800-12

FLOOD PLAIN INFORMATION

MOJAVE RIVER

(VICINITY OF VICTORVILLE)

SAN BERNARDINO COUNTY
CALIFORNIA

PREPARED FOR
SAN BERNARDINO COUNTY
BY
CORPS OF ENGINEERS, U. S. ARMY
LOS ANGELES DISTRICT, CALIFORNIA

APRIL 1969

Property Of
MOJAVE WATER AGENCY

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Aerial view of the City of Victorville along the Mojave River.

INTRODUCTION

This report relates to the flood situation along the Mojave River in the vicinity of the City of Victorville, Calif. It was prepared at the request of the Board of Supervisors of San Bernardino County to aid in the solution of local flood problems and in the best utilization of land subject to overflow. The information contained in the report is based on hydrologic data, theoretical flood heights and limits, and other technical data related to the flood problems along the Mojave River in the Victorville area.

The nature and effect of two probable future floods, namely, the Intermediate Regional Flood and the Standard Project Flood, are considered in this report. Intermediate Regional Floods are floods that have an average frequency of occurrence of once in 100 years and are determined from an analysis of known floods on the Mojave River and on other streams that have similar physical characteristics and are in the same general geographical region. Standard Project Floods are floods that may be expected from the most severe combination of meteorological and hydrological conditions considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. They are floods of rare occurrence and, on most streams, are considerably larger than any floods that have occurred in the past.

In reaching decisions on the sizes of floods to be considered in planning for development in the flood plain of the Mojave River, appropriate consideration should be given to the possible future occurrence of floods of the sizes of the Intermediate Regional Flood and of the Standard Project Flood.

The report contains maps, profiles, and cross sections, which indicate the extent and depth of flooding that might occur in the future along the study reach of the Mojave River. This

report should prove helpful in planning the best use of the flood plain. With this information, building plans could provide for floor levels high enough to avoid flood damage or, if not, such planning should recognize the chance and hazards of flooding that may be expected.

The report does not include plans for the solution of flood problems. Rather, it is intended to provide information for future study and planning on the part of San Bernardino County, the City of Victorville, and other local entities as to the acceptable use of the flood plain of the Mojave River and for the protection of public health and safety. This might involve local planning programs to guide development by controlling the use made of the flood plain through zoning, subdivision regulations, building codes, health regulations, or construction of flood protection works, or a combination of these approaches.

The Los Angeles District of the Corps of Engineers will, upon request, provide technical assistance to Federal, State, and local agencies in the interpretation and use of the information contained herein and will provide other available flood data related thereto.

SUMMARY OF FLOOD SITUATION

The Mojave River originates in the San Bernardino Mountains at the junction of Deep Creek and the West Fork of the Mojave River. The river flows generally northeastward from the junction of the two streams for about 125 miles through the Mojave Desert to Soda Dry Lake, passing the Cities of Victorville and Barstow and the communities of Helendale, Daggett and Yermo (see pl.1). The Mojave River from river mile 84.00, a point near the community of Helendale, to river mile 116.15, a point just downstream from the Mojave River Reservoir is considered in this report. The reach downstream from Helendale to Yermo is covered in a previous report entitled "Flood Plain Information Report, Mojave River (Vicinity of Barstow)." The principal commercial and residential developments in the City of Victorville are on high ground west of the river, but scattered agricultural, residential, commercial, and recreational developments are on land along the river. With the Mojave River Reservoir in operation, future flooding from floods originating from the San Bernardino Mountains on lands adjacent to the river would not be as extensive as those which occurred during the March 2, 1938, the January 25, 1967, and the February 25, 1969, floods. However, floods caused by local thunderstorms in the Mojave River could be large enough to cause substantial damage to developments along the river because of the large drainage areas involved downstream from the reservoir.

The U.S. Geological Survey maintains stream-gaging stations on the Mojave River and on some of its tributaries, such as Deep Creek and the West Fork of the Mojave River. One stream-gaging station is in the study reach of the Mojave River. This gaging station is located on the west bank of the Mojave River about 1,000 feet upstream from the National Trails Highway bridge. The flood history in the study reach of the Mojave River was developed from historical accounts of past floods - such

as those given in the local newspaper, The Victor Press (renamed the Daily Press in 1967) and in reports of investigations made after large floods - and from runoff records of gaging stations on the Mojave River. The following paragraphs summarize the significant findings, which are discussed in more detail in succeeding sections of this report.

* * *

THE LARGEST FLOOD OF RECORD on the Mojave River at Victorville occurred on March 2, 1938. Photographic records and newspaper accounts indicate that this flood - which had an estimated peak discharge of 70,600 cubic feet per second at Victorville from a drainage area of about 514 square miles - caused extensive damage to railroad and highway bridges, as well as to agricultural lands adjacent to the river. This flood washed out the stream-gaging station at Victorville. However, records of the stream-gaging station at Barstow confirms that this flood was the largest flood of record that occurred in this river.

* * *

THE NEXT LARGEST FLOOD OF RECORD on the Mojave River at Victorville occurred on January 25, 1969. This flood had a peak discharge of about 37,500 cubic feet per second from a drainage area of 514 square miles. Residents living on the lowlands adjacent to the Mojave River were forced to evacuate their homes. Parts of crossings, such as Rock Springs Road and Harper Lake Road, were washed out. Newspaper accounts and field investigations indicated that damage to property was scattered along the course of the Mojave River. This flood exceeded the February 25, 1969, flood which had an estimated peak discharge of 35,000 cubic feet per second, the December 29, 1965 flood, which had a peak discharge of 32,800 cubic feet per second, and the January 23, 1943 flood, which had a peak discharge of 32,000 cubic feet per second; all

of which were either recorded or estimated at the gaging station at Victorville.

* * *

OTHER LARGE FLOODS on the Mojave River at Victorville occurred in February 1932, in November 1965, and in April 1958. Their peak discharges were relatively small compared to the peak discharge of the March 2, 1938, flood. However, the April 1958 flood washed out the Harper Lake Road bridge near Helendale.

* * *

THE INTERMEDIATE REGIONAL FLOOD, which is a flood that has an average frequency of occurrence in the order of once in 100 years, is determined from an analysis of flood records and from computed hydrographs of characteristic floods. For this report, the computation of the Intermediate Regional Flood was based on the assumption that the Mojave River Reservoir, a flood control structure under construction to control the headwater flows of the Mojave River was already in operation (see pl. 1). The analysis indicates that the Intermediate Regional Flood would generally create depths of flow of about 2 feet on the flood plain of the Mojave River in the reach studied.

* * *

STANDARD PROJECT FLOOD determinations indicate that this flood would have a depth about 0.5 foot greater than the Intermediate Regional Flood on the flood plain of the Mojave River. The computation of the Standard Project Flood was also based on the assumption that the Mojave River Reservoir was already in operation.

FLOOD DAMAGES that would result from recurrence of major floods would be substantial. Extensive damage has been caused by past floods to agricultural land, highway and railroad bridges, and other facilities. With the Mojave River Reservoir in operation, magnitudes of floods on the Mojave River originating from the San Bernardino Mountains and under general storm conditions would be substantially reduced. However, because of the large tributary drainage areas downstream from the Mojave River Reservoir site, floods resulting from local thunderstorms would be large enough to cause extensive damage to developments along the river downstream from the reservoir site.

* * *

THE MAIN FLOOD SEASON for the Mojave River basin is from December through March. Storms occurring during those winter months last for several days, are widespread, and produce the larger floods. Thunderstorms are not uncommon, and the amount of rainfall from such storms in the summer may be sufficient to cause large floods in the Mojave River.

* * *

THE VELOCITY OF WATER in the channel of the Mojave River in the study reach for the Standard Project Flood and for the Intermediate Regional Flood would generally range between 6 to 10 feet per second (4.0 to 6.5 miles per hour), reaching a maximum velocity near the stream-gaging station near Victorville. The velocity at this point would be as much as 22 feet per second (15.0 miles per hour) for the Standard Project Flood and 21 feet per second (14.5 miles per hour) for the Intermediate Regional Flood. The velocity of water on the flood plain outside the channel would generally range from 1 to 4 feet per second (0.5 to 2.5 miles per hour),

but it would be as much as 9 feet per second (6.0 miles per hour) at certain locations. Velocities greater than 3 feet per second (2.0 miles per hour), combined with depths of 3 feet or greater, are generally considered hazardous.

* * *

THE DURATION OF FLOODS is relatively short on the study reach of the Mojave River. Stages would rise from streambed to extreme flood peaks in less than one-half day. During the January 1943 flood, the river rose to its peak in about 7 hours and its floodwaters remained on the overbank area at Victorville for about one-half day. When the Mojave River Reservoir is put into operation, general storm flood stages will rise less rapidly at Victorville but floodflows will be protracted. However, thunderstorms occurring downstream from the Mojave River Reservoir will cause rapidly rising flood stages in the Mojave River.

* * *

HAZARDOUS CONDITIONS would occur during large floods as a result of the rapidly rising stream, high velocities, and deep flows.

* * *

FLOOD DAMAGE PREVENTION MEASURES. There is, at present, a Federally constructed flood control channel, which was completed in February 1969, on the Oro Grande Wash, a major tributary to the Mojave River in the study reach. Another Federal flood control project is the Mojave River Reservoir, which is scheduled for completion by June 30, 1971. When completed, it will substantially reduce flood damages from floods originating from the San Bernardino Mountains along the Mojave River. Local interests have also

constructed flood protection measures, such as wood post and wire fences and sand levees, at various locations along the Mojave River. The occupancy of the flood plain is controlled to some degree by building codes, subdivision regulations, and flood plain zoning ordinances.

* * *

FUTURE FLOOD HEIGHTS determined for the Intermediate Regional Flood and for the Standard Project Flood are compared in table 1 with the recorded height of the January 23, 1943, flood at the stream-gaging station at Victorville. The flood crests of the March 2, 1938, flood and the January 25, 1969, flood are also compared in table 1 with that of the January 23, 1943, flood. As shown, the crest of the Intermediate Regional Flood would be 2.0 feet below the crest of the January 23, 1943, flood and the crest of the Standard Project Flood would be about the same as that of the 1943 flood. The low recorded gage height of the 1943 flood was due to scouring of the river bottom during that flood. The difference in magnitude for future floods is due to the existence of the Mojave River Reservoir. The flood heights at the gaging station for the Intermediate Regional and the Standard Project Floods were computed on the basis of the riverbed conditions as reflected by the topographic maps prepared in 1962, in 1963, and in 1966.

