DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
CALIFORNIA DEPARTMENT OF WATER RESOURCES

HYDROLOGIC INVESTIGATIONS
ATLAS HA-348

FLOODS ON NAPA RIVER AT NAPA, CALIFORNIA

Introduction.–This atlas summarizes the results of an investigation of the floodflow characteristics of the Napa River in the vicinity of Napa, Calif. The approximate areas inundated during the floods of February 27, 1940, and December 22, 1955, are shown on the map to record past floods and to aid in estimating future flood risk. The boundaries of areas flooded January 31, 1963, and January 21, 1967, were comparable to those for the December 22, 1955, flood; with exceptions because of land filling, levee construction, and flood-channel alterations in the interim period. Although historical information indicated that floods greater than those of 1940 and 1955 have occurred, available data are inadequate for delineating their flood boundaries.

All stages mentioned in this report are referred to the gaging-station datum at Napa River near Napa, Calif., located at Oak Knoll Avenue 5 miles north of the city of Napa. The gage near Napa was operated by the Geological Survey 1930–32 and since 1960, and by the U.S. Army Corps of Engineers in 1940.

Cooperation and acknowledgments.– The preparation of this report was financed through a cooperative agreement between the California Department of Water Resources and the U.S. Geological Survey. This report was prepared under the direction of Loren E. Young, chief, Menlo Park subdistrict office. William M. Brown assisted the author in the field investigation and computation.

Information concerning flood elevations and overflow boundaries was furnished by the following agencies: Napa City Engineer's office, Napa County Engineer's office, U.S. Army Corps of Engineers, and U.S. Soil Conservation Service. Many residents in the area also provided valuable information on flood boundaries.

Basin description.– The drainage area upstream from the Geological Survey stream-gaging station Napa River near Napa, near the north limit of the flood-inundation map, is about 220 square miles. The principal tributaries—Conn, Dry, Milliken, and Redwood Creeks—enter the Napa River in the 10-mile reach upstream from Napa. Within the study area, Soda, Tulucay, and Milliken Creeks enter from the east and Napa Creek enters from the west. The Napa valley ranges from 1 to 4 miles in width and is about 40 miles long. Elevations in the drainage basin range from sea level at San Pablo Bay to 4,340 feet above sea level at Mount St. Helena. North of Napa the terrain adjacent to the Napa River is relatively flat farmland. South of the city the wide plain is mostly reclaimed land or tidal marshes. The Napa River is a navigable waterway from the southern city limits of Napa through San Pablo Bay to San Francisco Bay.

Flood inundation.–The extent of flood inundation in the city of Napa is not only directly related to the rate of runoff from the Napa River basin but also to the elevation of the tide at the mouth of the river. A high tide can increase the height of a flood as far as 2 miles north of the city.

The height of a flood at a gaging station is usually stated as the gage height, or stage, which is the height of the water surface above an arbitrary datum plane. Gage heights are shown in feet above the selected datum plane, and elevation of the height of a flood is shown in feet above mean sea level. Gage heights at the Napa River near Napa gaging station can be converted to elevations above mean sea level by adding the elevation of the gage datum, which is 24.74 feet above mean sea level, to the gage height.

Flooding of low-lying areas in the city occurs when streamflow exceeds 12,000 cfs (cubic feet per second), or at stages above an elevation of about 47 feet above mean sea level (gage height, 23 feet) at the gaging station on Napa River near Napa, Calif. Flood stages in the city are about 19 feet above mean sea level at the Lincoln Avenue bridge and about 15 feet above mean sea level at the First Street bridge. The duration of flooding within the city limits and upstream generally is from 1 to 3 days, whereas south of the city the flood duration is indefinite because of tidal effect and poor drainage due to vegetation, debris, and ponding of water in leveed areas.

Tributaries can overflow their banks as a result of local storms of high intensity, whether or not the Napa River floods. Areas flooded by tributary overflow are not delineated on the map because of lack of data regarding the extent of flooding. Tributaries to the Napa River usually crest several hours before the Napa River begins to flood the city; therefore, they are not necessarily large contributors to the inundation caused by the Napa River.

Floods of the same magnitude may result in different flood damage, depending on the efficiency of the main channel. Debris in the river and the elevation and direction of tide (incoming or outgoing) will affect the area inundated. Although the flood of December 22, 1955, was generally more extensive than the flood of January 31, 1963, several areas, not flooded in 1955, were inundated in 1963. On January 21, 1967, the water at Lincoln Street bridge and First Street bridge was about 2½ and 1½ feet deeper, respectively, than during the flood in 1963; however, the peak discharge in 1967 was about 7 percent lower than the peak discharge in 1963.

