cambrian and Precambrian rocks (see figure A-2). The predominant glacial deposits are presumed to be from the last glacial epoch called the Wisconsin Ice Sheet. The glacial drift at Rockford is approximately 300 feet thick. A well drilled in Rockford to a depth of 175 feet was still in the glacial drift (see figure A-3).

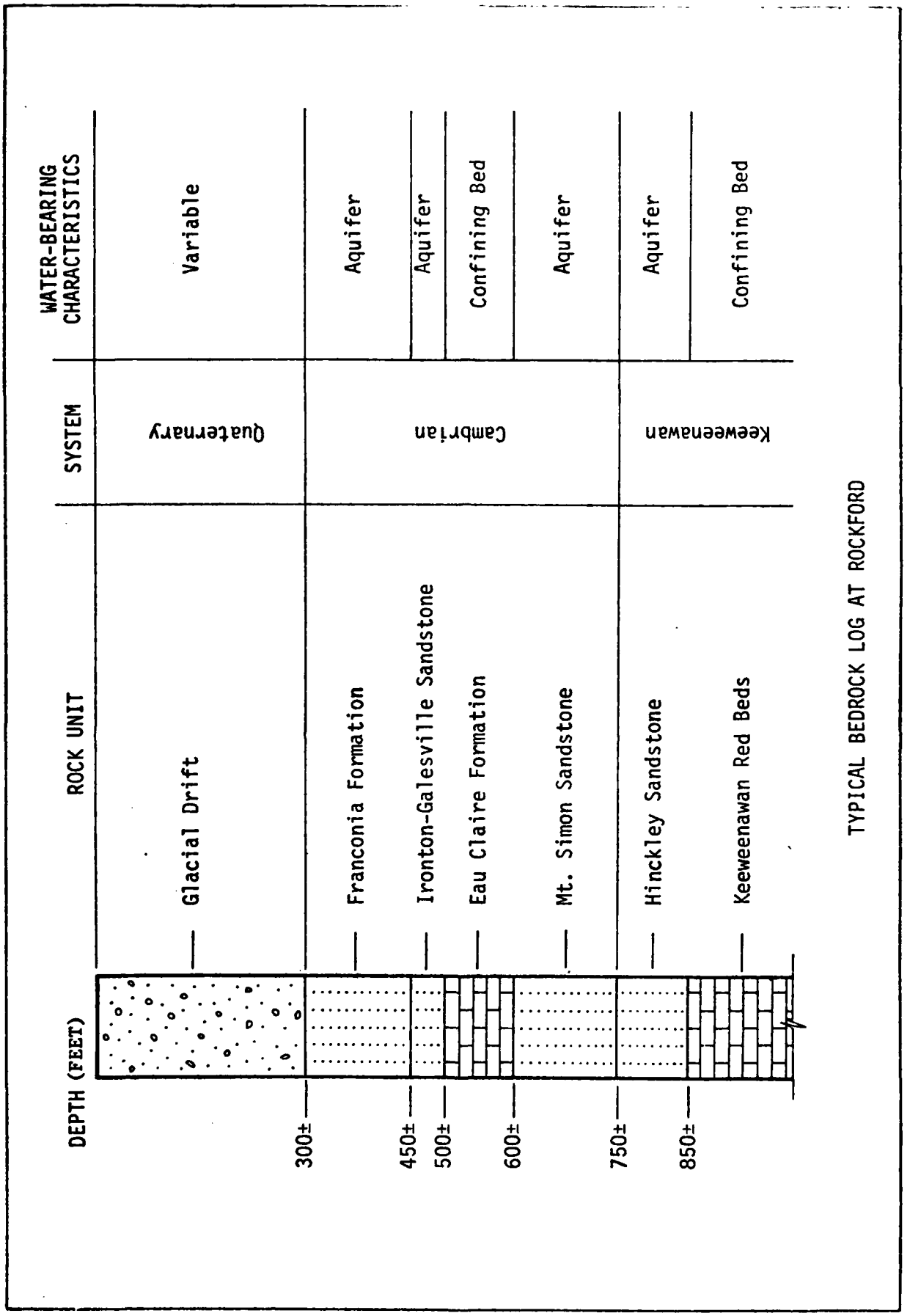


Figure A-2 - Typical bedrock log at Rockford, Minn.

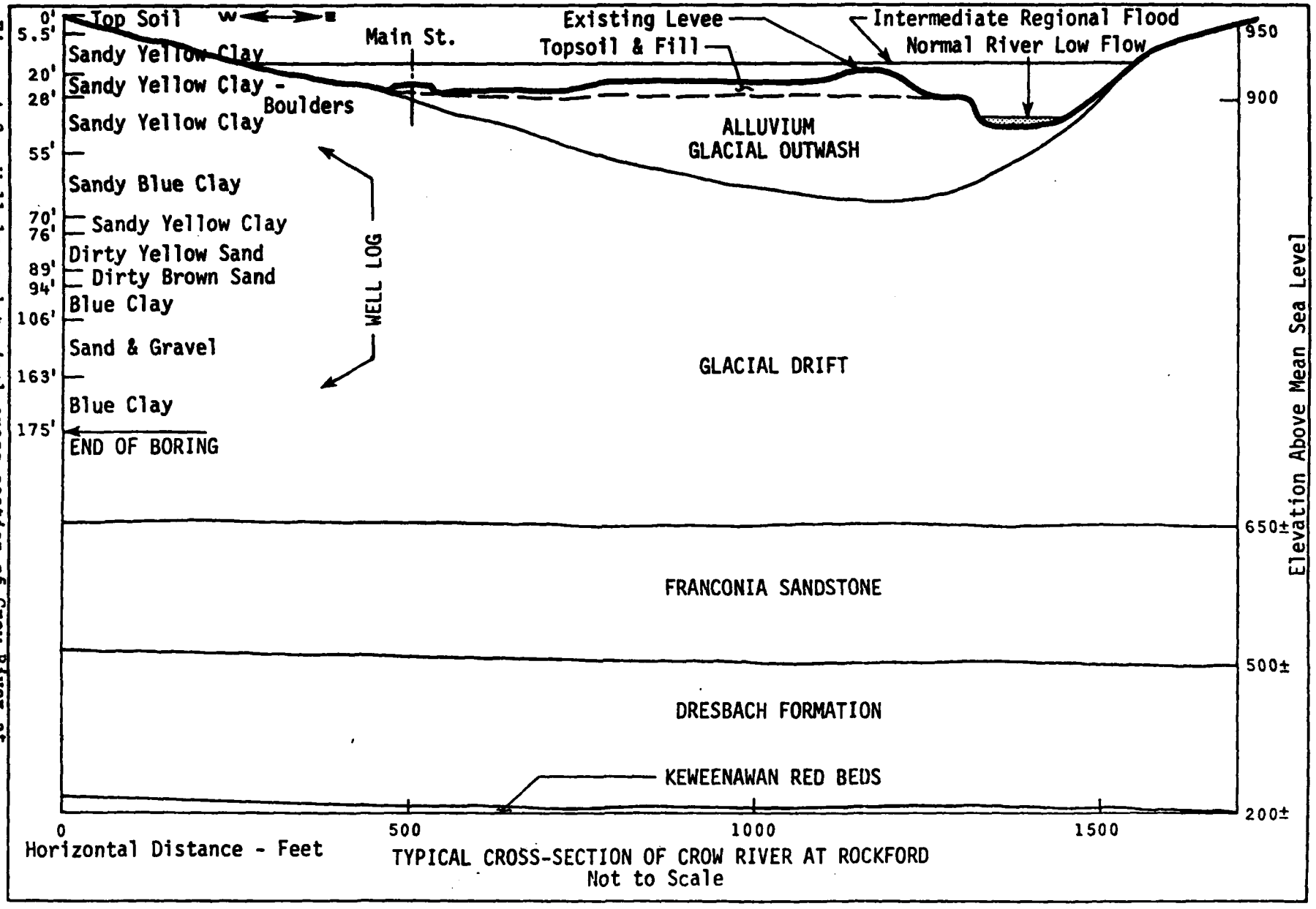


Figure A-3 - Well log and typical cross-section of Crow River at Rockford, Minn.

The surface material includes two till sheets. The lower sheet is a red, coarse-textured drift deposited by the Superior Lobe and the upper sheet is a clayey, gray calcareous drift deposited by the Gransburg Sublobe. The upper till sheet is considered a good groundwater source.

Bedrock in this area consists of the Franconia Sandstone and the Dresbach Formation. Records of local wells in the study area show a depth to bedrock of approximately 300 feet.

A typical cross section north of Bridge Street at Rockford showing the stratigraphy and the normal low flow and the intermediate regional flood of the Crow River is illustrated in the preceding figure (A-3).

The course of the present Crow River generally follows the course of a glacial river which deposited the glacial outwash (see figure A-4). The glacial river began near Delano, Minn., and ended at its confluence with the Mississippi River near Dayton, Minn. The lower lands near the Crow River are subject to occasional flooding, and deposition of alluvial material continues in the same manner as during the glacial period.

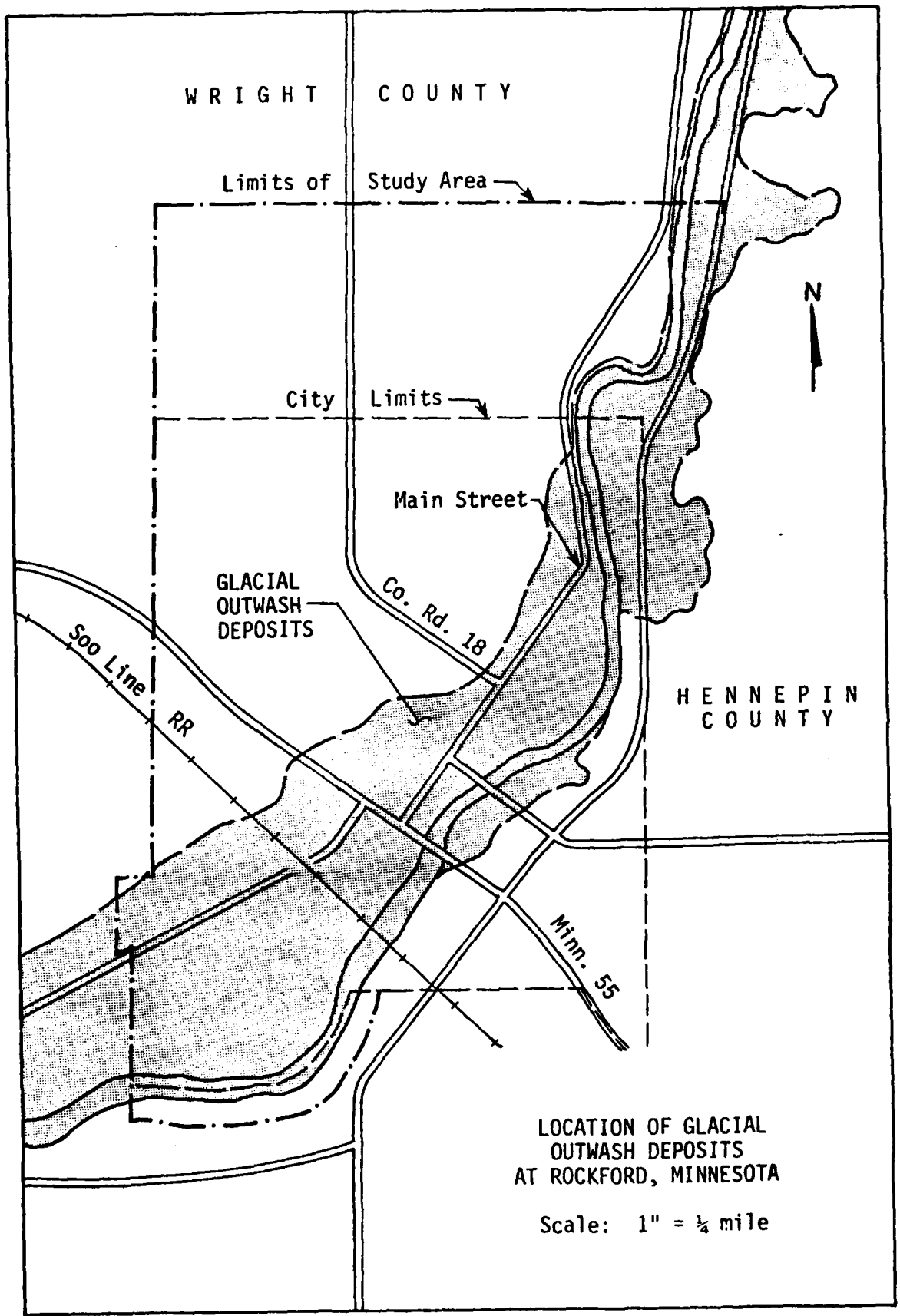
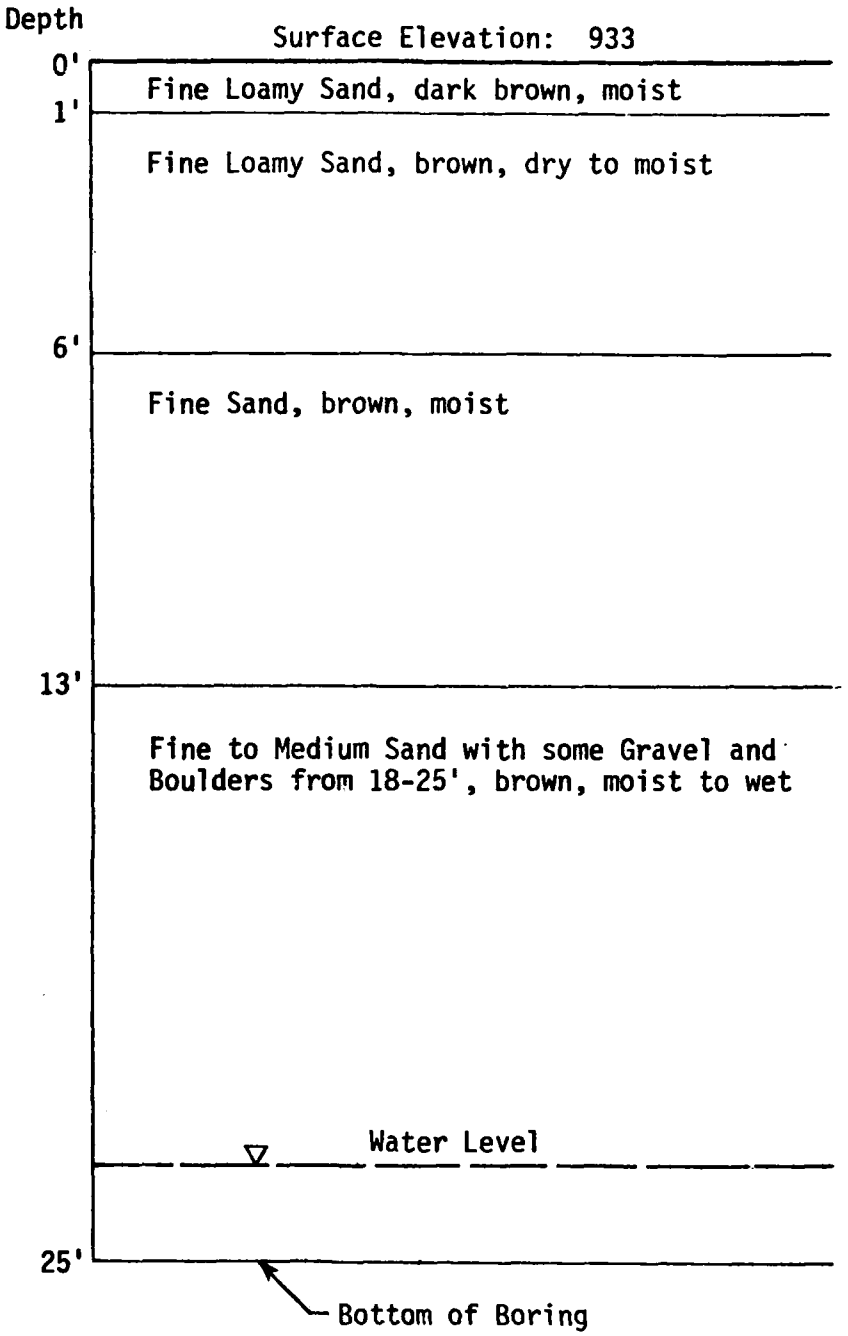


Figure A-4 - Location of glacial outwash deposits at Rockford, Minn.

The glacial outwash at Rockford is typically a stratified coarse-textured material consisting of sand and gravel with large stones. The alluvium is generally a finer material and large stones are usually absent. A typical shallow boring log at Rockford in the glacial outwash area is shown in the following figure (A-5). The location of shallow borings for which this log is considered typical is illustrated on plate 1.



TYPICAL BORING IN GLACIAL OUTWASH

Vertical Scale: 1" = 4'

Figure A-5 - Typical shallow boring log in glacial outwash, Rockford, Minn.

The till which borders the glacial outwash deposits began as a gray, heterogeneous mixture of sand, silt, and clay. Leaching and exposure to air have transformed the well-drained soil to an olive brown, yellowish color. The well log in figure A-3 (page A-7) shows a soil profile through the glacial till.

The glacial till soils are primarily Hayden and Lester soil associations and are considered generally fair to good as a topsoil for agriculture. The glacial outwash soils are not as productive as cropland and are more suited for pasture. All the soils in the area are acceptable for development and recreation provided the slopes are not excessively steep, causing erosion. The glacial till soils may become sticky when wet and are not recommended for high use camping areas, play areas, or trails. The glacial till soils normally are capable of providing excellent habitat for wildlife such as pheasants, squirrels, rabbits, ducks, mink, muskrat, and deer.

The foundation material beneath the existing levee and along the river terrace is primarily alluvial soils consisting of loose to medium dense sand, as illustrated in figure A-6 (page A-13). The alignment of the existing levee is indicated in figure A-7 (page A-14). The levee was constructed under emergency conditions preceding the 1969 flood and consists predominantly of a sand-silt mixture which has the characteristic yellowish coloration of the area. The material is presently compacted and has adequate vegetation on the side slopes to reduce erosion. The existing levee is assumed to overlay fill material of a fine sand-silt mixture with occasional debris. Photograph A-1 on page A-15 indicates the general condition of the existing emergency levee.

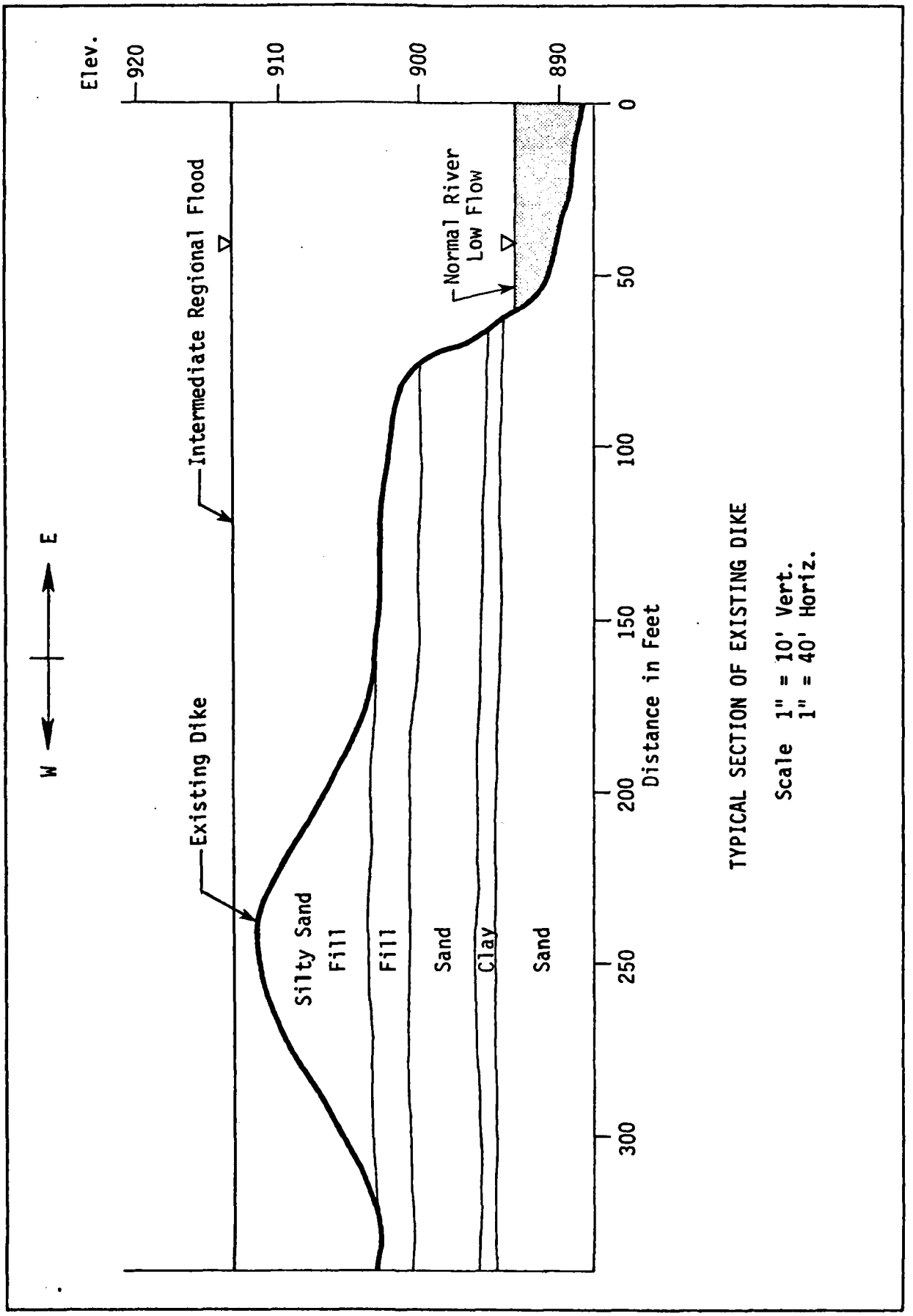
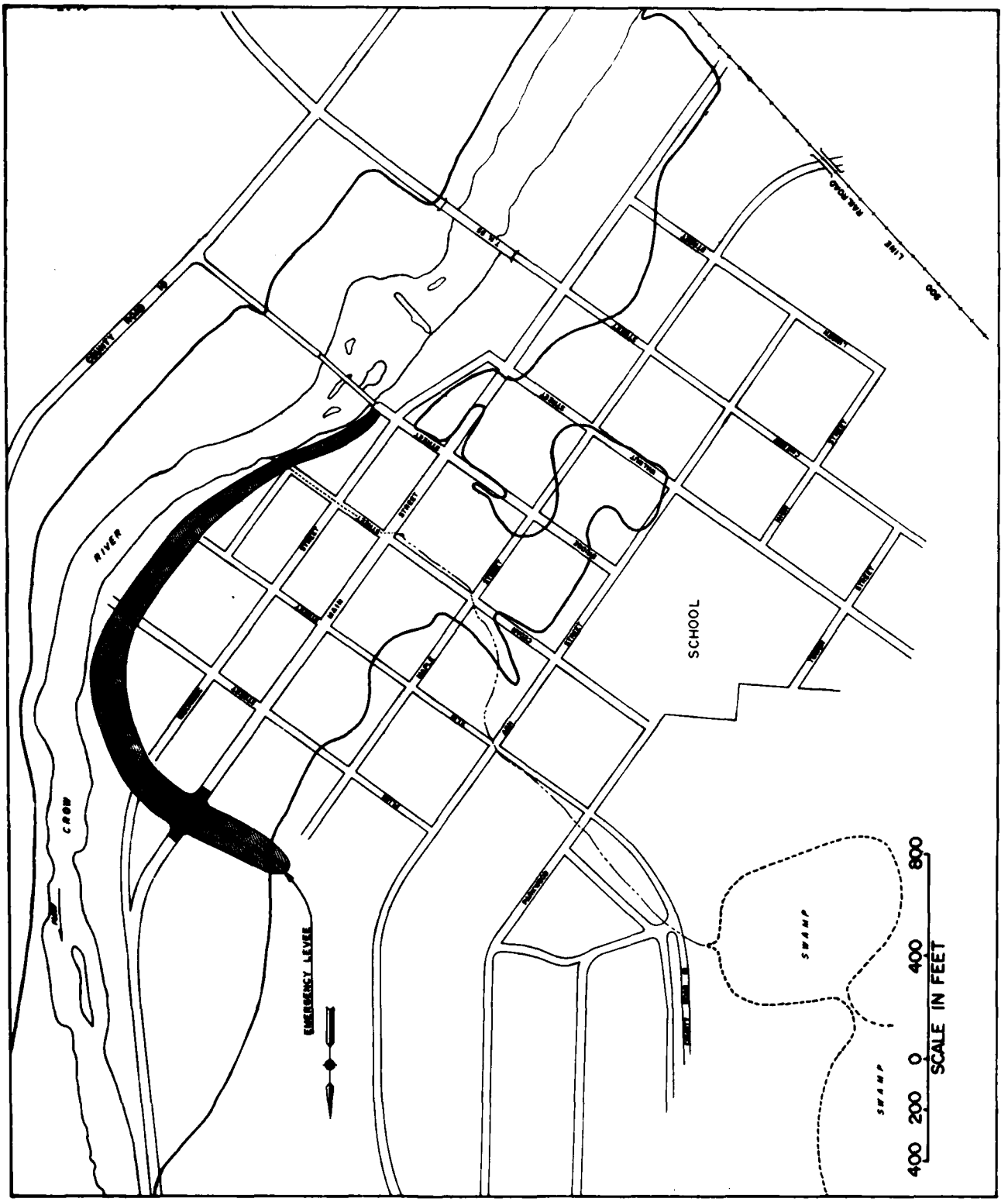


Figure A-6 - Typical cross-section of existing levee, Rockford, Minn.



ALIGNMENT OF EXISTING EMERGENCY LEVEE
ROCKFORD MINNESOTA

FIGURE A-7

Photo A-1 - Emergency levee along river looking north

CLIMATE

The climate of Rockford and its vicinity is moderate, characterized by frequent temperature variations, normally sufficient rainfall, and moderate snowfall. Climatological data are available for the vicinity of Rockford dating back to January 1896. The closest weather station is at Maple Plain, Minn., about 7 miles southeast of Rockford.

The mean annual temperature for Rockford is about 44° F and the mean monthly temperature varies from 73° F in July to 13° F in January. Extreme temperatures of record are a high of 110° F in July 1936 and a low of -37° F in January 1912. The average number of frost-free days is 150 (7 May to 5 October). Prevailing winds are from the northwest during the winter and from the south during the remainder of the year.

The normal annual precipitation in Rockford is 28.8 inches. Annual precipitation has ranged from a maximum of 44.8 inches in 1951 to a minimum of 21.0 inches in 1896. Average annual snowfall is 44 inches, approximately 15 percent of the normal annual precipitation. Table A-1 summarizes climatological data for Rockford.

Table A-1 - Climatological data for Rockford vicinity

Item	Minimum	Maximum	Mean
Rainfall (inches)	21.0	44.8	28.8
Snowfall (inches)	19.0	89.0	44.0
Temperature	-37° F	110° F	44° F

STREAMFLOW CHARACTERISTICS

The Crow River is divided into two major streams known as the South Fork and the North Fork, which combine approximately 1 mile upstream of Rockford. The main stem of the Crow River downstream of its two main forks is relatively short - approximately 24 miles to its mouth at the Mississippi River. There are no main tributaries below the junction of the North and South Forks.

The approximate drainage area of the Crow River at Rockford is 2,520 square miles. The drainage area extends into 10 Minnesota counties including Hennepin, Wright, Carver, Kandiyohi, Meeker, Renville, McLeod, Sibley, Stearns, and Pope. The sizes of the drainage areas for each fork are approximately the same - 1,250 square miles and 1,270 square miles for the North Fork and South Fork, respectively. However, the South Fork has a greater potential for flooding since there is less storage in the drainage area, such as lakes and swamps; the watershed is shorter and wider than the North Fork; and the average main channel slope is greater, allowing the water to drain off more rapidly.

The North Fork flows in a well-defined channel in a valley 40 to 50 feet below the adjacent land surface for the greater share of its length. Channel slopes are fairly uniform and average 2.9 feet per mile in the upper 100 miles and 1.6 feet per mile in the lower 75 miles. The North Fork watershed is about 85 miles long and averages 15 miles in width.

The Middle Fork of the Crow River is the major tributary of the North Fork and has a drainage area of about 280 square miles. The flow on the Middle Fork is partially controlled by dams at New London, Minn., and below Nest Lake. Part of the flow of the Middle Fork is diverted through Calhoun Lake.

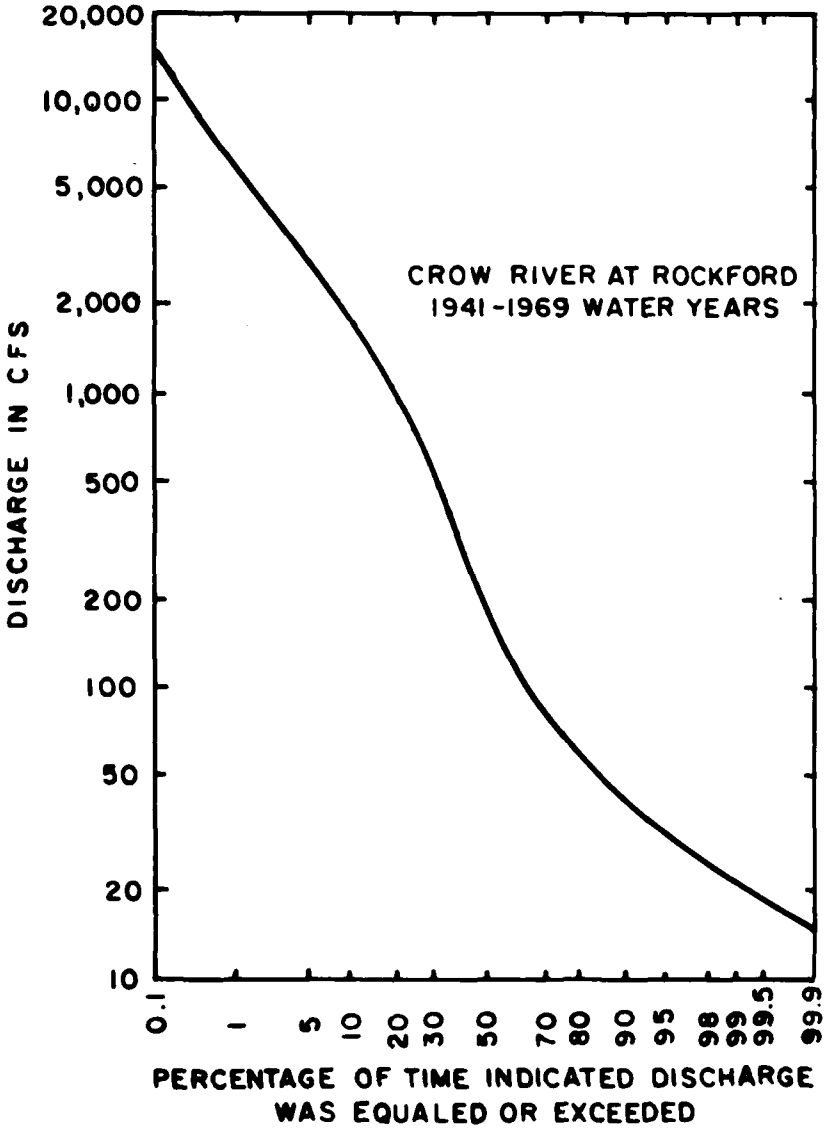
The upper part of the South Fork drains relatively flat prairie land with numerous lakes, ponds, and marshes. Channels are only slightly below the elevations of the adjacent land, and slopes are not over 1 foot per mile. The slope of the main channel increases to 2.5 feet per mile below Hutchinson, Minn., and the valley becomes deeper and the topography more rolling in the lower part of the watershed. The watershed area is approximately 65 miles long and 20 miles wide. Drainage areas at various points on the Crow River and its main branches are given in the following table.

