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NOAA TECHNICAL MEMORANDUM NWS CR-95



FLOODS ALONG DES PLAINES AND FOX RIVERS: SEPTEMBER-OCTOBER 1986

Thomas L. Dietrich
National Weather Service Forecast Office
Chicago, Illinois

FEBRUARY 1989

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FLOODS ALONG DES PLAINES AND FOX RIVERS: SEPTEMBER-OCTOBER 1986

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Chicago, Illinois

ABSTRACT. September and October of 1986 saw some of the most severe flooding on record in the Central United States. The time of year (fall), the severity, and the widespread nature of the flooding made this a very significant and unusual hydrologic event.

Record floods occurred in Michigan, Illinois, Missouri, and Kansas. Additional significant flooding occurred in Iowa, Wisconsin, Nebraska, South Dakota, North Dakota, Minnesota, and Indiana. Eleven of fourteen states in the National Weather Service's Central Region were affected by this flood event.

1. INTRODUCTION

Four to 10 inches of rain fell across the Southeast Wisconsin-Northeast Illinois watershed of the Des Plaines and Fox Rivers from early August to September 10. Then, in the 18-day period from September 10 through September 27, an additional nine to 16 inches occurred across the same area. Counties primarily affected by the rains were Walworth, Racine, and Kenosha in Wisconsin and Boone, McHenry and Lake in Illinois. Additionally, one to three inches of rain fell across central and south Cook County from the 28th through the 30th of September.

Significant flooding on the Des Plaines and Fox Rivers began on September 26 in northern Lake County and ended on October 6 in Cook County. Flood crests exceeded previous records along the Des Plaines, while the Fox River crested just below the flood of record from Wilmot, Wisconsin down to Algonquin, Illinois.

The Des Plaines River flooded Gurnee, Libertyville Estates and the densely urbanized flood plains in Cook County. The flooding damaged approximately 2,200 houses and 150 business establishments in Lake and Cook Counties, with damage estimated at \$42,000,000. At the height of the flooding, 3,300 people were displaced from their homes. Automobile traffic was snarled in Cook County because so many east-west roads were closed where they crossed the Des Plaines River which traverses the suburban area from north to south.

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2. DESCRIPTION OF RIVERS

a. Fox River

The Fox River (Fig. 1), a major tributary of the Illinois River, rises in Waukesha County, Wisconsin, about 15 miles northwest of Milwaukee. The river flows southward for about 70 miles to where it enters the State of Illinois. The river continues southerly for an additional 70 miles, then flows southwesterly for approximately 45 miles to its junction with the Illinois River at Ottawa. The total watershed area is approximately 2,580 square miles of which 940 square miles are located in Wisconsin and 1,640 square miles in Illinois. The Fox River basin has an hourglass outline varying in width from 23 miles at the Illinois-Wisconsin line to a minimum of 10 miles near Geneva and widening again to a maximum of 28 miles in the lower basin.

The extreme upper portion of the basin above Algonquin has a flat low-lying terrain abounding in lakes, swamps, marshes and sloughs. The surface area is in excess of 40 square miles in Illinois alone. Included in this area is the Fox Chain of Lakes which has a combined surface area of 13 square miles at McHenry Dam crest elevation 736.70 feet. At some distance from the river, the topography gradually changes to a gently undulating prairie and hill country with a maximum elevation in excess of 1,100 feet near the western boundary of the watershed.

Through the central portion of the watershed from Algonquin to Geneva, the basin narrows considerably with the topography changing noticeably to a rolling, hilly character. The river is more deeply incised and the bluff lines alternately encroach on the flood plain area.

In the lower portion of the watershed, the basin widens out and the topography varies from flat to rolling in the uplands to the extremely hilly and at times rugged terrain along the river channel. In many reaches the bluffs encroach on both sides of the river channel leaving little or no flood plain area. A profile of the Fox River is shown in Fig. 2.

b. Des Plaines River

The Des Plaines River (Fig. 1) watershed covers an area of 670 square miles in Lake, Cook, DuPage and Will Counties of Illinois as well as Kenosha and Racine Counties of Wisconsin. The watershed is aligned along a north-south axis with a length of 72 miles and an average width of 10 miles. The watershed is bounded on the north by Union Grove and Sturtevant, Wisconsin and on the south by Lockport, Illinois.

The majority of the watershed in Cook and DuPage Counties consists of highly developed residential and commercial properties. What little land that is left for farming is diminishing constantly because of the establishment of new shopping centers, subdivisions and light industry.

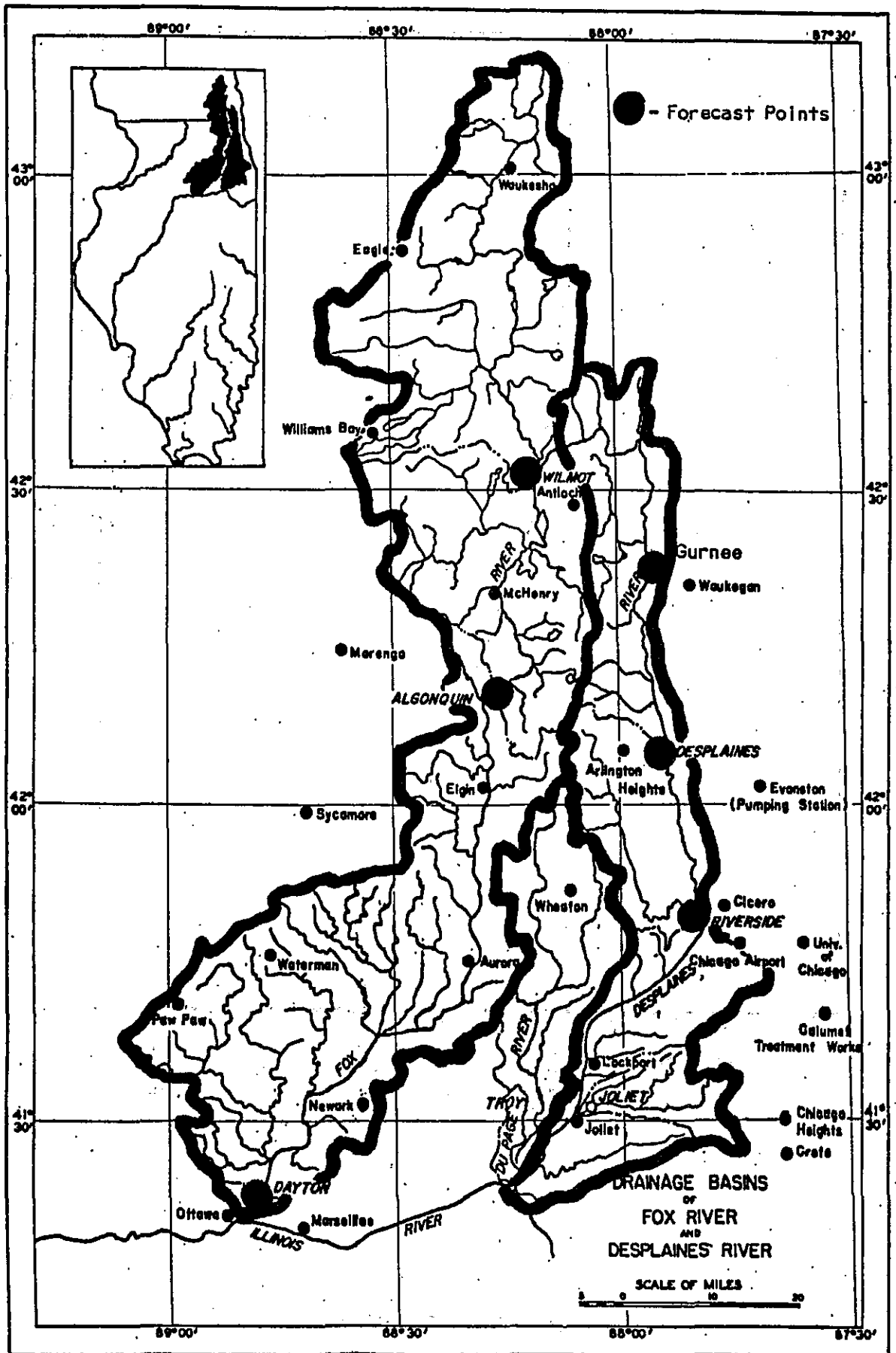


Fig. 1. Drainage basins of Fox River and Des Plaines River.