Table 1

RELATIVE FLOOD HEIGHTS

Flood	Location	Peak discharge cfs	Above 1943 flood crest feet	Below 1943 flood crest feet
January 23, 1943	Stream-gaging station at Victorville (river mile 98.00)	32,000	---	---
Intermediate Regional		*23,600	---	2.0
Standard Project		*30,000	---	---
March 2, 1938		70,600	4.7	---
January 25, 1969		37,500	---	** 2.5

* Controlled by the Mojave River Reservoir
** Scour to the riverbed (as much as 10 feet) caused the 1969 flood to record a lower gage height.

GENERAL CONDITIONS AND PAST FLOODS

The City of Victorville, San Bernardino County, Calif., is about 45 miles north of the City of San Bernardino and about 100 miles northeast of the City of Los Angeles. The reach of the Mojave River studied extends from river mile 84.00, a point near the community of Helendale, to river mile 116.15, a point just downstream from the Mojave River Reservoir dam. The drainage area of the Mojave River above the downstream limit of this study is 866 square miles. All of the watershed is in San Bernardino County, except for three small parts that extend into Los Angeles and Kern Counties. Plate 1 shows the watershed of the Mojave River.

The Mojave River flows generally northward in the reach considered in this report. It follows a meandering course through a broad flood plain. The main residential and commercial developments of the City of Victorville are on high ground, outside the areas subject to inundation by floodflows in the Mojave River. However, some scattered residential and agricultural developments are located in the flood plain, and they would be inundated by floodflows in the Mojave River.

The first records of river stage and discharge on the Mojave River at Victorville date from February 1899, when the U.S. Geological Survey installed a staff gage on the west bank of the river about 3.8 miles upstream from its present site at river mile 98.00, which is about 1,000 feet upstream from the National Trails Highway bridge (river mile 97.80). The gage was relocated to its present site on December 9, 1936 (see pl. 2).

From the stream gage records on the Mojave River and on some of its tributaries and from reports of investigations made following large floods, such as the March 2, 1938, the January 23, 1943, the December 29, 1965, the January 25, 1969, and the

February 25, 1969, floods, it was possible to develop a knowledge of past floods on the Mojave River in the vicinity of Victorville.

The following parts of this report discuss the general conditions and flood history of the Mojave River in the study reach.

Mojave River

Settlement

The Mojave River valley was first described by Francisco Hermenegildo Garces, a missionary-priest, who, traveling overland from the Colorado River area in 1776 on his way to the San Gabriel Mission near Los Angeles, Calif., followed a trail that paralleled the river. In 1826, Jedediah Smith - a famous mountain man, fur trader and explorer - was the first known North American to reach California by an overland route. After arriving at the Mojave villages from the Great Salt Lake, he followed the old Spanish Trail to the San Bernardino Valley.

Victorville, which is the only incorporated city within the study reach, was founded in 1885 during the construction of the Santa Fe railroad through this area. The railroad's telegraph station was established at the present site of Victorville and was named "Victor" in honor of Jacob N. Victor, construction superintendent of the Santa Fe railroad. Subsequently, a small railroad town developed around this station.

A few years later, agricultural development, spurred by the abundance of water and excellent river bottom soils along the Mojave River, began to occur in the vicinity of Victorville. Subsequent discovery of limestone and granite, which were of excellent quality, engendered the development of cement manufacturing plants, such as that in the community of Oro Grande.

The community's name, Victor, was changed to its present name in 1901, and on September 21, 1962, Victorville was incorporated as a city. The population within the city limits has grown from about 8,200 in 1960 to the 1968 population of about 11,200. Major sources of income are derived from the manufacturing of cement and lime and from employment in utility companies and in the Government. George Air Force Base, a permanent base of the Tactical Air Command, is located about 5 miles northwest of Victorville.

Flood damage prevention measures

There are no proposed or authorized Federal flood control projects for the Mojave River in the reach studied. However, a channel improvement project for the Oro Grande Wash, extending from the Mojave River upstream to a point on the wash about 700 feet from the junction of Hesperia Road and Center Street, was completed in February 1969. The channel improvement consists of a total of about 6,400 feet of concrete rectangular open and covered channel. This project will prevent flood damage to the City of Victorville from floods up to the magnitude of the Intermediate Regional Flood on Oro Grande Wash. Floods greater than the Intermediate Regional Flood will exceed the capacity of the channel and will cause some residential and commercial developments in the City of Victorville to be inundated. The overflow limits of the Standard Project Flood in Oro Grande Wash with the channel improvement are shown on plates 13 and 14.

The major flood protection to developments along the Mojave River will be provided by the Mojave River Reservoir, which is presently under construction and scheduled for completion by June 30, 1971. Upon completion of the dam, which will form the reservoir, the magnitude of floods in the Mojave River will be substantially reduced. A Standard Project Flood peak inflow of 94,000 cubic feet per second into the reservoir will be reduced to a peak outflow of about 23,500 cubic feet per second, and an

Intermediate Regional Flood peak inflow of 89,000 cubic feet per second will be reduced to a peak outflow of about 23,200 cubic feet per second.

Local interests' flood protection measures consist of wood post and wire fences, sand levees, and channel realinement and clearing projects. The occupancy of the flood plain is controlled to some degree by building codes, subdivision regulations, and flood plain zoning ordinances.

Flood warnings and forecasting services

The City of Victorville does not receive specific flood warnings or forecasting services from the U.S. Weather Bureau. General weather forecasts are issued by the U.S. Weather Bureau office in the City of Los Angeles.

The stream and its valley

The Mojave River, from its headwaters in the San Bernardino Mountains to its mouth at Soda Dry Lake, drains an area of about 4,700 square miles. The river flows generally northeastward for about 125 miles to its mouth. The watershed of the Mojave River is in San Bernardino County, except for three small parts that extend into Los Angeles and Kern Counties (see pl. 1).

The watershed is irregularly shaped, with a southwest-northeast length of about 100 miles and a southeast-northwest width of about 70 miles. Most of the watershed consists of desert, with broad and gently sloping valleys, some of which are separated by sharp-crested mountains. The headwater area is mountainous, with deep and narrow canyons. Elevations in the basin range from about 900 feet at Soda Dry Lake to 8,357 at Delmar Mountain in the San Bernardino Mountain range.

The average fall of the Mojave River from the junction of Deep Creek and the West Fork of the Mojave River to Victorville,

a distance of about 14 miles, is about 20 feet per mile; from Victorville to Barstow (39 miles), it is about 15 feet per mile; and from Barstow to Soda Dry Lake (60 miles), it is about 21 feet per mile.

Major tributaries of the Mojave River in and near the study reach are Deep Creek, the West Fork of the Mojave River, Antelope Valley Wash, Oro Grande Wash, Bell Mountain Wash, and Fremont Wash - the latter tributary joins the Mojave River near Helendale.

The Mojave River in the reach studied follows a meandering course through a flood plain that ranges in width from about 100 feet to about 1 mile. The widest part of the flood plain in the study reach is at about river mile 113.00.

Table 2 shows the drainage area above selected points along the study reach of the Mojave River.

Table 2

DRAINAGE AREAS IN WATERSHED OF THE MOJAVE RIVER

Stream and Location	Mile above mouth	Drainage area sq. mile
Mojave River		
about mouth	0.00	4,700
above lower limit of study	84.00	866
above stream gage at Victorville	98.00	514
above Victorville	101.30	359
above Hesperia	110.50	259
above upper limit of study	116.15	215
Fremont Wash		
above confluence with Mojave River	0.00	247
Bell Mountain Wash		
above confluence with Mojave River	0.00	41
Oro Grande Wash		
above confluence with Mojave River	0.00	30
Antelope Valley Wash		
above confluence with Mojave River	0.00	22

Developments in the flood plain

Plate 2 is a location map that shows, among other things, pertinent features along the study reach of the Mojave River.

In addition to agricultural land, there are scattered residential and commercial developments in the flood plain of the Mojave River in the reach studied. Most of the important commercial facilities in the City of Victorville are outside

the area subject to flooding from the Mojave River.

Interstate Route 15 is the most important highway crossing the Mojave River. Other main highways that cross the river are National Trails Highway, State Highway No. 18, and Bear Valley Cutoff.

The jointly used main line of the Union Pacific and of the Atchison, Topeka and Santa Fe railroads generally parallels the Mojave River. This railroad is on the east side of the river from Helendale to river mile 98.42, where it crosses over to the west side of the river. From Victorville, the railroad gradually diverges southwestward away from the Mojave River. An Atchison, Topeka and Santa Fe railroad spur crosses the Mojave River at river mile 111.07. Photographic records indicate that the jointly used main line of the Union Pacific and of the Atchison, Topeka and Santa Fe railroads was damaged by the flood that occurred on March 2, 1938.

Bridges across the stream

Two highway, three local road, part of an abandoned road, and three railroad bridges cross the Mojave River in the study reach. Table 3 contains pertinent information on the bridges that cross the river in the study reach and show their relationship to the flood crests of the Intermediate Regional Flood and of the Standard Project Flood. Except for the Harper Lake Road bridge, all of the bridges crossing the Mojave River in the study reach have openings that are adequate to pass the Standard Project Flood and the Intermediate Regional Flood. Figures 1 through 9 are views of the bridges crossing the river in the study reach.

The two highway bridges that cross the Mojave River are the Interstate Route 15 bridge (fig. 5) and the State Highway No. 18 bridge (fig. 6). The Interstate Route 15 bridge at river mile 100.40 is a twin, eight-span concrete bridge, having a total

length of about 575 feet. The State Highway No. 18 bridge at river mile 101.58 is a five-span concrete bridge, having a total length of about 447 feet. This bridge links Victorville to Apple Valley and to other surrounding areas.