Table A-2 - Drainage areas in watershed of Crow River

Stream	Location	Miles above mouth	Drainage area (sq. mi.)
Main stream	Mouth	0.0	2,756
Main stream	Rockford	23.5	2,520
North Fork	Confluence with South Fork	24.5	1,250
South Fork	Confluence with North Fork	24.5	1,270
South Fork	1.3 miles north of Mayer, Minn.	16.0	1,170
Middle Fork	Mouth	0.0	280
Buffalo Creek	Mouth	0.0	394

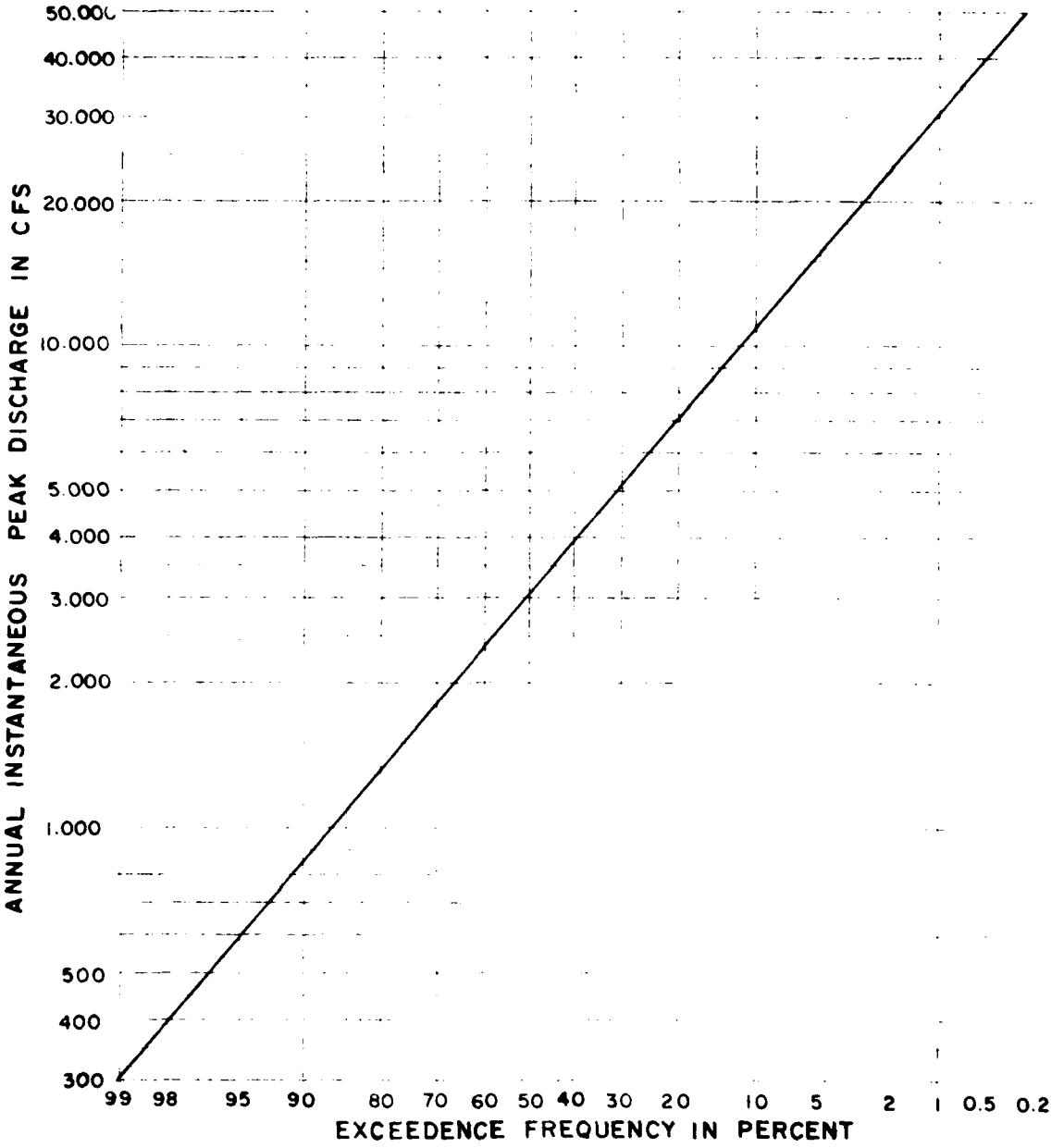
The first records of river stage and discharge on the Crow River were made in 1896 at a point about 1 mile above the mouth near Dayton. Intermittent records are available for this point and Rockford from 1896 to 1934. The U.S. Geological Survey has maintained a recording gage at Rockford from March 1934 to the present. Since there is relatively little additional drainage area tributary to the Crow River between Rockford and the mouth, the discharge records from near Dayton can be used as a close approximation of the discharge occurring at Rockford for those periods when records are not available at Rockford.

Flow-duration relationships for the Crow River at Rockford, as illustrated in figure A-8 (page A-19) indicate that a fairly reliable flow can be expected to occur throughout the year. The streamflow has never been reduced to zero; however a minimum discharge of record of 1.8 cfs (cubic feet per second) occurred on 15 November 1936.



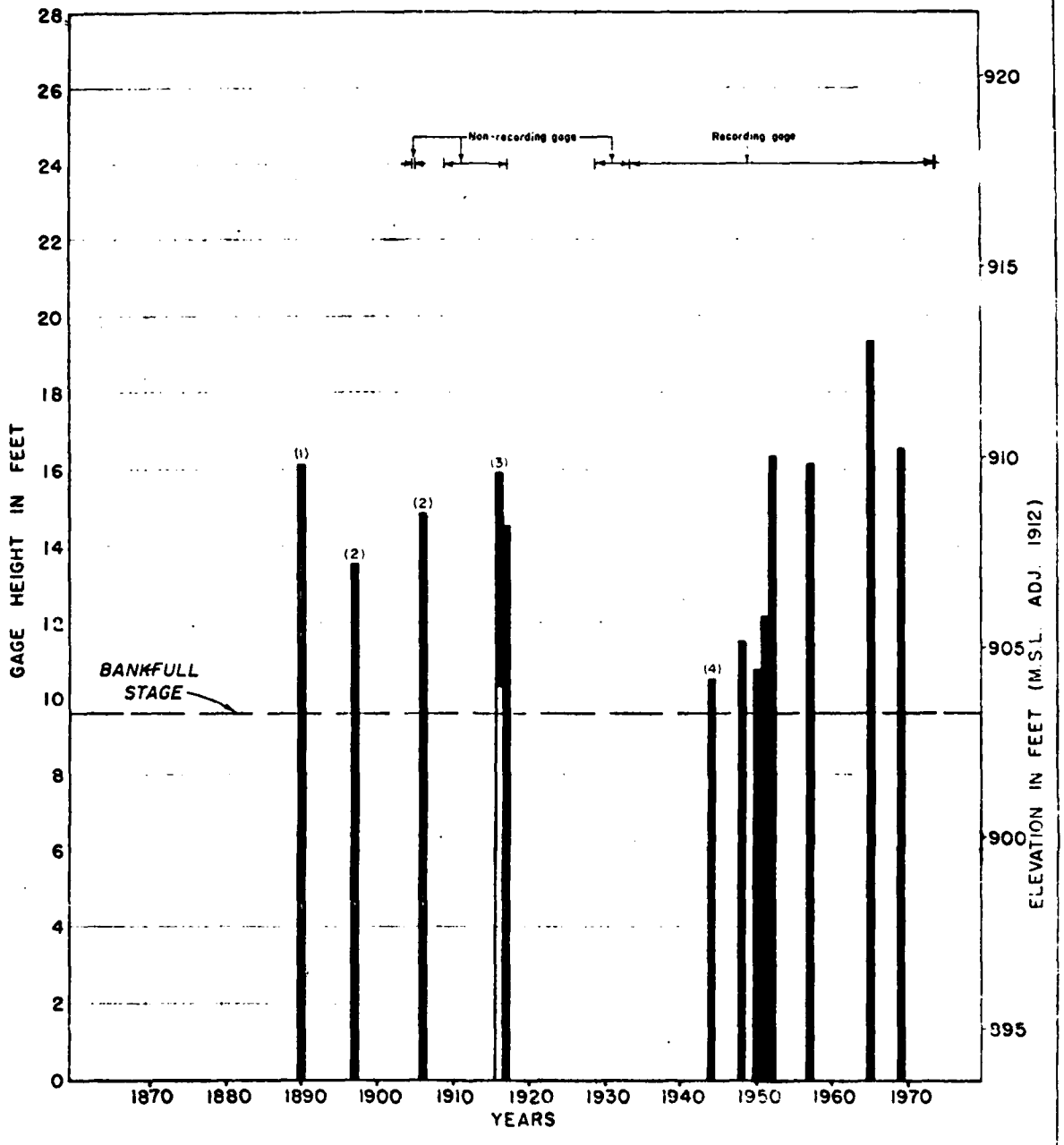
FLOW-DURATION CURVE
CROW RIVER AT ROCKFORD, MINN.
FIGURE A-8

The average discharge in the Crow River at Rockford is 625 cfs for the 48 years of record prior to 1974, which converts to about 3.4 inches of runoff over the drainage area per year. The discharge-frequency relationships for the Crow River at Rockford are illustrated in figure A-8a (page A-21). The 1-percent chance discharge is estimated at 30,600 cfs.



DISCHARGE-FREQUENCY CURVE
CROW RIVER AT ROCKFORD, MINN.
FIGURE A-8a

The greatest discharges of record have normally occurred in April as a result of snowmelt and runoff from heavy coincidental rainfall. Fifteen events have been recorded for which the river exceeded its banks and flooded adjacent low-lying areas. These events are illustrated in figure A-9 (page A-23). The flood of record occurred on 16 April 1965 with an estimated peak discharge of 22,400 cfs and a stage of 19.27 feet (elevation 912.92 msl (mean sea level), 1912 adjustment). The 10 highest known floods of record are arranged in the order of magnitude in table A-3 (page A-24).



(1) Estimated from flood mark near Dayton Stage related back to Rockford gage

(2) From discharge measurement near Dayton Stage related back to Rockford gage

(3) Variation in shading on the bar graph indicates more than one flood during the year, gage heights were 15.9 and 10.3

(4) Two floods occurred in this year at the same stage

Zero of gage, elevation 893.65

CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL, MINNESOTA, DISTRICT

FLOODS ABOVE BANKFULL STAGE

CROW RIVER
AT
ROCKFORD, MINNESOTA

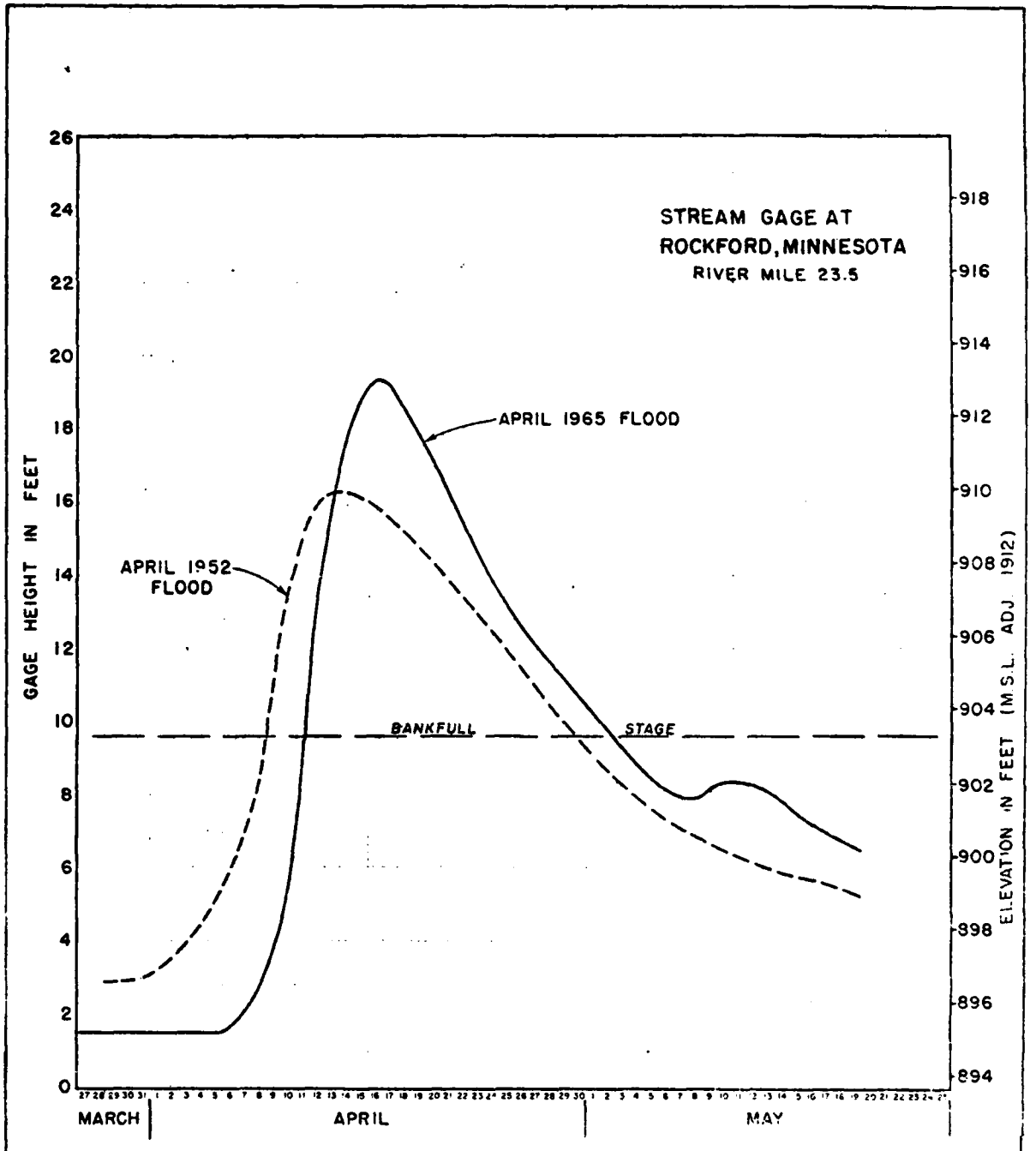
HIGHEST KNOWN FLOODS OF RECORD
CROW RIVER AT ROCKFORD, MINN.
FIGURE A-9

Table A-3 - Highest 10 known floods in order of magnitude, Crow River at Rockford, Minn.

Number	Date of crest	Gage height stage elevation		Estimated peak discharge (cfs)
		Feet	Feet (msl 1912 adj)	
1	16 April 1965	19.27	912.92	22,400
2	13 April 1969	16.51	910.16	15,100
3	13 April 1952	16.24	909.89	13,900
4	26 June 1957	16.14	909.79	13,500
5	June 1890(1)	16.14(3)	909.79	13,500
6	31 May 1906(2)	14.83(3)	908.48	11,000
7	2,3 April 1961	15.9	909.55	10,600
8	9 April 1897(2)	13.54(3)	907.19	9,180
9	6,7 April 1917	14.5	907.15	8,500
10	16 April 1951	12.13	905.78	7,720

(1) Estimated from flood mark near Dayton, Minn.
(2) From discharge measurement near Dayton, Minn.
(3) Stage is determined from rating curve (1 Oct 1964 to 11 Apr 1965) at Rockford, Minn., U.S. Geological Survey gaging station.

The stage hydrographs on the Crow River at the Rockford stream gaging station for the floods of April 1952 and April 1965 are illustrated in figure A-10. During the 1965 flood the river rose to its crest stage in 11 days at the average rate of 1.6 feet per day with a maximum rate of 4.2 feet per day and remained above bank-full stage for 21 days. During the 1952 flood the river rose to its crest stage in 13 days at an average rate of 1.0 foot per day with a maximum rate of 2.3 feet per day and remained above bank-full stage for 21 days.



STAGE HYDROGRAPHS
1952 AND 1965 FLOODS
CROW RIVER AT ROCKFORD, MINN.
FIGURE A-10.

During the April 1965 flood, it is estimated that velocities in the main channel ranged up to 6.7 fps (feet per second). Overbank velocities ranged up to 2.0 fps. During larger floods, such as the intermediate regional and standard project floods, velocities would be greater. Velocities up to and over 5 fps in the main channel and up to 2 fps in the floodplain areas would be considered typical of most past floods. The velocities in the floodplain vary greatly, depending upon the depth of flow and type of development and/or vegetation. Generally the deeper the flow depth and the more open the area, the higher the velocities will be. Water surface profiles for various flood levels are illustrated on plate 3.

WATER QUALITY

The Crow River is classified as a 2-B stream under the WPC-14 Standards set by the Minnesota Pollution Control Agency. This level of water quality permits propagation and maintenance of cool or warmwater fishes (walleye, bass, panfish) and is suitable for aquatic recreation of all kinds including swimming. On 6 December 1974, the Crow River was sampled at the following four locations within the study area for the parameters specified in the WPC-14, 2-B standards:

Station 1: At the end of Beach Drive.
Station 2: Under the bridge located on Bridge Street.
Station 3: Just north of the end of Oak Street.
Station 4: The bend just north of the Rockford city limits.

These stations are shown on plate 1. The following table (A-4) lists the parameters, standards, and test results for each station sampled.

Table A-4 - Water quality test results for Crow River within project area, 6 December 1974

Substance	WPC-14 2-B standard	Station number (1) 1	2	3	4
Oil and grease	0.5 mg/l	< 1	< 1	< 1	< 1
Total chromium	50 mg/l	< 1	< 1	< 1	< 1
Total copper	0.01 mg/l	< 0.001	< 0.001	< 0.001	< 0.001
Ammonia-nitrogen	1 mg/l	1.0	1.1	2.1	1.5
pH	6.5 to 9.0	8.0	8.0	8.1	8.1
Phenol	0.01 mg/l	0.016	0.008	0.012	0.02
Fecal coliform	200/100 ml	< 10	< 10	< 10	< 10
Turbidity	25 JTU	6.4	6.4	6.0	6.8
Cyanide	0.02 mg/l	0.005	0.002	0.002	0.004

Key: < means "less than".
mg/l = milligrams per liter or parts per million (ppm).
JTU = Jackson Turbidity Unit.
(1) Values given are in same unit as corresponding WPC-14, 2-B standard.

The test used to determine the concentration of oil and grease was not sensitive enough to accurately measure concentrations of less than 1 mg/l (milligrams per liter). Therefore, it was not conclusively established that this parameter was within the 2-B standards. All samples tested were well within the 2-B standards for the remaining parameters except for the amounts of ammonia-nitrogen and phenols. The standards for both of these parameters were exceeded at three of the four stations. The magnitude with which the phenol standards were exceeded at stations 1, 3, and 4 was small and does not represent a significant departure from the required levels. The ammonia-nitrogen level exceeded the standards at stations 2, 3, and 4 and was slightly less than the 1 mg/l-standard at station 1. Station 3 had the highest ammonia-nitrogen level, but this may be due to the station's location

just upstream from the sewage treatment plant outfall. Ammonia-nitrogen is a product of bacterial decomposition of organic material and its concentration in natural waters fluctuates from day to day. A single value exceeding the standards does not necessarily indicate a point source of contamination.

The Minnesota Pollution Control Agency has water quality data for two locations on the Crow River outside of the study area and a limited amount of data for the Crow River at Rockford for the years 1956 and 1957. Various chemical parameters were sampled at Dayton and at a location 35 miles upstream from the mouth of the Crow River in addition to the Rockford data. The following table (table A-5) summarizes the more recent data obtained from the Minnesota Pollution Control Agency for the years 1970-74, which are available only for the Dayton location. Only those parameters included in the WPC-14, 2-B standards are listed. The total number of samples taken each year is given together with the percentage of these samples which met the water quality standards.

Table A-5 - Minnesota Pollution Control Agency water quality data and WPC-14, 2-B standards for the Crow River at Dayton, Minn., 1970-74

		Percent of samples meeting WPC-14, 2-B standards						
Year	Total number of samples	Turbidity (25 JTU maximum)	Fecal coliform (200/100 ml maximum)	Ammonia-nitrogen (0.001 mg/l maximum)	Copper (0.01 mg/l maximum)	Dissolved oxygen (6 mg/l April and May, 5 mg/l other maximum)	Temperature (not to exceed 5^{o} above natural)	pH (6.5-9.0)
1970	9	100	55	100	100	100	100	100
1971	11	100	36	91	100	100	100	100
1972	9	100	22	100	100	100	100	100
1973	12	100	17	92	100	100	100	100
1974	7	100	57	100	100	100	100	100
Average		100	37	97	100	100	100	100

These data indicate that a decreasing number of the fecal coliform samples met the standards between 1970 and 1973, but over half the samples met the 200 organisms/100 ml (milliliter) standard during 1974. Fecal coliform bacteria are present in the intestines of all warm-blooded animals and are washed into the rivers during periods of heavy rainfall. Fecal coliform counts often temporarily exceed the standards at these times. In general, the water quality of the Crow River in and downstream of the project area meets the 2-B standards during most of the year and from this standpoint is suitable for the recreation activities listed under the 2-B classification.

AQUATIC ENVIRONMENT

STREAM CHARACTERISTICS

The Crow River within the study area averages about 200 feet in width, is relatively straight, and has an average velocity of approximately 1 to 3 fps during nonflood periods. The bottom of the main channel consists primarily of firm gravel with randomly scattered boulders. The gravel bottom is overlain by approximately 1 to 2 feet of silt near the banks. This silt extends approximately 30 feet out from the banks on both sides of the river except in the riffle areas. The relative percentages of the various bottom types are approximately 55 percent gravel, 15 percent boulders, and 30 percent silt.

The stream type within the study area consists of approximately 10 percent riffle and approximately 90 percent slack water and pools. At normal summer flow, the midchannel depths average about 3 feet. The stream bed is relatively uniform in the upstream end of the study area adjacent to the mobile home park. A rocky riffle area extends from the east end of the mobile home park to just east of the Soo

Line Railroad bridge and slack water extends from the downstream end of this riffle area to the old dam between Highway 55 and Bridge Street. Another riffle area extends from the old dam to just downstream of Bridge Street. The remaining downstream reach in the study area consists primarily of relatively deep slack water and pools. Several islands are interspersed in the stream. Photograph A-2 illustrates a typical view of the Crow River in the Rockford area.

Photograph A-2 - View of Crow River upstream of Soo Line trestle.

AQUATIC INVERTEBRATES

The Crow River, within the project boundaries, was sampled for invertebrates on 6 December 1974. Specimens were collected along the west shore of the river between Highway 55 and Bridge Street. The organisms were collected by hand using forceps to remove individual organisms from the substrate. The most abundant group was the caddis flies. Mayflies were common, but less abundant. Aquatic beetles represented by the water scavenger and diving beetle were present on some of the larger logs and branches. Aquatic worms and midge and black fly larvae were common. Stone flies, damselflies, snails, and clams were present, but relatively scarce.

The organisms present in the stream reflect both substrate type and the quality of the water. An abundance of mayflies, stone flies, caddis flies, and clams are indicators of good water quality. Biological studies have shown that these organisms are very sensitive to deteriorating water quality conditions. Snails, midge larvae, black fly larvae, and damselfly larvae are more tolerant and can withstand a greater degree of water quality degradation.

FISH

During July and August 1974, the Minnesota Department of Natural Resources completed an electrofishing survey of the Crow River at the following three locations:

Station 1: Approximately 3 miles upstream from Rockford in the North Fork of the Crow River.

Station 2: From just downstream of the South Fork to the Soo Line Railroad bridge in Rockford.

Station 3: Downstream from Rockford about 10 miles from the study reach.

A summary of types of fish taken and percentage of catch is given in table A-6. The catch is divided into rough fish and game fish groups. Rough fish include: carp, suckers, redhorse, and bullheads. Game fish include: crappies, northern pike, walleyes, and smallmouth bass. A complete listing of species and percentage of catch is given in table A-7 (page A-34).

Table A-6 - Summary of electrofishing data, Crow River near Rockford, Minn.

Type	Station 1		Station 2		Station 3	
	Number	Percent	Number	Percent	Number	Percent
Rough fish	163	94	105	96	82	96
Game fish	11	6	4	4	3	4
Total	174	100	109	100	85	100

Table A-7 - Electrofishing data for the Crow River near Rockford, Minn. - Minnesota Department of Natural Resources

Common name	Scientific name	Number	Percent of catch	Weight (pounds)	Percent of weight
	Station 1 - 7 August 1974				
White sucker	*Catostomus commersoni*	5	2.9	5.3	2.0
Northern redhorse	*Moxostoma macrolepidotum*	9	5.2	20.2	7.7
Silver redhorse	*Moxostoma anisurum*	1	0.6	2.1	0.8
Carp	*Cyprinus carpio*	128	73.6	227.0	87.0
Black bullhead	*Ictalurus melas*	20	11.5	3.2	1.2
Northern pike	*Esox lucius*	2	1.1	1.2	0.5
Walleye	*Stizostedion vitreum*	1	0.6	0.7	0.3
Bluegill	*Lepomis macrochirus*	3	1.7	0.1	-
Black crappie	*Pomoxis nigromaculatus*	3	1.7	0.8	0.3
White crappie	*Pomoxis annularus*	2	1.1	0.5	0.2
Johnny darter	*Etheostoma nigrum*	-	-	-	-
Total		174	100.0	261.1	100.0
	Station 2 - 2 July 1974				
White sucker	*Catostomus commersoni*	2	1.8	2.7	1.3
Carp	*Cyprinus carpio*	102	93.7	201.0	95.6
Black bullhead	*Ictalurus melas*	1	0.9	0.1	-
Northern pike	*Esox lucius*	1	0.9	5.0	2.4
Walleye	*Stizostedion vitreum*	1	0.9	1.1	0.5
Black crappie	*Pomoxis nigromaculatus*	2	1.8	0.4	0.2
Spotfin shiner	*Notropis spilopterus*	-	-	-	-
Total		109	100.0	210.3	100.0
	Station 3 - 3 July 1974				
White sucker	*Catostomus commersoni*	12	14.1	11.4	7.9
Northern redhorse	*Moxostoma macrolepidotum*	24	28.2	39.4	27.2
Silver redhorse	*Moxostoma anisurum*	12	14.1	34.5	23.9
Carp	*Cyprinus carpio*	33	38.8	58.3	40.3
Black bullhead	*Ictalurus melas*	1	1.2	0.5	0.3
Smallmouth bass	*Micropterus dolomieu*	1	1.2	0.1	0.1
Bluegill	*Lepomis macrochirus*	1	1.2	0.1	0.1
Black crappie	*Pomoxis nigromaculatus*	1	1.2	0.3	0.2
Spotfin shiner	*Notropis spilopterus*	-	-	-	-
Bigmouth shiner	*Notropis dorsalis*	-	-	-	-
Bluntnose shiner	*Pimephales notatus*	-	-	-	-
Longnose dace	*Rhinichthys cataractae*	-	-	-	-
Total		85	100.0	144.6	100.0

Included in the 105 rough fish taken at station 2, which is partially within the study area, were 102 carp, 2 common suckers, and 1 black bullhead. The game fish consisted of one northern pike, one walleye, and one black crappie. The other two stations outside of the study area showed similar ratios of rough fish to game fish with rough fish representing over 90 percent of all fish taken. Carp appear to make up the large majority of the total fish biomass in the Crow River within and adjacent to the study area. This abundance of carp limits the production of game fish species which are generally less adaptable and less prolific than the carp. The large carp population does not necessarily reflect poor water quality or poor game fish habitat, but indicates that the carp has adapted well to the existing conditions in the Crow River and is adversely affecting the game fish population through competition for food and space. The carp utilizes many different food sources, both plant and animal, and has a high rate of proliferation. The impact of the carp population on the game fish reduces the value of the river as a recreation resource; however, a fairly diverse game fish population is present in the Crow River, which provides some existing recreation use and a potential for future improvement of the game fish populations through appropriate management practices.

TERRESTRIAL ENVIRONMENT

VEGETATION

Natural vegetation patterns in the vicinity of Rockford are generally discernible subdivisions of the Eastern Deciduous Forest (historically known as the "big woods") which once covered most of the project area. For this study, the area has been separated into three main habitat types: (1) river corridor, (2) upland marsh, and (3) hardwood forest. The areas within the study limits which are included in these categories are shown

on plate 2. Data for this study were gathered through field inspections, by consulting biologists, interviews with University of Minnesota botanists, and review of various scientific keys and publications. Common plant species observed in the Rockford area are listed in the following table (A-8).

Table A-8 - Common plant species in Rockford, Minn., study area

Common name	Scientific name	Location	Density
Trees			
Box elder	*Acer negundo*	FH, FF	A
Silver maple	*Acer saccharinum*	FF	A
Rock elm	*Ulmus thomasii*	FF	C
Cottonwood	*Populus deltoides*	FF	C
Green ash	*Fraxinus pennsylvanica*	FF	C
Red maple	*Acer rubrum*	FF, FH	C
Ironwood	*Ostrya virginiana*	FH	S
American elm	*Ulmus americana*	FF, FH	C
Prickly ash	*Zanthoxylum americanum*	FH	C
Willow	*Salix sp.*	FF	C
Hawthorn	*Crataegus sp.*	FF	S
Sugar maple	*Acer saccharum*	FH	A
Quaking aspen	*Populus tremuloides*	FH, FF	C
Red oak	*Quercus rubra*	FH	C
Hickory	*Carya cordiformis*	FH	S
Basswood	*Tilia americana*	FH	S
Bur oak	*Quercus macrocarpa*	FH, FF	C
Shrubs			
Gray dogwood	*Cornus racemosa*	FH	C
Red-osier dogwood	*Cornus stolonifera*	FF	C
Wild rose	*Rosa sp.*	FF	C
Smooth sumac	*Rhus glabra*	M	C
Frost grape	*Vitis riparia*	FH	C
Prickly gooseberry	*Ribes cynosbati*	FF	C
Black raspberry	*Rubus occidentalis*	FH	C
Willow	*Salix sp.*	FF, M	C

Table A-8 - Common plant species in Rockford, Minn., study area (cont)

Common name	Scientific name	Location	Density
Herbs			
Canary grass	Phalaris arundinacea	FF, M	A
Creeping charlie	Glechoma hederacea	FF	A
Goldenrod	Solidago sp.	FF, M	A
Common thistle	Carduus lanceolatus	FF, M	C
Wild cucumber	Echinocystis lobata	FF	C
Common mullein	Verbascum thapsus	FF	C
Bluegrass	Poa sp.	M	C
Smartweed	Polygonum coccineum	M, FF	C
Bristle grass	Sertaria viridis	FF, M	C
Giant ragweed	Ambrosia trifida	M	A
Sedges	Carex sp.	M	A
Cattail	Typhus latifolia	M	C
Milkweed	Asclepias syriaca	FF, M	C
Bulrush	Scirpus	M	C
Stickweed	Lappula echinata	FF, M	C
Tall coneflower	Rudbeckia laciniata	M	C
Blue vervain	Verbena hastata	M	C
Evening primrose	Oenuthera biennis	M	C
Meadowsweet	Spiraea alba	M	C
Dock, sorrel	Rumex sp.	M, FF	A
Smooth sweet cicely	Osmorphiza longistylis	FH	C
Yarrow	Archillea millefolium	FF,M	A
Nettle	Urtica dioica	M	C
Cord grass	Spartina pectinata	FF	C
Rye grass	Elymus canadensis	M	C
Burdock	Arctium minus	FH, FF	C
Cocklebur	Xanthium strumarium	FF	C

Key: FH = Hardwood forest.
FF = Floodplain forest.
M = Marsh.
A = Abundant, dense growth in area.
C = Common, scattered growth in area.
S = Scarce, occasional plants sighted.

The river corridor consists of 55 acres, bounded on the east side of the river by bluffs and on the west side of the river by the existing levee, the county road fill, and fill in the trailer court area. This area is comprised of 39 acres of river channel, 9 acres of floodplain forest, and 7 acres of open field habitat.

The forested area forms a strip of land extending the full length of the river within the study limits. On the west side of the river, the width of this strip varies from a narrow bank of scattered trees just south of the community to approximately 100 feet at the north end of the existing levee. Although there is much variation between these limits, the average width of this wooded area is approximately 20 feet. On the east side of the river, the width ranges from approximately 200 feet near the Bridge Street Bridge to approximately 50 feet in the vicinity of the meander near the northeast corner of the corporate limits. The average width of the wooded area on this bank is approximately 100 feet.

Some of the common forest species in the river corridor include box elder, silver maple, elm, and cottonwood. Open field vegetation consists mostly of grasses and forbs with scattered as well as clumped shrub and sapling growth. Representative species include canary grass, milkweed, goldenrod, dogwood, willow, and ash. The area is subject to occasional periods of short duration flooding which may account for the various stages in plant succession. Mammals associated with this habitat include white-tailed deer, raccoon, skunk, squirrels, mink, mice, and other small rodents. The following photograph illustrates a typical view of the river corridor at Rockford.

Photograph A-3 - Typical view of river corridor at Rockford, Minn.

The upland marsh includes the low-lying area on the northeast limits of the study area, which retains surface water drainage from the higher ground surrounding it. This habitat is a Type 3 inland shallow marsh.(1)

(1) Wetlands of the United States, U.S. Department of the Interior, Fish and Wildlife Service, Circular 39, 1956.

The marsh consists of two levels; the large and more northerly portion has an area of approximately 31 acres and is approximately 15 feet higher than the smaller portion which has an area of approximately 9 acres. During periods of spring runoff or heavy rainfall, standing water is present on one or both levels for short periods.

Characteristic vegetation of the marsh includes grasses, sedges, cattail, bulrush, vervain, dock and other herbaceous species. Sedges and grasses are the primary ground cover with scattered cattails and bulrushes occurring in the lower marsh area. Vegetation on the drier upper level is primarily grasses and sedges mixed with willow and meadowsweet. Of particular importance is the use of this area by waterfowl, shorebirds, and songbirds. Many of the latter use this type of habitat for breeding. Mallards, blue-winged teal, and wood duck are also attracted due to the marsh's close proximity to the forest. Because of the uncertain timing and duration of periods of standing water, waterfowl breeding is limited or nonexistent. Pheasants currently use this area for cover and mammals including cottontail rabbits, field mice, skunk, raccoon, and an occasional fox are also found in this type of habitat.

The hardwood forest occupies approximately 44 acres within the study area. Dominant species include elm, oak, and aspen; and the young understory trees consist primarily of sugar maple, and some box elder, hickory, and basswood. Mammals nesting and feeding in this area include red and gray squirrels, cottontail rabbits, raccoons, skunk, and several species of mice. The different forms of birdlife that use this area include woodpeckers, nuthatches, chickadees, cardinals, and sparrows, as well as many migratory species. Habitat for game species such as the white-tailed deer and ruffed grouse is minimal because the cover provided in this area is not sufficient for adequate protection during fall and winter months. However, this area may be used as a food source by these species.

WILDLIFE

Wildlife species in the study area are quite varied. The Crow River provides food and water for many species and the marsh area and woods northwest of Rockford also provide habitat. Wildlife, including migratory waterfowl, shorebirds, and songbirds find limited resting and nesting locations in the area. However, population densities, especially of large mammals, are small due to the small usable area present. Some of the more representative species are as follows:

Mammals: White-tailed deer, raccoon, skunk, squirrel, rabbit, mink, and field mice.

Birds: Mallard, blue-winged teal, wood duck, chickadee, hairy and downy woodpecker, and many species of songbirds.

A more detailed listing of the species, including the population densities and preferred habitat, is presented in the following table (A-9).

