MISSISSIPPI RIVER
FLOOD PLAIN INFORMATION

ROCK ISLAND COUNTY, ILLINOIS
SCOTT AND MUSCATINE COUNTIES, IOWA

PREPARED FOR
THE STATE OF ILLINOIS
DIVISION OF WATERWAYS
DEPARTMENT OF PUBLIC WORKS AND BUILDINGS
STATE OF IOWA
IOWA NATURAL RESOURCES COUNCIL

BY

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

This report evaluates the flood situation along the Mississippi River in Rock Island County, Illinois and Scott and Muscatine Counties, Iowa. The study includes the flood plain area of Mad Creek and Geneva Creek in Muscatine, Iowa, from the mouth to a point just upstream from the H. J. Heinz plant on the right bank of Mad Creek. The report was prepared at the request of the Bi-State Metropolitan Planning Commission and several Iowa communities and counties through the Illinois Division of Waterways and the Iowa Natural Resources Council to aid in the solution of local flood problems and to determine the best use of land subject to overflow. The report covers an area of the Mississippi River flood plain from the Rock Island County line near Albany, Illinois, downstream to the mouth of Michael Creek in Louisa County, Iowa. The study area begins and ends at Miles 512 and 441, respectively, upstream from the mouth of the Ohio River. The study reach extends south into Louisa County, Iowa to include all of the Muscatine Island Levee District and the Muscatine-Louisa-County Drainage District No. 13.

The report covers two significant phases of the Mississippi River flood problem in the study reach. First, it reviews the records of the largest known past floods on the Mississippi River. Second, the report estimates possible future floods; the Intermediate Regional and Standard Project Floods. The Intermediate Regional Flood has an average frequency of occurrence in the order of once in 100 years, although it may occur in any year. The Intermediate Regional Flood was determined from a statistical analysis of known flood data on the Mississippi River. The

The Standard Project Flood is an estimate of the reasonable upper limit of possible flood flows. On the Mississippi River, it is considerably larger than any past floods. Although the occurrence of the Standard Project Flood would be extremely rare, it could happen in any year.

Decisions must be made relative to logical and practical flood plain development which is compatible with the flood hazards of the Mississippi River. Appropriate evaluation must be made of the possible recurrence of past floods and the occurrence of the Intermediate Regional and Standard Project Floods.

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

The report evaluates the flood hazard along the Mississippi River in Rock Island County, Illinois, and Scott and Muscatine Counties, Iowa, and small portions of Clinton and Louisa Counties, Iowa. It does not include plans for the solution of flood problems. However, it does provide the basis for further study and planning by the affected municipalities and counties to minimize vulnerability to flood damages. Local planning programs may guide development by managing flood plain use through zoning and subdivision regulations, construction of flood protection works, or a combination of the two approaches.

Chapter 24, Paragraph 11, of the Illinois Revised Statutes, 1967, authorizes cities and villages within the State to prepare and enforce zoning regulations, establish setback and building lines, adopt subdivision regulations, prepare and adopt an official comprehensive plan, and prescribe building construction regulations. Division 13 of Paragraph 11 provides for the adoption of zoning ordinances and one of the stated objectives of this authorization is to lessen or avoid the hazards to persons and damage to property resulting from the accumulation or run-off of storm or flood waters. Under Division 14, municipalities are empowered to establish building and setback lines along any storm or flood water run-off channel for the purpose of securing safety from personal and property damage. Cities and villages are also authorized to establish subdivision regulations and require the submission and approval of all subdivision plats before they are recorded or have any validity. The enabling legislation further provides that, where a municipality has adopted an official comprehensive plan, the corporate authorities may establish reasonable subdivision requirements for the adequate handling of storm drainage. The corporate authorities of municipalities are authorized under Division 30 to prescribe rules and regulations for the construction and alteration of buildings for the purpose of lessening or avoiding the hazards to persons and damage to property resulting from flooding.

Counties in the State of Illinois are authorized under Chapter 34, Paragraph 3152, of the Illinois Revised Statutes, 1967, to establish zoning regulations which may restrict the location and use of buildings, structures, and land in unincorporated areas or in municipalities where no zoning ordinance is in effect. One of the purposes of the zoning regulations is to lessen or avoid the hazards to persons and damage to property resulting from the accumulation of run-off of storm or flood waters. Land, structures, and buildings used for agricultural purposes are specifically exempt from the zoning regulations by the enabling legislation. Counties, under Chapter 34, Paragraph 414, are provided the authority to adopt regulations for the subdivision of land in unincorporated areas. One of the specifically stated purposes of these regulations is to prescribe reasonable rules governing the location, width, and course of storm or flood water run-off channels and basins. Where a county has adopted such regulations no subdivision plat may be submitted for recording or have any validity until it is approved by the appropriate officer of the county.

Under the provisions of "An Act in relation to the regulation of rivers, lakes and streams of the State of Illinois, as amended", Illinois Revised Statutes, Chapter 19, Paragraphs 52-78, the Department of Public Works and Buildings, on behalf of the State of Illinois, is assigned jurisdiction and supervision over all the rivers and lakes of the State wherein the State of Illinois or the people of the State have any rights or interests. The authority contained in this Act empowers the Department of Public Works and Buildings to investigate all complaints relative to alleged encroachments, abuses, or mis-uses of public waters and to hold hearings pertinent thereto and to enter such orders as may be required to rectify the situation. Further, it is unlawful to make any fill or deposit of rock, earth, sand, or other material, or to build or commence the building of any wharf, pier, dolphin, boom, weir, breakwater, bulkhead, jetty, causeway, harbor, or mooring facilities for watercraft, or to build or commence to build any other structure, or do any work of any kind whatsoever in any of the public bodies of water within the State of Illinois, without first submitting the plans, profiles, and specifications therefor to the Department of Public Works and Buildings and receiving a permit therefor signed by the Director of the Department and authenticated by the seal thereof. The "Recorders Act", Illinois

Revised Statutes, Chapter 115, Paragraph 13, further provides that no subdivision plat be recorded if any part of the subdivision is situated within 500 feet of any surface drain or watercourse serving 640 acres or more until such subdivision plat has been reviewed by the Department of Public Works and Buildings and flood hazard report thereon filed by the Department with the County Recorder.

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

In addition, the authority of local governing bodies to zone land for protection from floods is included in the standard objectives listed in the state enabling statutes, Chapter 358A and Chapter 414 of the Iowa Code 1966, as amended. (See also Chapter 455A of the 1966 Code).

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

GUIDELINES FOR FLOOD DAMAGE REDUCTION

General

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

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

Historically, man has tried to reduce flood damages through structural measures to confine floods within the river banks. Many different types of control works have been constructed for this purpose. Dams and reservoirs have been constructed to store water for gradual release after the threat of flooding has passed. Channel improvements have been used to remove constrictions and improve flow characteristics so that future flood stages are reduced. Watershed treatment involves the regulation of the rate of run-off to the main stem and tributaries. Levees, dikes, and flood walls have been constructed to confine the river to a definite course at stages which may be well above the adjacent flood plain. These methods are generally very costly and therefore are more often used in areas where development has already heavily encroached on the flood plain, or where future plans call for extensive use of the flood plain. However, continued uncontrolled encroachment on the flood plain has taken place faster than construction of flood control works, with the result that development in flood hazard areas with their associated flood damages have been steadily increasing across the nation.

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

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

Fortunately, the need for flood plain planning on the Mississippi River has been recognized by local interests. This means that future damages in the study area can be reduced, at little or no cost to the taxpayer, by developing and enacting flood plain regulations. The Bi-State Metropolitan Planning Commission has done extensive research on the present and projected growth in the areas of land use, population, economy, recreation and transportation and have published comprehensive planning reports. The flood data in this report, together with the planning program for future land use, will enable State and local interests to minimize flood damage risks.

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

Encroachment Lines

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

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

Zoning

Zoning is a legal tool used by cities, towns, villages, and counties to control and direct the use and development of land and property within their jurisdiction. Division of a municipality or county into various zones should be the result of a comprehensive planning program for the entire area, with the purpose of guiding its growth. The planning program as such has no legal status. Zoning, as described above, is a legal tool that is used to implement and enforce the details of the planning program. Its objectives are the conservation of property value and the achievement of the most appropriate and beneficial use of available land. Flood plain zoning is not a special type of ordinance, but merely another set of provisions which can be incorporated into a comprehensive zoning ordinance so that flood damage can be minimized. Zoning regulations may be used in lieu of encroachment laws or as a supplement to them. Thus, designated floodways may be zoned for the purpose of passing flood waters and for other limited uses that do not conflict with that primary purpose. The ordinance may also establish regulations for the flood plain areas outside the floodway. These include designating elevations above which certain types of development must be constructed. The enabling statutes which authorize municipalities and counties in Iowa to adopt zoning regulations are Chapters 358A and 414, respectively, of the Iowa Code 1966, as amended. In Illinois, the enabling statutes are Chapters 24 and 34, respectively, of the Illinois Revised Statutes, 1967.

Subdivision Regulations

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

Building Codes

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

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

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

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

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

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

Flood Plain Regulations

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

The profiles shown on Plates 10 through 13, combined with the detailed information contained in this report, provide a basis for formulation of flood plain regulations.

CONCLUSIONS

Over the last two decades and especially in the past five years Rock Island, Clinton, Scott, and Muscatine Counties and certain municipalities adjacent to the Mississippi River in the counties have devoted considerable time and funds in preparing plans for development of their respective jurisdictions. Generally, these plans are based upon forecasts of future economic and population growth and the resulting need for residential neighborhoods, commercial facilities, industrial areas, parks, schools, streets, and public utilities. These studies indicate that certain areas within the vicinity of the Mississippi River will experience substantial urban development within the next 15 to 20 years. For example, the total population of the Rock Island, Scott, and Muscatine Counties is forecast to increase from 308,898 in 1960 to 406,900 in 1985. This represents a 27 percent increase in population for the three counties during the period. This population increase will be accompanied by a need for additional lands suitable for urban development. While all of this growth will not occur within the vicinity of the Mississippi River, a substantial amount of urban development is projected to occur on lands in the vicinity of the river. As a result the Mississippi River flood plain will continue to be subject to the pressures of residential, commercial, and industrial development. History has shown that such development of areas bordering a stream's flood plain will produce considerable increases in future flood damages if allowed to occur without adequate flood plain management practices.

The process of developing effective flood plain regulations should be coordinated with a comprehensive planning program for future land uses. Plans in the past for the Scott, Muscatine, and

Rock Island Counties recommended the development of park and other open areas along substantial portions of the Mississippi River flood plain. The Metropolitan Recreation and Open Space Plan for Scott and Rock Island Counties adopted by the Bi-State Metropolitan Planning Commission in 1968 indicates that the Mississippi River is the most important natural feature and recreation resource in the two-county area. This plan includes the following recommendations: (1) development of several new large parks adjacent to the river, (2) establishment of scenic districts at several points along the river, (3) expansion and improvement of existing riverfront parks, (4) provision of additional river access areas, (5) rehabilitation and improvement of the riverfront in the Central Urbanized Area, and (6) adoption and enforcement of flood plain zoning for areas subject to periodic flooding.

The Park, Recreation, and Open Space Plan prepared in 1966 for the Muscatine County Conservation Board includes the following proposals: (1) investigation by the County of the establishment of flood plain zoning, (2) beautification of the Mississippi shoreline, (3) establishment of river access points, (4) and development of additional parks adjacent to the river.

In view of forecasted urban growth along the Mississippi River, it is essential that adequate flood plain management practices be instituted. If the flood plain is to be an asset rather than a liability in the future, the counties and municipalities must take action as soon as possible to manage the flood plain. The information contained herein provides the local units of government with a base for preparing regulations to promote the most efficient development of the flood plain consistent with the potential flood hazards.

SUMMARY OF THE FLOOD SITUATION

The report covers the flood plain on both banks of the Mississippi River from the mouth of Michael Creek on the Iowa side (441 miles upstream from the mouth of the Ohio River) upstream to the Rock Island County line in Illinois (512 miles upstream from the mouth of the Ohio River). Two major tributaries empty into the Mississippi River in the study reach; the Wapsipinicon from the Iowa side at Mile 506.8 and the Rock River from the Illinois side at Mile 479.1. The Mississippi River flood plain includes parts of the Illinois cities and villages of Cordova, Port Byron, Rapids City, Hampton, East Moline, Moline, Rock Island, and Andalusia. Also included are parts of the Iowa cities, towns, and communities of Camanche, Princeton, LeClaire, Bettendorf, Davenport, Buffalo, Fairport, and Muscatine.

Major industrial, commercial, and residential developments occupy the Mississippi River flood plain within the Iowa-Illinois Quad Cities Metropolitan area and in the City of Muscatine. Portions of the flood plain lands have been inundated by recorded past floods and substantially larger areas are vulnerable to the potentially greater floods of the future.

Several stream gaging stations have been established and maintained to record stages on the Mississippi River in the study reach. The Environmental Science Services Administration, U. S. Weather Bureau maintains the gage at Muscatine. The U. S. Geological Survey maintains the gage at LeClaire, Iowa, and a gage at Camanche, Iowa, in cooperation with the Corps of Engineers. The Corps of Engineers maintains pool and tailwater gages at Lock and Dam 14, 15, and 16 in the study reach in addition to gages at Princeton, Iowa; 48th Street in Moline, Illinois; Lock 32, Illinois and Mississippi Canal; Montpelier, Iowa; and Fairport, Iowa. Available gaging records for these stations are discussed under the heading, Flood Records.

In addition to the gaging records, newspaper files and historical documents were searched for information concerning past floods. From these historical records as well as from engineering studies of possible future floods, the local flood situation has been determined. The following paragraphs summarize the significant findings.

THE GREATEST KNOWN FLOOD on the Mississippi River in the study reach occurred in April of 1965. At the Corps of Engineers gaging station at the Chicago and Northwestern Railway bridge in Clinton, Iowa, the maximum flow was 307,000 cubic feet per second at a stage of 24.85 feet on April 28, 1965. The previously recorded maximum flow of 250,000 cubic feet per second occurred in June of 1880 at a stage of 21.00 feet. The prior maximum recorded stage was 23.4 feet established from a flood mark of the 1828 flood. Flow during this flood is unknown.

OTHER LARGE FLOODS in the study reach occurred in May 1888, June 1892, October 1881, April 1969, April 1952, April 1920, April 1951, April 1922, and April 1967 in the order of flow magnitude.

THE INTERMEDIATE REGIONAL FLOOD by definition is a flood that has an average frequency of occurrence in the order of once in 100 years. In the study, the Intermediate Regional Flood was determined from an analysis of flood data on the Mississippi River. The analysis shows that the Intermediate Regional Flood would be higher than the April 1965 flood by the following amounts: 1.3 feet at the Chicago and Northwestern Railway bridge in Clinton; 2.0 feet at the gage in Camanche; 1.5 feet at the gage in LeClaire; 2.1 feet at the gage at 48th Street in Moline; 2.2 feet at the tailwater gage at Lock and Dam 15; 2.9 feet at the gage at Fairport; 3.7 feet at the tailwater gage at Lock and Dam 16; and 3.6 feet at the gage at Muscatine.

STANDARD PROJECT FLOOD determination indicates that floods could occur on the Mississippi River which would be higher than the April 1965 flood by the following amounts: 6.4 feet at the gage at Clinton; 4.8 feet at the gage in Camanche; 4.7 feet at the gage in LeClaire; 5.6 feet at the 48th Street gage in Moline; and 5.4 feet at the tailwater gage at Lock and Dam 15.

FLOOD DAMAGES from recurrence of major known floods would be substantial without considerable expenditures for emergency flood fighting measures. More extensive damage would be caused by the Intermediate Regional and Standard Project Flood due to greater depths, higher velocities and wider extent. Extensive localized flood damages may result from unpredictable ice jams during late winter and spring floods.

MAIN FLOOD SEASON for the Mississippi River is in the spring. Of the 10 highest recorded floods, 9 occurred in April, May or June and resulted generally from snowmelt or snowmelt in combination with rainfall. General intense thunderstorms may cause floods during other seasons.

FLOOD DURATION of spring snowmelt floods varies with the rate of melt and volume of run-off. During the flood of April 1965, the river rose to its peak stage in 30 days and remained above flood stage of 16 feet for 28 days at the gage at Clinton, Iowa. During the floods of April 1967 and April 1952, the river rose to its peak stage in 19 days and 29 days, respectively, and remained above flood stage of 16 feet for 14 days and 23 days, respectively. Plate 3A shows the observed stage hydrographs for the floods discussed in this paragraph. Plate 3B shows the observed stage hydrograph for the February 1966 ice jam flood at the tailwater gage of Lock and Dam 15. The estimated natural stage hydrograph is also plotted to show the effect of the ice jam on observed stages.

FUTURE FLOOD HEIGHTS during occurrence of the Intermediate Regional and Standard Project Floods on the Mississippi River are shown in Table 1 in addition to observed flood heights during the April 1965 flood. The water surface elevations for the Intermediate Regional and Standard Project Floods are based on existing developments on the Mississippi River flood plain. Future developments, if allowed to reduce the effective flow area of the flood plain, could cause higher water surface elevations than those shown in Table 1. In addition, the water surface elevations for the Intermediate Regional and Standard Project Floods assume no clogging at bridges, dams, or natural channel constrictions by debris or ice jams.

TABLE 1

RELATIVE FLOOD HEIGHTS

Mile	Identification	April 1965 High Water Elevation Feet	Intermediate Regional Flood Elevation Feet	Intermediate Regional Flood Relation to max. High Water Feet	Standard Project Flood Elevation Feet	Standard Project Flood Relation to max. High Water Feet	Remarks
441.3	Port Louisa, Iowa	551.0	554.4	3.4			Gage no longer in use
443.7	Near Bogus Island	551.9	555.3	3.4			1965 high water mark
448.4	Bass Island Gage	553.1	556.5	3.4			Gage discontinued November 15, 1967
450.2	Blanchard Island Gage	553.9					Gage established March 11, 1968
455.3	Muscatine Gage	556.3	559.9	3.6			Gage established January, 1878
457.2	Lock & Dam No. 16 Tailwater	556.9	560.6	3.7			Gage established December 16, 1935
457.2	Lock & Dam No. 16 Pool	557.6	561.1	3.5			Gage established June 16, 1936
460.0	Near Drury Slough	557.9	561.2	3.3			1965 high water mark
463.5	Fairport Gage	558.7	561.6	2.9			Gage established November 26, 1912
467.5	Montpelier Gage	559.7					Gage established December 27, 1962
471.1	Near upstream end of Sunfish Slough	560.6	563.5	2.9			1965 high water mark
479.1	Lock 32 (I & M Canal) Gage	563.6	566.1	2.5	569.4	5.8	Gage established January 1, 1896
481.9	Downstream side of R.I. Centennial Br.	564.7	566.9	2.2			1965 high water mark
482.9	Lock & Dam No. 15 Tailwater	565.0	567.2	2.2	570.4	5.4	Gage established January 1, 1878
482.9	Lock & Dam No. 15 Pool	565.9	568.1	2.2			Gage established March 8, 1934
487.9	Moline Gage on 48th Street	572.1	574.2	2.1	577.8	5.6	Gage established January 1, 1928
491.0	Near Campbell's Island	574.1	575.8	1.7			1965 high water mark
493.3	Lock & Dam No. 14 Tailwater	574.8	576.5	1.7	579.5	4.7	Both lock gages were
493.3	Lock & Dam No. 14 Pool	577.1	578.7	1.6			established May 16, 1939
495.4	Interstate 80	578.5	580.4	1.9			1965 high water mark
497.0	LeClaire Gage	580.2	581.7	1.5	584.9	4.7	Gage established January 1, 1878
502.1	Princeton Gage	583.6	585.2	1.6	588.2	4.6	Gage established August 4, 1930
507.0	Just above Wapsipinicon River	585.9	587.9	2.0			
509.8	Near the downstream end of Marais Dosier Slough	587.2	589.1	1.9			
511.8	Camanche Gage	587.7	589.7	2.0	592.5	4.8	Gage established May 27, 1939

GENERAL CONDITIONS AND PAST FLOODS

GENERAL

This section of the report is a history of floods on the Mississippi River in Rock Island County, Illinois, Scott and Muscatine, and portions of Clinton and Louisa Counties, Iowa. The drainage area for specific locations within the study reach are shown in Table 2.

Major industrial, commercial, and residential developments occupy the Mississippi River flood plain in and near the larger metropolitan areas of the study reach. In the rural area, the flood plain is used for agriculture. Many permanent and summer homes are built near the river banks in the rural area. Some of the agricultural area has been organized into levee districts and has been protected from floods of the magnitude of the Intermediate Regional Flood by construction of levees. Existing and proposed flood protection projects are discussed under the heading, Flood Damage Prevention Measures.

Records of river stages in the study reach are available for several locations. Some gage height records are available for as early as June 1875. Gage height records for the gages in the study reach are discussed in detail under the heading, Flood Records.

Flood history searches have been made to develop information on Mississippi River floods. A search was made of newspaper files and historical documents. From these sources and the gage records for the several gaging stations in the study reach, it has been possible to develop a history of floods on the Mississippi River.

The Stream and Its Valley

The Mississippi River headwaters begin in northern Minnesota at Lake Itaska southwest of Bemidji. Major tributaries upstream from the study reach include: The Minnesota River in southwestern Minnesota and eastern South Dakota; the Chippewa, Black, and Wisconsin Rivers in Wisconsin; the Cannon, Zumbro, and Root Rivers in southeastern Minnesota; and the Turkey, Maquoketa, and Upper Iowa Rivers in northeastern Iowa. Major tributaries entering the Mississippi River in the study reach are the Rock River from Illinois and Wisconsin and the Wapsipinicon River from Iowa. Plate 1 shows the watershed, the stream drainage, and the Mississippi River reach covered by this report. Pertinent drainage areas of the Mississippi River are shown in Table 2.

TABLE 2

DRAINAGE AREAS WITHIN THE STUDY REACH

Stream	Location	Miles Above Ohio River	Drainage Area Sq. Mi.
Mississippi River	Port Louisa, Iowa	441.3	99,600
	Bass Island	448.4	99,500
	Muscatine, Iowa	455.2	99,400
	Fairport, Iowa	463.5	99,300
	Lock 32, I&M Canal	479.1	99,200
	Lock and Dam No. 15	482.9	88,500
	48th St., Moline, Ill.	487.9	88,400
	Princeton, Iowa	502.1	88,300
	Camanche, Iowa	511.8	85,700
Rock River	At mouth	479.1	10,630
Wapsipinicon River	At mouth	506.9	2,540

REACH COVERED BY THIS REPORT

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

UPPER MISSISSIPPI RIVER WATERSHED

50 25 0 50 100 150 200
SCALE IN MILES
JUNE 1969

One of the first detailed descriptions of the upper Mississippi River and its valley was recorded by Major General G. K. Warren in his report to the House of Representatives (Executive Document No. 58, 39th Congress, 2nd Session, January 1867) regarding surveys of the upper Mississippi River and its tributaries. Following are excerpts from Warren's Report:

"As one travels up the Mississippi River from LeClaire, at the head of the upper rapids (Rock Island), to Fulton and Lyons, some twenty miles, he sees the banks which rise above the bottom lands slope gently back to the prairie lands of Iowa and Illinois. - - at Fulton and Lyons, these high lands become more steep and naked rocks project from their sides, and here the banks reach an elevation of 120 feet (above the valley floor) at points about 4,000 feet apart on opposite sides. Above Fulton and Lyons the bluffs stand farther apart: They generally remain steep, often precipitous, and their elevation gradually increases from 150 feet at first to 400 feet in the neighborhood of Prairie du Chien. They maintain this height to above Lake Pepin, then declining again somewhat toward St. Paul."

"This wide cut or chasm of the Mississippi has a direction nearly northwest from Fulton and Lyons to St. Paul - - -. Its width just above St. Paul is about one-half mile, at Lake Pepin about five or six miles, and generally varies from one and a half to five miles down to Fulton and Lyons. These are nearly the widths of the river at its highest floods, where artificial works have not been made to contract it."

"The bottom lands of the Mississippi are now overflowed to the depth of from six to twelve feet, and are also from six to twelve feet above the low stages, the river ranging from high to low water about eighteen feet. These bottoms are generally covered with trees, such as cottonwood, elm, linn, willows, and vines of various kinds."

"The Mississippi, in its floods, covers all the bottom lands to the depth of six to twelve feet and flows through the forests - - -. When within the banks formed by the bottom lands, the river is almost entirely free from those sweeping bends and returning folds that characterize the Minnesota and lower Mississippi below the junction of the Ohio - - -. The river channel, however, does not long remain on one side of the valley before it gradually makes its way among its islands to the opposite bluff, usually forming, in crossing, places of difficult navigation at low stages. At these crossings there is a greater slope, an increased velocity and width, a diminished depth, and more changing sand bars. One of the most notable features of the Upper Mississippi is the multiplicity of the islands which everywhere exist, in all possible sizes, and the great variety of their shapes, as well as that of the lakes found in the islands and bottom lands. The extreme gentleness of the current, which at low water averages about one and a half mile an hour, and rarely exceeds three miles in the swiftest places, also attracts one's first attention - - -. Our levels show the slope to be only on the average about four-tenths to six-tenths foot per mile; sometimes, in making the crossings of the valley, reaching nearly one foot per mile for short distances, and in intervening pools being as low as three-tenths foot per mile. - - - from the Bad Axe River down to the rapids at LeClaire there is at nearly all times a draught of at least four feet, except in the two channels which, separating above Mendota, go one by that place and the other by Guttenburg, each about twelve miles long, and unite again at Cassville. The left hand channel is called Crooked Slough, and is more narrow and crooked than the other, and joins the other at its foot by several mouths. - - - the obstruction from snags have not been specially alluded to; but snags are found in limited numbers at all parts of the river, and at least one snag-boat should be constantly employed removing them and the wrecks that lie in the channel way."

General Warren's report to Congress was in regard to navigation of the Upper Mississippi River to promote settlement and development of the surrounding country. As early as the 1830's the Federal Government, aware of the upper river's important role in settlement of the valley, began improvements in the interest of navigation. The original surveys of the rapids at the mouth of the Des Moines River and at Rock Island were prepared by Lieutenant Robert E. Lee. By 1878, the first comprehensive plan of improvement, the $4\frac{1}{2}$-foot channel project was authorized by Congress. As features of that project, several of the most seriously obstructive rapids were by-passed by short lateral canals with navigation locks. In 1907 a six-foot channel project was authorized, the increased depth being obtained mainly by construction of hundreds of wing dams to constrict low water flows. In 1930, Congress authorized the nine-foot channel project including the Mississippi River from the mouth of the Missouri River to Minneapolis.

The present day Upper Mississippi River between St. Louis, Missouri and Minneapolis, Minnesota, is a stairway of water which makes navigation possible during low flow periods. In the 699 miles of river from St. Anthony Falls and the last lock of the project, No. 27, the Mississippi has a fall of about 420 feet through the 29 locks and dams.

Settlement

The Louisiana Purchase of 1803 gave the United States control over both banks of the Mississippi River. In 1805, Lieutenant Zebulon Pike, under orders from the Government, came up the river to discover its source and to select locations for United States outposts. Pike, in command of 20 soldiers, left St. Louis on August 9, 1905. On August 27, 1805, the party arrived at the mouth of the Rock River and landed on the Illinois side of the

Mississippi. Pike counciled with Chief Black Hawk at the old Sac village on the Rock River. The event was the first record of a white man's presence on Rock Island County, Illinois, soil.

The military outposts were the beginnings of permanent settlements along the Mississippi River. Fort Edwards opposite the mouth of the Des Moines River was established in 1815 just a year before Colonel William Lawrence and the Eighth Regiment of U. S. Regulars built Fort Armstrong at Rock Island. George Davenport accompanied Colonel Lawrence and was the first permanent settler in Rock Island County, Illinois.

There were no permanent settlers in Iowa at that time, nor were there until 1833. Although Julien Dubuque staked out his "Mines of Spain" in 1796, the settlement at Dubuque was not permanent. Five years after Pike explored the upper Mississippi in 1805, Dubuque died. In the years that followed, the Fox Indians reclaimed the mining settlement and drove off all white men who sought to work Dubuque's mines.

In 1823, the Virginia made the first steamboat voyage on the upper Mississippi. Navigation was extremely important to settlement of the frontier area since the settlers depended on the steamboats for both freight and passenger service.

It is not intended here to describe the history of settlement of the individual river communities in the study reach. Historical information can be found in most public libraries in the local communities.

Flood Damage Prevention Measures

Development of flood prone areas along the Mississippi River is continually taking place. As a result, numerous permanent flood protection projects have been and are continuing to be proposed and constructed to protect the developed areas from Mississippi River floods. The following paragraphs describe existing and proposed projects proceeding from the upstream end of the study reach to the downstream end.

Possible improvement of local protection of the Meredosia Levee and Drainage District from Mississippi and Rock River flooding under the authority of Section 205 of the Flood Control Act of 1948 as amended has been proposed. The proposed project includes improvement of about 1.7 miles of existing Mississippi River levee in Rock Island and Whiteside Counties, Illinois, at approximately 511 miles upstream from the mouth of the Ohio River. Also included in the proposed project are modification of existing interior drainage facilities, underseepage treatment, and road ramping. Status: Draft of the detailed project report has been approved for preparation in final form.

A private levee district, the Carroll Levee District, just upstream from Princeton, Iowa, was organized in 1905. Levees were constructed to protect approximately 750 acres of land which were periodically covered by Wapsipinicon and Mississippi River floods. Land in the drainage district was acquired by the U. S. Government as a part of the nine-foot navigation project since cost of rectification of seepage damages with the increased water levels were estimated to be greater than cost of the land. Currently, the levee and interior drainage facilities provide desired water levels for the Princeton Wildlife Area, a part of which was the old Carroll Levee District. That part of the Carroll Levee District which is located on U. S. Government land is managed under a cooperative agreement between the Department of the Army and the Department of Interior, Bureau of Sport Fisheries and Wildlife. The Bureau has in turn allocated this land to the State of Iowa for management purposes. Status: Inactive.

The Flood Control Act of September 1954 authorized construction of a project on Campbell's Island for protection from Mississippi River floods. The project provided mainly for construction of a levee around the perimeter of the island with ties to high ground at the downstream end, riprapping of levee slopes where necessary, and installation of a pumping plant and interior drainage facilities. The project plan was restudied based on criteria established by the April 1965 Mississippi River flood and was found economically unjustified. Status: Inactive.

The Flood Control Act of 1968 authorized a project at Bettendorf, Iowa. The project includes about 2.4 miles of main stem levee and about 0.6 mile of tieback levee along the right bank of Duck Creek. Improvement of about one mile of main stem levee constructed by the J. I. Case Company will be included in the project along with providing closure structures, interior drainage facilities, a ramp to boat launching facilities, and raising a city street and railroad grade. Status: Authorized, not funded.

The Flood Control Act of 1968 also authorized construction of a project at East Moline, Illinois. The proposed project includes about 2 miles of main stem levee and 0.5 mile of tieback levee. The area to be protected extends from the west city limits to a point just upstream from the intersection of First Avenue and 19th Street and includes the Ametek Company, Deere and Company, and International Harvester Company industrial developments. The project includes construction of new levees and floodwalls, improvement of existing levees and provision of railroad ramps, street raises, closure structures and interior drainage facilities. Status: Authorized, not funded.

In addition, the Flood Control Act of 1968 authorized construction of a project at Milan, Illinois, to protect the area from direct flooding from the Rock River and Mill Creek and from backwater flooding from the Mississippi River. Total length of proposed levees is about 5 miles. The project also includes interior drainage facilities along with sandbag closures at primary and secondary highway crossings. Status: Authorized, not funded.

The Flood Control Act of 1962 authorized construction of a project at Rock Island to provide local protection from the Mississippi River. The project includes a system of levees and flood walls extending for about 3.5 miles along the city waterfront and closure structures for streets and railroads. Status: Detailed planning is in progress, construction to begin in spring of Fiscal Year 1970.

Additional Mississippi River local protection projects are being studied for Davenport and Black Hawk Creek in Iowa, and Moline, Illinois. Authority for preparation of the study reports is contained in two resolutions adopted on September 18, 1944, by the Committee on Flood Control, U. S. House of Representatives. Status: Survey Report studies are in progress.

The Flood Control Act of September 1954 authorized improvement of existing agricultural levees of the Drury Drainage District to provide increased protection from Mississippi River floods. The project includes about 8 miles of main stem levee and 2 miles of tieback levee along Copperas Creek on the Illinois side of the river from a point 451 miles to 459 miles upstream from the mouth of the Ohio River. Status: Construction completed August 1963.

The Flood Control Act of September 1954 authorized construction of a project at Muscatine for the protection of an industrial section of the city on the right bank of Mad Creek. The project protects the area from flood damage chiefly caused by Mississippi River backwater in the creek. The project provided mainly for construction of a system of flood walls and levees along a part of the Muscatine river front and along the right bank of Mad Creek. An interceptor sewer and an interior drainage pumping plant were also provided. Status: Construction completed, August 1961.

Further investigation of flood protection works on Mad Creek was authorized by a resolution adopted August 15, 1961, by the Committee on Public Works of the U. S. House of Representatives. A proposed project to be authorized under Section 205 of the 1948 Flood Control Act as amended will protect the industrial area along Mad Creek from coincidental floods on Mad Creek and the Mississippi River. The proposed project includes 4,100 feet of earth levee, 100 feet of flood wall, interior drainage facilities and closure structures. Status: Draft of detailed project report has been submitted to higher authority for approval.

The Flood Control Act of September 1954 authorized improvement of existing levees of Sub-district No. 1 of Drainage Union No. 1 and Bay Island Drainage and Levee District No. 1. The two districts form a joint drainage and flood protection system. The project includes about 17 miles of main stem levee, 1½ miles of tieback levee along the left bank of Copperas Creek on the north, and about 8 miles of tieback levee along the west bank of the Eliza Creek diversion channel. The main stem levee begins at Mile 434 and ends at about Mile 451 upstream from the mouth of the Ohio River. The project provides protection to agricultural land in the district from Mississippi River floods. Status: Construction completed, December 1966.

The Flood Control Act of September 1954 authorized improvement of existing levees of the Muscatine Island Levee District and the Muscatine-Louisa County Drainage District No. 13. The two districts form a joint drainage and flood protection system. The project provides increased protection from Mississippi River floods to agricultural lands of the districts and to the downstream portion of the City of Muscatine, Iowa. The project includes about 13 miles of main stem levee with a tieback levee upstream from Michael Creek. The main stem levee begins at Mile 442 and ends at about Mile 455 upstream from the mouth of the Ohio River. Status: Construction scheduled for completion in Spring 1969.