PROFILE OF FOX RIVER

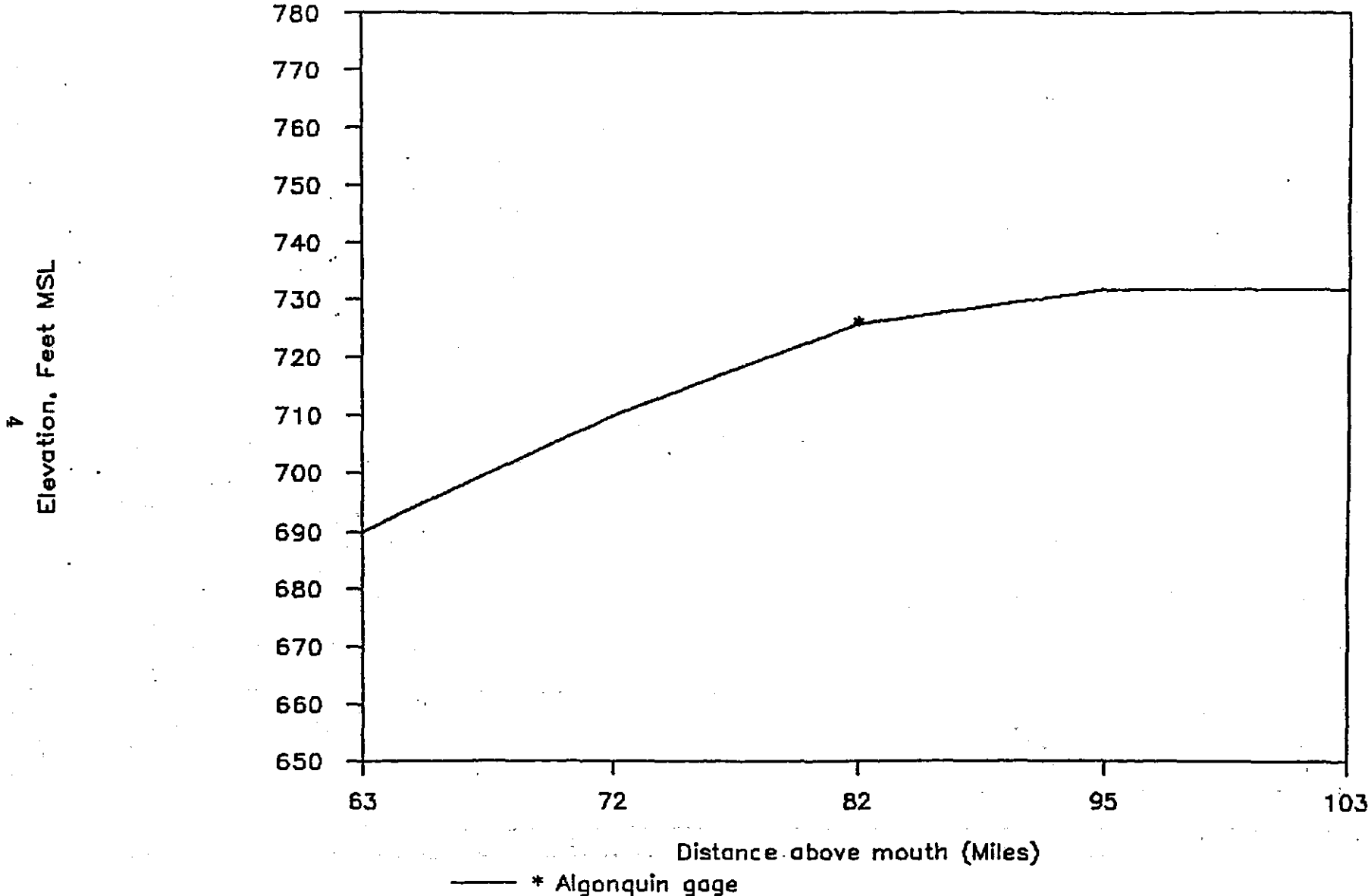


Fig. 2. Profile of Fox River from River Mile 63 to River Mile 103.

In Cook County practically the entire Des Plaines River channel is located on sections of land owned by the Cook County Forest Preserve District. For the most part the channel courses through a dense overgrowth of brush and second growth timber as it traverses the forest preserve lands. However, the flood plain itself extends beyond the forest preserve boundaries. As a result, many homes and businesses are located on the flood plains of the Des Plaines in Cook County. Between the Lake-Cook County line and Libertyville the river channel passes through a few small communities and light timber lands. Libertyville is centrally located in reference to Lake County and the Des Plaines River watershed. The village is presently considered to be the northern extent of the heavier developed areas of the watershed and Metropolitan Chicago. North of Libertyville and up into Wisconsin the river channel passes through marsh and lowland areas which are very lightly developed. Fig. 3 shows the profile of the Des Plaines River.

3. METEOROLOGY

The flooding along the Des Plaines and Fox Rivers was also part of more extensive flooding in the Central United States. Synoptically, a long fetch of southwesterly flow at 500 mb persisted throughout much of a three week period from mid-September to the first part of October. This low level moisture was constantly being advected into the southern Wisconsin-northern Illinois region from the Gulf of Mexico.

Rainfall resulted mainly from showers and thunderstorms which were almost a daily occurrence for the last 10 days of September and the first four days of October. Thunderstorms which moved through the basin often times dumped 3 1/2 to 4 inch amounts at many reporting stations. The runoff to the Des Plaines and Fox Rivers increased each day with every passing thunderstorm. As a result the Des Plaines at Gurnee crested on September 27 at 11.9 feet (flood stage = 7 feet). The rain after that date, which continued for another week, served to keep the Des Plaines at Gurnee above flood stage for an extended period of time.

The interesting aspect of this flood event relates to the persistent southwesterly flow and the resulting precipitation pattern. Fairly localized thunderstorms over an extended period of time resulted in record-setting flooding. Bar graphs of daily precipitation for 11 stations in Northeastern Illinois are shown in Figs. 4 through 16. (National Weather Service cooperative stations reported 24-hour rainfall from 7:00 a.m. to 7:00 a.m.) The bar graphs show geographic variability of rainfall amounts quite well.

Of particular interest are the bar graphs for Lake Villa and McHenry L&D. Although the Des Plaines River at Gurnee was two feet above flood stage on the morning of September 26th, it was a thunderstorm on the afternoon of September 26th that caused the final rise to a record crest at Gurnee. (The Village of Gurnee is only 8 miles east-southeast of Lake Villa.) This thunderstorm was fairly localized in that it resulted in 2.84 inches at McHenry L&D (for location see Fig. 1), while at Lake Villa, less than 12 miles to the northeast, a cooperative observer received no rain. The heaviest rainfall on the 26th, which essentially caused the record crest was centered on a line

PROFILE OF DES PLAINES RIVER

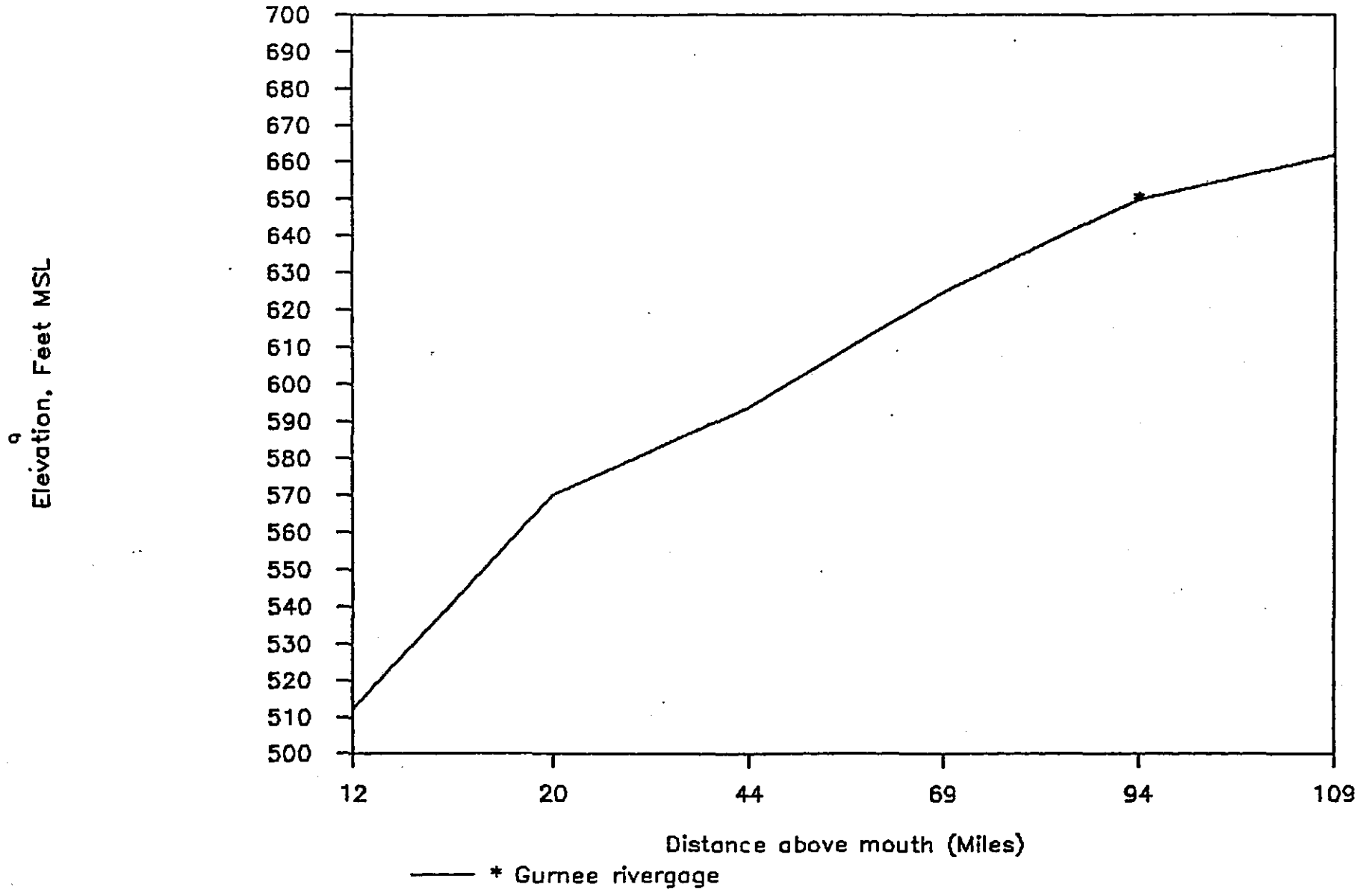


Fig. 3. Profile of Des Plaines River from River Mile 12 to River Mile 109.

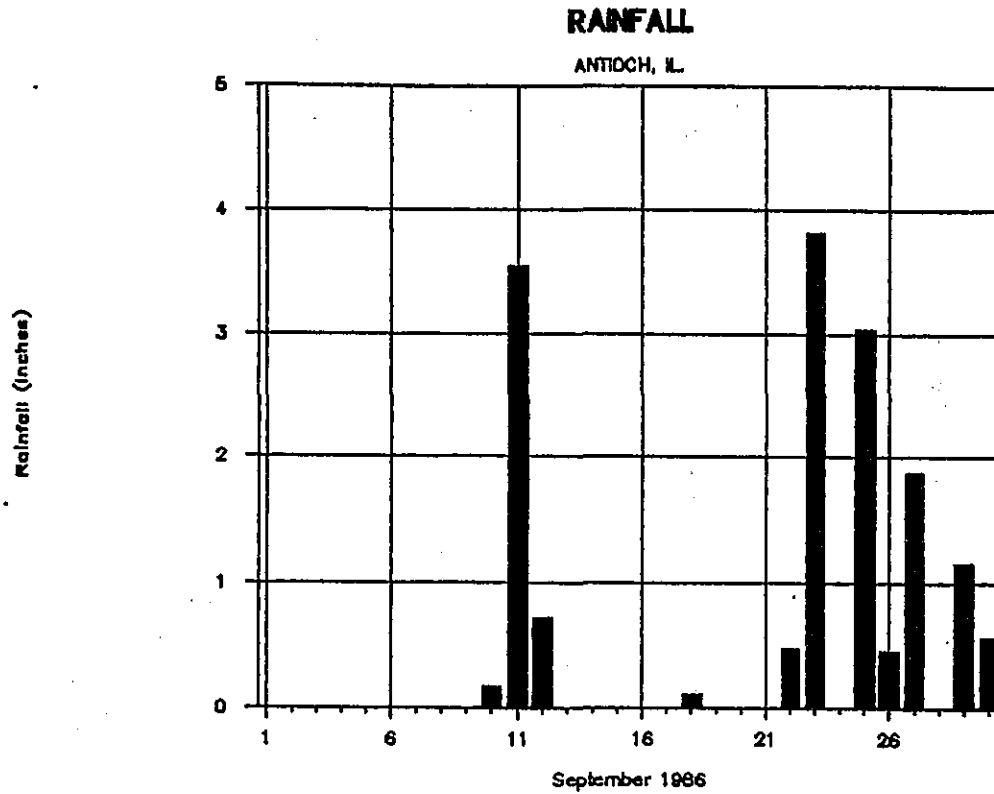


Fig. 4. September 1986 precipitation at Antioch, Illinois.