Table A-9 - Common wildlife species in the Rockford, Minn., study area

Species	Population density[1]	Location[2]
Deer	C	A,U,F
Raccoon	C	U,F
Skunk	C	A,U,F
Mink	S	F
Gray squirrel	A	F
Pocket gopher	C	A,U
Downy woodpecker	A	F
Chickadee	A	F
Cardinal	C	F
Tree sparrow	C	F,U
Duck	C	M
Rabbit	C	M,U,F,A
Mice	C	M,U,F,A
Pheasant	C	M,U,A

(1) Key: A = Abundant, high density throughout study area.
C = Common, density lower in area as a whole, but high in certain sectors.
S = Scarce, density low throughout study area.

(2) Key: A = Agricultural.
F = Floodplain forest.
M = Marsh
U = Open field.

According to the U.S. Department of the Interior listings, Rare and Endangered Fish and Wildlife of the United States, 1974, and United States List of Endangered Fauna, 1974, there is no evidence of rare or endangered species in the project area.

HISTORICAL AND ARCHEOLOGICAL SITES

Until February 1853, the land area in Wright County was occupied by Indians. The Winnebago Indians occupied Wright County for a period and had large villages in several localities. In 1855, after the Winnebago Indians were removed by treaties, the Sioux Indians

continued a nomadic existence in Wright County. In December 1857, Little Crow's band of Sioux Indians camped for the winter near Rockford. Their campground was 2 blocks south of Highway 55 at the present location of the Soo Line Railroad embankment.

According to the records of the Minnesota Historical Society, Indian mounds were built in Rockford. It is believed that these mounds were built by the ancestors of the Indians encountered by the early settlers. The general location of the mounds is south of Highway 55 along the Crow River. It is not known if any of these mounds remain today. Therefore, prior to final design and construction, it would be desirable to have a field investigation performed by the Minnesota Historical Society.

Rockford Township was settled in 1855 and Rockford Village was founded in 1856, platted in 1857, and incorporated in 1881. It became the city of Rockford in 1974.

Rockford became the manufacturing center of Wright County after a steam-powered sawmill and a water-powered grain mill were established in 1856 and 1857, respectively. However, these industries ceased to exist after the sawmill was destroyed by fire and the grain mill was rendered ineffective when legal action forced the owner to lower the pool above the dam. Rockford is not listed in the National Register of Historic Places. However, the old damsite and the Bridge Street Bridge have local historical significance.

HUMAN RESOURCES

The population of Wright County was approximately 38,933 in 1970, showing an increase of 30 percent from 1960. The population of the city of Rockford was 730 in 1970, showing an increase of 37 percent from 1960. Available information indicates the current population

of Rockford is approximately 1,200. During the period 1950 to 1960, Rockford showed a population increase of 51 percent compared to Wright County's 8-percent increase. The mobile home park, which has a 428-mobile home capacity, houses almost half of the total population of Rockford. Currently the population of the mobile home park is approximately 540. An additional 350 mobile homesites are planned in the near future to be located in the area west of Maple Street. The population of Rockford and related areas for 1940 through 1970, as reported by the U.S. Department of Commerce, Bureau of the Census, is given in the following table (A-10).

Table A-10 - Population of Rockford and related areas, 1940-1970

Area	Population			
	1940	1950	1960	1970
Rockford Village	267	352	533	730
Rockford Township	873	790	922	1,626
Wright County	27,550	27,216	29,935	28,933
Hennepin County		676,579	842,854	960,080

Historical trends and projected changes give a reasonable suggestion as to the direction of development. Rockford is approximately 25 miles west-northwest of Minneapolis. The Hennepin County portion of Rockford is in the Minneapolis-St. Paul SMSA (Standard Metropolitan Statistical Area). Because of the proximity to the largest growth center in the Water Resource ASA (Aggregate Subarea) 701, Rockford can be expected to develop at approximately the same rate or a greater rate.

The Minneapolis-St. Paul SMSA recorded a 22.4-percent increase in population from 1960 to 1970. Population growth outside the central cities increased by 55.9 percent, and growth in Hennepin County outside the central city increased by 46.0 percent. In 1974, the population

of Rockford increased by 540 persons with annexation of the mobile home park and adjacent acreage. Because the increase resulted from annexation as opposed to immigration, the additional population was added only after linear regression projections had been made, and was subject to the same rate of growth as previously projected. Projections are based on series E Water Resources Council OBERS (Office of Business Economics Research Service) projections. The SMSA projections tend to be slightly higher than those projections for the whole ASA area as seen in the following table (A-11). However, projections indicate Rockford is growing at approximately the same rate as the entire SMSA. Historical evidence suggests that such projections would be too low, inasmuch as fringe areas have been growing faster than central cities and primary suburbs. The third projection reflects this increased rate of growth though not to the same rate as has been occurring historically.

Table A-11 - Population projections for Water Resource Aggregate Subarea 701, SMSA 141, and Rockford, Minn.

Area	Historic				Projected				
	1950	1960	1970	1974[1]	1975	1980	2000	2020	2030
Water Resource Aggregate Subarea 701	2,171,152	2,549,200[2]	2,927,302			3,220,900	3,983,300	4,481,700[3]	4,711,000[3]
SMSA 141	1,156,656	1,482,030	1,821,718			2,095,000	2,760,000	3,284,600	3,546,900[2]
Rockford, Minn.	369	533	730	1,270	1,301	1,390[4]	2,226	3,188	3,669
						1,453[5]	2,276	3,239	3,721
						1,653[6]	2,592	3,671	4,210

(1) Annexation of mobile home park.
(2) Estimated by extrapolation.
(3) Decreasing proportion to SMSA.
(4) Based on OBERS projection for SMSA 141 and linear extrapolation 2030 figure.
(5) Based on BEA OBERS projections for Water Resource Aggregate Subarea 701 and linear extrapolation 2030 figure.
(6) Graphic trend line.

DEVELOPMENT AND ECONOMY

EMPLOYMENT

Rockford is located primarily in Wright County on the western edge of Hennepin County. It is approximately 20 miles from the developed western suburbs of the Minneapolis-St. Paul metropolitan area. These western suburbs offer many employment opportunities since they are heavily industrialized. A significant number of Rockford residents work in the metropolitan area.

At present there are approximately 40 small businesses in the Rockford area. The largest employers are the elementary and secondary schools and the shops in the new shopping center. Buffalo, Minn., which is the Wright County seat, is located 9 miles west of Rockford and also offers opportunities for employment.

The total labor force in Wright County, including rural farm and nonfarm populations, was 13,248 at the time of the 1970 census. A breakdown of the labor force of Wright County by occupational categories is included in the following table (A-12). The rural nonfarm population constituted 72 percent of the labor force.

Table A-12 - Rural farm and nonfarm occupations in Wright County, Minn, 1970

Occupation	Percent		
	Farm	Nonfarm	Total
Professional, technical	1.2	7.3	8.5
Managers and administrators, except farm	0.4	5.1	5.5
Sales workers	0.9	3.8	4.7
Clerical	2.2	9.0	11.2
Craftsmen, foremen	2.2	11.9	14.1
Operative, including transport	3.7	16.7	20.4
Laborers, except farm	0.6	3.4	4.0
Farmers and farm managers	10.9	1.0	11.9
Service workers, except private household	1.7	4.1	5.8
Other	3.9	10.0	13.9
Total	27.7	72.3	100.0

In Hennepin County each industry's share of employment has remained relatively stable for the past 30 years and most industries recorded moderate gains. Only agriculture suffered a serious decline of 61 percent from 1940 to 1970, as shown in the following table (A-13).

Table A-13 - Employment changes by industry, Hennepin County, 1940-1970

Industry	1940 Number	1940 Percent of total	1950 Number	1950 Percent of total	Percent change 1940-1950	1960 Number	1960 Percent of total	Percent change 1950-1960	1970 Number	1970 Percent of total	Percent change 1960-1970	Percent change 1940-1970
Agriculture	5,635	2.6	4,556	1.6	-19	2,858	0.8	-37	2,194	0.5	-23	-61
Construction	10,398	4.9	16,478	5.7	+58	18,232	5.3	+11	21,118	5.1	+16	+103
Manufacturing	44,203	20.7	69,382	24.0	+57	84,296	24.7	+21	91,605	21.8	+9	+107
Wholesale trade	13,743	6.4	19,235	6.7	+40	22,282	6.5	+16	30,708	7.3	+38	+123
Food, dairy stores & eating, drinking places	15,919	7.4	18,979	6.6	+19	18,328	5.4	-4	23,798	5.7	+30	+49
Other retail trade	25,907	12.1	35,514	12.3	+37	37,443	11.0	+5	51,407	12.2	+37	+98
Finance, insurance, and real estate	13,280	6.2	16,996	5.9	+28	22,655	6.6	+33	21,052	5.0	-7	+59
Business and repair services	5,772	2.7	8,602	3.0	+49	10,738	3.1	+25	22,896	5.5	+113	+297
Medical and professional services	21,317	10.0	33,701	11.7	+58	49,178	14.4	+46	83,786	20.0	+70	+293
Public administration	8,071	3.8	12,081	4.2	+50	13,501	4.0	+12	14,885	3.5	+10	+84
Other industry	49,594	23.2	52,687	18.3	+6	62,110	18.2	+18	56,405	13.4	-9	+14
Total	213,839	100	288,211	100	+35	341,621	100	+18	419,914	100	+23	+96

Service industries have realized the greatest growth. Business and repair industries increased by 297 percent over the last 30 years with a 113-percent increase occurring in the last decade. From 1940 to 1970, medical and professional services have increased their share of total employment from 10 to 20 percent, with the largest increase of 5.6 percent occurring between 1960 and 1970.

In contrast to the stable composition of employment in Hennepin County, Wright County has shown innumerable shifts in composition and strong growth in several industries, as shown in the following table (A-14).

Table A-14 - Employment changes by industry, Wright County, Minnesota 1940-1970

Industry	1940 Number	1940 Percent of total	1950 Number	1950 Percent of total	Percent change 1940-1950	1960 Number	1960 Percent of total	Percent change 1950-1960	1970 Number	1970 Percent of total	Percent change 1960-1970	Percent change 1940-1970
Agriculture	5,525	62.9	5,149	51.0	-7	3,374	33.6	-35	1,932	14.0	-43	-65
Construction	278	3.2	521	5.2	+87	669	6.7	+28	1,152	8.3	+72	+314
Manufacturing	374	4.3	668	6.6	+79	1,780	17.8	+166	3,296	23.8	+85	+781
Wholesale trade	131	1.5	276	2.7	+111	244	2.4	-12	688	5.0	+182	+425
Food, dairy stores, and eating and drinking places	331	3.8	569	5.7	+72	565	5.6	-1	792	5.7	+40	+139
Other retail trade	485	5.5	768	7.6	+58	762	7.6	-1	1,477	10.7	+94	+205
Finance, insurance, and real estate	84	0.9	149	1.5	+77	233	2.3	+56	157	1.1	-33	+87
Private households	236	2.7	145	1.4	-39	272	2.7	+87	320	2.3	+18	+36
Business and repair services	172	1.9	266	2.6	+55	234	2.3	-12	527	3.8	+125	+206
Medical and professional services	499	5.7	546	5.4	+9	895	8.9	+64	1,891	13.7	+111	+279
Public administration	115	1.3	201	2.0	+75	196	2.0	-2	373	2.7	+90	+224
Other industry	553	6.3	835	8.3	+51	809	8.1	-3	1,235	8.9	+53	+123
Total	8,783	100	10,093	100	+15	10,033	100	-0.5	13,840	100	+38	+57

Total employment has increased by 57 percent since 1940. Employment in manufacturing has increased by 780 percent during the 30-year period, changing from 4.3 percent of those employed to 23.8 percent. Other rapidly growing industries are the wholesale trades, construction, and medical and professional services with increases of 425, 314, and 279 percent, respectively, since 1940. The large employment gains in these industries are offset by major losses in agricultural employment. In 1940 approximately 62.9 percent of employed persons worked in agricultural occupations. In 1950 this percentage dropped to 51 percent and larger drops occurred in 1960 to 33.6 percent and in 1970 to 14.0 percent. From 1960 to 1970 the number of agricultural workers declined by 1,442 persons. Part of this decrease is due to increased agricultural efficiency allowing for larger farms. Large increases in other nonagricultural areas and the proximity to a major urban center suggest a shift toward more urban pursuits. With this shift, Rockford can expect increases in employment as it becomes less farm orientated.

Employment opportunities in both Hennepin and Wright Counties have kept pace with population increases. Proximity to a major metropolitan area as well as local opportunity in Wright County have kept unemployment rates low.

INCOME

For 1970, per capita income for the Upper Mississippi ASA 701 which includes Rockford, was $3,536, approximately 2 percent higher than the national average and up 4 percentage points from the 1960 average, as shown in the following table(A-15). Per capita income for the adjacent Minneapolis-St. Paul SMSA 141 was 18 percent higher than the national average in 1970, 1 percentage point down from the previous decade. Both areas are expected to increase their per capita income threefold over the life of the project. More significant, however, is that both are expected to stay above the national average, with the fringe area gradually catching up with the SMSA area. Rockford is expected to exceed the projection for both areas.

Table A-15 - Per capita income projections for WRA 701 and SMSA 141

Area	Year							
	1950	1960	1970	1975	1980	2000	2020	2030
Upper Mississippi WRA 701								
Per capita income	$2,014	$2,775	$3,536	$4,260	$4,984	$8,428	$14,200(1)	$16,800(1)
Index for project life					1.00	1.69	2.85	3.37
Index from 1975				1.00	1.17	1.98	3.33	3.94
Per capita income relative to the United States as a whole (U.S. = 100)	0.98	0.98	1.02	-	1.04	1.03	1.08	1.06
Minneapolis-St. Paul SMSA 141								
Per capita income	2,517	3,089	4,117	4,800	5,600	9,200	14,400(1)	17,000(1)
Index for project life					1.00	1.64	2.57	3.04
Index from 1975				1.00	1.17	1.92	3.00	3.54
Per capita income relative to the United States as a whole (U.S. = 100)	1.22	1.19	1.18	-	1.18	1.14	1.09	1.08

(1) Extrapolated from straight trend line.

LAND USE

The study area consists of approximately 858 acres, which is depicted on a generalized land-use map shown on plate 2. Current land use includes approximately 231 acres of developed residential property, 301 acres of agricultural land, and 55 acres of river corridor. The remaining land is currently utilized for commercial-industrial development, transportation, and public buildings, parks, and schools. A more detailed breakdown of the current land use is given in table A-16.

Table A-16 - Current land use, Rockford, Minn., study area

Category	Area (acres)		Symbol
Residential	231		R
Single family dwellings		150	
Multiple family dwellings		4	
Trailer park		77	
Commercial-industrial	44		C-I
Agricultural	301		A
Cropland		183	
Pastureland		118	
Undeveloped	120		
Hardwood forest		44	F
Open field		36	U
Marsh		40	M
River corridor	55		
Floodplain forest		9	F
Open field		7	U
River channel		39	
Public	100		
Public buildings		< 1	
Utilities		2	
Parks and recreational		5	P
Schools		35	
Transportation		57	
Other	7		
Cemeteries		6	
Churches		1	
Total	858		

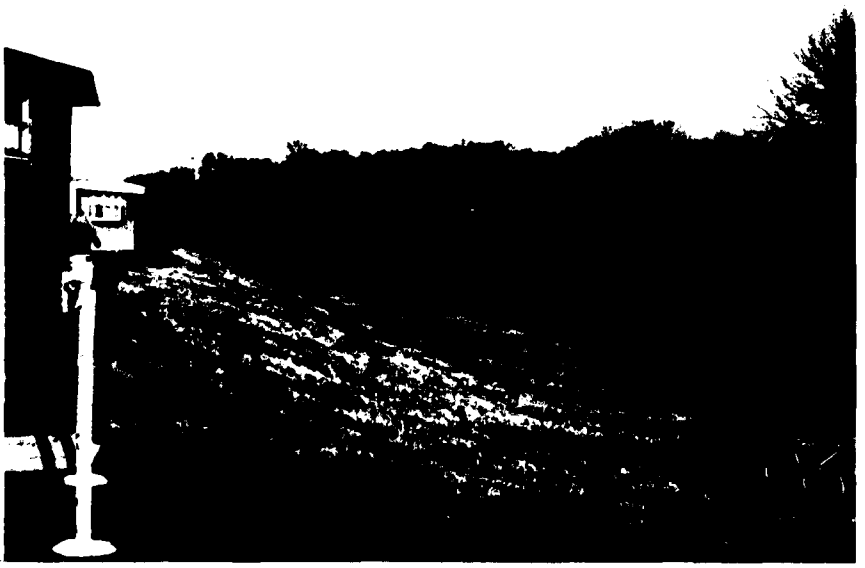
The following photographs (A-4 through A-8) illustrate the types of current land use at Rockford.

Photograph A-4 - Intersection of Main Street and Bridge Street looking east.

Photograph A-5 - Commercial business located in Rockford

Photograph A-6 - Residence in floodplain along emergency levee

Photograph A-7 - Rockford Riverview Estates mobile home park



Photograph A-8 - Floodplain forest bordering mobile home park

Being located on the western edge of the seven-county metropolitan area, Rockford possesses a high potential for future development. However, there are currently no future land use or development plans for the community due, in part, to potential hazards associated with developing the floodplain, since the existing emergency levee does not adequately protect the flood prone areas of the city from an intermediate regional flood event.

ZONING

Rockford is now adopting a detailed zoning ordinance. Until such an ordinance is adopted, the city is operating under interim ordinances and resolutions adopted by the city council. Existing regulations recognize three zoning categories: residential, commercial-industrial, and public open development.

RECREATION

The existing recreation facilities in the project area are adequate to meet most land-based recreation needs. Facilities for hiking, bicycling, and nature activities are limited, but have good potential. Local recreation resources include a 1-acre city park with picnic shelter, tables, and restrooms; playground equipment at the elementary school; athletic fields at the high school; a ball park near the river; and one-half acre of green open space which may have park potential. The following table (A-17) indicates recreation facilities available in Rockford.

Table A-17 - Recreation facilities available in Rockford, Minn.[1]

Recreation area	Acres	Picnic facilities	Restrooms	Playground equipment	Ball fields
Lions Club park	2	X	X	X	
Ball park	2				X
High school	22		X		X
Elementary school	12		X	X	X
Mobile home park[2]	1	X	X	X	X
Oval Park	1				

(1) Source: Development Guide/Policy Plan for Recreation Open Space, Metropolitan Council, October 1974.

(2) Facilities may be used by mobile home park residents only.

The regional recreation facilities are summarized in the following table (A-18).

Table A-18 - Existing regional recreation facilities[1]

Activity	Lake Rebecca Park Reserve	Morris T. Baker Park Reserve	Elm Creek Park Reserve	Crow Hassan Park Reserve
Interpretive			X	
Skating				
Snowmobiling				
Snowshoeing	X			
Downhill skiing				
Ski touring	X	X	X	
Bicycling				
Horseback riding		X		
Camping		X		
Picnicking	X	X	X	
Hiking	X	X		
Water skiing		X		
Sailing	X	X		
Canoeing		X		X
Boating	X	X		
Swimming	X	X	X	
Fishing	X	X		

(1) Source: Development Guide/Policy Plan for Recreation Open Space, Metropolitan Council, October 1974.

WATER SUPPLY

Rockford presently obtains its water supply from two wells located near the existing water tank. The wells are approximately 150 feet deep and draw water from the glacial drift aquifer. The combined capacity of the wells is approximately 450 gpm (gallons per minute) and the storage tank has a capacity of 75,000 gallons. Normal water use in Rockford is approximately 135,000 gpd (gallons per day). The maximum water demand in the summer months is approximately 500,000 gpd. Another well is planned on the east side of the Crow River primarily to meet fire-fighting requirements. It is believed that the present groundwater supply is adequate for Rockford's future needs.

The quality of ground and surface waters in the Rockford area is considered to be good. Any pollution of surface waters around the Rockford area is limited to urban and agricultural runoff. At present, local industry does not generate a significant amount of industrial wastes.

TRANSPORTATION

Rockford has good transportation access to surrounding population centers, markets, and rural areas. Highway 55 running northwest and southeast through Rockford is the main highway link with the Minneapolis-St. Paul area. The Highway 55 bridge over the Crow River is of recent construction, with the bridge deck about 2 feet above the intermediate regional flood level. Photograph A-9 illustrates the current condition of the Highway 55 bridge. The northerly approach to the bridge through Rockford would be under less than 1 foot of water during occurrence of the intermediate regional flood. Several county and township roads also connect Rockford with the surrounding rural areas.

Photograph A-9 - Highway 55 bridge crossing Crow River

The Bridge Street Bridge is a steel girder, high-truss bridge with two main spans and two short approach spans. It was built prior to 1900. The bridge is 16 feet wide out-to-out of the wooden curb and has a wooden deck overlain with bituminous. It has single-lane traffic and is restricted to lighter vehicles. When this bridge was the only bridge across the river in the vicinity, loaded trucks would cross the river just upstream of the bridge at a natural ford in the stream. The bridge presently provides an alternate crossing of the river for local traffic and relieves congestion for through-traffic using the Highway 55 bridge. Its deck would be covered by about 3 feet of water with occurrence of the intermediate regional flood. The Bridge Street Bridge is illustrated in photograph A-10.

Photograph A-10 - Bridge Street Bridge from east bank of Crow River

The Soo Line Railroad goes through Rockford and has a siding on the southeast side of Rockford. This provides rail access for commodity transport to and from Rockford. The railroad bridge over the Crow River is well above any flood levels. Photograph A-2 (page A-31) illustrates the railroad bridge.

Rockford is about 40 miles from Minneapolis-St. Paul International Airport which provides excellent national and international air passenger and cargo connections.

DESCRIPTIVE PUBLICATIONS

Available maps of the study area include:

Topographic quadrangle maps, scale 1:62,500, with 20-foot contour intervals, prepared by the U.S. Geological Survey.

Topographic maps, scale 1:250,000, with 50-foot contour intervals, prepared by the U.S. Army Topographic Command.

County highway maps, scale 1 inch equals 2 miles and 1 inch equals 1 mile, prepared by the Minnesota Department of Highways.

Miscellaneous aerial photography of the Rockford area.

Topographic map of Rockford, scale 1 inch equals 100 feet, with 2-foot contour intervals, prepared by Mark Hurd Aerial Surveys for the U.S. Army Corps of Engineers, November 1971.

Publications describing the study area include:

Barr Engineering Company report: Evaluation of Flood Control Alternatives, Crow River at Rockford, Minnesota, 1975.

Curtiss-Wedge, F., History of Wright County, Minnesota, H. C. Cooper, Jr. and Co., Chicago, 1915.

Dodge, A. W., H. F. Fullerton, W. J. Brechenridge, and D. W. Warren, Birds of the Minneapolis-St. Paul Region, Bell Museum of Natural History, University of Minnesota, 1971.

Fuller, Bruce L. and William R. Miles, Minnesota's Forest Trees, Extension Bulletin 363, University of Minnesota, 1972.

Metropolitan Council, Development Guide/Policy Plan for Recreation Open Space, 1974.

Minnesota Department of Natural Resources, Minnesota State Comprehensive Outdoor Recreation Plan, St. Paul, Minn., 1974.

Soil Engineering Services, Inc., report: Preliminary Soil Borings, Proposed Mobile Home Park, Rockford, Minnesota, 1970.

U.S. Department of Agriculture, Soil Conservation Service, Hennepin County Soil Survey, 1974.

U.S. Department of Agriculture, Soil Conservation Service, Wright County Soil Survey, 1968.

U.S. Department of the Interior, Geological Survey, Water Resources of the Crow River Watershed, South-Central Minnesota, Hydrologic Investigations Atlas HA-528, 1974.

Upper Mississippi River Basin Coordinating Committee, The Upper Mississippi River Comprehensive Basin Study, 1970.

SECTION III

PROBLEMS AND NEEDS

PROBLEMS AND NEEDS

INTRODUCTION

This section presents a discussion of the problems and needs of the Rockford, Minn., area, emphasizing flood damage reduction and considering water supply and quality, recreation, fish and wildlife conservation, public health and safety, and aesthetic and cultural features. The improvements desired by local interests are also discussed. Not all of these problems and needs can be addressed and/or solved within the authorities under which this study is being conducted. However, wherever practicable within the alternatives and plans evaluated, these problems and needs will be considered so that any actions taken will be compatible with programs of other governmental agencies or jurisdictions.

FLOOD DAMAGES

GENERAL

The problems and needs relating to flood damages at Rockford will be considered under the categories of damages due to past floods, potential damages under existing conditions, and potential damages under projected future conditions.

FLOOD HISTORY

The Crow River forms the boundary between western Hennepin and eastern Wright Counties, Minn. The Wright County portion of Rockford is subject to frequent inundation and damages. Damages begin at an elevation of 903.4 feet msl (mean sea level) with a discharge of 5,900 cfs (cubic feet per second).

Since 1950, Rockford has been inundated by four major floods. An emergency levee constructed in 1969 protected the city from two other floods. Rockford has experienced an average of about one flood every 4 years. Under present conditions of development, the floods of 1952, 1957, 1965, and 1969 would each cause damages of more than $200,000. The highest recorded peak discharge was 22,400 cfs and occurred in 1965. Damages attributed to the 1965 flood in 1965 prices and conditions totaled $233,000. A recurrence of the 1965 flood under 1975 prices and conditions would cause damages of about $508,000. Portions of the residential areas would again be inundated to a depth of 4 to 5 feet on the first floor. Potential damages for a recurrence of the six most recent floods are shown in the following table (A-19).

Table A-19 - Estimated flood damages for historic floods, Rockford, Minn., 1975 conditions and January 1975 price levels

Date of flood peak	Instantaneous peak (cfs)	Potential damages under 1975 conditions
16 April 1951	7,720	$18,000
13 April 1952	13,900	239,000
26 June 1957	13,500	215,000
16 April 1965	22,400	508,000
13 April 1969	15,100	287,000
25 March 1972	7,410	15,000

FLOOD DAMAGES - EXISTING CONDITIONS

Damages were estimated for a 100-year flood of 30,600 cfs with an elevation of 914.5 feet msl at the Highway 55 bridge. Floods 1 foot higher and 2 feet lower with discharges of 35,000 cfs and 22,400 cfs, respectively, were also analyzed for estimated damages, with the lower flood approximating the 1965 flood of record. Market values were

obtained for the 73 residential units in the 100-year floodplain and the average depth of flooding for the 100-year flood was calculated. These units were divided into three categories depending on the type of flooding sustained: first-floor flooding with basements, first-floor flooding without basements, and basement only flooding. This information was then applied to previously determined curves which relate potential flood damages to market value and depth of inundation for each residential unit. Included in the residential damages are 92 mobile homes located on the floodplain with an average ground elevation of 914.0 feet msl and floor elevation of 916.7 feet msl. The 100-year flood elevation in the mobile home park is 916.0 feet msl. Few damages would occur to the park at this flood elevation. The major damage would be scour, necessitating releveling of the mobile homes. For higher flood elevations estimated damages were obtained from interviews with the park owner. Damages are also incurred by the mobile home park grounds and recreation area.

Twenty-three businesses are located in the Rockford floodplain representing approximately 33 percent of the damages in any one flood. Most business establishments have basements and suffer some seepage damage from the rising water table each spring, even in nonflood years. This seepage and continual inundation have sufficiently weakened foundations that the potential for extensive damages is recognized by most proprietors. Damages were estimated by interviews with building owners and proprietors for the 100-year flood and for flood elevation variations above and below the 100-year flood.

Public damages and costs of cleanup of the fire station, city hall, parks, and street systems were determined by interviews with public officials and correlation with past flood damages. Public damages comprise 11 percent of total flood damages. The following table (A-20) summarizes damages for the three floods.

Table A-20 - Estimated flood damages for the 100-year flood, Rockford, Minn., 1975 conditions

Item	100-year flood	100-year flood minus 2 feet[1]	100-year flood plus 1 foot	10-year frequency flood
Discharge (cfs)	30,600	22,400	35,000	10,000
Elevation (feet msl)	914.5	912.5	915.5	906.8
Damages				
Residential	$399,500	$306,600	$536,200	$46,200
Business	253,500	143,900	310,900	8,400
Public damage and cleanup	81,200	60,500	94,000	3,000
Total damages	734,200	511,000	941,100	57,600

(1) Approximates 1965 flood.

To better determine the damages caused by floods of lower intensity a detailed sensitivity analysis of damages was made for a hypothetical 10,000-cfs flood with an elevation of 906.8 feet msl, shown in the preceding table. The results from these four evaluations were correlated with the corresponding discharges yielding a discharge-damage curve of relationships. By correlating the discharge-damage curve with a frequency-discharge curve, a frequency-damage curve is derived. The curves and their corresponding relationships are illustrated on figure A-11 (page A-67). Because of the distinctly different nature of flooding in the mobile home park as opposed to the rest of Rockford, and the higher zero point of damage, figure A-12 (page A-68) represents the discharge-damage and frequency-damage curves for just the mobile home park section of Rockford (see area map, plate 1). Figure A-13 (page A-69) shows the same relationships for the remainder of Rockford.