Flood Warning and Forecasting Services

The Environmental Science Services Administration Weather Bureau, Department of Commerce, provides a general flood forecasting service for the Upper Mississippi Basin. The system involves the prediction of river stage at a particular gage or gages in the basin based on observed precipitation and flow at upstream points as well as anticipated weather conditions. The flood warnings and statements on flood conditions are transmitted to city officials as well as newspapers and radio and television stations in the basin. These sources disseminate the information to residents of the flood plain in the form of flood warnings or general advisories. Such forewarning permits industrial plants, public utilities, municipal utilities, municipal officials, and individuals with property in the lowlands to take protective measures. Services available are a combination of three types described below:

1. Flash Flood: In areas of the Mississippi Basin, procedures utilizing radar or local flash flood reporting networks are a practical means of implementing flood warnings. The WSR-57 radar facilities at Chicago and Minneapolis and the low-powered radar at Madison have effective range to cover the basin. Commercial radio and television stations have 24-hour telephone warning service from the Weather Bureau at Moline, Illinois. Radar coverage is used to provide general, but immediate, broadcast to identify areas of

intense and persistent rainfall and potential flooding.

2. <u>Major Flood Forecasts</u>: Flood forecasts prepared by the Kansas City River Forecast Center for the Mississippi River gage at LeClaire Dam 14, Davenport Dam 15, and Muscatine Dam 16, are issued through the Moline Weather Bureau Office. Forecasts are based on radar coverage, numerous rainfall reporting stations, river gages, anticipated weather conditions, and hydrologic factors. The lead time may range from a few hours with rapidly fluctuating ice conditions or locally heavey rains, to several days with normal basin rainfall pattern, and a week or more with snowmelt advisories.

3. <u>Hydroclimatic Data</u>: The basic data network in the basin above Moline, Illinois, consists of 300 stations, 100 of which automatically record precipitation intensity. Most of the data from the network is published. These records provide the basis for forecasts, as well as for the planning and design of protective works and their operation during floods.

Developments in the Flood Plain

Many structures in the Mississippi River flood plain have been damaged by past floods. Many others have been protected from damage at great cost by emergency flood fighting measures during major floods. Many additional buildings including residences, commercial, and major industrial establishments would be damaged by the Intermediate Regional and Standard Project Floods.

In 1930, Congress authorized the canalization of the upper Mississippi River to provide a nine-foot channel of adequate width for navigation by construction of a system of locks and dams supplemented by channel dredging. The dams were constructed to provide a minimum of nine feet in the navigation channel during low flow periods. During these low flow periods, the river has been changed into a series of steps or pools which river tows and other watercraft climb or descend as they travel upstream or downstream. Locks 14, 15, and 16, in the study reach, were opened to navigation on June 14, 1939, May 9, 1934, and July 11, 1937, respectively.

Provision of adequate commercial navigation depths and the stablization of river stage fluctuations by the nine-foot canalization project resulted in land use patterns oriented toward the project functions. Riverside land developments have included harbor and dock facilities for commercial and industrial utilization, small boat harbors and marinas, and recreational and residential areas.

In the reach from Muscatine downstream to the mouth of Michael Creek, the agricultural land on both sides of the river is protected by levees. Details of the levee protection are discussed under the heading, Flood Damage Prevention Measures. Additional agricultural levees include those protecting the Meredosia Levee and Drainage District across the river from Camanche, Iowa. Many other private levees have been constructed or improved since the flood of April 1965 in addition to emergency levees constructed during that flood.

Major highways parallel both banks of the river. In the study reach, some of these highways are subject to inundation from floods of the magnitude of the April 1965 flood and of the Intermediate Regional and Standard Project Floods. The following highways were inundated during the April 1965 flood: Illinois 84 near Albany; U. S. 67 at the mouth of the Wapsipinicon River and just upstream from LeClaire, Iowa; U. S. 67 in Bettendorf and Davenport, Iowa; U. S. 61 in Davenport, Iowa; Illinois 84 in East Moline, Illinois; Illinois 92 downstream from Big Island; Iowa 22 at several locations at and near Buffalo, Fairport, and Muscatine, Iowa; Illinois 92 downstream from Andalusia, Illinois; and Iowa 92 and U. S. 61 at Muscatine, Iowa.

Permanent homes and summer residences occupy the river banks in the study reach and most are damaged during major floods. Residential developments most vulnerable to flood damages include those on Campbell's Island, the low lying area of East Moline and Moline upstream from the U. S. Highway 6 dual bridges, Garden Addition in west Davenport, Big Island near the mouth of the Rock River, Buffalo, Iowa, and Andalusia, Illinois.

Plates 4 and 5 are index maps of the four sheets showing the flooded areas of the Mississippi River in the study reach. The aerial photos used to make up the index map were taken on April 27, 1965 and show the approximate limits of flooding during the April 1965 flood. The crest flow for this flood occurred on April 28, 1965, in the Quad City area. However, the lateral extent of flood water was very little different from that on April 27, 1965. Plates 6 through 9 show the flooded area covered by this report.

Bridges and Dams Across the River

Six bridges span the Mississippi River main channel in the study reach. Of the six bridges, one is a railroad bridge, one is a combination railroad and road bridge, and four are road bridges. Two of the road bridges are dual bridges. Table 3 lists, locates, and describes the bridges across the Mississippi River in the study reach and shows the relation of low steel elevations to the April 1965 flood and Intermediate Regional Flood Crest elevations.

The Davenport, Rock Island and Northwestern Railroad bridge at Mile 481.4 is a low level bridge and requires a swing span opening to accommodate river navigation. The combination bridge at Mile 482.9 was built by the U. S. Government in 1899 with a low level road crossing and a high level crossing of the Chicago, Rock Island and Pacific Railroad. This low level bridge also requires swing span opening to accommodate river navigation. The U. S.

TABLE 3

BRIDGES ACROSS MISSISSIPPI RIVER

Miles Above Ohio River	Identification	Type	Number of Spans and Total Length in Feet	Intermediate Regional Flood Crest Elev. Feet	Minimum Clearance of Channel Span: Low Steel Elev. Feet	Minimum Clearance of Channel Span: Above Intermediate Regional Flood Feet	Minimum Clearance of Channel Span: Above 1965 Flood Feet
455.5	Muscatine Highway Bridge	Steel Truss, Fixed	3 Viaduct Spans - 158; 10 River Spans - 2203; 19 Approach Spans - 380	560.0	603.6	43.6	47.3
481.4	D,RI,&NW RR	Steel Truss, Swing	9 River Spans - 2310	566.8	572.0	5.2	7.5
482.1	Rock Island Centennial Hwy Bridge	Tied Arch, Fixed	24 Viaduct Spans - 1586; 5 River Spans - 2262; 3 Approach Spans - 144	567.0	611.0	44.0	46.2
482.9	U. S. Government RR & Hwy Bridge (Main Channel)	Steel Truss, Swing	2 Approach Spans - 292; 7 River Spans - 1548	568.1	570.4	2.3	4.5
485.8	Moline-Bettendorf Hwy Bridge	Dual, Suspension, Fixed	32 Approach Spans - 1780; 12 River Spans - 3304	571.6	629.6	58.0	60.1
495.4	Interstate 80	Dual, Continuous Steel Girder	12 Approach Spans - 754; 16 River Spans - 2691	580.4	632.0	51.6	53.4

Highway 6 bridge at Mile 485.8 and the Interstate 80 bridge at Mile 495.4 are dual suspension and dual continuous steel girder bridges, respectively.

Three navigation dams span the Mississippi River in the study reach. Lock and Dam No. 14 crosses near LeClaire, Iowa, at Mile 493.3. The dam is 2,700 feet long with a 1,343-foot movable gate section made up of 4 roller and 13 tainter gates. Lock and Dam No. 15 crosses just downstream from the U. S. Government bridge at Mile 482.9. The dam is 1,203 feet long with 11 roller gates making up the total length. Lock and Dam No. 16 crosses near Muscatine, Iowa, at Mile 457.2. Total length is 3,940 feet with about 1,100 feet of movable gates made up of 4 roller and 15 tainter gates. This dam has 1,700 feet of concrete spillway and 726 feet of overflow earth dam.

In addition to the main channel bridges and dams, several bridges and dams span the slough areas. At Campbell's Island, an access road bridge spans the slough at Mile 490.3. The approaches to this bridge as well as a major portion of the island were inundated during the April 1965 flood. At Arsenal Island, two road bridges, one railroad bridge and a dam span Sylvan Slough. Access to the island is from 24th Street in Rock Island, and 16th Street in Moline. In addition, the Chicago, Rock Island and Pacific Railroad bridge crosses Sylvan Slough just upstream from the 24th Street bridge into Rock Island. The Rock Island Arsenal dam crosses Sylvan Slough near the foot of Sylvan Island. The Moline Water Power dam is constructed across the bypass channel between Moline and Sylvan Island. Figures 1 through 16 show the bridges and dams across the main channel of the Mississippi River in the study reach and the Mad Creek bridges at Muscatine.

Obstructions to Flood Flow

The high water profiles of Plates 10 through 13 indicate the effect of bridges and dams on flood flows. The bridges and dams are not serious obstructions to flood flows. However, increased flood crest elevations could result from reduction of effective flow area by localized ice jams at bridges and dams.

Natural channel restrictions are conducive to the formation of ice jams. The February 1966 ice jam flood at Davenport and Rock Island is an instance of an ice jam occurring at a natural channel restriction. The February 1966 ice jam flood is discussed further under the heading, Flood Descriptions.

Although wind effect is not necessarily an obstruction to flood flow, the result is nearly the same. Wind forces acting on the water surface may cause localized increases in water surface elevations depending on wind direction, wind velocity and duration, orientation of wind direction with open water, and the length of open water exposed to wind forces. During a wind storm on November 11, 1940, maximum velocities reached 40 to 50 miles per hour and averaged more than 20 miles per hour for a 20-hour period. Wind direction varied from south to west. Observations were made of wind effect on the navigation pools above Locks and Dams 14, 18, and 19. The maximum observed wind effect in the upper end of the pools was 1.8 feet with a maximum decrease in pool elevation near the dams of 2.5 feet. River traffic was forced to tie up along the bank for a period of 12 to 24 hours as waves were reported 10 to 15 feet high.

The navigation dams are constructed and operated so that they have no more effect on flood crest elevations than a multi-span railroad or highway bridge. The dams have movable gates with concrete gate sills on the bed of the river. During low flow periods, the movable gates are in the water with small openings between the bottom of the gate and the gate sill on the river bed. Gate openings may be adjusted several times every day at each of the navigation dams to allow as much water to pass out of each pool at the lower end as is coming in at the upstream end to maintain flat pool elevation at the dams. Plate 15 illustrates the operation of the navigation dams during flood flows.

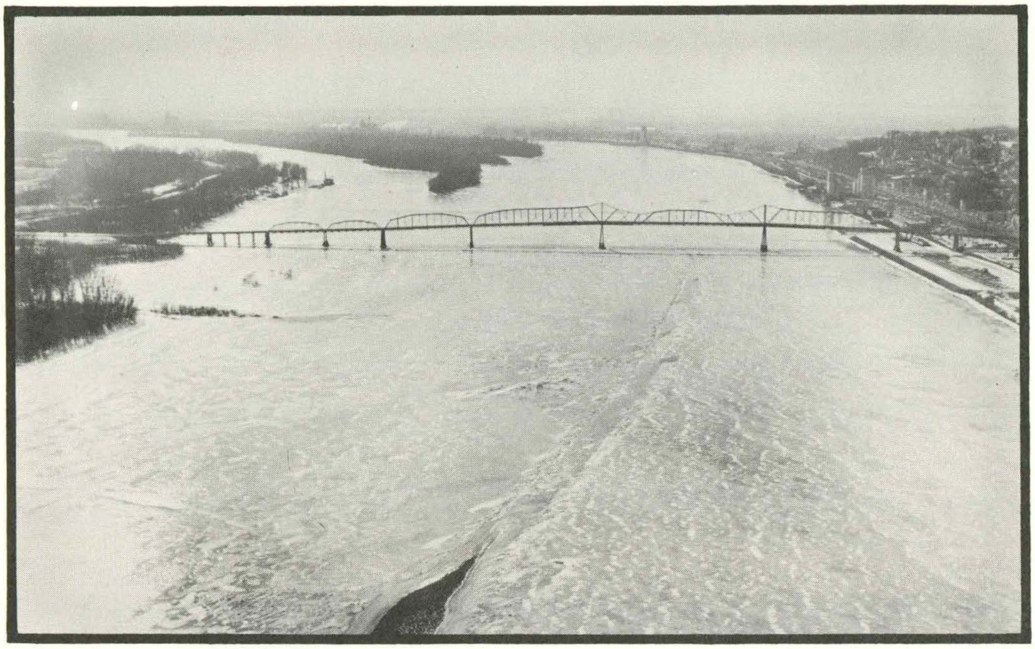


Figure 1. Looking downstream at the Highway 92 bridge at Muscatine, Iowa, Mile 455.5.

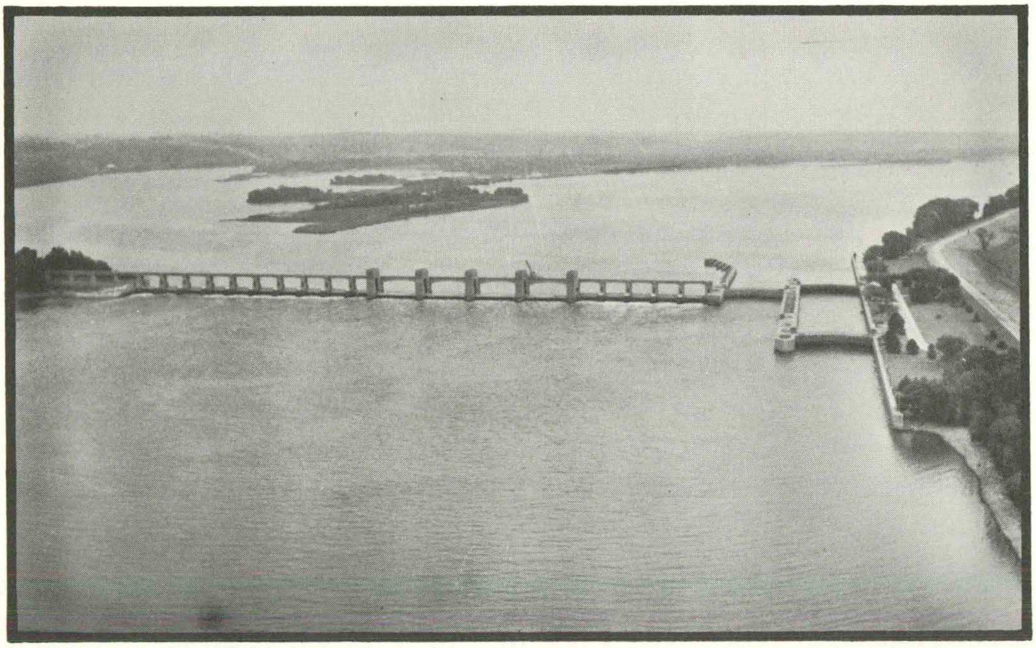


Figure 2. Looking upstream at Lock and Dam No. 16 near Muscatine, Iowa, Mile 457.2.

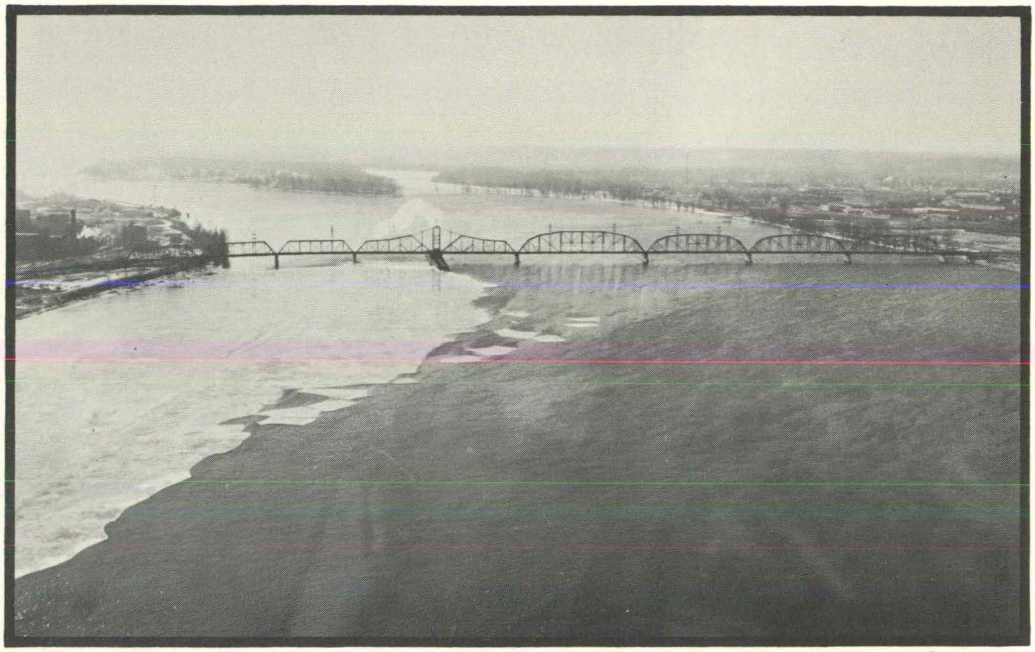


Figure 3. Looking downstream at the Davenport, Rock Island and Northwestern Railway bridge at Davenport, Iowa, Mile 481.4.

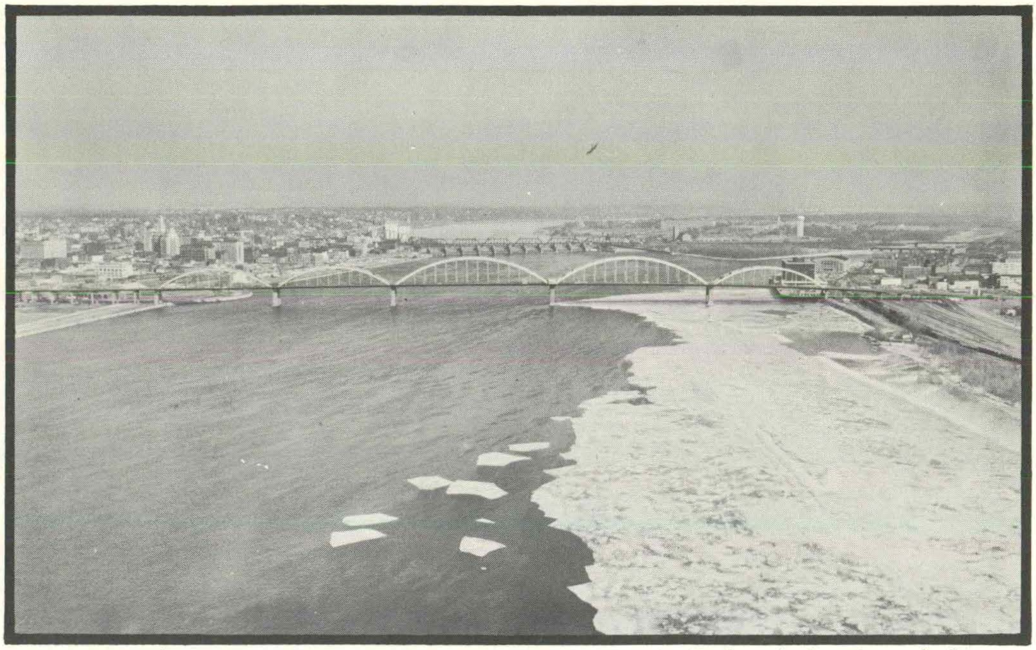


Figure 4. Looking upstream at the Rock Island Centennial bridge, Mile 482.1.

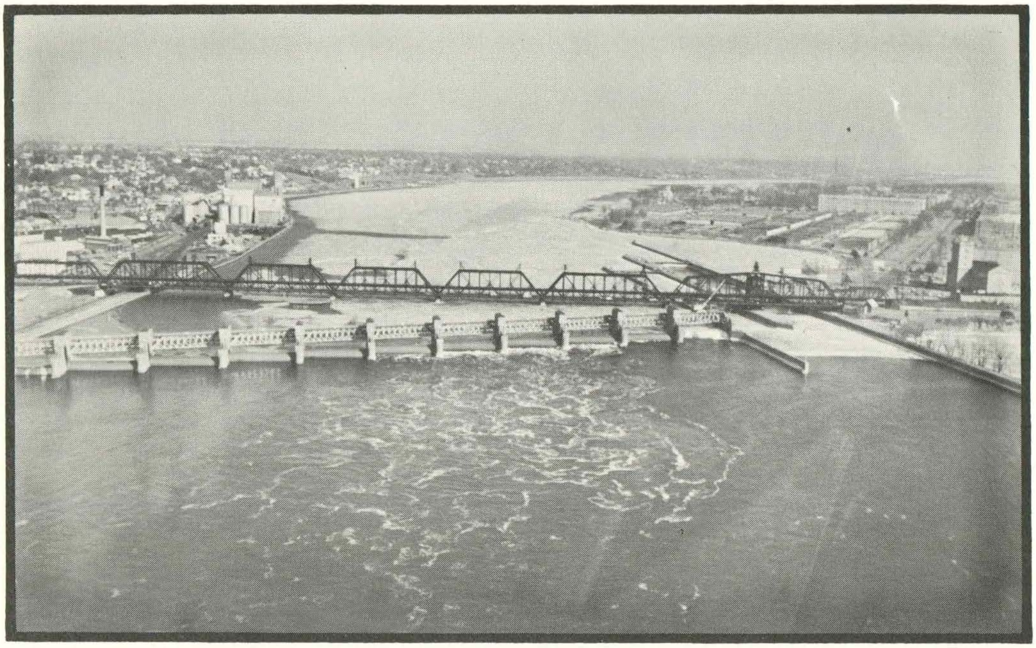


Figure 5. Looking upstream at Lock and Dam No. 15 and the Government bridge at Davenport, Iowa, Mile 482.9.

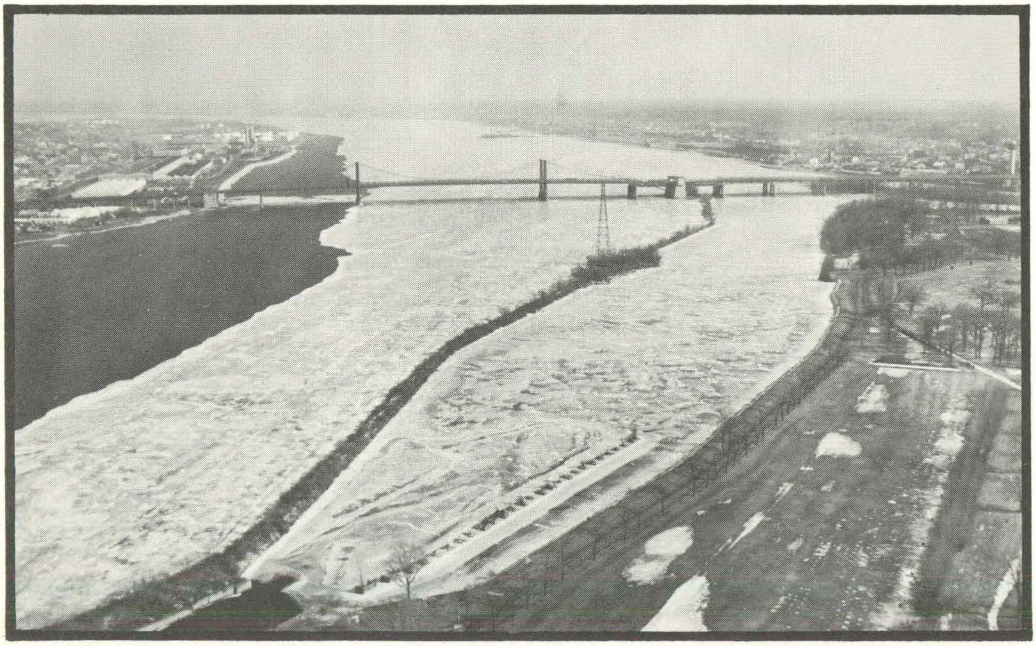


Figure 6. Looking upstream at the Iowa-Illinois Memorial bridge (Highway 6), Mile 485.8.

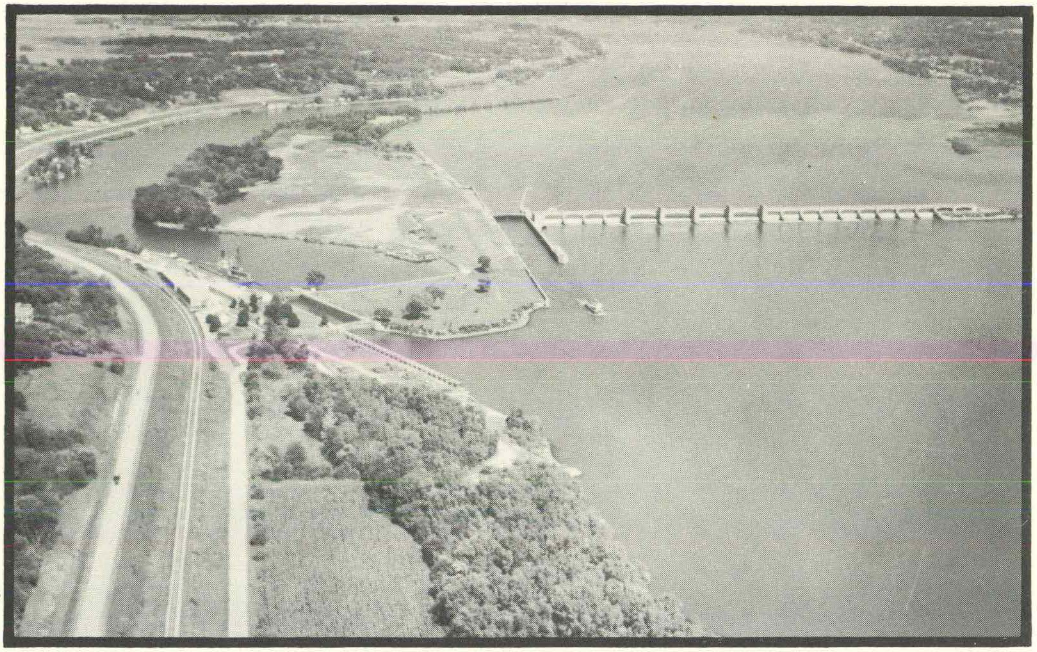


Figure 7. Looking upstream at Lock and Dam No. 14 near LeClaire, Iowa, Mile 493.3.

Figure 8. Looking upstream at the Interstate 80 dual bridges, Miles 495.4.

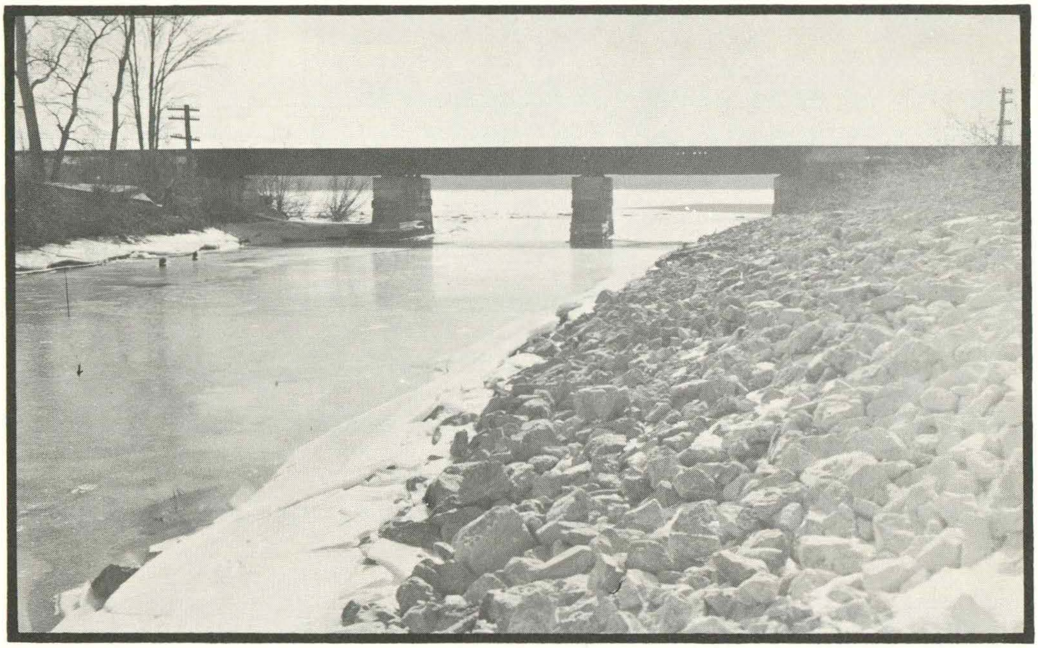


Figure 9. Looking downstream at the Chicago, Rock Island and Pacific Railroad bridge over Mad Creek at Muscatine, Iowa, Sta. 11+00.

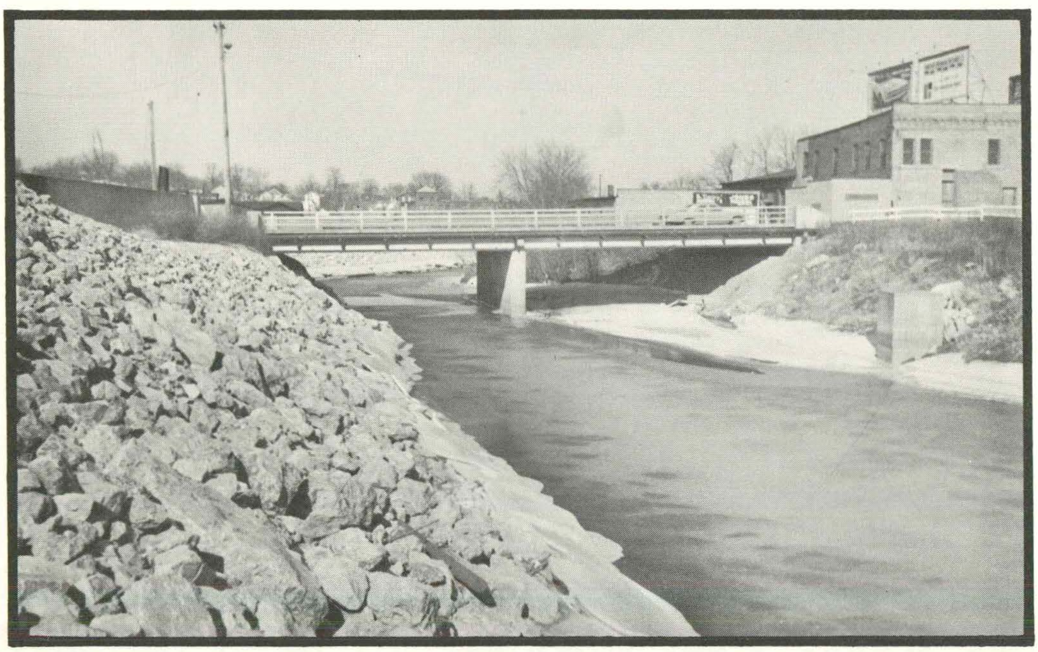


Figure 10. Looking upstream at the Second Street bridge over Mad Creek at Muscatine, Iowa, Sta. 16+00.

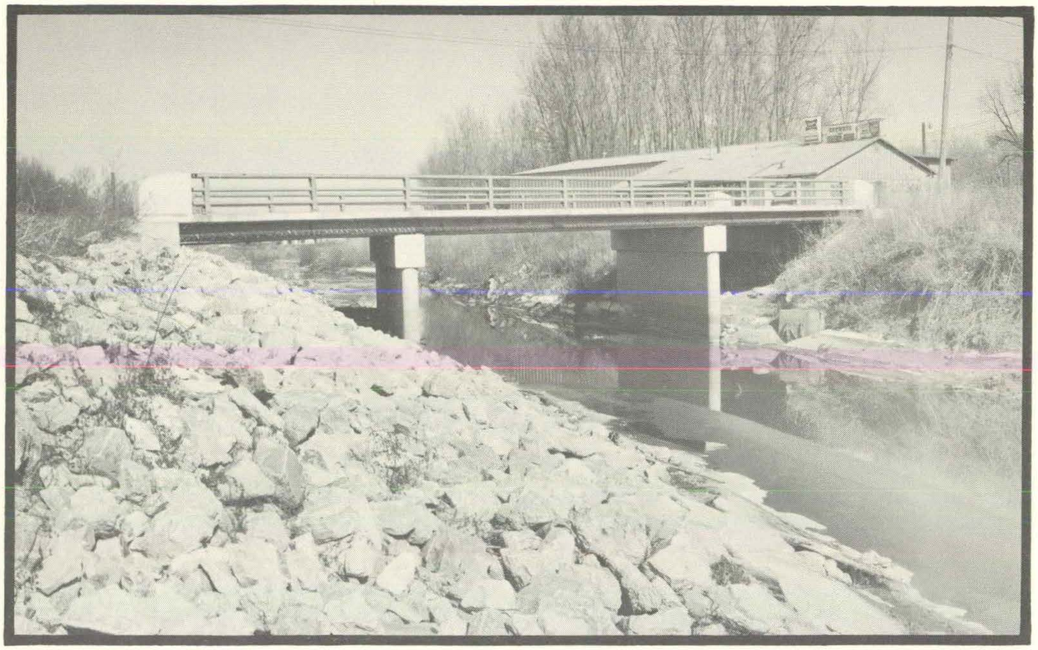


Figure 11. Looking upstream at Fifth Street bridge over Mad Creek at Muscatine, Iowa, Sta. 31+00.

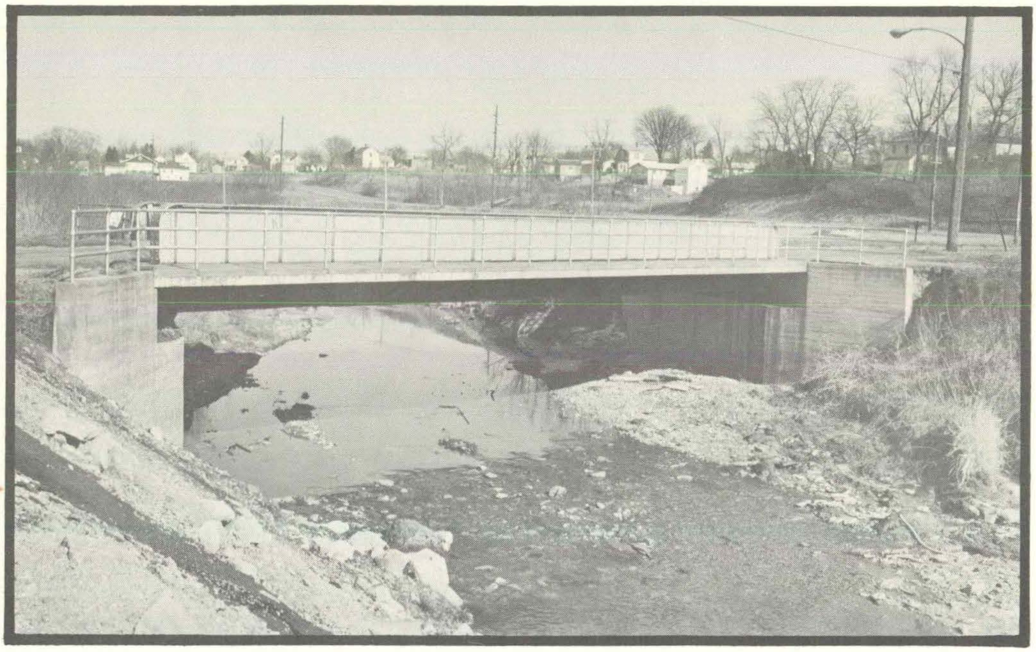


Figure 12. Looking upstream at Ninth Street bridge over Mad Creek at Muscatine, Iowa, Sta. 46+50.