The three local road bridges that cross the Mojave River are the Harper Lake Road bridge (fig. 1) at river mile 84.41, National Trails Highway bridge (fig. 2) at river mile 97.80, and the Bear Valley Cutoff bridge (fig. 7) at river mile 106.83.

The Harper Lake Road bridge is the most recently constructed bridge within the study limits. This bridge is a two-span concrete bridge, having a total length of about 70 feet. It will pass only low flows in the Mojave River and will not accommodate any large floods. This Harper Lake Road bridge replaced the bridge that was damaged by the April 1958 flood on the Mojave River. The approaches to the bridge were washed out by the January 25, 1969, flood.

The National Trails Highway bridge is a part concrete and a part steel truss bridge. It has a total length of 575 feet in seven spans. The longest span, which is the steel truss part of the bridge, measures 270 feet in length.

The Bear Valley Cutoff bridge is an 814-foot concrete bridge with 11 spans. This highway bridge is the only bridge available for vehicles to cross the Mojave River between the Mojave River Reservoir, which is presently under construction, and the State Highway No. 18 bridge near Victorville, a distance of about 13 miles. Rock Springs Road, which is upstream from this bridge is a dip crossing and it will be inundated whenever a flood would occur in the Mojave River. The January 25, 1969, flood washed out the section of the roadway crossing the river, making the road inaccessible to vehicular traffic.

The abandoned highway bridge (fig. 6) at river mile 101.55 was replaced by the adjacent State Highway No. 18 bridge. This

abandoned highway bridge is a steel arch bridge with a span of about 255 feet.

The three railroad bridges that cross the Mojave River are the Union Pacific and the Atchison, Topeka, and Santa Fe railroads jointly used main line bridge (fig. 3) at river mile 98.42, the Atchison, Topeka and Santa Fe railroad bridge (figs. 8 and 9) at river mile 111.07 and the Mojave Northern railroad bridge (fig. 4) at river mile 99.53. The railroad bridge at river mile 98.42 is a one-span steel truss bridge, and the railroad bridge at river mile 111.07 is primarily a wooden bridge with timber supports. The Mojave Northern railroad bridge at river mile 99.53 is a steel bridge with concrete supports. A 40-foot span, including a pier, of the railroad bridge at river mile 99.53 and about a 100-foot span of the railroad bridge at river mile 111.07 were washed out by the January 25, 1969, flood. The damage was primarily caused by debris which accumulated on the piers.

Obstructions to floodflow

Obstructions to floodflows are caused primarily by silt and debris accumulated at the highway and railroad bridges.

Flood records

Records of river stage and discharge in the Mojave River and in its tributaries have been maintained since February 1899, when the U.S. Geological Survey installed a staff gage on the Mojave River near the City of Victorville. This gage, which was moved to its present location at river mile 98.00 on December 9, 1936, is, at present, the only stream-gaging station within the reach studied. Streamflow records from this gage, together with newspaper and other accounts of past floods have provided the necessary information from which a knowledge of past floods in the Mojave River in the reach studied was developed.

Table 3

BRIDGES ACROSS THE MOJAVE RIVER

Mile above mouth	Identification	Streambed elevation feet	Floor elevation feet	Low steel feet	Intermediate Regional Flood crest elevation feet	Standard Project Flood crest elevation feet
84.41	Harper Lake Road	2,419.0	2,432.0	2,427.0	2,432.2	2,432.4
97.80	National Trails Highway	2,649.0	2,678.5	2,670.5	2,658.6	2,659.8
98.42	Union Pacific and Atchison, Topeka and Santa Fe railroads	2,656.0	2,691.5	2,689.0	2,675.5	2,678.3
99.53	Mojave Northern railroad	2,673.0	2,696.0	2,692.0	2,683.5	2,684.5
100.40	Interstate Route 15 (U.S. Route 66 & 91)	2,688.0	2,715.5	2,710.5	2,695.0	2,696.6
101.55	Old State Highway No. 18 (Abandoned)	2,706.5	2,754.0	2,749.0	2,717.7	2,719.0
101.58	State Highway No. 18	2,707.5	2,752.0	2,747.0	2,718.7	2,720.1
106.83	Bear Valley Cutoff	2,812.0	2,828.0	2,823.0	2,820.6	2,820.9
111.07	Atchison, Topeka and Santa Fe railroad	2,888.0	2,903.0	2,900.0	2,892.7	2,892.9

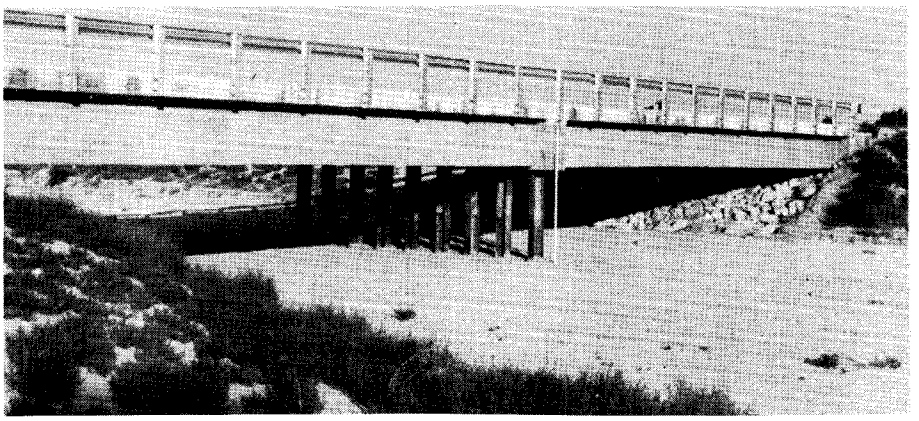


Figure 1.--View of downstream side of Harper Lake Road bridge at mile 84.41 near Helendale.

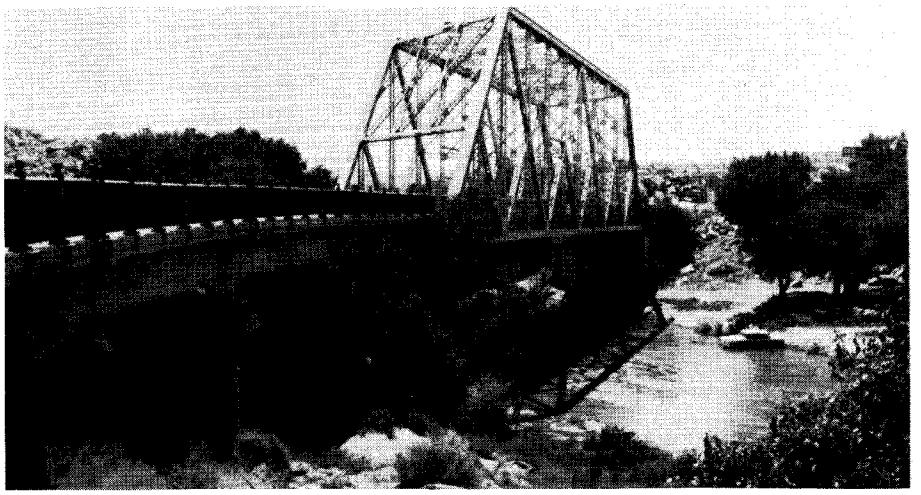


Figure 2.--View of downstream side of National Trails Highway bridge at mile 97.80 near Victorville.

Figure 3.--View of downstream side of Union Pacific and of Atchison, Topeka and Santa Fe railroads jointly used main line bridge at mile 98.42 near Victorville.

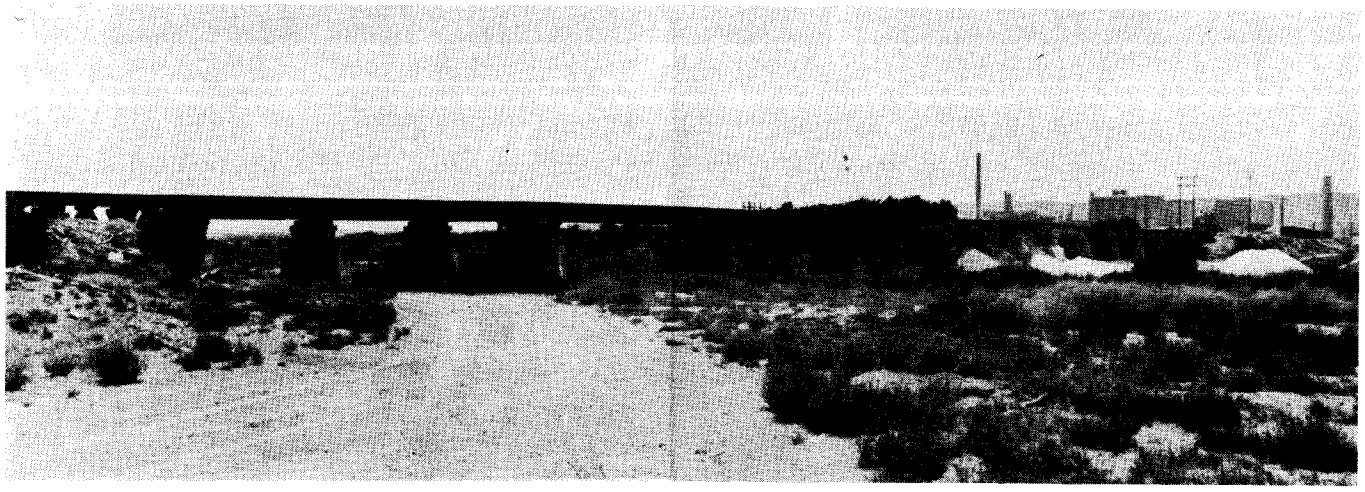


Figure 4.--View of downstream side of Mojave Northern railroad bridge at mile 99.53 near Victorville.