AD-A137 437 REPORT ON FLOOD CONTROL ALTERNATIVES CROW RIVER AT ROCKFORD MINNESOTA(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 75 2/3

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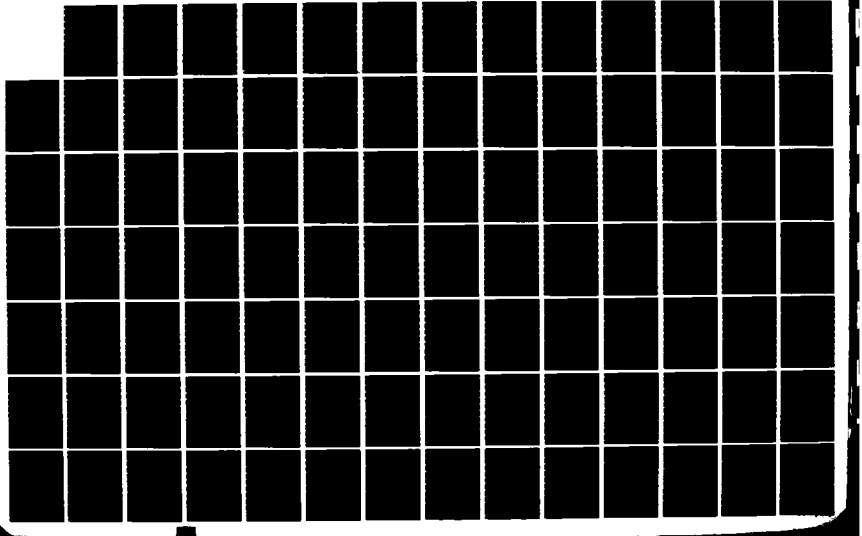

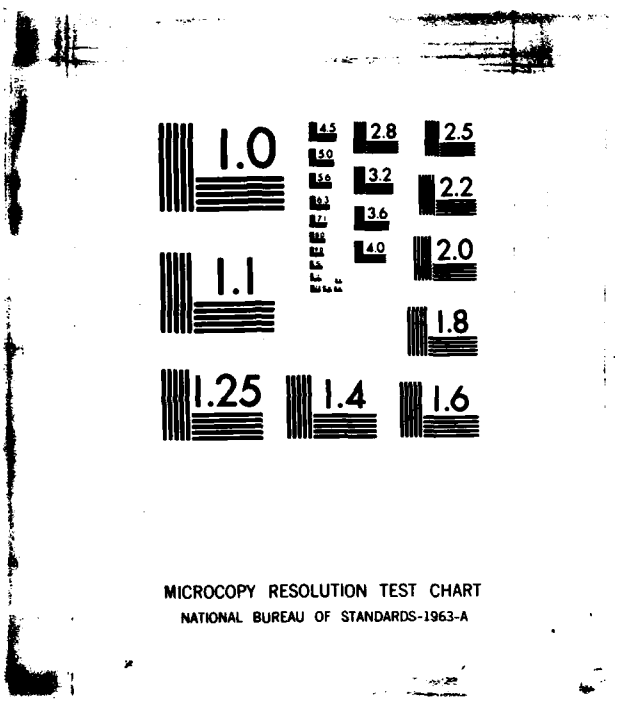
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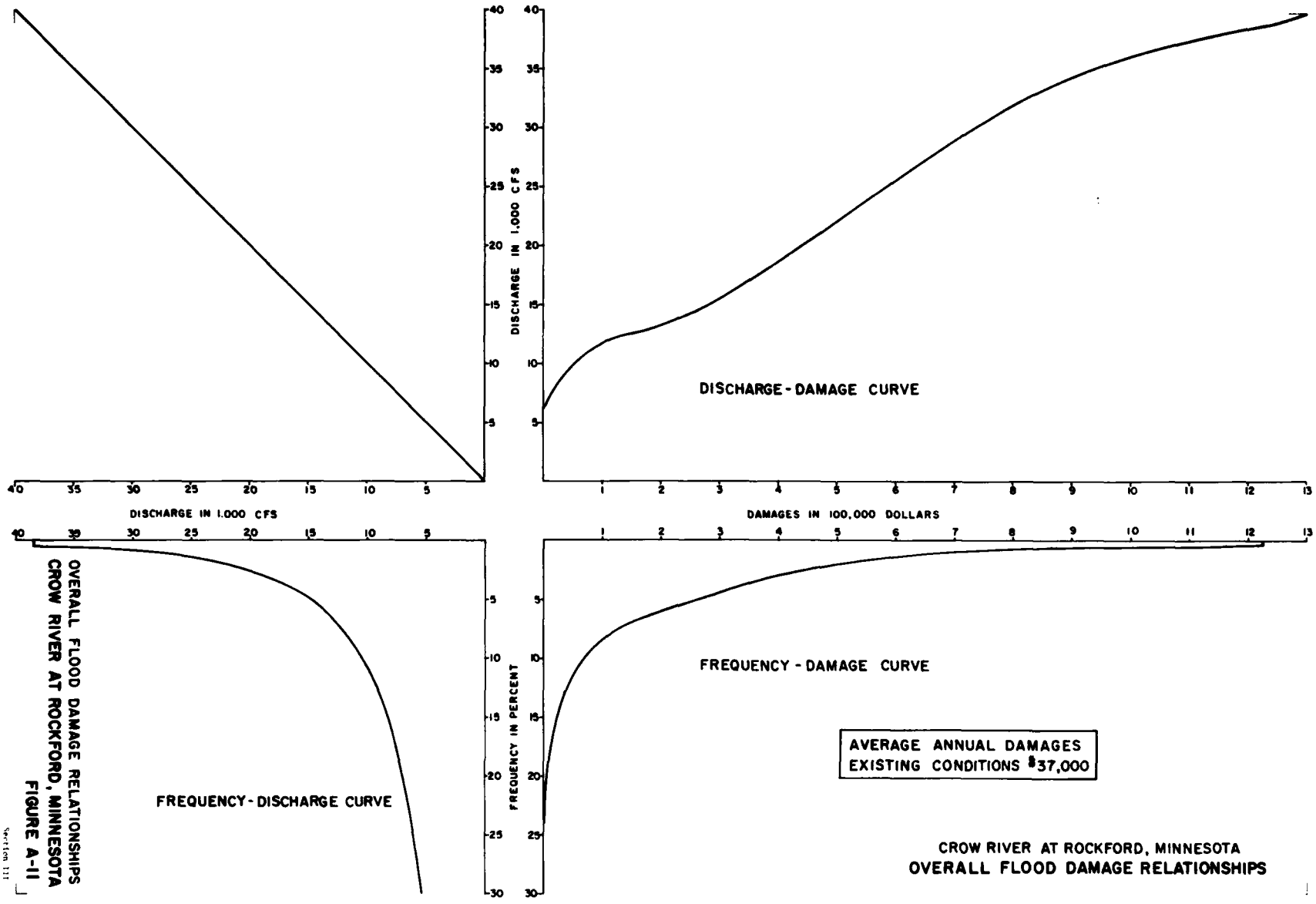
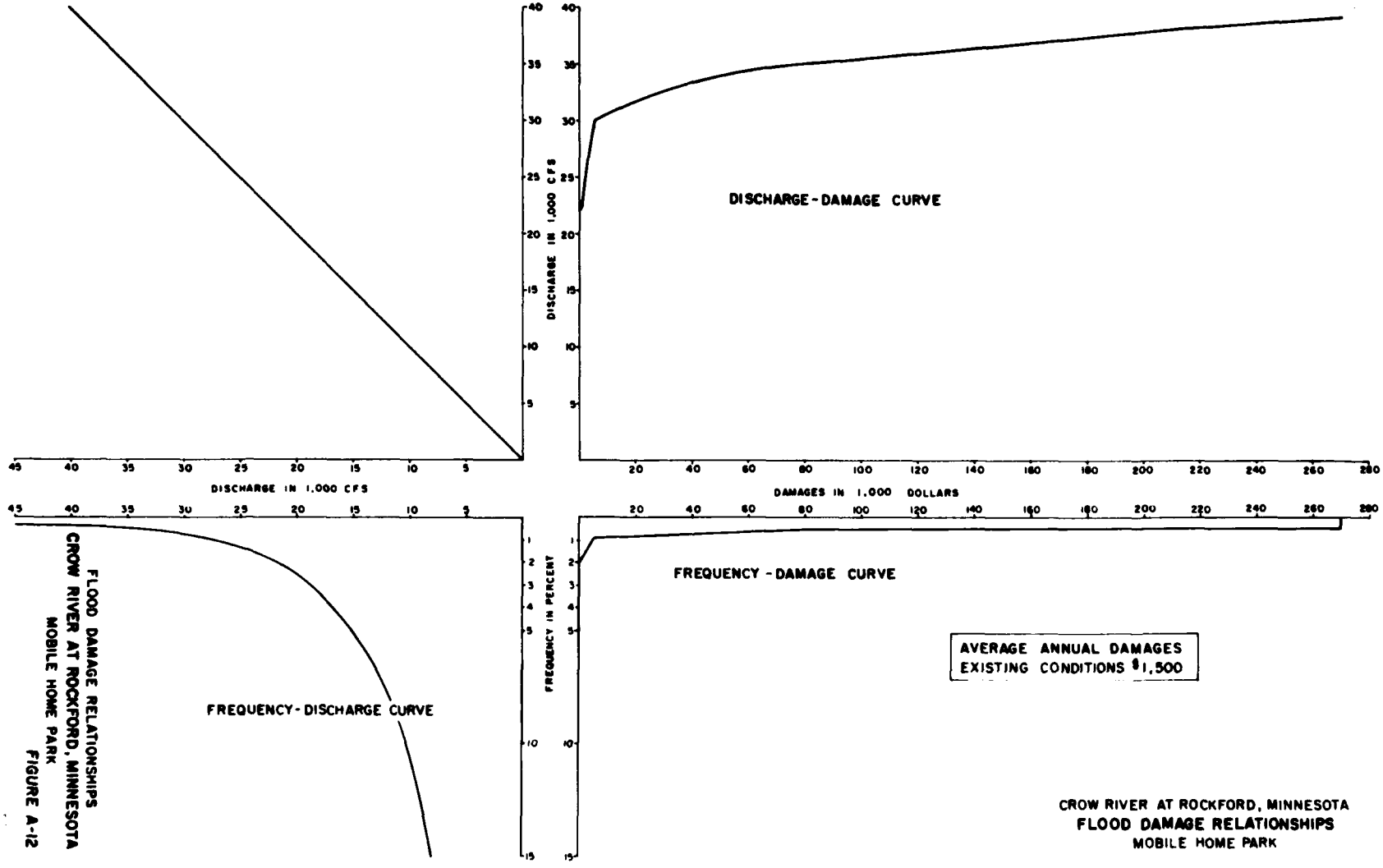


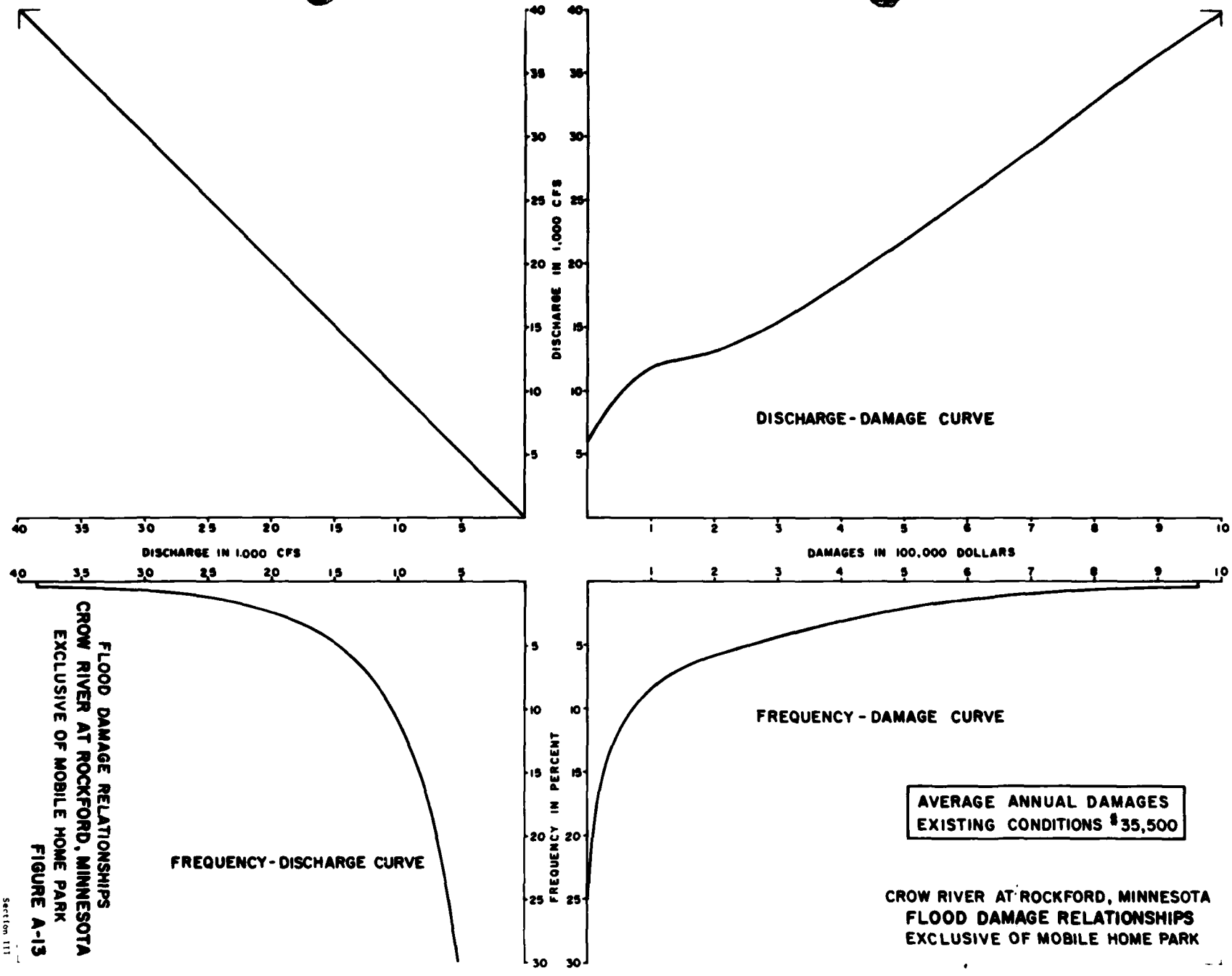
OVERALL FLOOD DAMAGE RELATIONSHIPS
CROW RIVER AT ROCKFORD, MINNESOTA
FIGURE A-11

Section III
A-67



FLOOD DAMAGE RELATIONSHIPS
CROW RIVER AT ROCKFORD, MINNESOTA
MOBILE HOME PARK
FIGURE A-12

CROW RIVER AT ROCKFORD, MINNESOTA
FLOOD DAMAGE RELATIONSHIPS
MOBILE HOME PARK



FLOOD DAMAGE RELATIONSHIPS
CROW RIVER AT ROCKFORD, MINNESOTA
EXCLUSIVE OF MOBILE HOME PARK

FIGURE A-13

Section III
A-69

Average annual damages are calculated by determining the area under the frequency-damage curve and multiplying by the value of each unit measured. Average annual damages for the city of Rockford are $37,000, of which $1,500 occurs in the mobile home park and $35,500 occurs in the remainder of town.

FLOOD DAMAGES - FUTURE CONDITIONS

GROWTH TO NEW DEVELOPMENT

In 1974, Rockford passed a zoning ordinance to comply with requirements of the Flood Disaster Protection Act of 1973. This ordinance restricts building on the floodplain to those buildings that can be flood proofed to the 100-year level. Elevations for vacant land in the 100-year floodplain north of the Burlington Northern Railroad bridge range from 905.2 feet msl to 900.0 feet msl with water surface elevations for the 100-year flood ranging from 914.3 to 913.0 feet msl. The additional cost of providing 9 to 13 feet of fill or watertight structures to that height would be prohibitive in view of the fact that abundant vacant land exists outside the floodplain.

In recent years, development has shifted away from the floodplain. New residential development has taken place on top of the bluff on the east bank of the river in Hennepin County and in the Maplewood Manor addition northwest of the business district with a minimum elevation of 980 feet msl, well above the intermediate regional flood levels. Residential growth can be expected in the recently annexed mobile home park. Elevation of the first floor of the mobile homes is above 100-year flood levels. This would keep damages to a minimum. Few vacant lots exist just outside the 100-year floodplain. Any new construction would suffer damages so infrequently that their effect would be insignificant on the total. New commercial growth for the most part has shifted out of Rockford to a recently constructed shopping center 2 miles west of the city on Highway 55. Two businesses presently located downtown plan to relocate there.

The current Rockford city hall, located in the floodplain, was built after the 1965 flood caused the collapse of the old building. The 1965 flood also necessitated updating the sewer system and new sewage treatment plant. The present system is designed to prevent damages during

flooding. The sewage treatment plant is well outside the floodplain. A new fire station recently constructed in the floodplain is large anough to handle any future needs of the city of Rockford. As a result of floodplain zoning, flood damages resulting from new construction would occur so infrequently that they would have an insignificant effect on total average annual damages.

GROWTH TO EXISTING DEVELOPMENT

Three categories of growth to existing development were evaluated: residential, commercial, and public.

Residential Damages. - Beyond routine maintenance of structures in the floodplain, Rockford city building permits show physical improvements, such as garages and additions, of approximately $4,300 per year for the last 7 years of record. These improvements result in an increase in the value of the housing stock of the floodplain by about 0.4 percent per year. Residential structural contents are approximately 25 percent of the total residential damages. As per capita income increases, contents value is expected to parallel this increase. An upper limit to contents value is reached when it is 75 percent of the value of the structure. Because a large portion of the community is still in the floodplain, residential structures are expected to be maintained as long as possible with contents damage approaching the maximum value. Average annual residential damages are expected to increase by 63 percent over the life of the project.

Commercial Damages. - Proximity to a large urban center and the development of a shopping center just west of town make future commercial growth uncertain. While urban stores and shopping centers might offer a greater variety and quantity of merchandise, downtown Rockford is more convenient to local citizens. Since a sufficient number of structures exists in the floodplain, Rockford might retain its character as a small regional center, shift to a more service-oriented area, or deteriorate as other centers take over. None of the growth indicators - per capita income, employment, or population - can give an accurate prediction of which way the city will develop. Existing average annual damages of $11,800 are rather precise and it appears that, because of the uncertainty of the future of Rockford, these damages would not grow.

Public Damages. - As floodplain lands are vacated over time, they will be acquired by the city of Rockford either through purchase or abandonment. Within the 100-year floodplain are a municipal ball park and playground. Abandoned land adjacent to these two parks could gradually be used to meet additional demand for future recreation facilities. Local abandoned floodplain land will also incur additional public cleanup costs in case of a flood. Government structures, all of which were recently built, are located in the 100-year floodplain. These can be expected to expand within the limits prescribed by the Flood Disaster Protection Act of 1973. Existing utilities, sewers, and roadways provide interconnecting systems with portions of Rockford outside the 100-year floodplain. These facilities must be maintained and improved to meet community standards and demand. Demand for public services can be approximated by population expansion. Population can be expected to increase by 190 percent over the life of the project, with public services increasing proportionately. With a great deal of public land in the floodplain, damages can be expected to increase at about the same rate.

Total growth to existing damage is summarized in the following table (A-21). The overall increase in average annual damages over the 55-year growth period is $20,900 or 56 percent.

Table A-21 - Average annual flood damages, Rockford, Minn., January 1975 prices

Category	Average annual damages 1975	1980	2030	Change in damages 1980-2030	Average annual equivalent of change	Average annual equivalent damages
Residential						
Structures	$15,900	$16,200	$19,700	$3,500	$1,200	$17,400
Contents	5,300	6,100	14,800	8,700	2,900	9,000
Commercial	11,800	11,800	11,800	-	-	11,800
Public	4,000	4,500	11,600	7,100	2,400	6,900
Total	37,000	38,600	57,900	19,300	6,500	45,100

RECREATION

The Rockford area is located on the northwest periphery of the Minneapolis-St. Paul, Minn., metropolitan area and has excellent potential for both present and future recreation development.

The Crow River could be an important recreation resource to the community. The river's rocky bottom and wooded banks provide a somewhat primitive experience to the user and the variation in topography from floodplains to bluffs adds to the scenic beauty of this area. The marsh area and adjoining woods could be important in providing open space for the community which may have future implications as the Minneapolis-St. Paul metropolitan area expands. At present, users of the project area include canoeists and fishermen from the local community and the metropolitan area. Inclusion of the area in the State Wild, Scenic, and Recreation Rivers System is currently being studied by the Minnesota Department of Natural Resources. Canoeing and boating will take on greater importance if the Crow River is included in the System. Economic development in this area, however, may limit access to potential recreation areas along the river. There are no existing trail systems, although neighboring Lake Rebecca Park Reserve provides some opportunity for hiking, snowshoeing, and cross-country skiing. Also located in the vicinity of Rockford are the Crow Hassen, Elm Creek, and Morris T. Baker Park Reserves.

Projected shortages for the metropolitan area will be near 20,000 acres of recreation land, according to a metropolitan county study. The area's present resources along with future proposed developments, which include approximately 25 miles of trails, will aid in meeting a portion of this projected demand.

Although specific participation data for the Rockford area were not available, rates from the State of Minnesota's 1974 Outdoor Recreation Plan are indicated in the following table (A-22). Projected increases in each category indicate a future need for additional recreation resources.

Table A-22 - Annual per capita recreation participation rates of Minnesota residents (activity occasions per year)

Activity	Year		
	1975	1980	1990
Picnicking	5.4	5.7	6.3
Camping	4.0	5.0	7.0
Boating	1.3	-	-
Swimming	18.2	19.8	22.9
Fishing	7.7	7.9	8.4
Bicycling	42.2	48.0	54.5
Water-skiing	2.5	3.0	3.8
Canoeing	0.8	0.9	1.0

WATER QUALITY AND WATER SUPPLY

The present groundwater supply is considered adequate to meet Rockford's future needs. The quality of ground and surface waters in the Rockford area is considered to be generally good. No major water quality problems are anticipated.

FISH AND WILDLIFE

Local interest in the Crow River as a fishery is demonstrated by its use by the local community as well as fishermen from other points in the metropolitan area. Although little technical data are available, local reports indicate the need to improve the quality of the fishery to meet future demands. At present, water quality appears to be adequate to support game fish populations, although rough fish are

dominant. The river has usable game fish habitat in the study area. A rough fish control program would be required if the game fish population is to be increased.

Hunting and trapping in either the hardwood forest or floodplain forest within the study area are limited due to the proximity of residential developments to these areas. Larger wooded lots outside the city limits to the north could have some small game hunting potential with proper management of the area. Expanding urban pressures, however, are making these areas less adaptable to hunting due to habitat elimination as well as urban conflicts.

PUBLIC HEALTH AND SAFETY

The health and safety of residents in the study area are directly affected during major flood periods. No known flood-related deaths have occurred, but a serious threat to life and limb is always present during flood periods due to the potential for drowning, electrical shocks, and injurious falls. Other previously experienced and future threats to public health include impedance of local traffic flow, backup of sewers into basements, migration of rodents from flooded areas, contamination of private water supplies, restricted degree of sewage treatment at the municipal plant, and increased vector production during a major flood. The restriction on sewage treatment during a flood is due to increased infiltration into the sewer system and direct discharge into the river of sewage entering the lift station located in the floodplain. The operations of the Rockford Fire Department are also seriously affected during a major flood due to the location of the fire station in the floodplain.

STATUS OF EXISTING PLANS AND IMPROVEMENTS

The emergency flood protection works were constructed in Rockford under authority of Public Law 84-99 during the 1969 flood emergency. These works consisted of an earthen levee of a temporary nature along portions of the left bank of the river to protect the main business and residential sections of Rockford. Since this is considered an emergency levee built to provide flood damage reduction for only that one flood event, it is not considered adequate flood protection. The removal of emergency flood works constructed under Public Law 84-99 is a local responsibility. The local interests at Rockford have elected to leave most of the emergency levee system in place. The National Weather Service river stage forecasts for Rockford provide reliable indications of anticipated flood stages, including the estimated peak level and the predicted date of the crest. The flood forecasting services would generally provide sufficient time to move personal belongings and/or to reconstruct the degraded portions of the emergency levee or to upgrade it as necessary. However, the existence of this emergency flood protection does not replace the need for an affirmative long-range flood damage reduction plan.

IMPROVEMENTS DESIRED

The city of Rockford has indicated a desire for alleviation of the flood problems and has furnished resolutions requesting this study of possible solutions. The emergency levees constructed for the 1969 flood have been effective in preventing subsequent flood damages at Rockford. However, due to their temporary nature, they are not recognized as providing an adequate degree of flood protection. The city is thus subject to provisions of the State of Minnesota Floodplain Management Act and the Federal Flood Disaster Protection Act of 1973.

A public meeting was held on 26 November 1973 at which the results of the reconnaissance report of 20 August 1973 were presented to the public. There was no firm indication of general positive or negative reactions to either of the plans presented, although the need for flood damage reduction was expressed. Subsequent to this meeting, the city again indicated its desire that the investigation of flood damage reduction alternatives continue and indicated its willingness to provide the necessary items of local cooperation in conjunction with an acceptable plan. The city also indicated the desirability of maintaining the Bridge Street Bridge in place.

A questionnaire circulated to members of the community concerned with flood damage reduction requested their responses and feelings regarding the need for and the most acceptable method of providing flood protection. Ten questionnaires were completed and the results indicated that the needs, in order of priority, were:

a. New industries.
b. Increased flood protection.
c. Improvements in utilities.
d. New river crossings.
e. Better schools.
f. Better recreation facilities.

The acceptable flood damage reduction alternatives at Rockford were, from most to least acceptable:

a. Floodplain regulations and flood insurance.
b. Upstream reservoir storage.
c. Channel modifications.
d. Do nothing.
e. Levees and/or floodwalls.
f. Floodplain evacuation.

The results of the questionnaire indicate that there is a desire for flood damage reduction, and the most preferred method of achieving this objective is through use of floodplain regulations and flood insurance. Levees and/or floodwalls and floodplain evacuation ranked low on the list of acceptable alternatives.

SECTION IV

PLAN FORMULATION

SECTION IV

PLAN FORMULATION

INTRODUCTION

The principal purpose of plan formulation studies conducted for this report is to evaluate alternative plans which will provide the best use, or combination of uses, of water and related land resources to meet foreseeable short- and long-term needs of the Rockford, Minn., area. In accordance with the principles and standards for planning water and related land resources, as published in the Federal Register, Volume 38, No. 174, Part III, dated 10 September 1973, the parameters of national economic development and environmental quality are considered the two principal planning objectives. In addition to these two objectives, the accounts of social well-being and regional economic development are also considered important. The potential alternative plans to solve current and prospective water and related land resource problems and needs of the study area are evaluated and examined with the goal of increasing national economic gains, enhancing the quality of the environment, and improving social well-being and regional economic gains. An interdisciplinary approach was utilized in evaluation of alternatives.

In analyzing various water and land resource plans, beneficial and adverse effects of each plan are measured by comparing the estimated conditions with the plan to conditions expected without the plan. Thus, in addition to projecting the beneficial and adverse effects expected with the plan in operation, a projection of conditions likely to occur without the plan is required. Only the new or additional changes to the social, economic, and environmental conditions that can be attributed to a plan are then credited to that plan.

FORMULATION AND EVALUATION CRITERIA

GENERAL

A standard set of criteria was adopted to permit an objective appraisal of the merits and disadvantages of various alternatives. Criteria were considered under five main categories:

a. Technical

b. National economic development.

c. Environmental quality.

d. Social well-being.

e. Regional economic development.

TECHNICAL CRITERIA

The following technical criteria were adopted and used as a basis for evaluating and comparing alternative plans:

a. The plan must be technically feasible to implement.

b. The plan should be complete within itself and not require additional future improvements.

c. The optimum scale of project development should be provided by analyzing the effects of trade-offs between national economic development and environmental quality.

d. The plan should insure against worsening upstream or downstream flood conditions.

NATIONAL ECONOMIC DEVELOPMENT CRITERIA

The national economic development criteria which were applied in plan formulation are those included in Senate Document No. 97, 87th Congress, entitled "Policies, Standards, and Procedures in the

Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources." Economic criteria used in evaluating each alternative plan include the following:

a. Tangible benefits must exceed project economic costs.

b. The scope of the proposed development is scaled to provide maximum net benefits. However, developments providing less than the economic optimum can be recommended if appropriate gains in environmental quality and social well-being can be shown.

c. No more economical means, evaluated on a comparable basis, would accomplish the same purpose(s) which would be precluded from development if the plan were undertaken. This limitation applies only to those alternatives that would be physically displaced or economically precluded from development if the project were undertaken.

d. Average annual benefits and costs are based on an interest rate of 5 7/8 percent and January 1975 price levels and conditions. An economic life of 100 years was used to evaluate all alternative plans of improvement.

ENVIRONMENTAL QUALITY CRITERIA

Environmental factors utilized in the plan formulation and evaluation process included the following:

a. Management, protection, enhancement, or creation of areas of natural beauty and human enjoyment.

b. Management, protection, and enhancement of especially valuable or outstanding archeological, historical, biological, and geological resources and ecological systems.

c. Enhancement of quality aspects of water, land and air while recognizing the need to harmonize land-use objectives in terms of productivity for economic use and development with conservation of the resource.

d. Study, development, and description of appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources.

e. Evaluation of the environmental impact of any proposed action, any adverse environmental effects which could not be avoided should a proposal be implemented, and alternatives to the proposed action.

f. Determination of the relationship between local short-term uses and the maintenance and enhancement of long-term productivity.

g. Determination of any irreversible and irretrievable commitment of natural resources and biological systems which could be utilized in any proposed action.

h. Coordination with local, State, and Federal environmental agencies. The final plan should be acceptable to these agencies.

SOCIAL WELL-BEING CRITERIA

Social well-being factors considered in the study included the following:

a. Possible loss of life and hazards to health and safety of the people, with and without project conditions.

b. Preservation and enhancement of social, cultural, education, and historical values in the area.

c. Preservation of pleasing aesthetic values and other desirable environmental effects such as pleasing landscapes.

d. Improvement of recreational facilities for the benefit of the general public.

REGIONAL ECONOMIC DEVELOPMENT CRITERIA

Factors considered which affect the regional economic development of the area include most of the factors described in the national economic development account and also the following:

a. Effect on the area tax base of taking private lands and placing them in public ownership.

b. Employment changes in the area as a result of the project.

c. Expenditures of nonarea residents in the study area.

d. Disruption of desirable community and regional growth.

PLAN FORMULATION OBJECTIVES

In this study of flood and related problems in the Rockford area, the following specific planning objectives have been identified:

a. Any plan developed must preserve to the maximum extent possible the quality of the riverscape environment.

b. The plan must provide flood damage reduction to a degree acceptable to the people being protected. Protection from the 1-percent chance flood is considered the minimum degree of protection acceptable.

c. The plan must be socially acceptable to the people being protected and must be acceptable to the local sponsor.

d. The plan must enhance the overall economic welfare of the local people and add to their security and well-being.

e. The plan must fit integrally into an overall plan for water and related land resource management and development for the Crow River basin,

ALTERNATIVE SOLUTIONS

GENERAL

Alternative solutions considered in this study to meet water and related land resource problems and needs, particularly with regard to flood damage reduction, were classified under three principal categories: do nothing, nonstructural measures, and structural measures. Each alternative was evaluated on its suitability for meeting identified problems and needs, technical and economic feasibility, social

acceptability, and capacity to preserve and, where practicable, enhance the quality of the natural and human environment. Alternatives considered for flood damage reduction and related purposes included:

No Action (Base Condition)

Nonstructural

1) Flood proofing.
2) Permanent floodplain evacuation.

Structural

3) Levee system.
4) Channel modifications.
5) Upstream reservoir storage.

These alternatives are described in detail in the following paragraphs.

NO ACTION (BASE CONDITION)

The "no action" or base condition alternative would consist of maintaining the status quo. No major Federal action would be taken to permanently alleviate flood and related problems of the area. No major expenditure of public funds, Federal or non-Federal, would be required. Average annual flood damages, estimated at $45,100, would remain as a social and economic burden to Rockford, especially to those individuals with property located in the floodplain.

Existing programs and policies relating to flood problems would remain in effect with this alternative. These include flood forecasting and warning, emergency action, floodplain regulations, and flood insurance.

Flood forecasts are provided by the National Weather Service and consist of predictions of the time and magnitude of flooding to allow for evacuation of flood prone areas or implementation of emergency protection measures. Spring snowmelt floods can be reasonably predicted. Major flooding caused by excessive rainfall can also be predicted, but the time interval between rainfall occurrence, issuance of a flood warning, and the start of flooding is much shorter than for snowmelt flooding. Emergency evacuation of persons and belongings or construction of emergency flood protective measures might well be undertaken for spring snowmelt floods. These emergency measures would be much less effective in preventing damages from floods resulting from excessive rainfall. With increased technology, more accurate predictions and additional warning time could be provided. This improved prediction service would allow for greater reliance on emergency protection measures.

Prior to the 1969 flood, temporary emergency levees were constructed at Rockford under Federal financing. These levels do not provide permanent protection but have kept flood damages at Rockford to a minimum since their construction. Reinforcement and construction of additional closures at appropriate locations could prevent additional flood damages from future major floods. However, this emergency levee must be considered as only a temporary means of flood damage reduction.

An integral part of the base condition is the requirement for implementation of floodplain regulations and the availability of federally subsidized flood insurance for flood prone properties.

The State of Minnesota passed a floodplain regulation law in 1969 as amended in 1973, requiring flood prone governmental units (counties and cities) to adopt, enforce, and administer sound floodplain management ordinances in their respective jurisdictions whenever sufficient technical information is available for delineation of floodplains and floodways on their watercourses. Floodplain regulations consist primarily of regulating new development in flood prone areas, thus preventing or reducing future flood damages. Rockford has passed a resolution which meets the State floodplain management law.

The federally subsidized flood insurance program requires that appropriate floodplain regulations be in effect within a governmental unit before the properties within that governmental unit are eligible to purchase federally subsidized flood insurance.

On 5 February 1975, Rockford became eligible for participation in the National Flood Insurance Program. The basic objectives of the flood insurance program are first, to provide flood insurance at subsidized rates on existing structures and their contents; second, to provide coverage at actuarial rates for future properties located in flood-prone areas; and third, to promote appropriate land use in areas subject to flooding in order to reduce flood hazards.

By participating in the flood insurance program, those citizens affected may purchase insurance policies to compensate for damages that might result from naturally caused flooding. Maximum subsidized coverage is limited to $35,000 for a single family dwelling and $100,000 for a multiple family dwelling of four units or more. For a small business, the maximum subsidized coverage is $100,000. Insurance of contents of buildings is limited to $10,000 per unit for residences and $100,000 for nonresidential units. By participating in this program, residents of Rockford can obtain coverage in accordance with the preceding limits at an estimated total cost of $6,593 annually which provides coverage for the 46 residential, 4 apartment, 22 business, and 3 public structures in the floodplain. (Three residences in which small businesses are located are treated as residential structures.)

The total cost quoted is based on the assumption that each owner would obtain flood insurance coverage equal to the full value of his structure and its contents in accordance with the preceding limits. It is likely, however, that owners would base the amount of coverage

purchased on their anticipated flood damages rather than the total value of the structure and contents. This would substantially reduce the amount and the cost of the coverage. The detailed estimate of the annual cost of federally subsidized flood insurance for floodplain property owners is presented in the following table (A-23).

The flood insurance program compensates for flood damages by spreading the cost over a wider base. However, this does not reduce the damages due to flooding and annual flood damages of approximately $45,000 would remain.

Table A-23 - Detailed estimate of annual cost of flood insurance

Structure number (1)	Value		Annual insurance premium		
	Structure	Contents	Structure	Contents	Total
Residential and apartment					
1	$ 8,500	$ 5,000	$ 21.25	$ 17.50	$ 38.75
2	18,500	5,000	46.25	17.50	63.75
3	15,000	5,000	37.50	17.50	55.00
4	10,000	5,000	25.00	17.50	42.50
5	10,500	5,000	26.25	17.50	43.75
6	14,000	5,000	35.00	17.50	52.50
9	80,000	10,000	320.00	75.00	395.00
10	12,000	5,000	30.00	17.50	47.50
11	13,500	5,000	33.75	17.50	51.25
12	11,000	5,000	27.50	17.50	45.00
24	26,500	5,000	66.25	17.50	83.75
25	27,000	5,000	67.50	17.50	85.00
27	12,500	2,000	50.00	15.00	65.00
35	15,000	5,000	37.50	17.50	55.00
40	13,000	5,000	32.50	17.50	50.00
41	12,900	5,000	32.25	17.50	49.75
42	10,000	5,000	25.00	17.50	42.50
49	11,000	5,000	27.50	17.50	45.00
50	10,000	5,000	25.00	17.50	42.50
53	14,000	5,000	35.00	17.50	52.50
54	10,500	5,000	26.25	17.50	43.75
55	8,170	5,000	20.40	17.50	37.90
56	8,000	5,000	20.00	17.50	37.50
57	9,500	5,000	23.75	17.50	41.25
58	17,000	5,000	42.50	17.50	60.00
61	3,500	0	8.75	0	8.75
62	10,100	5,000	25.25	17.50	42.75
63	13,000	5,000	32.50	17.50	50.00
64	5,500	5,000	13.75	17.50	31.25
66	12,000	5,000	30.00	17.50	47.50
67	20,000	10,000	80.00	75.00	155.00
68	12,000	5,000	30.00	17.50	47.50
70	18,000	5,000	45.00	17.50	62.50
71	14,000	5,000	56.00	38.00	94.00
72	5,000	5,000	12.50	17.50	30.00
73	15,000	5,000	37.50	17.50	55.00
74	6,000	5,000	15.00	17.50	32.50
75	8,500	5,000	21.25	17.50	38.75
76	23,000	5,000	57.50	17.50	75.00
77	12,000	5,000	30.00	17.50	47.50
79	24,500	5,000	61.25	17.50	78.75
82	15,000	5,000	37.50	17.50	55.00
83	8,000	5,000	20.00	17.50	37.50

Table A-23 - Detailed estimate of annual cost of flood insurance (cont)

Structure number(1)	Value		Annual insurance premium		
	Structure	Contents	Structure	Contents	Total
Residential and apartment (cont)					
84	$21,000	$5,000	$52.50	$17.50	$70.00
87	13,000	5,000	32.50	17.50	50.00
92	15,100	5,000	37.75	17.50	55.25
93	29,000	5,000	72.50	17.50	90.00
99	17,500	5,000	43.75	17.50	61.25
103	17,000	5,000	42.50	17.50	60.00
106	14,000	5,000	35.00	17.50	52.50
Business					
7	12,000	5,000	48.00	38.00	86.00
8	20,000	5,000	80.00	38.00	118.00
13	32,000	5,000	128.00	38.00	166.00
22	60,000	10,000	240.00	75.00	315.00
23	7,000	2,000	28.00	15.00	43.00
28	35,000	5,000	140.00	38.00	178.00
29	25,000	5,000	100.00	38.00	138.00
30	37,000	5,000	148.00	38.00	186.00
31	7,000	2,000	28.00	15.00	43.00
32	15,000	5,000	60.00	38.00	98.00
33	27,000	5,000	108.00	38.00	146.00
34	32,000	5,000	128.00	38.00	166.00
36	15,000	5,000	60.00	38.00	98.00
37	55,000	10,000	220.00	75.00	295.00
39	18,000	10,000	72.00	75.00	147.00
51	20,000	15,000	80.00	113.00	193.00
52	11,000	5,000	44.00	38.00	82.00
81	6,000	10,000	24.00	75.00	99.00
86	21,000	10,000	84.00	75.00	159.00
88	10,000	5,000	40.00	38.00	78.00
102	16,000	10,000	64.00	75.00	139.00
Public					
26	18,350	5,000	74.00	38.00	112.00
65	55,000	10,000	220.00	75.00	295.00
89	30,000	5,000	120.00	38.00	158.00
Total(2)	1,334,120	411,000			6,592.65

Total insured property value = $1,745,120
($1,334,120 + $411,000)

(1) Properties numbered between 1 and 106 not included on this list are located outside the intermediate regional floodplain.