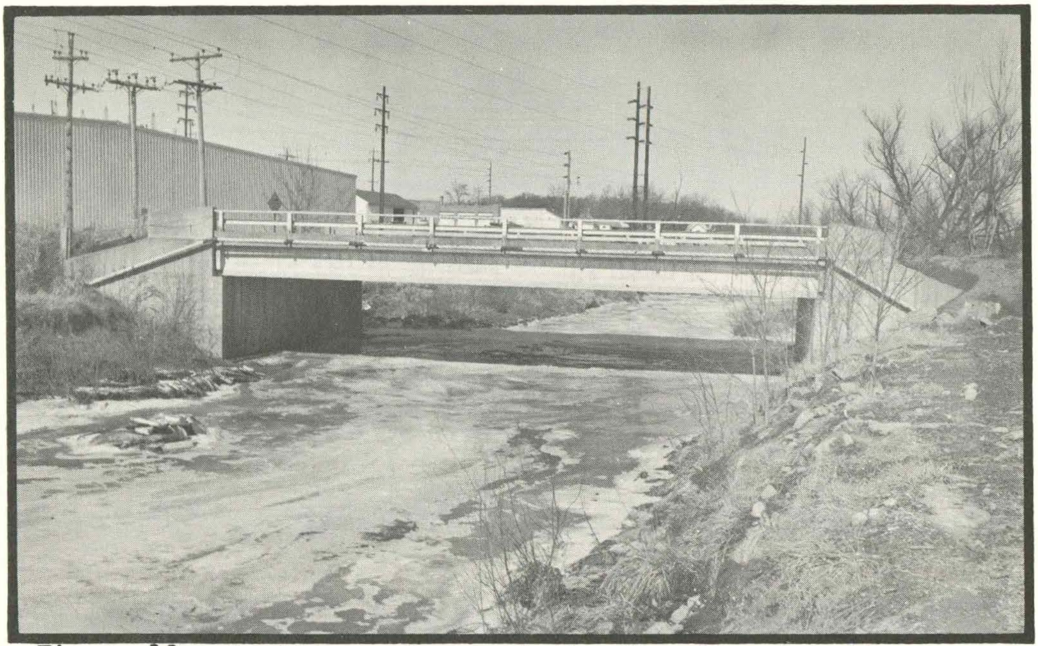


Figure 13. Looking upstream at the Clay Street bridge over Mad Creek at Muscatine, Iowa, Sta. 75+00.

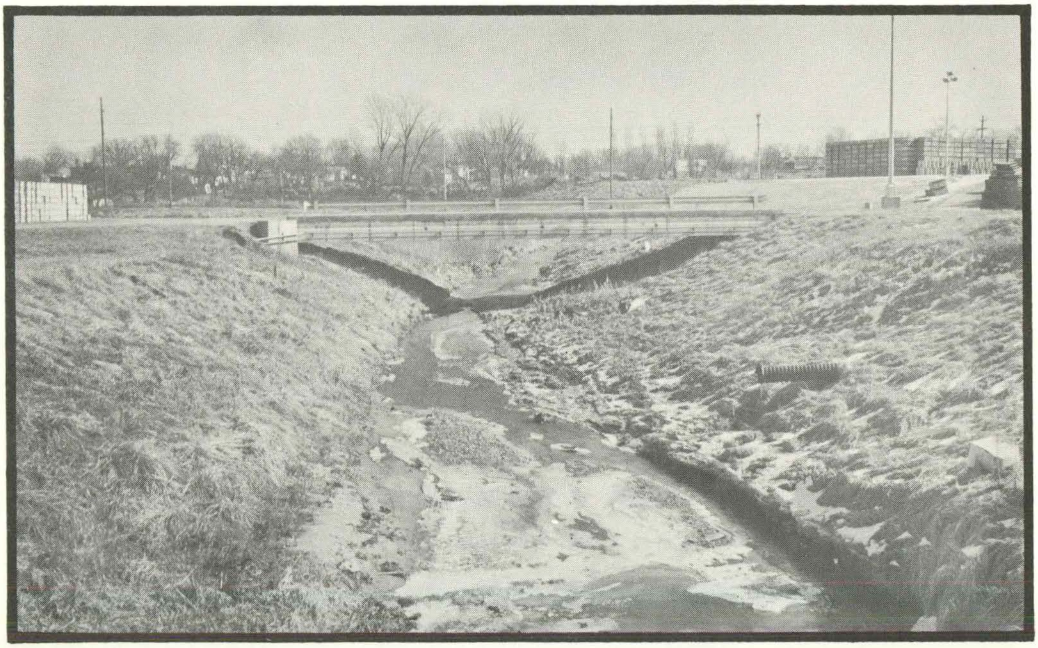


Figure 14. Service road bridge at the H. J. Heinz Company plant, looking downstream, Muscatine, Iowa.

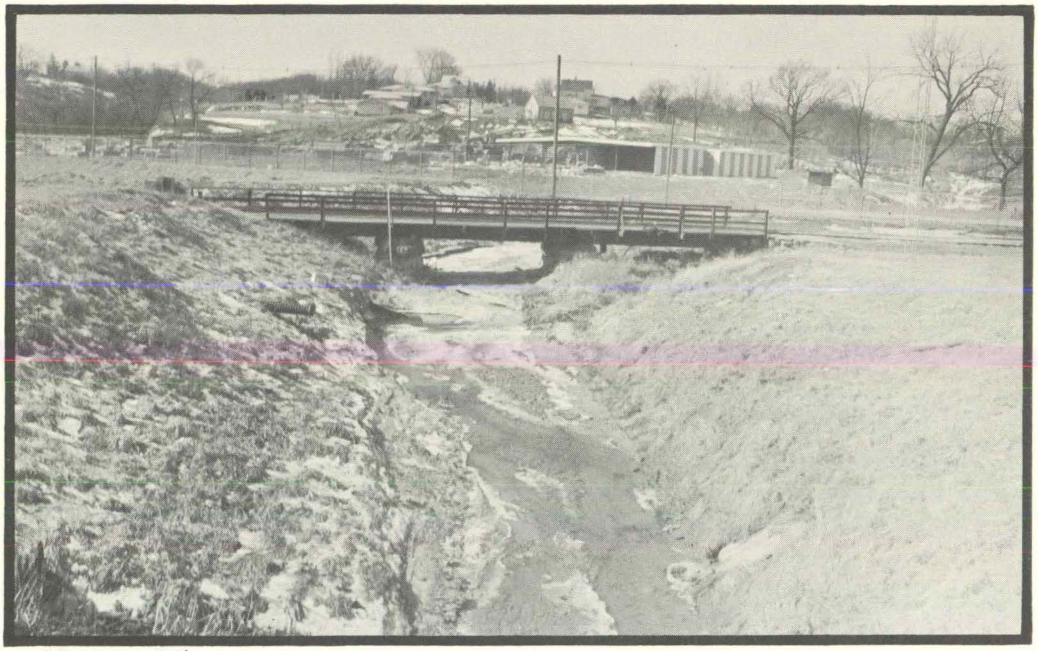


Figure 15. Railroad bridge at H. J. Heinz Company compound, looking downstream, Muscatine, Iowa.

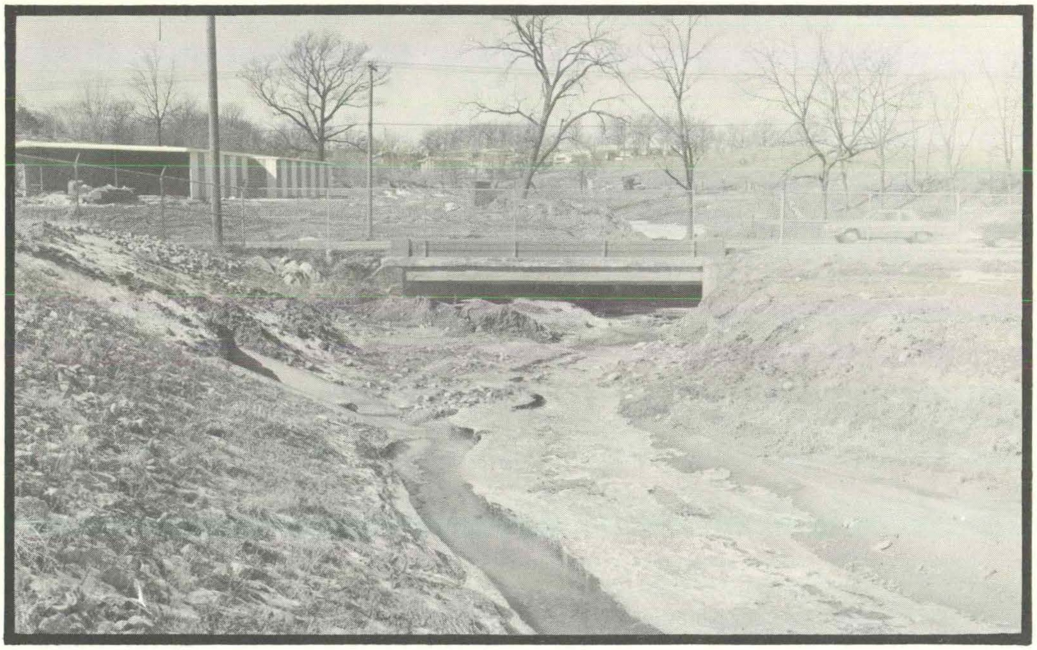


Figure 16. Looking upstream at the Isett Avenue bridge over Mad Creek at Muscatine, Iowa.

FLOOD SITUATION

Flood Records

Records of Mississippi River stages have been maintained for several locations in the study reach. Table 4 lists and describes the gages and the records available.

To supplement the gaging records, newspaper files and historical documents and records were searched. Through these investigations, a knowledge of Mississippi River floods has been developed.

Flood Stages and Discharges

Tables 5A, 5B, and 5C list crest stages above flood stage and corresponding discharges (where available) for the gages at Clinton, Iowa, tailwater of Dam 15 at Davenport, and Muscatine, Iowa, respectively. Table 6 lists the ten greatest known floods in order of flow magnitude at the Clinton gage.

Flood Occurrences

Plate 2 shows crest stages and dates of known floods exceeding flood stage of 16.0 feet at the Clinton gage.

Duration and Rate of Rise

Plate 3A shows the recorded stage hydrographs for the floods of April 1952, 1965, and 1967 at the Clinton gage. Plate 3B shows the recorded stage hydrograph for the February 1966 ice jam flood at the tailwater gage at Lock and Dam 15. The estimated stage hydrograph without ice effect is also shown on Plate 3B. During the April 1965 flood the river rose to crest stage in 30 days and remained above flood stage of 16.0 feet at the Clinton gage for 29 days.

Velocities

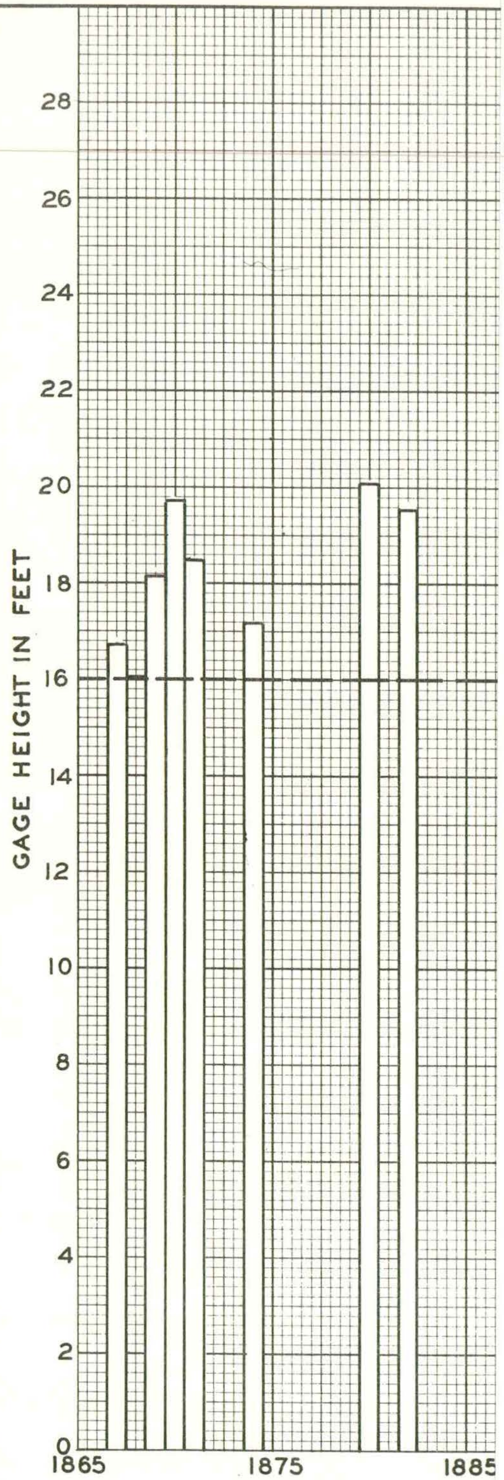
Plate 14 shows the channel cross section and measured flow velocities at the Centennial Bridge at Rock Island, Illinois, during the flood crest flow of April 28, 1965. Note the higher velocities near bridge piers and the negative velocities near the left end of the bridge. The negative velocities were measured as a result of eddy currents downstream from the lateral flood wall protecting the Modern Woodmen of America building in Rock Island.

Flooded Areas, Flood Profiles, and Cross Sections

Plates 6 through 9 show the approximate areas along the Mississippi River that would be inundated by the Intermediate Regional and Standard Project Floods under assumed conditions discussed under the heading, Areas Flooded and Heights of Flooding. The contour interval, scale of the maps and changes in topography do not permit precise plotting of flooded area boundaries. Therefore, the actual limits of these overflow areas on the ground may vary from those shown on the maps. For specific locations, the water surface elevations for the Intermediate Regional and Standard Project Floods should be taken from the profiles of Plates 10 through 13.

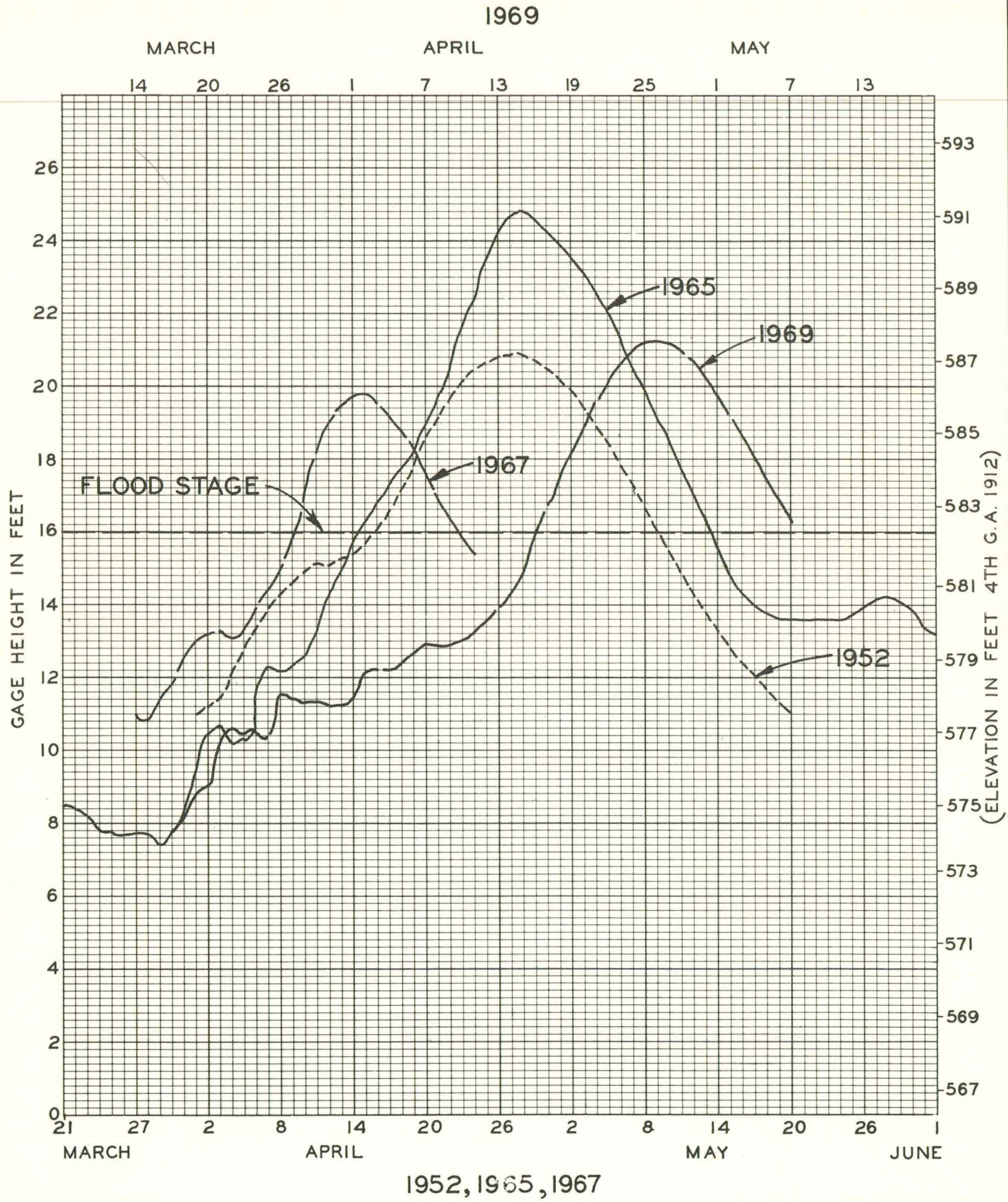
The index sheets on Plates 4 and 5 are made up of aerial photos taken on April 27, 1965. These photos show the approximate area inundated by the crest flow which occurred on April 28, 1965.

Plate 14 shows a measured cross section at the Rock Island Centennial Bridge. The elevation of the Standard Project and Intermediate Regional Floods are indicated on this Plate.



STREAM GAGE AT RIVER MIL

VARIATION IN SHADING ON
INDICATES MORE THAN ONE
THE YEAR. FOR EXAMPLE,
WERE 2 FLOODS; GAGE HEI
AND 18.50 FEET.

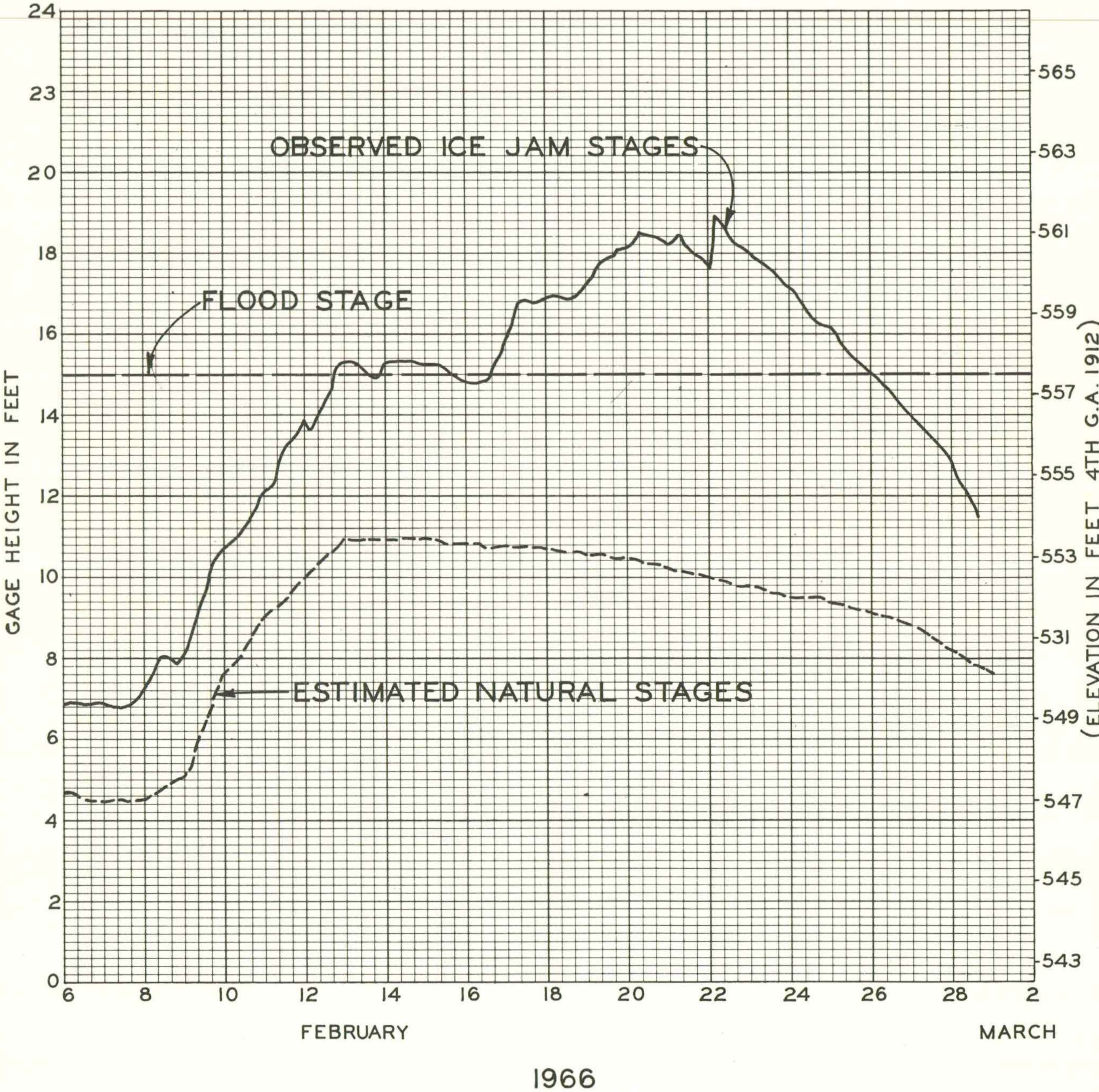


WEATHER BUREAU STREAM GAGE
AT RIVER MILE 518.0

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

STAGE HYDROGRAPH

MISSISSIPPI RIVER
CLINTON, IOWA
JUNE 1969



U.S. ARMY CORPS OF ENGINEERS
GAGE AT MILE 482.9

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

STAGE HYDROGRAPH

MISSISSIPPI RIVER
TAILWATER, LOCK AND DAM 15
JUNE 1969

TABLE 4

MISSISSIPPI RIVER GAGES

Gage	Miles Above Ohio River	Gage Location	Gage Type	Gage Zero Elevation 4th G.A., 1912	Flood Stage (Feet)	Records Available
Clinton, Iowa (C of E)	517.9	5 feet downstream from pivot pier of the C&NW Rwy Bridge	Wire-weight and staff gage	566.29	16.0	March 1888 - Date
Camanche, Iowa (C of E -) (U.S.G.S.)	511.8			563.21	17.0	May 1939 - Date
Princeton, Iowa (C of E)	502.1	Right bank, 2200 feet downstream from main business district, 89 feet riverward from Front Street	Inclined & vertical staff	563.56	13.0	Daily stages from 4 August 1930 to present
LeClaire, Iowa (U.S.G.S.)	497.0	Right bank, foot of Dodge Street	Water-stage recorder	563.18	12.0	January 1878 - Date
Dam 14, Pool (C of E)	493.4		Water-stage recorder	557.08	-	May 1939 - Date
Dam 14, Tailwater (C of E)	493.2		Water-stage recorder	557.08	12.0	May 1939 - Date
48th Street, Moline, Illinois (C of E)	487.9	Left bank, 420 feet downstream from 48th Street in Moline	Vertical staff	551.54	13.5	Daily stages from 1 January 1928 to present Present gage replaced original gage on 24 October 1938
Dam 15, Pool (C of E)	482.9		Water-stage recorder	542.50	-	March 1934 - Date
Dam 15, Tailwater (C of E)	482.9		Water-stage recorder	542.50	15.0	January 1878 - Date
Lock 32, I & M Canal (C of E)	479.1	Left bank Mississippi River at confluence with Rock River	Vertical staff	534.05	17.0	January 1896 - Date
Montpelier, Iowa (C of E)	467.5	Right bank, attached to river wall at powerhouse of Eastern Iowa Power & Light Company Plant at Montpelier	Vertical staff	540.00	-	January 1963 - Date
Fairport, Iowa (C of E)	463.5	Right bank at U. S. Bureau of Fisheries property	Staff	535.16	14.0	November 1912 - Date
Dam 16, Pool (C of E)	457.3		Water-stage recorder	533.60	-	June 1936 - Date
Dam 16, Tailwater (C of E)	457.1		Water-stage recorder	533.60	-	December 1935 - Date
Muscatine (ESSA)	455.3	Right bank at foot of Sycamore Street, in pumping station building	Wire-weight gage	531.71	16.0	January 1878 - Date

TABLE 5A

FLOOD CREST ELEVATIONS ABOVE FLOOD STAGE (16 FEET)

MISSISSIPPI RIVER AT CLINTON, IOWA

1785 - 1969

The table includes stages and mean daily discharges above flood stage of 16.00 feet at the Corps of Engineers stream gage, 5 feet downstream from the pivot pier of the Chicago and Northwestern Railroad bridge in Clinton, Iowa, at Mile 518.0 upstream from the Ohio River. Annual maximum stages were taken from flood marks prior to 1865 and from staff gage readings since 1865. Gage datum = 566.63 feet prior to May 1, 1909, and 566.29 feet since May 2, 1909, adjustment of 1912. The drainage area is approximately 85,600 square miles.

Date of Crest	Gage Heights Stage feet	Gage Heights Elevation feet	Discharge cfs
1785	20.50	-	-
1828	23.40	-	-
1837	23.10	-	-
1844	20.70	-	-
1851	20.00	-	-
1858	21.10	-	-
May 16, 1859	18.80	-	-
1867	16.78	583.41	-
1868	16.08	582.71	-
1869	18.18	584.81	-
April 27, 1870	19.73	586.36	-
April 15, 1871	18.50	585.13	-
March 17, 1874	17.20	583.83	98,400

TABLE 5A (continued)

Date of Crest	Gage Stage feet	Heights Elevation feet	Discharge cfs
June 25, 1880	21.00	587.63	250,000
October 26-27, 1881	19.50	586.13	237,000
May 14-16, 1888	20.50	587.13	248,000
June 26, 1892	20.00	586.63	238,000
April 17-18, 1897	16.80	583.43	198,000
May 5, 1916	18.00	584.29	195,000
April 9, 1920	19.00	585.29	222,000
April 23, 1922	18.90	585.19	212,000
September 23, 1938	18.30	584.59	167,400
June 13, 1942	17.80	584.09	169,600
April 17, 1943	16.80	583.09	-
June 30, 1943	17.10	583.39	158,700
May 26-27, 1944	16.20	582.49	-
June 28, 1944	18.50	584.79	168,500
March 31, 1945	17.60	583.89	164,400
March 28, 1946	16.60	582.89	144,800
April 26, 1951	20.70	586.99	221,500
April 27, 1952	20.92	587.21	225,400
May 14, 1954	18.20	584.49	175,900
May 18, 1960	16.30	582.59	151,000
April 27, 1965	24.85	591.14	307,000
April 14-15, 1967	19.80	586.09	207,000
April 25, 1969	21.18 1/	587.47	226,000 1/

1/ Preliminary, subject to revision.

TABLE 5B

FLOOD CREST ELEVATIONS ABOVE FLOOD STAGE (15 FEET)

MISSISSIPPI RIVER AT DAVENPORT, IOWA

1860 - 1969

Date of Crest	Gage Stage feet	Heights Elevation feet
May 4-7, 1862	15.20	558.30
May 4, 1866	15.70	558.20
March 10, 1868	22.00*	564.50
April 25, 1870	16.80	559.30
March 9, 1874	15.60	558.10
June 26, 1880	18.40	560.90
April 12, 1881	16.30	558.80
October 27, 1881	17.70	560.20
May 16, 1888	18.60	561.10
June 27, 1892	19.40	561.90
March 13, 1893	15.10	557.60
April 17, 1897	15.10	557.60
May 5, 1916	15.90	558.40
April 9, 1920	17.10	559.60
April 23, 1922	17.10	559.60
September 24, 1938	15.80	558.30
June 14-15, 1942	15.20	557.70
June 29, 1944	16.40	558.90
April 28-29, 1951	18.30	560.80
April 28, 1952	18.63	561.13
May 15, 1954	15.54	558.04
April 3, 1960	15.30	557.80

TABLE 5B (continued)

Date of Crest	Gage Stage feet	Heights Elevation feet
April 28, 1965	22.48	564.98
February 21, 1966	18.30 *	560.80
April 15, 1967	17.40	559.90
April 26-27, 1969	19.20	561.70 1/

* Ice gorge effect.

1/ Preliminary, subject to revision.

TABLE 5C

FLOOD CREST ELEVATIONS ABOVE FLOOD STAGE (16 FEET)

MISSISSIPPI RIVER AT MUSCATINE, IOWA

1878 - 1969

Date of Crest	Gage Stage feet	Heights Elevation feet
June 26-27, 1880	16.90	548.37
October 29, 1881	16.80	548.27
May 16-17, 1888	16.90	548.37
June 28, 1892	17.60	549.07
May 7-8, 1916	17.00	548.47
April 9, 1920	18.00	549.47
April 24, 1922	19.50	550.97
April 21, 1929	17.00	548.47
September 24, 1938	18.50	549.97
June 15, 1942	17.50	549.07
April 17-18, 1943	16.20	547.67
May 27, 1944	17.00	548.47
June 30, 1944	18.90	550.37
April 1-2, 1945	17.20	548.67
March 28-30, 1946	16.80	548.27
March 22, 1948	16.60	548.07
April 29, 1951	21.00	552.47
July 13, 1951	16.30	547.77
April 28, 1952	21. 05	552.52
May 16, 1954	17.50	548.97
April 3-4, 1960	18.30	549.77
May 20, 1960	17.40	548.87

TABLE 5C (continued)

Date of Crest	Gage Stage feet	Heights Elevation feet
April 4, 1961	16.50	547.97
April 6-8, 1962	16.60	548.07
April 29, 1965	24.81	556.28
April 16, 1967	19.40	550.87
April 26, 1969	21.20	552.67 1/

1/ Preliminary, subject to revision.

TABLE 6

HIGHEST TEN KNOWN FLOODS IN ORDER OF FLOW MAGNITUDE

MISSISSIPPI RIVER AT CLINTON, IOWA, MILE 518.0

Order No.	Date of Crest	Gage Heights Stage feet	Gage Heights Elevation feet	Estimated Peak Discharge cfs
1	April 27, 1965	24.85	591.14	307000
2	June 25, 1880	21.00	587.63	250000
3	May 14-16, 1888	20.50	587.13	248000
4	June 26, 1892	20.00	586.63	238000
5	October 26-27, 1881	19.50	586.13	237000
6	April 25, 1969	21.18	587.47	226000 1/
7	April 27, 1952	20.92	587.21	225400
8	April 9, 1920	19.00	585.29	222000
9	April 26, 1951	20.70	586.99	221500
10	April 23, 1922	18.90	585.19	212000

1/ Preliminary, subject to revision

FLOOD DESCRIPTIONS

Descriptions of large Mississippi River floods that have occurred are based on newspaper accounts and historical records. The following descriptions of historical floods through the great flood of 1892 were taken from "Mississippi River Floods" by William J. Petersen, Ph.D., in The Palimpsest, Volume 46, Number 7, issued in July 1965, by the State Historical Society of Iowa.

Flood of June 1828

The military posts along the Upper Mississippi River recorded destructive floods before permanent settlement of the area began. "The first Fort Crawford at Prairie du Chien was continually plagued with spring freshets that frequently flooded the barracks to a depth of three or four feet for several days in succession and were invariably followed by bilious diseases," according to Dr. Petersen. "In 1828, for example, the June flood made Prairie du Chien an island over which steam boats could pass in any direction. Fences were swept away, the fort was for a time abandoned and many inhabitants of the village were compelled to retreat across the slough to the higher part of the Prairie or to seek safety in boats, on rafts, or in the lofts of houses. - - - Although reference is made to the great flood of 1828, it should be remembered that actual measurements could not be made in land uninhabited by the white man. Doubt must therefore be placed on the accuracy of the year 1828 as a measuring rod for floods that follow."

Flood of 1844

"There can be no doubt about the flood of 1844. The Davenport Gazette that year noted that the Mississippi had been rising for 10 or 12 days until now it is higher than it has been since 1828.

The editor estimated the river was at least a mile and a quarter wide in front of Davenport."

Flood of 1851

"The Upper Mississippi and all its tributaries were out of their banks in the great flood of 1851. The flood was probably worse than actually recorded in the Iowa press of that period. Newspaper editors were fearful of discouraging prospective immigrants from settling in their communities because of the possible danger of floods. On June 5, 1851, the Davenport Gazette declared that flood damage had been terrible elsewhere but grudgingly admitted that the only trouble Davenport has had was a little water, never more than 12 inches, in some stores on Front Street."

"The Burlington Hawk-Eye of April 13, 1851, noted that the Mississippi was over its banks on the Illinois side and that because of recent storms, it could be expected to go higher."

"On May 29 the editor of the Hawk-Eye, in observing that the Mississippi was out of its banks in Illinois, commented that the water was higher than it had been for many years. The Des Moines, Skunk, and Iowa rivers were also swollen to many feet beyond their depth, causing large quantities of cordwood and many fences to be swept away."

"On June 5, 1851, the Hawk-Eye declared the Mississippi was higher than it had been in 1844 and threatened to go as high as in 1828, which was six feet higher than in 1844 and was the highest recorded. Davenport had suffered 'a great deal of damage' while farmlands along both sides of the Mississippi were expected to be covered by four feet of sandy silt when the river receded. There was so much lumber, logs, and other debris floating in the river as to endanger steamboat navigation. Fortunately, the editor assured his readers, 'Burlington has a locality which exempts her to a large extent from sharing in this calamity.'"

"The flood of 1851 was memorable to many Iowa pioneers not only because of the havoc created by the Mississippi but also because of the damage by Iowa streams which had overflown their banks, thus combining to increase the already heavy streamflow of the Father or Waters as it journeyed south along the eastern border of Iowa."

