FLOOD INSURANCE STUDY

VOLUME 1 OF 4

RIVERSIDE COUNTY, CALIFORNIA
AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
AGUA CALIENTE BAND OF CAHUILLA INDIAN RESERVATION	060763
BANNING, CITY OF	060246
BEAUMONT, CITY OF	060247
BLYTHE, CITY OF	060248
CANYON LAKE, CITY OF	060753
CALIMESA, CITY OF	060740
COACHELLA, CITY OF	060249
CATHEDRAL, CITY OF	060704
COLORADO RIVER INDIAN RESERVATION	060069
CORONA, CITY OF	060250
DESERT HOT SPRINGS, CITY OF	060251
HEMET, CITY OF	060253
INDIAN WELLS, CITY OF	060254
INDIO, CITY OF	060255
LA QUINTA, CITY OF	060709
LAKE ELSINORE, CITY OF	060636
MORENO VALLEY, CITY OF	065074
MURRIETA, CITY OF	060751
NORCO, CITY OF	060256
PALM DESERT, CITY OF	060629
PALM SPRINGS, CITY OF	060257
PERRIS, CITY OF	060258

COMMUNITY NAME	COMMUNITY NUMBER
RANCHO MIRAGE, CITY OF	060259
RIVERSIDE, CITY OF	060260
RIVERSIDE COUNTY (UNINCORPORATED AREAS)	060245
SAN JACINTO, CITY OF	065056
TEMECULA, CITY OF	060742

EFFECTIVE:
AUGUST 28, 2008

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
06065CV001A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

Initial Countywide FIS Effective Date: August 28, 2008

Revised Countywide FIS Date:

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FLOOD INSURANCE STUDY
RIVERSIDE COUNTY, CALIFORNIA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This countywide Flood Insurance Study (FIS) investigates the existence and severity of flood hazards in, or revises and updates previous FISs/Flood Insurance Rate Maps (FIRMs) for the geographic area of Riverside County, California, including: the Cities of Banning, Beaumont, Blythe, Canyon Lake, Calimesa, Coachella, Cathedral, Corona, Desert Hot Springs, Hemet, Indian Wells, Indio, La Quinta, Lake Elsinore, Moreno Valley, Murrieta, Norco, Palm Desert, Perris, Rancho Mirage, Riverside, San Jacinto, and Temecula, and the unincorporated areas of Riverside County (hereinafter referred to collectively as Riverside County).

This FIS aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This FIS has developed flood risk data for various areas of the county that will be used to establish actuarial flood insurance rates. This information will also be used by Riverside County to update existing floodplain regulations as part of the Regular Phase of the National Flood Insurance Program (NFIP), and will also be used by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

This FIS was prepared to include the unincorporated areas of, and incorporated communities within, Riverside County in a countywide format. Information on the authority and acknowledgments for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is shown below.

Agua Caliente Band of Cahuilla Indian Reservation:	the hydrologic and hydraulic analyses from the FIS report dated May 1, 1985, were performed by the Toups Corporation, as reported in the FISs for Riverside County and the City of Palm Springs, California (FEMA, 1980; FEMA, 1982).

the hydrologic and hydraulic analyses from the FIS report dated April 15, 1980, were performed by Anderson-Nichols & Co., Inc., for FEMA, under Contract No. EMW-83-C-1164.

The hydrologic analysis for Lake Elsinore was performed by the U.S. Army Corps of Engineers (USACE), Los Angeles District, in 1983. Hydrologic analyses for areas in the vicinity of the City of Desert Hot Springs were performed by the Riverside County Flood Control and Water Conservation District. These analyses are included as part of this updated study.

That work was completed in April 1985.

The hydrologic and hydraulic analyses for the initial study were performed by Toups Corporation, for FEMA, under Contract No. H-3692. That work was completed in November 1975.

Hydrologic and hydraulic analyses for areas in the vicinity of the Cities of Perris and Desert Hot Springs were also performed by the Toups Corporation under Contract No. H-3692. That work was completed in September 1977.

The hydrologic and hydraulic analyses were performed by Toups Corporation for FEMA, under Contract No. H-4032. That work, which was completed in August 1979, covered all significant flooding sources affecting the City of Palm Springs, with the exception of West Cathedral Channel.

Banning, City of: the hydrologic and hydraulic analyses from the FIS report dated October 17, 1978, were performed by Toups Corporation, for the Federal Insurance Administration, under Contract No. 3692. That work, which was completed in August 1977, covered all significant flooding sources affecting the City of Banning.

Beaumont, City of: the hydrologic and hydraulic analyses from the FIS report dated October 17, 1978, were performed by Toups Corporation, for the Federal Insurance Administration (FIA), under Contract No. H-3692. That work, which was completed in

August 1977, covered all significant flooding sources affecting the City of Beaumont.

Cathedral City, City of:	the hydrologic and hydraulic analyses from the FIS report dated May 1, 1985, were performed by the Toups Corporation, as reported in the FISs for Riverside County and the City of Palm Springs, California (FEMA, 1980; FEMA, 1982).
Corona, City of:	the hydrologic and hydraulic analyses from the FIS report dated May 15, 1978, were performed by Toups Corporation, for FEMA, under Contract No. H-3692. That study was completed in April 1977. Hydraulic analyses for Temescal Wash were revised by the Riverside County Flood Control District in 1984 to reflect improvements to the Temescal Wash channel between Lincoln Avenue and the Atchison, Topeka & Santa Fe Railway crossing just downstream of Riverside Freeway.
Desert Hot Springs, City of:	the hydrologic and hydraulic analyses from the FIS report dated April 2, 1979, were performed by Toups Corporation, for the Federal Emergency Management Agency (FEMA), under Contract No. H-3692. That study was completed in September 1977. Additional hydrologic analyses for that study were performed by the Riverside County Flood Control and Water Conservation District, and the hydraulic analyses were performed by Anderson-Nichols & Co., Inc., for FEMA, under Contract No. EMW-83-C-1164, Amendment No. M119-2. That work was completed in May 1985.
Hemet, City of:	the hydrologic and hydraulic analyses from the FIS report dated September 29, 1978, were performed by Toups Corporation, for FEMA, under Contract No. H-3692. That work, which was completed in July 1977, covered all significant flooding sources affecting the City of Hemet.
Indian Wells, City of:	the hydrologic and hydraulic analyses from the FIS report dated January 19, 1982, were performed by Toups Corporation, for the FIA,

under Contract No. H-3692. That work, which was completed in February 1978, covered all significant flooding sources affecting the City of Indian Wells.

Indio, City of: the hydrologic and hydraulic analyses from the FIS report dated September 14, 1979, were performed by Toups Corporation, for FEMA, under Contract No. H-3692. The original study was completed in January 1978.

Hydraulic analyses for that study were revised by the Coachella Valley Water District (CVWD) in March 1984 to reflect recent improvements to levees along the Whitewater River (Coachella Valley Stormwater Channel) and improvements to the La Quinta Evacuation Channel.

La Quinta, City of: the hydrologic and hydraulic analyses from the FIS report dated June 19, 1985, were performed by Toups Corporation, as reported in Flood Insurance Study, Riverside County, California (Unincorporated Areas) (FEMA, 1980).

The hydrologic and hydraulic analyses for the restudy were completed in 1990 and performed by Bechtel Civil, Inc. (Bechtel Civil, Inc., 1990).

Lake Elsinore, City of: the hydrologic and hydraulic analyses from the FIS report dated September 17, 1980, were performed by Toups Corporation, for the FIA, under Contract No. H-3692. That work, which was completed in November 1977, covered all significant flooding sources affecting the City of Lake Elsinore.

Moreno Valley, City of: the hydrologic and hydraulic analyses from the FIS report dated June 18, 1987, were performed by Toups Corporation for FEMA as part of the FIS for Riverside County, California, under Contract No. H-3692. The Riverside County FIS was completed in November 1975 and revised May 1, 1984.

Murrieta, City of: the hydrologic and hydraulic analyses from the FIS report dated November 20, 1996, were performed by Schaaf & Wheeler, Consulting Civil Engineers, of San Jose, California, for

FEMA, under Contract No. EMW-90-C-3110. That study was completed in April 1994.

Norco, City of: the hydrologic and hydraulic analyses from the FIS report dated February 15, 1979, were performed by the Toups Corporation for the FIA, under Contract No. H-3692. That work, which was completed in June 1977, covered all significant flooding sources affecting the City of Norco.

Palm Desert, City of: the hydrologic and hydraulic analyses from the FIS report dated April 15, 1980, were performed by Toups Corporation, for FEMA, under Contract No. H-3692. That study was completed in January 1978.

Hydraulic analyses for that study were revised in 1984 to reflect improvements to the Palm Valley Stormwater Channel and the construction of Ironwood Channel, Cat Canyon, Dead Indian, and Living Desert debris basins, and other flood control projects within Palm Desert, the adjacent City of Indian Wells, and Riverside County.

Palm Springs, City of: the hydrologic and hydraulic analyses were performed by Toups Corporation for FEMA, under Contract No. H-4032. That work, which was completed in August 1979, covered all significant flooding sources affecting the City of Palm Springs, with the exception of West Cathedral Channel.

