FLOOD OF JUNE 15, 1981, IN GREAT BEND AND VICINITY, CENTRAL KANSAS

by Ralph W. Clement and David G. Johnson

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 82-4123

Prepared in cooperation with the

KANSAS DEPARTMENT OF TRANSPORTATION

Lawrence, Kansas

1982

UNITED STATES DEPARTMENT OF THE INTERIOR

JAMES G. WATT, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
1950 Avenue "A" - Campus West
University of Kansas
Lawrence, Kansas 66044-3897
(Telephone: [913] 864-4321)

Copies of this report can
be purchased from:

Open-File Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Denver, Colorado 80225
(Telephone: [303] 234-5888)

CONVERSION TABLE

For those readers who are interested in the metric system of measurement, the conversion factors from the inch-pound units used in this report to the International System of Units (SI) are listed below:

To convert from inch-pound unit	To SI unit	Multiply by
inch	millimeter	1/25.4
mile	kilometer	1.609
acre	square hectometer	0.4047
square mile	square kilometer	2.590
cubic foot per second	liter per second	28.32
inch per hour	millimeter per hour	1/25.4

1 Exact conversion factor.

CONTENTS

ILLUSTRATIONS

TABLES

FLOOD OF JUNE 15, 1981, IN GREAT BEND AND VICINITY, CENTRAL KANSAS

by Ralph W. Clement and David G. Johnson

ABSTRACT

Intense thunderstorm activity associated with a slow-moving weather system produced as much as 20 inches of rainfall in 12 hours, causing unprecedented flooding in southwestern Barton County, Kansas. Estimates of maximum rainfall intensity were as much as 4 inches per hour during 1 hour. Local runoff and overtopping of the streambanks caused significant flooding in rural Barton County and in the communities of Pawnee Rock and Great Bend, Kansas. Total damages to agriculture, rural and urban residences, and commercial and transportation facilities were estimated to be more than $42 million. Magnitudes of peak discharge in the downstream part of the Dry Walnut Creek watershed, where the most extensive flooding occurred, exceeded discharges having recurrence intervals of 100 years and in some locations exceeded the maximum previously observed discharges for the area.

INTRODUCTION

Torrential rains on June 15, 1981, in the vicinity of Pawnee Rock and Great Bend, Kansas, resulted in unprecedented flooding on Dry Walnut Creek and its tributaries in and upstream from the city of Great Bend. Unofficial reports indicate that as much as 20 inches of rain fell during the storm.

Measurement of peak discharges indicate that the magnitudes greatly exceed those for the 100-year flood (probability of occurrence of less than 1-percent in any 1 year), and in some locations the magnitudes exceeded the maximum previously observed discharges for that area.

The purpose of this report is to summarize the events that led to the flooding in and around Great Bend, Kansas, to present a summary of estimated damages resulting from the storm, and to document the magnitude and frequency of the measured peak discharges. The report was prepared in cooperation with the Kansas Department of Transportation. Information and additional assistance were obtained from the National Oceanic and Atmospheric Administration and the U.S. Army Corps of Engineers, Albuquerque District.

PRECIPITATION

The weather system associated with the flood of June 15, 1981, consisted of a line of thunderstorms located at the leading edge of a cold air mass that had stalled along a line extending from about Larned to Great Bend. Supplied with warm, moist air from the south, the system produced numerous thunderstorms that began to intensify during the early afternoon on June 14. Precipitation data were collected by the Albuquerque District, U.S. Army Corps of Engineers, in a "bucket survey" of about 160 locations. The survey also included data collected by the U.S. Soil Conservation Service and the National Weather Service. Lines of equal precipitation based on these data are shown in figure 1 . These unofficial reports indicated rainfall of as much as 20 inches and estimated intensities that were as much as 4 inches per hour for 1 hour during the severest part of the storm, which occurred between 6:00 and 7:00 p.m. on June 14.