Flood of 1870

"The flood 1870 was devastating below Dubuque. The Davenport Daily Democrat of April 18 noted that the river was rising 'very fast at this point, having raised 12 inches in the last 24 hours' Two days later it quoted the Rock Island Argus as follows:

'Never in the memory of the earliest resident have we been visited by such a high stage of water on the Mississippi at this point. The lowest water known here was in the year 1864, from which hydrographic calculations are made as from zero. The highest water mark known is that of 1862, when the water reached the height of 15 feet and eight inches above zero or low water mark.'"

"On April 21 Thomas Winkless, who had kept a measurement of the Mississippi at various stages, informed the Democrat that the 1870 flood was eight inches above the high water mark of 1859. The next day the same editor revealed that nearly every cellar on the levee was flooded and factories and mills were shut down with at least one foot of water on the floor. Gazing over the vast expanse, the editor declared, 'the water has full sway from the bridge to the slaughter house, three miles away on Front Street.'"

"The next day, on April 23, the Daily Democrat quoted old settlers as saying the river was higher than it had been since 1828. Front Street was full of water to the curbstone, and factories and warehouses near the river were islands, while the ferry dock 'looms up somewhere out at sea.'"

"Upstream from Davenport word from the Clinton-Fulton area indicated that all the bottom land for miles about was overflowed, rail traffic had been interrupted, and many had been forced to abandon their homes. Downstream the same destructive forces were at work. The flood of 1870 was truly a memorable one for residents of Iowa and the Upper Mississippi Valley."

Flood of 1880

"The flood of 1880 occurred in June, a decade after the flood of 1870. The Dubuque Daily Times of June 16 noted that the Mississippi had risen more than two feet in forty-eight hours and was 'still walking up like a race horse.' A dispatch from LaCrosse said the Mississippi was already four inches over the high-water mark of 1870 and still was rising. On the levee the scene was lively, the Daily Times recorded. Small boats were constantly going out or coming in loaded with wood and other plunder, and storekeepers were busy shoving their wares to higher quarters. The river stood at 16'4" and lacked five feet of coming up to the 1870 high-water mark."

"On June 17, 1880, the Daily Times noted the Mississippi had risen eight inches in ten hours, causing hundreds of cords of wood to be scattered about or sent floating down the river. Businessmen were fearful of the impending flood damage to their merchandise."

"The store rooms in the long brick building on the levee are filled with grain, and speculators are very nervous, as the water is very apt to compel them to throw their grain on a busted market which will be a large loss to them. It is estimated that 90,000 bushels of grain are stored in this building alone which cannot be removed without a serious loss."

"With their goods in danger of irreparable damage, the firm of Hansen & Linehan offered idlers on the levee 40 cents per hour to roll hay to the Belle of LaCrosse, but they refused to work and a

Wisconsin crowd of raftsmen was engaged at $1.75 per day. At eleven o'clock in the evening of June 16, the river stood at 18'8½" at Dubuque and was within 33 inches of the high-water mark of April 22, 1870."

"On June 18 the Daily Times forecast a stand in the river with two feet still to go before reaching the 1870 level. The next day, however, the Times told its readers that all hopes of a stand were unfounded as the Mississippi continued to rise at an ever-increasing rate. Word from up river reached Dubuque that three feet more could be expected before the flood came to a crest. 'The grain and corn dealers on the levee are frantically engaged in bagging wheat and hauling out corn,' the Dubuque editor observed. The merchants are building trestles on the floor to hold their goods, or are moving them to an upper floor. Dubuque's talented artist, Alex Simplot, was reported making a sketch of the flooded levee for Frank Leslie's pictorial magazine."

"By noon on June 20, the water had reached within 15 inches of the 1870 high, and railroad men were reported 'piling rock on their bridges' to hold them down. According to a reporter for the Daily Times, over one-half the houses on the flats were filled with water and people were swimming in knee deep water in their back yards. The sidewalks and bridges were all held down with stones and tied to trees. Along Elm Street people were reported to have built elevated sidewalks from their second story windows."

"The Daily Times of June 22 recorded sightseers flocking to the levee which could be approached only by skiff. Two thousand Dubuquers made the round trip to East Dubuque by ferry on Sunday. 'The saloon floors were awash,' the Times declared, 'and thirsty patrons rowed in the door, up to the bar, and had their drink without getting out of their boats.'"

"The Mississippi was said to be several inches above the 1870 mark on June 21 and still was rising. On June 23 the water was reported at a stand of nine inches above the 1870 mark but still a few inches below the 1844 mark. It stood at 22'5" on June 22 and 22'8" on June 24, at which point it crested. Iowa river towns downstream from Dubuque underwent similar ravages."

Flood of 1881

"The flood of 1880 occurred during the normal June rise but soon receded. In contrast, the flood of 1881 occurred in October and was of much longer duration. On September 22, 1881, the Mississippi stood at 13 feet causing the Dubuque Daily Times to declare:

'The river has the appearance of a flood in June. Such high water was as unexpected as it was unwelcome. Considerable property is threatened and much inconvenience experienced. On the Seventh Street extension a large amount of wood, pine chiefly, is in danger, and some of it is already floating off. Work on Ryan's new building is interrupted somewhat in the laying of the stonework. Many lumber piles are under water and cellars inundated."

"On October 7 the Mississippi stood at 16'9" and two days later it was at 18'1". On October 11 the levee was submerged but no great damage done. The Couler Creek bridge on Lake Street (now Garfield) was held down by piles of rock. Twenty-five houses between Eleventh and Seventeenth Streets east of the railroad tracks were surrounded by water and their inhabitants were forced to move to the second story. For a few days the river receded but heavy rains in the north brought flood waters up over the twenty-foot level again. According to the Daily Times:

'Fantastic stories of the flood have come in from the north. Hundreds of square miles are reported to be submerged, farmers are picking their corn from boats, and cows are belly-deep in the field, eating hay from the tops of hay cocks. Thousands of tons of hay have been destroyed and farmers are selling their cattle at any price rather than run the risk of wintering them.'"

"From Davenport word came to Dubuque that navigation had become dangerous for rafts--one was broken up and another wrecked within twenty-four hours. Meanwhile, the water stood at one foot below the 1870 level and two feet under the 1880 level at Dubuque. Damage was less than expected, the greatest loss was due to the closing of the factories and the resulting loss of work for 1,500 men. According to the Dubuque Daily Times:

'This terrible flood has taught Dubuque a lesson, and hereafter when putting up new buildings on the river front there will be a higher standard gauge for high water than any hitherto known.'

'The high water has knocked business completely. There is nothing doing in the way of carrying freight. The warehouses and landings up and down the river are drowned out, the roads are impassable, and there is no delivering of receipts by rail, owing to the switches being under water.'"

"The Burlington Daily Hawk-Eye warned its readers on October 4, 1881, that word from Minneapolis indicated heavy rains had prevailed throughout September and flood waters would shortly arrive in Burlington. By October 15, the water had entered the Diamond Jo Line warehouse and only a few inches more were needed to seep into the quarters of the St. Louis & St. Paul line."

"Meanwhile, Clinton had wired that the Mississippi was within two feet of its all-time high-water mark. The two saw mills in Lyons as well as the paper mill had shut down because of the fall freshet. The Davenport Gazette reported the river so high at that point that a strong southerly wind would 'undermine' buildings along the water front while a 'few inches more in the river and the remains of the old Keokuk Northern line office, at the foot of

Perry Street, will make a good start for St. Louis.'"

"Just when relief seemed in sight, renewed and continuous rainfall brought further woes to Burlington. On October 25 the Daily Hawk-Eye declared the swelling waters had passed the mark of June, 1880, and were the highest recorded in thirty years. Once more hope for a decline mounted as reports reached Burlington of falling water farther upstream. According to the editor:

'Tis a concummation devoutly to be wished for, though there has been no cutting, crashing, grinding ice to damage property and endanger life, neither growing crops to be destroyed, an immense loss has come from the flood. Farmers, merchants, mill owners, lumbermen, steamboat men, railroad men, all have felt the misfortune attending the overflow and all will with rejoicing hail the falling of the waters.'"

Flood of 1888

The spring flood of 1888 was one of the worst on the Upper Mississippi. On April 20th the Dubuque Daily Times chronicled a 17-foot stage. "The islands are all covered; the lower portion of East Dubuque being a vast lake." The editor reported, "Lower Main Street is nearly underwater and the flats along the east side of the city are gradually being submerged." The next day the river reached the curbstone of the Diamond Jo boat store after a one-foot rise.

On April 22nd the river stood at 19 feet and had "reached around the low lands at the foot of Seventeenth Street and invaded the flats surrounding the round house and the works of the National Iron and Brass works" and was "gradually creeping up Couler Avenue." The ferryboat Campbell was landing in the rear of the Julien House for conveying passengers to and from Dubuque and East Dubuque. This was the first time since 1880 that the ferry had been "compelled to make this change."

On April 24 the Times reported the river at 20'1" compared with 21'4" in October 1881 and 21'8" in 1870. Although the 1880 flood was two feet higher the editor observed that the 1888 flood "occasions quite as much inconvenience as did the high water of that year for the reason that the low lands of the city are much more populous than they were at that time. As a result of the present flood all the sawmills and many of the factories have been compelled to suspend operations and hundreds of operators are walking the streets today when they should be at work."

The Mississippi stood at 20.3 feet for several days but then dropped slowly, only to rise again to 20.8 feet by May 9, due to heavy rains and melting snow. This was only a scant foot below the 1880 high water mark. Business houses built platforms on which to store their goods or removed the merchandise. Many factories and lumber yards were closed, and hundreds of men were thrown out of work. People in the flats moved out of their homes and General C. H. Booth's newly-built levee on Third Street was washed out. According to the Times:

"Drift wood of every description is coming down freely, and many parties are making good wages in picking up cord wood, lumber logs, and other floating property. Many of the raft boats are lying up, there being no work for them at present."

"All the way from Dubuque to Keokuk the Mississippi set records or near records in 1888. The Clinton Weekly Herald of April 26, 1888, declared the river had been rising 'continuously' since early spring. After a slight decline, the Herald of May 10 noted the Mississippi had reached the 17'10" mark, the same point reached on April 26, 27, 28. All low places 'in Lyons, Chancy, Fulton, and East Clinton' were once more submerged and the editor suggested a 'notice to quit' ought to be served on the rising waters. 'Evidently the river is convalescent,' the Weekly Herald concluded, 'for it is out of its bed and running all over the country.' By May 17 the Weekly Herald reported a stage of 20'2" above the low water mark of 1864 or within two inches of its all-time high of 1880. The 1888 flood, lasting as it did over a long period of time, was one of the most costly in the bustling lumber town's history."

"The Muscatine Daily News of May 14, 1888 reported a 17'5" flood stage which 'will stand as the highest on record for years, possibly for a century, as it is the highest point ever reached here of which there is any authentic data. While this is barely an inch higher than the great rise of 1881, an inch added to that made flood with a surface of 3 to 8 miles in width means a vast volume of water.'"

Flood of 1892

"The year 1892 marks the most devastating Upper Mississippi flood in the closing decade of the Nineteenth Century. The 1892 flood actually exceeded all records in Davenport and Muscatine and came within a fraction of equaling the highest in Clinton and Burlington. Since Upper Mississippi river towns enjoyed their greatest growth between 1851 and 1900, the increasing population, the development of manufacturing, and the spread of agriculture to lowlands that were subject to inundation made floods more costly in each succeeding decade of this period.

POPULATION OF THE MAJOR RIVER TOWNS

	1850	1860	1870	1880	1890	1900
Dubuque	3,108	13,000	18,434	22,253	30,311	36,297
Clinton	*	*	6,129	9,052	13,619	22,698
Davenport	1,848	11,267	20,038	21,831	26,872	35,254
Muscatine	2,540	5,324	6,718	8,295	11,454	14,073
Burlington	4,082	6,706	14,930	19,450	22,565	23,201
Keokuk	2,478	8,136	12,766	12,117	14,101	14,641

*Lyons had 453 in 1850 and 2,703 in 1860

Due in part to their rapid growth, and also to the fact that their topography made them more susceptible to the ravages of the river, Dubuque and Davenport always looked forward to costly floods.

A COMPARISON OF RECORD HIGHWATER MARKS
IN THE ABOVE TOWNS FOLLOWS

	Dubuque	Clinton	Davenport	Muscatine	Burlington	Keokuk
1851	23.0	20.0	16.4	---	---	20.9
1870	21.83	19.73	16.9	---	15.0	16.4
1880	21.7	21.0	18.4	16.9	15.8	17.5
1881	20.2	19.5	17.7	16.8	16.53	18.9
1888	21.4	20.5	18.6	16.9	17.55	19.65
1892	17.6	20.0	19.4	17.6	17.5	19.25

The above statistics bear out the main facts of population growth and the relation of the major Upper Mississippi floods to this growth down to 1892. Since rafting, lumbering and wood-working were the major industries along the Mississippi at this time, it is not surprising that these should be especially subject to floods. And, since railroads had been constructed along both banks of the Father of Waters, their yards and depots were almost invariably located on or near the river bank. The Iron Horse, therefore, could be just as easily hampered, if not completely throttled by highwater, as could steamboating itself. In 1892, for example, the Dubuque Daily Times recorded:

'The first accident attributable to the heavy rains and high water, to occur in this city happened this morning in the Burlington yard at the foot of Third Street, resulting in throwing an engine into the slough and fatally injuring the fireman, Eddie Good.'

Throughout May and June of 1892, railroad tracks were inundated, undermined, and badly damaged. This caused frequent delays in transit and costly repairs along railroad right-of-ways.

The flood of 1892 swept down the Mississippi with devastating velocity, a rise of four feet in four days being chronicled by the Dubuque Daily Times of June 1892. 'All lowlands are flooded,' the editor declared. 'Farmers were driven from their fields again, and may abandon corn planting altogether. It is still raining tonight.'

The Dubuque Herald of June 2 reported the lowlands submerged and the Mississippi 'a vast sheet of water from shore to shore.'

Sawmills are closed, and large sawdust accretions are being cut away. The Burlington road's tracks are surrounded and caving in. All the cellars along Front Street are filled with water from the seepage. Along the valley of Couler Creek the worst situation is found. Sewers are reported washed out, the street cars are cut off, houses and streets under water, and bad damage being done by washing. This is only a hasty summary of the mischief. By the time this reaches the reader's eye it will have been considerably greater.

The Davenport Democrat of June 1, 1892, did not minimize the serious flood situation.

A continuation of rain and resulting high water will relieve the river engineers from the necessity of doing any great amount of work this summer. In the first place any efforts they might put forth in the way of keeping the channel clear will not be needed. Steamboating is very good over the cornfields now in a good many places and the actual channel is of small moment. In the next place improvement work cannot be done, except in rare instances, at such a stage of water as this.

By June 2nd Muscatine Island was 'largely under water' and hundreds of acres of melon and sweet potato lands were three to four feet beneath the surface. The river at Burlington was 'eight miles wide,' the lands on the Illinois side being completely submerged. Although Fort Madison had not been seriously damaged the farms around the mouth of the Skunk River and the Green Bay flats were inundated. Meanwhile, the Mississippi continued to rise.

Sometimes a larger Iowa tributary to the Upper Mississippi played a leading role at flood time. Thus, when the Mississippi at Keokuk rose 3.2 feet in 24 hours, the Keokuk Gate City of May 6, 1892, explained:

This was due largely to backwater from the Des Moines which is spread out all over the bottoms; but the rise up river was something remarkable. The Illinois bottoms opposite Keokuk do not often overflow, but now they are inundated.

The high water mark of 1851 was 20.93 feet, and that of 1888, 19.65. In that year the lower lock grounds were flooded. A couple of years ago the lock walls were raised four feet and the ground filled in, making them above high water mark. Yesterday the water had risen as high as the lock gates and they were opened, allowing steamers to pass through without interruption.

By 1892 most river folk were keenly aware of the many moods of the Father of Waters. Despite its frequent depredations, they loved to dwell upon the bank of the majestic waterway and neither storm nor flood could lure them to a safer and more certain shore."

Floods of 1920 and 1922

The flood of 1920, declared the Dubuque Times-Journal of March 27, was "an extraordinary occurrence" because "high water usually comes during May and June." The flood was remarkable for several reasons: its early season---which began on March 22; its unprecedented rise of 4½ feet in 48 hours---which the United States Weather Bureau at Dubuque felt was perhaps the greatest rise for a 48-hour period ever recorded in Dubuque; and its precipitate decline after cresting at 21.0 feet on April 6. "The present high water," the Dubuque editor concluded, "is a result of the large amount of rain and snow during March and the quick breakup of the ice in the river."

Although ample warning was given of the oncoming flood, the original forecasts fell short by three or four feet of the ultimate crest. During the last three days in March, lowlands were flooded, cordwood and timber set adrift, and many small boats carried downstream. Then, on April 2, the Times-Journal reported a rise of 2.5 feet in 24 hours, bringing the stage to 15.8 feet. Many factories were forced to suspend operations and several residential areas were flooded, particularly on the flats east of the railroad tracks, and those in the Couler Avenue area because of the "backing up of the Bee branch sewer." The flood stage of 18 feet was passed on April 3, and a rise to the 21-foot mark was predicted over Sunday. The boat houses in the harbor would have to be "anchored" to prevent their beginning "a journey up Main Street." "The greatest inconvenience and damage," the Dubuque editor complained, "is caused by the backing up of the city sewers into residential basements."

The unparalleled rise of the Mississippi was recorded in the Times-Journal of April 5.

March 22.....7.1	March 27.....10.5	April 1.....13.5
March 23.....7.4	March 28.....11.0	April 2.....15.8
March 24.....8.2	March 29.....11.4	April 3.....18.0
March 25.....8.7	March 30.....11.8	April 4.....19.5
March 26.....9.8	March 31.....12.4	April 5.....20.6
		(9:00 a.m.)

The Dubuque editor felt the city was fortunate there had been no big rain in conjunction with the flood. According to the Times-Journal: "In the 1881 flood, 9.31 inches fell in one week.. During the 1888 flood, it rained every day but three in a 16-day period for a total of 5.49 inches."

The peak of the flood---21 feet---was reached on Tuesday, April 6, at which time the United States Engineers estimated 130 billion gallons of water flowed by Dubuque within the 24-hour period. The

Mississippi was three miles wide at Eagle Point Park and health authorities viewed with concern the thousands of rats from the sewers that were "infesting" the city. Of further concern were the dead animals---"horses, pigs, cows, and a great variety of live-stock"---that filled the trees both on the lowlands and on the islands.

The flood of 1922 began a fortnight later than did that of 1920. It actually started at a higher level and it did not have the phenomenal rises recorded two years previously. Its starting date was virtually the ending date of the flood of 1920. Both floods, however, must be considered early in occurrence as compared with the proverbially normal June rise.

Much the same area was inundated at Dubuque in both 1920 and 1922. "Snaggers, with boats in the water," the Dubuque Times-Journal of April 17, 1922, recorded, "are reaping a rich harvest in floating timber, boats, and a wide variety of articles that are traveling south on the crest of the waves." As in the previous flood, a highly undesirable "harvest" was being reaped, one which local citizens hoped might be harvested for the last time. The harvest---hordes of rats were driven from the "dumps" to "seek food" uptown, "cat or no cat."

Flood of April 26, 1951

This flood originated from snowmelt in the central portions of Minnesota and Wisconsin. The Minnesota River basin was the principal contributor to the flood flow since the spring snowmelt did not extend far upstream on the Mississippi breakwater area above Minneapolis. The Minnesota River basin experienced an average of 36 inches of snowfall in March as compared to a normal fall of 8 inches. Melting of the snow cover was rapid starting near the end of the first week in April. The resulting crest flow on the Minnesota River at Mankato was the highest of record. During April and May, the Turkey River upstream from the study reach and the Wapsipinicon and Rock Rivers in the study reach were at or above flood stage.

Flood damage in navigation pools 14 and 15 downstream from Clinton, Iowa, was not extensive except at Campbell's Island. Many homes on the island were severely flooded. Industrial plants in East Moline, Moline, and Bettendorf prevented extensive damage by placing protective works before the crest flow arrived. Downstream from Lock and Dam 15 in Davenport, the overflow extended landward of River Street. The underpass at the Iowa approach to the government bridge was flooded, closing both highway and rail traffic through the underpass. In Rock Island, a temporary sand bag dike was placed from the National Guard Armory downstream along the railroad embankment to high ground near 18th Avenue. At Muscatine, industrial plants and commercial concerns located near the mouth of Mad Creek were seriously damaged by Mississippi River overflow and backwater. The Chicago, Rock Island and Pacific Railroad raised their main line tracks 1.5 feet to prevent interruption of service.

A break occurred in the levees protecting Drury Drainage District across the river from Muscatine. The original break occurred just upstream from Lock and Dam 16. Squall winds produced waves which overtopped the levee on April 29.

The Davenport Daily Times on April 23 described conditions as follows:

"No Milwaukee or Burlington trains are being operated over the Davenport, Rock Island and Northwestern tracks in Davenport. At the J. I. Case plant in Bettendorf, one-third of the labor force has been working since early Sunday sandbagging the one and one-quarter mile levee, 100 yards east of the plant. In Davenport, additional sections of River Street were invaded by floodwaters today. At the monument at the foot of Main Street, water was edging close and was starting up Brady from the intersection with River Street."

The Des Moines Register issue of April 24 reported:

"Two hundred forty city blocks (in Davenport) were under water as residents awaited the river crest. About 500 families in the Quad-City area are homeless as a result of highwater, 350 of them on the Iowa side."

The Rock Island Argus issues of April 25 and 26 described flood conditions as follows:

"The worst flooding in the history of Andalusia was reported with water creeping up three blocks on the west side of the village. Both ends of the community facing the river were inundated although banking and sanding operations have been successful."

"Possible great flood damage in the Meredosia Drainage District in the upper end of Rock Island County (Illinois) was prevented yesterday by sandbagging both sides of the Route 84 pavement embankment. The route serves as a levee for the district which includes 50,000 acres of fertile farm land. Water was within a foot of the top of the Route 84 pavement in places below Albany and in some places it was over the railroad tracks adjacent to Route 84."

Flood of April 27, 1952

The April 14, 1952 issue of the Davenport Daily Times described the flood potential as follows:

"Nature set the stage for what is expected to be the worst flood in history along the upper Mississippi. - - - a year ago, heavy snow covering, heavy rains and fairly rapid thawing combined to produce the 18.3 (foot) stage here (tailwater of Lock and Dam 15). What could not be foreseen was that the thaw (snowmelt) this year would be much more rapid, although the snow covering was only a little heavier than normal, that the ground was frozen to a greater depth, preventing water from going into the ground, and that the run-off covered a considerably greater area this year including both the upper watersheds of the Mississippi and Minnesota Rivers."

Emergency flood fighting efforts were described by the April 18 issue of the Davenport Daily Times as follows:

"City workmen today were engaged in construction of a three-foot earthen dike on the north bank of Black Hawk Creek in west Davenport and also sandbags were being placed atop the Rock Island Lines embankment at the south end of Garden Homes addition as a protective measure. . . .water was reported to have entered a number of basements in the area (on River Street) including the St. James Hotel."

"At the J. I. Case plant (Bettendorf), the dikes along the riverfront have been strengthened, while at the Innes Company, and Riverside Foundry, east of Bettendorf, workmen constructed dikes to protect the plants and homes."

"Nearly 3,000 employees of International Harvester Company, at East Moline, faced a layoff as the results of the company to minimize flood damages.

In Rock Island, two blocks of Mill Street in the industrial section were flooded."

"Water also began to seep into the yards of Moline Consumers Company on Third Avenue (Moline) and in other spots near the industrial section on the same avenue."

The Rock Island Argus of April 24 described conditions at Muscatine:

"....a note of extreme urgency was expressed in the Muscatine-Drury vicinity.

Most feared are heavy winds which could send waves smashing through the dikes. . . . Wind was responsible for the Drury break last year. . . . Last year's Drury disaster was believed responsible for relieving the pressure on the Muscatine dike thus saving the city from excessive damage."

The Des Moines Register of April 24 described disruption of rail traffic at Davenport:

"All railroad traffic north of Davenport on the three roads operating along the riverfront was cut off when water overflowed into the underpass at the government bridge."

The April 25th issue of the Davenport Democrat described flood conditions as follows:

"In Davenport's downtown district, water started to trickle into Second Street at the Iowa intersection and the water had almost reached the alley between River Street and Second on Perry. At Brady Street, the water is across River Street and near the entrance drive at Blackhawk Chevrolet Company. The intersection at West River and Main is also partly covered."

The Clinton Herald described conditions at Muscatine on April 28:

"The river crest rolled into Muscatine today. The river at Muscatine was at a record all-time level of 21 feet. All levees in the Muscatine area still were holding.

In the Drury district across the river in Illinois, the water-sodden dikes were requiring careful attention. Mad Creek, filled by Mississippi River backwater, overflowed into about 20 industrial blocks at Muscatine, but the main dike along the river was holding."

Flood of April 28, 1965

The flood of April 1965 in the study reach was caused by a combination of hydrologic factors contributing to a high rate of run-off. Precipitation in August and September of 1964 in the upstream areas of the Upper Mississippi Basin was considerably above normal. As a result, the ground was nearly saturated when very cold temperatures in December caused deep frost penetration. The deep frost made the ground impervious to snowmelt and spring rainfall. Normal snowfall followed over most of the Upper Mississippi Basin during December 1964 and January 1965. Early in February, one-half to one inch of rain fell with above freezing temperatures. The snow cover absorbed the rain and increased in density. Above normal snowfall occurred during March with exceptionally heavy amounts in the basin above Minneapolis and St. Paul. Below normal temperatures were recorded through January, February, and March. After the first of April, temperatures rose to and remained above freezing. The heavy run-off from the general spring thaw in combination with that from heavy rainfall during April, caused record flooding on the Mississippi River between Dubuque, Iowa, and Hannibal, Missouri. Run-off from snowmelt on the tributary streams in Iowa and Illinois occurred before the crest on the main stem arrived.

Flood damages were severe where emergency protective works were either not employed or were breached. At Camanche, Iowa, the E. I. du Pont deNemours Company plant was forced out of operation after an emergency dike failed, flooding the entire manufacturing area. City streets, sewer lines and sewage disposal plant were severely damaged. At Princeton, Iowa, damages occurred to property riverward of the railroad fill. Evacuation of property and residents prior to the crest prevented excessive damages. At LeClaire, Iowa, only marginal flooding occurred, while at Pleasant Valley, Iowa, 739 people were evacuated when the flood waters inundated 140 homes located in the flood plain. In East Moline, Illinois, 968 homes suffered extensive damages and 2,537 persons were evacuated. Damages were extensive to the sewage disposal plant, water works, sewers and streets. Campbell's Island was extensively flooded. In Moline, 67 homes were affected requiring 117 persons to evacuate. In Milan, Illinois, damage was extensive from Mississippi River backwater. Smith's Island and Big Island were entirely inundated. The village of Andalusia, Illinois was severely damaged with 58 houses affected and 122 persons evacuated. Buffalo, Iowa also experienced extensive flood damage. In Muscatine, Iowa the riverfront portion of the central business district experienced basement flooding caused by sewer backup and inadequate interior drainage facilities. An emergency levee was started to protect the riverfront area. However, a 7-inch rain which fell over a short period of time halted construction. An emergency flank levee along the left bank of Michael Creek and the Muscatine Island levee system successfully prevented flood damage in the Levee District and in South Muscatine.

A special issue of the Rock Island Argus published Tuesday, May 18, 1965 gave a chronological account of the flood as follows:

"April 15, River stage 15.0 feet---The Mississippi topped its 15-foot flood stage, sending water into LeClaire Park in Davenport and covering S. Concord Street. National Guardsmen stood by to help evacuate Garden Addition residents.

Rock Island began filling two openings in the dike.

Milan Legionnaires were asked to help with sandbagging on Chaney Lane.

An inch-and-a-half of rain fell in the past 24 hours, slowing flood protection work. Engineers said the rain would not affect the flood crest.

The state highway spur leading into Keithsburg was closed to traffic.

April 16, River stage 15.6 feet---The Weather Bureau raised its flood crest prediction to 20.5 feet, a foot higher than predicted earlier. Rock Island officials were optimistic that dikes would hold.

Fear was expressed that rats might become a problem if flood waters forced them to higher ground. Poisoning in the dump area was increased.

Additional typhoid inoculation centers were set up.

East Moline banned sightseers from the flood area, and Moline's flood protection efforts were hampered by a shortage of sand and volunteers.

April 17, River stage 15.9 feet---Rock Island officials were more concerned about the dike holding against a 20.5-foot crest, but still believed it would. A call for more volunteers to fill sandbags was issued.

Moline's River Drive was closed as flood waters covered it.

Residents of Davenport's Garden Addition were required to get permits to go to and from their homes.

April 18, River stage 16.1 feet---Thousands of sightseers and camera fans visited flooded areas in Davenport. (It was Sunday.) Sandbagging operations were suspended. Water was up to the railroad tracks on Main Street.

Seepage was a problem in the Meredosia Dike area north of Cordova. Farmers were moving livestock to higher ground.

In Andalusia, water covered the park area.

April 19, River stage 16.4---Engineers reported 650,000 sandbags have been provided so far for flood fighting.

National Guardsmen were patrolling the Bay Island dike which protects 20,000 acres of farm land in the New Boston area.

The Illinois Bell Telephone Company was installing emergency phone equipment at business places that might be flooded. Expensive phone equipment in the basements of such places was to be removed.

Typhoid shots were given to 1,700 in East Moline.

April 20, River stage 16.7---Second defense lines were being constructed behind two weak spots in the Rock Island dike as the crest prediction was raised a half foot to 21 feet. An additional 10,000 sandbags were acquired. National Guardsmen from Rock Island were sent to East Dubuque for dike patrol duty.

Davenporters were warned to "get out while the getting's good."

Milan asked for more volunteers to work on the Chaney Lane dike.

Evacuees moved into East Moline Red Cross shelters.

The Salvation Army began serving food to flood fighters.

April 21, River stage 17.2---Davenport's River Drive was closed west of the Centennial Bridge and emergency water supplies were made available. Evacuees moved into St. Mark's Lutheran Church.

At New Boston about 40 high school youths from Aledo began working on the Bay Island levee and appeal was issued for more help.

Downtown Rock Island businesses were making flood preparations. The Federal Building was sandbagged and basement evacuated. A weak section of dike near the Kahlke Boat Yard was abandoned and a new one was being built.

April 22, River stage 17.9---Flood dangers mounted as the Weather Bureau again raised its flood crest estimate by a half foot, making it 21.5 feet. The situation was considered critical.

Rock Island police went on 12-hour shifts and started foot patrols of the dike.

Between Cordova and Albany 500 volunteers battled to save the Meredosia dike. Highway 84 on top of the dike was closed.

Two breaks occurred in the Moline dike but were quickly contained.

Credit Island was completely flooded.

April 23, River stage 18.8---The Mississippi reached the previous high water mark for this century set in 1952 at 18.63 feet and kept right on going up. It reached 19 feet by noon.

Rain during the night totaled .45 of an inch and again hampered dike work.

Heavy seepage under the dike near the Container Corporation of America was causing concern.

An evacuation center was set up by the Red Cross at Prince Hall Masonic Home.

In East Moline, flood victims being cared for by the Red Cross totaled 160.

Davenport business places along River Drive were being closed. The St. James Hotel was evacuated.

The cost of flood protection for business places and industries was expected to total $200,000 in Rock Island, a survey showed. Estimates of the cost to the city ranged from $50,000 to $100,000. (These estimates turned out to be pitifully low.)

April 24, River stage 20.0---This day, a Saturday, was Rock Island's blackest in the long flood fight.

A half-inch of rain Thursday night and two inches more Friday night had weakened the dikes and made the use of trucks and heavy earth-moving equipment to reinforce them impossible.

Another heavy downpour Saturday morning led City Manager Botch to warn downtown merchants that the dikes probably would give way in 8 to 10 hours, pouring water into the city from the west and north.

And to make matters worse, the Weather Bureau revised its crest estimate upward another foot to 22.5, or 7.5 feet above flood stage. This would put 18th Street and 4th Avenue under 4.5 feet of water if the dikes failed.

Evacuation headquarters were set up at the Rock Island City Hall on a 24-hour basis. Families began moving out of houses on Rock Island's 1st Street.

Davenport's River Drive was closed completely, as was part of Rockingham Road.

In East Moline, water flowing over 19th Street forced the closing of the last route to the Watertown area.

Governor Kerner asked President Johnson to declare Illinois a disaster area, citing flood and tornado damage of more than $25 million.

April 25, River stage 21.42---A major break in the dike near the Rock Island Boat Club flooded the area west of the railroad tracks, including plants of Macomber, Inc., and Container Corporation of America.

Flood fighters retreated to the railroad tracks and built a new dike there.

About 1,000 persons left their homes in Arsenal Courts which would be flooded if the railroad dike failed to hold. This brought the total to 1,500 Rock Islanders flooded out so far, with the crest still three days away.

A volunteer army, which during the day and night may have numbered 1,500, built a dike along the railroad tracks from 18th Avenue to 6th Avenue and Mill Street. Included were men, young adults, and teen-agers of both sexes who worked in a raw wind and drizzle to the point of exhaustion, filling and placing sandbags.

In Milan, work of reinforcing and building the Chaney Lane dike still higher continued around the clock. The flood danger was created by the Mississippi River backing up into Jimmy Creek.

Flooding of the Davenport approach forced closing of the Government bridge.

April 26, River stage 21.5---Rock Island's dike broke again, this time near the J. I. Case plant at the foot of 8th Street. Flood fighters fell back to a secondary defense at 3rd Avenue.

Hundreds of students formed a long chain gang to build another sandbag dike at the Centennial Bridge to hold back water spilling over the dike just west of the bridge.

Augustana College dismissed classes so students could help fight the flood. Dormitories were nearly deserted as students of both sexes hurled their tremendous youthful energies into the battle to save a city. Future ministers from Lutheran School of Theology also were in the thick of it, as were some 200 students from Rock Island High School and scores more from Alleman High School.

Rock Island's two flood shelters had 150 evacuees.

In East Moline an army of volunteers also was working and hopes were high that the flood lines could be held. The water supply emergency was eased as new pumps were activated. Registrations at three evacuation centers totaled 240. An estimated 700 families have been displaced.

Some Moline plants were forced to shut down and 3rd Avenue between 15th and 18th Streets was beyond control by flood fighting crews. Bursting sewers were spewing water high into the air. Moliners were warned to conserve water. It was uncertain whether a sandbag dike protecting the waterworks would hold.

Davenport was standing by, watching the flood waters creep higher. Officials said all that could be done had been done.

Business firms along 2nd Street were pumping furiously to hold down seepage. Water had crossed 3rd Street in places.

Campbell's Island was badly flooded with water reaching half way to the eaves of many houses. The same was true of lower Vandruff's Island and Smith's Island.

April 27, River stage 22.1---Thanks to the efforts of hundreds of volunteers, the flood situation in Rock Island appeared to be under control as the crest neared.

But on Big Island the problem was acute. All but about 25 of the island's estimated 400 residents had fled.

Rock Island's worst trouble spot was near 22nd Street where sand boils developed. Nearly 100,000 sandbags were used to build a new dike from 20th Street to a point near 23rd Street.