Perris, City of: the hydrologic and hydraulic analyses from the FIS report dated April 16, 1979, were performed by Toups Corporation, for FEMA, under Contract No. H-3692. That study was completed in September 1977.

Rancho Mirage, City of: the hydrologic and hydraulic analyses from the FIS report dated September 14, 1979, were performed by Toups Corporation, for the FIA, under Contract No. H-3692. That work, which was completed in January 1978, covered all significant flooding sources affecting the City of Rancho Mirage.

The hydrologic and hydraulic analyses for the revision were performed for FEMA by Bechtel Corporation. The work was completed in 1991.

Riverside, City of: the hydrologic and hydraulic analyses from the FIS report dated January 6, 1983, were performed by Cornell, Howland, Hayes & Merryfield, Clair A. Hill & Associates, for FEMA, under Contract No. H-1790. That work, which was completed in July 1973, covered all significant flooding sources affecting the City of Riverside. Due to recent improvements made to the channels and floodplains of Springbrook Wash, University Wash, Box Springs Wash, and Tequesquite Arroyo, FEMA undertook new hydrologic and hydraulic analyses for these streams. The new hydrologic analyses were performed by the Riverside County Flood Control and Water Conservation District and Dames & Moore, and the new hydraulic analyses were performed by Dames & Moore. That work was completed in 1980.

Other flooding sources were evaluated by approximate methods by Dames & Moore in 1976 and 1977, under contract to the FIA.

Riverside County (Unincorporated Areas): the hydrologic and hydraulic analyses from the FIS report dated April 15, 1980, were performed by Anderson-Nichols & Co., Inc., for FEMA, under Contract No. EMW-83-C-1164.

The hydrologic analysis for Lake Elsinore was performed by the U.S. Army Corps of Engineers (USACE), Los Angeles District, in 1983. Hydrologic analyses for areas in the vicinity of the City of Desert Hot Springs were performed by the Riverside County Flood Control and Water Conservation District. These analyses are included as part of this updated study.

That work was completed in April 1985.

The hydrologic and hydraulic analyses for the initial study were performed by Toups Corporation, for FEMA, under Contract No. H-3692. That work was completed in November 1975.

Hydrologic and hydraulic analyses for areas in the vicinity of the Cities of Perris and Desert Hot Springs were also performed by the Toups Corporation under Contract No. H-3692. That work was completed in September 1977.

San Jacinto, City of: the hydrologic and hydraulic analyses from the FIS report dated September 28, 1973, were performed by the USACE, Los Angeles District, for FEMA, under Inter-Agency Agreement No. IAA-H-15-72, Project Order No. 14. That study was completed in May 1973, but was unpublished.

The revised and expanded hydrologic and hydraulic analyses were performed by Anderson-Nichols & Co., Inc., for FEMA, under Contract No. EMW-83-C-1164 as part of the Riverside County FIS.

Temecula, City of: the hydrologic and hydraulic analyses from the FIS report dated September 2, 1993, were performed by Anderson-Nichols & Co., Inc., as reported in Flood Insurance Study, Riverside County, California (Unincorporated Areas) (FEMA, 1980), with the exception of the detailed study of Temecula Creek, upstream of Pala Road, for which the hydraulic analysis was performed by the McCutchan Company, Inc.

The original hydraulic analysis for this reach of the Perris Valley Storm Drain was revised based on more recent topography developed for that area. This work was performed by J. F. Davidson Associates, Inc., and completed in December 1990.

This study was revised on November 20, 1996, to modify the floodplain delineations for Temescal Wash, the San Jacinto River, and Cajalco Creek. The hydraulic analysis for this study was performed by Schaaf & Wheeler, Consulting Civil Engineers, of San Jose, California, for FEMA, under Contract No. EMW-90-C-3310.

This study was revised on June 18, 1996, to modify the floodplain delineations for Temescal Wash and Whitewater River. The hydraulic analysis for this study was performed by Schaaf & Wheeler, Consulting Civil Engineers, San Jose, California, for FEMA, under FEMA Contract No. EMW-90-C-3110.

This study was revised on November 20, 1996, to modify the floodplain delineations for Murrieta Creek. The hydraulic analyses for this study were performed by Schaaf & Wheeler, Consulting Civil Engineers (the study contractor), of San Jose, California, for FEMA, under Contract No. EMW-90-C-3110.

On selected FIRM panels, planimetric base map information was provided in digital format. These files were compiled at a scale of 1:12,000. Additional information was derived from U.S. Geological Survey (USGS) Digital Line Graphs. Additional information may have been derived from other sources. Users of this FIRM should be aware that minor adjustments may have been made to specific base map features.

The coordinate system used for the production of this FIRM is Universal Transverse Mercator (UTM), North American Datum of 1983 (NAD 83), GRS80 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the UTM projection, NAD 83. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the FIRM.

1.3 Coordination

Consultation Coordination Officer's (CCO) meetings may be held for each jurisdiction in this countywide FIS. An initial CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to explain the nature and purpose of a FIS, and to identify the streams to be studied by detailed methods. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

The dates of the initial and final CCO meetings held for Riverside County and the incorporated communities within its boundaries are shown in Table 1, "Initial and Final CCO Meetings."

TABLE 1 - INITIAL AND FINAL CCO MEETINGS

Community	For FIS Dated	Initial CCO Date	Final CCO Date
Banning, City of	October 17, 1978	March 18, 1976 and May 4, 1977	September 14, 1977
	June 17, 1991	*	*
Beaumont, City of	October 17, 1978	March 18, 1976 and May 4, 1977	September 14, 1977
Cathedral City, City of	May 1, 1985	June 23, 1982	February 17, 1984
	September 27, 1991	*	July 11, 1990
	June 18, 1996	October 25, 1989	October 25, 1994
	July 7, 1999	*	*

*Data not available

TABLE 1 - INITIAL AND FINAL CCO MEETINGS - continued

Community	For FIS Dated	Initial CCO Date	Final CCO Date
Corona, City of	May 15, 1978	March 19, 1976 and November 17, 1976	April 28, 1977
	June 18, 1996	October 25,1 989	October 25, 1994
Desert Hot Springs, City of	April 2, 1979	March 17, 1976 and July 8, 1977	May 2, 1978
	September 30, 1988	*	*
Hemet, City of	September 29, 1978	March 18, 1976 and March 7, 1977	September 15, 1977
	August 4, 1988	*	*
	September 28, 1990	*	*
	August 19, 1997	*	*
Indian Wells, City of	September 14, 1979	March 17, 1976; September 29, 1977; November 1, 1977; December 7, 1977; and December 27, 1977	*
	January 19, 1982	*	*
	November 19, 1987	*	*
	August 2, 1990	*	*
Indio, City of	September 14, 1979	March 17, 1976 and March 8, 1977	September 28, 1979
	May 1, 1985	*	*
La Quinta, City of	June 19, 1985	April 1, 1984	July 12, 1984
	August 19, 1991	*	*
Lake Elsinore, City of	September 17, 1980	March 22, 1976 and July 18, 1977	October 23, 1978
	June 18, 1996	October 25, 1989	October 25, 1994
	August 18, 2003	*	*
Moreno Valley, City of	June 18, 1987	December 1985	July 2, 1986
	May 17, 1993	*	*
Murrieta, City of	November 20, 1996	October 25, 1989	October 25, 1994
Norco, City of	February 15, 1979	March 19, 1976 and November 17, 1976	May 2, 1977

*Data not available

TABLE 1 - INITIAL AND FINAL CCO MEETINGS - continued

Community	For FIS Dated	Initial CCO Date	Final CCO Date
Palm Desert, City of	April 15, 1980	March 17, 1976; September 29, 1977; November 1, 1977; November 21, 1977; December 1, 1977; and December 27, 1977	September 28, 1978
	September 4, 1986	*	*
	June 18, 1996	October 25, 1989	October 25, 1994
Perris, City of	April 16, 1979	March 22, 1976 and July 7, 1977	May 30, 1978
	July 2, 1992	*	*
Rancho Mirage, City of	September 14, 1979	March 17, 1976; September 29, 1977; November 1, 1977; November 21, 1977; December 7, 1977; and December 27, 1977	September 27, 1978
	June 18, 1996	October 25, 1989	October 25, 1994
Riverside, City of	January 6, 1983 August 2, 1996	*	February 18, 1981
Riverside County (Unincorporated Areas)	April 15, 1980	December 10, 1974 and December 12, 1974	January 22, 1976
	March 22, 1983 September 30, 1988	July 12, 1984 and March 1, 1985	*
	November 20, 1996 August 18, 2003	October 25, 1989	October 25, 1994
San Jacinto, City of	April 15, 1980	December 10, 1974 and December 12, 1974	
	May 17, 1990	*	*
Temecula, City of	September 2, 1993	April 1992	*
	November 20, 1996	October 25, 1989	October 25, 1994

*Data not available

For this countywide study, a final CCO meeting was held on October 19, 2007.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Riverside County, California.