The general pattern of the rainfall indicates that the majority of precipitation occurred about 5 miles on either side of a line from Great Bend southwest to near Larned. The severest part of the storm was located over the Arkansas River and its tributaries between Larned and Great Bend and over the downstream one-half of Dry Walnut Creek. Precipitation began about 4:00 p.m. on June 14 and continued at varying intensities until about 4:00 a.m. on June 15. Most of the precipitation fell during the first 4 hours of the storm.

DESCRIPTION OF FLOODING

Although runoff resulting from the storm of June 14 and 15 occurred throughout a large area, the flood was confined to an area of about 350 square miles in Pawnee and Barton Counties. The most extensive flooding occurred on Dry Walnut Creek and its tributaries in southwestern Barton County, which includes the city of Great Bend. Dry Walnut Creek originates in eastern Rush County and flows eastward through southwestern Barton County and the northern part of the city of Great Bend before it joins Walnut Creek about 1 mile east of the city.

Rural flooding was limited for the most part to the downstream one-half of the Dry Walnut Creek basin, with the most extensive flooding occurring south of the main channel and north of the Pawnee-Barton County line. Interviews with local residents indicated that the stage in the main channel of Dry Walnut Creek was the highest in at least 70 years. Significant overbank flow occurred along the main channel and all major tributaries of the Dry Walnut Creek watershed located in Barton County. Overbank flow along the tributaries was most significant in their downstream reaches where shallow channels and the wide flood plains allowed the flow to spread considerably. In many instances, flow actually traversed watershed boundaries contributing to the flow in adjacent watersheds. The relatively low topographic relief and the characteristically meandering channel caused backwater that resulted in overtopping of the banks. Overbank flooding generally ranged from 1- to 3-feet deep and from 0.25- to 0.5-mile wide.