(2) Does not include trailer court.

Social and environmental impacts of the base condition would be the continued disruption of homes, families, and businesses during periods of flooding. The individuals who own property in the floodplain would have difficulty in obtaining loans for any improvements to their properties, which could lead to the degradation of the existing environment as owners allow their property to deteriorate. As a requirement for participation in the flood insurance program, an interim floodplain zoning resolution has been adopted which will prevent the development of facilities within the floodplain that are subject to flood damage. The resolution will remain in effect until sufficient data are available to adopt a permanent regulation. Therefore, it is anticipated that over a period of time the flood damages would be gradually reduced as existing property within the floodplain is phased out.

However, because flood prone home and business owners can, by purchasing flood insurance if eligible, obtain home improvement loans and because residential and business content values can be expected to increase, flood damages are expected to increase even with floodplain regulations in effect. Thus, the base condition is not considered as a completely effective method of reducing flood damages at Rockford.

NONSTRUCTURAL ALTERNATIVES

The nonstructural alternatives evaluated emphasize utilization of nonstructural solutions to the maximum extent practicable. Flood proofing and floodplain evacuation were the principal components of the two alternative plans evaluated. The flood proofing plan emphasized use of flood proofing measures, but also utilized levees and floodplain evacuation in areas where flood proofing techniques were not practical. The floodplain evacuation plan emphasized evacuation and/or relocation of all residences, businesses, and public buildings in the floodplain.

FLOOD PROOFING

Flood proofing is a combination of structural changes and adjustments to flood prone buildings for flood damage reduction. For the purposes of this study, it is not considered feasible to flood proof a structure if the elevation of the intermediate regional flood is equal to or greater than the first-floor elevation. This is based on the fact that it is not feasible to redesign the existing structure to enable it to withstand the hydrostatic forces generated by flooding.

In Rockford, 50 residences, 25 businesses, 3 public buildings, and a segment of the mobile home park are located within the intermediate regional floodplain. Since the elevation of the intermediate regional flood is several feet above the first floor of many of these structures, it would be feasible to flood proof only 28 percent of the residences, 28 percent of the businesses, 33 percent of the public buildings, and the mobile home park.

The plan would consist of flood proofing the area bounded by Highway 55 and the Soo Line Railroad tracks as a single unit. This would be accomplished by construction of a 250-foot-long levee along the west riverbank near the railroad embankment and a raise in the grade of approximately 300 feet of Highway 55 by approximately one-half foot. Construction of the levee and regrading of Highway 55 would prevent floodwaters from entering the area between Highway 55 and the Soo Line Railroad embankment. Interior drainage for this area would be accomplished by the construction of approximately 700 feet of curb and gutter and storm sewer along Maple Street, and approximately 660 feet of storm sewer parallel to Highway 55 from Maple Street to the river. The storm sewer would be designed to intercept the drainage from the area lying to the west of Maple Street and would have sufficient capacity to carry the quantity of runoff anticipated during time of flooding. A small ponding area and a gravity outlet through the levee would be provided near the Soo Line Railroad embankment to protect the area from the runoff generated from the 50-year frequency storm. This part of the flood proofing plan would provide protection for nine residences, one apartment building, and three businesses.

Approximately 230 mobile homesites lie within the intermediate regional floodplain. Since the elevations of the floors of the mobile homes are approximately 1 foot above the elevation of the intermediate regional flood, the mobile homesites can be readily flood proofed. Flood proofing of the mobile homesites would consist of modifying the sewer, telephone, and electric hookups to prevent seepage into the systems. No sewer backup in the mobile homes would be anticipated because the elevation of the utilities within the mobile homes is well above the flood elevation. Contamination of the drinking water supply during flood conditions is also not likely because Rockford's water supply is located at a much higher elevation than the mobile home park. This would create positive water pressure in the distribution pipes at all times, making flow of floodwater into distribution pipes unlikely.

The remainder of the flood proofing plan consists of flood proofing individual homes and businesses by conventional methods such as blocking lower structure openings, installing sewer check valves, and the use of sump pumps. These methods would be used to protect six businesses and three residences which are located on the fringe of the floodplain.

The estimated first cost of the flood proofing alternative is approximately $183,000. A breakdown of the cost estimate is given in the following table (A-24).

Table A-24 - Estimate of first costs for flood proofing

Item	Estimated first costs
Area bounded by Highway 55 and Soo Line Railroad	$100,670
Mobile home park	13,920
Individual flood proofing	15,800
	130,390
Contingencies (20 percent)	26,110
Direct first costs	156,500
Indirect first costs	26,500
Total first costs	183,000

It would be necessary to evacuate the 36 homes, 18 businesses, and 3 public buildings located in the floodplain which could not be feasibly flood proofed. The estimated first cost for evacuation of these structures is $2,287,000, making the total estimated first cost of the flood proofing plan $2,470,000. The average annual cost of this plan is estimated at $148,600, based on a 100-year period of evaluation, a 5 7/8-percent interest rate, and an operations, maintenance, and replacement cost of $3,000.

The total average annual benefits attributable to this plan are estimated at $90,800, which include $40,800 for flood damage reduction and $50,000 for social betterment due to improved housing conditions resulting from the evacuation of floodplain residences. The comparison of these average annual benefits of $90,800 to the average annual costs of $148,600 gives an unfavorable benefit-cost ratio of 0.6.

The environmental impact of the flood proofing plan would be centered on the construction of the levee adjacent to the Soo Line Railroad embankment. This area currently contains a narrow bank of trees adjacent to the river and since this bank of trees would not be disturbed by the construction of the levee, the environmental effect would be minimal. The levee would have an adverse effect on the aesthetics of the area, but this effect would be limited due to the small size of the levee. Since flood proofing measures are not feasible for a large proportion of the floodplain, evacuation of this area would create approximately 40 acres of land which could be developed for recreation or open space. The evacuation required by this plan represents approximately 80 percent of the area affected by the evacuation plan. The environmental and social impacts caused by evacuation are discussed in detail under the evacuation plan.

EVACUATION

Permanent evacuation of all portions of the intermediate regional floodplain would involve the removal and relocation of improvements and conversion of such lands to uses less susceptible to flood damage. Currently, 50 residences, 25 businesses, 3 public buildings, and a segment of the mobile home park are located in the floodplain. A summary of these structures with respect to market value is shown in the following table (A-25).

Table A-25 - Summary of structures within the floodplain, Rockford, Minn.

Structure value		Description and number			
Market	Average	Single family	Apartment	Business	Public
0-5,000	$ 3,333	2	0	3	1
5,001-10,000	8,261	12	0	4	0
10,001-20,000	14,354	26	3	9	0
20,001-30,000	25,400	6	0	3	1
30,001-40,000	34,000	0	0	4	0
40,001-60,000	56,667	0	0	2	1
>60,000	80,000	0	1	0	0

This plan would provide for total evacuation of all flood damage prone property from the floodplain with the exception of the segment of the mobile home park. Approximately 200 people would have to be relocated. Since Rockford has no significant amount of vacant housing outside the floodplain, a new housing development would have to be constructed, probably near the new shopping center on the west side of Rockford. All businesses within the floodplain would be relocated probably in or near the new shopping center. The 232 of the 428 sites in the mobile home park within the floodplain would be flood proofed, since evacuation does not appear to be a reasonable alternative.

The estimated tangible first cost of evacuation, including approximately $20,000 for flood proofing of the mobile homesites, is $3,334,000. Based on a 100-year period of evaluation and a 5 7/8-percent interest rate, the average annual cost is estimated at $196,300. A detailed breakdown of first costs is contained in the following table (A-26).

Table A-26 - Detailed estimate of first costs, evacuation plan, Rockford, Minn.

Number[1]	Structure value	Land value	Fees	Moving allowance	Site restoration	Supplemental payments[2]	Total relocation cost	Relocation type[3]
1	$ 8,500	$ 3,000	$ 45	$ 500	$ 1,000	$ 18,500	$ 31,545	1
2	18,500	2,000	65	500	1,400	9,500	31,965	1
3	15,000	3,000	60	500	1,400	12,000	31,960	1
4	10,000	5,000	53	500	1,100	15,000	31,653	1
5	10,500	3,500	51	500	1,050	16,000	31,601	1
6	14,000	2,000	55	500	900	14,000	31,455	1
7	12,000	10,000	68	500	1,200	2,500	26,268	3
8	20,000	5,000	75	500	1,050	2,500	29,125	3
9	80,000	10,000	218	4,000	4,500	16,000	114,718	4
10	12,000	6,000	60	500	1,400	12,000	31,960	1
11	13,500	3,500	57	500	1,100	13,000	31,657	1
12	11,000	3,500	52	500	1,500	15,500	32,052	1
13	32,000	5,000	101	500	1,800	2,500	41,901	3
15	--	2,000	15	--	--	--	2,015	1
16	--	1,000	13	--	--	--	1,013	1
17	--	2,500	15	--	--	--	2,515	1
18	--	6,000	23	--	--	--	6,023	1
19	--	1,000	13	--	--	--	1,013	1
22	60,000	5,000	163	500	1,200	2,500	69,363	3
23	7,000	2,500	41	500	1,500	2,500	14,041	3
24	26,500	4,000	87	500	300	19,700	20,587	2

Table A-26 - Detailed estimate of first costs, evacuation plan, Rockford, Minn. (cont)

Number(1)	Structure value	Land value	Fees	Moving allowance	Site restoration	Supplemental payments(2)	Total relocation cost	Relocation type(3)
25	$27,000	$ 4,000	$ 88	$ 500	$ 300	$ 17,300	$ 18,188	2
26	18,350	2,000	64	1,500	1,500	4,000	27,414	465
27	12,500	1,500	51	2,000	1,400	8,000	25,451	4
28	35,000	5,000	108	500	2,000	2,500	45,108	3
29	25,000	5,000	86	500	1,500	2,500	34,586	3
30	37,000	6,000	115	--	2,000	--	45,115	3, vacant
31	7,000	1,500	39	500	900	2,500	12,439	3
32	15,000	5,000	64	500	2,000	2,500	25,064	3
33	27,000	3,000	86	500	4,000	2,500	37,086	3
34	32,000	3,000	97	500	4,000	2,500	42,097	3
35	15,000	3,000	60	500	1,400	12,000	31,960	1
36	15,000	2,000	57	500	1,300	2,500	21,357	3
37	55,000	3,000	148	500	1,800	2,500	62,948	3
38	--	7,000	25	--	--	--	7,025	1
39	18,000	3,000	66	500	1,500	2,500	25,566	3
40	13,000	3,000	55	500	2,000	15,000	33,555	1
41	12,900	4,000	58	500	1,400	13,100	31,958	1
42	10,000	1,500	45	500	1,400	18,500	31,945	1
43	--	1,000	13	--	--	--	1,013	1
44	--	2,000	15	--	--	--	2,015	1
45	--	2,500	16	--	--	--	2,516	1

Table A-26 - Detailed estimate of first costs, evacuation plan, Rockford, Minn. (cont)

Number[1]	Structure value	Land value	Fees	Moving allowance	Site restoration	Supplemental payments[2]	Total relocation cost	Relocation type[3]
46	$ --	$ 3,000	$ 17	$ --	$ --	$ --	$ 3,017	1
47	--	2,500	16	--	--	--	2,516	1
48	--	6,600	25	--	--	--	6,625	5
49	11,000	2,500	50	500	1,400	16,500	31,950	1
50	10,000	2,400	48	500	1,400	17,600	31,948	1
51	20,000	2,000	68	500	1,200	2,500	26,268	3
52	11,000	2,000	49	500	1,300	2,500	17,349	3
53	14,000	5,000	62	500	1,050	11,000	31,612	1
54	10,500	2,000	48	500	1,250	17,500	31,798	1
55	8,170	2,000	42	500	1,400	19,830	31,942	1
56	8,000	2,000	42	500	1,050	20,000	31,592	1
57	9,500	2,000	45	500	1,100	18,500	31,645	1
58	17,000	2,000	62	500	1,100	11,000	31,662	1
59	--	5,000	21	--	--	--	5,021	5
60	3,500	9,000	38	500	1,000	--	14,038	5
61	3,500	1,000	30	500	1,050	--	6,080	1, vacant
62	10,100	3,000	49	500	1,400	16,900	31,949	1
63	13,000	1,500	52	500	1,100	15,500	31,652	1
64	5,500	2,000	37	500	1,400	22,500	31,937	1
65	55,000	3,000	138	500	3,000	--	61,638	5
66	12,000	2,000	51	500	1,200	16,000	31,751	1

Table A-26 - Detailed estimate of first costs, evacuation plan, Rockford, Minn. (cont)

Number[1]	Structure value	Land value	Fees	Moving allowance	Site restoration	Supplemental payments[2]	Total relocation cost	Relocation type[3]
67	$20,000	$ 4,000	$ 73	$ 2,000	$ 1,600	$ 8,000	$ 35,673	4
68	12,000	2,000	51	500	1,200	16,000	31,751	1
69	--	4,000	19	--	--	--	4,019	1
70	18,000	2,000	64	500	1,400	10,000	31,964	1
71	14,000	2,000	55	1,500	1,100	6,000	24,655	4
72	5,000	2,500	37	500	300	4,800	5,637	2
73	15,000	3,000	60	500	1,050	12,000	31,610	1
74	6,000	2,000	38	500	900	22,000	31,438	1
75	8,500	2,000	53	500	1,400	19,500	31,953	1
76	23,000	4,000	79	500	300	15,900	16,779	2
77	12,000	2,000	51	500	1,500	16,000	32,051	1
79	24,500	3,000	81	500	300	15,600	16,481	2
80	--	4,000	19	--	--	--	4,019	1
81	6,000	2,000	38	500	1,700	2,500	12,738	3
82	15,000	2,500	58	500	1,050	12,500	31,608	1
83	8,000	2,500	43	500	1,200	19,500	31,743	1
84	21,000	3,000	73	500	300	17,200	18,073	2
86	21,000	6,000	79	500	1,600	2,500	31,679	3
87	13,000	2,000	53	500	950	15,000	31,503	1
88	10,000	2,000	47	500	1,300	2,500	16,347	3
89	30,000	5,000	87	500	1,100	--	36,687	5

Table A-26 - Detailed estimate of first costs, evacuation plan, Rockford, Minn. (cont)

Number(1)	Structure value	Land value	Fees	Moving allowance	Site restoration	Supplemental payments(2)	Total relocation cost	Relocation type(3)
92	$15,100	$ 4,000	$ 62	$ 500	$ 1,200	$ 10,900	$ 31,762	1
93	29,000	3,000	88	500	300	19,700	20,588	2
99	17,500	3,000	65	500	1,400	9,500	31,965	1
102	16,000	3,000	62	500	1,300	2,500	23,362	3
103	17,000	4,500	67	500	2,000	13,000	37,067	1
106	14,000	2,000	55	500	900	14,000	31,455	1

Total of relocation costs	2,387,430
Mobile home flood proofing	13,920
Contingencies (20 percent)	479,650
Direct first costs	2,881,000
Indirect first costs	453,000
Total first costs	3,334,000

(1) Properties numbered between 1 and 106 that are not included in this list are not located in the intermediate regional flood plain.

(2) See page A-101.

(3) See page A-102.

Table A-26

Footnote 2. -

Supplemental housing payments under Public Law 91-646:

On the basis of discussions with the United States Department of Housing and Urban Development, it was determined that the cost of a development to house the current floodplain population of Rockford on what is currently agricultural land would be $30,000 per single-family housing unit. Such housing would have to meet HUD's Minimum Property Standards and State of Minnesota Uniform Building Code requirements for basic, decent, safe, and sanitary housing. This figure of $30,000 includes all land and construction costs, utility services, and legal and other fees.

Public Law 91-646 states that the Federal Government must make supplemental housing payment to a displaced family if the market value of the acquired property does not enable the family to purchase comparable, decent, safe, and sanitary replacement housing in the area. Public Law 91-646 also states that such supplemental payment cannot exceed $15,000.

In determining supplemental housing payments for this report, the responsibility of the Federal Government to provide replacement housing that meets its own minimum housing standards has been considered to be the determining factor. Where the appraised value of acquired family property is less than $15,000, supplemental housing payments in excess of $15,000 have been used in the estimates of first costs in order to provide every displaced family with minimum Department of Housing and Urban Development standard housing.

Table A-26

Footnote 3. -

Relocation cost determination for various relocation types:

Type 1: Residential property. - Relocation cost includes market value of structure and land, fees (purchase, transfer, recording, disconnect utilities), complete site restoration, supplemental payment to cover the cost of acquiring comparable, decent, safe, and sanitary replacement housing, and an allowance for moving expenses, where applicable.

Type 2: Residential property. - Relocation cost includes fees (purchase, transfer, recording, disconnect utilities), supplemental payment to cover the cost of moving the structure to a new site and the new site costs, an allowance for moving expenses, and complete restoration of the old site.

Type 3: Business property. - Relocation cost includes market value of structure and land, fees (purchase, transfer, recording, disconnect utilities), complete site restoration, supplemental payment for lost earnings, and an allowance for moving expenses.

Type 4: Apartment property. - Relocation cost includes market value of structure and land, fees (as above), complete site restoration, supplemental payment for the replacement housing costs of the tenants, and an allowance for the moving expenses of the tenants.

Type 5: Public property. - Relocation cost includes market value of structure and land, fees (as above), complete site restoration, and an allowance for moving expenses where applicable.

The area of the floodplain that would be evacuated under this plan is 51 acres. Of this area, 45 acres are currently occupied by residential and commercial property, 1 acre is occupied by public buildings, and 5 acres are currently utilized as public park and recreation areas. Future use of most of the evacuated area for residential or commercial development does not appear to be feasible, since it would be necessary to fill the area to a depth of 6 to 8 feet in order to remove it from the floodplain. This would be extremely expensive. Therefore, it is contemplated that the evacuated area would be utilized for purposes which are not susceptible to significant damage in the event of flooding.

There are several alternative uses for the evacuated land as recreational or open space area. Developments of these types would not sustain significant damage in the event of flooding. One alternative would involve the development of picnic areas, athletic fields, and playgrounds. This could be accomplished at an estimated first cost of $20,000 and would provide people residing in the vicinity of Rockford and the western metropolitan area with expanded recreational opportunities.

A second alternative use for the evacuated floodplain would involve reforestation which would provide additional forest habitat. Elm, maple, cottonwood, ash, and willow are species which are well adapted for growth in the floodplain. This alternative would expand wildlife habitat for present species by approximately 40 acres, as well as provide increased natural habitat to attract different species such as deer, fox, weasel, grouse, and woodland songbirds. It would also provide open space for the Rockford area where activities such as hiking and nature study could be enjoyed. It is estimated that reforestation of the evacuated floodplain could be accomplished for approximately $4,000 by planting seedlings, producing a semimature forest in approximately 30 years.

Both of these alternative uses for the evacuated floodplain would enhance the river aesthetics and provide needed recreational and open space area. These types of development would be particularly valuable if the Crow River is included in the Wild, Scenic, and Recreational River System and the development of temporary campsites to accommodate canoeists and boaters on the river could be included.

Although the environmental impact of the evacuation plan would be primarily beneficial, the development of a new subdivision to accommodate the people displaced from the floodplain might have an adverse effect on the environment. The new subdivision would require the development of approximately 48 acres of land which is currently utilized for agricultural purposes. The proposed relocation site, however, is in an area where the biological systems are less sensitive than those of the bottomland areas and it is anticipated that the long-term net effects would be beneficial. However, recovery of the bottomland systems would require considerable time and demolition of the existing structures would result in substantial quantities of solid waste. It is also likely that many of the existing structures would not be immediately removed; therefore, the evacuated area would remain scarred for some time. The effect of this plan on the water quality and aquatic biota of the Crow River would be insignificant.

Total evacuation of the floodplain would have adverse social impacts on the approximately 200 people who currently inhabit the floodplain, including disruption of existing physical, social, and cultural relationships; increased cost to displaced persons and businesses in seeking alternative housing; increased cost of new financing; and the added burden of moving costs. Since the persons displaced from the floodplain would be relocated within the boundaries of the community, it is anticipated that most of the social impacts, with the exception of the adverse financial impacts, would be minor and of short duration.

The estimated average annual benefits attributable to this plan are $105,500, including $41,700 attributable to flood damage reduction and $63,800 attributable to social betterment. This average annual benefit of $105,500 compared to the average annual cost of $196,300 gives an unfavorable benefit-cost ratio of 0.5.

STRUCTURAL ALTERNATIVES

The structural alternatives evaluated include levees and floodwalls, channel modification, and upstream reservoir storage. Several alternate levee alignments were evaluated, with the most feasible plan being used as a comparison with other alternative plans. The pertinent economic, social, and environmental impacts and aspects of the levee and floodwall and channel modification alternatives are displayed in table A-37 (page A-142) and discussed in the following paragraphs. The various aspects of the reservoir alternative are presented only in the discussion.

LEVEES AND FLOODWALLS

This plan would provide flood protection for the developed portion of Rockford lying north of the Soo Line Railroad tracks and for the mobile home park located south of the Soo Line Railroad tracks for floods up to and including the intermediate regional flood. Flood protection would be implemented by the construction of flood barriers between the river and the developed areas. Since the embankment for the Soo Line Railroad tracks effectively segregates the mobile home park from the remainder of Rockford, as far as flood protection is concerned, separate plans were developed for protecting the mobile home park and the developed area of Rockford. These plans are illustrated on plate 4.

The plan for protecting the developed portion of Rockford lying to the north of the Soo Line Railroad embankment provides for the construction of a levee between the river and the developed area. Two major

levee alignments were evaluated. The first levee alignment would be essentially the same as the alignment of the existing emergency levee and an average of 3 feet higher than the existing emergency levee to provide 3 feet of freeboard above the elevation of the intermediate regional flood. A typical section of the proposed levee is shown on plate 4. Due to insufficient space for the construction of an earth levee, the apartment building located on the riverbank south of Highway 55 would be protected by a section of concrete floodwall approximately 140 feet long. Closure structures would be provided at the Bridge Street and Highway 55 bridges. At the north end of the town, Main Street would be regraded to provide a ramp over the levee and eliminate the need for a closure structure. Typical views of the floodwall and closure structures are illustrated in the following figures (A-14, A-15, and A-16).

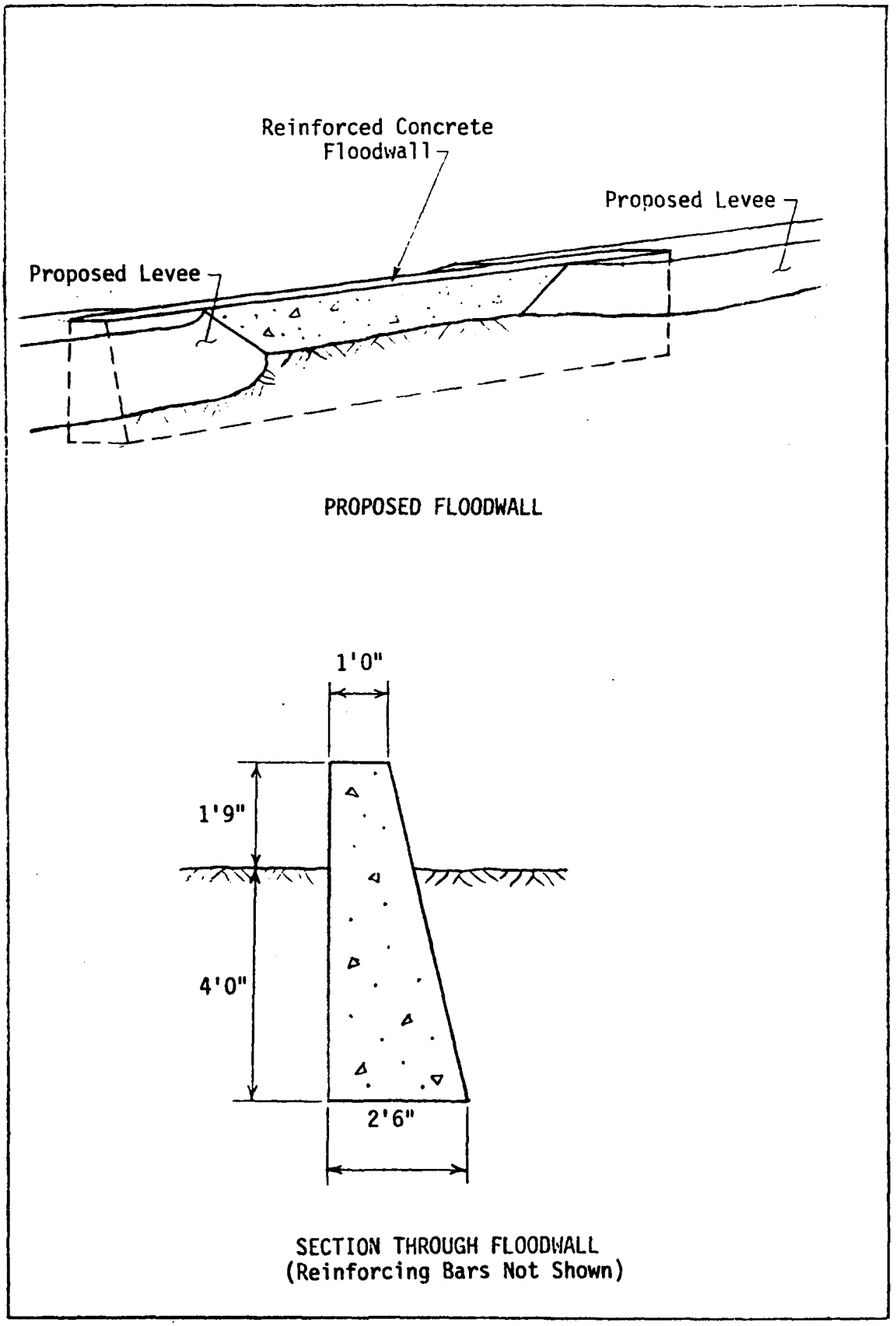


Figure A-14 - Typical view, concrete floodwall

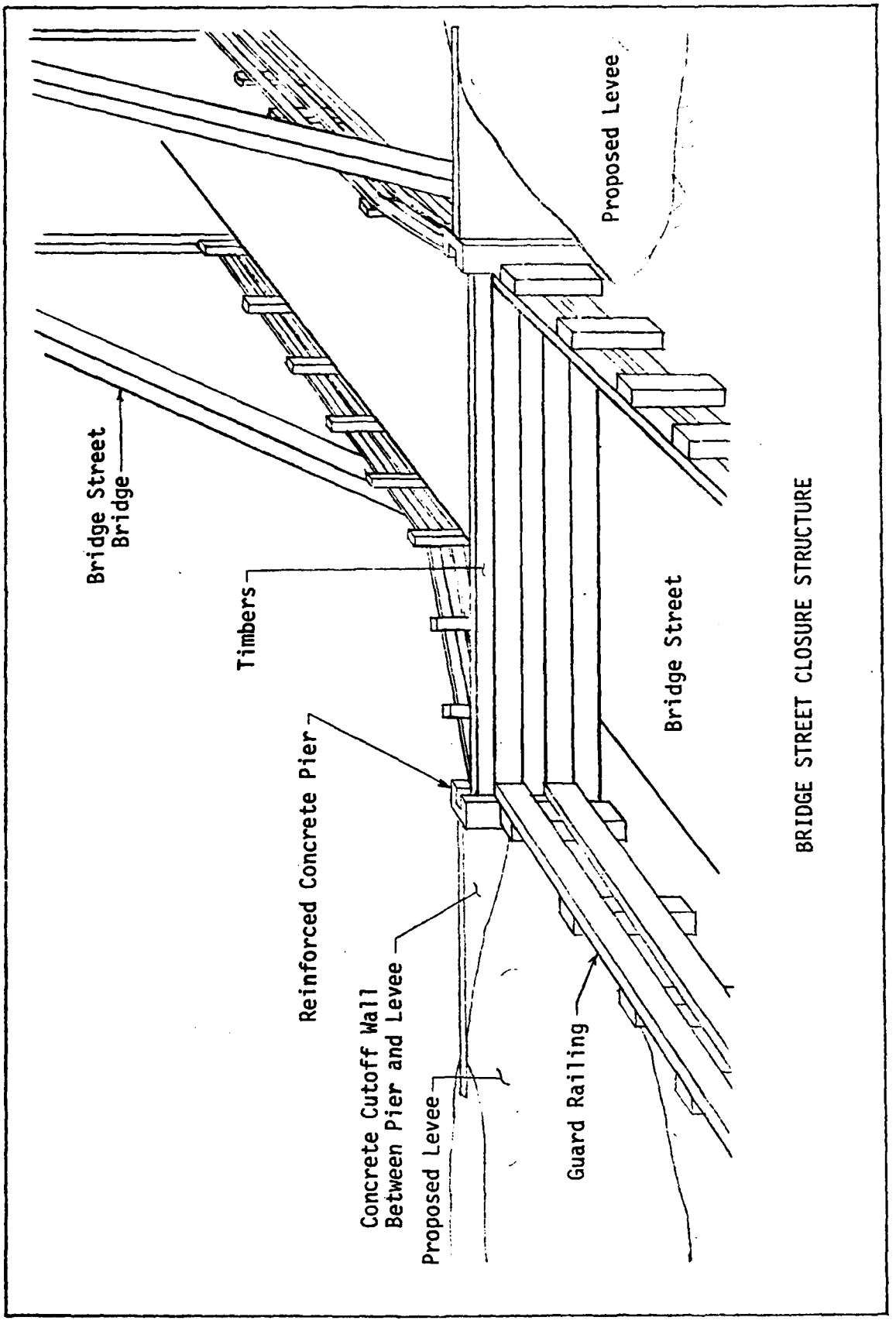


Figure A-15 - Schematic diagram, Bridge Street closure structure

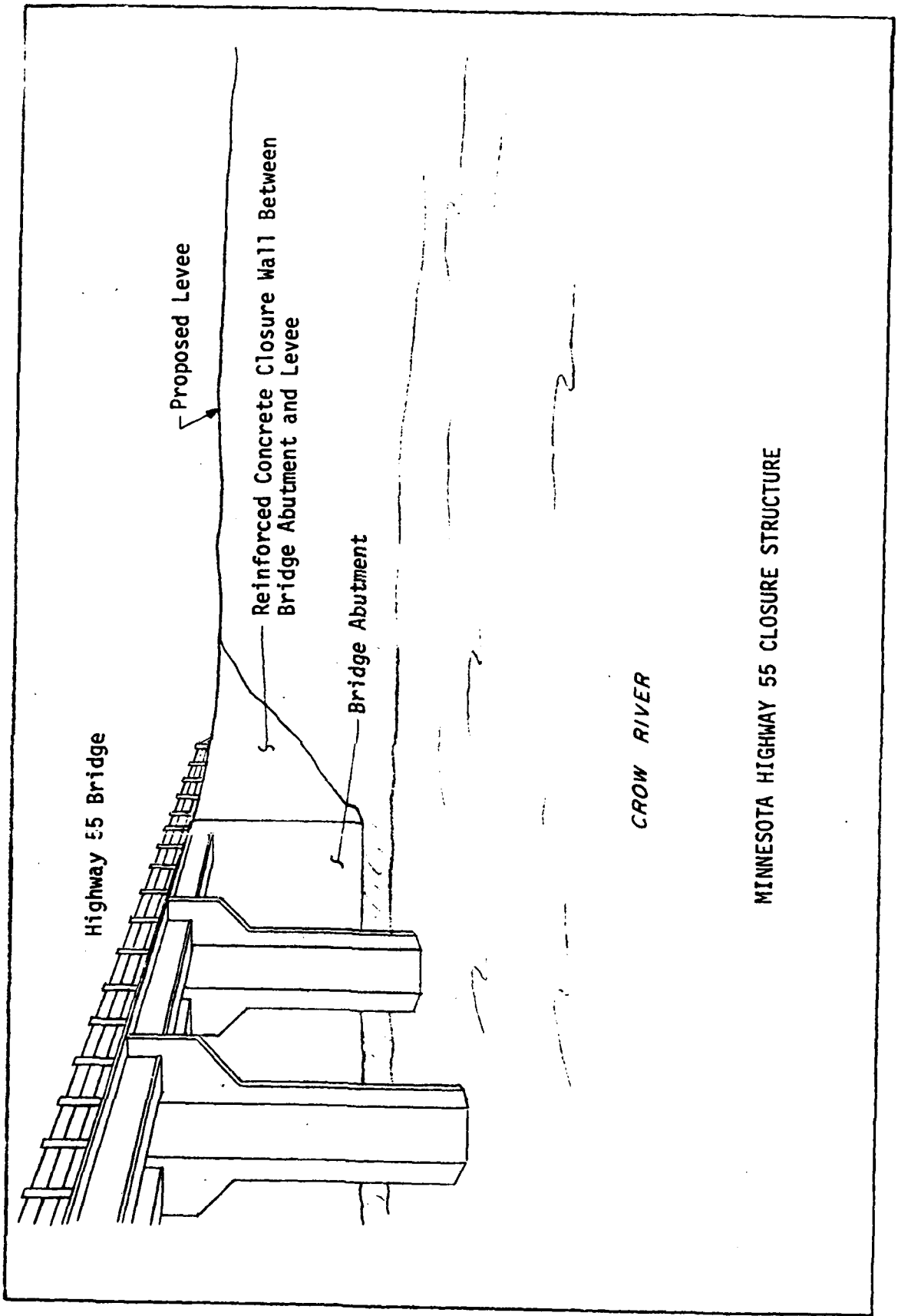


Figure A-16 - Schematic diagram, closure structure between levee and Highway 55 bridge

Interior drainage of the area protected by this levee would be accomplished by the installation of one pump station and two ponding areas with gravity outlets to the river. A gravity outlet and a 1-acre ponding area would be located 200 feet north of the Soo Line Railroad embankment. Runoff from the area lying to the west of Maple Street and between the Soo Line Railroad tracks and Highway 55 would be intercepted by a storm sewer constructed along Maple Street and from Maple Street to the river along the south side of Highway 55. The storm sewer system would have sufficient capacity to carry the runoff generated by the design storm occurring in conjunction with flood conditions. The capacity of the ponding area would be sufficient to store the runoff from the area lying to the south of Maple Street. The storm sewer system and the ponding area make the installation of a pumping station between Highway 55 and the Soo Line Railroad unnecessary.