Red Cross flood shelters in Rock Island County were housing and feeding 464. The Salvation Army was bringing food to the dike workers night and day.

Hundreds of individuals and organizations have donated time, money, food, clothing, equipment, and energies to help in the flood effort.

Davenport opened a second Red Cross flood shelter, after 100 evacuees filled the first one.

Quad-City flood damage was estimated at $1 million, if the dikes hold.

National Guardsmen battled furiously to protect Point Mississippi in Bettendorf.

Five Quad-City industries closed because of high water and six others were operating on a curtailed basis.

The Centennial and Iowa-Illinois Memorial bridges were clogged with traffic. They were the only ones open along a 200-mile stretch of the Mississippi.

April 28, River stage 22.4---All dikes were holding as the Mississippi flood crest arrived, with a reading of 22.48 feet at 11:30 a.m.

Hundreds of volunteers remained available, but their work was slacking off after they held back flood waters that endangered the waterworks.

In Milan the situation was more tense. Three hundred volunteers answered an emergency call to shore up weak spots on the Chaney Lane and Jimmy Creek dikes. The volunteers won out.

Evacuees in Rock Island County Red Cross shelters numbered 560. Scott County had about 150.

Flood costs in Rock Island were estimated at $1.6 million, with the city's share being $807,000.

Moline's damage was figured at $2.5 million.

Damage in the Rock Island District of Army Engineers, stretching from Guttenberg, Iowa, to Clarksville, Missouri, was placed at $10 million.

Water spilled over the seawall in Davenport upstream from the Government Bridge to near Bettendorf. The International Milling Company was surrounded by water and $2 million worth of grain was endangered.

April 29, River stage 22.5---Victory was believed near in the long, hard flood fight in Rock Island, but volunteers continued to stand by, and day and night patrolling of the dikes went on. The river dropped ever so slightly, .02 of a foot, but it was still 35 feet deep out in the channel.

The Salvation Army reported 22 staff workers had been brought into the area for flood duty. An appeal for funds was made.

Davenport's sewage treatment plant is expected to be out of operation for six months due to flood damage.

April 30, River stage 22.3---Senator Paul Douglas, meeting with Quad-City mayors, announced that legislation has been introduced to provide federal relief for cities put to great expense in preventing flood loss.

Mayor Muhleman expressed the official thanks of the City of Rock Island to Augustana students for their flood fighting efforts.

Ice Jam Flood of February 1966

The effects of flooding were first experienced on February 12, 1966, at two locations, Smiths Island and Vandruffs Island. These residential developments are located on separated islands of the Rock River about one-half mile upstream from the mouth. The developments were affected by Mississippi River backwater. Water rose above the 15.0-foot flood stage at Davenport on February 13. A total of 150 residential properties in Davenport and 62 residential properties on Vandruffs and Smiths Islands were affected by flood water. Approximately 50 commercial and industrial properties were affected. The principal cause of this February ice jam was unseasonably warm temperatures followed by six days of cold weather. The ice jam developed in two stages. In the first stage the unseasonably warm temperature of 8-12 February weakened the thick sheet of ice (10-15") on pools 14 and 15 and high discharge rates caused this ice sheet to break up and to be carried downstream to lodge under the ice sheet in the Linwood-Horse Island reach. The ice sheet on pools immediately upstream and downstream remained unbroken during this period. This inflow of ice from pools 14 and 15 was further augmented by a heavy ice run-out from the lower reaches of the Rock River and Wapsipinicon River. These flows of ice knitted into the existing field and further contributed to the development of the gorge. This ice partially restricted the river flow and caused the rise in tailwater beginning on 12 February which resulted in the first rise above flood stage on 14 February. The jam of heavy sheet ice could likely have cleared itself by the normal melting action of river water at temperatures slightly above the freezing point if it had not been followed in rapid sequence by a second stage of jamming quite different in character.

This second stage occurred between the 16th and 22nd of February and was caused by the run-out of huge quantities of thin sheet ice and frazil ice formed on pools 14 and 15 during this period of cold weather and high flow rates. It should be particularly noted that the sequence of weather events created a natural ice making machine which produced a huge quantity of loose ice that was carried downstream into the Linwood-Horse Island jam and severely restricted stream flow. The cumulative blocking effects of this loose ice is seen in the steady rise of tailwater. By the 21st of February the ice was consolidated to a point upstream of Dam 15 in the Quad-Cities. This cumulative blockage at the Horse Island channel by glacier-like flows of loose ice was responsible for the rise of tailwater to the 18.5-foot flood stage on the 20th of February. This was relieved by a flow of ice downstream late in the morning of 21 February which caused the tailwater stage to drop to 17.2 feet. The major flood height of 19 feet on 22 February was caused by the glacier-like flow of a large mass of thin sheet ice and frazil which flowed downstream early on that afternoon and blocked the Mississippi River channel at the upper end of Credit Island and resulted in the flooding of the Davenport area. The graph of tailwater stage at Dam 15 (Plate 3B) indicates that the stage began to drop as the dammed waters flowed around this jam and gradually opened up channels through this loose, spongy mass of ice.

A decrease in the ice supply caused by moderating temperatures on the 24th and 25th of February, together with erosive and melting processes was sufficient to enlarge the water courses through and around the jam to the extent that continually falling tailwater stages prevailed thereafter.

Flood of April 1967

Snow surveys conducted by the St. Paul District, Corps of Engineers, in cooperation with the Weather Bureau, indicated the following water content of the snow on February 21, 1967:

Minnesota River Basin, 2 to 4 inches
Wisconsin River Basin, 2 to 6 inches
Chippewa River Basin, 3 to 6 inches
St. Croix River Basin, 5 to 6 inches
Mississippi Basin above Minneapolis, 4 to 6 inches

The tributary basins in Iowa and Illinois had insignificant amounts of water content on that date.

By March 29, normal and below normal rainfall and above normal temperatures produced rapid snowmelt and run-off from the smaller tributaries in southern Minnesota and Wisconsin. By April 15 only minor rises had been experienced on the tributaries and no major highways or railroads were out of service. Moderate to severe wave damage to levees and shore installation occurred on April 14 due to high winds. Ten-foot waves were reported in pool 19 when the towboat, Bixby, was swamped and sunk. One crewman lost his life in the mishap. High winds with gusts up to 50 miles per hour occurred on April 17. Some wave wash damage to levees downstream from Muscatine was reported.

Crest stages during the flood reached levels approximately one foot lower than the flood of April 1952. Although considerable rain fell during the snowmelt run-off period, it came ahead or behind the Mississippi River crest wave and had only minor effects on flood crest elevations.

Flood of April 1969

The five major elements for spring snowmelt floods include fall precipitation, frost depth, snow depth, rate of snowmelt, and additional precipitation during the snowmelt period. Events leading up to the April 1969 flood are described in the following paragraphs.

Heavy rainfall over parts of Minnesota and Wisconsin began in August 1968 and continued into September. Above normal precipitation in central and southern Minnesota continued into October. Minnesota River flows from Mankato downstream were the highest for any October since records began in 1903.

Frost depths were not particularly great, but the soil was saturated with moisture from the heavy summer and fall rains combined with an early deep snowfall. Cold temperatures came after the early snowfall. As a result, frost penetration was not great. Depth of frost in January averaged only 6 to 7 inches in Wisconsin.

Weather Bureau records dating back to 1890 indicated record to near record December snowfall over most of Minnesota. Minneapolis-St. Paul recorded 28.7 inches of snow compared to previous record of 25.0 inches in 1950; International Falls reported 18.9 inches with previous record of 16.9 inches in 1953; La Crosse, Wisconsin reported in excess of 26 inches compared to previous record of 25.5 in 1927. Near record snowfall occurred at Duluth with 37.7 inches as compared to 44.3 inches in 1950. Through January 31, 1969 Minneapolis-St. Paul established a new total snow season record of 55.2 inches. Normal snow season snowfall is 20.8 inches.

Snowmelt during the last two weeks in March occurred ideally. Alternate periods of warming and cooling melted the snow slowly over the Turkey River Basin in northeast Iowa, the Root and Zumbro River Basins in Minnesota and the Kickapoo and the small basins in southern Wisconsin. Very little additional precipitation accumulated over the heavy snowpack in Minnesota and Wisconsin during March.

The main snowmelt rise on the Minnesota River began during the first week in April. Snowmelt over the extreme upper portion of the Minnesota River basin and the Mississippi River basin above Minneapolis was of little consequence until the beginning of the second week in April.

Crest flows arrived in the upper end of the Rock Island District near Lock and Dam No. 10 on April 23. In the study reach, crest stages were observed on April 26 from Camanche to Muscatine. At most gaging stations in the study reach, this flood equaled or exceeded the observed flood stages of 1952. At most gaging stations in this study reach, the 1952 flood produced the second highest observed flood crest elevations.

Flood emergency assistance was provided to the following Iowa communities under authority of Public Law 99 passed by the 84th Congress of the United States: Bettendorf, 0.6 mile of earth levee; Buffalo, 0.6 mile of earth levee; Davenport, 0.7 mile of earth levee; Muscatine-Louisa County Drainage District No. 13, 0.1 mile of earth levee. The listed communities also received sandbags, pumps, and polyethylene as requested along with the communities of Camanche, Fairport, LeClaire, Montpelier, Muscatine, Pleasant Valley, Princeton, Riverdale Scott County, and Muscatine Island Levee District.

In Illinois, the following communities received emergency assistance under Public Law 99: Andalusia, 1.6 miles of earth levee; Big Island, 1.2 miles of earth levee, East Moline, 1.0 mile of earth levee; Hampton, 0.5 mile of earth levee; Milan, 0.7 mile of earth levee; Moline, 0.9 mile of earth levee; Rock Island, 1.0 mile of earth levee; and Meredosia Levee District, 2.0 miles of earth levee. In addition, sandbags, pumps, and polyethylene were provided to the listed communities, as well as to Andalusia Township, Campbell's Island, Hampton Township, Moline Marine Reserve Training Center, Port Byron, Rapids City, Rock Island Post Office, and Rock Island Reserve Training Center.

No emergency or permanent levees failed during the flood in the study reach. Flood damages occurred only in those areas which were unprotected or where seepage through and under the levees was not controlled.

Additional large floods are listed in Table 6. Figures 17 through 28 show typical scenes for selected floods in the reach of the Mississippi River covered by this report.

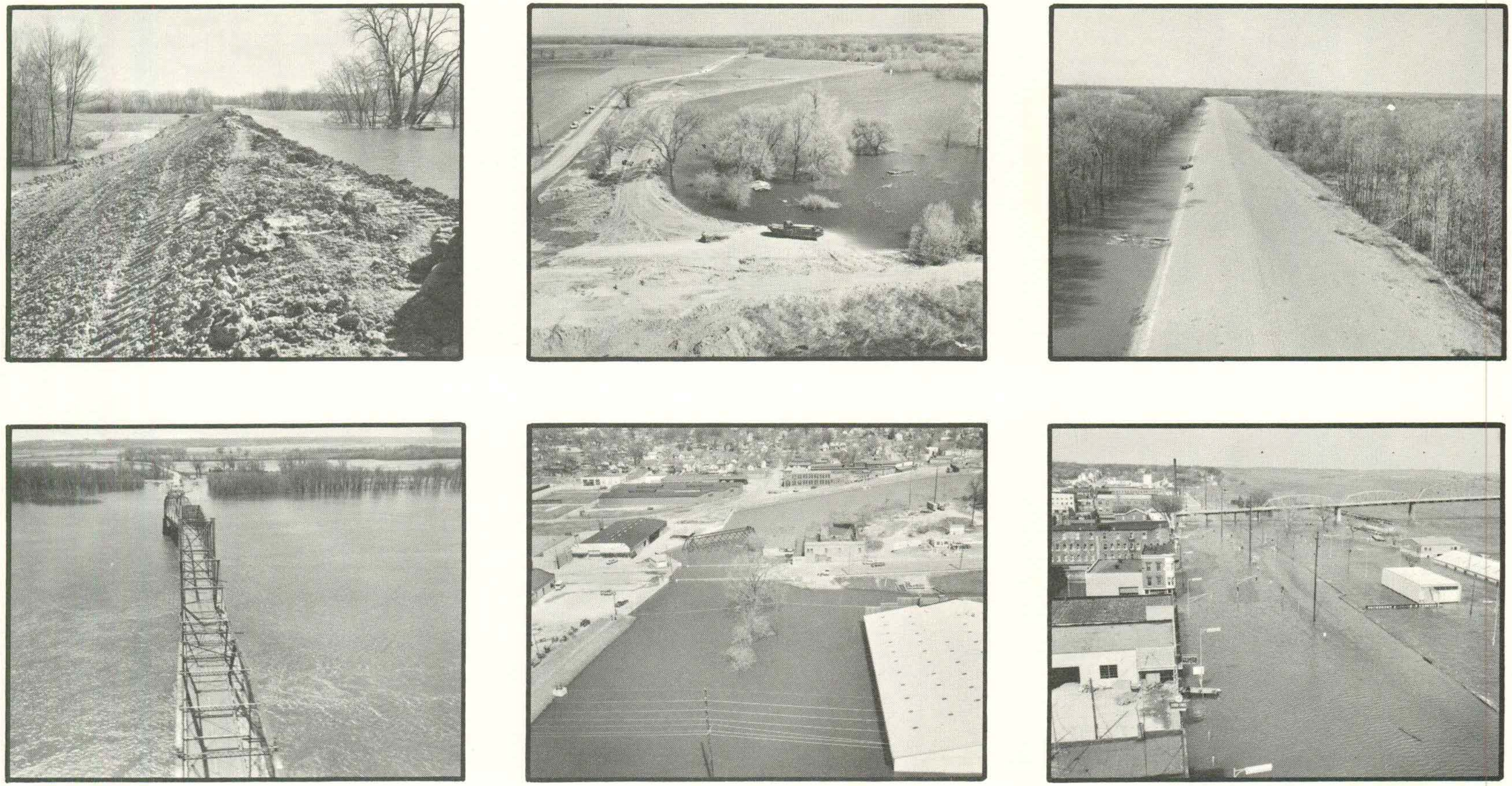


Figure 17. April 1965 high water at Muscatine, Iowa. Top row left to right: Emergency flank levee looking northeast toward tie-in with sand levee from Muscatine Slough; looking north at Michael Creek emergency flank levee and flooding forebay area of the pumping station; and looking south along Muscatine Island Levee District. Bottom row left to right: Illinois Highway 92 Bridge looking east; Mad Creek looking west; and looking north on River Drive from Iowa Avenue.

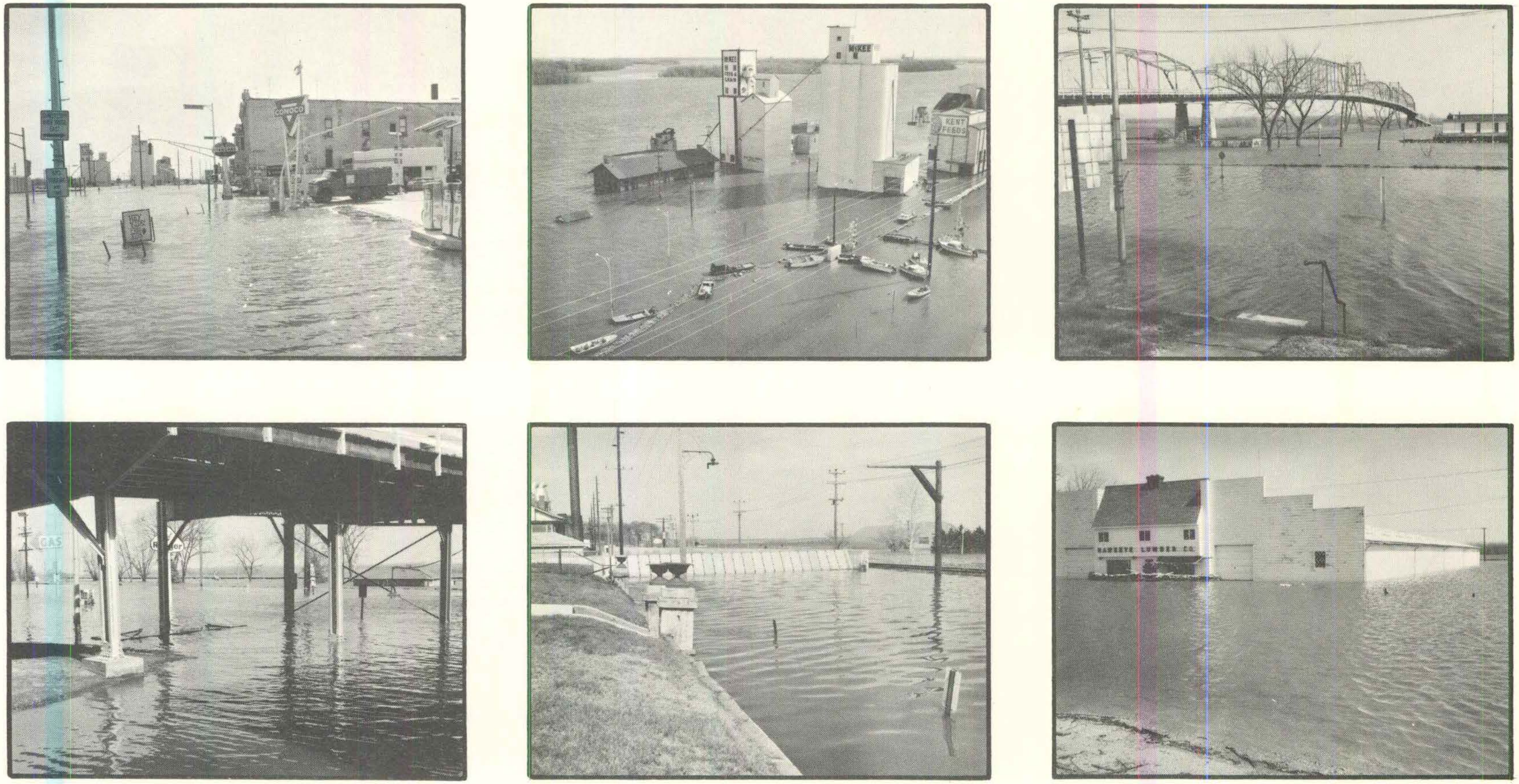


Figure 18. April 1965 high water at Muscatine, Iowa. Top row left to right: Looking south along River Drive from Muscatine Bridge; looking south from corner Iowa Avenue and River Drive; and looking across River Drive - Muscatine Bridge in background. Bottom row left to right: Looking northeast across River Drive from under Muscatine Bridge; looking north at railroad closure structure on East River Drive; and looking east on Hawkeye Lumber Company on 2nd Street.

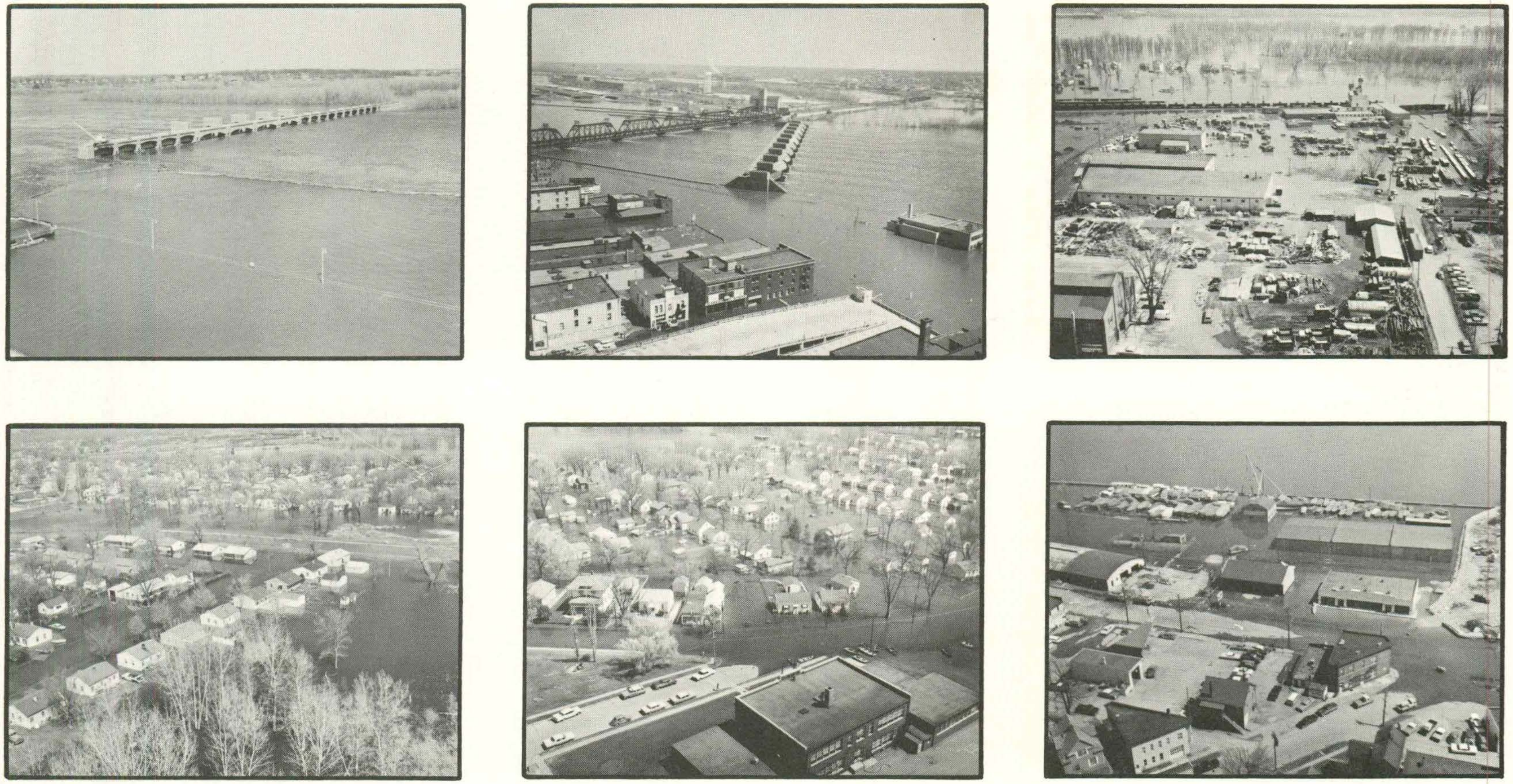


Figure 19. Aerial photographs of the 1965 high water at Davenport and Suburbs. Top row left to right: Lock and Dam No. 16; Lock and Dam No. 15; and South Farragut Street with CRI&P RR in the background. Bottom row same order: Two scenes of the Garden Addition; and the Quad-City Marine Club.

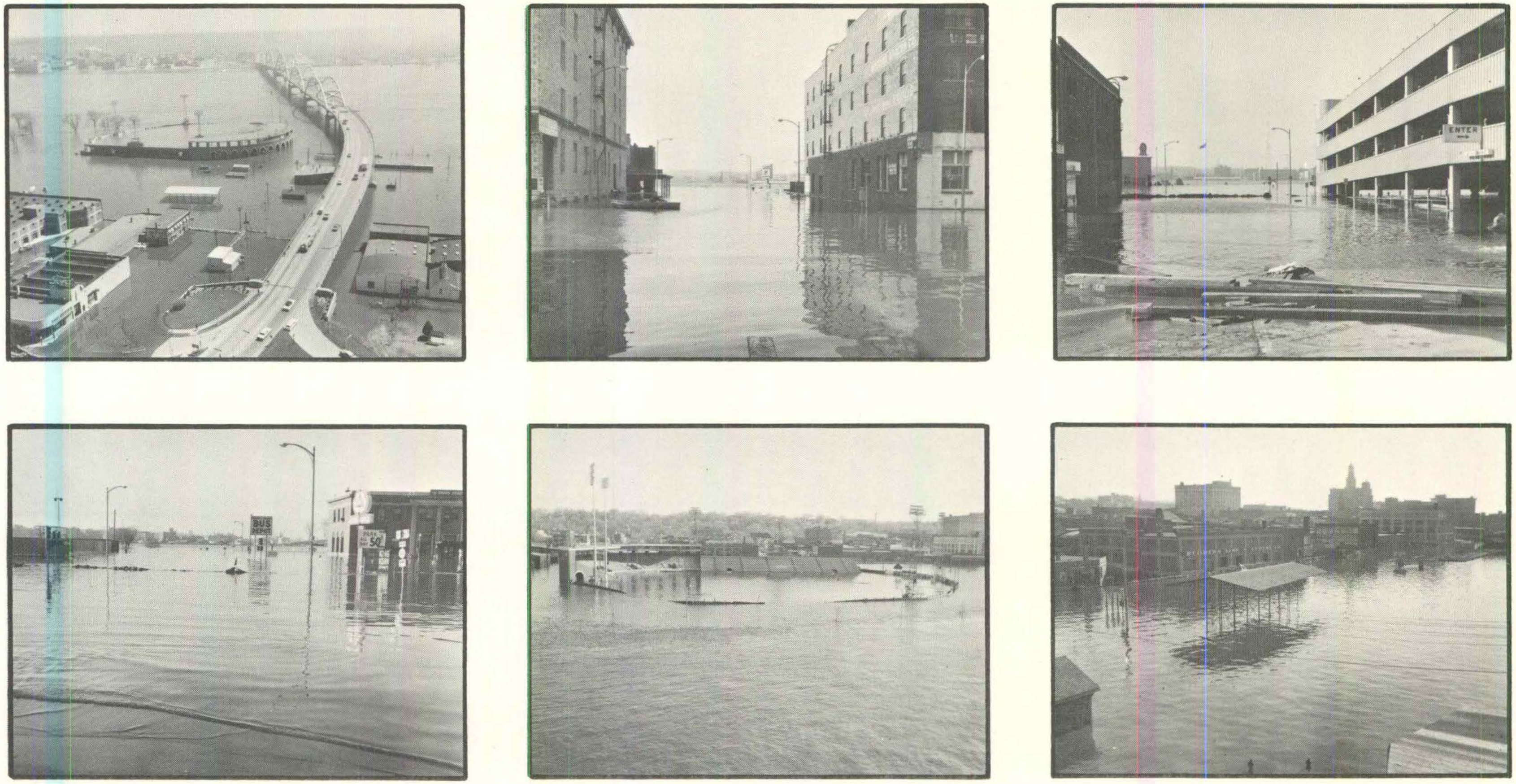


Figure 20. April 1965 high water at Davenport, Iowa. Top row left to right: Aerial view of Centennial Bridge and baseball stadium; looking south along Pershing Street across 2nd Street; and looking south along Perry Street across River Drive. Bottom row left to right: Looking south on Harrison Street across River Drive; looking north at the baseball stadium from Centennial Bridge; and looking east at Davenport river front from Centennial Bridge.

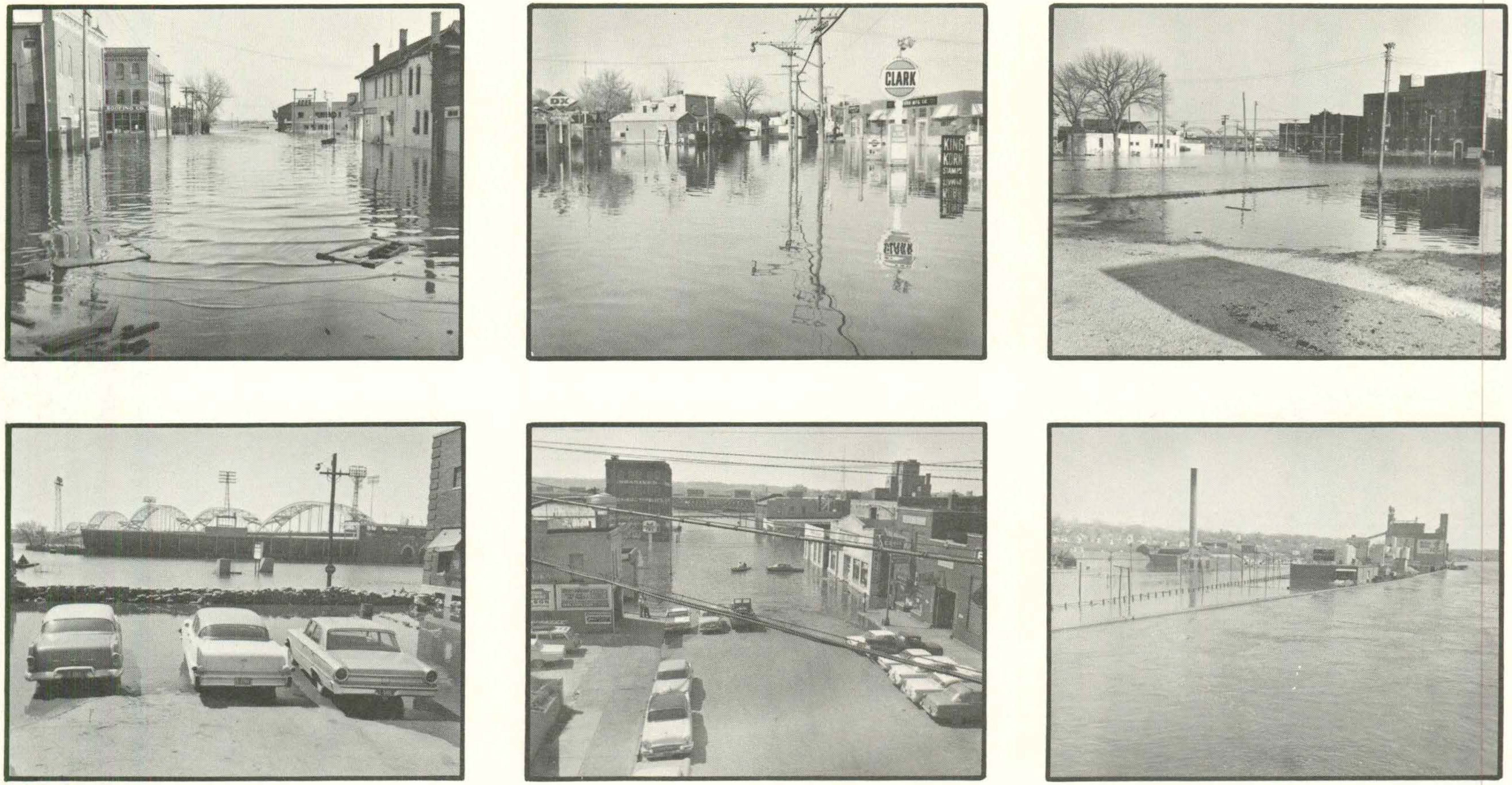


Figure 21. April 1965 high water at Davenport, Iowa. Top row left to right: Looking south on Warren Street; looking east at Rockingham Road and Sturdevant Street intersection; and looking east at Rockingham Road and Taylor Street intersection. Bottom row left to right: Looking south on Western Street across River Drive; looking south on Iowa Street from railroad bridge; and looking east from Government Bridge - Robin Hood Flour Plant in the background.

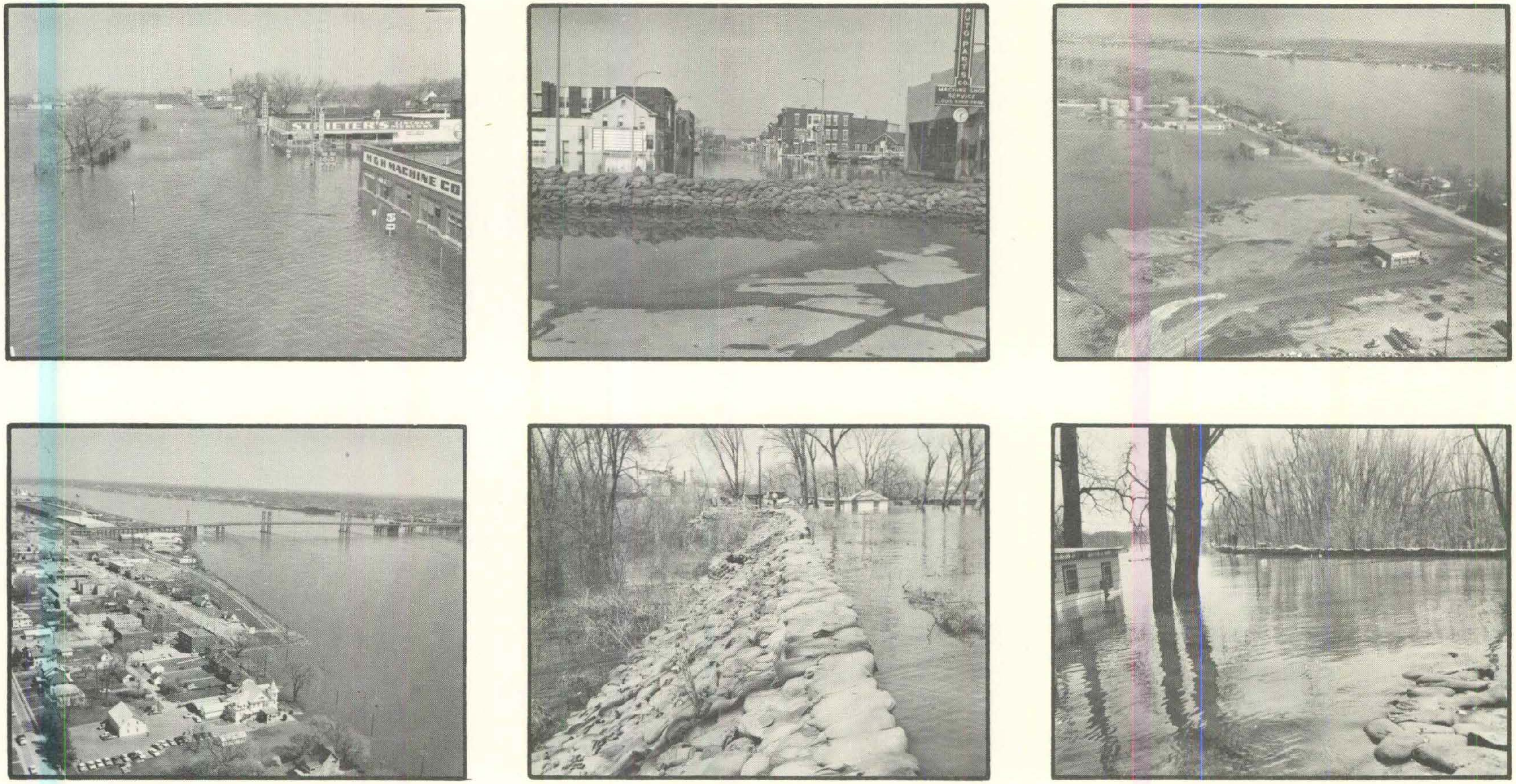


Figure 22. April 1965 high water. Top row left to right: View from Centennial Bridge looking west along River Drive, Davenport; looking west on 2nd Street from Gaines Street, Davenport; and aerial view of Mississippi Point below mouth of Duck Creek, Bettendorf. Bottom row left to right: Aerial view of Bettendorf river front; looking north at Mississippi Point sandbags, Bettendorf; and looking south from just below the railroad tracks at Mississippi Point.