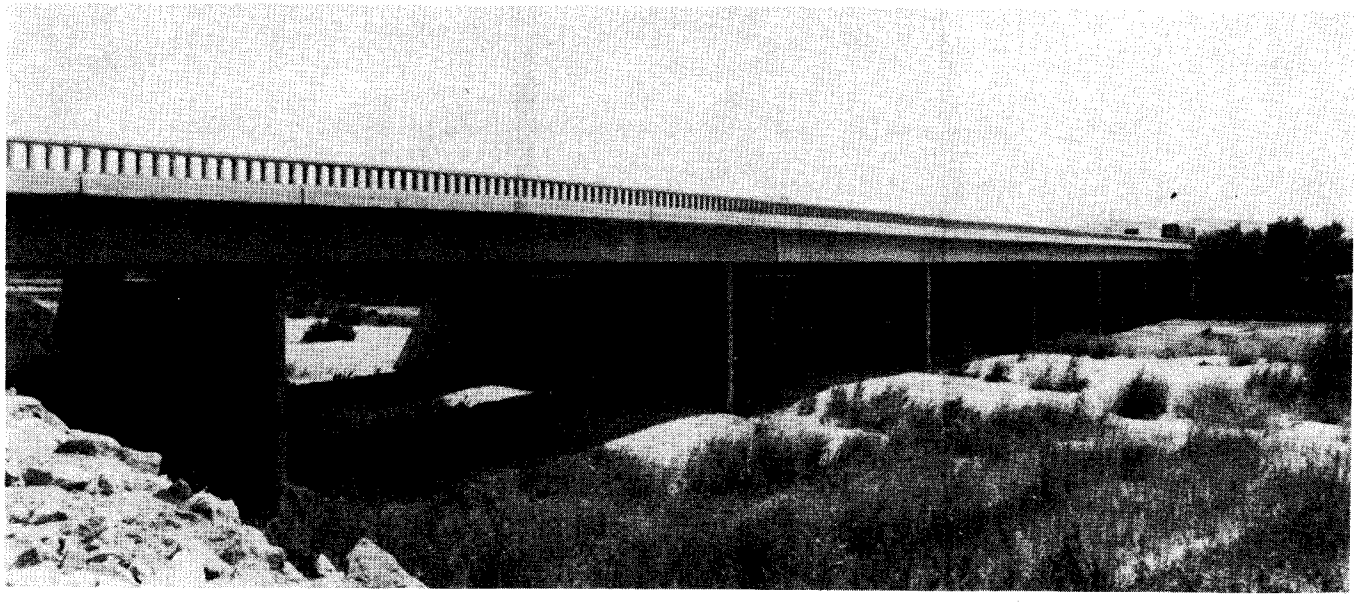


Figure 5.--View of downstream side of Interstate Route 15 (U.S. Highway 66 & 91) bridge at mile 100.40 in Victorville.

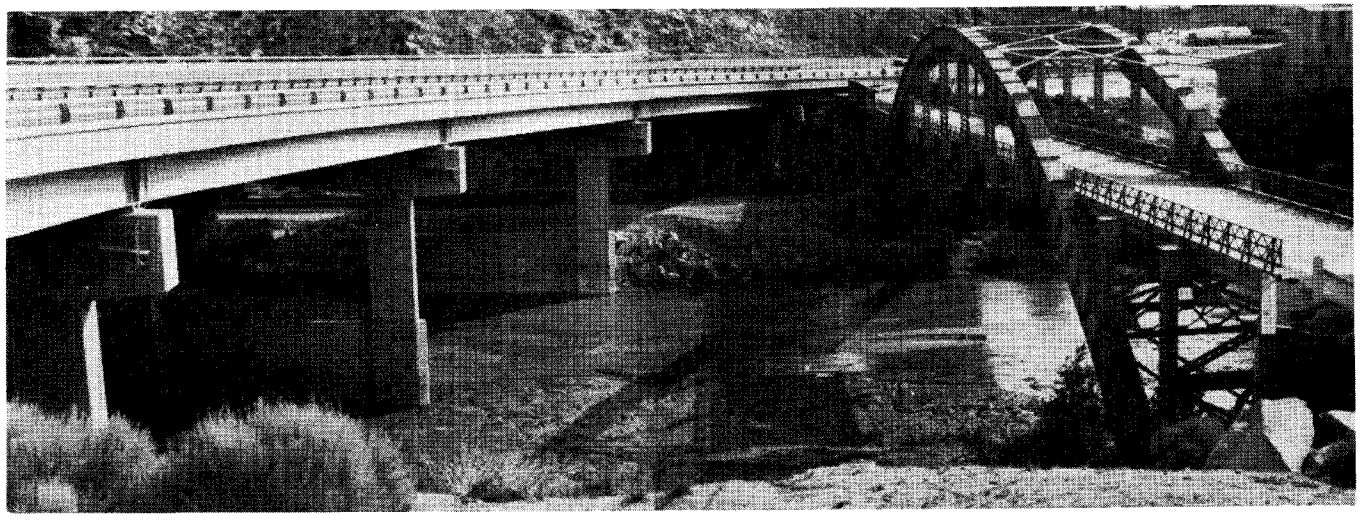


Figure 6.--View of State Highway No. 18 bridge and the abandoned State Highway No. 18 bridge near Victorville. The downstream side of the bridge currently in use, at mile 101.58, is shown at the left of the picture. The upstream side of the abandoned bridge, at mile 101.55, is shown at the right of the picture.

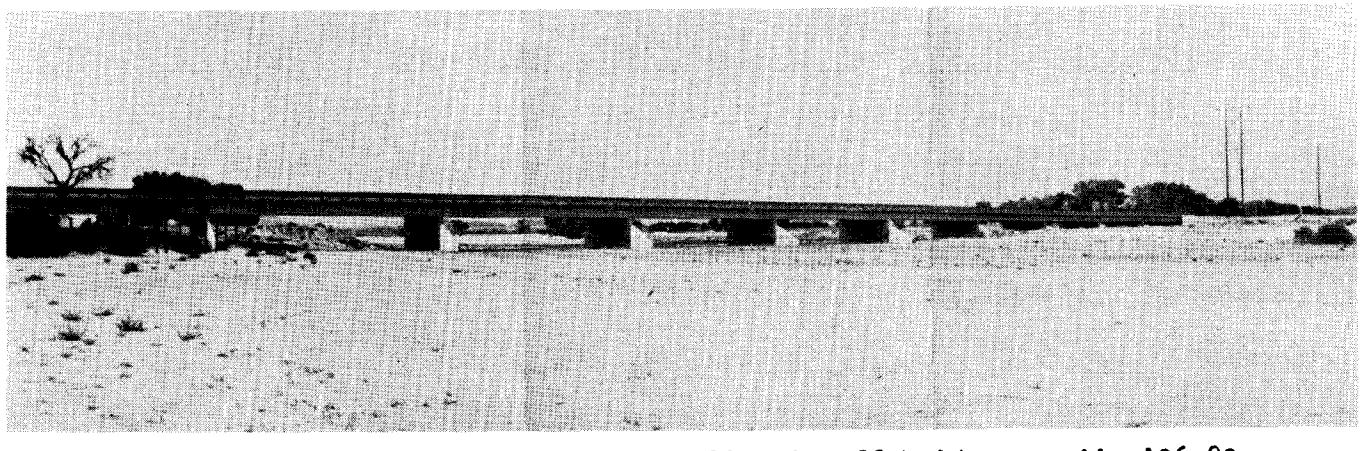


Figure 7.--View of upstream side of Bear Valley Cutoff bridge at mile 106.83.

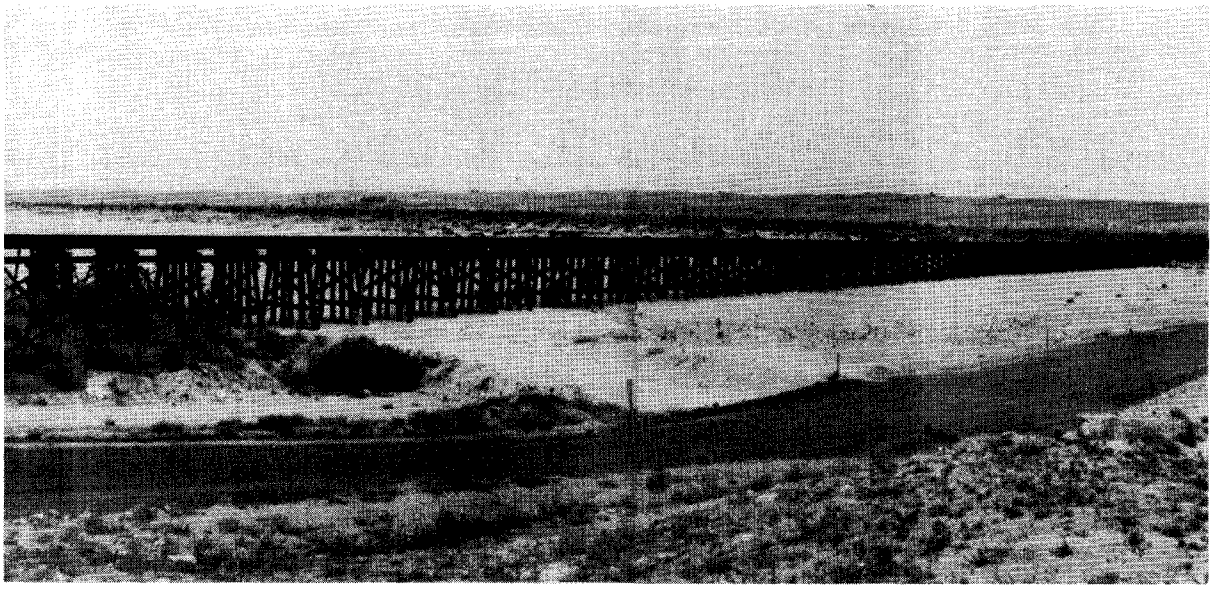


Figure 8.--View of upstream side of Atchison, Topeka and Santa Fe railroad bridge at mile 111.07 near Hesperia. Road shown adjacent to railroad is Rock Springs Road.