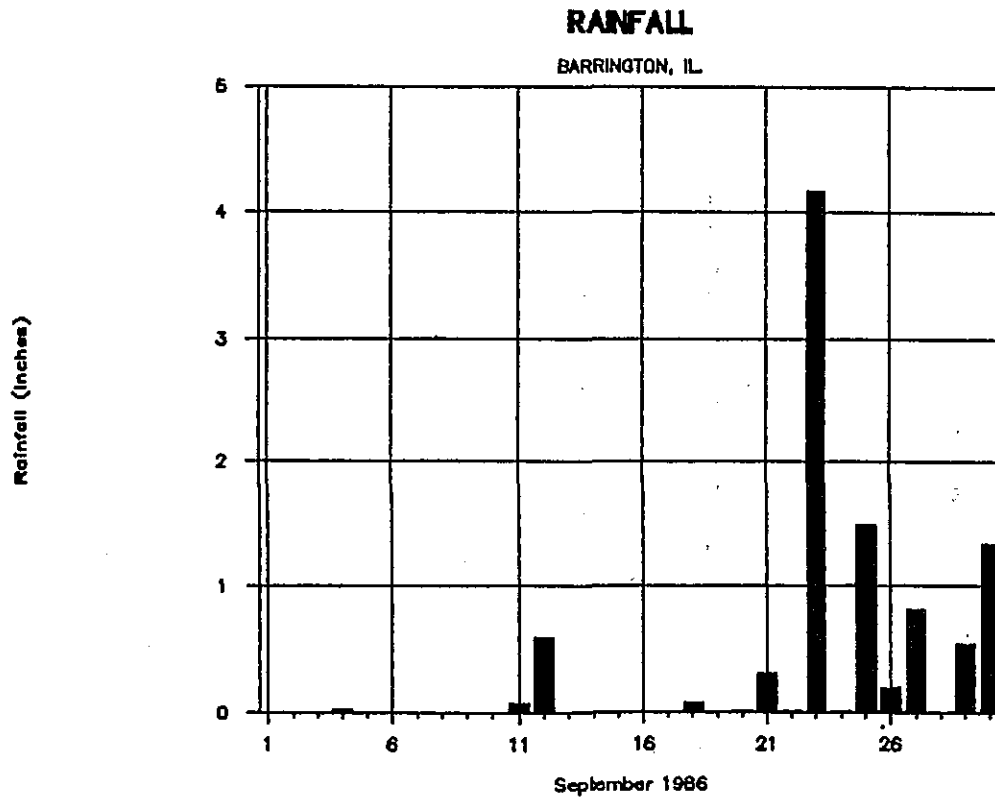


Fig. 5. September 1986 precipitation for Barrington, Illinois.

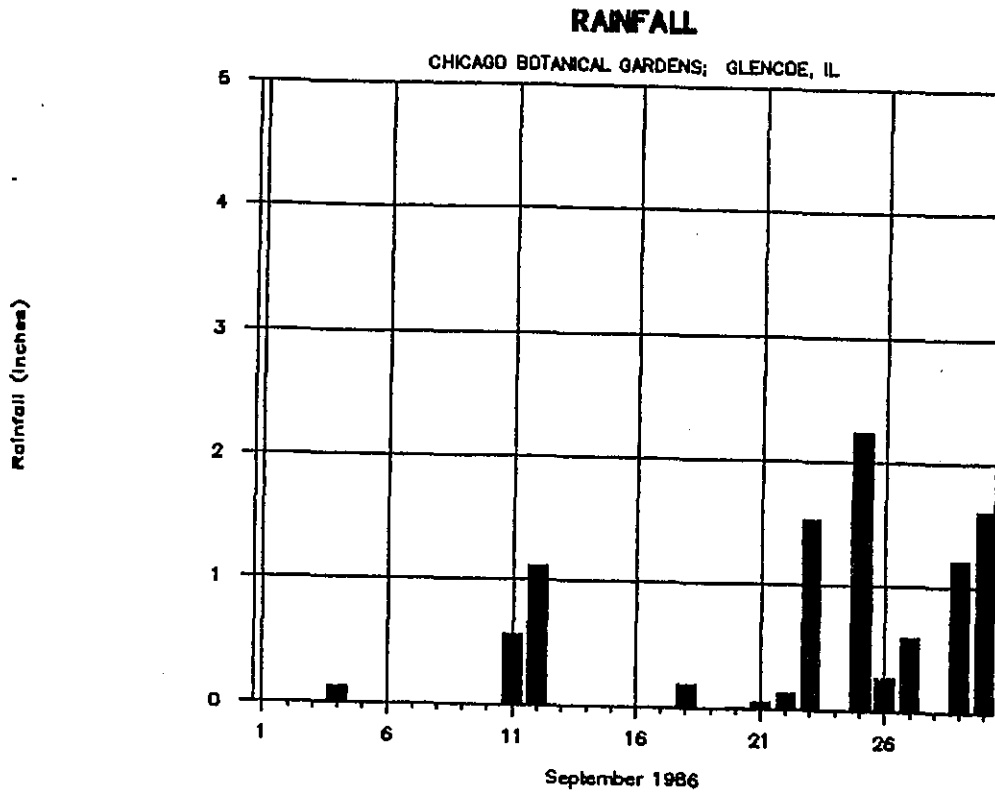


Fig. 6. September 1986 precipitation for Chicago Botanical Gardens; Glencoe, Illinois.

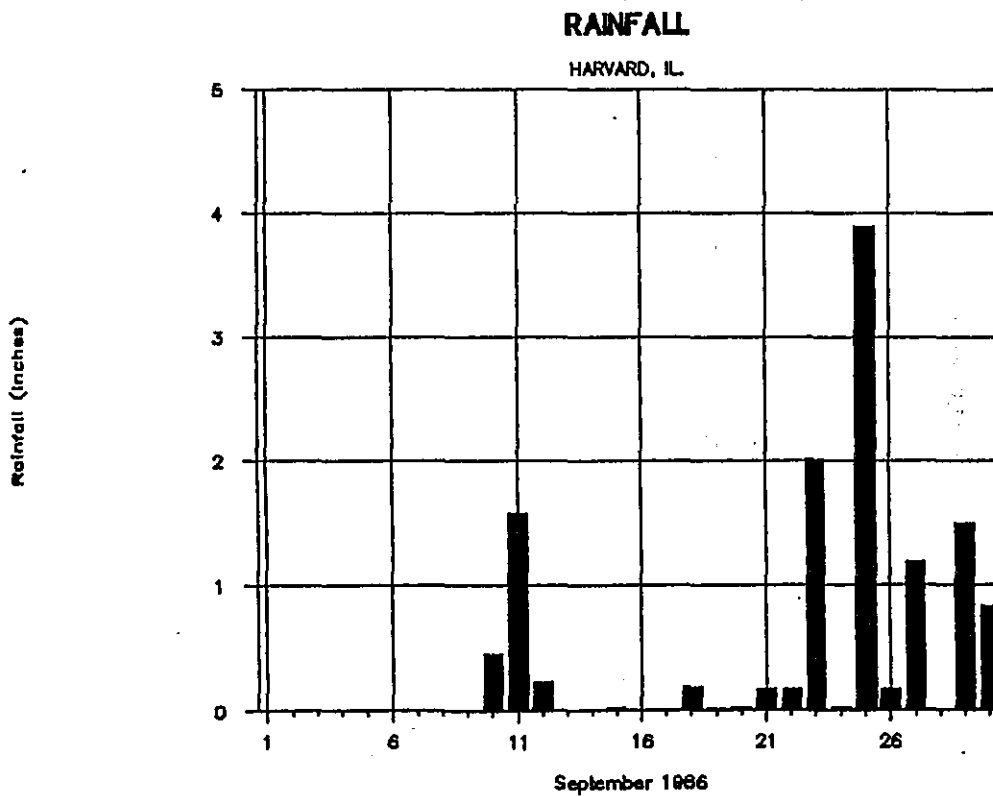


Fig. 7. September 1986 precipitation for Harvard, Illinois.

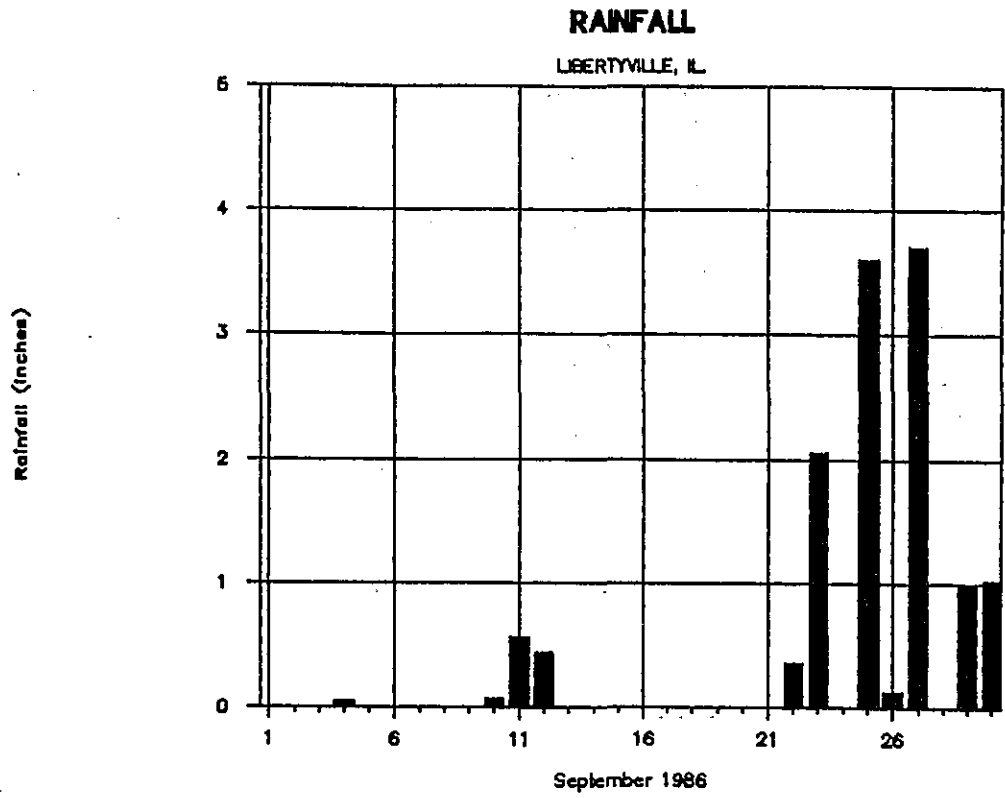


Fig. 8. September 1986 precipitation for Libertyville, Illinois.