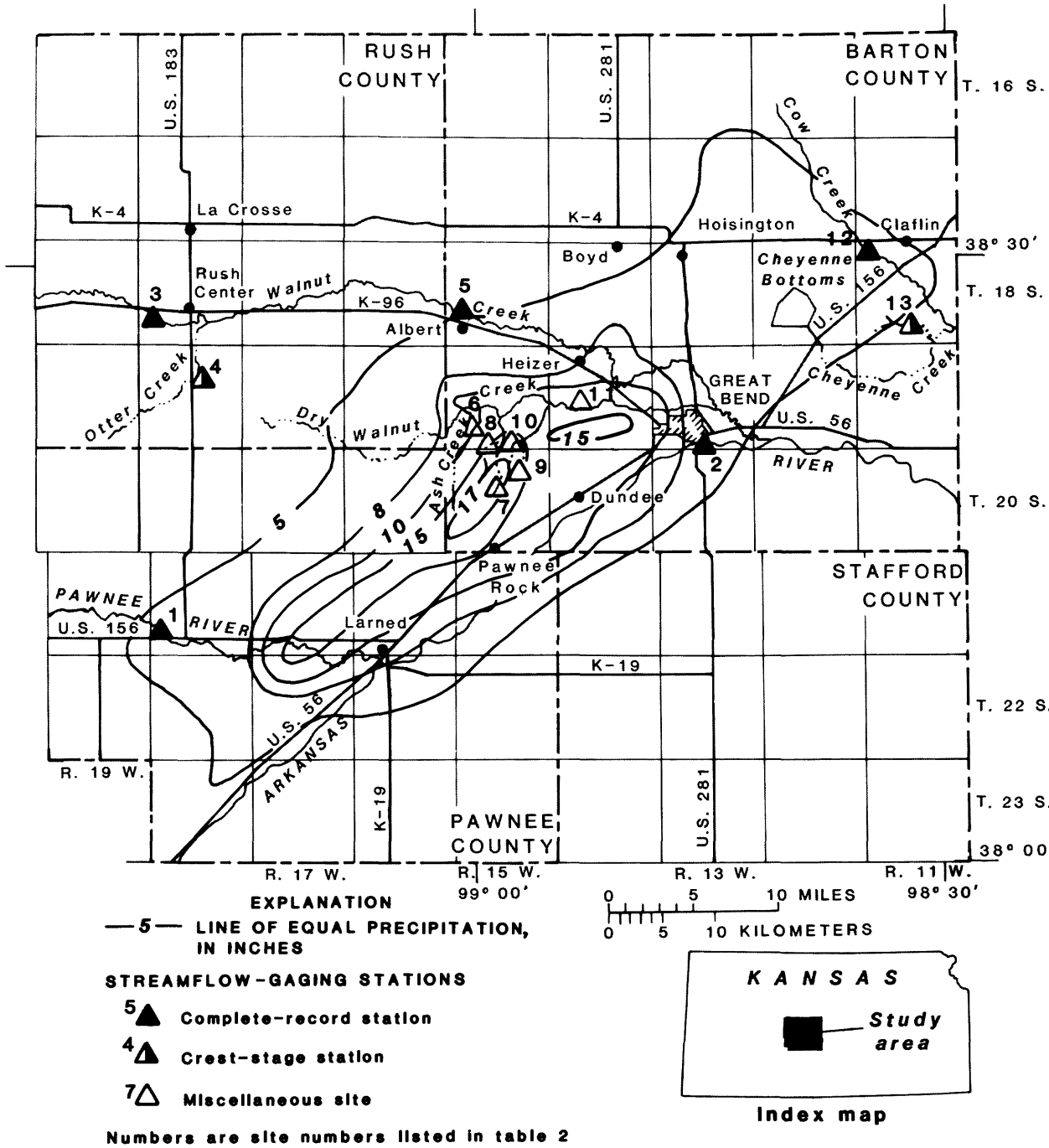

Figure 1.--Rainfall distribution and location of peak-discharge measurements for flood of June 15, 1981.

Significant depths of overland flow in the headwaters of Dry Walnut Creek tributaries were quite prevalent as evidenced by the erosion observed in open fields and residual debris left on the ground in other locations. These conditions resulted from rainfall intensities that greatly exceeded the maximum infiltration rate of the upper soil zone during the most intense part of the storm.

Flood-detention structures located in the tributary watersheds south of the main channel of Dry Walnut Creek had varying effects on the peak discharges resulting from the storm. Structures located in watersheds where the greatest rainfall occurred filled rapidly during the early part of the storm; hence, they afforded little attenuation of the maximum flows that occurred during the height of the storm. In contrast, detention structures in watersheds where rainfall was less intense were able to store a greater percentage of the runoff, afforded more attenuation, and hence reduced the magnitude of peak discharges.

Significant urban flooding was limited to the communities of Pawnee Rock and Great Bend. The town of Pawnee Rock experienced some flooding from Ash Creek, which overtopped its banks on the western edge of town. About one-half of the city of Great Bend was inundated; maximum depths were about 4 feet. Flooding in Great Bend was produced by direct runoff from precipitation and by excessive flow in Dry Walnut Creek. Walnut Creek did not contribute directly to the flooding in Great Bend. However, Walnut Creek was affected by backwater from the Arkansas River; this caused backwater in the Dry Walnut Creek channel, thus adding to the flooding within the city. Flow in the Arkansas River did not contribute directly to flooding in the city of Great Bend. Although the U.S. Geological Survey streamflow-gaging station on the Arkansas River at Great Bend (site 2) recorded a record stage, levees along the left (north) bank of the river were sufficient to protect the city of Great Bend. However, overtopping of the levee along the right (south) bank of the Arkansas River resulted in some local flooding of unincorporated areas south of the city of Great Bend.

FLOOD DAMAGES

The severity of the flood of June 15, 1981, is reflected in the damage caused by the rising water. The U.S. Army Corps of Engineers estimated total tangible damages at about $42,200,000 (see table 1). Most of the damage was sustained by residential property located in the cities of Great Bend, Pawnee Rock, and Dundee, and in rural Barton County. The flood also caused considerable damage to transportation facilities, to agricultural crops, livestock, and machinery, and to commercial and industrial sites.