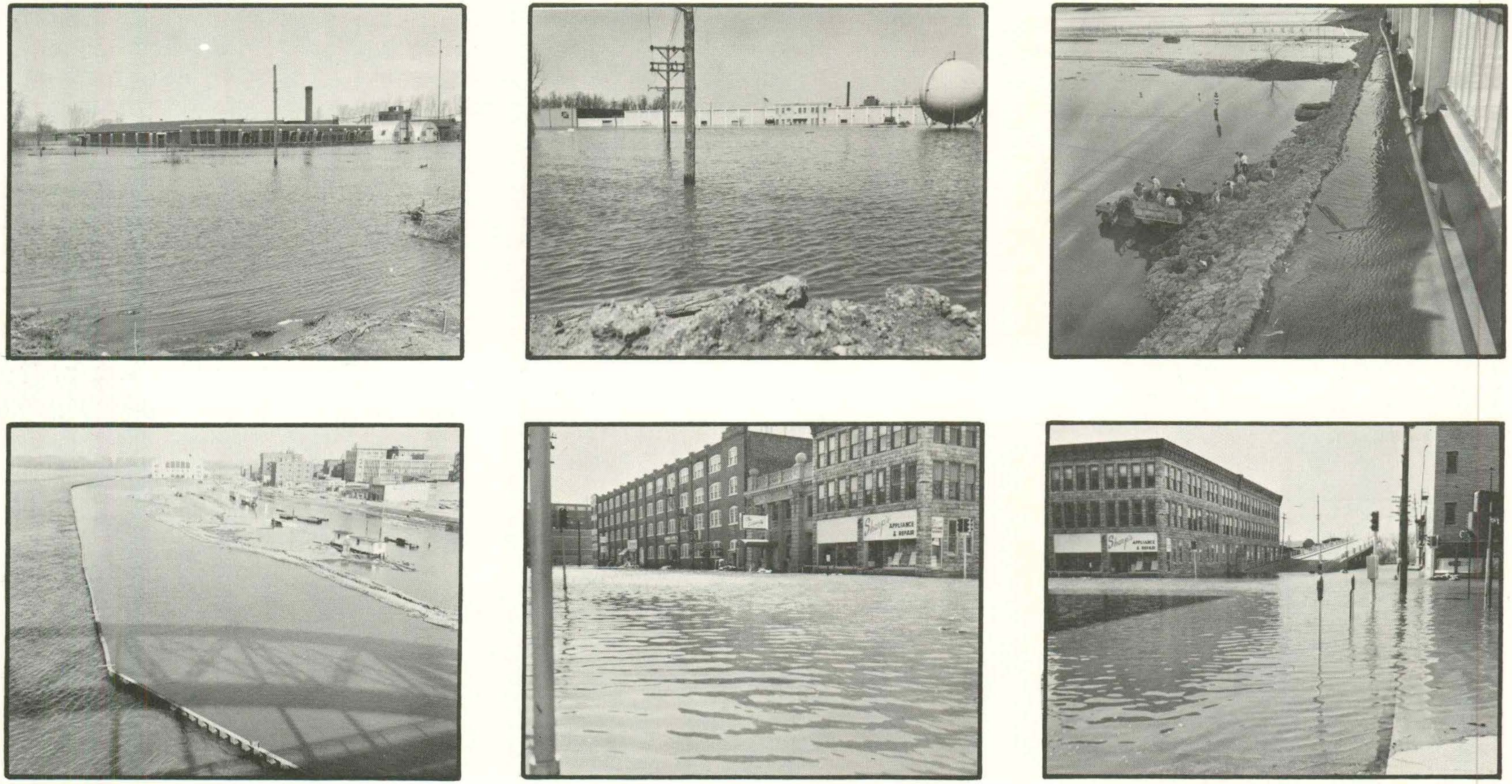


Figure 23. April 1965 high water. Top row left to right: View from railroad tracks at 18th Avenue, Rock Island, showing Gellman Manufacturing Company; view from 13th Avenue, Rock Island, of Container Corporation of America; and sandbagging at the east side of Centennial Bridge, Rock Island. Bottom row left to right: View of levee upstream from Centennial Bridge, Rock Island; looking east on 3rd Avenue across 15th Street, Moline; and Arsenal Bridge approach at 15th Street, Moline.

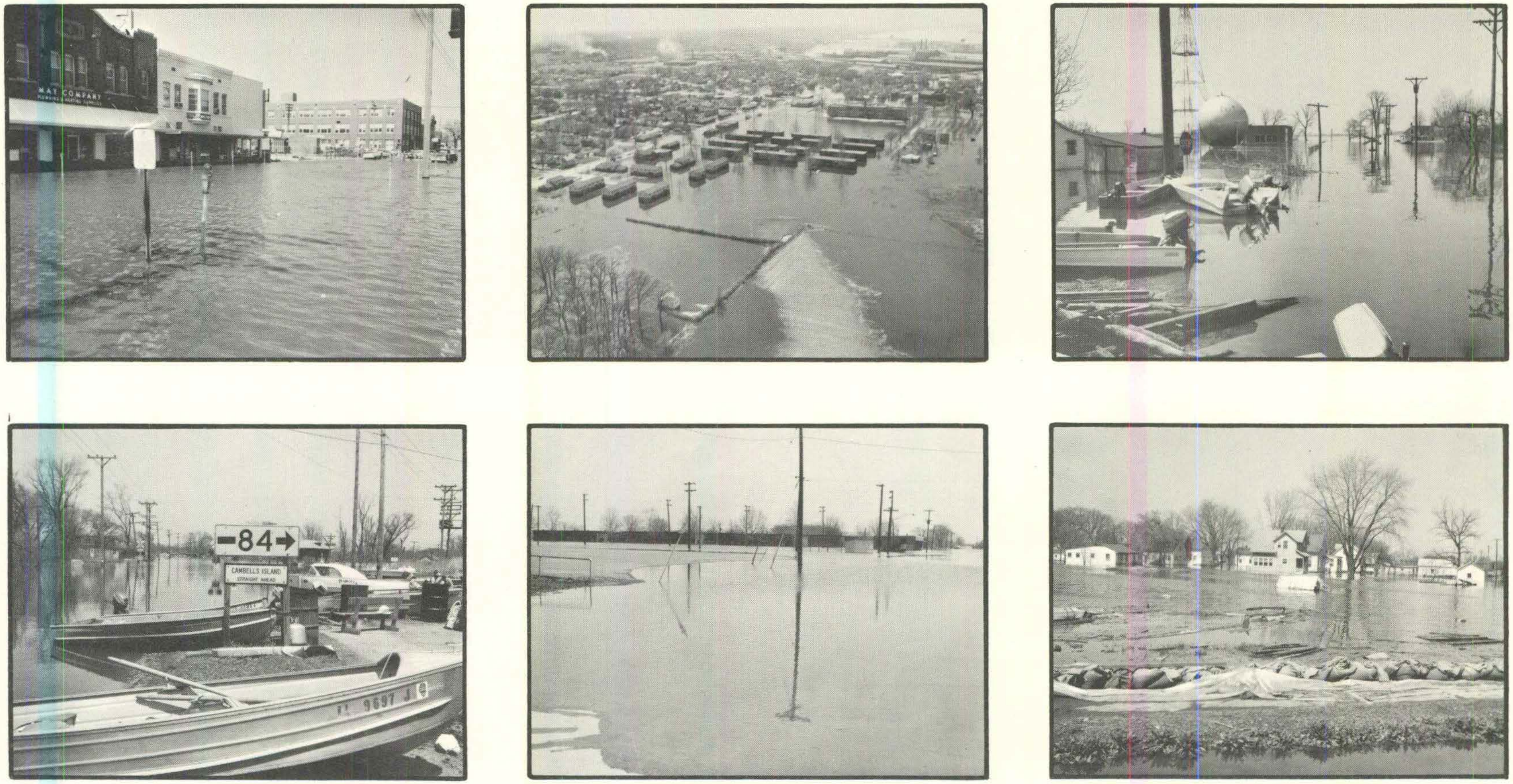


Figure 24. April 1965 high water. Top row left to right: Looking east along 3rd Avenue, Moline; aerial view of East Moline - International Harvester in the background; and East Moline Waterworks. Bottom row left to right, flood scenes in East Moline: Entrance to Campbell's Island; looking east along 7th Avenue from 19th Street; and looking west at UAW Hall on 19th Street.

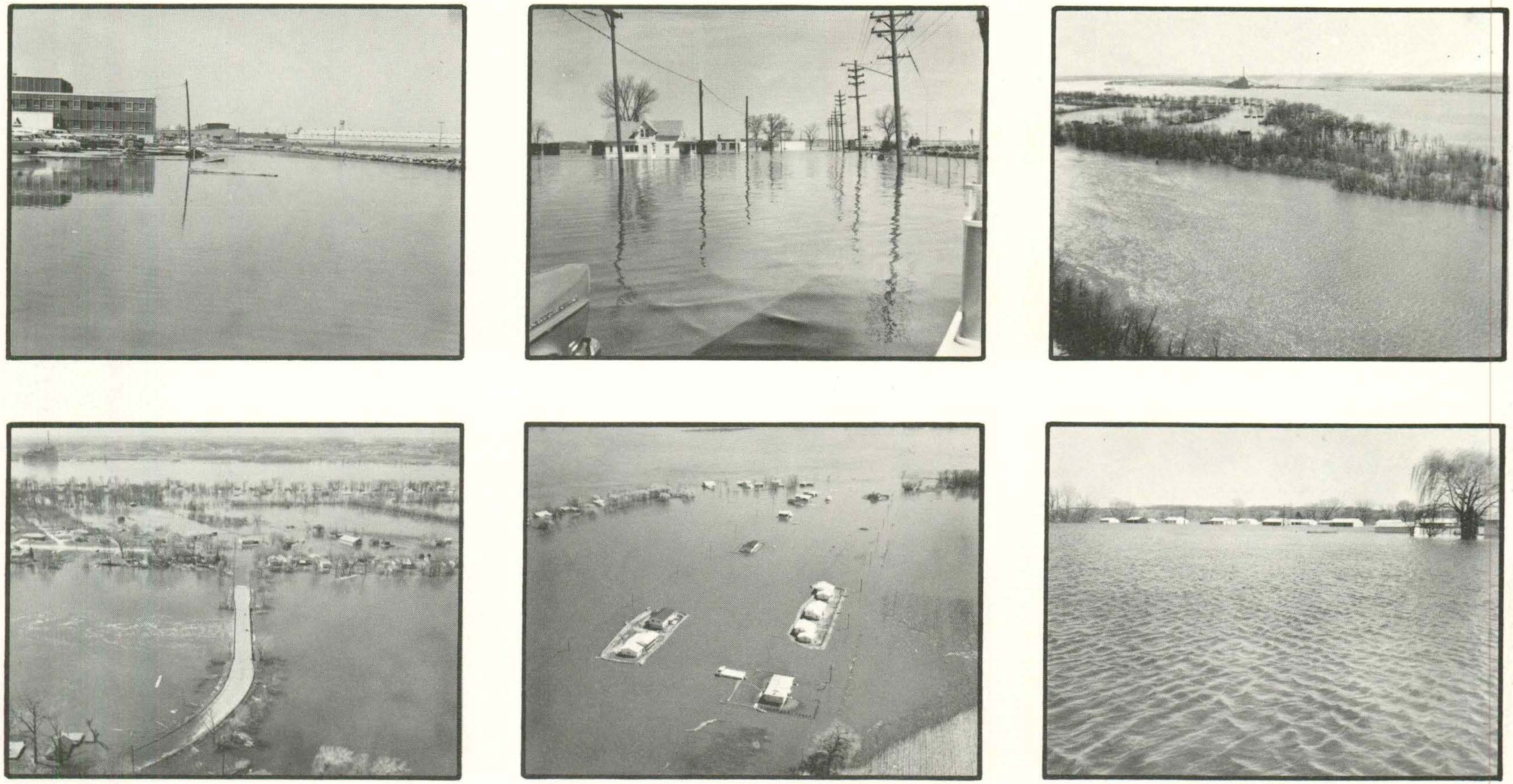


Figure 25. April 1965 high water. Top row left to right, flood scenes in East Moline: Looking west at the rear of **Ametek** Plant; west side of International Harvester; and aerial view of Campbell's Island. Bottom row left to right: Aerial view of Campbell's Island; aerial view of flooded homes in Pleasant Valley; and view from the railroad tracks looking southeast, Pleasant Valley.

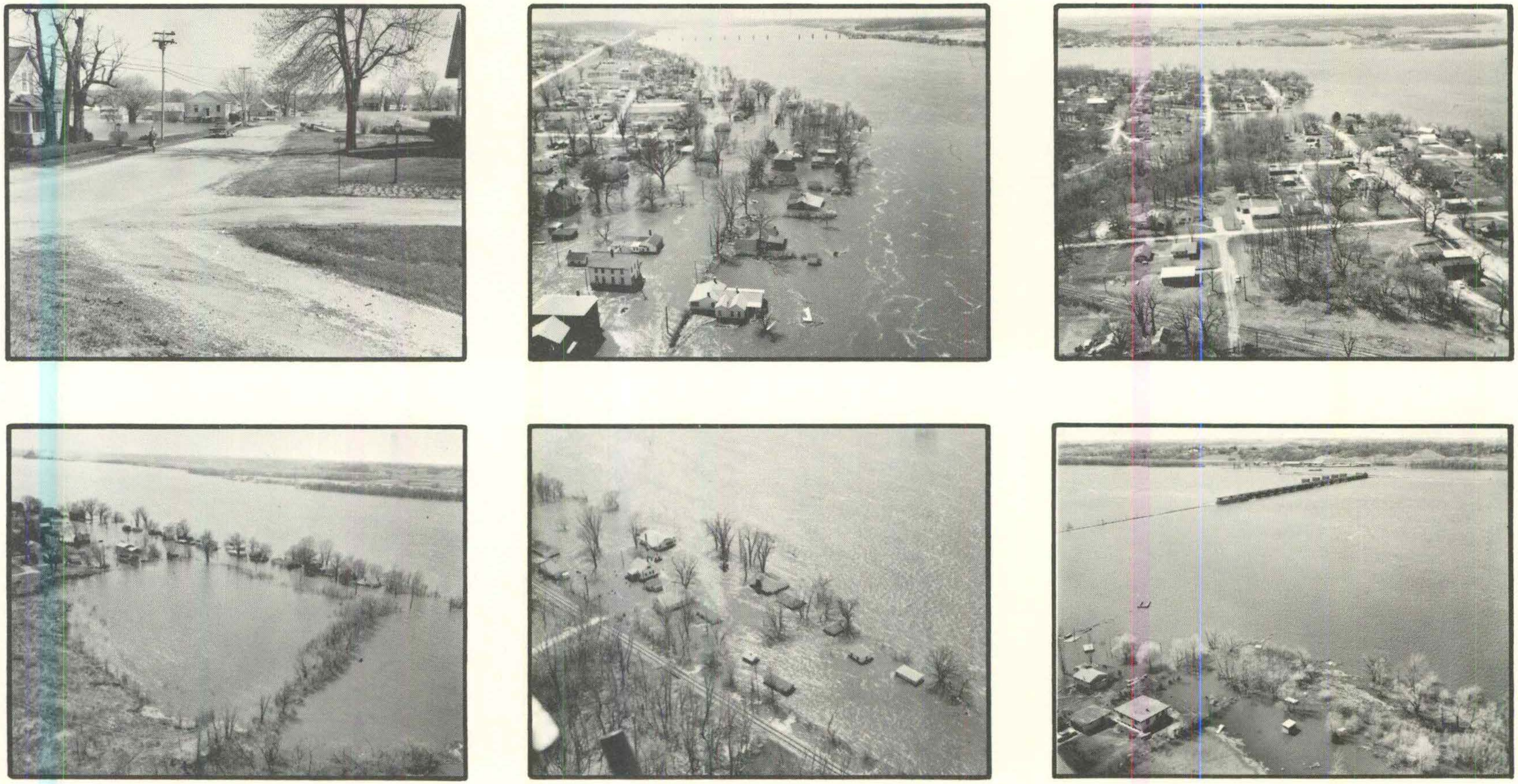


Figure 26. April 1965 high water. Top row left to right: Pleasant Valley, Iowa; aerial view of the upstream side of Interstate 80 Bridge on the Illinois side; and aerial view of Cordova river front. Bottom row left to right: Aerial view of Hampton river front; aerial view of Rapid City river front; and aerial view of Lock and Dam No. 14.

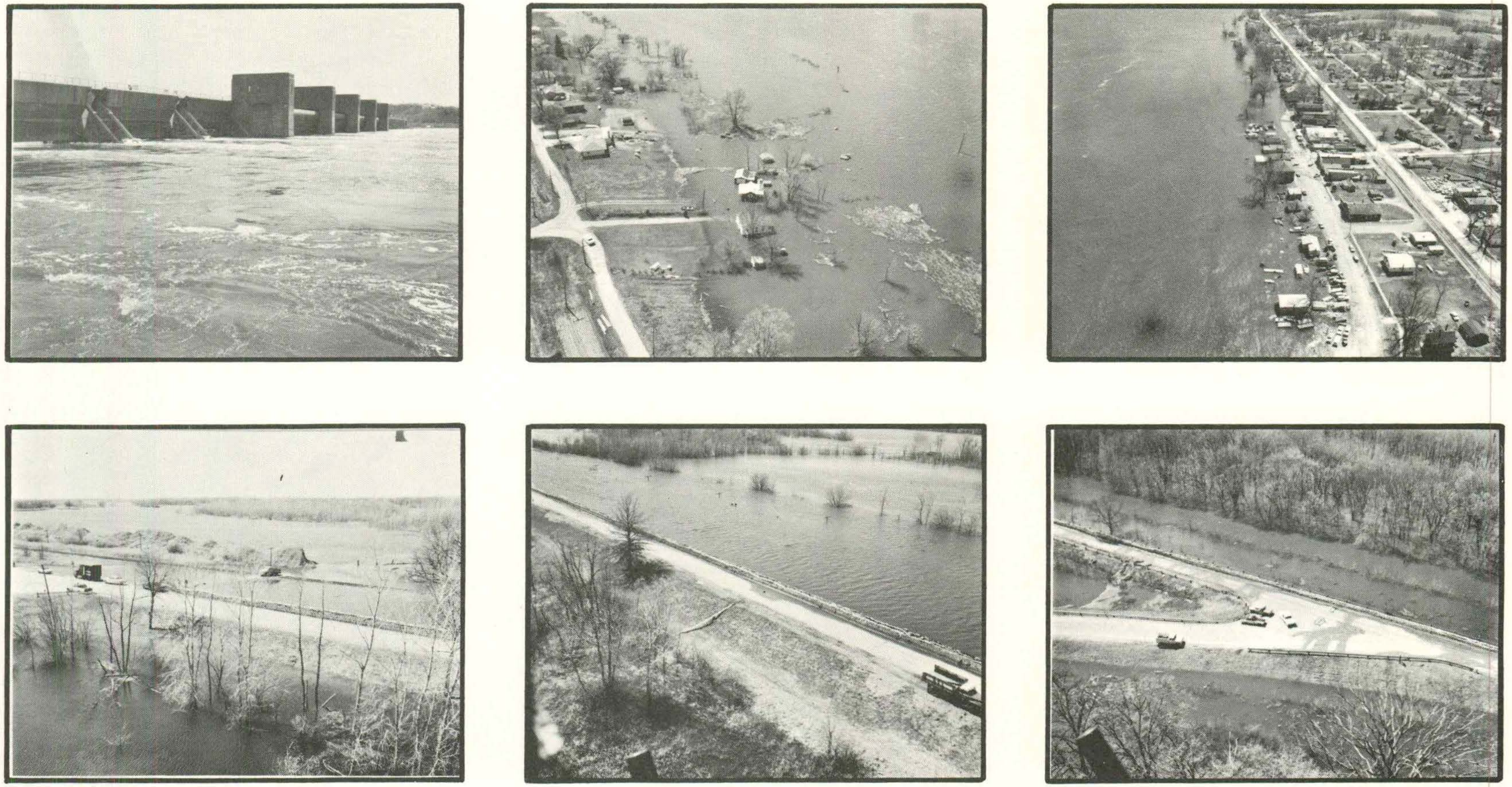


Figure 27. April 1965 high water. Top row left to right: Raised tainter gates of Lock and Dam No. 14; aerial view of Port Byron river front; and aerial view of Princeton river front looking downstream. Bottom row left to right: Junction of Illinois Highway 84 and County Road T; Illinois Highway 84 and the C.M.St.P.&P. RR Tracks, south of the pumphouse; and Illinois Highway 84 and the submerged C.M.St.P.&P. RR Tracks in the background.

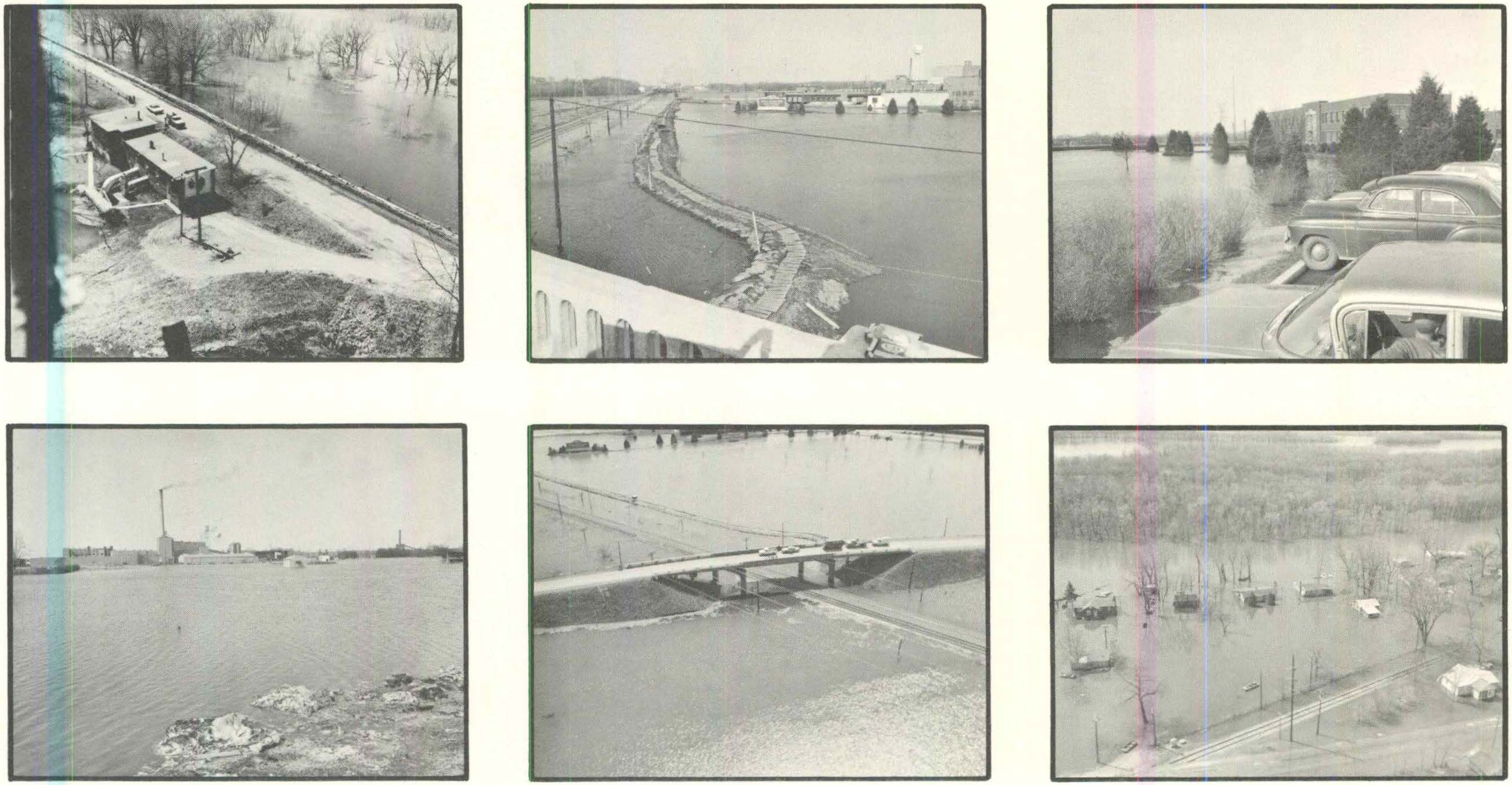


Figure 28. April 1965 high water. Top row left to right: Illinois Highway 84 pumphouse at the Rock Island-Whiteside County line; levee north of Du Pont Plant, Camanche; and Du Pont Plant and parking lot at Camanche. Bottom row left to right, flood scenes in Camanche, Iowa: Looking north at Du Pont Plant; U.S. Highway 67 over the Northwestern Railroad Tracks; and Swan Slough area west of Camanche.

TABLE 7

MAXIMUM KNOWN FLOOD DISCHARGES

ON THE MISSISSIPPI RIVER

Location	Miles Above Ohio River	Drainage Area Sq. Mi.	Date	Peak Discharge Amount cfs	Peak Discharge Per Sq. Mi. cfs
Near Deer River, Minnesota	-	1442	August 6, 1905	4370	3.0
At Grand Rapids, Minnesota	1182.0	3370	September 3, 1948	12500	3.7
Near Libby, Minnesota	1106.0	5060	May 17, 1950	16000	3.2
At Aitkin, Minnesota	1055.9	6140	May 20, 1950	20000	3.2
Near Royalton, Minnesota	956.0	11600	April 16, 1965	37700	3.2
Near Anoka, Minnesota	864.8	19100	April 17, 1965	91000	4.8
At St. Paul, Minnesota	839.3	36800	April 16, 1965	171000	4.6
At Prescott, Wisconsin	811.4	44800	April 18, 1965	228000	5.1
At Winona, Minnesota	725.7	59200	April 19, 1965	268000	4.5
At McGregor, Iowa	633.4	67500	April 24, 1965	276000	4.1
At Clinton (Camanche Gage), Iowa	511.8	85600	April 28, 1965	307000	3.6
At Keokuk, Iowa	364.2	119000	May 1, 1965	327000	2.7

FUTURE FLOODS

This section of the report discusses the Standard Project Flood and the Intermediate Regional Flood on the Mississippi River in the study reach. The Standard Project Flood represents reasonable upper limits of possible flooding under existing conditions of development of and encroachment into the Mississippi River flood plain. The Intermediate Regional Flood represents a flood that may reasonably be expected to occur more frequently.

Although large floods from heavy general storms have occurred on the Mississippi River in the study reach, the main flood season is in early spring. The basin area covered by a heavy intense storm is generally small when compared to the total basin area at the study reach. Timing of crest flows from tributary streams in relation to crest flow on the main stem critically influences the height of the main stem crest. The potential for spring snowmelt floods is generally more probable than those from general heavy storms. Table 7 lists the maximum recorded flood discharges and dates of occurrence for several locations on the Upper Mississippi River.

Five major factors influence the magnitude of spring snowmelt floods. These factors include fall precipitation, frost depth, snow depth, rate of snowmelt, and spring rainfall. The first two factors affect the ability of the ground to absorb appreciable amounts of water during the spring run-off period. Snow depth and its water content provide the potential run-off volume. The rate of snowmelt influences both the length and height of the flood crest. Ideally, with above freezing daytime temperatures and below freezing night-time temperatures, the snowmelt will take place slowly producing a long flood crest but reducing its height. With continuous above freezing temperatures after snowmelt begins, flood heights may achieve the potential maximum. The fifth factor, spring rainfall, may or may not seriously affect flood heights depending on extent and amount of rainfall and its geographic location in relation to the location of the main stem flood crest.

DETERMINATION OF INTERMEDIATE REGIONAL FLOOD

The Intermediate Regional Flood is defined as a flood having an average frequency of occurrence in the order of once in 100 years, at a designated location, although the flood may occur in any year. Probability estimates are based on statistical analyses of stream flow records available for the watershed under study. The Intermediate Regional Flood represents a major flood which could occur on the Mississippi River in the study reach.

In order to determine the Intermediate Regional Flood for the study reach of the Mississippi River, statistical analyses were made of the stream gaging records listed in Table 4 for the study reach. Peak discharge of the Intermediate Regional Flood for several locations in the study reach are given in Table 8.

TABLE 8

INTERMEDIATE REGIONAL FLOOD

PEAK DISCHARGES ON MISSISSIPPI RIVER

Location	Miles Above Ohio River	Drainage Area Sq. Mi.	Discharge cfs
Port Louisa, Iowa	441.3	99600	380000
Above Rock River	479.1	88500	347000
Camanche, Iowa	511.8	85700	344000

DETERMINATION OF THE STANDARD PROJECT FLOOD

It is commonly accepted that floods larger than any experienced on a specific stream can and probably will occur. The Corps of

Engineers, in cooperation with the Weather Bureau (ESSA) has made broad and comprehensive studies and investigations based on records of experienced storms and floods, and has evolved generalized procedures for estimating the flood potential of streams. However, due to the complexity of application to drainage areas of the size of the Upper Mississippi River Basin and the scope of this study, a Provisional Standard Project Flood for the study reach has been developed. An estimate of the Standard Project Flood is based on an envelope curve of maximum discharges which includes the 1965 peak flood discharges on the Mississippi River. The envelope curve is based on a Standard Project Flood estimate for the Mississippi River at Mankato, Minnesota and the Mississippi River contribution to a Standard Project Flood at St. Louis, Missouri. A definition of the Standard Project Flood is found in the Glossary of Terms in this report. Table 9 lists Standard Project Flood discharges for several locations in the study reach.

TABLE 9

STANDARD PROJECT FLOOD

PEAK DISCHARGES ON MISSISSIPPI RIVER

Location	Miles Above Ohio River	Drainage Area Sq. Mi.	Discharge cfs
Port Louisa, Iowa	441.3	99600	502000
Above Rock River	479.1	88500	465000
Camanche, Iowa	511.8	85700	460000

Frequency

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

Possible Larger Floods

Floods larger than the Standard Project Flood are possible; however, the combination of factors that would be necessary to produce such floods would seldom occur. The importance of floods of this magnitude depends on the consequences should they occur. Extensive damage could be avoided by consideration of the Standard Project Flood in planning for flood plain development.

HAZARDS OF GREAT FLOODS

The damage caused by any flood depends, in general, upon how much area is flooded, the development of the flooded area, the height of flooding, the velocity of flow, the rate of rise, and the duration of flooding. Mississippi River floods are developed by two sets of conditions. The melting of the winter accumulation of snow, with or without additional run-off due to rainfall, results in the late winter and early spring floods. Summer and fall floods are due to heavy rainfall over the Mississippi River basin.

Ice jams occur on the Mississippi River and produce higher stages than would be obtained with open river conditions. However, ice jams are difficult to evaluate and their occurrence is mentioned as a potential flood risk.

Areas Flooded and Height of Flooding

The areas flooded along the Mississippi River by the Standard Project Flood and the Intermediate Regional Flood are shown in Plates 6 through 9. Depths of flow may be estimated from the water surface profiles shown in Plates 10 through 13 in combination with the flooded area maps.

During a Standard Project Flood, the Drury Drainage District and the Bay Island Drainage and Levee District agricultural levees are assumed to fail. It is further assumed that failure will occur when the flow and water surface profile elevations exceed those of the Intermediate Regional Flood. The Muscatine Island Levee District and Muscatine-Louisa County Drainage District No. 13 urban levees and the Meredosia Drainage District levees are assumed to hold with emergency flood fighting measures. Precise quantitative evaluation of the ultimate flood height reached when failure has occurred during a Standard Project Flood is beyond the scope of this report and the available basic data. Evaluation of the effect of failure would have to consider the rate of flow through the breach, storage within the drainage district, possible levee failures downstream in other drainage districts, timing of the failure in relation to the peak rate of flow and the storage effect at the time of the peak rate of flow as well as other factors which may influence the main stem flow rate and water surface elevations.

Failure of the Drury and Bay Island levees during the Standard Project Flood would lower the water surface profile elevations upstream from the breach. For this report, it was assumed that the effect would diminish proceeding upstream from the levee failures and would disappear at the mouth of the Rock River. Consequently, the delineation and the water surface profile for the Standard Project Flood downstream from the mouth of the Rock River is an estimate of the reasonable upper limit of expected flooding. The actual extent and elevation of the water surface may be somewhat less should the Standard Project Flood occur.

During an Intermediate Regional Flood all existing levee projects are assumed to hold with emergency flood fighting measures. The effects of existing private levee systems and possible failure during either the Intermediate Regional or Standard Project Floods are considered negligible due to the small amount of storage within the leveed area and the relatively small lateral extent along the river.

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

Figures 29 through 37 show the heights that would be reached by the Standard Project Flood and the Intermediate Regional Flood on the facilities existing on the flood plain of the Mississippi River.

Velocities, Rates of Rise and Duration

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

Plate 14 shows measured velocities at the Rock Island Centennial Bridge during the flood of April 1965. Velocities would be higher at more severe flow restrictions and would also be higher for flows of greater magnitude. Plate 3A shows the total rise above low water, the rate of rise, and the duration above flood stage for the April and May floods of 1952, 1965, 1967, and 1969. Plate 3B shows similar data for the ice jam flood of February 1966 at the tailwater of Lock and Dam No. 15 at Davenport.

Duration of flooding may have significant effects on protective works during major floods. Saturation may weaken the works and may encourage erosion of the riverward face by high flow velocities and wind generated wave action. In addition, duration of flooding in combination with high overbank and channel velocities would create hazardous conditions in deceloped areas. Velocities greater than 3 feet per second combined with flow depths of 3 feet or greater are generally considered hazardous.