Future protective works and channel dredging may reduce the frequency of flooding in a given area by increasing the channel capacity, but will not necessarily eliminate the flood hazard.

Flood discharge.– The elevation, gage height, discharge, and year of each annual flood that exceeded an elevation of 47 feet are shown in figure 1. An annual flood is defined as the highest peak discharge that occurred during the water year which begins October 1 and ends September 30. The magnitude of annual floods for 1900–1929 and 1933–39 was estimated from rainfall-runoff studies. For 1941 and 1943–59, annual maximum discharges were estimated by correlation with annual maximum discharges at the Geological Survey gaging station near St. Helena.

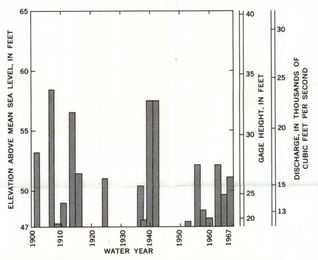

FIGURE 1.—*Annual floods above 47-foot elevation, 1900–1967, Napa River near Napa, California.*

The 1942 annual flood was estimated from flood heights known to have been virtually equal to those of the annual flood of 1940. Elevations for the annual floods that were estimated were determined by applying each annual flood discharge to the current stage-discharge relation, or rating curve, for the gaging station.

Although their extent of inundation is not known, major historical floods have occurred 7 times between 1862 and 1900. The greatest flood since at least 1862 occurred March 18, 1907. The next greatest flood occurred February 27, 1940, and was substantially equaled in stage February 6, 1942, at various points in the city. Major floods that have occurred since 1900 at the gaging station near Napa are listed in table 1.

The irregular occurrence of floods is shown in figure 1. The 47-foot elevation was exceeded by floodwater 18 times in 68 years, or, on the average, 1 time in less than 4 years; however, periods of 9, 11, and 12 years passed without a flood as high as the 47-foot elevation. On the other hand, 6 floods above the 47-foot elevation occurred in the 12-year period from 1956 to 1967.

TABLE 1. —*Major floods at the U.S. Geological Survey gaging station Napa River near Napa, California, 1900–1967.*

Date of flood	Stage (feet)	Elevation above mean sea level (feet)	Discharge (cubic feet per second)
March 18, 1907	a33.8	a58.5	a23,800
February 27, 1940	32.8	57.5	22,500
February 6, 1942	a32.8	a57.5	a22,500
December 31, 1913	a31.8	a56.5	a21,500
February 24, 1902	a28.5	a53.2	a18,000
January 31, 1963	27.5	52.2	16,900
December 22, 1955	a27.5	a52.2	a16,800
January 3, 1916	a26.8	a51.5	a16,200
January 21, 1967	26.5	51.2	15,800
February 12, 1925	a26.4	a51.1	a15,700

a. Estimated

Several small reservoirs on tributaries of the Napa River are parts of water-supply systems for municipal, industrial, and domestic needs and have varying effects on annual floods, depending on the reservoir-storage capacity. Lake Hennessey, the largest storage facility in the basin (capacity 31,000 acre-feet) was formed when Conn Dam was built in 1946. Flow from 24 percent of the Napa River drainage above the gaging station near Napa is subject to storage in Lake Hennessey. At the onset of the storm that caused the December 1955 flood, the water level in Lake Hennessey was 14 feet below the spillway elevation, and a considerable part of the flood runoff was stored in the reservoir. On January 31, 1963, the water level was only 1 foot below the spillway elevation, and most of the ensuing flood runoff spilled. This caused extensive damage along Conn Creek and increased the flow of the Napa River through Napa. Conn Dam is not equipped to permit release of water other than to water-supply lines or over the spillway structure. Accordingly, this dam will serve flood-control purposes only to the extent of available storage capacity when a major storm occurs.

Flood frequency.–The frequency of flooding on the Napa River is derived initially from a compilation of annual floods since 1900 at the Geological Survey gaging site near Napa. Recurrence interval is the average interval of time within which a given flood will be exceeded once. For floods having recurrence intervals greater than 10 years, probability is virtually the reciprocal of recurrence interval. For example, the probability of occurrence in any year of a flood event designated as a 25-year flood (or 25-year recurrence interval) is 1/25; therefore, it has a 4-percent chance of being exceeded in any given year. The frequency curve shown in figure 2 is based on fitting