An estimated 70,000 acres of crops were damaged, including about 30,000 acres of wheat, 20,000 acres of sorghum, 15,000 acres of alfalfa, and 5,000 acres each of corn and soybeans. Land damages were not assessed, but substantial erosion was evident. Losses to transportational services included damage at the Great Bend airport and to property of the Atchison, Topeka and Santa Fe Railway. No Federal highways were damaged, but many State and county roads required extensive cleanup and repair. About 220 rural homes were damaged to some extent. Damage to farm equipment machinery and losses to livestock were significant.

Damages were sustained by the levees along the Arkansas River due to overtopping. All breaches occurred south of the river and, as a result, did not contribute to the flooding of Great Bend.

An estimated 2,850 homes in Great Bend, 43 homes in Pawnee Rock, and 3 homes in Dundee sustained damage from flooding. Significant damage occurred to public properties and utilities, including buildings, utilities, machinery, roads, and protective structures. About 170 small manufacturing and service businesses and small industries sustained considerable cost for loss, cleanup, and repair from the flood.

A summary of damage estimates is contained in table 1.

Table 1.--Summary of estimated flood damages for flood of June 15, 1981

[Flood-damage information was obtained from the U.S. Army Corps of Engineers, Albuquerque District]

Item	Damages
Residential:	
Rural	$ 960,000
Urban (Great Bend, Pawnee Rock, and Dundee)	26,327,000
Agricultural:	
Crops	3,600,000
Equipment, machinery, livestock	530,000
Transportation	6,406,000
Flood-control structures	80,000
Public property and utilities (excluding telephone, electric, and water)	795,000
Commercial and industrial	3,494,000
Total	$42,192,000

DETERMINATION OF FLOOD MAGNITUDE AND FREQUENCY

In order to assess the magnitude and frequency of the flood of June 15, 1981, data on peak discharges resulting from the storm were obtained at streamflow-gaging stations operated by the U.S. Geological Survey and were supplemented by determinations of peak discharge at miscellaneous locations. The U.S. Geological Survey operates several complete-record and crest-stage (partial-record) streamflow-gaging stations in the vicinity of the study area. Seven of these stations recorded significant discharges in response to the storm of June 14 and 15. None of these stations are located in the area where the most extensive flooding occurred. Therefore, indirect measurements of peak discharge were made at selected miscellaneous locations within the area of extensive flooding to determine the magnitude of the discharges. A summary of peak discharges at streamflow-gaging stations and at miscellaneous locations is contained in table 2. Locations of all sites are shown in figure 1.

The flood of June 15, 1981, has not been exceeded in Barton County since record keeping began. Long-time residents confirmed that it was the greatest that they could remember, and one observer indicated that the stage on the Dry Walnut Creek near Heizer was the highest in at least 70 years.

Peak-discharge data have been collected on Kansas streams for more than 80 years. Numerous studies have been made to estimate the magnitude-frequency relations based on these data. In the most recent study, Jordan and Irza[1/] developed regression equations using contributing drainage area and 2-year, 24-hour rainfall to estimate flood magnitudes for recurrence intervals of as much as 100 years. For the purpose of this study, the regression equations were reduced to a single variable, contributing-drainage area, by applying the value of the 2-year, 24-hour rainfall for the Great Bend area. Thus, the equations became unique to those locations having the same 2-year, 24-hour rainfall and, in particular, to the Great Bend area.

Jordan and Irza also developed graphical relations (envelope curves) relating the maximum previously observed discharges to contributing drainage area for the eastern one-third and the western two-thirds of Kansas. The regression equations and the envelope curve for western Kansas, which are shown graphically in figure 2, were used to estimate the frequency of peak discharges determined for the flood of June 15. Peak discharges determined for the flood of June 15, 1981, are plotted in figure 2 to illustrate their magnitude relative to estimates of the 2-, 5-, 25-, and 100-year floods for the study area and the maximum previously observed discharge for western Kansas.

1/ Jordan, P. R., and Irza, T. J., 1975, Kansas streamflow characteristics--Magnitude and frequency of floods in Kansas, unregulated streams: Kansas Water Resources Board Technical Report No. 11, 34 p.