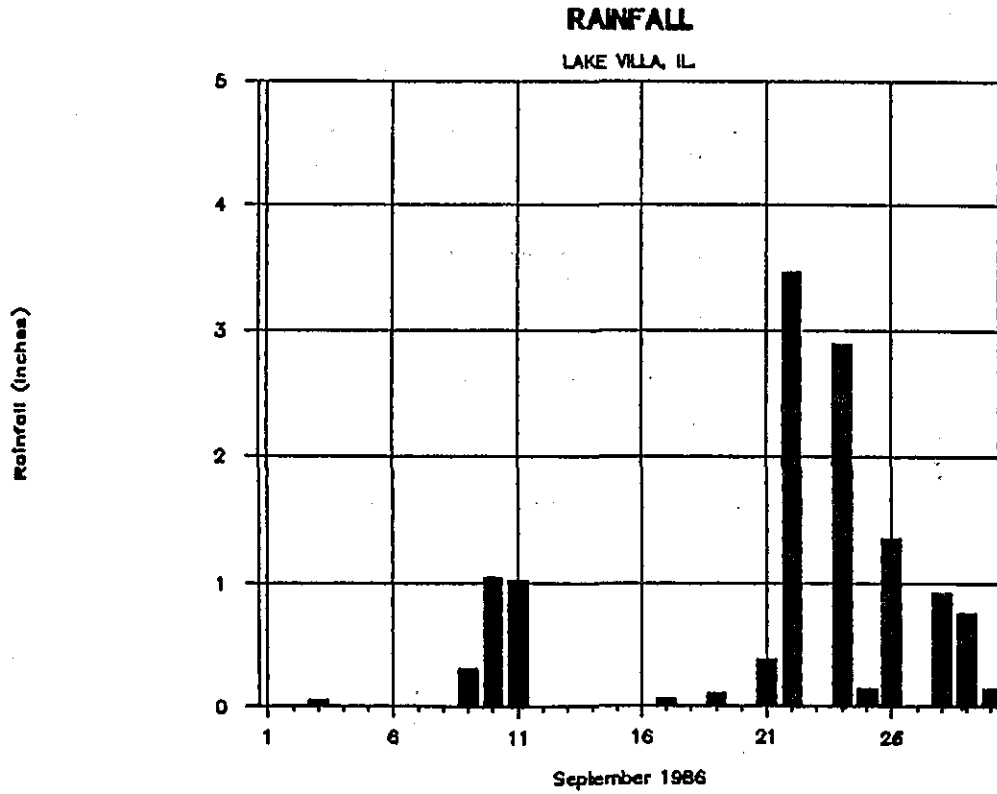


Fig. 9. September 1986 precipitation for Lake Villa, Illinois.

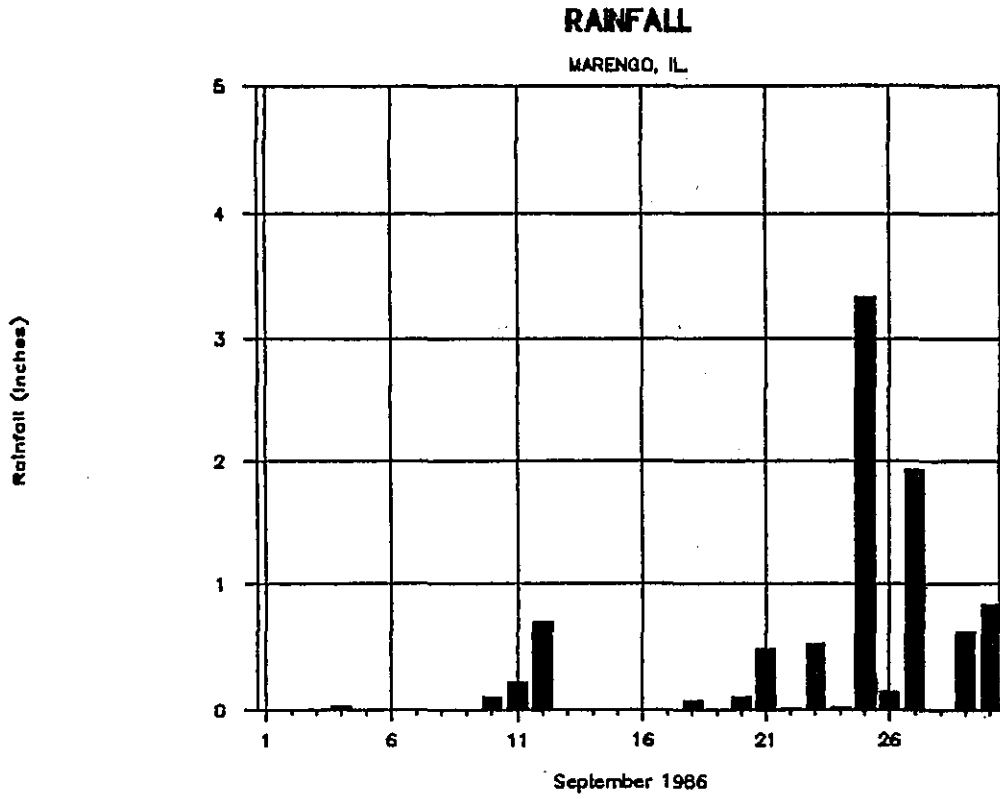


Fig. 10. September 1986 precipitation for Marengo, Illinois.

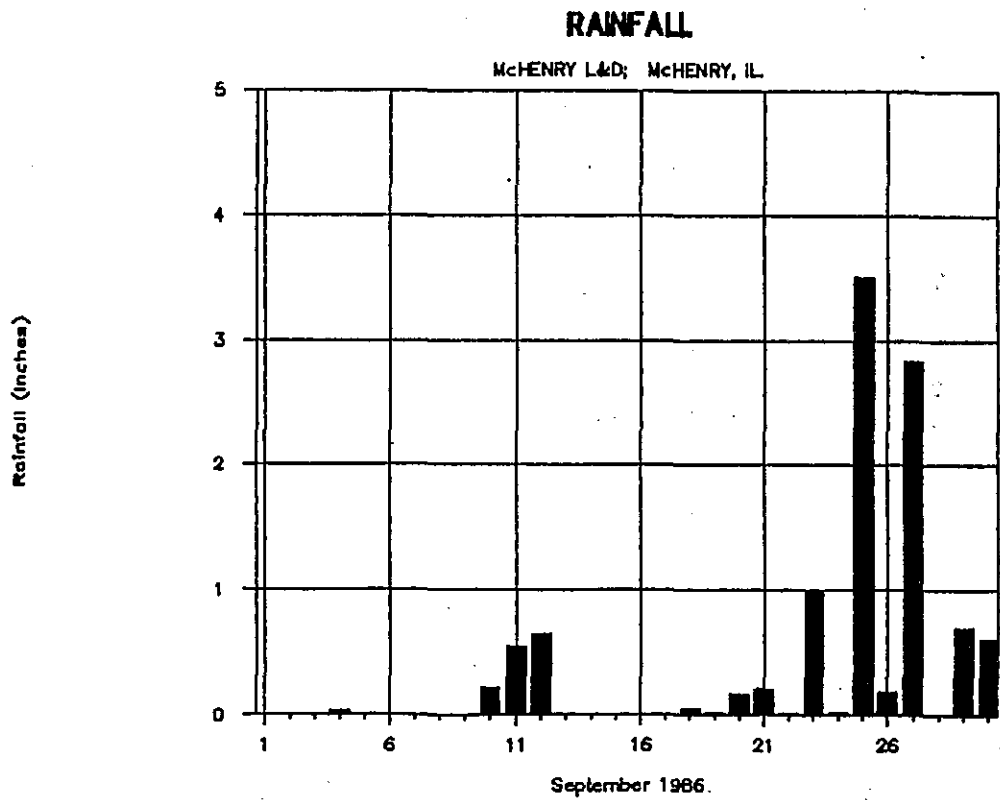


Fig. 11. September 1986 precipitation for McHenry L&D, Illinois.