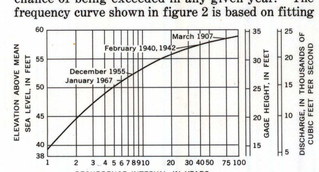

FIGURE 2.—*Frequency of floods above 39-foot elevation at gaging station on Napa River near Napa, California.*

a standard statistical distribution (log-Pearson Type III) to the array of annual flood discharges at the gaging site on the Napa River near Napa, converted statistically to a curve representing all floods above a base discharge. The frequency of floods exceeding specific elevations or gage heights is defined in figure 2 for the channel characteristics existing in 1967. Five significant floods are indicated in figure 2. The recurrence interval for a flood exceeding the discharge of the 1907 annual flood is about 75 years and for a flood exceeding that of January 31, 1967, it is about 7 years. The Napa River will overflow its channel in the city of Napa once in about 3 years, on the average, over a long period of time. The reliability of recurrence interval estimates depends on the length of record and not on the method of analysis. The peak discharge of flood stage of a 10-year flood could be estimated with considerably more assurance than that for a 75- or 100-year flood.

Flood profiles.–Profiles of the water surface along the Napa River thalweg for the floods of February 27, 1940, and December 22, 1955, are shown in figure 3. These profiles were constructed from floodmarks and other high-water information. Profiles of floods having recurrence intervals of less than 50 years can be plotted in figure 3 generally parallel to the profiles shown. Future floods of the same magnitude will not necessarily duplicate previous profiles because alterations to the flood plain and main channel will modify the flow patterns. The profiles may not be representative of the flood elevation across the entire width of the flood plain because of the arrangement of levees and other local influences. Areas of inundation, water depths, and velocities in the overflow areas will be increased if further encroachment is made along the main channel and, conversely, will be reduced if the main channel is improved hydraulically.

Depth of flooding at selected points in the inundation zones of the 1940 or 1955 floods can be estimated by subtracting the ground elevation (interpolated between map contour lines) from the water-surface elevation on the profiles in figure 3.

Additional data.–Other information pertaining to floods in the Napa River basin can be obtained at the office of the U.S. Geological Survey, Water Resources Division, 855 Oak Grove Ave., Menlo Park, Calif., and from the following reports:

Hofmann, Walter, and Rantz, S. E., 1963, Floods of December 1955–January 1956 in the Far Western States: U.S. Geol. Survey Water-Supply Paper 1650–A, 156 p. and 1650–B, 580 p.

U.S. Geological Survey, 1960, Compilation of records of surface water of the United States through September 1950, pt.11–A, Pacific slope basins in California except Central Valley: U.S. Geol. Survey Water-Supply Paper 1315–B, 874 p.

———1964, Compilation of records of surface water of the United States, October 1950 to September 1960, pt.11, Pacific slope basins in California: U.S. Geol. Survey Water-Supply Paper 1735, 715 p.

U.S. Geological Survey, 1966, Water resources data for California, pt. 1, surface water records, volume 1: Colorado River Basin, Southern Great Basin, and Pacific Slope Basins excluding Central Valley: U.S. Geol. Survey basic data rept., 482 p. (Published annually).

Young, L. E., and Cruff, R. W., 1967, Magnitude and frequency of floods in the United States, pt. 2, Pacific slope basins in California: U.S. Geol. Survey Water-Supply Paper 1685, 272 p.

Young, L. E., and Harris, E. E., 1966, Floods of January–February 1963 in California and Nevada: U.S. Geol. Survey Water-Supply Paper 1830–A, 472 p.

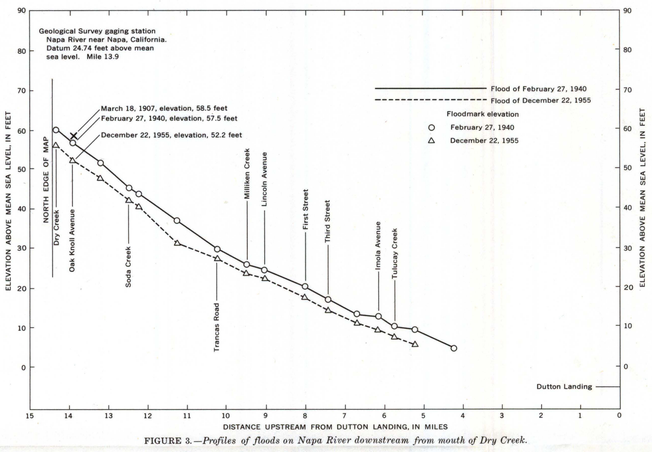

FIGURE 3.—*Profiles of floods on Napa River downstream from mouth of Dry Creek.*

Aerial view of South Napa, California, and flooding Napa River, February 28, 1940.

Aerial view of Napa, California, and flooding Napa River, February 28, 1940.

EXPLANATION

Flood of February 27, 1940

Flood of December 22, 1955

Boundary of 1940 flood — 1940 —

Boundary of 1955 flood — 1955 —

River mile measured along stream channel upstream from Dutton Landing (14)

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