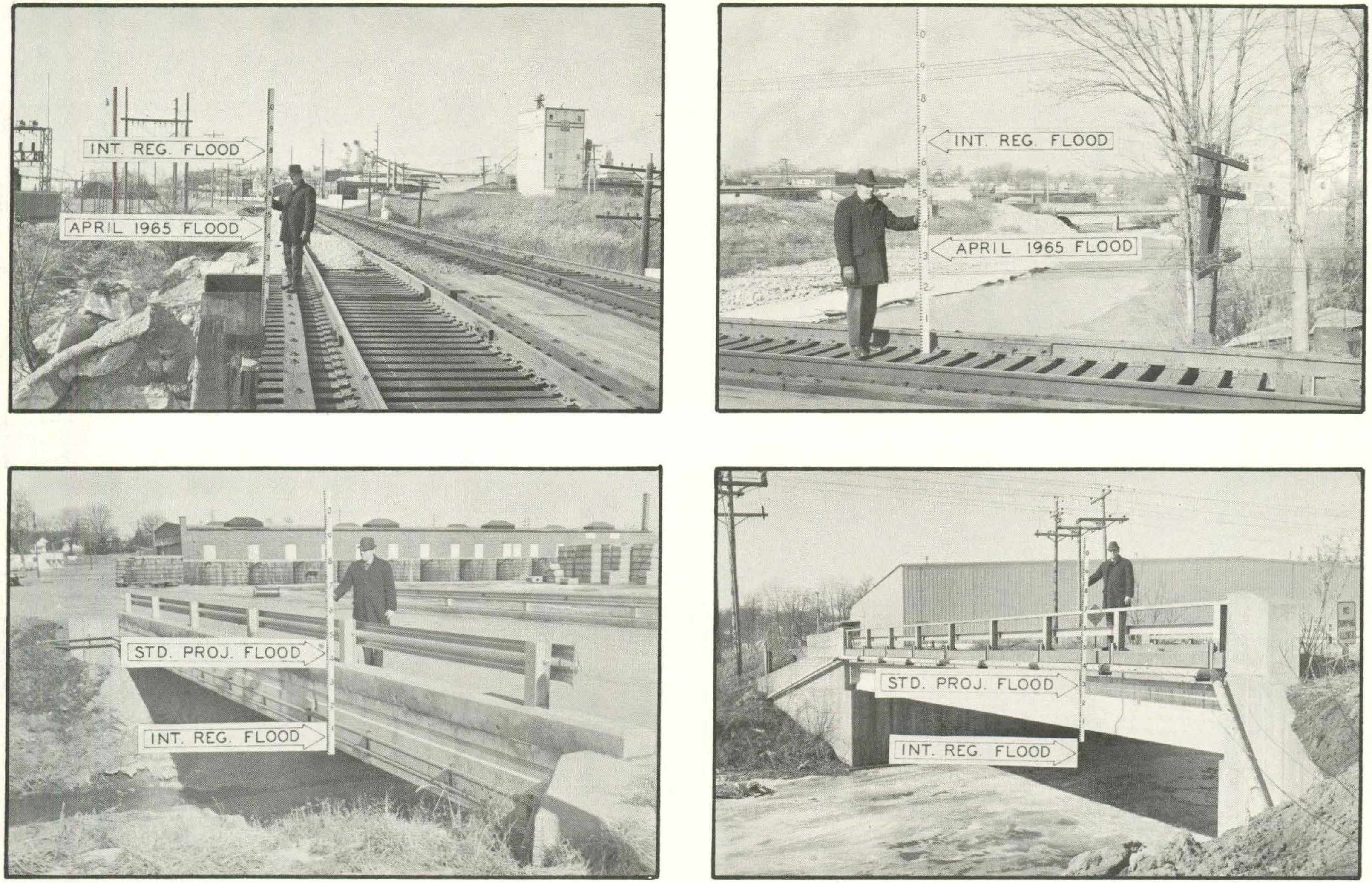


Figure 29. Top left: CRI&P RR Bridge at the mouth of Mad Creek looking toward business district of Muscatine. Top right: CRI&P RR Bridge looking up Mad Creek. Bottom left: Access road bridge to H. J. Heinz Plant across Geneva Creek. Bottom right: Looking upstream at the Clay Street bridge over Mad Creek.

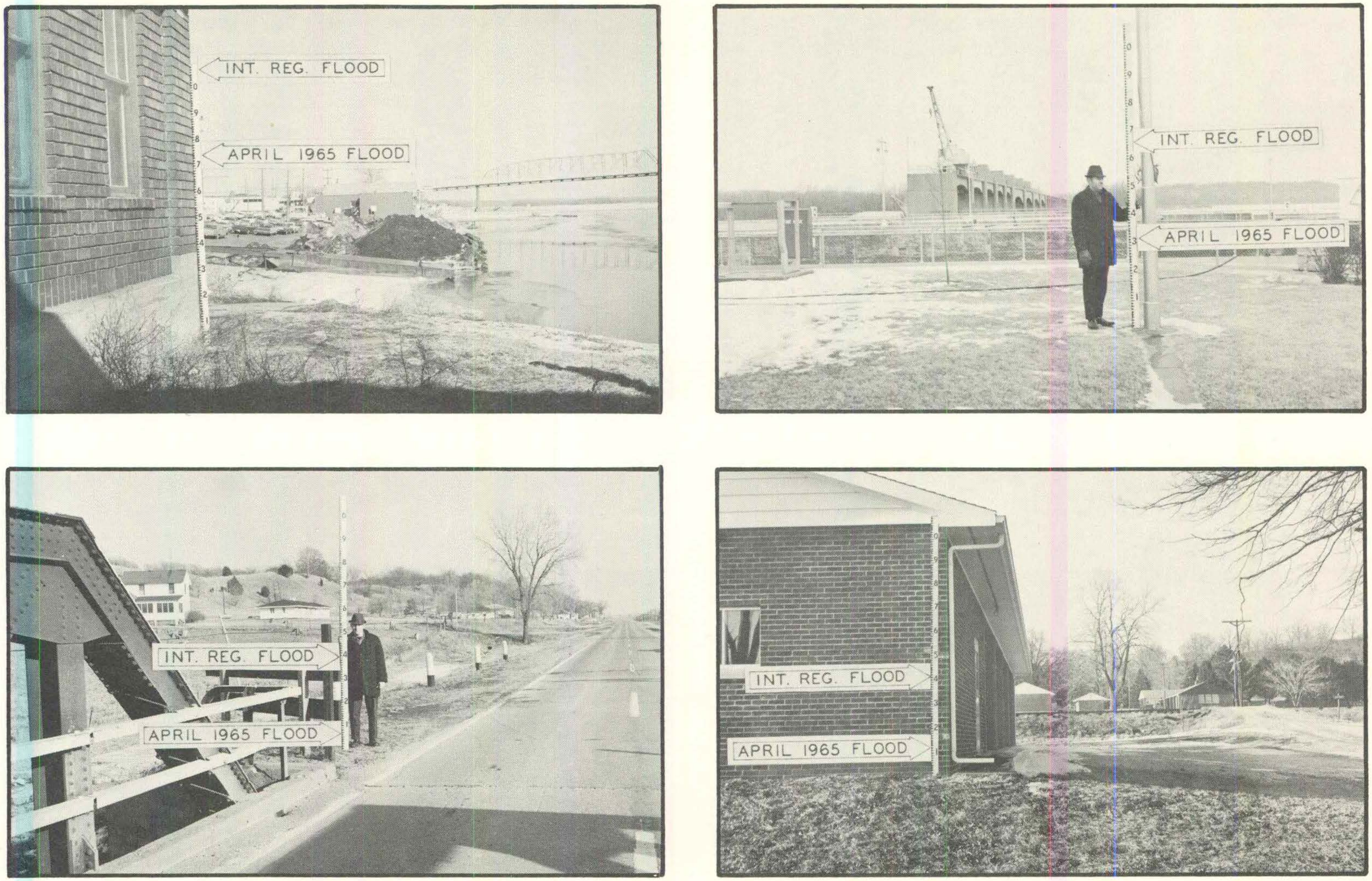


Figure 30. Top left: Building adjacent to Muscatine Gage at Mile 455.3. Top Right: Flagpole on the upstream side of Lock & Dam No. 16 - Mile 457.2. Bottom left: Looking east on Iowa State Highway 22 Bridge over Sweetland Creek at Mile 459.9. Bottom right: Building of the U. S. Bureau of Fisheries adjacent to the Fairport Gage at Mile 463.5.

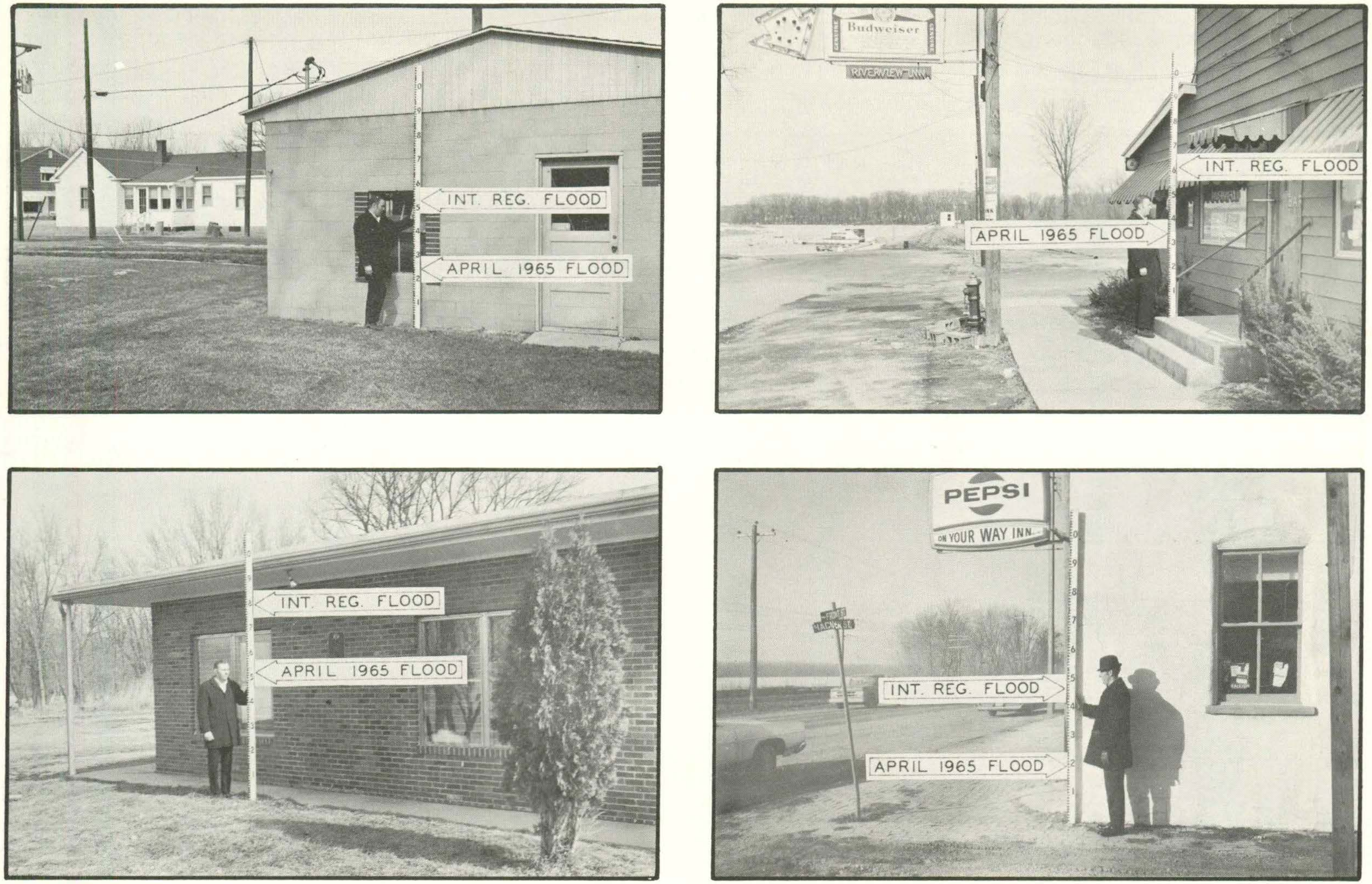


Figure 31. Top left: The Finco Plastics Shop at Third Avenue, Andalusia - Mile 472.9. Top Right: The Riverview Inn at First Street, Andalusia - Mile 473.0. Bottom left: Municipal Building at Andalusia - Mile 473.0. Bottom right: Hacker Street and Front Street intersection, Buffalo - Mile 472.9.

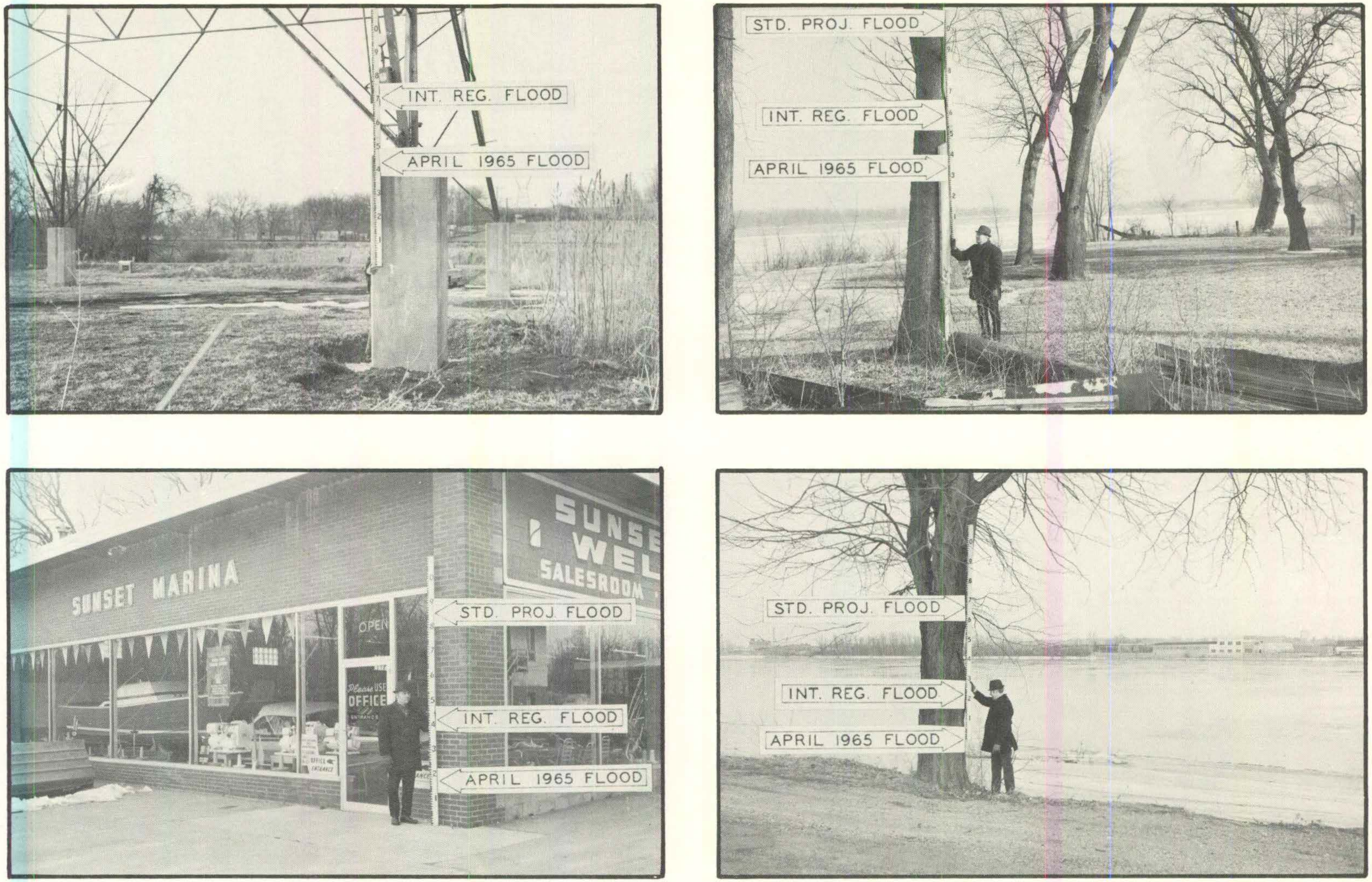


Figure 32. Top left: The first landward aerial cable crossing support one mile upstream of Linwood, Iowa - Mile 476.7. Top right: Lock 32 Gage of the I & M Canal at Mile 479.1. Bottom left: Sunset Marina Building, Rock Island - Mile 479.7. Bottom right: Tree opposite the 18th Fairway of the Credit Island Golf Course - Mile 480.2.

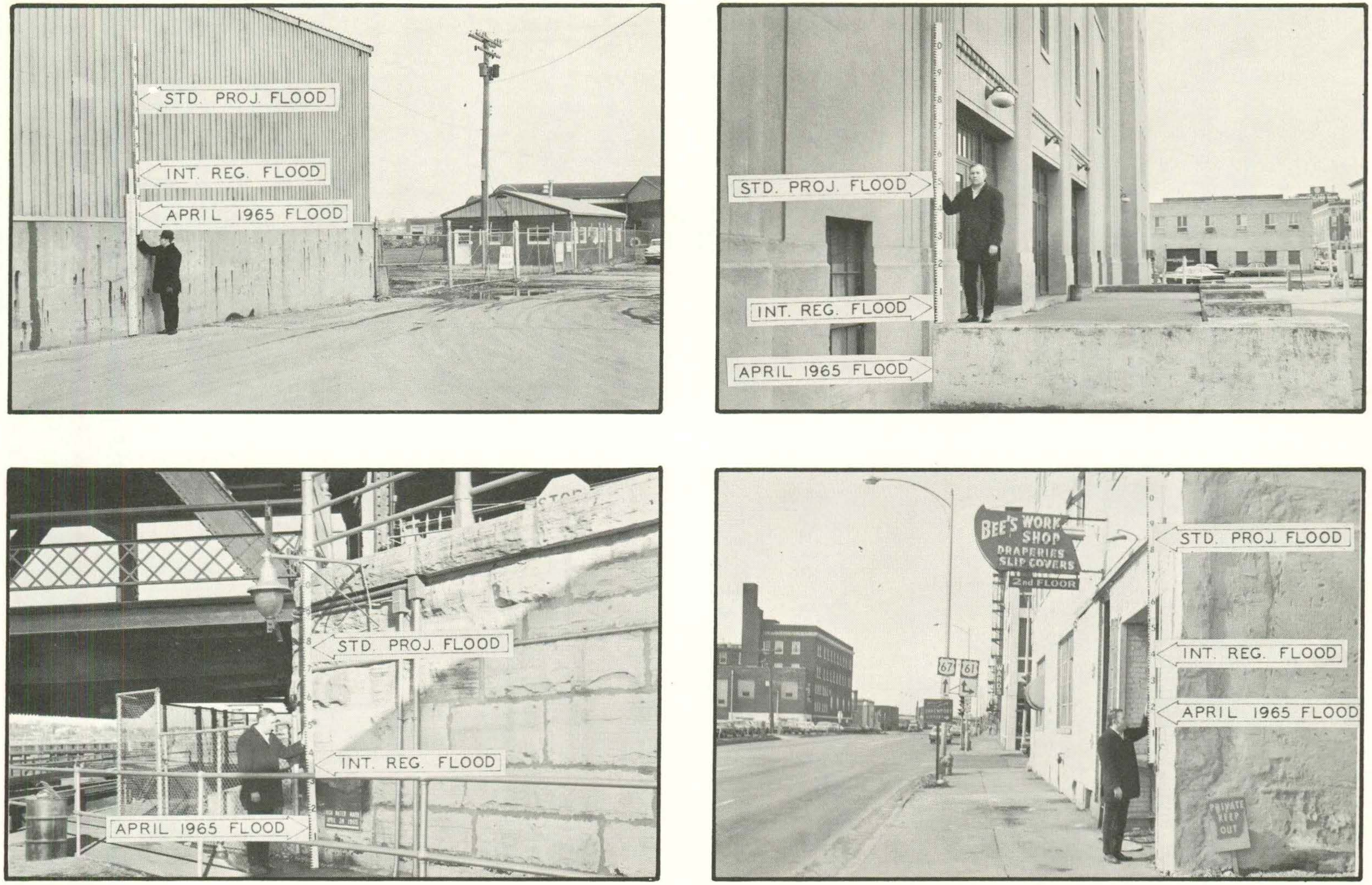


Figure 33. Top left: The Rock Island Boat Club at Mile 480.2. Top right: Main entrance of the Rock Island Armory - Mile 482.3. Bottom left: Looking west on River Drive, Davenport - Mile 482.6. Bottom right: Downstream side of the CRI&P RR and U. S. Government Bridge at Mile 482.9.

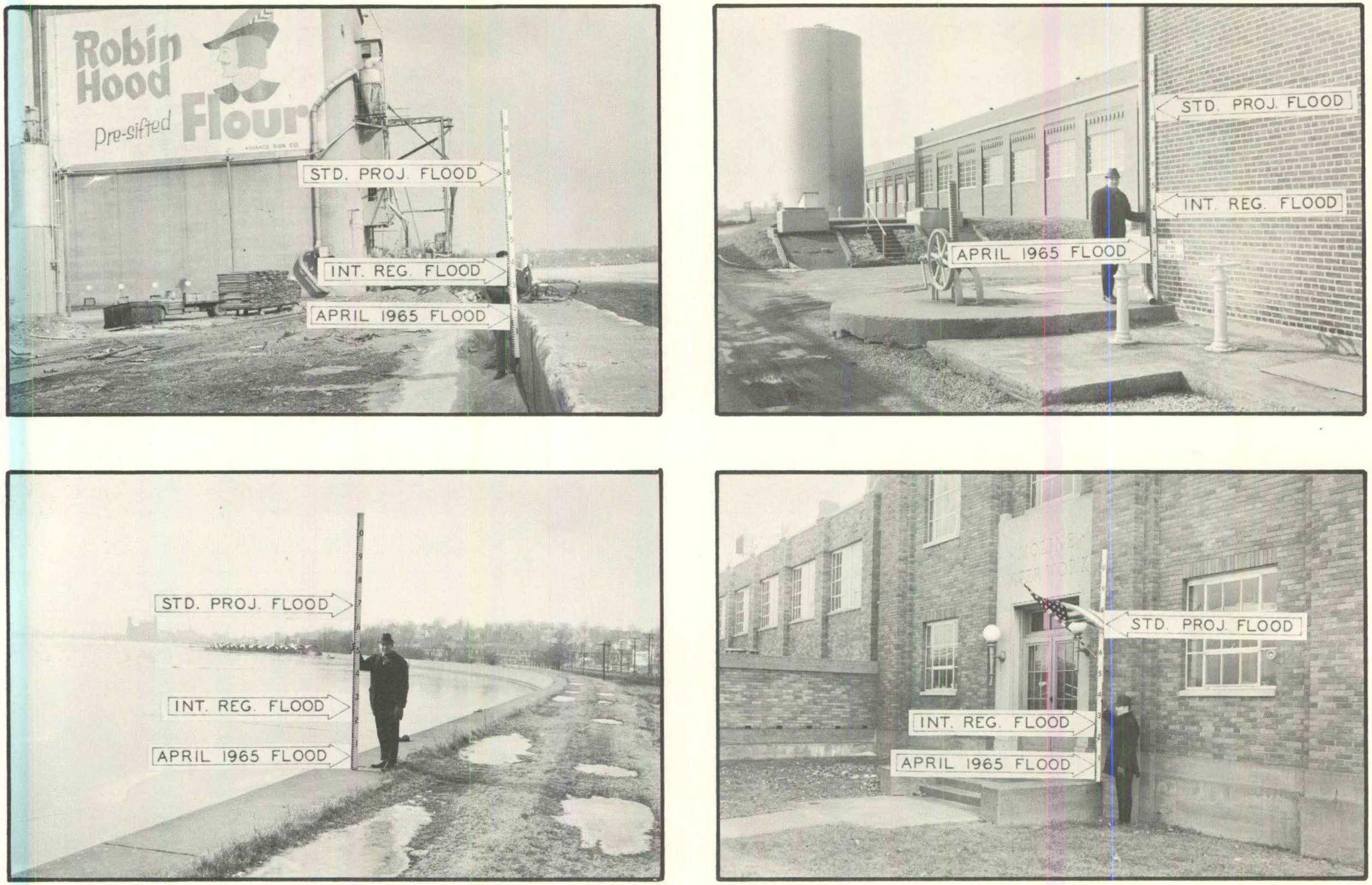


Figure 34. Top left: Floodwall near the Robin Hood Flour Building in Davenport at Mile 483.1. Top right: Looking west at the River Station of the Davenport Water Company on River Drive at Mile 483.9. Bottom left: Corps of Engineers bench mark about 500 feet downstream of McClellan Boulevard, Davenport - Mile 484.3. Bottom right: Moline Waterworks at Mile 485.6.

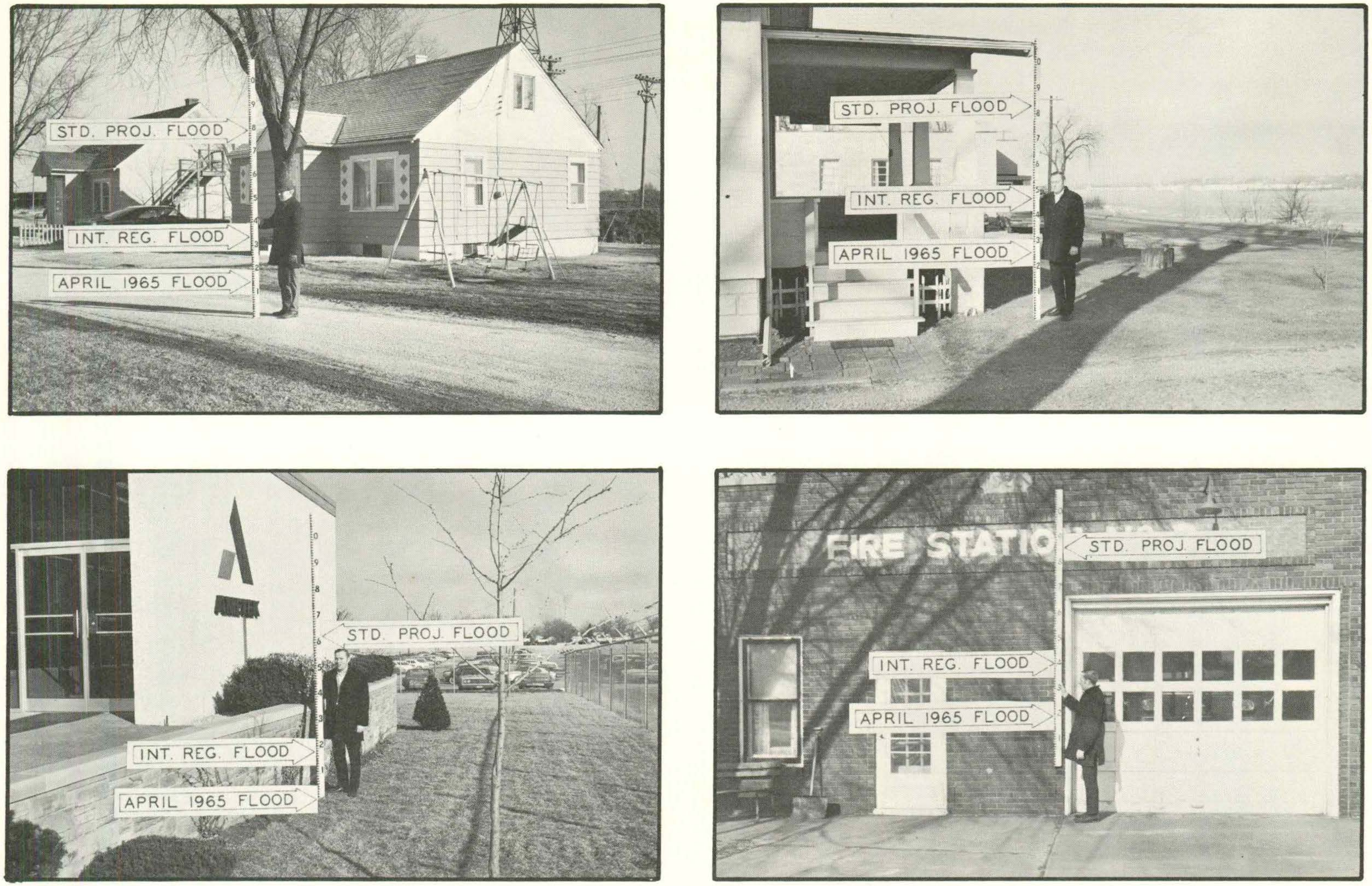


Figure 35. Top left: First house on the upstream side of Duck Creek, Bettendorf, between the tracks of the DRI&NW and CRI&P RR at Mile 487.9. Top right: Looking downstream at the house 30 feet downstream of 48th Street gage, Moline - Mile 488.0. Bottom left: The Ametek Plant on Seventh Street, East Moline - Mile 488.9. Bottom right: East Moline Fire Station at corner Thirteenth Street and Eighth Avenue - Mile 489.8.

Figure 36. Top left: Riverside Power Station near Riverdale, Iowa - Mile 489.0. Top right: First landward support of aerial cable crossing opposite Campbell's Island near the C.M.St.P.&P RR Tracks in East Moline - Mile 490.2. Bottom left: Upstream side of Interstate 80 Bridge looking from the left bank at Mile 495.4. Bottom right: Looking north at the LeClaire Fire Department Rescue Unit Center 30 feet upstream of the LeClaire Gage.

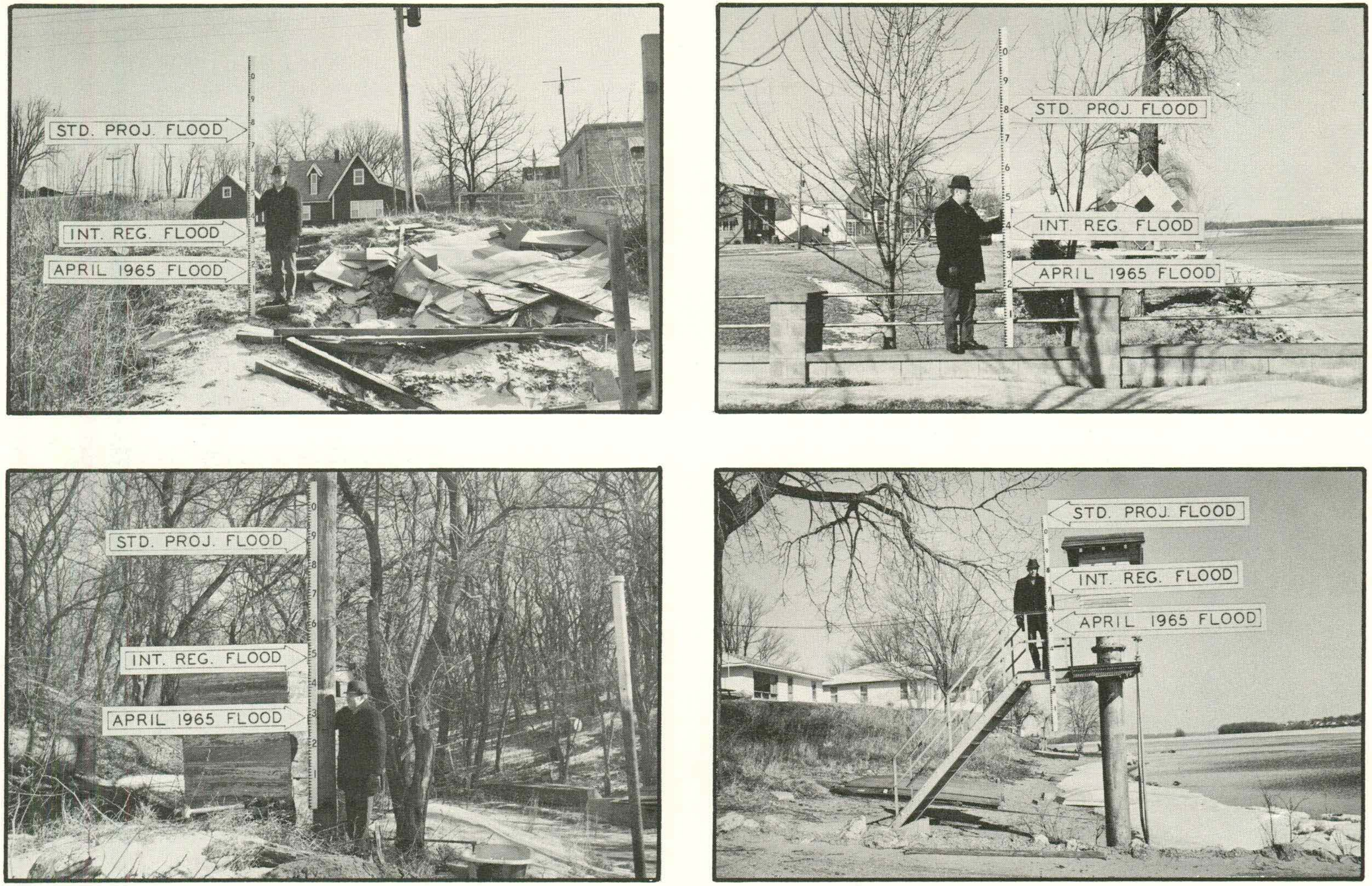


Figure 37. Top left: Looking east at 708 Main Street, Port Byron - Mile 497.5. Top right: Looking north at the Princeton Gage location - Mile 502.1. Bottom left: Mel McKay Pumphouse, Illinois, opposite the mouth of the Wapsipinicon River at Mile 507.0. Bottom right: Looking upstream at the Camanche recording gage.

GLOSSARY OF TERMS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

AUTHORITY, ACKNOWLEDGMENTS, AND INTERPRETATION OF DATA

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

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

Bi-State Metropolitan Planning Commission

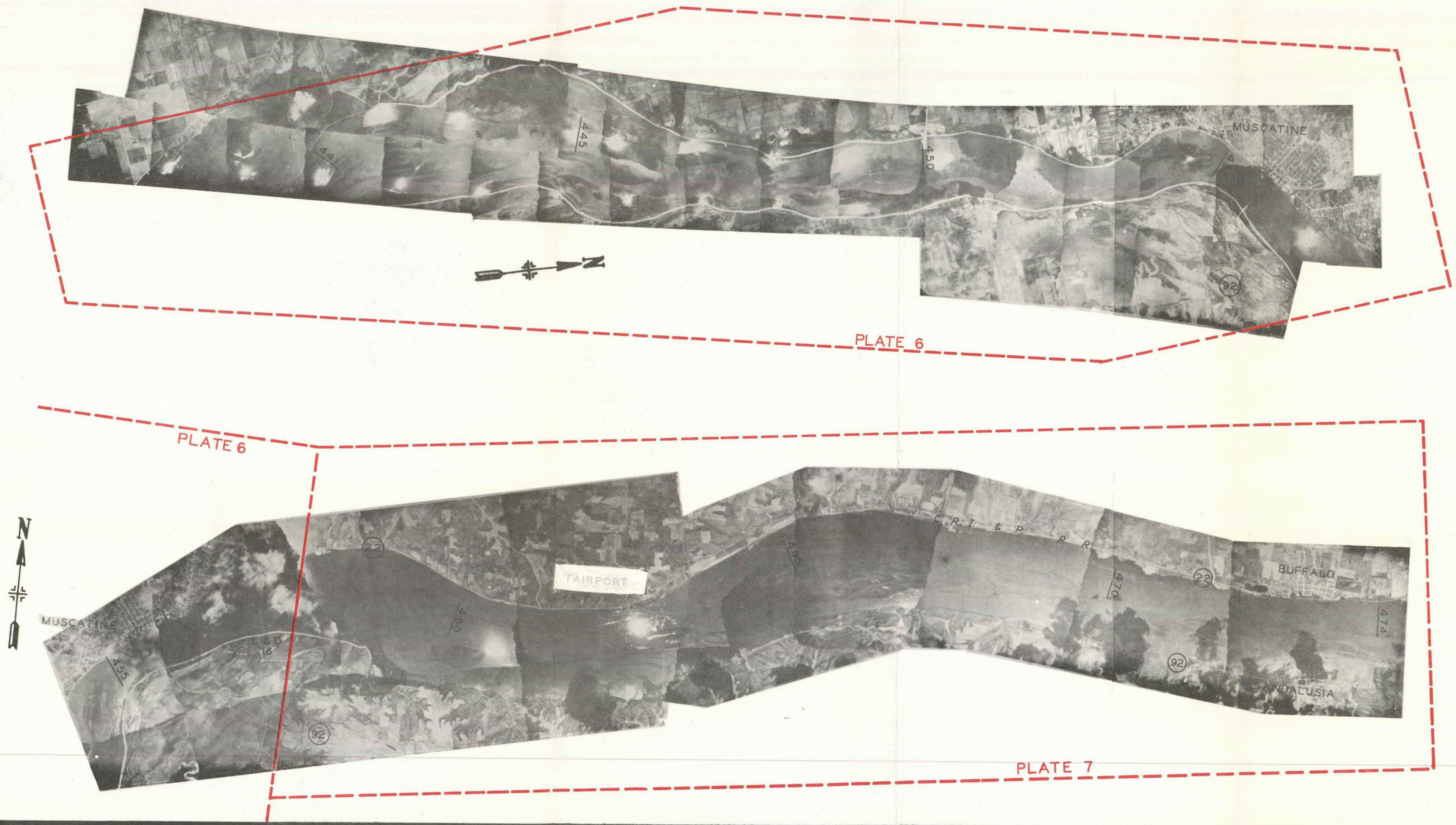
Illinois Division of Waterways, Department of Public Works and Buildings

Iowa Natural Resources Council

U. S. Geological Survey

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

This report evaluates the flood situation caused by the Mississippi River and its tributaries in Rock Island County, Illinois and Scott and Muscatine Counties, Iowa. The Rock Island District of the Corps of Engineers, upon request, will provide limited technical assistance in the interpretation and application of the data presented herein.