All or portions of the flooding sources listed in Table 2, "Flooding Sources Studied by Detailed Methods," were studied by detailed methods. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

TABLE 2 - FLOODING SOURCES STUDIED BY DETAILED METHODS

Acacia Creek Drain
Alessandro Wash
All American Canal
Arlington Channel
Arroyo Del Toro
Bear Creek
Beaumont Channel
Bedford Canyon Wash
Big Morongo Wash
Biskra Palms Channel
Blind Canyon Channel
Bly Channel
Box Springs Wash
Calimesa Channel
Carrizo alluvial fan
Channel H
Cherry Avenue Channel
County Club Creek
County Club Creek North Tributary
Day Creek Santa Ana River
Dead Indian alluvial fan
Deep Canyon alluvial fan
Deep Canyon Storm Water Channel
Desert Hot Springs Channel
Dunes View Road
Dry Morongo Wash
East Cathedral Channel
East Gilman Home Channel
East Rancho Mirage Storm Channel
El Cerrito Channel
Elsinore Spillway Channel
Garden Air Gold Course Wash
Gilman Home Channel
Harrison Wash
Hemet Storm Channel
Highland Springs Channel
Interstate 10 Wash
Kalmia Street Wash
Lake Elsinore
Lakeland Village Channel
Lakeview Wash
Leach Canyon Channel
Lime Street Channel
Lincoln Avenue Drain
Little Morongo Wash
Long Canyon
Macomber Palms Channel
Magnesia Falls Road
Magnesia Springs Channel
Main Street Drain
Mangular Channel
Marshall Creek
McVicker Canyon
Metz Road Basin
Mirage Indian Trail
Mission Creek
Mockingbird Canyon Wash
Montgomery Creek
Mountain Avenue Wash
Murrieta Creek at Murrieta
Murrieta Creek at Temecula
North Cathedral Channel
North Norco Channel
North Norco Channel Tributary A
North Norco Channel Tributary B
North Norco Channel Tributary C
North Palm Springs Wash
North Side Wolf Valley Creek
Oak Street Channel
Ocotillo Drive
Orange Lateral
Ortega Wash
Ortega Channel
Palm Canyon Wash
Palm Valley Drain
Park Hill Drain
Pechanga Creek
Perris Valley Storm Drain
Pigeon Pass Channel
Prenda Wash
Pushawalla Canyon
Pyrite Channel
Rache Channel
Ramsey Street Drain
Rice Canyon
Salt Creek
Salt Creek Overflow
Salt Creek Tributary
San Gorgonio River
San Jacinto River
San Jacinto Lateral
San Sevaine Channel
Santa Ana River
Sheet Flow along Ocotillo Road
Smith Creek

TABLE 2 - FLOODING SOURCES STUDIED BY DETAILED METHODS - continued

Smith Creek West Tributary	Sunny Slope Channel	University Wash
South Norco Channel	Sunnymead Storm Channel	Wash G
South Norco Channel Tributary A	Taylor Avenue Drain	Wash I
South Norco Channel Tributary B	Temecula Creek	Wasson Canyon Creek
Spring Brook	Temescal Wash	West Cathedral Channel
Spring Brook Wash	Tequesquite Arroyo	West Norco Channel
Stetson Avenue Channel	The Veldt	West Pershing Channel
Stovepipe Canyon Creek	Third Street Basin	Whitewater River
Stream A (Vicinity of Desert Hot Springs)	Thousand Palms Canyon	Whitewater River (Coachella Valley Stormwater Channel)
Sun City Channel A-A	Thousand Palms Main Channel	Whittier Avenue Channel
Sun City Channel C-C	Thousand Palms Tributary A	Woodcrest Wash
Sun City Channel H-H	Thousand Palms Tributary B	Unnamed Stream A
Sun City Channel X-X	Thousand Palms Tributary C	Unnamed Stream B
Sun City Southeast Tributary	Thunderbird Wash	Unnamed Stream C
	Tramview Wash	1001 Ranch Drain
	Tramview Wash Tributary	1001 Ranch Drain West Tributary

This study was revised on September 30, 1992, to include the results of a reanalysis of the Perris Valley Storm Drain. This stream was restudied by detailed methods from approximately 9,000 feet upstream of the confluence with the San Jacinto River to approximately 2,300 feet upstream of Rider Street and by approximate methods from that point upstream to the Ramona Expressway.

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

All or portions of numerous flooding sources in the county were studied by approximate methods and are shown in the tabulation below. Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Riverside County.

APPROXIMATE STUDIED STREAMS

Acacia Avenue	Avery Canyon
Alessandro Reservoir	Bautista Wash
Anza Creek	Bear Creek
Arroyo Del Toro Creek	Big Morongo Wash
Atchison, Topeka and Santa Fe Railroad	Blaisdel Canyon Creek

<u>APPROXIMATE STUDIED STREAMS</u> - continued

Bly Channel
Bundy Canyon
Cactus Valley
Cahilla Creek
Cahilla Creek Tributary
Cat Creek Quincy Wash
Channel A
Channel B
Cherry Avenue Channel
Cherry Valley Creek
Country Club Creek
Country Club Wash
Day Creek Romoland Wash
Desert Hot Springs Creek
Devonshire Avenue
East Hemet Wash
East Homeland
East La Quinta Channel
East Pershing Channel
Easton Avenue
Edgemont A
Edgemont B East Fork
Edom Hill Canyon
El Cerrito Channel
El Cerrito Tributary
Ethanac Wash
Florida Avenue
Fruitvale Avenue
Fun Valley Wash
Garner Valley Wash
Gilman Home Channel A
Gilman Home Channel B
Hamilton Creek
Hargrave Street Drain
Homeland – East Fork
Homeland – West Fork
Howell Canyon
Indian Canyon Channel
Indio Hills Area – Numerous Small Unnamed Streams
Jenson Creek
Joseph Canyon
Kitching Drain
Lake Elsinore Shoreline
Lakeland Village Area
Latham Avenue
Lincoln Avenue Drain
Line "J" Channel
Little Morengo Wash
Little San Gorgonio Creek
Long Canyon
Mais Creek
Marshall Creek Tributary
Mayberry Avenue
McVicker Canyon
Menlo Avenue
Millard Canyon
Mission Creek
Mockingbird Canyon
Mockingbird Reservoir
Montgomery Creek Tributary
Moreno Beach Wash
Mountain Avenue Wash
Murrieta Creek
Murrieta Creek Tributary
Murrieta Hot Springs Creek
North Norco Channel Tributary B
North Palm Springs Wash
North Shore Beach Channel
Oakland Avenue
Park Hill Drain
Pechanga Creek
Perris Lateral A
Perris Lateral B
Perris Valley Storm Drain
Pershing Creek
Pigeon Pass Channel
Prenda Reservoir
Pyrite Channel
Ramsey Street Drain
Railroad Canyon Reservoir
Railroad Channel
Reche Canyon
Rice Canyon
Rosewood Drive
Ryan Field
Salt Creek
San Gorgonio River
San Jacinto River

APPROXIMATE STUDIED STREAMS - continued

Santa Ana River
Santa Gertrudis Creek
Sedco Hills Creek
Sidney Street Channel
Sinclair Wash
Smith Creek
Smith Creek East Tributary
Spring Brook
St. Johns Canyon
Stovepipe Canyon Creek
Strawberry Creek
Strawberry Creek Tributary
Sunnyslope Channe;
Sycamore Reservoir
Taylor Avenue Drain
Temecula Creek
Temescal Wash
Thunderbird Wash
Tributary to Oak Street Channel
Unnamed Wash South of Hemet
Valle Vista Drain
Vander Verr Creek
Vander Verr Creek East Tributary
Wardlow Wash
Warm Springs Creek
Wasson Canyon Creek
White House Canyon Wash
Whitewater River
Wilson Canyon
Wide Canyon Wash
Woodcrest Reservoir
1001 Ranch Drain

2.2 Community Description

Riverside County is located in the southeastern portion of California. The county encompasses an area of more than 7,300 square miles, and resembles an elongated rectangle. It ranges from approximately 150 to 180 miles from east to west, and extends approximately 45 miles from north to south. Its southwestern boundary lies within 10 miles of the Pacific Ocean and its eastern border is the Colorado River, which separates it from Arizona. Riverside County is bordered on the north by San Bernardino County, and on the south by San Diego and Imperial Counties. The Santa Ana Mountains, located in the Cleveland National Forest, separate Riverside County from its western neighbors, Los Angeles and Orange Counties. With peaks rising up to 5,700 feet, these mountains overlook the San Jacinto Valley to the east. This valley, with elevations ranging from 1,500 to 2,000 feet, extends from the Santa Ana Mountains to the San Jacinto Mountain Range, which divides the coastal watersheds from the interior regions. The San Jacinto Mountains rise to approximately 11,000 feet and act as a buffer between the western portion of the county and the central deserts. East of these mountains is the Coachella Valley, a desert that has become a major agricultural area with the aid of imported Colorado River water. It ranges from 12 to 15 miles in width and slopes from the San Jacinto Mountains to the Salton Sea, which has a water-surface elevation of -232 feet. Eastward from the Coachella Valley are numerous mountain areas, which are relieved occasionally by flat valleys and dry lake beds, all desert in character. The highest peaks reach approximately 5,000 feet, while the valleys range in elevation from 500 to 1,000 feet. The vast Chuckwalla Valley separates this region from the Palo Verde area. This desert area is characterized by barren slopes, arid plains, and sand dunes that stretch eastward to the Colorado River. Located in the southeastern corner of the county, the Palo Verde area consists of a broad mesa in the west and a fertile valley in the east. The valley forms a nearly level plain, which is approximately 30 miles long, 10 miles wide, and stops at the Colorado River.