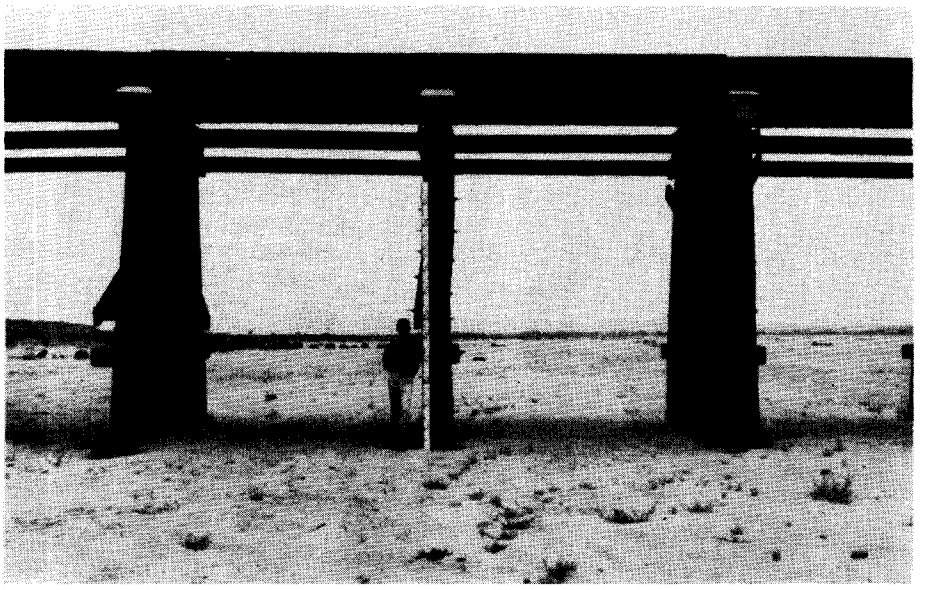


Figure 9.--Close up view of bridge shown in figure 8.

Flood stages and discharges

Five floods of significant magnitude have been recorded by the stream gages on the Mojave River since the first gage was installed on the river in February 1899 near Victorville. The largest flood, with an estimated peak discharge of 70,600 cubic feet per second at Victorville occurred on March 2, 1938. Other large floods at Victorville are those that occurred on January 25, 1969, with a peak discharge of about 37,500 cubic feet per second; on February 25, 1969, with an estimated peak discharge of 35,000 cubic feet per second; on December 29, 1965, with a peak discharge of 32,800 cubic feet per second and on January 23, 1943, with a peak discharge of 32,000 cubic feet per second. The gage heights attained by four of the floods, relative to the present (1969) gage datum, are about 20.7 feet (estimated, since the gage was washed out) for the 1938 flood, which corresponds to elevation 2,670.7 feet above mean sea level; 16.0 feet for the 1943 flood, which corresponds to elevation 2,666.0 feet above mean sea level; 14.2 feet for the 1965 flood, which corresponds to elevation 2,664.2 feet above mean sea level; and 13.5 feet for the 1969 flood, which corresponds to elevation 2,663.5 feet above mean sea level. Although the January 23, 1943, flood was of a lesser magnitude than the December 29, 1965, flood and the January 25, 1969, scour to the river bottom by the 1965 flood and subsequently by the 1969 flood has caused a lowering of the river invert. This, in turn, has caused subsequent floods to flow at a lower elevation as reflected by the relative flood height of the 1965 and the 1969 floods. The gage at Victorville was inoperative during the February 25, 1969, flood; and, consequently, its peak discharge value of 35,000 cubic feet per second is only a rough estimate.

Flooded areas, flood profiles, and cross sections

Plates 4 through 22 show the areas along the Mojave River that would be inundated by the Intermediate Regional Flood and

by the Standard Project Flood. The actual limits of these overflow areas on the ground may vary from those shown on the map because the small scale of the map does not permit precise plotting of the flooded area boundaries. The base maps were prepared from aerial surveys made in 1962, in 1963, and in 1966 for the San Bernardino County Flood Control District. Additional developments have taken place in the overflow areas since the maps were prepared, and they were considered in the analysis.

Plates 23 through 28 show the high water profiles for the Intermediate Regional and the Standard Project Flood. The flood heights were computed on the basis of the riverbed conditions as reflected on the topographic maps prepared for the county in 1962, 1963, and in 1966.

Plates 29 and 30 show cross sections that are typical of the reach investigated. The locations of all cross sections are shown on plates 4 through 36. The elevations and extent of overflow of the Intermediate Regional Flood and the Standard Project Flood are indicated on these cross sections.

FLOOD DESCRIPTIONS

The following descriptions of known large floods that have occurred in the Mojave River in the vicinity of Victorville are based on stream-gage records, on newspaper accounts, and on reports of field investigations made following the floods.

March 2, 1938, flood

The flood of March 2, 1938, which was the largest flood in the Victorville area, had an estimated peak discharge of 70,600 cubic feet per second. The storm producing this flood was centered over the San Gabriel and San Bernardino Mountains, but was generally widespread over the rest of the southern California area. Maximum storm precipitation for a 24-hour period was 14.1 inches for the Deep Creek drainage area and 12.6 inches for the West Fork of the Mojave River drainage area.

Floods resulting from the storm caused widespread damages to buildings, roads, railroad tracks, bridges, and farmlands along the Mojave River. All the stream gages along the Mojave River, except the one in Barstow, were destroyed.

Photographs of flood damages, figures 10 through 12, followed by excerpts from The Victor Press, show the devastation caused by this flood.

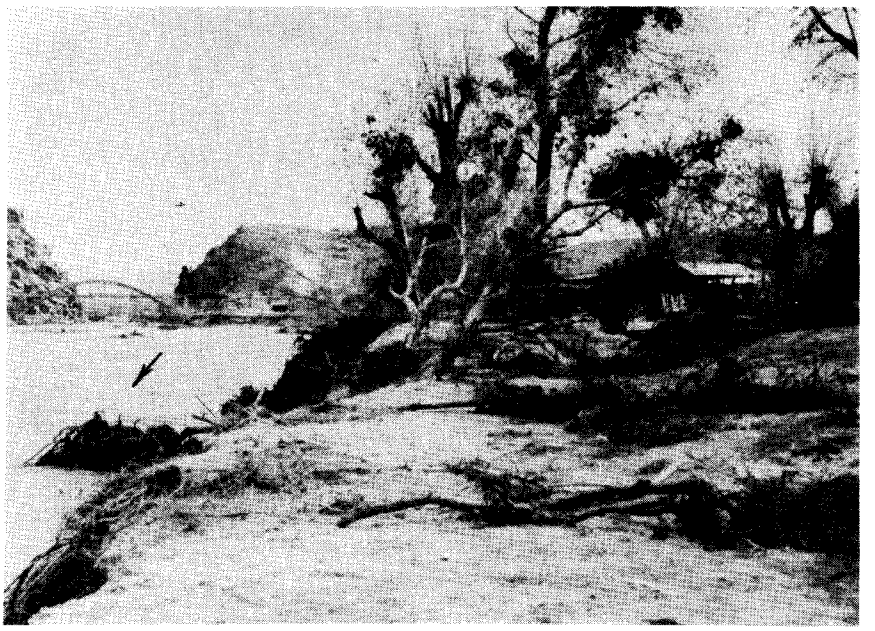


Figure 10.--Looking upstream toward State Highway No. 18 bridge from left bank of Mojave River at river mile 100.95 in Victorville. A number of houses were washed away in the area shown. March 1938

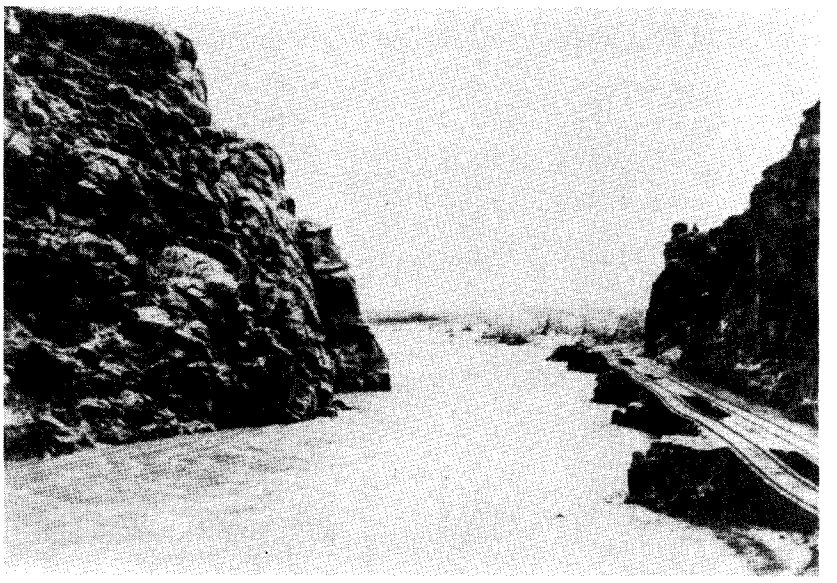


Figure 11.--Looking upstream from State Highway No. 18 bridge in Victorville. Railroad tracks were severely damaged by floodwaters. March 1938

Figure 12.--View of Bear Valley Cutoff bridge near Hesperia damaged by floodwaters. March 1938

The Victor Press
March 11, 1938

"More than $2,000,000 damage has been done to the Mojave River Valley by last week's unprecedented flood."

"Ranchers across the river from Victorville shared a total damage loss of $18,000, according to Lee Dolch."