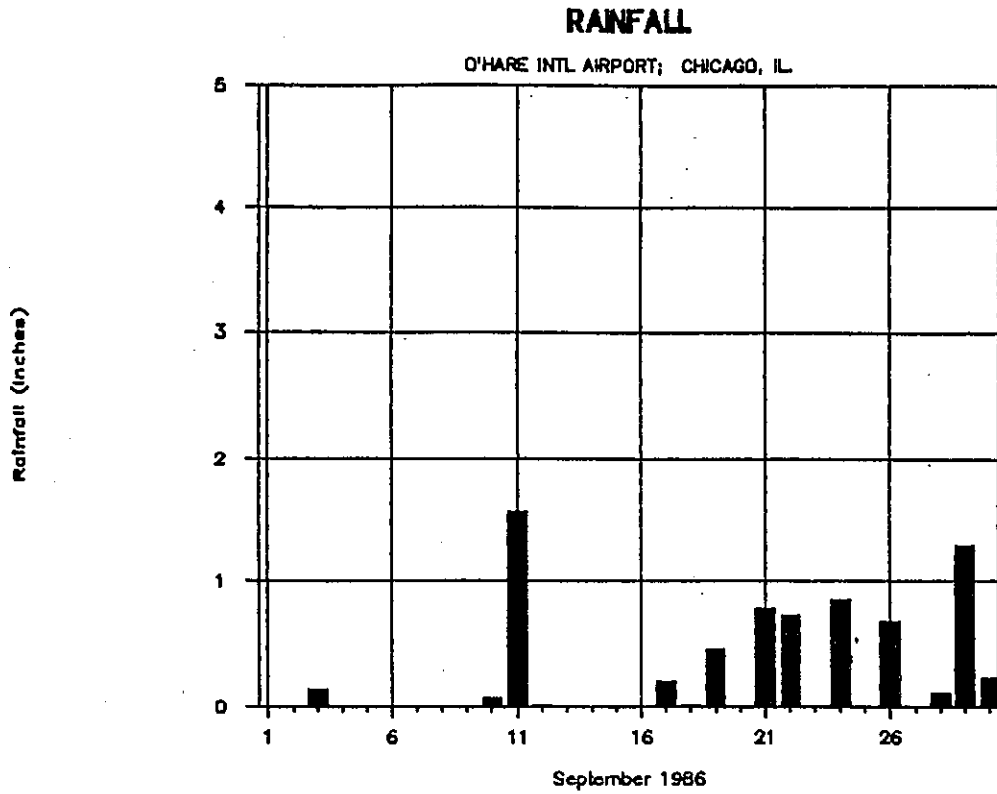


Fig. 12. September 1986 precipitation for O'Hare AP, Illinois.

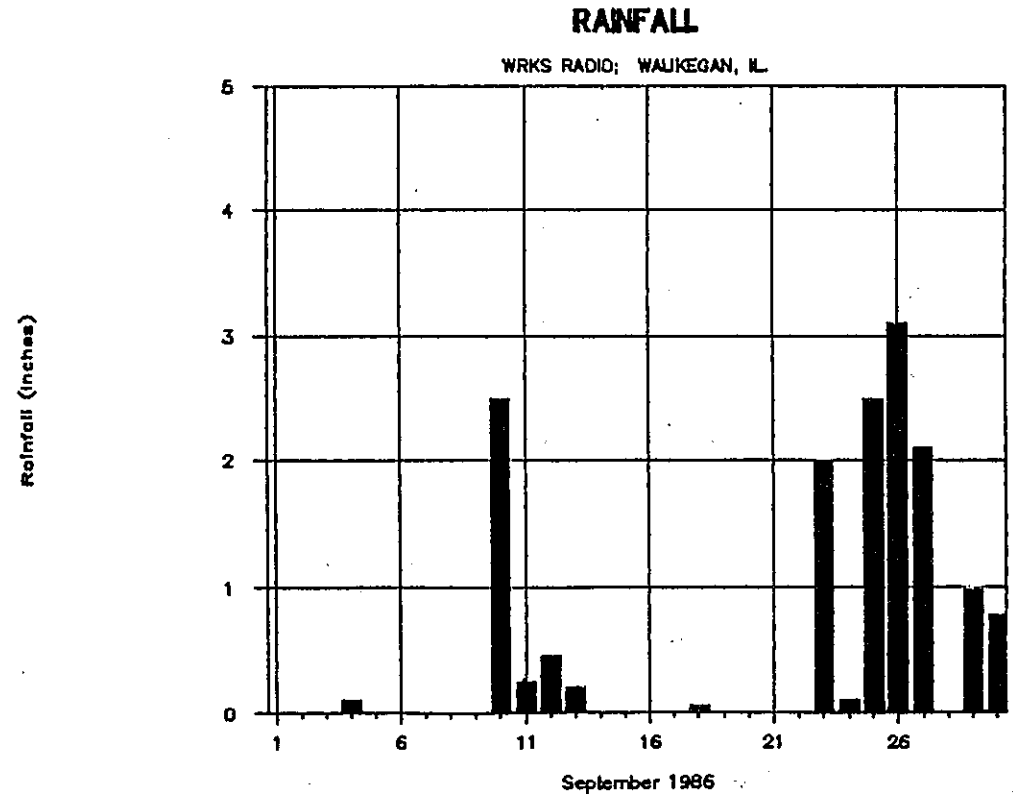


Fig. 13. September 1986 precipitation for Waukegan, Illinois.

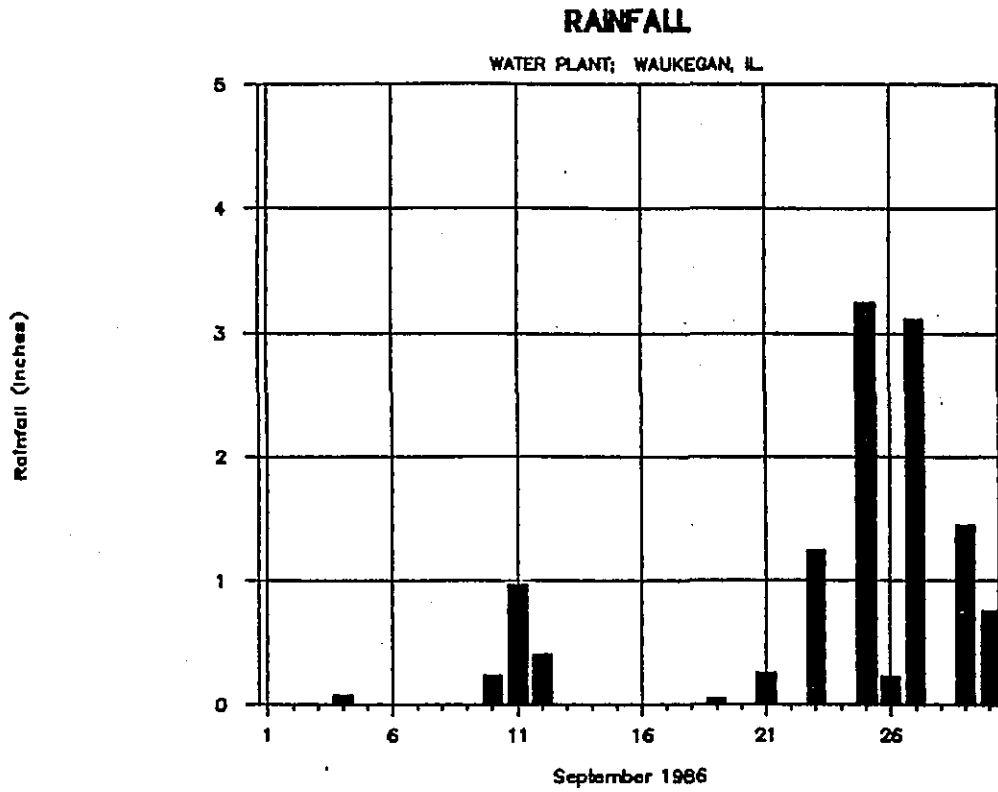


Fig. 14. September 1986 precipitation for Waukegan, Illinois.

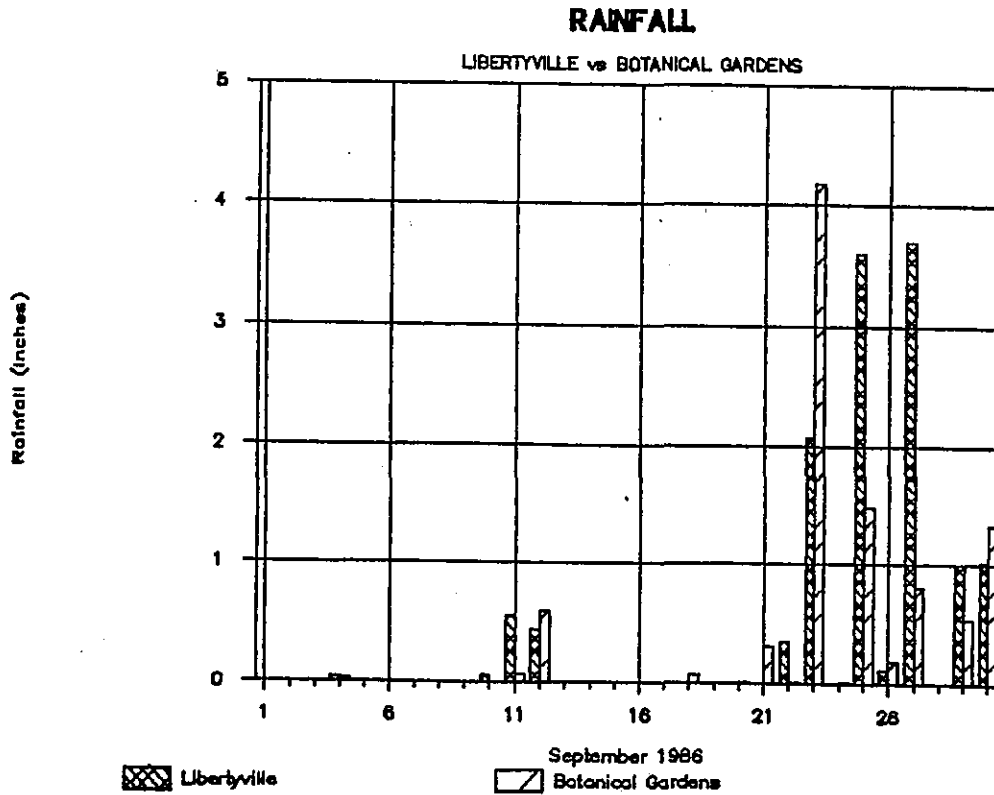


Fig. 15. Comparison of precipitation for September 1986 for Libertyville and Chicago Botanical Gardens.