In 2000, the population of Riverside County was 1,545,387. This represents a 32.0% increase from 1990 to 2000.

Extensive commercial and residential development has occurred within the floodplain of the Santa Ana River in the Rubidoux area and on Murrieta Creek in the communities of Murrieta and Temecula. Extensive residential development has encroached upon the floodplains of San Sevaine and Salt Creeks in the Mira Loma area. San Sevaine Channel was constructed to divert flows away from development along San Sevaine Creek, but with minimal effect on large floods. Some degree of improvement exists on the Santa Ana River, Murrieta Creek, and Salt Creek in these high-hazard reaches as well. Moderate industrial, commercial, and residential development exists along the Temescal Wash floodplain, primarily adjacent to the Corona corporate limits along Sixth Street. Moderate residential development exists in the floodplains of the following streams: Day Creek in the community of Sunnymead; Edgemont B North Fork in the Edgemont areal portions of Noble Creek and Little San Gorgonio Creek; numerous small tributaries in the Lakeland Village area; the Romoland and Homeland areas; the east side of the City of Hemet; and along San Gorgonio Creek in the Cabazon area. In most cases, some improvement to the watercourse has occurred along with the progress of development.

Lake Elsinore is situated in the southwestern corner of Riverside County in the Santa Ana River basin. The total drainage area of the lake is 770 square miles, of which the San Jacinto River watershed contributes 717 square miles. Located in a natural sink, the lake's only outlet is via the Elsinore Spillway Channel and Temescal Wash. Under current conditions, the lake level must exceed an elevation of 1,260 feet (the highest point along the spillway channel) before any outflow will occur. Since 1965, Colorado River water has been brought in via the San Jacinto River, as needed, to maintain a lake surface of approximately 6 square miles. Prior to this importation scheme, the lake was intermittent, occasionally being dry for several consecutive years (USACE, 1983; Wahl, K. L., 1980). Further information about Lake Elsinore's outlet channel can be found at the bottom of page 121.

Development around the lake is concentrated on the urbanized northern shore, within the corporate limits of the City of Lake Elsinore. Moderately dense residential development can be found in unincorporated areas around much of the lake perimeter, but generally is significantly less dense than within the City of Lake Elsinore.

The Lakeview Wash study area is situated on an alluvial fan, positioned at the base of the Lakeview Mountains and adjacent to the floodplain of the San Jacinto River. The upper portion of the study area is largely undeveloped and the wash has eroded an entrenched path in the lightly vegetated natural fan surface. Below 10th Street, the wash enters residential areas of moderate density and flow becomes subject to control by buildings and paved roads. Floods on Lakeview Wash are usually produced by orographically induced thunderstorms.

The Bautista Wash watershed, which includes Park Hill Drain, is located on the western flank of the San Jacinto Mountains in west-central Riverside County. Flooding from Park Hill Drain and Bautista Wash affects portions of the Cities of Hemet and San Jacinto, as well as unincorporated county areas. Before reaching the San Jacinto River, the study streams flow over the relatively smooth surfaces of an alluvial fan and apron. The lack of topographic relief allows floodwaters to spread out over wide areas. The residential and commercial area is moderately dense and further development is expected in the area.

The Pechanga Creek/Wolf Valley study area is a wide alluvial wash in southwestern Riverside County. The topography of the valley indicates that the floodwater of Pechanga Creek formerly affected wide areas. At present, the creek is largely confined to the southern edge of Wolf Valley due to its own encroachment and the influence of Pechanga Road. The transfer of some flow from the creek to the northern portion of the valley appears possible; an occurrence which would augment the flood hazard potential posed by the smaller tributary streams now threatening the north side of Wolf Valley. Runoff from Wolf Valley enters Temecula Creek and finally the Santa Margarita River. Within the Pechanga Indian Reservation, yearly mining of the bottom of Pechanga Creek as a source of sand causes alterations in the natural configuration of the channel.

The alluvial fans studied near Thousand Palms and Desert Hot Springs are located on the northeastern side of the Coachella Valley at the bases of the Indio Hills and the Little San Bernardino Mountains, respectively. Coachella Valley is a northwest/ southeast trending valley lying between the Little San Bernardino and Santa Rosa Mountains. The major settlements of Palm Springs and Palm Desert are located on the southwestern side of the valley on the alluvial fans along the Santa Rosa Mountains. The detailed study areas (on the opposite side of the Coachella Valley) are affected by floodwater that originates in both the Indio Hills and the Little San Bernardino Mountains. Runoff from the large drainage basins of Thousand Palms Canyon, Pushawalla Canyon, and the Thousand Palms Main Channel have formed two sets of alluvial fans; between the Indio Hills and Little San Bernardino Mountains; and at the base of the Indio Hills. Runoff from the Little San Bernardino Mountains spreads out over the initial fan area, reconcentrates before flowing through or around the Indio Hills and opens out again onto the study fans. The intervening set of alluvial fans helps to reduce peak discharges from the larger watersheds by promoting the spreading and infiltration of runoff from the Little San Bernardino Mountains. The remaining basins under study are much smaller in size and represent watersheds draining only the Indio Hills. All of the study streams carry water and sediment into the general areas of Desert Hot Springs or Thousand Palms, forming numerous coalescent alluvial fans. Many locations within the study areas are subject to flood hazards from more than one flooding source due to the wide areas threatened by each of the streams as they flow over the debris cones.

Interstate Highway 10 (I-10) has been constructed at the base of the alluvial fans adjacent to the Indio Hills. Within the area of detailed study, I-10 appears to be located in an abandoned channel of Big Morongo Wash.

The community of Thousand Palms is a residential area of moderate density. The remainder of the Coachella Valley study area in the vicinity of Thousand Palms is unsettled except for a few isolated ranches. Vegetation consists of scrubby desert brush. Dunes formed by eolian sand at the southwestern end of the study area are inhabited by a rare species of lizard. Efforts are currently underway to form a conservation area to protect this threatened reptile.

The Coachella Valley area is seismically active and contains active faults. The area's main structural fracture is the San Andreas Fault.

Climatic conditions in the county vary substantially with the topography and the region. Between the high and low points in elevation, five distinct climatic zones exist. At Riverside, in the western part of the county, the average temperature is 52 degrees Fahrenheit (°F) in January and 76°F in July. The annual rainfall is approximately 11 inches. Typical desert conditions prevail throughout the eastern and central desert regions. In the desert city of Indio, the mean annual temperature is 92°F in July and 52°F in January, while the annual rainfall is approximately 4 inches. On the Colorado River, the City of Blythe records rainfall averaging 4 inches and temperatures averaging 50°F in January and 91°F in July. In contrast to the relatively low rainfall over most of the county, the high San Jacinto Mountains sometimes experience yearly precipitation exceeding 40 inches.

Windstorms have caused extensive property damage throughout the Coachella Valley. Generally, such storms are caused by the movement of marine air inland toward areas of lower barometric pressure. The prevailing winds are northwesterly, at a mean speed of 4 to 12 miles per hour (Coachella Valley County Water District, 1967).

2.3 Principal Flood Problems

The City of Banning is bounded on the south and on the east by Smith Creek and San Gorgonio River, respectively; however, the principal flooding problems result from flows tributary to Smith Creek. These originate in the hills to the north of the city, and as they exit the canyons, they flow across the alluvial, sloping plain of Banning. If not contained, these flows result in extensive sheet flooding through the city.

Due to the normally arid nature of the area, stream courses are dry, except during, and shortly after, a storm. When a major storm moves into the area, water collects rapidly as surface runoff and reaches the main channel quickly. Consequently, resultant floodflows are of the flash type, having sharp peaks and short durations. Due to the steepness and vegetative cover of the mountains in which they originate and to the average 4 percent slope of the plain on which Banning is situated, floodflows in the area carry large amounts of debris and travel at high velocities.

Damaging floods occurred in the area in 1938, 1965, 1966, and 1969 (USACE, 1973). The most recent flood occurred in 1969, although discharges were generally of less than 1-percent annual chance intensity, flows on the San

Gorgonio River near the Banning levee were approximately 1.4 times the 1-percent annual chance discharge. This flow was also equivalent to that of the large storm in March 1938 which is the maximum flood of record. In 1969, the Banning area had serious problems due to a lack of flood control works, and suffered extremely heavy damages in January, and had yet more severe flooding in February (Riverside County Flood Control and Water Conservation District, 1970). Highland Springs Road was washed out and access to the San Gorgonio Pass Hospital was cut off. Since that time, the Highland Springs Channel has been constructed.

Three types of flooding conditions exist in the City of Banning. These are flooding in defined watercourse (San Gorgonio River and lower reaches of Smith and Pershing Creeks), ponding, and sheet flow.