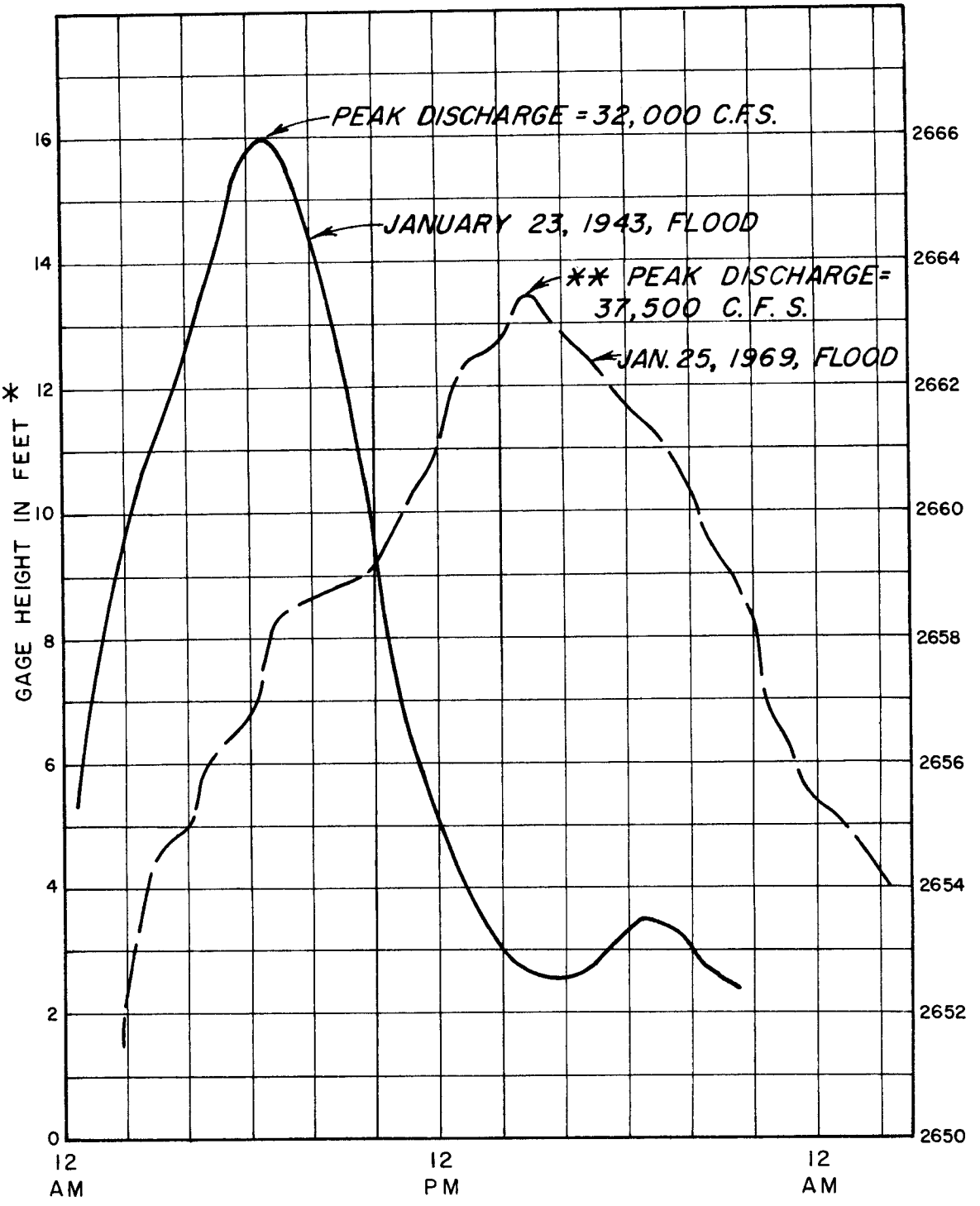
"Damage to the cement plant, according to superintendent O.C. Holstead, came to $22,500."

"Damages to railroad tracks and equipment, locally, came to $50,000, according to R. C. Cline."

January 23, 1943, flood

The storm producing the January 23, 1943, flood was, in many respects, the most severe on record in southern California. The storm, which was centered in the San Gabriel Mountains northeast of Los Angeles, was accompanied by strong winds and produced continuous precipitation from about noon on January 21 to the morning of January 23, including two periods of high intensity precipitation. The ground was very dry at the beginning of the storm, resulting in high rainfall losses. The maximum 24-hour storm rainfall over the Deep Creek and the West Fork of the Mojave River areas was 13.2 inches and 14.4 inches, respectively. Because of subnormal antecedent rainfall the ground was very dry when the storm began and the flood on the river was much smaller than if the ground was wet.

Floodwaters in the Mojave River at the stream-gaging station at Victorville reached a gage height of 16.0 feet, corresponding to an estimated peak discharge of 32,000 cubic feet per second. The stage hydrograph of the flood is shown on figure 13.



STREAM GAGE AT
RIVER MILE 98.00

* GAGE HEIGHT BASED ON PRESENT (1969) DATUM. 1943 DATUM 2 FEET HIGHER.

** SCOUR TO RIVERBED CAUSED THIS FLOOD TO FLOW AT LOWER STAGES.

CORPS OF ENGINEERS, U. S. ARMY
LOS ANGELES DISTRICT, CALIFORNIA

STAGE HYDROGRAPH

MOJAVE RIVER
VICINITY OF
VICTORVILLE, CALIFORNIA

APRIL 1969

FIGURE 13

December 29, 1965, flood

The flood of December 29, 1965, had a peak discharge of 32,800 cubic feet per second at Victorville. The gage height during the peak discharge measured 14.2 feet, based on the present (1969) datum of the gage. Newspaper accounts indicated that Victorville incurred some flood damage and that Rock Springs Road, a dip crossing, incurred flood damage of about $3,000 (1965 price level). The Atchison, Topeka and Santa Fe railroad at river mile 111.07 is shown in figure 14 after floodwaters receded.

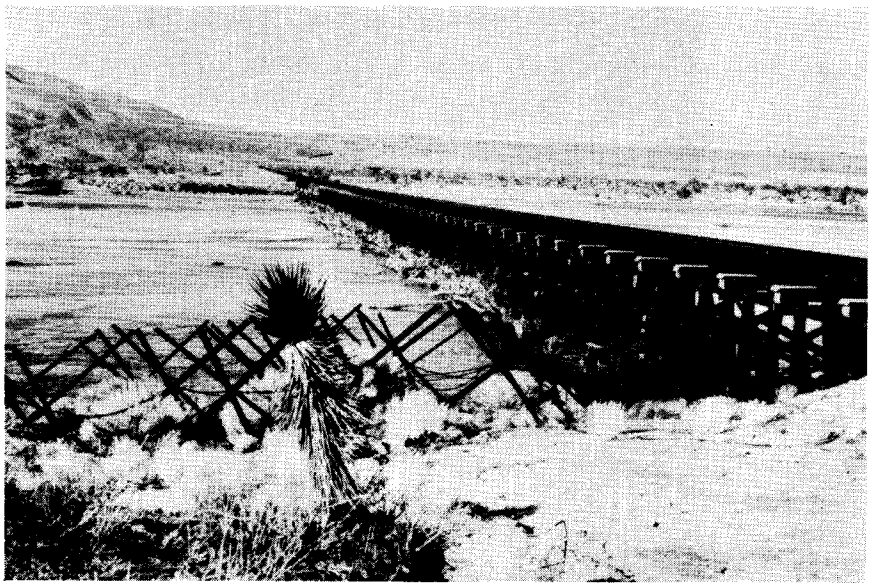


Figure 14.--View of debris left by floodwaters on the upstream side of the Atchison, Topeka and Santa Fe railroad bridge at river mile 111.07, near Hesperia. December 1965

January 25, 1969, flood

The storm producing the January 25, 1969, flood in the Mojave River was centered over the San Bernardino Mountains. Deep Creek had a recorded peak discharge of about 22,000 cubic feet per second and the West Fork of the Mojave River had an estimated peak discharge between 16,000 and 27,000 cubic feet per second.

Floodwaters in the Mojave River at the stream-gaging station at Victorville reached a gage height of 13.5 feet corresponding to an estimated discharge of 37,500 cubic feet per second. Scouring of the streambed at the site of the stream gage was in excess of 10 feet.

An investigation made by the Corps of Engineers after the flood indicated dip crossings, such as Rock Springs Road near Hesperia, and approaches to bridge crossings, such as the Harper Lake Road bridge, were washed out to river bed. Flood damage to ranches located along the river was scattered, with the most severe damages occurring to ranches near Helendale. Some residents such as those near the Interstate Route 15 bridge crossing in Victorville, along the river were forced to evacuate their homes.

Photographs of flood damage, figures 15 and 16, followed by excerpts from The Daily Press (formerly The Victor Press), show the damage caused by this flood. The stage hydrograph of the flood is shown on figure 13.

Figure 15.--Harper Lake Road bridge and abandoned Harper Lake Road bridge at Helendale. Both the north and south approaches were washed out by the flood. January 1969

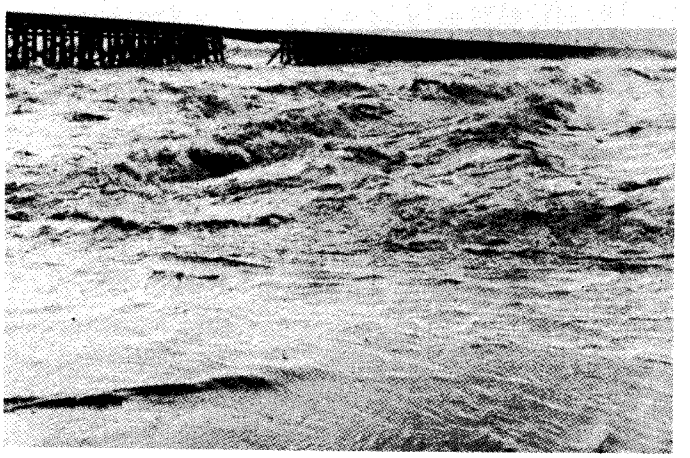


Figure 16.--The Atchison, Topeka and Santa Fe railroad bridge near Hesperia. About a 100-foot span of the railroad bridge was washed out. Rock Springs Road, a dip crossing, was completely inundated by the flood. January 1969

Daily Press

January 23, 1969

"Helendale--Residents of about 35 homes were temporarily stranded across the river from this community when the rain-swollen Mojave River washed away the approaches to the two bridges spanning the river."

January 27

"The normally placid Mojave River was transporting about 150,000 gallons of water per second beneath the Narrows Bridge in Victorville Saturday nearly flooding the lower E Street area."

January 28

"Helendale area ranchers hard hit by floodwaters."

January 29

"Last weeks disaster flood caused more than $250,000 in damage to public and private property in the Victor Valley area, according to a report received by Assemblyman Jerry Lewis (R-San Bernardino)."