Runoff from the area located to the north of Highway 55 would be routed to a 3-acre ponding area located along both sides of Main Street between Plum Street and the levee. Runoff resulting from storms which occur during nonflood periods would be discharged to the river through a gravity outlet to the river located approximately 100 feet west of Main Street. A pumping station would also be installed at this location to discharge the runoff generated by storms which occur during periods when flooding makes the gravity outlet inoperable. A typical section of a gravity outlet structure is shown in the following figure (A-17).

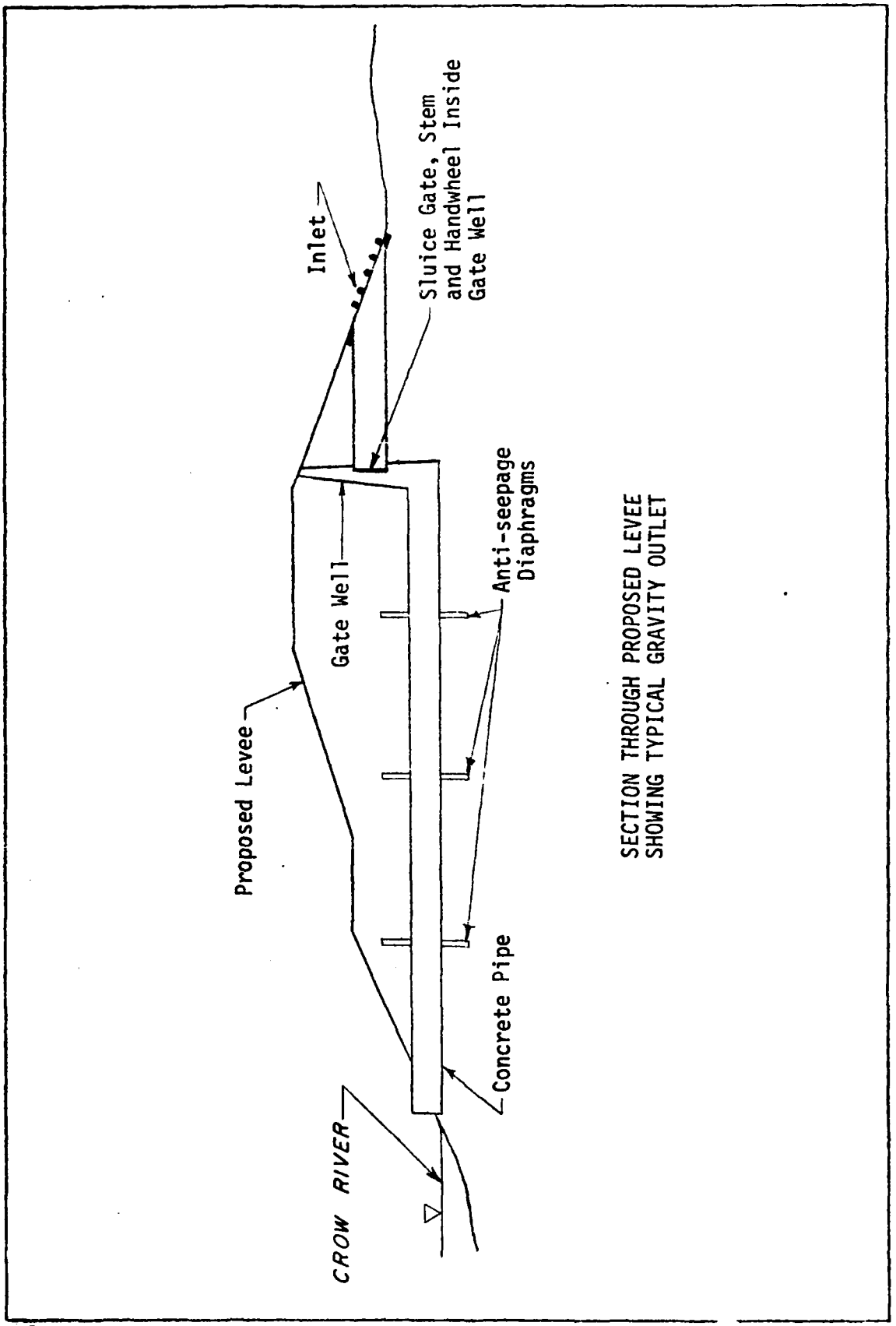


Figure A-17 - Typical section, gravity outlet structure

In addition to the drainage works outlined, hydraulic control structures would be installed at the outlets of the two marsh areas west of Elm Street near the elementary school. This would allow the marshes to be used as ponding areas during flood periods and periods of intense rainfall. The rate of runoff reaching the ponding area located between Plum Street and the levee would be substantially reduced and the size and cost of the gravity outlet and pumping station necessary to discharge runoff to the river would be decreased. Typical views of the hydraulic control structures for the upper and lower marshes are shown in the following figures (A-18 and A-19, respectively).

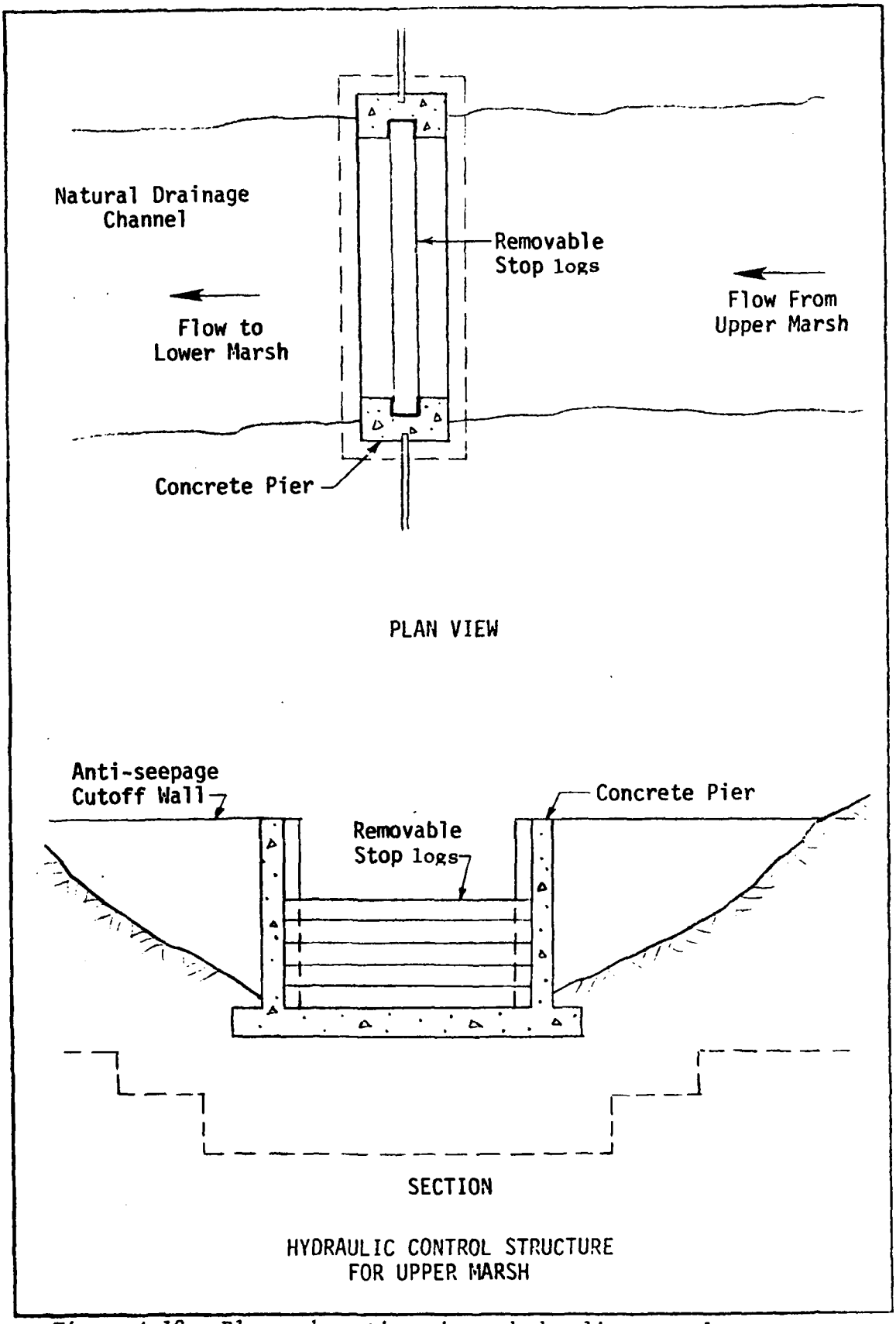
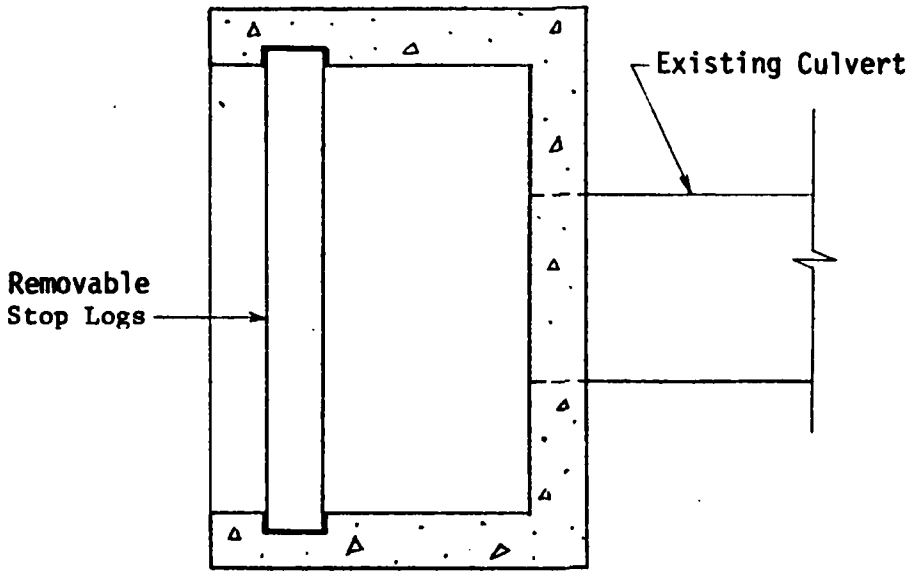
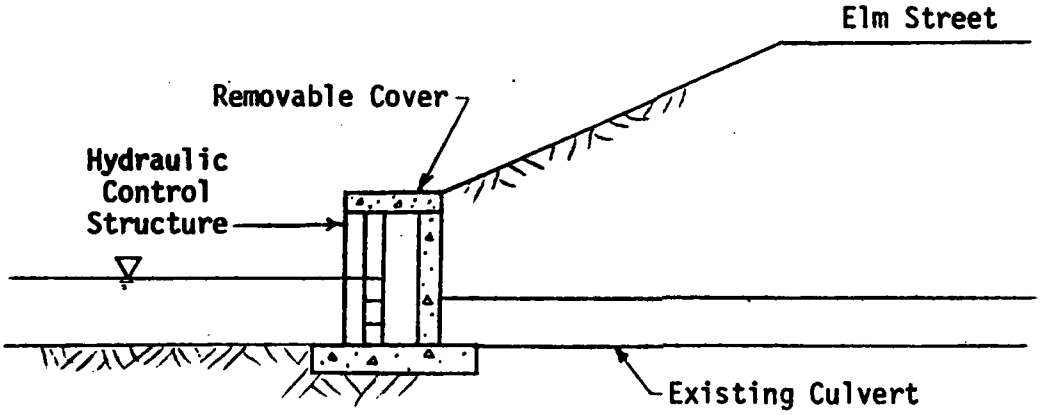


Figure A-18 - Plan and section views, hydraulic control structure for Upper Marsh



PLAN VIEW
(Cover Removed)



SECTION

HYDRAULIC CONTROL STRUCTURE
FOR LOWER MARSH

Figure A-19 - Plan and section views, hydraulic control structures for Lower Marsh

As an alternative to the plan, using the marshes for interior drainage control, drainage from the upper marsh could be diverted to the river via the long gully across Elm Street from the elementary school. This would entail securing right-of-way for and excavating a 1,200-foot-long drainage ditch to the gully, building culverts under Elm Street and County Road 19, and building a closure structure at the drainage channel between the upper and lower marshes. It would also be necessary to provide erosion protection measures along the gully. This alternative would have a higher cost, more adverse environmental impacts and, therefore, compares unfavorably with the other alternative for handling marsh drainage.

The total length of levee included in this plan is approximately 3,900 feet. Since the new levee would be higher and wider than the existing levee, its construction would necessitate the evacuation or relocation of four residences, one apartment building, the feed mill, post office, and adjacent apartments. The estimated first cost of this plan is approximately $1,600,000. The detailed cost estimate for this plan is presented in the following table (A-27).

Table A-27 - Detailed estimate of first costs, levee and floodwall, alignment coincides with existing emergency levee

Item	Unit	Quantity	Unit cost	Total cost
Direct first costs				
Levees				
Stripping	C.Y.	4,485	$0.75	$ 3,364
Clearing	Acre	3.4	1,000.00	3,400
Excavation	C.Y.	12,835	1.00	12,835
Embankment fill				
From existing dike	C.Y.	25,015	1.80	45,027
Hauled	C.Y.	31,475	2.10	66,098
Riprap	C.Y.	900	6.25	5,625
Riprap filter base	C.Y.	900	6.25	5,625
Topsoil	C.Y.	3,335	2.25	7,504
Seeding	Acre	8.3	550.00	4,565
Aesthetic treatment	Job	Sum		1,540
Contingencies (20 percent)				31,117
Total levees				186,700
Road raise				
Embankment fill	C.Y.	2,845	2.10	5,975
Aggregate base	C.Y.	590	7.50	4,425
Aggregate for bituminous surface	Ton	34	30.00	1,020
Bituminous material	Gal.	667	0.84	560
Prime coat	Gal.	498	0.99	493
Guard rail	L.F.	800	4.40	3,520
Contingencies (20 percent)				3,207
Total road raise				19,200
Floodwall				
Reinforced concrete	C.Y.	52	200.00	10,400
Excavation	C.Y.	166	3.00	498
Backfill	C.Y.	114	3.30	376
Aesthetic treatment	Job	Sum		113
Contingencies (20 percent)				2,313
Total floodwall				13,700

Table A-27 - Detailed estimate of first costs, levee and floodwall, alignment coincides with existing emergency levee (cont)

Item	Unit	Quantity	Unit cost	Total cost
Direct first costs (cont)				
Interior drainage works				
Gravity outlet "A"				
RCP, 36-inch	L.F.	100	$ 27.00	$ 2,700
Gate well	Job	Sum	--	6,300
Sluice gate, 36-inch w/stand	Ea.	1	5,000.00	5,000
End section, 36-inch RCP	Ea.	1	162.00	162
Safety guard for 36-inch RCP	Ea.	1	135.00	135
Diaphragms for 36-inch RCP	Ea.	4	184.00	736
Gravity outlet "B"				
RCP, 96-inch	L.F.	120	128.70	15,444
Gate well	Job	Sum	--	26,400
Sluice gate, 96-inch w/stand	Ea.	1	14,300.00	14,300
End section, 96-inch RCP	Ea.	1	979.00	979
Safety guard for 96-inch RCP	Ea.	1	358.00	358
Diaphragms for 96-inch RCP	Ea.	3	495.00	1,485
Storm sewer system				
Curbs and gutters	L.F.	700	6.00	4,200
Catch basins	Ea.	5	800.00	4,000
Catch basin w/manhole	Ea.	1	1,000.00	1,000
RCP, 48-inch	L.F.	660	37.00	24,400
RCP, 33-inch	L.F.	420	26.00	10,900
RCP, 24-inch	L.F.	150	24.00	3,600
End section, 48-inch RCP	Ea.	1	220.00	220
Roadwork	Job.	Sum	--	6,000
Resodding	S.Y.	1,367	1.28	1,750
Sidewalk	S.Y.	138	15.00	2,070
Culvert	Job	Sum	--	3,000
Hydraulic control structures				
Lower marsh	Job	Sum	--	2,000
Upper marsh	Job	Sum	--	5,000
Contingencies for drainage works (20 percent)				28,461
Total interior drainage works				170,600

Table A-27 - Detailed estimate of first costs, levee and floodwall, alignment coincides with existing emergency levee (cont)

Item	Unit	Quantity	Unit cost	Total cost
Direct first costs (cont)				
Closure structures				
Bridge Street[1]				
Reinforced concrete	C.Y.	20	$ 300.00	$ 6,000
Timbers	B.F.	1,023	0.70	716
Excavation	C.Y.	110	3.00	330
Backfill	C.Y.	91	3.30	300
Roadwork	Job	Sum	--	2,000
Steel	Lb.	96	3.00	288
Guard rail	L.F.	60	10.00	600
Minnesota Highway 55				
Reinforced concrete	C.Y.	215	160.00	34,400
Excavation	C.Y.	305	2.00	610
Backfill	C.Y.	215	2.20	473
Contingencies (20 percent)				9,183
Total closure structures				54,900
Pumping plant				
Pumping station	Job	Sum	--	481,600
Contingencies (20 percent)				96,400
Total pumping station				578,000
Evacuation				
Purchase, removal, and relocation of structures				178,642
Contingencies (20 percent)				35,758
Total evacuation				214,400
Land and right-of-way				
Ponding area A purchase cost				7,000
Ponding area B purchase cost				24,000
Marshes purchase cost				20,000
Levee right-of-way cost				26,500
Contingencies (20 percent)				17,500
Total land and right-of-way				95,000

Table A-27 - Detailed estimate of first costs, levee and floodwall, alignment coincides with existing emergency levee (cont)

Item	Unit	Quantity	Unit Cost	Total cost
Total direct first costs				$1,332,500
Indirect costs (engineering and design and supervision and administration)				267,500
Total first costs				1,600,000

(1) An alternative to the Bridge Street closure structure is the removal of the Bridge Street Bridge. Costs associated with removal are as follows:

Bridge removal costs	$30,000
Additional levee construction costs	932
Savings without Bridge Street closure structure	-10,234
Contingencies	4,102
Total direct costs	24,800
Indirect costs	5,200
Total removal costs	30,000

It is anticipated that a savings of approximately $300,000 in the initial cost of the plan could be realized by modifying the alignment of the portion of the levee lying to the north of Plum Street in order to increase the size of the ponding area. The alternative alignment would involve the construction of approximately 600 feet of additional levee which would extend along the east side of County Road 19. This change in alignment would increase the size of the ponding area from 3 to 7 acres, reducing the required capacities for the pumping station and the gravity outlet. The savings resulting from the reduced size of the pumping station and the gravity outlet would more than offset the cost of the additional levee required. The total estimated first cost for the plan utilizing this alternative alignment is approximately $1,310,000 as shown in the following table (A-28).

Table A-28 - Detailed estimates of first costs, levee and floodwall, alternate alignment

Item	Unit	Quantity	Unit cost	Total cost
Direct first costs				
Levees				
Stripping	C.Y.	5,590	$ 0.75	$ 4,193
Clearing	Acre	5.4	1,000.00	5,400
Excavation	C.Y.	15,185	1.00	15,185
Embankment fill				
From existing dike	C.Y.	35,900	1.80	64,620
Hauled	C.Y.	41,335	2.10	86,804
Riprap	C.Y.	1,434	6.25	8,963
Riprap filter base	C.Y.	1,434	6.25	8,963
Topsoil	C.Y.	4,090	2.25	9,203
Seeding	Acre	10.1	550.00	5,555
Aesthetic treatment	Job	Sum		2,089
Contingencies (20 percent)				42,225
Total levees				$253,200
Road raise				
Embankment fill	C.Y.	2,845	2.10	5,975
Aggregate base	C.Y.	590	7.50	4,425
Aggregate for bituminous surface	Ton	34	30.00	1,020
Bituminous material	Gal.	667	0.84	560
Prime coat	Gal.	498	0.99	493
Guard rail	L.F.	800	4.40	3,520
Contingencies (20 percent)				3,207
Total road raise				19,200
Floodwall				
Reinforced concrete	C.Y.	52	200.00	10,400
Excavation	C.Y.	166	3.00	498
Backfill	C.Y.	114	3.30	376
Aesthetic treatment	Job	Sum	---	113
Contingencies (20 percent)				2,313
Total floodwall				13,700

Table A-28 - Detailed estimates of first costs, levee and floodwall, alternate alignment (cont)

Item	Unit	Quantity	Unit cost	Total cost
Direct first costs (cont)				
Interior drainage works				
Gravity outlet "A"				
RCP, 36-inch	L.F.	100	$ 27.00	$ 2,700
Gate well	Job	Sum	--	6,300
Sluice gate, 36-inch w/stand	Ea.	1	5,000.00	5,000
End section, 36-inch RCP	Ea.	1	162.00	162
Safety guard for 36-inch RCP	Ea.	1	135.00	135
Diaphragms for 36-inch RCP	Ea.	4	184.00	736
Gravity outlet "B"				
RCP, 54-inch	L.F.	120	44.00	5,280
Gate well	Job	Sum	--	12,100
Sluice gate, 54-inch w/stand	Ea.	1	5,500.00	5,500
End section, 54-inch	Ea.	1	264.00	264
Safety guard	Ea.	1	209.00	209
Diaphragms, 54-inch	Ea.	4	281.00	1,124
Storm sewer system				
Curb and gutter	L.F.	700	6.00	4,200
Catch basins	Ea.	5	800.00	4,000
Catch basin w/manhole	Ea.	1	1,000.00	1,000
RCP, 48-inch	L.F.	660	37.00	24,400
RCP, 33-inch	L.F.	420	26.00	10,900
RCP, 24-inch	L.F.	150	24.00	3,600
End section, 48-inch RCP	Ea.	1	220.00	220
Roadwork	Job	Sum		6,000
Resodding	S.Y.	1,367	1.28	1,750
Sidewalk	S.Y.	138	15.00	2,070
Culverts	Job	Sum		6,000
Hydraulic control structures				
Lower marsh	Job	Sum	--	1,000
Upper marsh	Job	Sum	--	6,000
Contingencies for drainage works (20 percent)				22,150
Total interior drainage works				132,800

Table A-28 - Detailed estimates of first costs, levee and floodwall, alternate alignment (cont)

Item	Unit	Quantity	Unit cost	Total cost
Direct first costs (cont)				
Closure structures				
Bridge Street[1]				
Reinforced concrete	C.Y.	20	$ 300.00	$ 6,000
Timbers	B.F.	1,023	0.70	716
Excavation	C.Y.	110	3.00	330
Backfill	C.Y.	91	3.30	300
Roadwork	Job	Sum	--	2,000
Steel	Lb.	96	3.00	288
Guard rail	L.F.	60	10.00	600
Minnesota Highway 55				
Reinforced concrete	C.Y.	215	160.00	34,400
Excavation	C.Y.	305	2.00	610
Backfill	C.Y.	215	2.20	473
Contingencies (20 percent)				9,183
Total closure structures				54,900
Pumping plant				
Pumping plant	Job	Sum	--	$228,300
Contingencies (20 percent)				45,700
Total pumping plant				274,000
Evacuation				
Purchase, removal, and relocation of structures				178,642
Contingencies (20 percent)				35,758
Total evacuation				214,400
Land and right-of-way				
Ponding area A purchase cost				7,000
Ponding area B purchase cost				34,000
Marshes purchase cost				20,000
Levee right-of-way cost				45,500
Contingencies (20 percent)				21,300
Total land and right-of-way				127,800

Table A-28 - Detailed estimates of first costs, levee and floodwall, alternate alignment (cont)

Item	Unit	Quantity	Unit cost	Total cost
Total direct first costs				$1,090,000
Indirect first costs (engineering and design and supervision and administration)				220,000
Total first costs				1,310,000

(1) An alternative to the Bridge Street closure structure is the removal of the Bridge Street Bridge. Costs associated with removal are as follows:

Bridge removal costs	$30,000
Additional levee construction costs	932
Savings without Bridge Street closure structure	-10,234
Contingencies	4,102
Total additional cost for alternative including removal for the Bridge Street Bridge	24,800

A levee plan to provide flood protection for the mobile home park would include approximately 4,700 feet of earth levee located along the perimeter of the park. The levee would average 5 feet in height and would be located along the top edge of the fill on which the mobile home park was constructed. A typical section of this levee is shown on plate 4. Construction at this location would minimize the cost of the levee; however, approximately 10 mobile homesites would be eliminated and some of the remaining sites along the levee may be adequate only for smaller mobile homes.

Interior drainage for the mobile home park would be provided by the construction of a pumping station and a gravity outlet located approximately 100 feet east of Cascade Drive. During flood conditions, approximately 10 acres of land in the vicinity of the pumping station

would serve as a ponding area and, during the design storm, would contain water to a maximum depth of 1½ feet for an average duration of 4 hours. In the event of the design storm during nonflood periods, the ponding area would be flooded to a maximum depth of 1½ feet for an average duration of 30 minutes. Several mobile homesites are currently located within the ponding area and it would be necessary to flood proof these sites to prevent water from entering the sewage, electrical, and telephone systems.

The estimated first cost of protecting the mobile home park with the levee is approximately $530,000 as shown in the following table (A-29). A summary of the estimated first costs of providing flood protection for Rockford with structural barriers is given in the table (A-30) on page A-126. A summary of the interior drainage design data for the levee plans is presented in the table (A-31) on page A-127.

Table A-29 - Detailed estimate of first costs, levee through mobile home park

Item	Unit	Quantity	Unit cost	Total cost
Direct first costs				
Levee				
Stripping	C.Y.	3,460	$ .75	$ 2,595
Excavation	C.Y.	7,640	1.00	7,640
Embankment fill, hauled	C.Y.	26,715	2.10	56,102
Topsoil	C.Y.	2,470	2.25	5,558
Seeding	Acre	7	550.00	3,850
Aesthetic treatment	Job	Sum	--	1,313
Contingencies (20 percent)				15,442
Total levee				92,500
Interior drainage works				
Gravity outlet				
RCP, 84-inch	L.F.	100	106.70	10,670
Gate well	Job	Sum	--	19,800
Sluice gate, 84-inch w/stand	Ea.	1	11,000.00	11,000
End section, 84-inch	Ea.	1	688.00	688
Safety guard, 84-inch	Ea.	1	308.00	308
Diaphragms, 84-inch	Ea.	3	435.00	1,305
Contingencies for drainage work (20 percent)				8,729
Total interior drainage works				52,500
Flood proofing				
Utilities	Site	80	60.00	4,800
Contingencies				1,000
Total flood proofing				5,800
Pumping plant				
Pumping station	Job	Sum	--	126,200
Contingencies (20 percent)				25,300
Total pumping plant				151,500
Land and rights-of-way				
Levee right-of-way cost				100,000
Ponding area easement cost				15,000
Contingencies (20 percent)				23,000
Total land and rights-of-way				138,000
Total direct first costs				440,300
Indirect first costs (engineering and design and supervision and administration)				89,700
Total first costs				530,000

Table A-30 - Summary of cost estimates, levees, Crow River at Rockford, Minn.

Item	Levee location and alignment		
	Alignment of existing emergency levee	Alternate alignment	Through mobile home park
Direct first costs			
Levee	$186,700	$253,200	$92,500
Main Street ramp	19,200	19,200	-
Floodwall	13,700	13,700	-
Interior drainage works	170,600	132,800	52,500
Closure structures	54,900	54,900	-
Pump station	578,000	274,000	151,500
Evacuation and flood proofing	214,400	214,400	5,800
Land and rights-of-way	95,000	127,800	138,000
Total direct first costs	1,332,500	1,090,000	440,300
Indirect first costs	267,500	220,000	89,700
Total first costs	1,600,000	1,310,000	530,000
Average annual costs	110,900	93,200	33,000
Average annual flood control benefits	33,600	33,600	20
Net benefits	-77,300	-59,600	-32,980

Table A-31 - Interior drainage design data for levee plans, Crow River at Rockford, Minn.

Item	Pumping station design frequency (years)	Gravity outlets		Ponding area storage (acre-feet)
		Design frequency (years)	Gate closure elevation (feet,msl)	
Levee located along alignment of existing emergency levee	- 50	50 50	912 899	3.5 12.2
Levee located along alternate alignment	- 30	50 50	912 899	3.5 24.0
Levee through mobile home park	4	50	914	15.0
Maple Street storm sewer system	-	4	-	-

NOTE: Design frequencies were determined according to procedures outlined in EM 1110-2-1410, Interior Drainage of Leveed Areas: Hydrology.

Construction of a levee along the alignment of the existing emergency levee would affect approximately 22.5 acres. The alternate alignment would affect approximately 30 acres. Construction of a levee through the mobile home park and the use of land for a ponding area would affect approximately 17.5 acres. The following table (A-32) shows the land use types and habitat that would be affected by the levees.

Table A-32 - Effects of levee construction and ponding areas on land use types and habitat

Proposed levee	Land use type[1]	Riprap (acres)	Seeded grass (acres)	Ponding area (acres)
Along alignment of existing emergency levee	Residential	0	1.5	1.5
	Park	0	0	1.5
	Undeveloped open field	0	0	1
	River corridor open field	1	6	0
	Floodplain forest	0	0	0
	Marsh	0	0	10
Alternate alignment	Residential	0	1.5	1.5
	Park	0	0	1.5
	Undeveloped open field	0	0	5
	River corridor open field	1.5	8.5	0
	Floodplain forest	0.3	0.3	0
	Marsh	0	0	10
Mobile home park	Residential	0	7.5	10

(1) Residential, park, and undeveloped open field lands are west of the existing emergency levee. River corridor open field and floodplain forest lands are between the existing emergency levee and the Crow River. Marshlands are west of Elm Street near the elementary school.

The land between the Crow River and the proposed levees totals approximately 5 acres, of which 2 acres are wooded and 3 acres are open field. The wooded acreage is composed of a narrow band of trees lying between the existing levee and the river. Species present within this corridor include elm, silver maple, box elder, and cottonwood. Primary vegetation species in the open field habitat include canary grass, milkweed, goldenrod, dogwood, and wild rose. Animal species include deer, raccoon, skunk, mink, small rodents, and birds, including woodpeckers, chickadees, nuthatches, sparrows, and many migratory species. A summary listing of these species and their occurrence is included in the following table (A-33).

Table A-33 - Common animal species in the levee area

Species	Population density[1]	Location[2]
Deer	C	U, F
Raccoon	C	U, F
Skunk	C	U, F
Mink	S	F
Gray squirrel	A	F
Pocket gopher	C	U
Downy woodpecker	A	F
Chickadee	A	F
Cardinal	C	F
Tree sparrow	C	F

(1) A = abundant; C = common; S = scarce.
(2) U = open field; F = floodplain forest.

Construction of the levees would primarily affect the open field habitat adjacent to the existing levee; however, a few scattered trees near the Bridge Street Bridge would be removed. The construction would change the existing vegetal cover in a portion of this area from native grasses and shrubs to seeded grass. Vegetal cover along the portion of the levee which would be riprapped would be eliminated.

From an aesthetic viewpoint, the narrow corridor of trees along the river is very important because it provides a natural buffer between the river and human development. Preserving these trees is necessary if the river is to be maintained as a desirable aesthetic, as well as recreation resource. Removal of trees along this corridor will detract from the user's experience of a natural state. Of concern in this respect are those areas that require riprap to the edge of the river. In view of this, efforts should be made to save as many trees as possible. Planting of grass and trees along the levee would enhance its appearance as well as provide erosion control. Also, potential use of the levee as a recreation trailway is feasible.