Flooding of the first type is confined to undeveloped areas within the corporate limits because the floodplains are well defined and at some distance from both developed and developing areas. The only facilities currently subject to flooding from these sources are portions of the Banning Sewer Plant and of the Riverside County Road camp (both located along Smith Creek).

Flooding from ponding is created by manmade obstructions to flow in the middle reaches of Smith, Montgomery, and Pershing Creeks. These are the embankments of the Southern Pacific Railroad and Interstate Highway 10. The results of this study indicate that depths in this ponding area would reach maximums of 8 feet and 13 feet for the 1- and 0.2-percent annual chance storms, respectively.

The third flooding condition is sheet flow through the most-developed areas of the city. This occurs when capacities of existing channels through the city are exceeded. Existing facilities which consist primarily of Works Progress Administration (1938 and earlier) channels are inadequate to control the runoff generated in the area by the present level of development (Riverside County Flood Control and Water Conservation District, 1975). One of the most severe flooding sources is the Gilman Home Channel, a Works Progress Administration channel running through the heart of the city. During a major flood, or any flood exceeding a 10-percent annual chance frequency event, runoff is expected to exceed the capacity of the existing channel in the vicinity of 10th Street. It would likely fan out from there in a wide area, causing damage to homes and businesses along its path (Riverside County Flood Control and Water Conservation District, 1975). Additionally, homes in the vicinity of 12th and George Streets have been flooded by this source during storms of only moderate intensity.

The shallow flooding area from San Gorgonio Avenue to Wilson Street indicates the relatively high flood hazard in this area, where the overflow is contained in close proximity to the channel and does not spread out. At the intersection of Martin and Ramsey Streets, the flow is directed two ways: 50 percent to the east along Ramsey and Livington Streets, and 50 percent weirs across Interstate Highway 10 after it joins the overflow from Gilman Home Channel. The former flows down Ramsey and Livington Streets to Hargrave, and then under Interstate Highway 10 to rejoin the latter, which has weired across the highway. From this point down to the confluence with Smith Creek, the analysis is one of shallow sheet flow. The flow coming in from the northeast portion of the city at Phillips and Hathaway Streets weirs across Interstate Highway 10 along the Southern Pacific Railroad to rejoin the main channel and then the San Gorgonio River.

Although major and damaging storms occurred in the area in 1938, 1965, 1966, and 1969, the City of Beaumont has little history of flooding problems. This is due to its situation on the very crest of San Gorgonio Pass. Because it is on the crown of the alluvial fan which forms the divide, major flows generated in the mountains north and northeast of the city flow to the west and east of it, respectively.

There are two distinct types of potential flooding sources in Cathedral City. These are the Whitewater River and the canyons discharging onto alluvial fans upon which the city is situated.

Levees on the southern and western banks of the Whitewater River above Palm Canyon Wash do not provide adequate protection against 1- and 0.2-percent annual chance flood flows. These flood flows inundate the north-western portions of the city between the western corporate limits and the Whitewater River.

Other sources of flooding are the floodflows discharging from Tramview Wash and Tramview Wash Tributary.

Due to the lack of adequate upstream control structures, flood flows are not properly channelized and directed safely through the city to the Whitewater River. Consequently, in a 1-percent annual chance frequency event, flows leave the channels and travel overland down the fans inundating the western portion of the city adjacent to State Highway 111.

Although the mean annual precipitation at the valley floor is very low, in the surrounding tributary mountains it can be substantial due to the mountains lofty elevations, which range to 10,805 feet at the summit of Mount San Jacinto. As a result of the normally arid nature of the area, the stream courses are dry except during and shortly after a storm. When a major storm does move into the area, water collects rapidly as surface runoff and, due to the precipitous descent from the mountains surrounding Cathedral City, reaches the canyons leading onto the alluvial cones in a comparatively short period of time. Consequently, resultant flood flows in the surrounding canyons are of the flash type, having sharp peaks and short durations. Due to the steepness and lack of vegetative cover in the mountains, flood flows in the area also carry large amounts of debris.

Temescal Wash has a drainage area of approximately 250 square miles at the confluence with the Santa Ana River in the northwestern corner of the city. Damaging floods occurred in 1938, 1943, and 1969. The floods causing the greatest dollar damage occurred in January and February 1969 and caused major damage in the Temescal Wash floodplain. The January storm caused more than $2 million worth of damage, and the total was even higher for the February storm.

A major flooding problem is characteristic of the geological formation of the Corona fan at the foot of the Santa Ana Mountains. Floodwaters are generated in the Santa Ana Mountains and spill out onto the fan, which then transports large volumes of debris into Corona. A high seasonal rainfall, followed by 1 or 2 days of heavy rainfall, produced the devastating floods on the Corona fan in the areas of Main Street and Oak Street Channels in 1969.

The recorded flow for Oak Street Channel in 1969 was approximately 25 percent of the 1-percent annual chance frequency. However, a tremendous amount of debris was carried down from the mountains, and a significant portion of the hydraulic capacity of the channel was lost to rock and mud. The floodwaters overflowed the channel and severely damaged residential and commercial property en route to Temescal Wash.

The 1-percent flood water-surface elevation for the Prado Dam Basin is 549 feet. Flooding at this elevation inundated a considerable area in the northwestern section of the city. The Corona Municipal Airport, the Corona National Golf Course, and the Corona Pistol and Rifle Range were inundated, with depths of up to 30 feet at the airport. The Prado Dam reservoir extends southeasterly into the city to a point in Temescal Wash near the extension of Smith Avenue at Rincon Street.

Mission Creek and Big Morongo Wash, along with several smaller canyons that drain the eastern and southern slopes of the San Bernardino Mountains, form a large alluvial plain that extends southeasterly from State Highway 62, approximately 4 miles west of Desert Hot Springs, to a point where Big Morongo Wash joins the Whitewater River. This plain is supplemented by many alluvial cones from smaller canyons that drain the Little San Bernardino Mountains. The City of Desert Hot Springs is situated on an alluvial bench formed by several such cones and is, therefore, subject to flooding from Big Morongo Wash and its tributaries.

The major tributary that has the greatest potential for damage to the city is Blind Canyon Channel. The city has allowed development to continue on the alluvial cone formed by this watercourse, and this development extends into the mouth of the canyon. The same situation exists for several unnamed tributaries on the east side of the city. These flows originate in the hills to the north and east of the city and move through canyons and across the alluvial bench on which the city is situated. If not contained, these flows result in extensive sheet flooding throughout the city.

The maximum flood of record in the Coachella Valley occurred in 1965, with approximately 32 percent of the 1-percent annual chance discharge. Damaging floods also have occurred in the Coachella Valley in 1916, 1927, 1938, 1939, 1941, 1945, and 1976. Such floods result from three types of storms. The first type is a general winter storm, which combines high-intensity rainfall and rapid melting of the snowpack in the mountains that surround the valley. During the flood of 1927, for example, peak flow on the Whitewater River was 6,000 cubic feet per second (cfs), or less than 15 percent of the 1-percent discharge. The second type is a tropical storm from the Southern Pacific. In September 1976, flooding as a result of tropical storm Kathleen caused approximately $15 million worth of property damage in the Cities of Palm Desert and Indian Wells. The third type is summer thunderstorms, such as those experienced during 1941 and 1948.

When major floods occur in the Whitewater River basin, the tributaries that experience heavy rainfall and resultant flooding do not usually extend over large drainage areas. Even in the Thanksgiving Flood of 1965, during which the peak flow in the Whitewater River was 15,000 cfs, the floodwater originated in just a few tributary canyons. This situation has resulted in extensive flood damage to property on the alluvial fan from the canyon mouths to the Whitewater River. As in Desert Hot Springs, most development in the Upper Coachella Valley has been on alluvial fans.

During major floods, floodwaters carry heavy debris loads and cause considerable damage from deposition, in addition to that caused by erosion and scouring from high-velocity flow. Although routing and location of floodwaters cannot be determined with absolute accuracy, it can be expected that approximately the same amount of damage will occur with storms of the same magnitude. This is the case, even though the route of floods will vary substantially as the water emanating from the canyon mouths is directed from one point to another on the debris cones.

To provide a general indication of the relative severity of the more recent historical floods, peak discharge data have been complied from gaging stations throughout the area. The locations, periods of record, and peak discharges at these gages are as follows:

Location/Period of Record (Drainage Area)	Date	Peak Discharge (cfs)
Mission Creek Near		
Desert Hot Springs,	January 29, 1969	1,660
1968 to 1981	March 4, 1978	1,050
(35.70 square miles)	February 19, 1980	780
	July 28, 1968	544
Long Canyon Near		
Desert Hot Springs,	August 7, 1963	9,270
1963 to 1979	March 4, 1978	3,700
(19.40 square miles)	September 10, 1976	957
	October 22, 1974	790
	July 20, 1979	680

Location/Period of Record (Drainage Area)	Date	Peak Discharge (cfs)
Whitewater River At Whitewater, 1938 to 1980 (57.5 square miles)	March 2, 1938	42,000[1]
	November 22, 1965	24,000
	January 25, 1969	16,200
	February 25, 1969	13,500
	December 6, 1966	5,500
	March 4, 1978	5,000
	February 21, 1980	3,200

[1]Estimate

Numerous reports have been published recounting the extent and severity of the historical floods in Riverside County. Following are brief descriptions of some of the major events in the Desert Hot Springs area since 1969.