February 25, 1969, flood

The storm producing this flood was also centered over the San Bernardino Mountains. On the Mojave River at Barstow, the peak discharge was recorded to be about 30,000 cubic feet per second and at Afton, the peak discharge was recorded to be about 12,000 cubic feet per second. No record of the peak discharge is available at the gaging station at Victorville because the gage was inoperative during the flood. However, it was estimated that this flood had a peak discharge of 35,000 cubic feet per second at Victorville.

Although the estimated magnitude of this flood was slightly less than the January 25, 1969, flood, its effects were as devastating to farmlands, ranches, and transportation facilities along the river. Erosion to land along the river was extensive. In Baker, a trailer court adjacent to Soda Dry Lake experienced as much as 3 feet of flooding. The Mojave Northern railroad bridge was damaged again after being repaired. Overall, damage costs to properties, transportation facilities, and businesses were estimated to be several million dollars.

Figure 17, followed by excerpts from the Daily Press, show the damage caused by this flood.

Figure 17.--Indian Trail Road bridge between Helendale and Hodge. Picture shows approach to the bridge washed out. February 1969

Daily Press

February 25, 1969

"The raging Mojave River apparently claimed the life of the Cedar Springs Dam project manager who was attempting to rescue motorists stranded on the West Fork bridge Monday evening."

"Tom Clark, manager of Triangle Ranch, Helendale, reported today his range is again submerged by the Mojave River which is flooding across all the ranches west of the river."

"Ranches in the Helendale area that are suffering flood damage are Dil, Cordoza, Martin, and Halls. 'There are others too,' said Clark."

February 26

"San Bernardino flood control said today the Mojave crested before more damage was done in flooding to homes of Helendale ranchers west of the river."

"Several acres were under water at the Three Star Ranch belonging to Mr. and Mrs. Henry C. Smeltzer. Their ranch is located about one mile north of the Triangle Ranch. Henry Smeltzer had recently plowed the acreage to plant barley. North of that area was alfalfa under several feet of water."

February 27

"Helendale losses near $500,000."

FUTURE FLOODS

This section of the report discusses the Intermediate Regional Flood and the Standard Project Flood on the Mojave River in the vicinity of Victorville, Calif., and some of the hazards of these large floods. Floods the size of the Intermediate Regional Flood represent floods that may reasonably be expected to occur more frequently than the infrequent Standard Project Flood, and they will not have as high a peak discharge. Floods the size of the Standard Project Flood represent reasonable upper limits of expected flooding.

Floods of appreciable magnitude have occurred in the past on the Mojave River and its tributaries and the probability exists that floods of the magnitudes considered here, namely, the Standard Project Flood and the Intermediate Regional Flood, will occur on this river. However, the magnitudes of the Standard Project Flood and the Intermediate Regional Flood on the Mojave River will be considerably reduced upon completion of the Mojave River Reservoir (June 30, 1971). For example, without the reservoir, a Standard Project Flood occurring on the Mojave River will have an uncontrolled peak discharge of 96,000 cubic feet per second at Victorville. Upon completion of the dam, the uncontrolled Standard Project Flood discharge will be reduced to about 30,000 cubic feet per second at Victorville. It is desirable to consider the flood hazards from floods of these magnitudes in this report when making any determination concerning future development in the study reach along the Mojave River.

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 and more than once in any year. The Intermediate

Regional Flood represents a major flood, although it is less severe than the Standard Project Flood. The determination of the Intermediate Regional Flood is based on hydrologic and statistical analyses of streamflow records of the watershed under study. Discharges produced by the Intermediate Regional Flood downstream from the Mojave River Reservoir were determined by routing the general storm outflow from the reservoir to selected points along the Mojave River. Between the reservoir and Hesperia, flows from tributary areas will cause the magnitude of the Intermediate Regional Flood on the Mojave River to increase. Downstream from Hesperia, channel infiltration losses will be greater than the flows into the river from tributary areas during a general storm; and, consequently this will account for the lesser magnitudes of the peak discharges downstream from Hesperia (see Table 4). The Intermediate Regional Flood on the tributaries is based on the assumed occurrence of a local storm (thunderstorm) which can occur anytime, centered over the tributary area. The peak discharges in the tributary system, as shown in table 4, represent the upper limit of flooding that will occur in those streams; they do not necessarily represent the flows into the Mojave River during the occurrence of an Intermediate Regional Flood in that river.

With the Mojave River Reservoir in operation, an Intermediate Regional Flood peak inflow of 89,000 cubic feet per second into the reservoir will be reduced to a peak outflow of 23,200 cubic feet per second, utilizing only the ungated outlet works of the dam forming the reservoir.

Determination of Standard Project Flood

Severe as the maximum known flood may have been in any given stream, it is a commonly accepted fact that, in practically all cases, sooner or later a larger flood can and probably will occur. For the purpose of determining the Standard Project Flood, a standard project storm was derived in accordance with the

Corps of Engineers' criteria. Past floods were analyzed to determine loss rates. The loss rates were applied to the standard project storm precipitation to determine the Standard Project Flood. The Standard Project Flood is defined as the largest flood that can be expected from the most severe combination of meteorological and hydrological conditions considered reasonably characteristic of the geographical region involved.

Upstream from Hesperia, peak discharges of the Standard Project Flood in the Mojave River were determined by routing a Standard Project Flood (general storm) through the Mojave River Reservoir and to points downstream. Downstream from Hesperia, the peak discharges were determined on the assumed occurrence of a local storm (thunderstorm) centered over the contributing tributary area (up to about 100 square miles).

With the Mojave River Reservoir in operation, a Standard Project Flood peak inflow of 94,000 cubic feet per second into the reservoir will be reduced to a peak outflow of 23,500 cubic feet per second, utilizing only the ungated outlet works of the dam forming the reservoir.

Peak discharges of the Standard Project Flood and of the Intermediate Regional Flood are shown in table 4 for several points along the Mojave River and also at the mouth of major tributaries of the Mojave River.

Frequency. Assignment of a frequency to the Standard Project Flood is not practical. The occurrence of such a flood would be a rare event; however, it could occur in any year.

Table 4

PEAK DISCHARGES

Stream and location	Mile above mouth	Drainage area sq.mile	Intermediate Regional Flood discharge cfs	Standard Project Flood discharge cfs
Mojave River				
Downstream limit of study	84.00	866	**23,000	*30,000
Victorville	101.30	359	**24,500	*30,000
Hesperia	110.00	259	**25,000	**26,000
Upstream limit of study	116.15	215	**23,200	**23,500
Fremont Wash				
Confluence with Mojave River	0.00	247	*16,000	*30,000
Bell Mountain Wash				
Confluence with Mojave River	0.00	41	*11,000	*22,000
Oro Grande Wash				
Confluence with Mojave River	0.00	30	* 5,000	*12,000
Antelope Valley Wash				
Confluence with Mojave River	0.00	22	*10,000	*20,000

* Computed on the assumed occurrence of a local thunderstorm.
** General storm outflow from Mojave River Reservoir routed to the selected points.

Possible larger floods. Floods larger than the Standard Project Flood, such as the Probable Maximum Flood, (which is commonly 160 percent to 250 percent of the Standard Project Flood) are possible. However, this type of flood would very rarely occur. The consideration of floods of this magnitude is of greater importance in some problems, such as designing a dam, than in others; but, its importance should not be overlooked in the study of any problem. With the Mojave River Reservoir in operation, the Probable Maximum Flood peak inflow of 186,000 cubic feet per second into the reservoir would be reduced to a peak outflow of about 131,300 cubic feet per second, utilizing both the spillway and ungated outlet works of the dam forming the reservoir.

Hazards of great floods

The amount and extent of damage caused by any flood depend, in general, upon how much area is flooded, the depth of flooding, the velocity of flow, the rate of rise, and the duration of flooding.

Areas flooded and heights of flooding. Plate 3 is an index map of plates 4 through 22, which show the areas along the Mojave River that would be flooded by the Intermediate Regional and Standard Project Floods. Depths of flow can be estimated from the high water profiles that are shown on plates 23 through 28 and from the cross sections that are shown on plates 29 and 30. As shown, the Standard Project Flood profile is generally 0.5 foot higher than that of the Intermediate Regional Flood. The water surface profile computations were based on the topographic maps provided by the San Bernardino County Flood Control District, supplemented with information obtained during field investigations of the stream. The elevations derived from these profiles can be used to determine the depth of flow on the flood plain.

Figures 18 through 23 on pages 41 through 43 show the levels that would be reached by the Intermediate Regional Flood and by the Standard Project Flood at existing facilities on the flood plain of the Mojave River.

Velocity of water. The velocity of water during floods depends largely upon the size and shape of the cross section and upon the condition of the river bed and its slope, all of which vary at different locations on the river.

Table 5 lists the velocity of water that would occur in the main channel and on the overbank areas at selected points along the Mojave River during the Intermediate Regional Flood and during the Standard Project Flood.

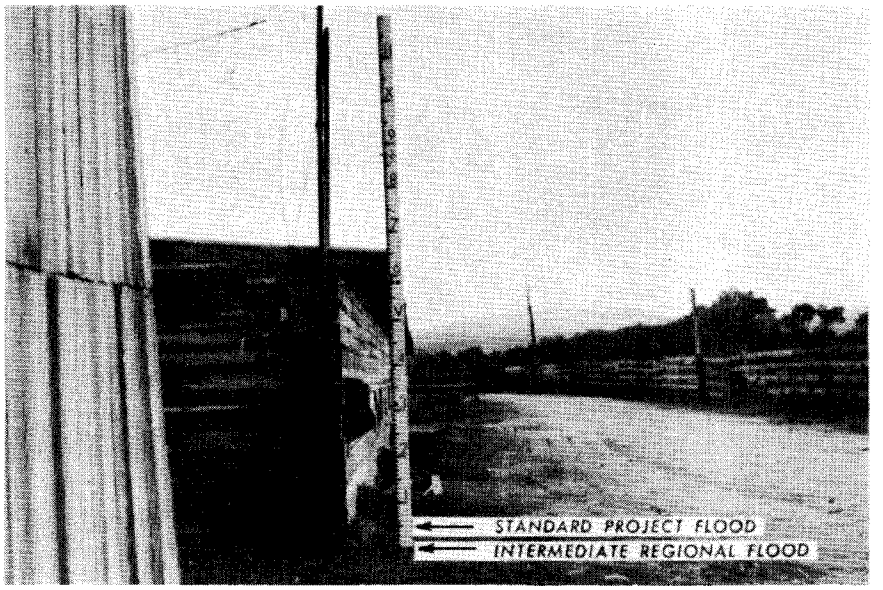


Figure 18.--View of barn on the west side of Mojave River at river mile 85.72 near Helendale.