The impact of utilizing the upland marshes located west of Elm Street near the elementary school as ponding areas would depend on the seasonal duration of inundation and the depth to which water was present. Short-term (i.e., 1 month or less) inundation would have little effect on existing species. Longer periods of flooding would eliminate those species that are less tolerant of standing water (e.g., willow and meadowsweet). Persisting species would include cattails, bulrushes, sedges, and other weeds. Utilizing the marshes as ponding areas would destroy habitat used by species such as skunks, rabbits, and mice, which now frequent the area. The habitat created by the ponded water would allow for potential waterfowl breeding areas for species such as mallards, blue-winged teal, and wood ducks. Success of the marsh as a breeding area would be dependent on area and duration of ponded water. Determination of this is beyond the scope of this study. The following table (A-34) summarizes existing and potential plant and animal species found in the marsh habitat.

Table A-34 - Current and potential plant and animal species in the marsh habitat

	Species			
	Plant		Animal	
Area	Current conditions	Potential conditions (1)	Current conditions	Potential conditions (1)
Upper marsh (31 acres)	Grasses Sedges Willow Meadowsweet	Cattail Bulrushes Smartweed	Pheasant Songbirds Rabbit Skunk Mice	Ducks Raccoon Deer
Lower marsh (9 acres)	Sedges Cattail Bulrushes Vervain Grasses	Duckweed Smartweed Pondweed	Pheasant Songbirds Rabbit	Ducks Skunk Deer

(1) Assuming inundation would be on a relatively permanent basis.

Community use of the marsh area for recreation and educational activities would be possible. The marshes would provide the opportunity for nature observation as well as an area for environmental education activities.

The impact of a levee plan on the water quality and aquatic biota of the portion of the Crow River lying within the study limits would be minimal.

The social impacts of a levee plan would be predominantly beneficial. People residing in the floodplain would be freed from anxiety and disruption of their lives, created by periodic flooding of their homes and businesses. Some temporary social disruption would occur due to the evacuation and relocation of residences and businesses to allow construction of the levees.

The alternate levee alignment plan appears to be more economic. Thus, economic, social, and environmental impacts of the alternative alignment are presented in table A-37 on pages A-141 through A-145. The levee plan for the mobile home park does not appear to be remotely feasible and is not considered further.

Several items of design considerations for any levee construction at Rockford include the following:

a. Preliminary hand auger borings have indicated the presence of a thin (6 inch to 1 foot) clay layer in the vicinity of the proposed levees, lying approximately 17 feet below the top of the existing emergency levee. The extent of this clay layer and the potential for uplift problems during a flood would have to be determined by a soil boring program and analysis undertaken prior to final design of a levee. If uplift problems are indicated, it would be necessary to install relief wells or sand drains which would increase the cost of levee construction.

b. The existing levee was constructed from material with fair stability characteristics. The material has a moderately slow permeability. Long-term hydrostatic pressure could create piping problems, especially where the foundation is more impervious than the levee. Keeping in mind the intended purposes of the levee and the underlying foundation material, piping should not be a problem.

c. The foundation material is adequate. The fill material beneath the existing levee and used in the levee is not detrimental to stability. It may be susceptible to piping under long-term hydrostatic head. The stability of the loose to medium-dense sand did not create any problems. A slip circle analysis was made to determine stability. A 3H to 1V slope on the upstream and downstream slopes is satisfactory. A sliding wedge analysis through the soft clay underneath the considered levee was made. This analysis showed that at the depth at which the layer occurs it is not a problem.

d. The borrow areas investigated would be adequate for levee construction. The Hayden and Lester soil associations have good stability characteristics and are relatively impermeable when compacted. The governing factors in selection of a borrow area would be the quantity required and the accessibility. If riprap is required, it would have to be commercially processed. The closest available location for processed riprap is in the Twin Cities, Minn., metropolitan area.

CHANNEL MODIFICATION

This alternative for reducing flood damage consists of modifying the channel of the Crow River in the vicinity of Rockford in order to increase the hydraulic efficiency of the channel to reduce the flood levels. The channel modification would include widening and straightening approximately 1¼ miles of the river channel immediately downstream from the

Highway 55 bridge. Along this reach, the channel would be widened to approximately 200 feet and natural restrictions to flow such as islands, debris, sandbars, trees, and dense vegetation would be removed from the channel and the banks. A new channel would be excavated across the meander located near the northeast corner of the corporate limits.

It was determined that to provide a channel width greater than approximately 200 feet would not be feasible due to the large amounts of riverbank excavation required. Deepening the channel in this reach would have an insignificant effect on flood levels; therefore, the elevation of the bottom of the improved channel would be essentially the same as the elevation of the bottom of the existing channel. In order to protect the bottom and banks of the channel from scour and erosion, it would be necessary to place riprap filter blanket and riprap along the sides of the entire length of the modified channel.

These channel modifications would contain discharges up to approximately 20,000 cfs (cubic feet per second) without overbank flow and would decrease the flood stage associated with the intermediate regional flood by approximately 1.2 feet at the U.S. Geological Survey gage. If the Bridge Street Bridge were removed, an additional reduction in the flood stage of 0.6 foot at the gage could be obtained, making the total reduction in flood stage approximately 1.8 feet. An examination of one-bank excavation procedures was made in view of decreased environmental impact and it was determined that this would produce very little change (0.6 foot) in the intermediate regional flood elevation.

The channel modification and floodplains associated with the existing and modified channels are shown on plate 5. Water surface profiles for the existing and improved channels are shown on plate 3.

The estimated first cost of channel modification is approximately $2,640,000 as shown on the following table (A-35).

Table A-35 - Detailed estimate of first costs, channel modification plan

Item	Unit	Quantity	Unit cost	Total cost
Direct first costs				
Clearing and grubbing	Acre	19.7	$2,000.00	$39,400
Excavation	C.Y.	455,000	3.50	1,592,000
Riprap and filter	C.Y.	36,000	6.25	225,000
Bridge removal	Job	Sum	-	30,000
Contingencies				377,600
Total direct first costs				2,264,000
Indirect first costs (engineering and design, supervision and administration)				376,000
Total first costs				2,640,000

Channel modification would result in a reduction in the area of the floodplain as illustrated on plate 5. This area includes all of the mobile home park currently within the floodplain, 12 residences, and 8 businesses. Thirty-eight residences and 17 businesses would remain in the floodplain and would have to be evacuated or protected by other means. If protection of the structures remaining in the floodplain were accomplished by the construction of levees, the first cost of the additional protection would be approximately $1,200,000.

The social impact of the channel modification plan without utilizing the additional levees or floodplain evacuation measures would be minimal. However, removal of the Bridge Street Bridge would make it necessary for the residents of Rockford and their children to utilize the Highway 55 bridge for crossing the river. Since this bridge is located on a major through highway, increased use of the bridge by local traffic and school children would create a potentially hazardous situation.

Approximately 40 acres of the existing river corridor would be affected by this plan. Of this, 28 acres are natural river channel, 7 acres are floodplain forest, and 5 acres are open field. The forested area is comprised of narrow bands along the riverbanks which vary from 10 feet to 200 feet in width. The most densely forested areas are located on the east bank of the river near the Highway 55 bridge and the more sparsely forested areas are located on the west bank of the river near the residential district of Rockford. Also affected by this plan would be 12 acres of agricultural land, mostly cornfields, located at the meander in the river near the northeast corner of the corporate limits of Rockford. The following table (A-36) summarizes the effect of the channel modification plan on current land use.

Table A-36 - Effects of channel modification on land use

Type	Total area (acres)	Riprap (acres)	Fill (acres)	Cleared and grubbed (acres)	Land use curtailed (acres)
Floodplain forest	7	7	0	0	0
Open field	5	5	0	0	0
Agricultural	12	8	0	0	4
River channel	28	0	6	22	0

Habitat within the affected floodplain includes forested areas interspersed with open field areas and two cornfields. One cornfield is located at the Bridge Street Bridge and the other is located at the above-mentioned meander in the river. Species common to this type habitat include deer, raccoon, skunk, mink, small rodents, and birds, including woodpeckers, chickadees, nuthatches, sparrows, and many migratory species.

The channel modification would have an adverse environmental impact on approximately 30 acres. The new channel would cut across the existing meander in the river near the northeast corner of the corporate limits. This would produce an adverse effect on approximately 12 acres of agricultural land. Approximately 8 acres of this land would be removed by the excavation of the new channel. The agricultural use of the remaining 4 acres would be sharply curtailed by the construction of the modified channel, and farm equipment access to this land would be permanently hampered.

Six acres of the existing river channel at the meander would no longer serve as river channel. Alternatives for its future use include using it as a fill area, for recreation development, or as a natural area to provide additional wildlife habitat. The thin border of trees which currently exists on the east bank of the river and provides a buffer zone between the river and the agricultural cropland would be destroyed. This would adversely affect river aesthetics.

Between the meander and the Highway 55 bridge, approximately 12 acres of riverbank, 7 acres of which are wooded, would be adversely affected. Along this reach, the thin borders of trees and natural vegetation along the riverbanks would be removed and replaced by riprap or grass. The species affected include elm, silver maple, box elder, and cottonwood. Habitat destruction would accompany the removal of this vegetation, ultimately decreasing the populations of such species as rabbit, squirrels, mice, and various songbirds.

The rock riprap and grass banks of the modified channel would have to be permanently maintained; therefore, the habitat types remaining after the channel modification would be marginal or nonexistent for the species now found in the area. Birds and mammals now present in the

area would be forced out and assuming surrounding habitat is occupied, chances of these individuals establishing new territories are minimal. This plan would also have a damaging effect on the river as a scenic hiking or canoe route and would destroy the wilderness attributes now in existence.

The channel modification would have both beneficial and adverse impacts upon the water quality and aquatic biota within the study limits; however, the net impact would be adverse. The silt present in the stream bed would be removed and the bottom and banks would be overlain with 1- to 6-inch diameter riprap. The resulting rocky stretch of stream would provide good substrate for stoneflies, mayflies, and caddis flies and eliminate the less productive silty areas. However, the uniformity of the depth and bottom type without true riffle areas would act to reduce this potential productivity. Straightening the stream channel, eliminating the productive shallow gravel bars and island shoreline, reducing the variety in the substrate types, and establishing a more uniform stream depth would reduce the variety and quantity of niches or habitat types available to the organisms and hence reduce the diversity of organisms.

While the increased velocity of flow in the modified channel and the uniformity of the bottom would eliminate nesting areas for game fish, it would have a similar effect upon the rough fish such as carp and bullheads which prefer sluggish waters with muddy bottoms. However, the carp is an extremely adaptable fish and thrives in a wide variety of habitats. A change in habitat which is deemed detrimental to both game fish and carp populations will usually have a more severe effect on the game fish population.

A summary of the pertinent economic, social, and environmental impacts of the channel modification plan are illustrated in table A-37 on pages A-141 through A-145.

UPSTREAM RESERVOIR STORAGE

In evaluating the alternative of upstream reservoir storage for reduction of flood damages at Rockford, the selection of a reservoir site which would provide control of the maximum drainage area possible was considered as being the most effective. Two reservoir sites were evaluated on a preliminary basis, one on the North Fork Crow River near Cokato, Minn., and one on the South Fork Crow River near Lester Prairie, Minn. The dam on the North Fork Crow River would be about 40 feet high, provide about 32,000 acre-feet of floodwater storage, and control about 35 percent of the drainage area above Rockford. The dam on the South Fork Crow River would be about 35 feet high, provide about 10,000 acre-feet of floodwater storage, and control about 20 percent of the drainage area above Rockford. Both structures would be compacted earth dams with concrete emergency spillways.

About 5,000 acres of land would be acquired for the two reservoirs, including about 3,500 acres of woodland and marsh, 1,000 acres of existing lake area, and 500 acres of crop and pasture land. There would be about 10 miles of roads relocated and about 35 residences and farmsteads to be acquired and/or relocated. The first cost of the two structures would be in excess of $6 million and the average annual cost would be in excess of $420,000. The average annual flood control benefits for Rockford attributable to the reservoirs would be less than $20,000. Additional flood damage reduction benefits could be realized at other communities along the Crow River from the reservoirs to the Mississippi River; however, due to the limited degree of effectiveness of the two reservoirs in controlling major floods, the benefits from these other areas would not be much above the benefits obtained at Rockford.

Although the two reservoirs would be in a position to control about 55 percent of the drainage area above Rockford, due to lack of sufficient available storage capacity they would have very little effect on major flood flows. The total flood control storage capacity of the two reservoirs is about 42,000 acre-feet. The total volume of runoff in excess of 4,000 cfs during the 1965 flood was about 400,000 acre-feet. Only about 10 percent or less of the flood volume of the 1965 flood would have been controlled by the reservoirs. For the intermediate regional flood much less than 10 percent of the flood volume would be controlled by the reservoirs. The peak discharge of the intermediate regional flood at Rockford could be reduced by up to about 2,500 cfs. This would represent about a one-half foot reduction in intermediate regional flood stage at Rockford. With such minor reductions in flood stage, other flood damage reduction measures such as levees and/or floodplain evacuation would have to be implemented to provide an adequate degree of flood damage reduction. The magnitude of such supplemental levee or evacuation measures would be about equivalent to the magnitude of such measures without the reservoirs.

PLAN SELECTION

RATIONALE

In selecting a plan it is necessary to evaluate the contribution each alternative makes to any specific objectives of this study and the effect each plan would have on State and national water resource planning objectives. Evaluation of the various alternatives entails a trade-off of advantages versus disadvantages of each alternative that results in a ranking of the alternative plans. This process provides a basis for choosing the most feasible and desirable alternative.

Every alternative offers some benefit to a particular segment of the populace. The plan selected as the most appropriate should rank high in providing the most benefits, the fewest adverse effects, and be economically feasible unless such a plan is altered by outstanding environmental and social gains, even though such gains are not measured in monetary terms.

The alternatives for flood damage reduction are discussed in detail in the preceding paragraphs. The pertinent economic, social, and environmental aspects are shown in the following table (A-37).

Table A-37 - Economic, social, and environmental impacts of alternative flood damage reduction plans for Rockford, Minn.

Item	Plan 1 Flood proofing	Plan 2 Floodplain evacuation	Plan 3 Permanent levees[1]	Plan 4 Channel modification
I. National Economic Development				
A. Total first cost	$2,470,000	$3,330,000	$1,310,000	$2,640,000
1. Federal first cost	1,000,000	1,000,000	1,000,000	1,000,000
2. Non-Federal first cost	1,470,000	2,330,000	310,000	1,640,000
B. Total average annual costs	148,600	196,300	93,200	178,600
1. Operation, maintenance, and replacement costs	3,000	0	16,000	23,000
2. Interest and amortization costs (0.058945 X first cost)[2]	145,600	196,300	77,200	155,600
C. Total average annual benefits	90,800	105,500	33,600	20,700
1. Average annual flood control benefits	40,800	41,700	33,600	20,700
2. Other	50,000	63,800	0	0
D. Net average annual benefits	-57,800	-90,800	-59,600	-157,900
E. Remaining average annual flood damage	4,300	3,400	11,500	24,400
Benefit-cost ratio	0.6	0.5	0.4	0.1

Table A-37 - Economic, social, and environmental impacts of alternative flood damage reduction plans for Rockford, Minn. (cont)

Item	Plan 1 Flood proofing	Plan 2 Floodplain evacuation	Plan 3 Permanent levees (1)	Plan 4 Channel modification
II. Environmental Quality				
A. Woods gained or lost (± acres)	+40	+45	-0.67	-7
B. Herbaceous areas (pasture, parks, lawns) gained or lost (± acres)	0	0	-1.5	-5
C. Wetlands gained or lost (± acres)	0	0	0	0
D. Natural channel bottom gained or lost (± acres)	0	0	0	-28
E. Artificial or improved channel bottom gained or lost (± acres)	0	0	0	+30
F. Unvegetated terrestrial areas (roads, building foundations, dredge material) gained or lost (± acres)	-2.5	-4	-0.5	0
G. Cultivated areas gained or lost (± acres)	0	0	0	-12
H. Linear miles of natural channel gained or lost	0	0	0	-1
I. Linear miles of improved channel gained or lost	0	0	0	+1
J. Wildlife management area and/or refuge gained or lost (± acres)	0	0	0	0

Table A-37 - Economic, social, and environmental impacts of alternative flood damage reduction plans for Rockford, Minn. (cont)

Item	Plan 1 Flood proofing	Plan 2 Floodplain evacuation	Plan 3 Permanent levees (1)	Plan 4 Channel modification
II. Environmental Quality (cont)				
K. Effect on river water quality	None	None	None	Slightly adverse
L. Effect on air quality	None	None	None	None
M. Effect on local wildlife breeding habitat	Beneficial	Beneficial	Slightly adverse	Negative
N. Unique, endangered, or threatened animal species affected (specify)	None	None	None	None
O. Rare or unique vegetation systems affected (specify)	None	None	None	None
P. Scenic, recreation, or wilderness areas affected (specify)	Floodplain	Floodplain	River channel, parks	River channel
Q. Historical and/or archeological sites affected (specify)	None	None	None	None
R. Effect on river erosion	None	None	None	None
S. Mineral resources affected	None	None	None	None
T. Effect on area water table	None	None	None	None

Table A-37 - Economic, social, and environmental impacts of alternative flood damage reduction plans for Rockford, Minn. (cont)

Item	Plan 1 Flood proofing	Plan 2 Floodplain evacuation	Plan 3 Permanent levees (1)	Plan 4 Channel modification
III. Social Well-Being				
A. Flood protection				
1. Residences protected	282	50	282	282
2. Businesses protected	25	25	25	25
3. Persons protected	850	225	850	850
4. Farmlands protected (acres)	0	0	0	0
5. Farmsteads protected	0	0	0	0
6. Total flood damage reduction (percent)	91	93	75	46
7. Effects on downstream flooding	None	None	Negligible	Negligible
B. Relocations required				
1. Farmsteads	0	0	0	0
2. Businesses	18	25	1	1
3. Residences	36	50	16	6
4. Persons	130	225	50	20
5. Highways and roads (miles)	0	0	0	0
6. Utilities	Yes	Yes	No	No
C. Bridge modifications or removals	None	None	2	1
D. Roads severed	0	0	0	0
E. Socially important sites affected (specify)	(3)	(3)	(3)	(3)

Table A-37 - Economic, social, and environmental impacts of alternative flood damage reduction plans for Rockford, Minn. (cont)

Item	Plan 1 Flood proofing	Plan 2 Floodplain evacuation	Plan 3 Permanent levees (1)	Plan 4 Channel modification
III. Social Well-Being (cont)				
F. Effect on community patterns	Major Beneficial	Major Beneficial	Minor Beneficial	Minor Beneficial
G. Effect on public health and safety	None	None	None	None
H. Effect on available water supply				
I. Effect on recreation activities				
1. Hunting	None	None	None	None
2. Fishing	Beneficial	Beneficial	Negative	Negative
3. Trapping	Beneficial	Beneficial	Negative	Negative
4. Boating	Beneficial	Beneficial	Negative	Negative
5. Camping	Beneficial	Beneficial	Negative	Negative
6. Canoeing	Beneficial	Beneficial	Negative	Negative
IV. Regional Economic Development				
A. Loss in area tax base	None	None	Beneficial	Beneficial
B. Area redevelopment benefits	Beneficial	Beneficial	Beneficial	Beneficial
C. Increased recreation expenditure	Beneficial	Beneficial	Negative	Negative
D. Effect on regional economic growth	Beneficial	Beneficial	Beneficial	Beneficial

(1) Lowest first-cost combination: levee alternative alignment with no bridge removal.
(2) Based on a 5 7/8-percent interest rate and an economic evaluation period of 100 years.
(3) Flood proofing and evacuation entail the relocation of the city hall, the post office, commercial district, and the loss of the town parks.
Channel modification entails the relocation of the post office.
Permanent levees entail the relocation of the post office and the loss of town parks.

The base condition, or "no action" plan includes continuation of the ongoing programs of floodplain regulations, flood insurance, and flood forecasting and emergency action. These programs will result in a gradual decrease in flood damageable property within the intermediate regional floodplain at Rockford. Individual property owners subscribing to the flood insurance program would be reimbursed for future losses suffered due to flooding. As flood prone properties change ownership and become outdated, they would gradually be removed from the floodplain. Enforcement of floodplain regulations would restrict future building and development in the flood prone areas to nondamageable levels for floods up to and including the intermediate regional flood. Accurate flood forecasting and prompt and adequate emergency flood fighting activities would alleviate the major existing flood damages under most flood emergency conditions. The possibility of failure of the emergency levee system due to overtopping of the levees or accumulation of runoff from within the leveed area could cause flood damages to the property within the flood prone area. Permanent flood damage reduction is the long-term goal of the base condition. Present new development is locating in nonflood prone areas of Rockford, and several existing developments have relocated to nonflood prone areas. The transfer from the existing developmental condition to a nonflood prone condition would be gradual and should not cause any severe social hardships.

The flood proofing plan which consists of partial evacuation, partial flood proofing of structures, and partial levee construction allows for adequate protection from flood damages for about one-fourth of the existing development and would rely on relocation of the remainder of the flood prone community to nonflood prone areas. This plan has a first cost of $2,470,000 and does not show economic feasibility with a benefit-cost ratio of only 0.6. The environmental aspects of the flood proofing plan would be beneficial with a general gain of about 40 acres of floodplain land for recreation use and/or natural wildlife habitat.

Although this plan would provide an effective means of reducing flood damages, the lack of economic feasibility offsets its other advantages. Because of the large number of homes and businesses to be relocated with this plan, the local residents would be very concerned with the social impacts of moving and the disruption to their current life patterns.

The floodplain evacuation plan, consisting of relocation of all flood prone properties, would almost eliminate flood damage losses. The first cost of this plan would be about $3,334,000. It is not economically feasible, having a benefit-cost ratio of only 0.5. The environmental quality aspects of this plan would be beneficial, realizing a gain of about 45 acres of floodplain areas for recreation or other uses more environmentally compatible than the current land use. Again, the floodplain residents have expressed much concern regarding social impacts of the evacuation. The lack of economic feasibility for this plan offsets any environmental or social advantages.

The levee plan using the alternate alignment would provide a substantial reduction in the flood damages at Rockford, providing for complete flood protection for floods up to and including the intermediate regional flood. The levee would be subject to overtopping for floods of greater magnitude. The first cost of the levee plan would be about $1,310,000. This plan also lacks economic feasibility with a benefit-cost ratio of only 0.4. The environmental aspects of the levee plan center primarily around about 2 acres of parks and woods that would be adversely affected, including the somewhat adverse aesthetic aspects of the levee and riprap protection. Several homes and businesses would need to be relocated or purchased to allow adequate space for installation of the levee. Local interests have indicated their preference for plans other than the levee, although the levee plan would probably be desired if no other, more desired plan would be recommended.

The channel modification plan, consisting of about 1¼ miles of channel widening and straightening, would not significantly reduce flood damages nor the extent of the intermediate regional floodplain. The first costs of the channel modification plan would be about $2,640,000, with a benefit-cost ratio of only 0.1. The environmental aspects of this plan would be negative, with about 30 acres of natural habitat being adversely affected and about 1 mile of aquatic river habitat being reduced in quality for game fish habitat. Socially the local people would prefer the channel modification plan above the levee plan, due primarily to the reduced amount of disruption to the landscape. Addition of other major flood damage reduction measures would be necessary to provide an adequate degree of flood protection for Rockford.

The upstream reservoir storage plan, consisting of two upstream flood control reservoirs, would not provide significant reductions in either flood damages nor in the magnitude of the intermediate regional flood. The first costs would be in excess of $6 million and the benefit-cost ratio would be in the area of 0.1 to 0.3. There would be major adverse environmental and social effects associated with these reservoirs.

The overall evaluation of the economic, environmental, and social aspects of the base condition and the various nonstructural and structural measures for flood damage reduction at Rockford indicate that none of the nonstructural or structural plans would be economically feasible to implement. The channel modification plan and the upstream reservoir storage plan would not provide adequate degrees of flood damage reduction and cannot be considered as acceptable means of providing flood protection for Rockford. The flood proofing plan, the floodplain evacuation plan, and the levee plan would provide adequate degrees of flood damage reduction; however, they cannot be considered acceptable plans for implementation because they all lack economic justification. None of the alternative nonstructural or

structural plans can be considered as capable of meeting the plan formulation criteria as set forth for evaluation of alternative plans. The base condition or "no action" plan is the plan which comes closest to meeting the evaluation criteria and the plan formulation objectives. Since the base condition requires no further major Federal action for implementation, the base condition is considered to be the best plan for Rockford.

THE SELECTED PLAN

The selected plan for reduction of flood damages at Rockford is the continuation of the flood damage reduction programs and measures already in effect and/or readily implementable within existing legislation. The principal elements of this plan include:

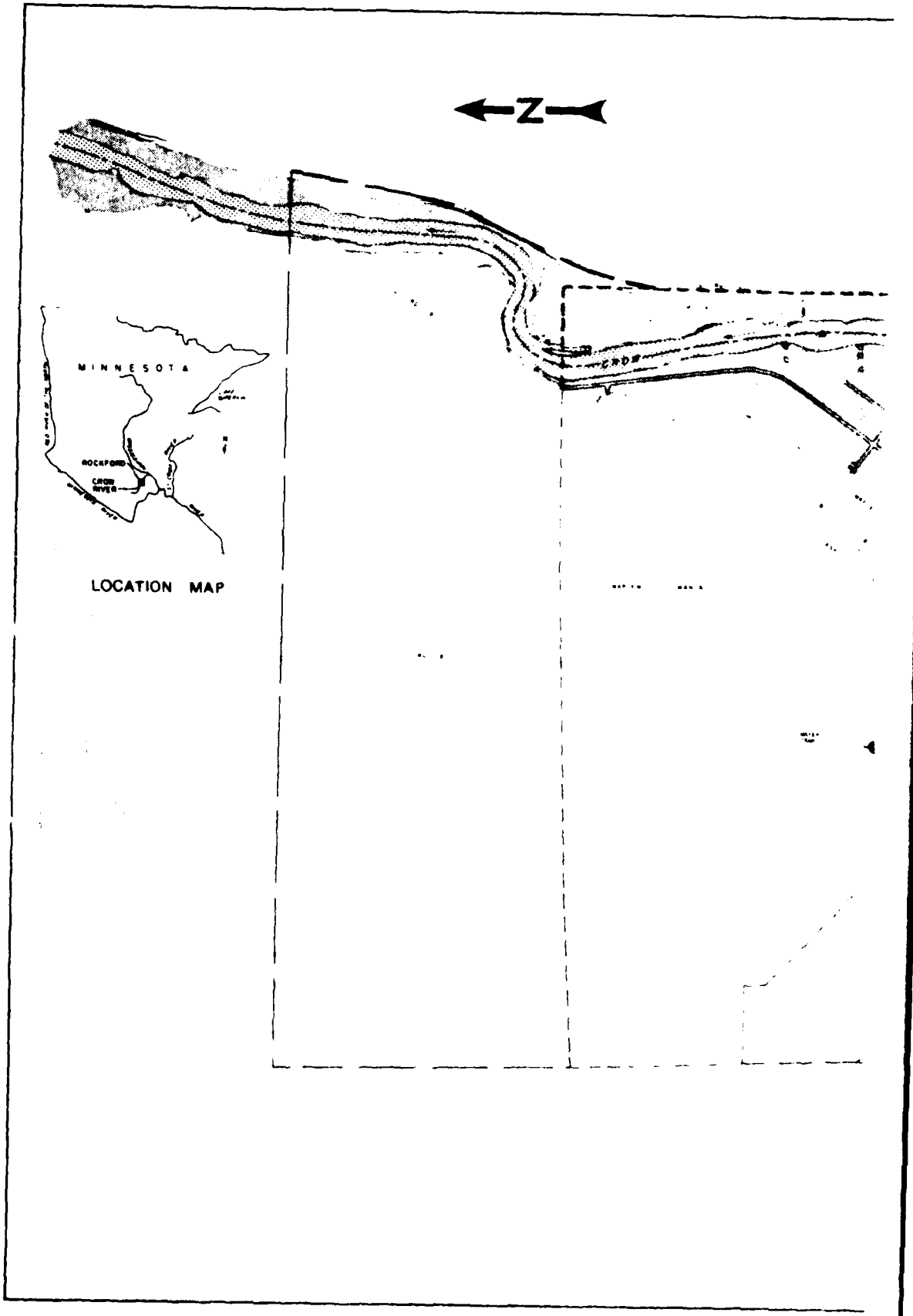
- Implementation of appropriate floodplain regulations to preclude unwise future development in flood prone areas.

- Participation in the federally subsidized flood insurance program.

- Preparation and implementation, as necessary, of a flood emergency plan to facilitate protection of the existing flood prone properties.

- Implementation of flood proofing measures on an individual basis for those structures which are feasible to flood proof.

- Continuation of flood forecasting services to predict time and rise of floodwaters.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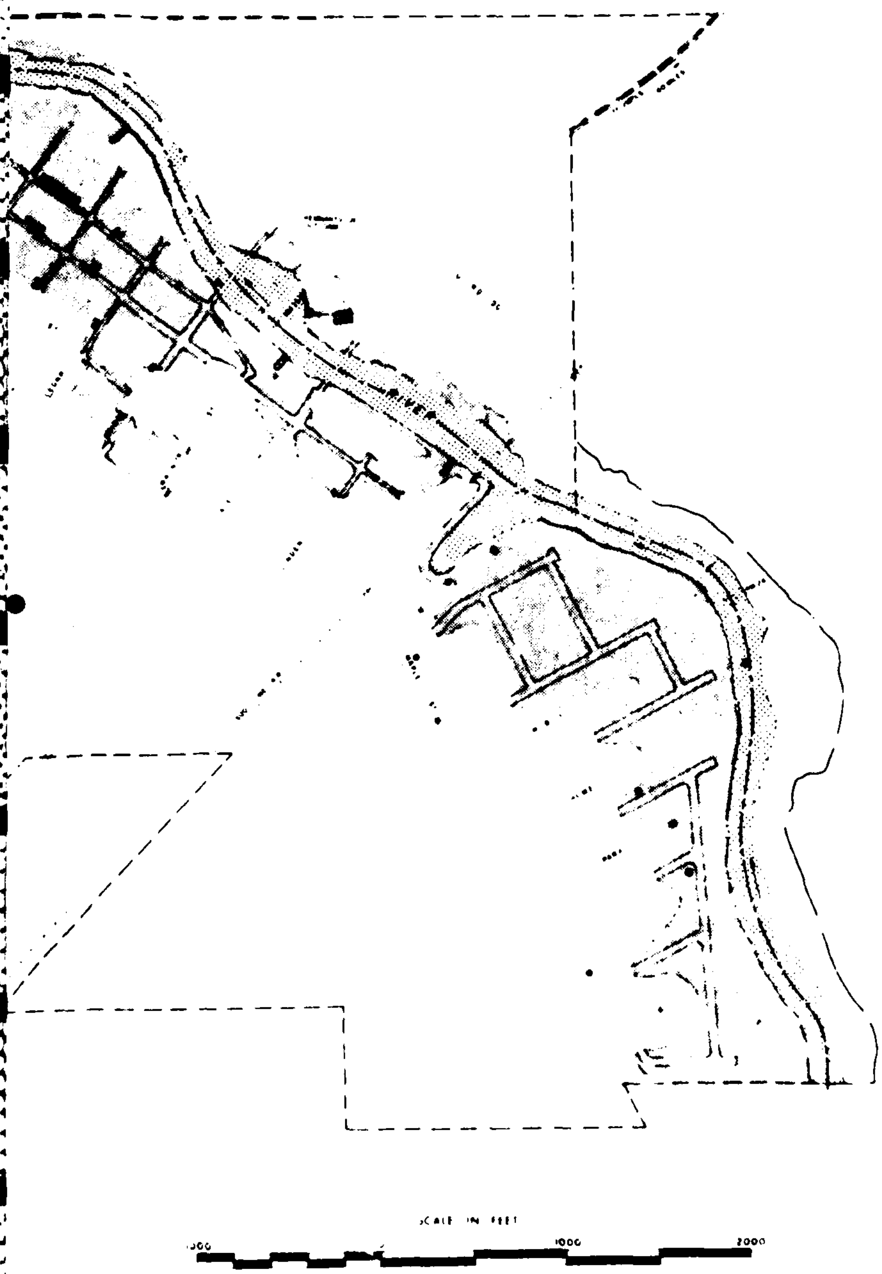
MINNESOTA
ROCKFORD
CROW RIVER
LOCATION MAP



LEGEND

- NORMAL RIVER CHANNEL
- INTERMEDIATE REGIONAL FLOODPLAIN
- POWER AUGER BORING
- HAND AUGER BORING
- WATER QUALITY SAMPLING LOCATION
- CORPORATE LIMIT
- STUDY LIMIT