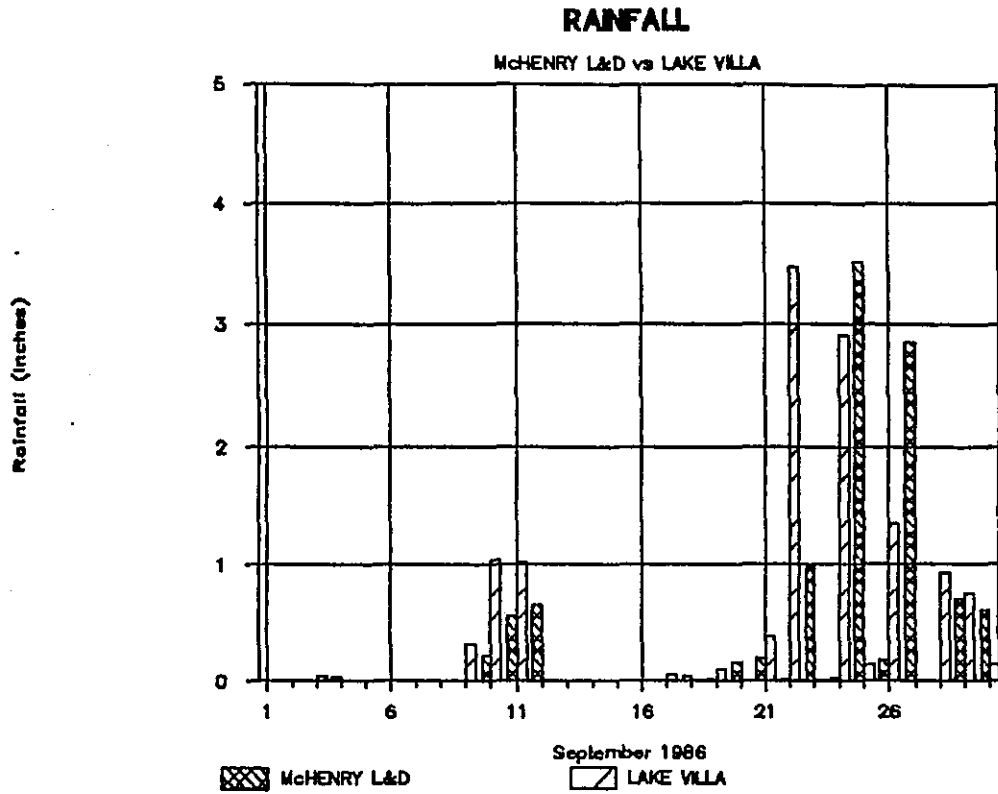


Fig. 16. Comparison of precipitation for September 1986 for McHenry L&D and Lake Villa.

from McHenry L&D through Grayslake and Gurnee. Libertyville received 3.70 inches and was on the south edge of the heaviest rainfall from the same thunderstorms. These thunderstorms remained stationary over this area for the better part of three hours from noon to about 3:00 p.m. on the afternoon of September 26th. Other areas were also hard hit by isolated thunderstorms on the 26th, including Antioch which received 1.88 inches.

4. STAGE DATA

During this period, flooding occurred along both the Des Plaines and Fox Rivers, especially in the Chain of Lakes area of the Fox. The Fox River basin represents a different forecast problem with all the lakes, marshes, swamps, and sloughs above McHenry. Although the same thunderstorms which affected the Des Plaines River also affected the Fox River, the Fox crested later and did not show the marked rise in stages. This is because the Fox River gradient above Algonquin is much flatter than the gradient of the Des Plaines River. At the same time, with all the lakes, marshes, etc., there is a large amount of storage area for the water to accumulate and spread out. The Chain of Lakes area acts as a large flood control reservoir dampening the peak stages downstream.

The Des Plaines River at Gurnee crested on September 27th at 11.9 feet, almost 1 1/2 feet above the old flood of record (10.6 feet, April 1960) while at Des Plaines the river crested at 10.9 feet on October 1st which was about two feet above the old flood of record (9.0 feet, July 1938). At Riverside the Des Plaines crested at 8.8 feet, almost 1/2 foot above the old discharge-related flood of record (8.28 feet, March 1948) (this is excluding the ice jam of January 1969 where the stage reached 9.82 feet). At the same time, the Fox River basin also experienced severe flooding, especially in the Chain of Lakes area but did not establish any new records.

Stage data for USGS gaging stations are plotted in Figs. 17 through 22. Stages plotted are for 7:00 a.m. on the day of observation. On the morning of September 25th the Des Plaines at Gurnee was almost two feet above flood stage (stage = 8.89 feet). By the morning of September 26th, the river at Gurnee rose another 0.82 feet to 9.71 feet from a localized thunderstorm in the Gurnee-Waukegan area on Thursday, September 25th. On Friday afternoon, as discussed in the preceding section, the final heavy rain episode occurred. Saturday morning, the 27th, the river at Gurnee had risen to 11.80 feet and from 4:00 p.m. through 9:00 p.m. the Des Plaines at Gurnee experienced a crest of 11.95 feet.

After the Des Plaines at Gurnee crested on the 27th the crest began to move on downstream towards Des Plaines. Although the heaviest rainfall was over northern Lake County, additional rainfall in southern Lake and northern Cook County continued to compound local flooding problems and add to the crest at Des Plaines. The actual crest at the USGS Des Plaines gage occurred on October 1st at 10.9 feet. Readings by the City of Des Plaines along the mainstem Des Plaines also confirmed this crest date.

STAGE HYDROGRAPH - FOX RIVER

Wilmot, WI.

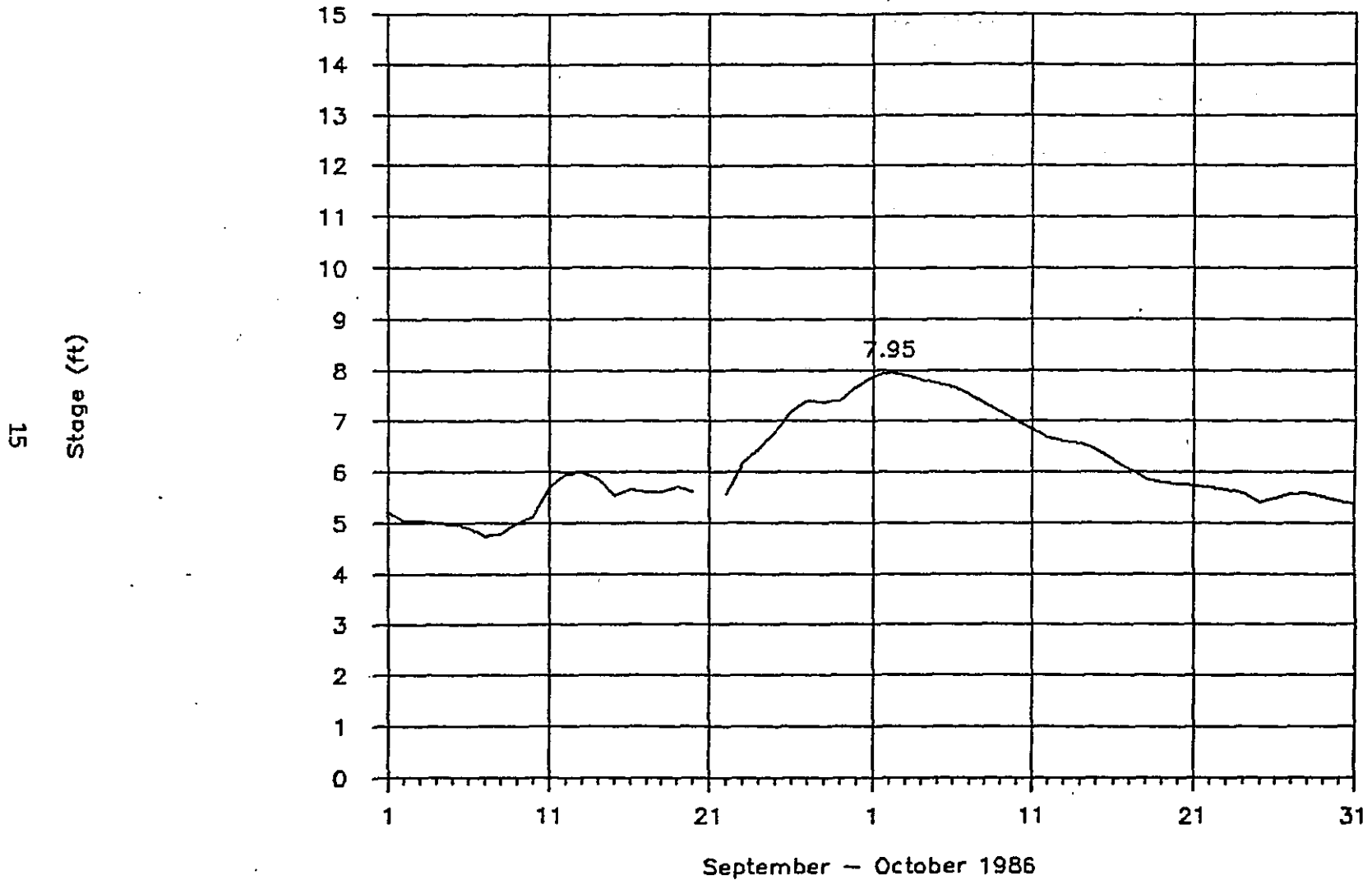


Fig. 17. Stage hydrograph for Fox River at Wilmot, Wisconsin.

STAGE HYDROGRAPH - FOX RIVER

Algonquin, IL.

Stage (ft)