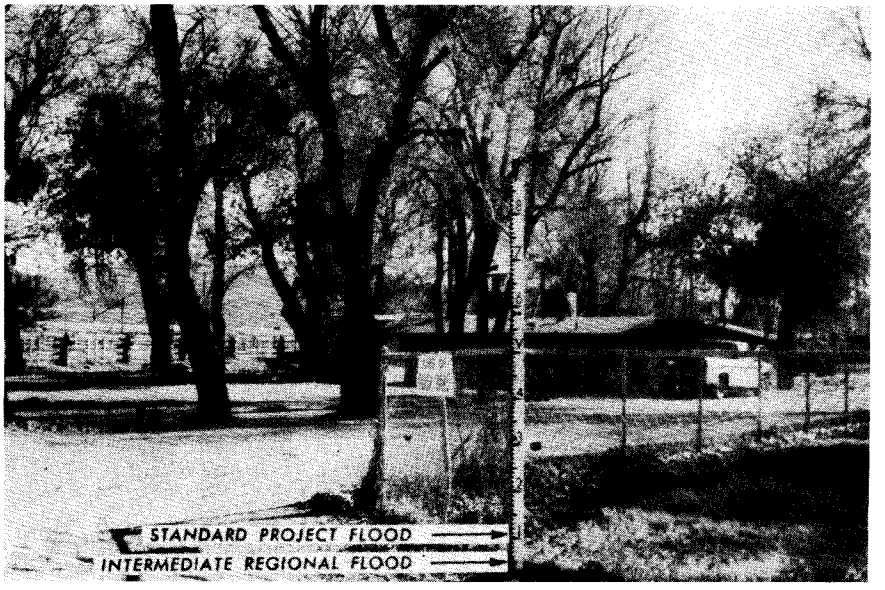


Figure 19.--View of fence along ranch on east side of Mojave River at river mile 91.00 between Helendale and Oro Grande.

Figure 20.--View of Mill Street where it crosses the Mojave River at river mile 95.00 near Oro Grande.

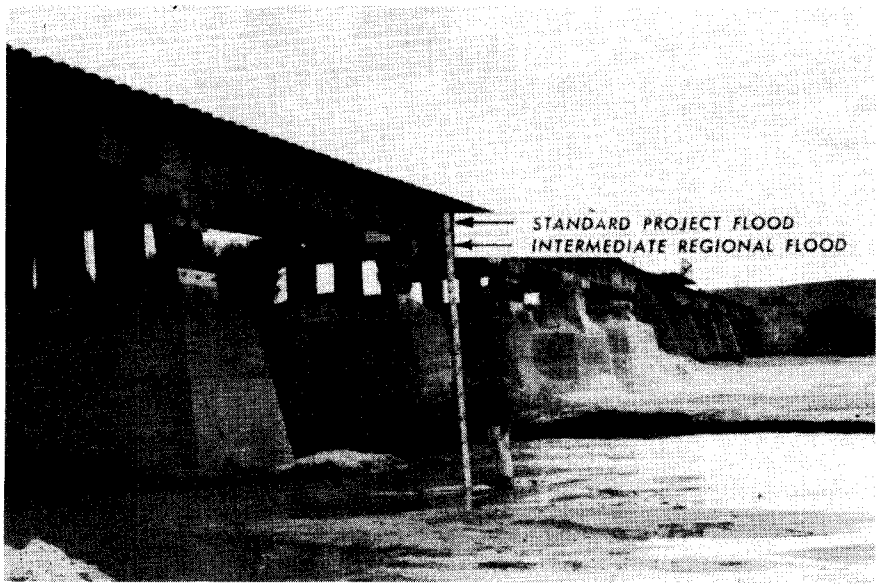


Figure 21.--View of downstream side of Mojave Northern railroad at river mile 99.53 in Victorville.

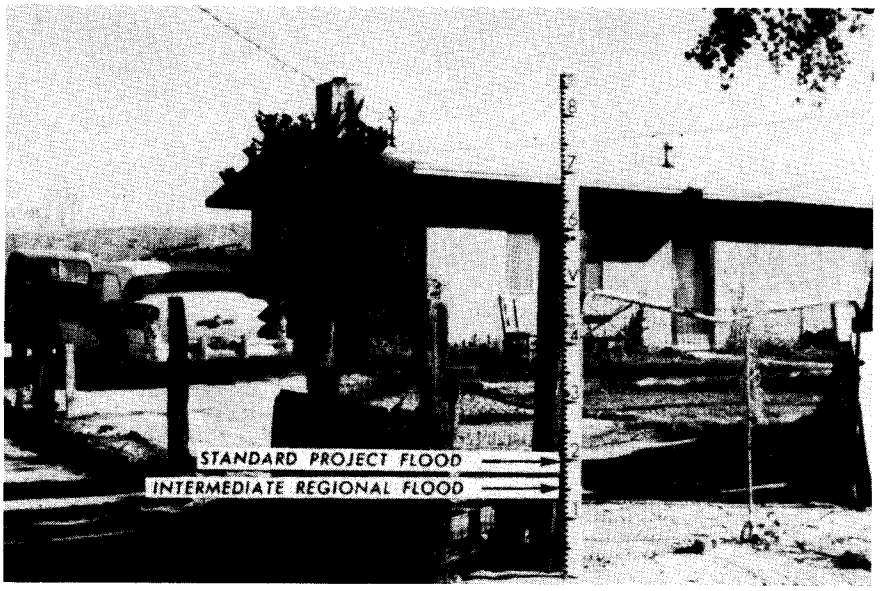


Figure 22.--View of property fence at the bank of Willow Street on the west bank of the Mojave River at river mile 100.60 in Victorville.

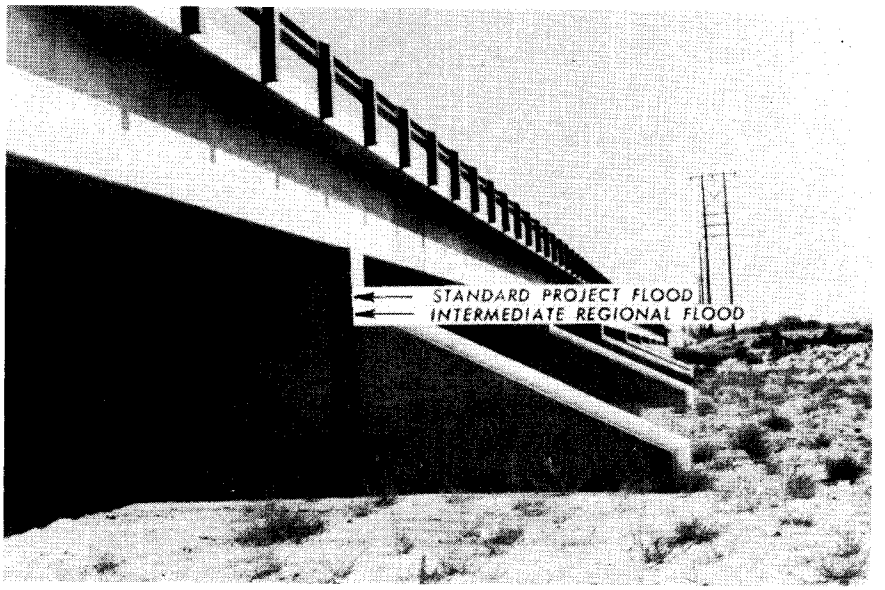


Figure 23.--View of upstream side of Bear Valley Cutoff bridge at river mile 106.83 between Hesperia and Victorville.

Table 5

VELOCITY OF WATER

Stream	Location mile	Intermediate Regional Flood velocity Channel fps	Intermediate Regional Flood velocity Overbank fps	Standard Project Flood velocity Channel fps	Standard Project Flood velocity Overbank fps
Mojave River					
Downstream limit of study	84.00	4.5	---	4.5	2.0
Victorville	101.30	10.5	2.0	11.5	2.0
Hesperia	110.00	4.5	1.0	5.0	1.0
Upstream limit of study	116.15	12.0	3.0	12.0	3.0

Rate of rise and duration of flooding. The rate of rise from streambed to extreme flood peak during a local thunderstorm would be about 2 to 3 hours and the floodwaters would remain on the flood plain for less than one-half day. During a general storm and with the Mojave River Reservoir in operation, the rate of rise from streambed to extreme flood peak would be about 2 days and the floodwaters would remain on the flood plain for about 2 to 3 days.

GLOSSARY OF TERMS

Flood. An overflow of lands not normally covered by water and that are used or usable 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 streamflow 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 streamflow, 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 floodwater.

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.

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 streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the "general region of the watershed."

Low Steel (or Soffit). 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.

Probable Maximum Flood. The probable maximum flood represents a flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Such floods, as used by the Corps of Engineers, are applicable to projects, such as dams, where consideration is to be given to virtually complete security from potential floods.

Standard Project Flood. The flood that may be expected from the more severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. Peak discharges for these floods are generally about 40 percent to 60 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.

AUTHORITY, ACKNOWLEDGMENTS, AND INTERPRETATION OF DATA

This report has been prepared in accordance with the authority granted by section 206 of the Flood Control Act of 1960 (Public Law 86-645), as amended.

* * *

Assistance and cooperation of the San Bernardino County Flood Control District and the U.S. Geological Survey in supplying useful data are appreciated.

* * *

This report presents the local flood situation for the Mojave River in the Victorville area. The Los Angeles District of the Corps of Engineers will, upon request, provide technical assistance to Federal, State, and local agencies in the interpretation and use of the information contained herein and will provide other available flood data related thereto.