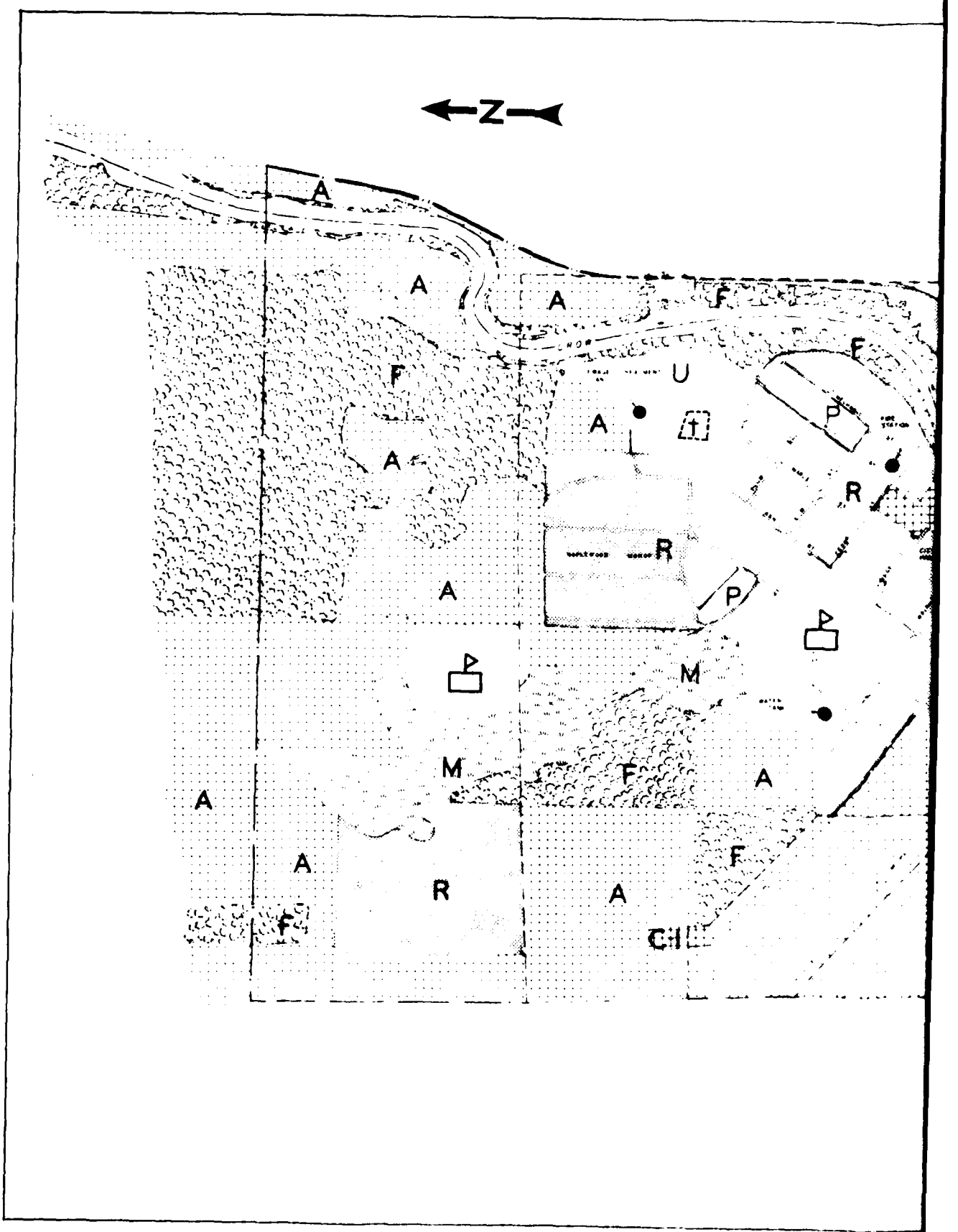
FLOOD CONTROL

CROW RIVER AT ROCKFORD, MINNESOTA

STUDY AREA & INTERMEDIATE REGIONAL FLOODPLAIN

PLATE

2



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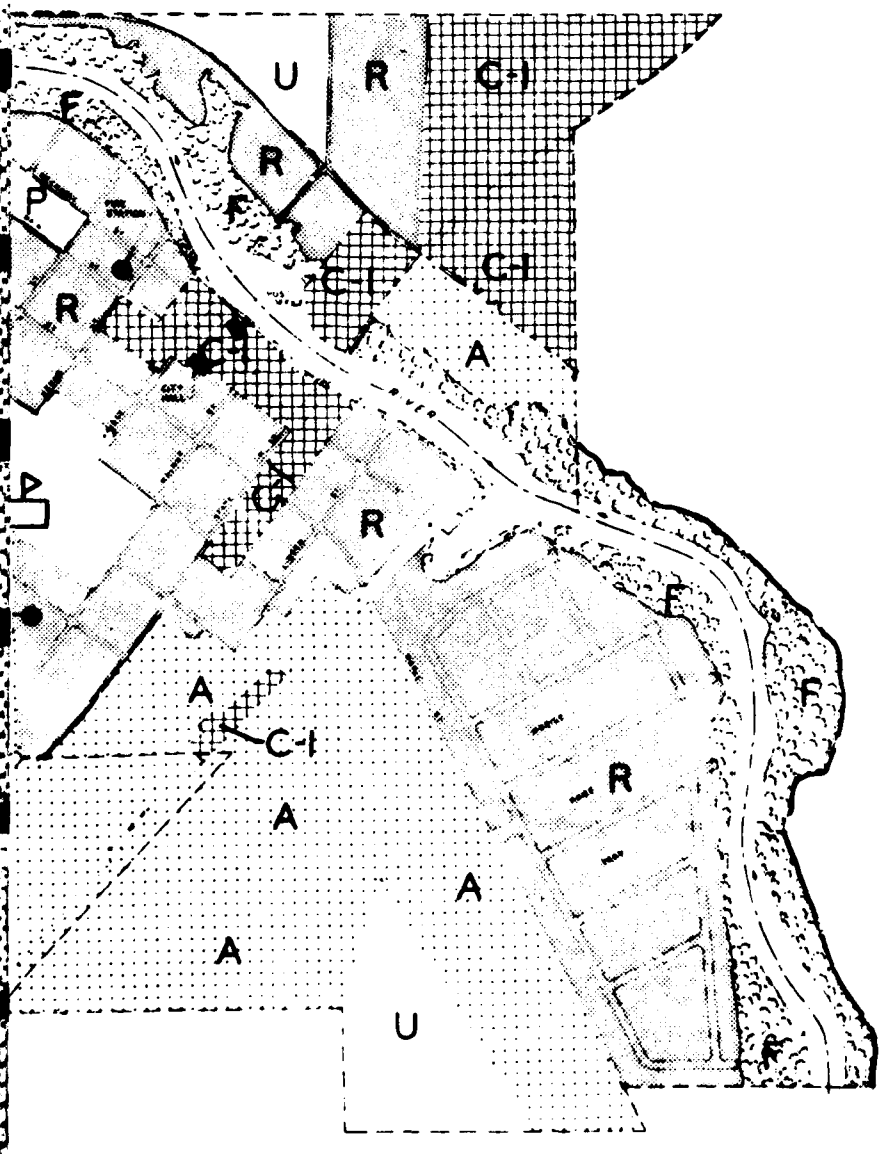


SCALE IN FEET

1000 0 1000 2000

LEGEND

RESIDENTIAL	R
COMMERCIAL–INDUSTRIAL	C-I
AGRICULTURAL	A
FORESTED	F
PARK & RECREATIONAL	P
MARSH	M
UNDEVELOPED	U
SCHOOLS	
CEMETERIES	
GOVERNMENT (FEDERAL, CITY)	
PUBLIC SERVICES	
CORPORATE LIMITS	
STUDY LIMITS	

SECTION 205

FLOOD CONTROL

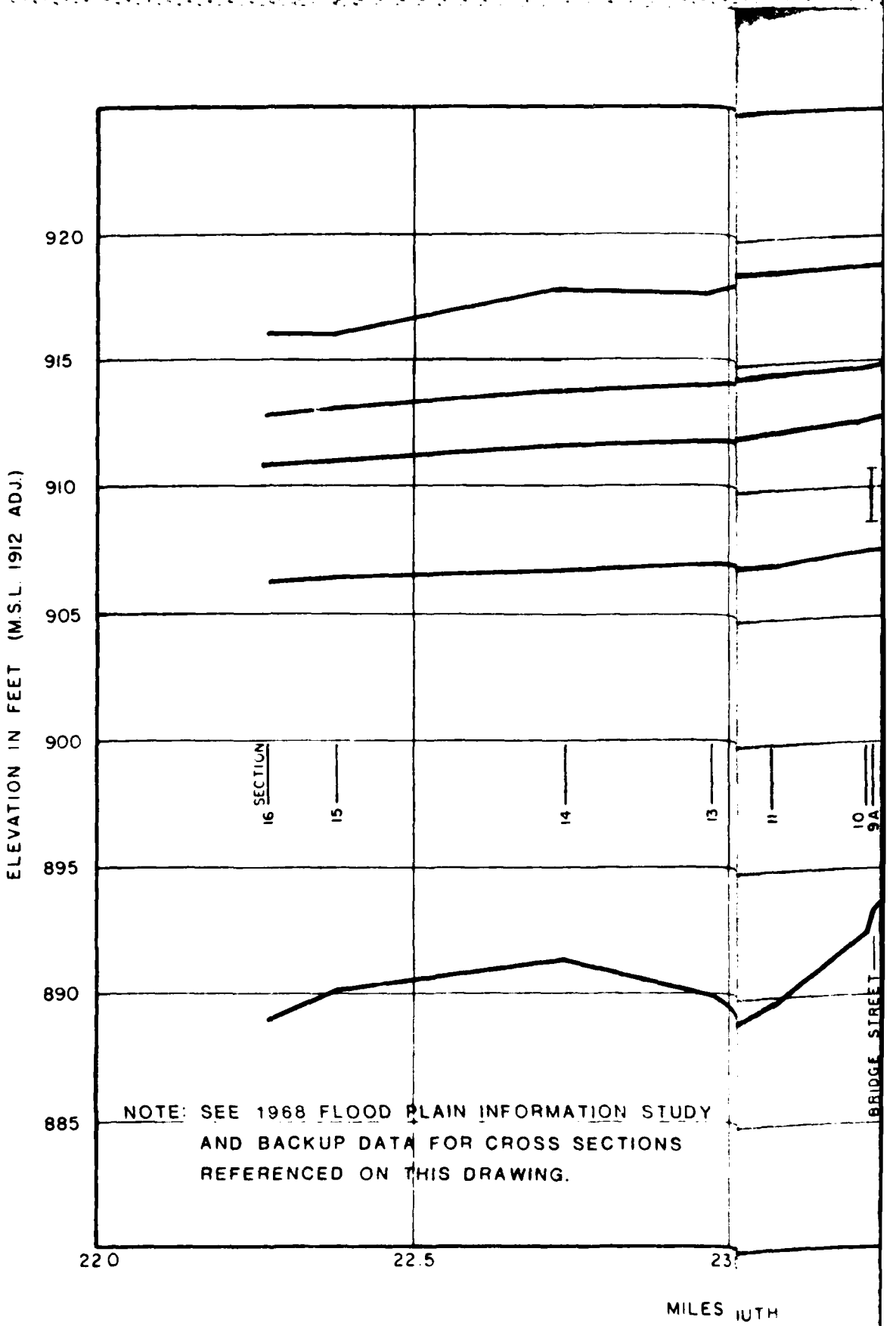
CROW RIVER AT ROCKFORD, MINNESOTA

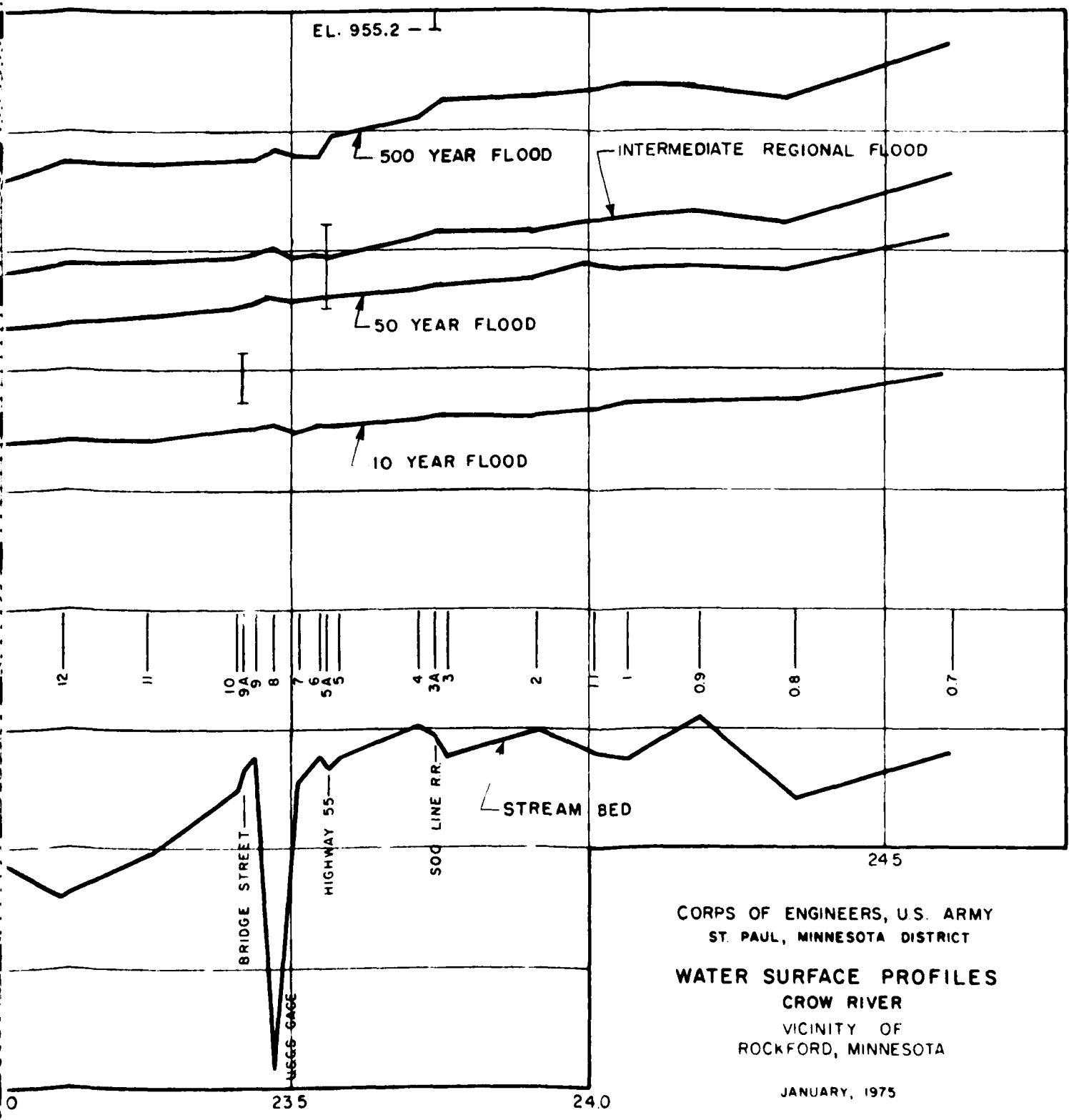
LAND USE MAP

ST. PAUL DISTRICT
CORPS OF ENGINEERS

PLATE 6

2


920
915
910
905
900
895
890
885
ELEVATION IN FEET (M.S.L. 1912 ADJ.)
SECTION
16
15
14
13
11
10
9A
BRIDGE STREET
NOTE: SEE 1968 FLOOD PLAIN INFORMATION STUDY AND BACKUP DATA FOR CROSS SECTIONS REFERENCED ON THIS DRAWING.
22.0
22.5
23
MILES

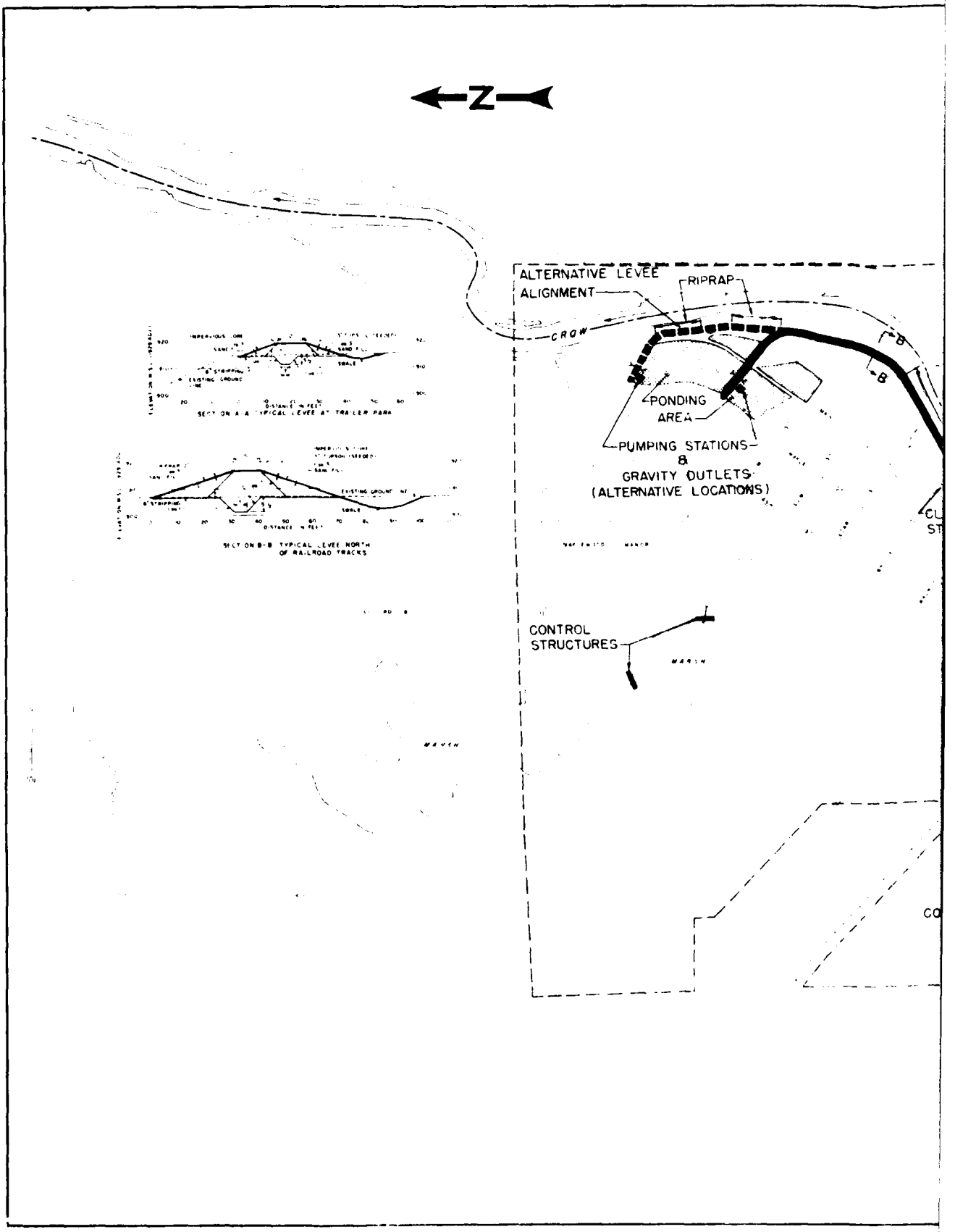


CORPS OF ENGINEERS, U.S. ARMY
ST. PAUL, MINNESOTA DISTRICT

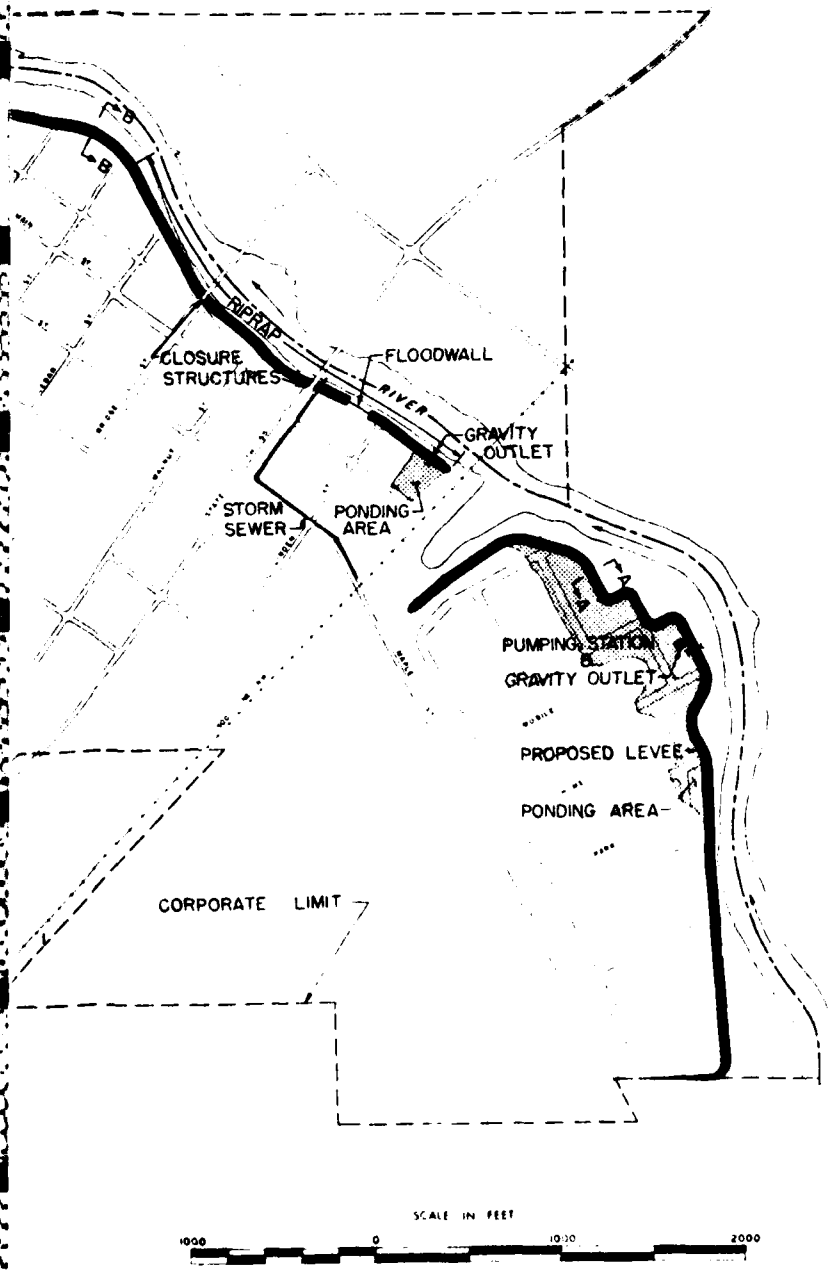
WATER SURFACE PROFILES
CROW RIVER
VICINITY OF
ROCKFORD, MINNESOTA

JANUARY, 1975

PLATE 3


Z
ALTERNATIVE LEVEE ALIGNMENT
RIPRAP
CROW
B
B
PONDING AREA
PUMPING STATIONS & GRAVITY OUTLETS (ALTERNATIVE LOCATIONS)
CONTROL STRUCTURES
SECTION A-A TYPICAL LEVEE AT TRAILER PARK
SECTION B-B TYPICAL LEVEE NORTH OF RAILROAD TRACKS

1



SCALE IN FEET

1000 0 1000 2000

LEGEND

- PROPOSED LEVEE
- PONDING AREA
- GRAVITY OUTLET OR CULVERT
- PUMPING STATION
- HYDRAULIC CONTROL STRUCTURE

SECTION 205

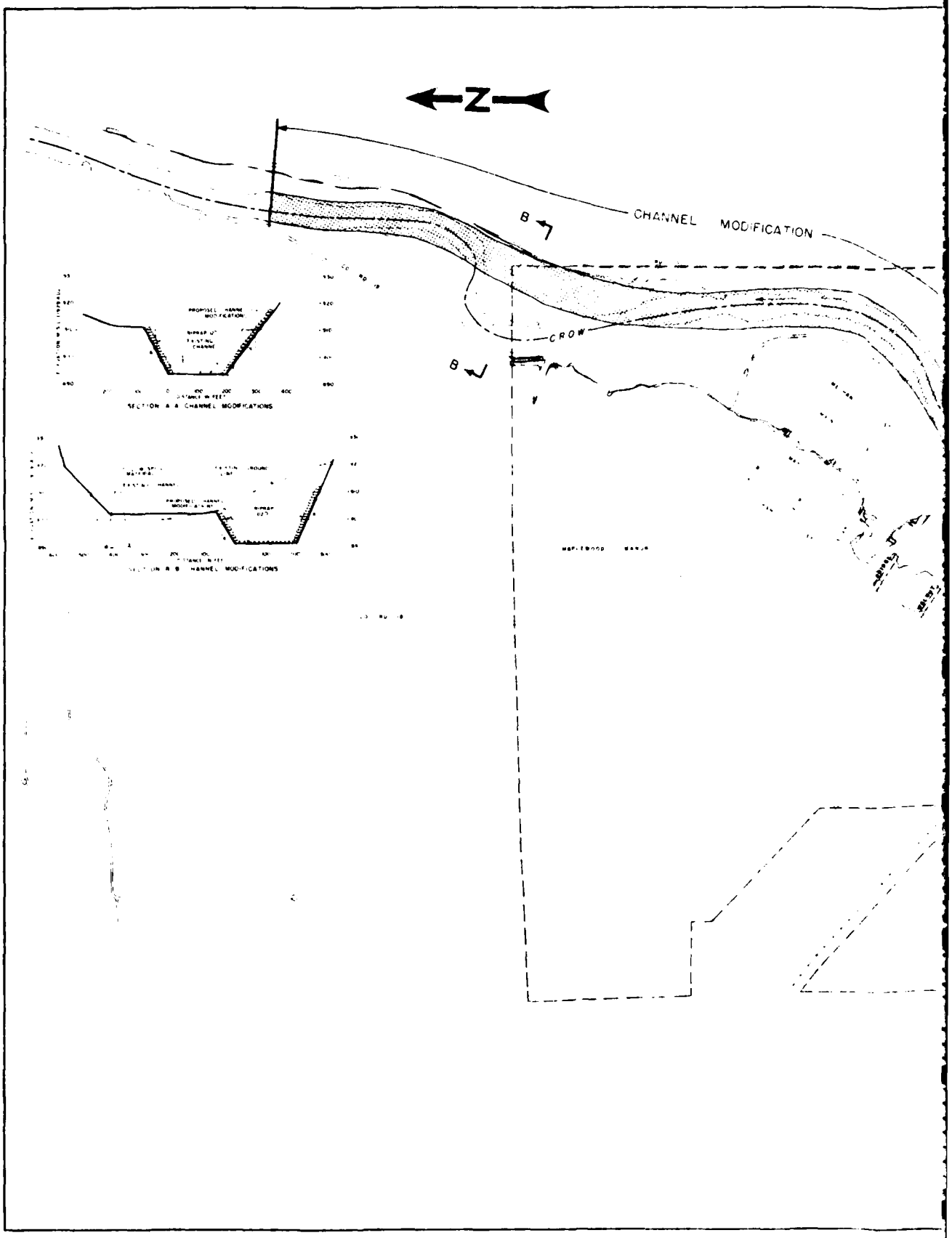
FLOOD CONTROL

CROW RIVER AT ROCKFORD, MINNESOTA

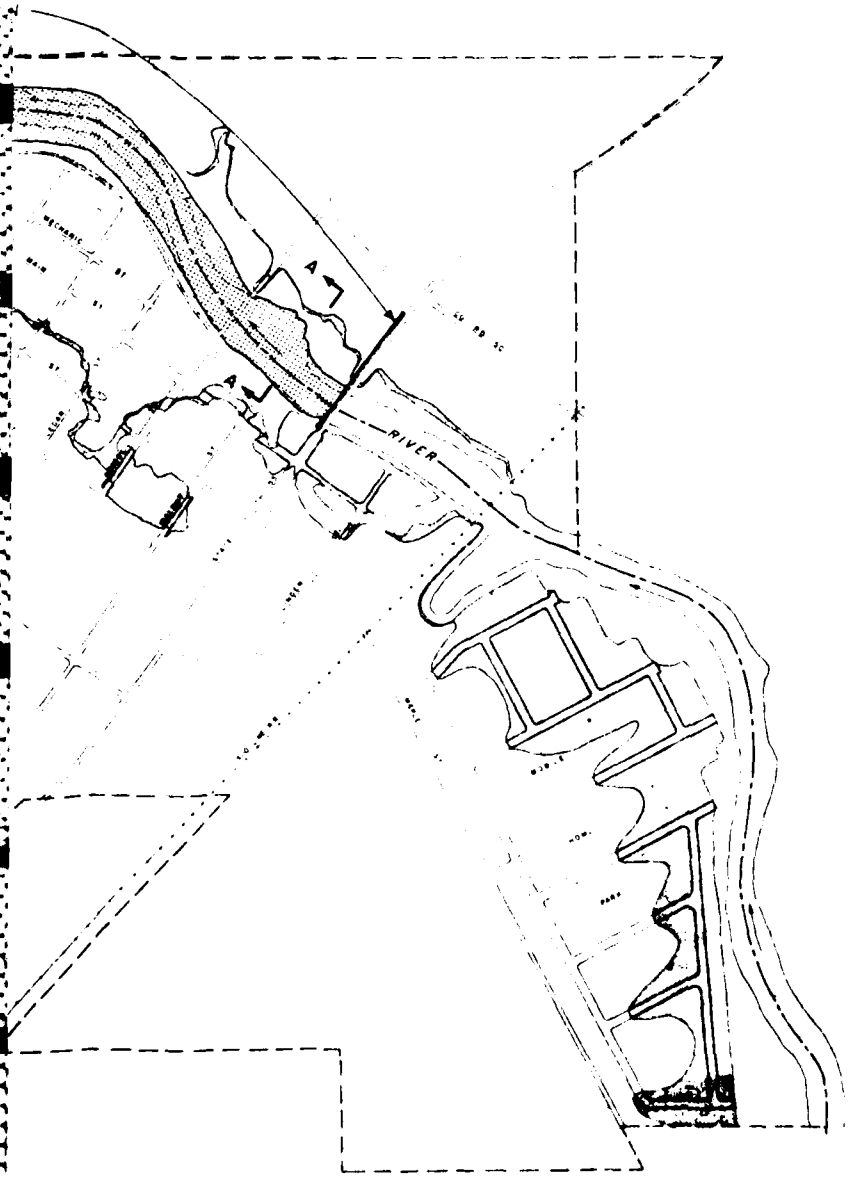
PLAN AND SECTIONS LEVEE AND FLOODWALL

ST. PAUL DISTRICT
CORPS OF ENGINEERS

PLATE 4


Z
CHANNEL MODIFICATION
B
B
CROW
SECTION A-A CHANNEL MODIFICATIONS
SECTION B-B CHANNEL MODIFICATIONS

1



SCALE IN FEET

1000 0 1000 2000

LEGEND

REDUCTION IN INTERMEDIATE REGIONAL FLOOD PLAIN DUE TO CHANNEL MODIFICATIONS

MODIFIED CHANNEL

SECTION 205

FLOOD CONTROL

CROW RIVER AT ROCKFORD, MINNESOTA

PLAN AND SECTIONS CHANNEL MODIFICATION

ST. PAUL DISTRICT
CORPS OF ENGINEERS

PLATE 5

2

SECTION V

PERTINENT CORRESPONDENCE

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE CENTRAL REGION
Room 1836
601 East 12th Street
Kansas City, Missouri 64106

January 27, 1976

WFC2x2

District Engineer
Corps of Engineers
1135 U. S. Post Office
and Custom House
St. Paul, MN 55101

Subject: Report on Flood Control Alternatives - Crow River at Rockford, MN

Reference: NCSED-PB, January 15, 1976

Dear Sir:

Your letter of January 15 requested comments and a statement of our concurrence concerning the above draft report. We agree with your statement of the Base Condition that indicates the continuation of the prediction of the time and level of flood flows. Floodplain zoning, as discussed on Page 13 of the report, is a viable means of minimizing flood damage and reduction in loss of life. Floodplain zoning in conjunction with adequate flood warning and a community action plan provides for a substantial reduction in flood damage.

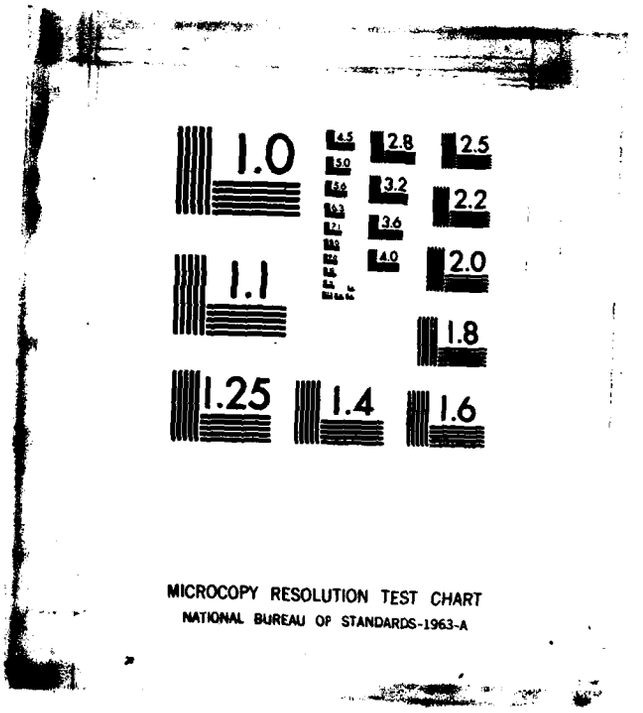
The National Weather Service will continue to provide its flood forecast and warning program to the residents of Rockford, MN. As time and monies permit, we plan to improve these warning systems to insure longer lead time to flood forecasts and the warning of possible flash flooding.

Sincerely,

Charles G. Knudsen
Director, Central Region

AD-A137 437 REPORT ON FLOOD CONTROL ALTERNATIVES CROW RIVER AT ROCKFORD MINNESOTA(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT SEP 75 3/3

UNCLASSIFIED F/G 13/2 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
7.1
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
CENTENNIAL OFFICE BUILDING • ST. PAUL, MINNESOTA • 55155

February 4, 1976

Colonel Forrest T. Gay III
District Engineer
U. S. Corps of Engineers
1135 U. S. Post Office and Custom House
St. Paul, MN 55101

Dear Colonel Gay:

We have reviewed your report on flood control alternatives for the Crow River at Rockford, Minnesota. We concur with your recommendations on pages 13 through 15 and have no further comments on the report. As in the past, this Department will continue to provide assistance to the City of Rockford in developing and implementing a comprehensive flood plain management program.

Very truly,

Division of Waters

Gene H. Hollenstein,
Chief Hydrologist

GHH:mrn