Table 2.--Summary of peak discharges for flood of June 15, 1981

Site no.	Permanent station no.	Stream name and location	Drainage area (square miles)	Maximum known flood				Flood of June 15, 1981		
				Period of record (water years)	Date	Gage height[1] (feet)	Discharge (cubic feet per second)	Gage height (feet)	Discharge (cubic feet per second)	Recurrence interval (years)
1	07141200	Pawnee River near Larned	2,148	1925-81	7/28/58	28.22	16,300	[2] 7.93	[2] 1,440	<2
2	07141300	Arkansas River at Great Bend	34,356	1941-81	6/23/65	17.18	27,800	[3] 16.56	14,000	15
3	07141780	Walnut Creek near Rush Center	1,256	1970-81	6/14/70	24.89	5,020	6.85	2	<2
4	07141800	Otter Creek near Rush Center	17.0	1957-81	7/26/58	20.71	5,080	16.87	1,100	5
5	07141900	Walnut Creek at Albert	1,410	1958-81	9/22/59	25.75	12,700	16.12	975	<2
6	-	Dry Walnut Creek near Pawnee Rock	4.39	-	-	-	-	-	1,260	25
7	-	Dry Walnut Creek tributary near Pawnee Rock	2.28	-	-	-	-	-	5,720	[4] 3 1/2
8	-	Dry Walnut Creek tributary near Pawnee Rock	1.19	-	-	-	-	-	3,080	[4] 2 1/2
9	-	Dry Walnut Creek tributary near Pawnee Rock	0.66	-	-	-	-	-	1,340	[4] 1 1/2
10	-	Dry Walnut Creek tributary near Pawnee Rock	0.92	-	-	-	-	-	1,870	[4] 1 3/4
11	-	Dry Walnut Creek near Heizer	107	-	-	-	-	-	19,400	[4] 1 1/2
12	07142860	Cow Creek near Clafin	43.0	1967-81	8/29/75	16.15	5,060	10.93	829	2
13	07143100	Little Cheyenne Creek tributary near Clafin	1.48	1957-81	2/08/66	15.6	290	13.68	180	2

[1] Referenced to datum used in 1981.
[2] Peak occurred on June 16, 1981.
[3] Maximum stage was 17.70 feet, which occurred prior to levee break.
[4] Ratio of peak discharge to that having a recurrence interval of 100 years.