An extremely high-intensity thunderstorm in October of 1974 resulted in widespread flooding and property damage in the area between Long Canyon, Wide Canyon, and Willow Hole.

During her passage over the Coachella Valley in August of 1977, tropical storm Doreen caused flooding in Desert Hot Springs, Indio, Palm Desert, and Thousand Palms. Although Desert Hot Springs experienced business and residential flooding, an emergency was not declared in the county (California Department of Water Resources, 1978; Riverside County Flood Control and Water Conservation District, 1982).

A series of winter storms between December 1977 and March 1978 brought near-record rainfall and major flows to numerous areas in Riverside County. An 8-day storm in March resulted in damaged roads and closed streets in Desert Hot Springs (Riverside County Flood Control and Water Conservation District, 1982; USACE, 1978).

The Salt Creek watershed is known to have suffered damaging floods during 1884, 1891, 1916, 1927, 1937, 1938, 1952, and 1969. Lack of runoff records preclude the documentation of the specific magnitude of those severe floods; however, the storms of 1927, 1916, 1938, and 1937, in the order of ascending magnitude, were the greatest recorded storms in the nearby San Jacinto River basin and probably also caused the greatest flooding in the Salt Creek watershed.

The most significant factor aggravating the flooding of Salt Creek in the vicinity of Hemet is the lack of adequate channelization. Constant cultivation of the land in the Salt Creek floodplain has virtually eliminated the presence of a distinct flow path. During large storms, this results in the random flooding of large areas by shallow water flowing at low velocities.

The major flood-prone area within the residential area of Hemet is located between Stetson and Whittier Avenues. In the vicinity of San Jacinto Street, existing topography begins to direct and concentrate flow generated east of San Jacinto Street into Johnston Avenue. This condition results in the shallow flooding of Johnston Avenue between San Jacinto Street and Santa Fe Avenue and shallow ponding in the trailer park development west of Lyon Street due to inadequate drainage facilities. Other flood-prone areas were identified by the RCFCD during their study of potential street flooding in the city north of Whittier Avenue and were incorporated in this study.

There are two potential flooding sources of concern to the City of Indian Wells. These are the Whitewater River and the Deep Canyon Storm Water Channel. The Whitewater River channel in the vicinity of Indian Wells is essentially of the 0.2-percent annual chance flood frequency capacity, so no appreciable flooding problems are due to this source.

The second potential source of flooding in the City of Indian Wells, and by far the most hazardous, is that of an overflow of the banks of the Deep Canyon Storm Water Channel. The drainage area of this tributary in the developed portion of the city is approximately 67 square miles. Extensive residential-country club development has occurred immediately adjacent to both banks of the channel in the City of Indian Wells. The hazard here is from a lessening of the channel gradient as it reaches the flatter slopes near the base of the alluvial fan in Indian Wells. This results in extensive deposition of sediment, consequent loss of channel capacity, and a resultant overflow of the channel banks. This results in potential for extensive damage to structures and contents due to their proximity to the channel bank. Upstream of the improved Deep Canyon Storm Water Channel, flooding hazards are due to uncontrolled overland sheet flow down the Deep Canyon alluvial fan and its tributary canyons.

While the mean annual precipitation at the valley floor is quite low, that in the surrounding tributary mountains can be substantial due to their lofty elevations, ranging to 10,805 feet at the summit of Mount San Jacinto. As a result of the normally arid nature of the area, the stream courses are dry except during and shortly after a storm. When a major storm does move into the area, water collects rapidly as surface runoff and, due to the precipitous descent from the mountains surrounding Indian Wells, reaches the canyons leading onto the alluvial fans in a comparatively short period of time. Consequently, resultant floodflows in the surrounding canyons are of the flash type, having sharp peaks and short durations. Due to the steepness and lack of vegetative cover in the mountains surrounding Indian Wells, floodflows in the area carry large amounts of debris.

From historical records dating back to 1769, the USACE has determined that relatively large winter floods occurred in the Whitewater River basin in 1825, 1833, 1840, 1850, 1859, 1862, 1876, 1884, 1886, 1889, and 1891. More recently, large winter floods occurred in January 1916, December 1921, April 1926, February 1927, February 1937, March 1938, and December 1940 (Philip Abrams, Consulting Engineers, 1975). Most recently, substantial floods occurred in

November 1965, December 1966, January and February 1969, and September 1976.

Prior to the construction of the Whitewater River Storm Channel, damage to lands in the vicinity of Indian Wells was caused by the uncontrolled flow of the Whitewater River. This was exemplified by the storm of January 1916, when the Whitewater cut a path from 25 to 50 feet deep and from 60 to 300 feet wide through the northern portions of what have since become the communities of Rancho Mirage, Palm Desert, and Indian Wells. With the channelization of the river, this threat has been essentially eliminated.

Current flooding problems consist of two types. Upstream of the city, the hazard is one of indeterminate sheet flooding down the debris cone of Deep Canyon. This flooding, however, is confined to areas that remain essentially undeveloped; therefore, it is dangerous only to potential future development in the area.

The second potential flooding hazard is of concern to the already developed portions of the city and is due to the overflow of the Deep Canyon Storm Water Channel as it passes through the developed portion of the city. An excellent example of this hazard was provided by tropical storm Kathleen. In this storm, flows generated by intense rainfall in the drainage area of Dead Indian Canyon entered the City of Indian Wells through the Palm Desert Channel and Haystack Channel. These combined with the lesser flows from Deep Canyon resulting in a flow of approximately 13,000 cfs in the Deep Canyon Storm Water Channel through the city. This produced major deposition of debris, which resulted in overflows of the channel banks through the populated portion of the city.

This flood caused two washouts of the levee—one on the left bank and the other on the right bank just downstream from the preceding breach. No overflow occurred from these two washouts; however, several acres of citrus trees were lost to the erosion. The flow exceeded the channel capacity at various locations downstream from the above-mentioned washouts, causing damages mainly to residential property (approximately 55 houses valued at from $60,000 to $125,000) along West El Dorado, Fairway, Iroquois, and Club Drives and Indian Wells Lane. Damage also occurred to business property, roads, and utilities. Some public property and agricultural land also suffered damage. Depth of overflow ranged from 1.0 to 1.5 feet, getting into structures (USACE, 1977). Damages resulting from this flooding amounted to approximately $2.6 million in the City of Indian Wells alone.

The principal watercourse traversing the City of Indio is the Whitewater River. This is the major drainage course of the entire Coachella Valley and Whitewater River basin, draining areas as far away as the summit of San Gorgonio Pass at Beaumont and including the steep southern and eastern slopes of Mount San Gorgonio and its satellite peaks. The tributary drainage area of this watercourse at Indio is approximately 900 square miles, being 850 square miles upstream of Indio, at Point Happy, and reaching a total of 1,600 square miles at the outlet to the Salton Sea. Because of the extremely large drainage area, major floods in the lower Whitewater River basin in the vicinity of Indio would last longer. The peak flows would be large because of the extreme size of the tributary area, while the flooding period would extend over several days due to the travel times involved for water coming from various extremities of the basin.

While the mean annual precipitation at the valley floor is quite low, that in the surrounding tributary San Bernardino, San Jacinto, and Santa Rosa Mountains can be substantial due to their great elevations, ranging to 11,485 feet at the summit of Mount San Gorgonio. These areas of potentially high precipitation can have tremendous effect on the valley floor many miles away.

In the case of tributaries to the Whitewater River, as a result of the normally arid nature of the area, the stream courses are dry except during and shortly after a storm. When a major storm does move into the area, water collects rapidly as surface runoff and, because of the precipitous descent from the lofty mountains surrounding the Coachella Valley, reaches the tributary channels in a short time. Consequently, resultant floodflows in the surrounding canyons are of the flash type, having sharp peaks and short durations. Because of the steepness and lack of vegetative cover in the mountains surrounding the Coachella Valley, floodflows in the area carry large amounts of debris.

In the vicinity of Indio, since the construction of the Coachella Valley Stormwater Channel (channelized portion of the Whitewater River), flood damages have consisted primarily of erosion of the channel, washouts of dip crossings of the channel, and street and debris cleanup. The only major threat to Indio of serious flooding during a 1-percent annual chance intensity storm is the potential for a major breakout of the Whitewater River at a point between Jefferson Street and Miles Avenue where the manmade channel deviates substantially from the traditional watercourse of the Whitewater River. A breakout at this point would result in a loss of 50 percent of the channel capacity and extensive flooding throughout the Cities of Indio and Coachella. The chance that this situation could occur has been reduced by improvements to levees along the Coachella Valley Stormwater Channel and to the La Quinta Evacuation Channel.

Additional potential for flooding problems exists in the northern portion of Indio. It is caused by sheetflow from alluvial fans exiting the hills located to the north. However, these flows are contained by a system of levees designed to protect the All American Canal; consequently, they never enter the city.

The potential flooding sources in La Quinta are Bear Creek and the Whitewater River.