16

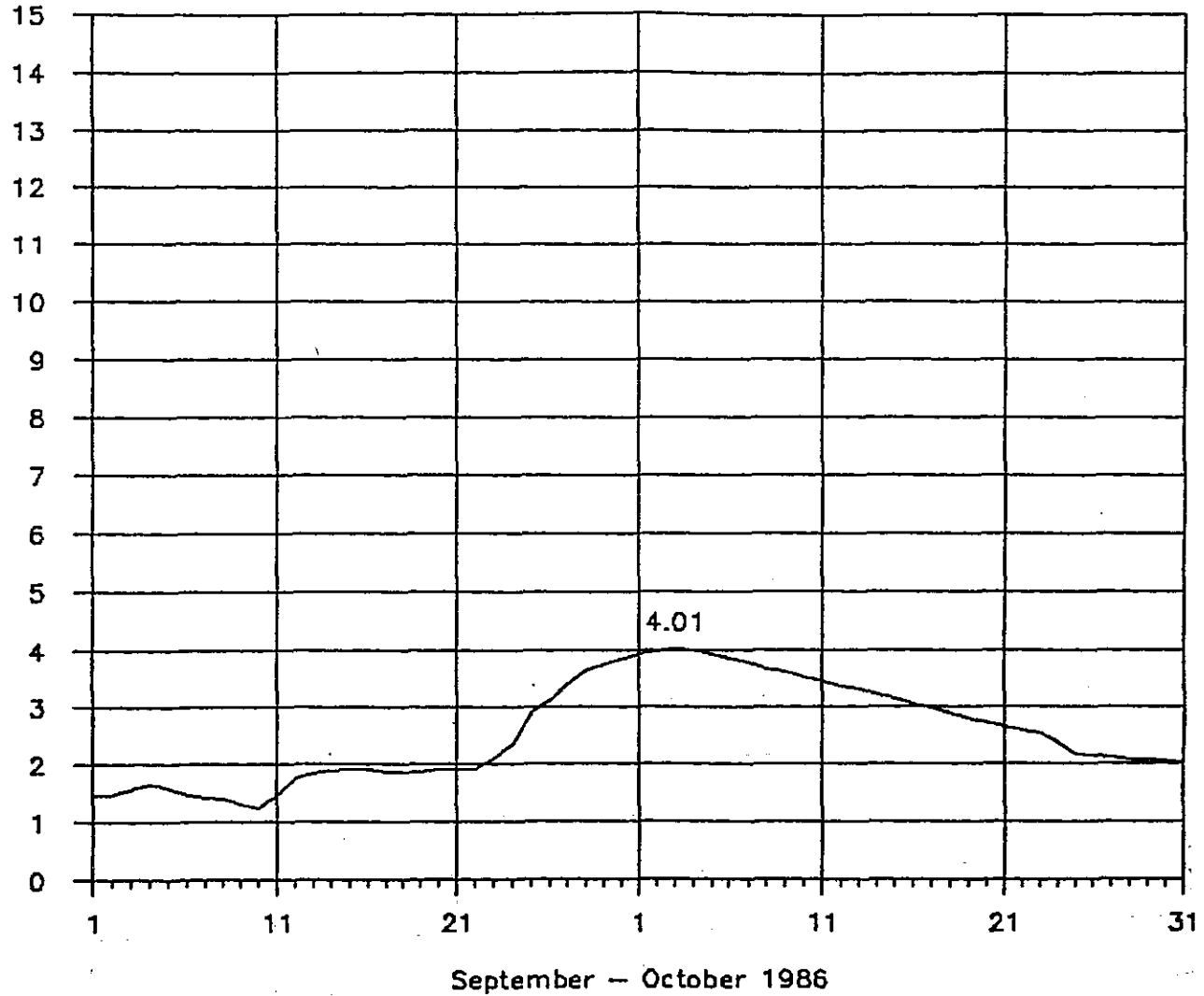


Fig. 18. Stage hydrograph for Fox River at Algonquin, Illinois.

STAGE HYDROGRAPH - FOX RIVER

Wilmot, WI. vs Algonquin, IL.

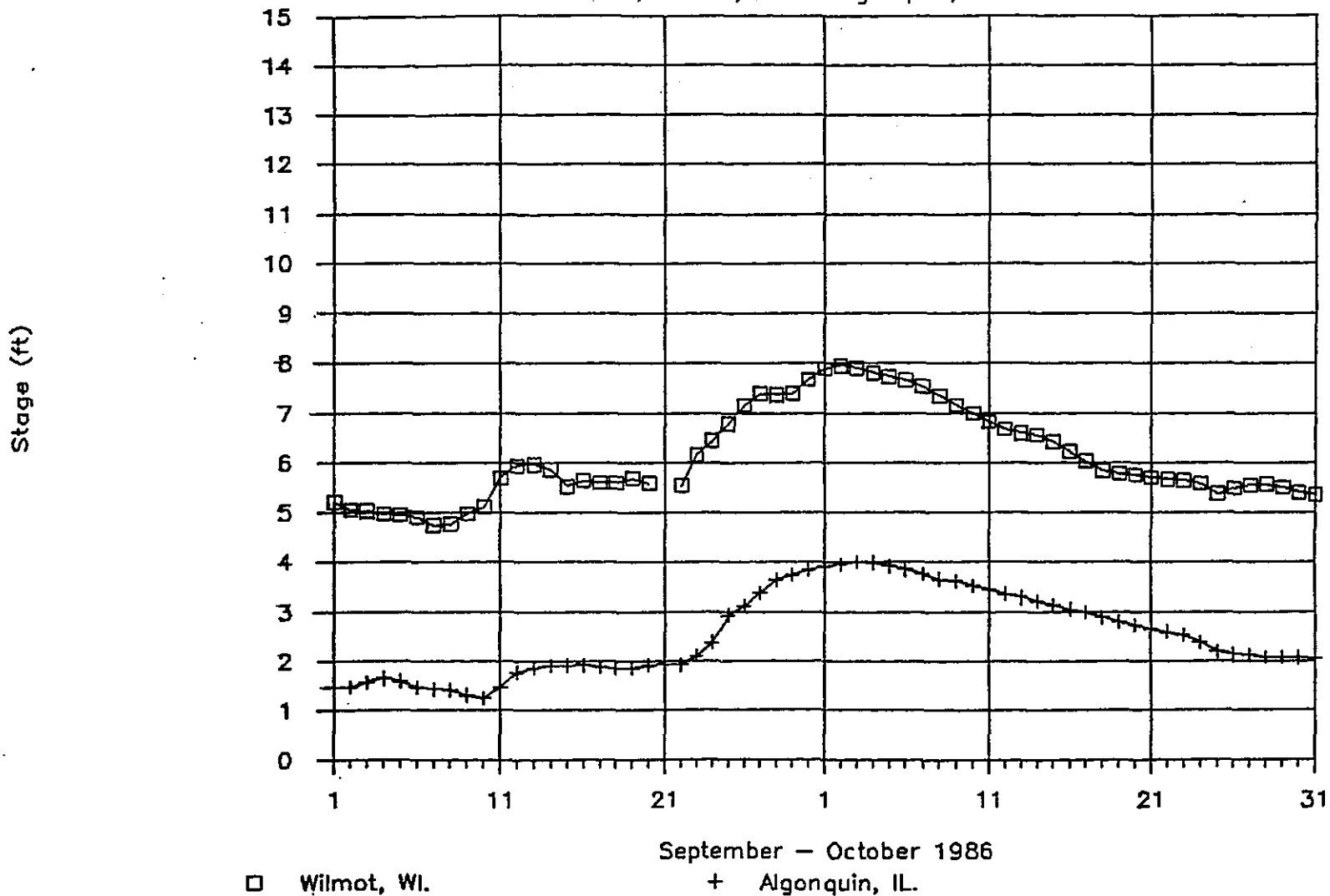


Fig. 19. Stage hydrograph for Fox River at Wilmot, Wisconsin and Algonquin, Illinois.

STAGE HYDROGRAPH - DES PLAINES R.

Gurnee, IL.

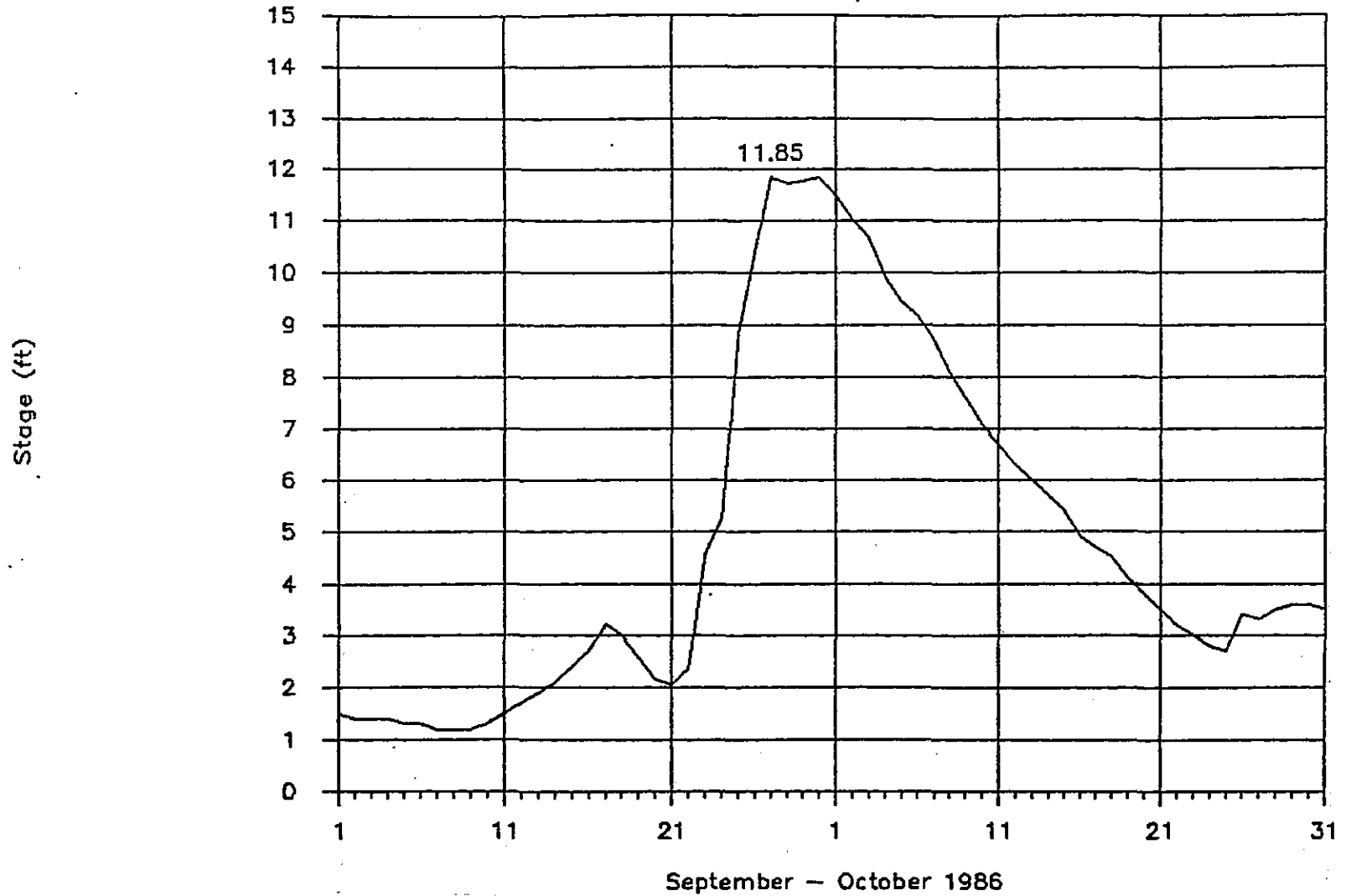


Fig. 20. Stage hydrograph for Des Plaines River at Gurnee, Illinois.

STAGE HYDROGRAPH - DES PLAINES R.