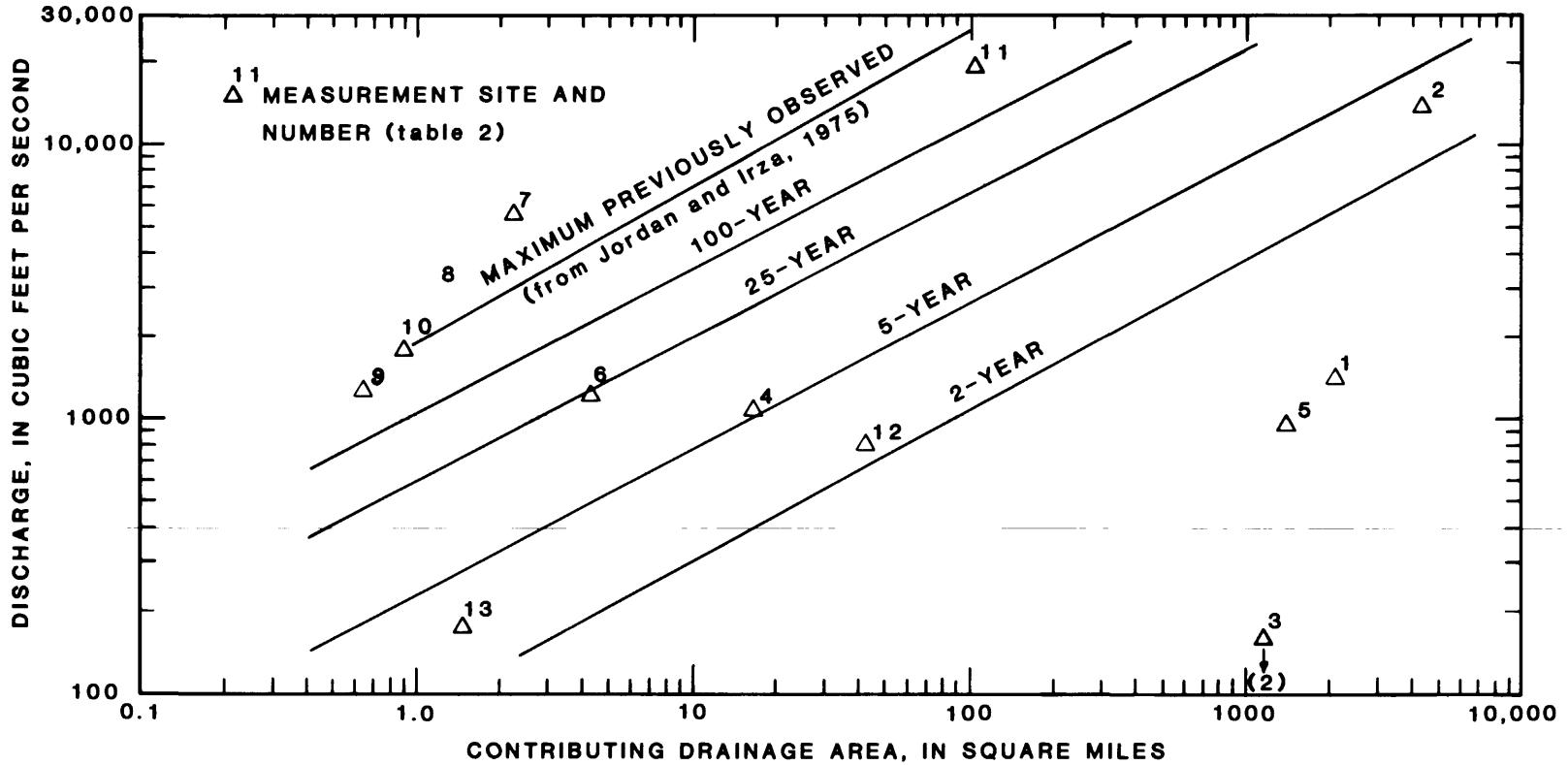

Figure 2.--Relation between peak discharges and drainage area for flood of June 15, 1981, and estimates of the 2-, 5-, 25-, and 100-year floods for the Great Bend area and maximum previously observed discharges for western Kansas.

Peak discharges on Dry Walnut Creek watershed in Barton County (sites 7-11) reflected the more intense rainfall as measurements of peak discharge generally exceeded the estimated 100-year magnitude. The peak discharge on the main stem of the Dry Walnut Creek (site 11) was about 1 1/2 times that of the estimated 100-year flood. The extreme is exemplified by the peak discharge at site 7 (5,720 cubic feet per second), which was about 3 1/2 times the estimated 100-year magnitude and about twice the magnitude of the curve value for maximum previously observed discharge.

Discharge at the streamflow-gaging station on Walnut Creek at Albert (site 5) was not historically significant, as the peak discharge of 975 cubic feet per second was less than the magnitude of the 2-year flood. The most intense part of the storm did not affect the Walnut Creek watershed.

The flood on the Arkansas River, however, was large enough to be significant. Although the peak discharge at Great Bend (site 2), 14,000 cubic feet per second, has been exceeded on several occasions, the peak stage of the water surface (affected by recently constructed levees) reached 17.70 feet, gage datum, which is the highest since at least 1895.

SUMMARY

Unprecedented flooding occurred in the downstream reaches of Dry Walnut Creek in and near Great Bend, Kansas, on June 15, 1981. The flooding was the result of intense rainfall produced from an isolated storm system that produced as much as 20 inches of precipitation in 12 hours. Maximum rainfall intensity was estimated to be as much as 4 inches per hour during 1 hour at the height of the storm.

Severe flooding was confined to the southwestern part of Barton County, including the city of Great Bend. Damages resulting from the flood were estimated to be in excess of $42 million. Peak discharges on Dry Walnut Creek generally exceeded estimates of the 100-year flood.