In the case of tributaries to the Whitewater River, as a result of the normally arid nature of the area, the stream courses are dry except during and shortly after a storm. When a major storm does move into the area, water collects rapidly as surface runoff and, due to the precipitous descent from the lofty mountains surrounding the Coachella Valley, reaches the tributary channels in short periods of time. Consequently, resultant floodflows in the surrounding canyons are of the flash type having sharp peaks and short durations. Due to the steepness and lack of vegetative cover in the mountains surrounding the Coachella Valley, floodflows in the areas carry large amounts of debris.

There is potential for a major breakout of the Whitewater River during a 1-percent annual chance intensity storm between Jefferson Street and Miles Avenue where the manmade channel deviates substantially from the traditional watercourse of the Whitewater River. This situation is due to the lack of sufficient levee capacity to contain the discharge at that point, and the erodibility of the levee which is located on a major bend of the river. A breakout at this point would result in loss of 50 percent of the channel capacity and extensive flooding downstream throughout the Cities of Indio and Coachella. The chance that this situation could occur has been reduced by improvements to levees along the Coachella Valley Stormwater Channel and to the La Quinta Evacuation Channel.

Shallow 1-percent annual chance flooding from Bear Creek will run off northward from the presently developed areas of the city into the lower areas of the city.

The San Jacinto River is the major watercourse within the City of Lake Elsinore, but, in terms of flood hazards, it has only a minor effect upon development within the city.

The 1-percent annual chance discharge (supplemented by the 1-percent annual chance runoff from the surrounding foothills) passes through the Railroad Canyon Reservoir, and results in a flow rate which is within the bed capacity of the San Jacinto River for the section of the river upstream of State Highway 71. Below that point, the confluence with Wash D, the flattening of the flowline slope, the deterioration of the hydraulic section, and the structural obstruction produced by the Railroad Avenue overpass cause the flow to leave the channel. This overflow takes the form of a weir flow over Railroad Avenue with depths up to 5 feet and hazardous flooding on the east bank of the river just south of the overpass. From this point, the flow fans out as it approaches the 1-percent flood elevation of Lake Elsinore, approximately 1,000 feet downstream from Railroad Avenue.

The major flood problems within the study area are due to inundation created by the water-surface elevations of Lake Elsinore and the Elsinore Spillway Channel and flooding on alluvial cones in the western part of the city. Damaging floods occurred in 1890, 1916, and 1969. The floods of 1890 and 1916 were the maximum floods of record for the lake, producing lake elevations of approximately 1,265 feet, which is the 1-percent annual chance water-surface elevation of the lake. The most recent flood of record occurred in 1969; its estimated recurrence interval is not available. Elevations of 1,265 feet inundate a considerable portion of the lower reach of the Elsinore Spillway Channel and the development surrounding it. Trailer parks located in the southwest and northwest portions of the city are partially inundated by the 1-percent annual chance lake elevation. At this elevation, the lake extends to the east within the corporate limits to a point in the San Jacinto River, approximately 1,000 feet downstream of Railroad Avenue.

A critical flood hazard exists as a result of the small capacity of the channel, in the area surrounding the Elsinore Spillway Channel. The channel consists of an improved earth ditch with substantial commercial and residential encroachments along overbank areas.

Another major flood problem exists in the lower reach of Temescal Wash. A backwater condition caused by Temescal Canyon extends from the corporate limits to a section upstream of Riverside Drive with the resulting flooding inundating a large portion of the valley floor.

Downstream of State Highway 71, the flow from Wasson Canyon Creek spreads out, due to an irregular flowline and the lack of any defined channel banks. Backwater forms behind the Atchison, Topeka & Santa Fe Railway bridge and extends upstream past the Collier Avenue weir, crossing at depths of nearly 6 feet.

Flood problems having the greatest effect on land-use planning and future development in the City of Lake Elsinore are due to flooding on alluvial portions of the city. This flooding results in extensive sheetflow with depths of up to 1 foot.

Leach Canyon Channel, Channel H, and Ortega Channel are fully improved, 1-percent annual chance design channels (Section 2.4). However, these channel improvements do not provide sufficient flood-hazard protection for all the surrounding overbank areas, due to a lack of inlet control in their upstream reaches. Flows from Leach Canyon cross the corporate limits and travel toward the lake as sheetflow, with depths of less than 1.0 foot. Only portions of these flows are picked up by the Leach Canyon Channel flood structure. The remainder flows across the overbanks of Leach Canyon Channel until it reaches Lake Elsinore.

A similar situation occurs at the confluence of Channel H and Wash G. Channel H is a fully improved, 1-percent annual chance design structure that never receives the total Wash G discharge due to the lack of adequate upstream control at the mouth of the canyon. Wash G has no defined flowline when flowing across the alluvial cone and through an orchard. This lack of channelization causes Wash G to proceed as sheetflow from its canyon mouth until it is either picked up by Channel H or flows into Lake Elsinore. This produces a zone of sheetflow along the northern overbank of the lower reach of Channel H.

The 1-percent annual chance design capacity of Ortega Channel is rendered ineffective by a similar situation. There are no channel improvements upstream of Grand Avenue, on Ortega Wash. As a result, flooding from Ortega Wash consists of sheetflow with depths of less than 1.0 foot in the lower reaches, and depths of 1.0 foot or greater in the upper reach where the slope is in excess of 6 percent. At the inlet structure to Ortega Channel on the northern side of Grand Avenue, only a portion of the flow will actually be carried by the channel due to the width of the floodplain. The remainder of the flow will be carried to Lake Elsinore as sheetflow along the channel overbanks.

Flooding from Wash I is in the form of sheetflow, with depths of less than 1.0 foot occurring on the lower reach. Farther upstream, the gradient of the terrain is greater than 6 percent. Resultant high velocities tend to channelize flows and result in flooding with depths greater than 1.0 foot.

Flooding from Rice Canyon results from the failure of an earth berm, located outside the corporate limits at the mouth of Rice Canyon. This berm is intended to direct flows to the northeast and into Temescal Wash. It is adequate to successfully divert low flows, but would fail during a 1-percent annual chance event. Failure of this dike allows flows to exit the canyon and flow to the southeast into Lake Elsinore. This condition results in an area of expansive sheet flooding at depths of less than 1.0 foot.

Flooding generated in McVicker Canyon results in sheetflow on the alluvial fan below the mouth of the canyon. In the lower reaches near Lake Elsinore, the slope is gentle with no defined flowpath; therefore, the flows spread out over a wide area, with depths of less than 1.0 foot. In the lower reach, these flows combine with those of Leach Canyon and Rice Canyon to create an expansive area of shallow sheet flooding on the western side of Lake Elsinore. Farther upstream, on the fan immediately below the mouth of the canyon, the slope increases to between 6.0 and 6.5 percent. Because of the higher velocities resulting from the greater slope in this area, the flows are more likely to erode flowpaths on the cone and channelize themselves, resulting in flooding on the cone at depths in excess of 1.0 foot.

Most of the major floods in Moreno Valley occur during winter storms. Occasionally, flooding occurs as a result of summer thundershowers. In the San Bernardino Mountains more than twice as much precipitation falls as in the valleys, due to orographic lifting (FEMA, 1984). Because of steep slopes, large peak flows occur, accompanied by the deposition of debris, which compounds the flooding problem. High velocities can also occur as a result of steep slopes.

Many areas of the City of Murrieta are within 1-percent annual chance flood zones and there is a history of severe flooding associated with overflow from Murrieta Creek and its tributaries. The most recent flooding occurred during storms in January and March 1993, causing leach fields and septic tanks to discharge into the creek as well as requiring the closure of roadways.

Damaging floods have occurred on the Santa Ana River in 1862, 1867, 1918, 1938, 1884, 1916, and 1969, in that order of magnitude. In the last century, large floods have occurred on the Santa Ana River on the average of once every 5 years (FEMA, 1984). The recorded flow for the Santa Ana River during the 1969 floods was from approximately 20 to 25 percent of the 1-percent annual chance frequency. The bridge at River Road was washed out during the floods of 1969.

The City of Norco abuts the river, but is somewhat protected by a high bluff. The elevation of the river flowline averages approximately 50 feet below the general plateau elevation of the city's property. However, a continuing problem exists, with the bluff eroding and receding toward the city and the property improvements atop the bluff along River Drive (F. Beach Leighton & Associates, 1974).

The two main factors that aggravate the flooding problems within the city are inadequate culverts at street crossings and low areas that cause local ponding. Also, a channel constriction has been created by placing dirt fill downstream of the Hamner Avenue crossing on South Norco Channel. Further upstream on this same channel, the culvert crossing at Temescal Avenue is not located at the low point of the roadway, causing major stormflows to cross the street at a point away from the channel. The foremost example of an inadequate culvert is at the River Road crossing of South Norco Channel, where significant upstream ponding is caused. A major natural ponding problem occurs on South Norco Channel, Tributary A, between Parkridge Street and Hamner Avenue, where trapped water could reach a depth of approximately 5 feet and inundate an area of 6 to 7 acres.

A discussion with a local resident living on the west side of Temescal Avenue along South Norco Channel, Tributary B, revealed that during the storm of 1969 approximately 3 feet of water flowed over Temescal Avenue and through some houses. "Throughout Norco local runoff from the hills east of the city created problems to homes and businesses. The interim surface drainage channels were a help, but could not handle all the floodwaters generated by this (1969) storm," (Riverside County Flood Control and Water Conservation District, 1970).