Des Plaines, IL.

Stage (ft)

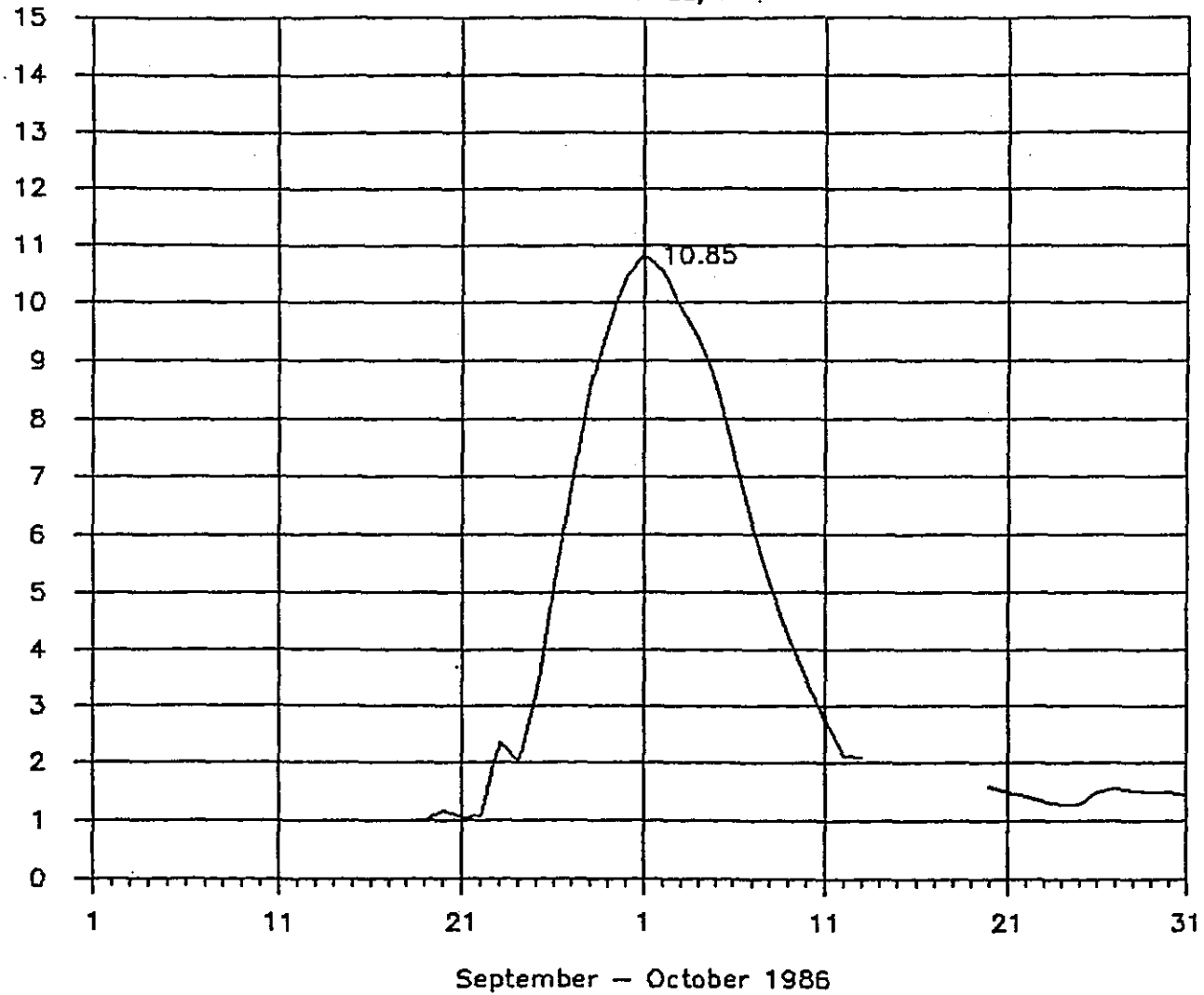


Fig. 21. Stage hydrograph for Des Plaines River at Des Plaines, Illinois.

Stage (ft)

STAGE HYDROGRAPH - DES PLAINES R.

Gurnee, IL vs Des Plaines, IL

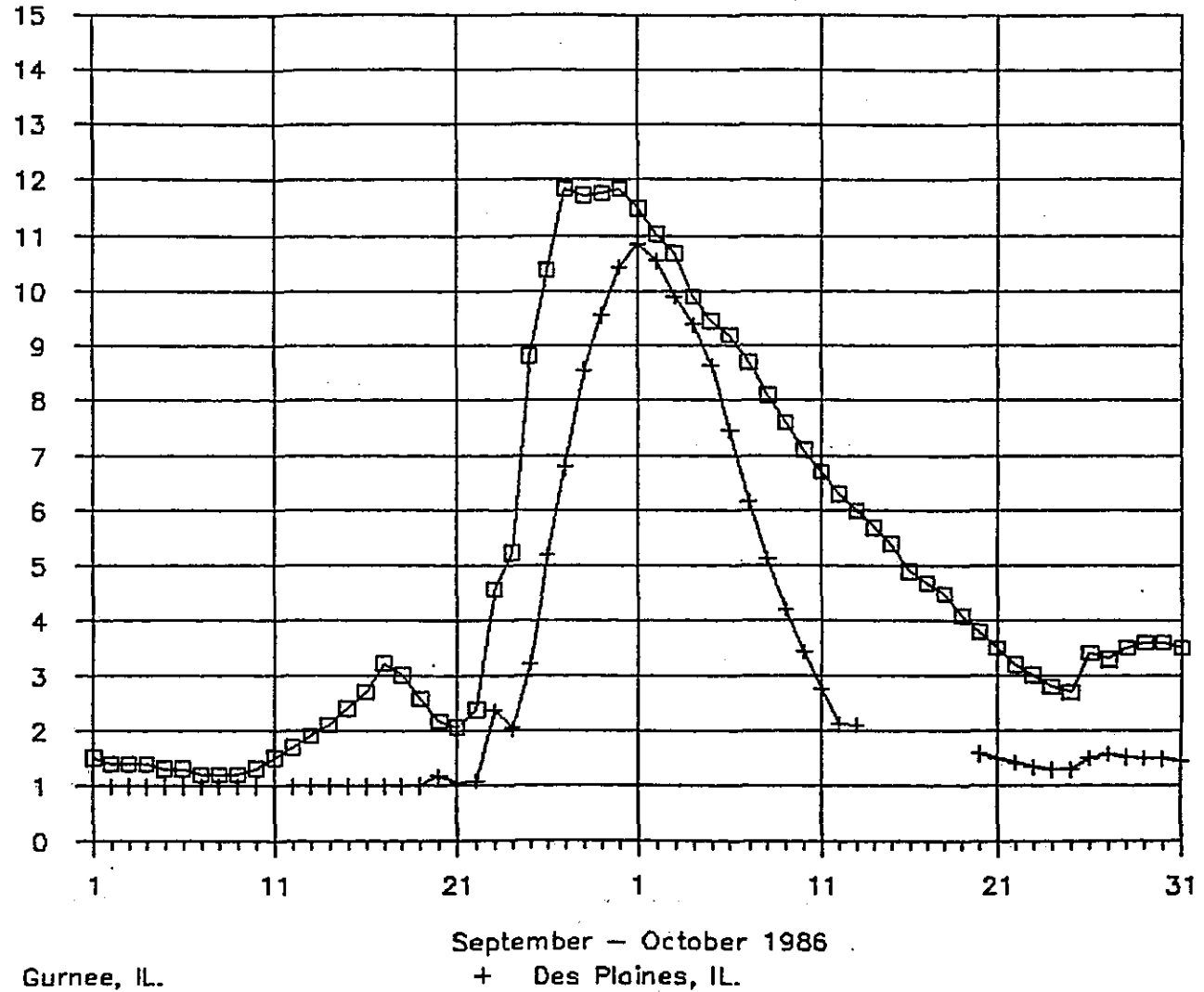


Fig. 22. Stage hydrograph for Des Plaines River at Des Plaines and Gurnee, Illinois.

The crest continued to move downstream toward Riverside. Rain which fell from a line of thundershowers on Friday, October 3rd, added another approximately 1/2 foot to the crest at Riverside.

Extensive flooding also occurred along the Fox River. Because the topography the headwaters of the Fox included an extensive area of lakes, marshes, and swamps, the Fox did not experience the dramatic rise which occurred on the Des Plaines. However, many homes which were built along the Chain of Lakes and in wetlands, were flooded.

The Fox River at Wilmot, Wisconsin rose slowly, but continuously, in response to the rainfall during September. On the 24th the river rose above flood stage (flood stage = 6.5 feet), but did not crest (crest = 7.95 feet) until the 2nd of October. This was six days after the heaviest of the rainfall occurred and five days after the Des Plaines crested at Gurnee. Likewise, with the Chain of Lakes area acting as a large reservoir, a very slow, flat crest (4.01 ft.) occurred at Algonquin (see Figs. 18 and 19) on October 3rd. Because of the attenuating affect by the Chain of Lakes the total rise at Algonquin was only 2.76 feet (from low stage on September 10th).

5. RECORDS

New stage records were set at Gurnee and Des Plaines. If you take into consideration that the Riverside record stage was from an ice jam situation, then a new stage record was set from discharge. While stages were also exceedingly high along the Fox River, no new record stages were set. Table 1 shows the record stages of the Des Plaines and Fox Rivers.

Table 1
Des Plaines River Record Stages

<u>Old</u>	<u>New</u>
Gurnee 10.64 feet (4/3/60)	11.95 feet (9/27/86)
Des Plaines 8.56 feet (4/2/60) 9.00 feet (7/4/38)*	10.90 feet (10/1/86)
Riverside 8.28 feet (3/20/48) 9.82 feet (1/26/69)**	8.8 feet (10/4/86)

* Outside period of record.

** Ice jam.

Fox River Stages

<u>Record</u>	<u>October 1986</u>
Wilmot, WI 9.25 feet (3/21/60)	7.95 feet (10/2/86)
Algonquin, IL 4.50 feet (4/1/16)	4.01 feet (10/3/86)

It is interesting to note that the record for Wilmot occurred during the flood event of March and April 1960. The old records at Gurnee and Des Plaines also occurred during the same flood event. What made the September/October 1986 flood so unusual was, without a doubt, the time of year. Fall floods which set record stages are not common occurrences.