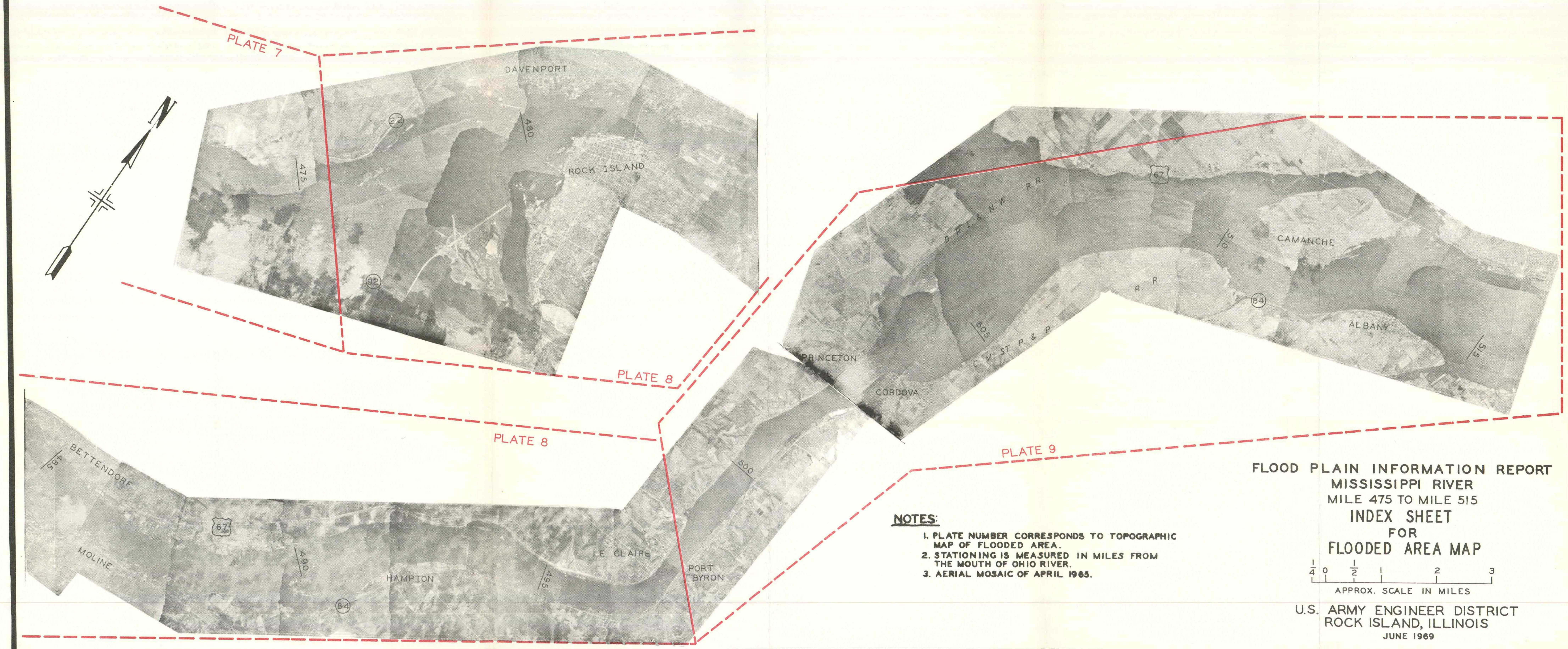
NOTES:

1. PLATE NUMBER CORRESPONDS TO TOPOGRAPHIC MAP OF FLOODED AREA.
2. STATIONING IS MEASURED IN MILES FROM THE MOUTH OF OHIO RIVER.
3. AERIAL MOSAIC OF APRIL 1965.

FLOOD PLAIN INFORMATION REPORT
MISSISSIPPI RIVER
MILE 441 TO MILE 474
INDEX SHEET
FOR
FLOODED AREA MAP

$\frac{1}{4}$ 0 $\frac{1}{2}$ 1 2 3
APPROX. SCALE IN MILES

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1969



NOTES:

1. PLATE NUMBER CORRESPONDS TO TOPOGRAPHIC MAP OF FLOODED AREA.
2. STATIONING IS MEASURED IN MILES FROM THE MOUTH OF OHIO RIVER.
3. AERIAL MOSAIC OF APRIL 1965.

FLOOD PLAIN INFORMATION REPORT
MISSISSIPPI RIVER
MILE 475 TO MILE 515

INDEX SHEET FOR FLOODED AREA MAP

1/4 0 1/2 1 2 3

APPROX. SCALE IN MILES

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1969

LEGEND:

- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- LEVEE

447 MILES ABOVE OHIO RIVER

NOTE:
1. ELEVATIONS BASED ON U.S.C. & G.S. DATUM 1929 G.A.
2. LEVEES EXTEND DOWNSTREAM FROM THE STUDY LIMIT ON BOTH BANKS.

FLOOD PLAIN INFORMATION REPORT
SCOTT AND MUSCATINE COUNTIES, IOWA
ROCK ISLAND COUNTY, ILLINOIS

TOPOGRAPHIC MAP OF FLOODED AREA
MISSISSIPPI RIVER
MILE 442.0 TO MILE 457.5

4000 2000 0 4000 8000 12000
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1969

MISS. RIVER

LEGEND:

- INTERMEDIATE REGIONAL FLOOD
- CHANNEL
- LEVEE

466 MILES ABOVE OHIO RIVER

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

FLOOD PLAIN INFORMATION REPORT
SCOTT AND MUSCATINE COUNTIES, IOWA
ROCK ISLAND COUNTY, ILLINOIS

TOPOGRAPHIC MAP OF FLOODED AREA

MISSISSIPPI RIVER

MILE 457.5 TO MILE 476.2

4000 2000 0 4000 8000 12000
SCALE IN FEET

U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1969


LEGEND
STANDARD PROJECT FLOOD
INTERMEDIATE REGIONAL FLOOD
CHANNEL
488 MILES ABOVE OHIO RIVER
NOTE:
ELEVATIONS BASED ON U.S.C. & G.S. DATUM 1929 G.A.
N
MATCH LINE PLATE 7
MATCH LINE PLATE 9
MISS. RIVER
MISSISSIPPI RIVER
IOWA
ILLINOIS
80
199
280
FLOOD PLAIN INFORMATION REPORT
SCOTT AND MUSCATINE COUNTIES, IOWA
ROCK ISLAND COUNTY, ILLINOIS
TOPOGRAPHIC MAP OF FLOODED AREA
MISSISSIPPI RIVER
MILE 476.2 TO MILE 497.7
4000 2000 0 4000 8000 12000
SCALE IN FEET
U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1969

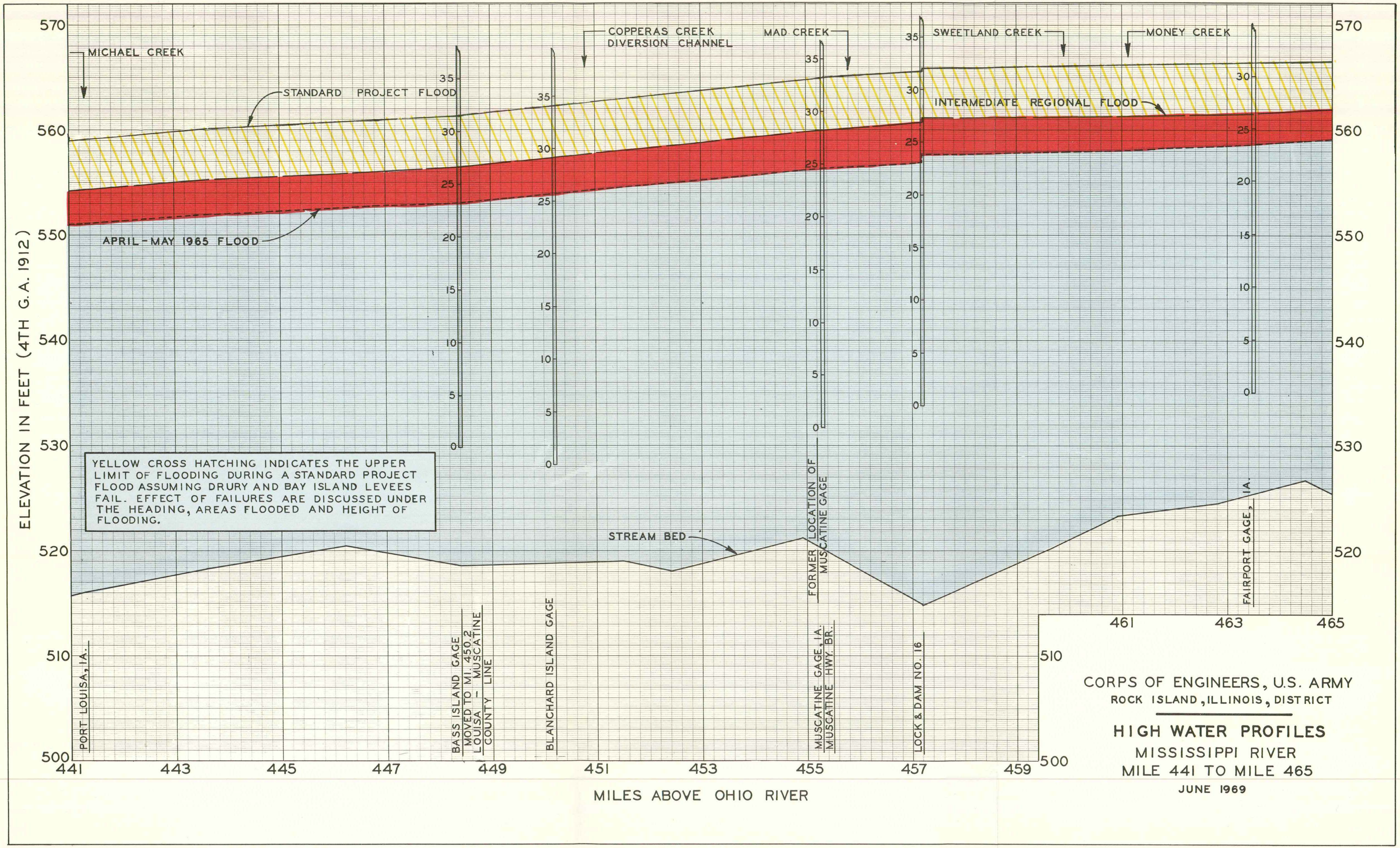
FLOOD PLAIN INFORMATION REPORT
SCOTT AND MUSCATINE COUNTIES, IOWA
ROCK ISLAND COUNTY, ILLINOIS

TOPOGRAPHIC MAP OF FLOODED AREA

MISSISSIPPI RIVER

MILE 497.7 TO MILE 512.3

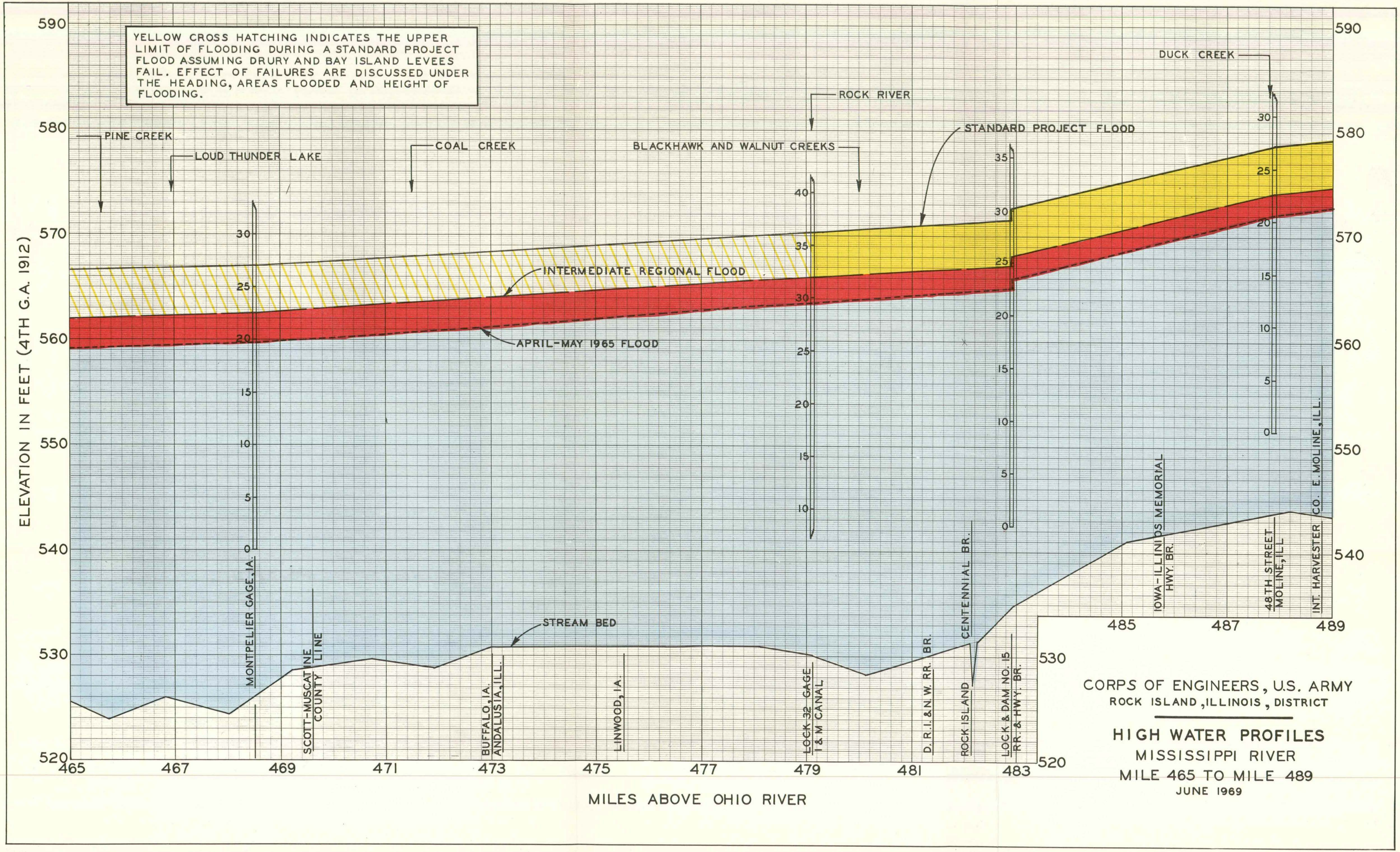
U.S. ARMY ENGINEER DISTRICT
ROCK ISLAND, ILLINOIS
JUNE 1969



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

HIGH WATER PROFILES
MISSISSIPPI RIVER
MILE 441 TO MILE 465
JUNE 1969

PLATE 10



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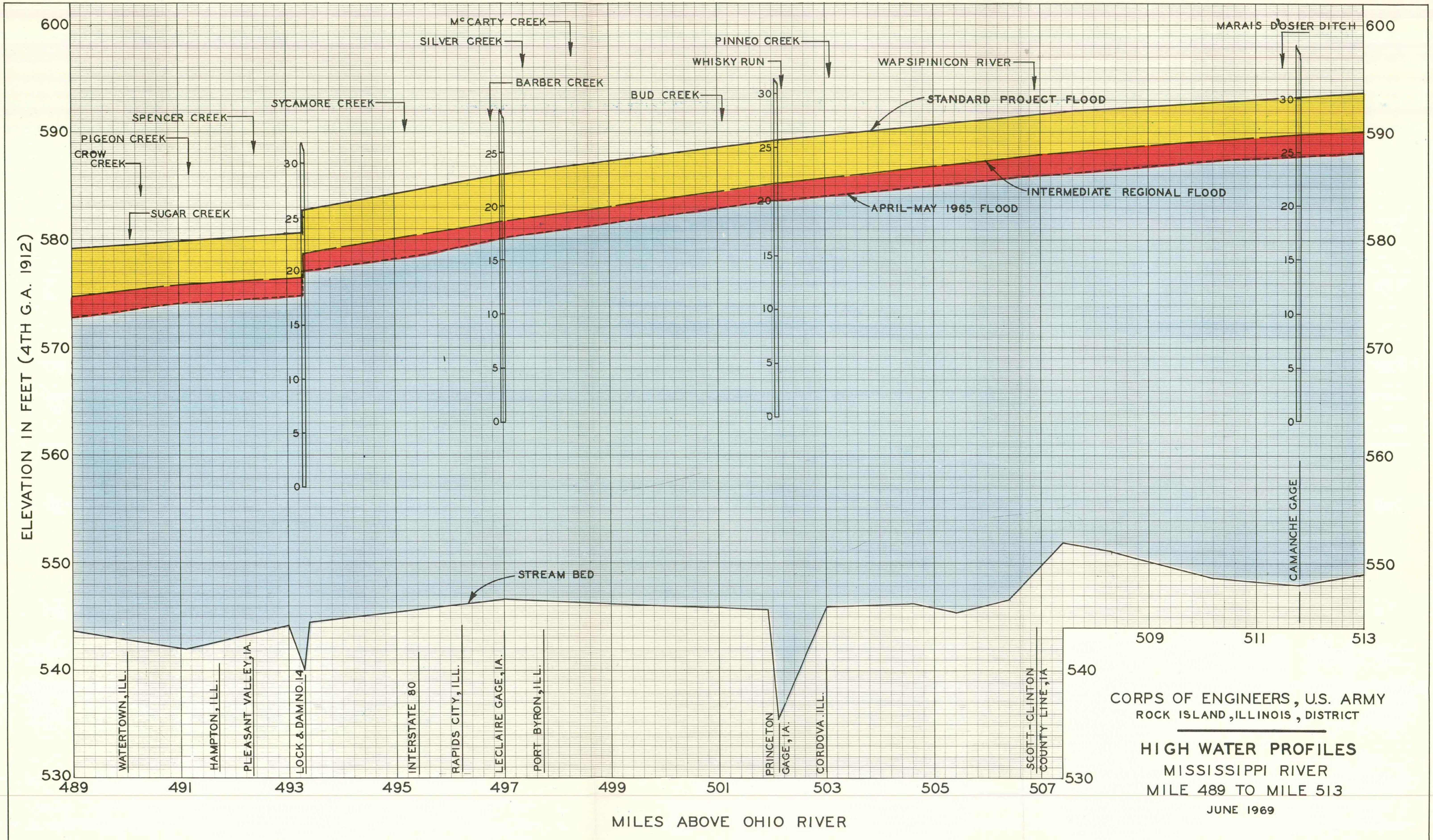
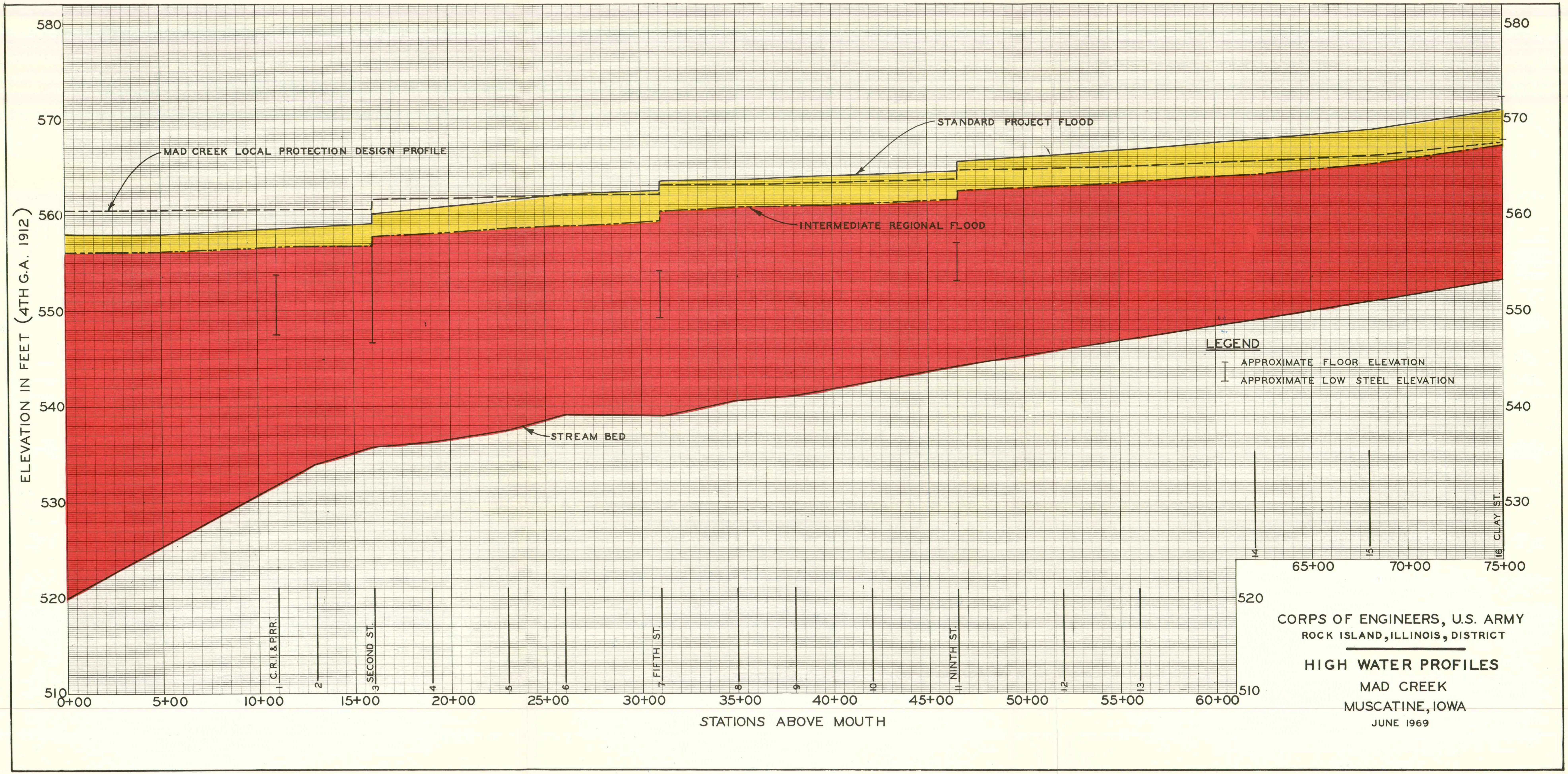
ROCK ISLAND, ILLINOIS, DISTRICT

HIGH WATER PROFILES
MISSISSIPPI RIVER
MILE 465 TO MILE 489
JUNE 1969



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

HIGH WATER PROFILES
MISSISSIPPI RIVER
MILE 489 TO MILE 513
JUNE 1969



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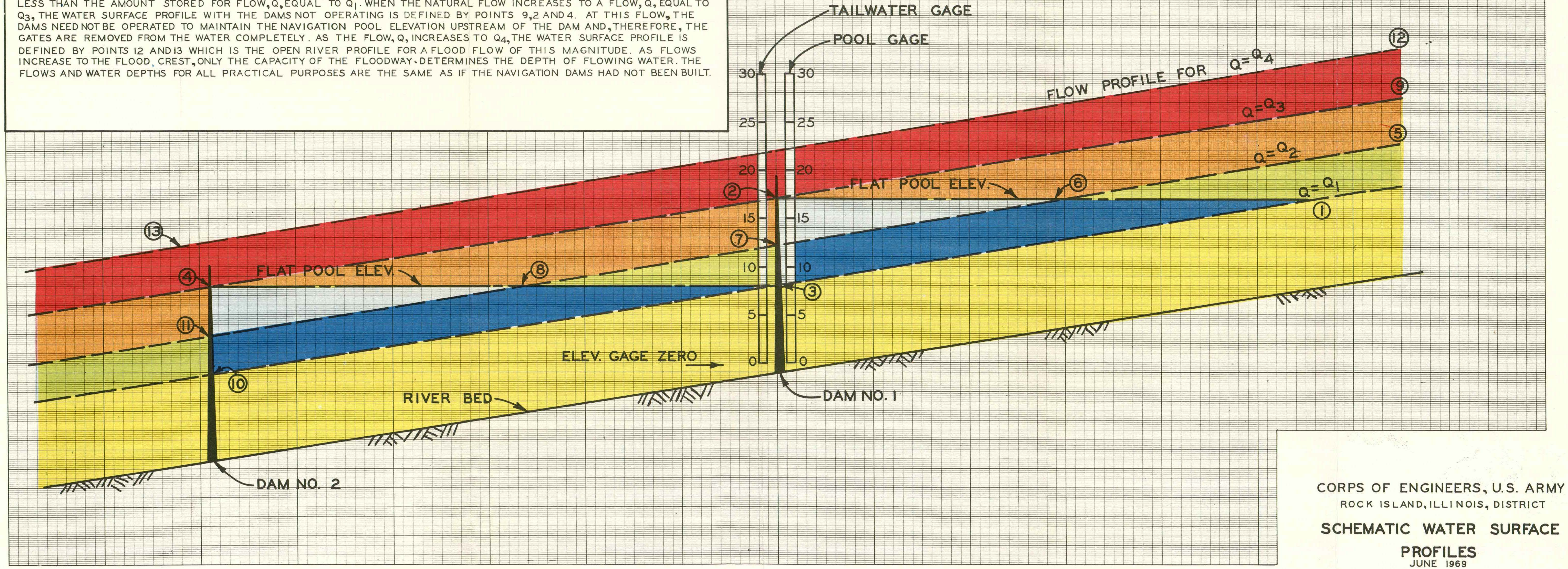
ROCK ISLAND, ILLINOIS, DISTRICT

HIGH WATER PROFILES
MAD CREEK
MUSCATINE, IOWA
JUNE 1969

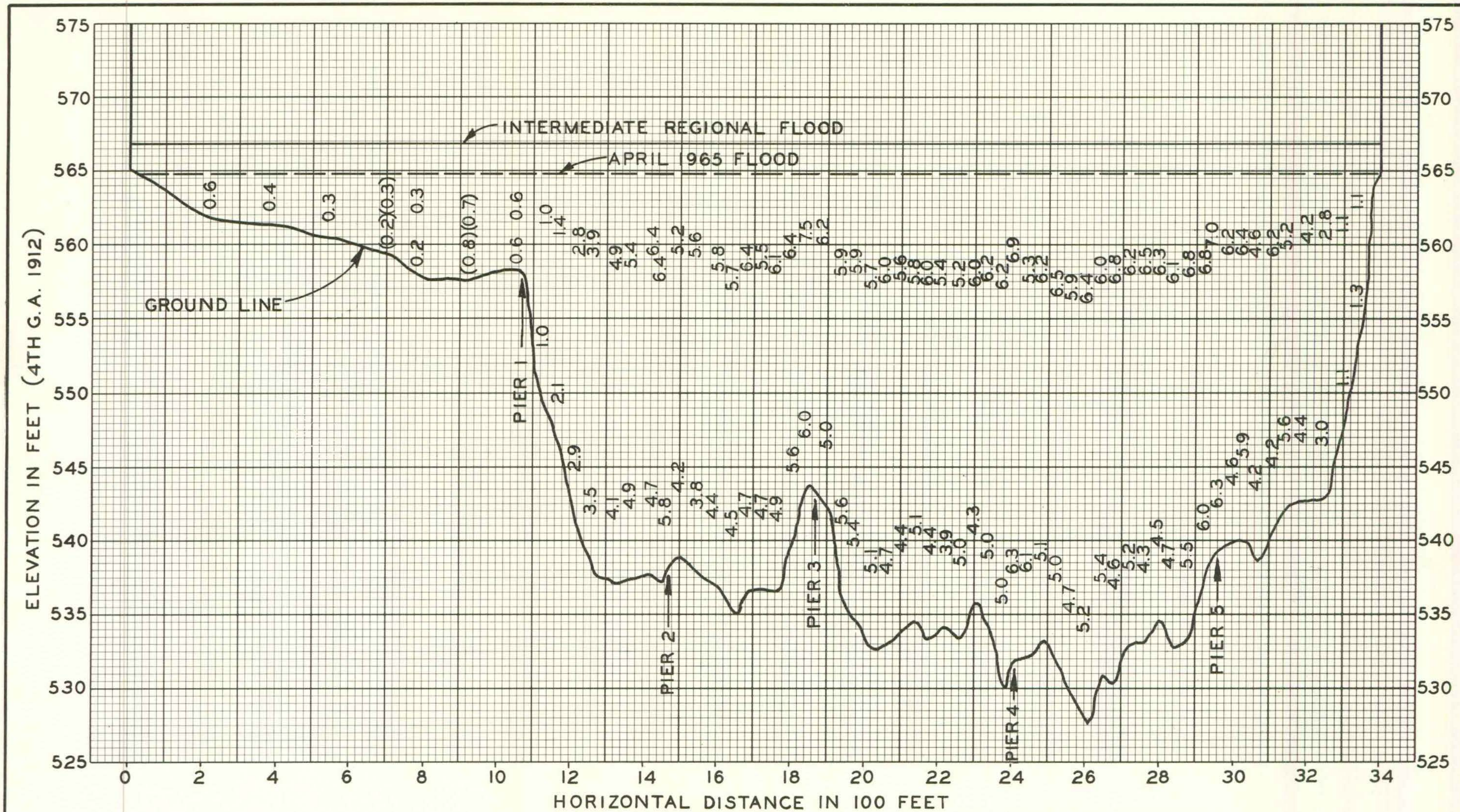
PLATE 13

THE DASHED LINES REPRESENT THE WATER SURFACE PROFILES FOR DISCHARGES OF $Q=Q_1, Q_2, Q_3$ AND Q_4, WITH NATURAL CONDITIONS AND THE NAVIGATION DAMS NOT OPERATING, FOR EXAMPLE, THE PROFILE DEFINED BY POINTS 1, 3 AND 10 REPRESENTS THE PROFILE FOR A FLOW, Q, EQUAL TO Q_1, WITH DAMS 1 AND 2 OPERATING, THE APPROXIMATE WATER SURFACE PROFILE FOR A FLOW EQUAL TO Q_1 IS DEFINED BY POINTS 1, 2, 3, 4 AND 10, AND THE WEDGE OF STORAGE ABOVE DAM NO. 1 IS REPRESENTED BY THE AREA BOUNDED BY POINTS 1, 2 AND 3. AS THE FLOWS INCREASE SO THAT THE FLOW, Q, IS EQUAL TO Q_2, THE WATER SURFACE PROFILE WITH THE DAMS NOT OPERATING IS DEFINED BY POINTS 5, 7 AND 11. WITH THE DAMS OPERATING AND THE FLOW EQUAL TO Q_2, THE PROFILE IS APPROXIMATELY DEFINED BY POINTS 5, 6, 2, 7, 8, 4 AND 11. NOTE THAT IN THE UPSTREAM END OF THE POOLS, THE WATER SURFACE ELEVATION IS INCREASING WHILE AT THE DAM, THE WATER SURFACE ELEVATION IS THE SAME AS IT WAS FOR THE DAMS OPERATING WITH A FLOW, Q, EQUAL TO Q_1. NOTE ALSO THAT THE WEDGE OF STORAGE BEHIND DAM NO. 1 FOR A FLOW, Q, EQUAL TO Q_2 IS REPRESENTED BY THE AREA BOUNDED BY POINTS 6, 7, AND 2, AND IS SUBSTANTIALLY LESS THAN THE AMOUNT STORED FOR FLOW, Q, EQUAL TO Q_1. WHEN THE NATURAL FLOW INCREASES TO A FLOW, Q, EQUAL TO Q_3, THE WATER SURFACE PROFILE WITH THE DAMS NOT OPERATING IS DEFINED BY POINTS 9, 2 AND 4. AT THIS FLOW, THE DAMS NEED NOT BE OPERATED TO MAINTAIN THE NAVIGATION POOL ELEVATION UPSTREAM OF THE DAM AND, THEREFORE, THE GATES ARE REMOVED FROM THE WATER COMPLETELY. AS THE FLOW, Q, INCREASES TO Q_4, THE WATER SURFACE PROFILE IS DEFINED BY POINTS 12 AND 13 WHICH IS THE OPEN RIVER PROFILE FOR A FLOOD FLOW OF THIS MAGNITUDE. AS FLOWS INCREASE TO THE FLOOD CREST, ONLY THE CAPACITY OF THE FLOODWAY DETERMINES THE DEPTH OF FLOWING WATER. THE FLOWS AND WATER DEPTHS FOR ALL PRACTICAL PURPOSES ARE THE SAME AS IF THE NAVIGATION DAMS HAD NOT BEEN BUILT.



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

SCHEMATIC WATER SURFACE PROFILES
JUNE 1969



NOTE:

NUMBERS IN THE SECTION ABOVE REPRESENT CHANNEL VELOCITIES AT POINTS INDICATED DURING THE FLOOD OF APRIL 28, 1965. NUMBERS IN PARENTHESIS INDICATE NEGATIVE VELOCITIES. MEASURENTS WERE TAKEN AT THE ROCK ISLAND CENTENNIAL BRIDGE ON APRIL 28, 1965.

CORPS OF ENGINEERS, U.S. ARMY

ROCK ISLAND, ILLINOIS, DISTRICT

MISSISSIPPI RIVER

CHANNEL CROSS-SECTION
AT MILE 481.9
LOOKING UPSTREAM

JUNE 1969

PLATE 14