There are two distinctly different types of potential flooding sources in the City of Palm Desert. These are the Whitewater River and the canyons discharging onto the alluvial fans upon which the city is situated.

The Whitewater River is the principal watercourse traversing the City of Palm Desert. It is also the major watercourse draining the Upper Coachella Valley and the Whitewater and San Gorgonio drainage area. This river drains areas as distant as the summit of San Gorgonio Pass at Beaumont, including the steep southern and eastern slopes of Mount San Gorgonio and its satellite peaks. The tributary drainage area of the watercourse at the City of Palm Desert is approximately 800 square miles. The Whitewater River channel in the vicinity of Palm Desert is essentially of 0.2-percent annual chance capacity; therefore, no appreciable flooding problems due to this source exist.

Prior to the construction of the Whitewater River Storm Channel, damage to lands in the vicinity of Palm Desert was caused by the uncontrolled flow of the Whitewater River. This was exemplified by the storm of January 1916, when the Whitewater River cut a path from 25 to 50 feet deep and from 300 to 600 feet wide through the northern portions of what have since become the communities of Rancho Mirage, Palm Desert, and Indian Wells. With the channelization of the river, this threat has been essentially eliminated.

The second potential source of flooding, and by far the most hazardous, is that of floodflows discharging from the canyon mouths south of Palm Desert, leaving their channels, and traveling overland down the alluvial fan upon which the major development of the city has occurred.

While the mean annual precipitation at the valley floor is quite low, that in the surrounding tributary mountains can be substantial due to their lofty elevations, reaching 10,805 feet at the summit of Mount San Jacinto. As a result of the normally arid nature of the area, the stream courses are dry except during and shortly after a storm. When a major storm does move into the area, water collects rapidly as surface runoff and, as a result of the precipitous descent from the mountains surrounding Palm Desert, reaches the canyons leading onto the alluvial fan in a comparatively short time. Consequently, resultant floodflows in the surrounding canyons area of the flash type, having sharp peaks and short durations. Due to the steepness and lack of vegetative cover in the mountains surrounding Palm Desert, floodflows in the area carry large amounts of debris.

An excellent example of the hazard associated with alluvial fans was provided by tropical storm Kathleen in September 1976. During this storm, flows generated by intense rainfall in the drainage area of Dead Indian Canyon breached, at four points, a series of earthen levees designed to direct the floodflows off the alluvial fan. The first breach occurred approximately 0.5 mile downstream of the State Highway 74 bridge, then spread over the alluvial fan; the second and third breaches were at a collector levee that extends from State Highway 74 to Dead Indian Creek approximately 1 mile below the first breach; the fourth breach occurred near the confluence with the Deep Canyon Channel. High-velocity overflow, heavily laden with debris from the second and third breaches, proceeded to the City of Palm Desert and caused major damage to residential property (approximately 460 houses). Overflow ranged up to approximately 4 feet, but averaged approximately 1.5 feet in depth in the upper part of the city, upstream from Haystack Road. Depths of flooding averaged approximately 1 foot below Haystack Road and State Highway 111 (USACE, 1977). Damage resulting from this flood was in excess of $6 million in the City of Palm Desert alone.

Flood hazards associated with a 1-percent annual chance event on the alluvial fans have been reduced as a result of improvements to the Palm Valley Stormwater Channel and the construction of other flood control structures in Palm Desert and neighboring Indian Wells and Riverside County.

The City of Perris is bounded on the southeast and east by two major watercourses. These are the Perris Valley Storm Drain and the San Jacinto River, respectively. These are the major sources of flooding in the Perris area. The Greater Perris Valley is extremely flat, causing floodwaters to move slowly and to spread out over a broad area. The expanse of flooding is further affected by the sudden constriction of floodflows presented by the entrance to the upper end of Railroad Canyon, which is located south of the City of Perris. This restriction of flow causes a ponding situation which, due to the flat topography of the Greater Perris Valley, causes floodflows to backup for a distance of 7 miles upstream.

The Perris Valley Storm Drain, which drains the March Air Force Base/ Sunnymead area to the north, generates flooding similar in nature to that of the San Jacinto River. These two flooding sources inundate primarily agricultural lands in the southeastern and eastern portions of Perris. The other flooding sources in Perris cause only shallow flooding resulting from local drainage problems. These are the Orange Lateral, San Jacinto Lateral, Mountain Avenue Wash, and Line "J" Channel.

The majority of flows tributary to the San Jacinto Lateral are intercepted by the Third Street Retention Basin and held there until they are fully discharged by the 18- to 24-inch reinforced concrete pipe draining the basin. Those flows that are not caught by the retention basin concentrate in a sump area west of the Atchison, Topeka and Santa Fe Railway. Weir flow occurs as the water-surface elevation of the pond exceeds the top of the rails and proceeds as sheetflow eastward towards the San Jacinto River. The street system acts as the principal conveyor for this shallow flow.

On Line "J" Channel, inadequate capacity at street crossings prevents maximum flows from remaining within the channel banks. Line "J" Channel intercepts overland sheetflow of the Orange Lateral coming from the northwest. This additional discharge entering Line "J" Channel results in an overflow condition from the point of confluence with Line "J" Channel down to the Perris Valley Storm Drain.

Damaging floods are known to have occurred in 1916 to 1927, 1931, 1937, 1938, 1965, 1966, and 1969 (the most recent flood of record). The largest flood of record on the San Jacinto River occurred on February 16, 1927, and had an estimated peak discharge of 45,000 cfs. This was approximately equal to the 1-percent annual chance frequency discharge of 44,000 cfs.

There are two distinctly different types of potential flooding sources in the City of Rancho Mirage. These are the Whitewater River and the canyons discharging onto the alluvial fans upon which the city is situated. The Whitewater River is the principal watercourse traversing the City of Rancho Mirage. This is the major watercourse draining the Upper Coachella Valley and the Whitewater and San Gorgonio drainage areas. This river drains areas as far away as the summit of San Gorgonio Pass at Beaumont, and includes the steep southern and eastern slopes of Mount San Gorgonio and its satellite peaks. The tributary drainage area of this watercourse at the City of Rancho Mirage is approximately 800 square miles; 740 square miles upstream of the city at the confluence of Palm Canyon and 840 square miles downstream near Point Happy. The Whitewater River Channel in the vicinity of Rancho Mirage is, essentially, of 1-percent annual chance capacity. The major flooding problem generated by this source is the 0.2-percent annual chance flood. This flood frequency caused shallow flooding in the overbanks.

The second potential source of flooding, and by far the most hazardous, is that of floodflows discharging from the canyon mouths south of Rancho Mirage leaving their channels and traveling overland down the alluvial fans upon which the major development of the city has occurred.

While the mean annual precipitation at the valley floor is quite low, that in the surrounding tributary mountains can be substantial, due to their lofty elevations ranging to 10,805 feet at the summit of Mount San Jacinto.

As a result of the normally arid nature of the area, the stream courses are dry, except during and shortly after a storm. When a major storm does move into the area, water collects rapidly as surface runoff and, due to the precipitous descent from the lofty mountains surrounding Ranch Mirage, reaches the canyons leading onto the alluvial fans in a comparatively short period of time.

Consequently, resultant floodflows in the surrounding canyons are of the flash type, having sharp peaks and short durations. Due to the steepness and lack of vegetative cover in the mountains surrounding Rancho Mirage, floodflows in the area carry large amounts of debris.

From historical records dating to 1769, the USACE determined that relatively large winter floods occurred in the Whitewater River Basin in 1825, 1833, 1840, 1850, 1859, 1862, 1867, 1876, 1884, 1886, 1989, and 1891. More recently, large winter floods occurred in January 1916, December 1921, April 1926, February 1927, March 1938, and December 1940 (Philip Abrams Consulting Engineers, 1975). Most recently, substantial floods occurred in November 1965, December 1966, January and February 1969, and September 1976.

The principal flood problems in the original study consisted of sheet flooding on the alluvial fans on which the city is situated. The completion of the Magnesia Spring Flood Control Project, the basis of the revision, eliminated this flooding problem.

The flat land on which most of Riverside is located was formed geologically as alluvial fans of streams coming out of the mountains. Much of the land, especially north and west of the Riverside Freeway, is of insufficient slope to carry off water during periods of intense rainfall. Stormwater collection systems are inadequate in this area and stormwater frequently backs up in streets, ponds, and natural depressions before it drains to the Santa Ana River.

The foothill areas are, for the most part, free from flooding. The streams in this area have generally eroded well-defined washes, and the developable land is well above high water during times of floods. Much of this area has been developed into orange groves.

The mountainous areas in the upper parts of the watersheds consist of steep, rocky lands which have only recently been developed for residential use In this area, there is no danger of inundation by stream flooding.

Many of the streams do not have well-defined low flow channels from the hills all the way to the Santa Ana River. Because the alluvial channels were not well-defined, they have been generally obliterated by development. In some cases, culverts have been installed to carry low flows in the extensions of the channels. Thus, during major floods, considerable overflow can occur, causing flooding of streets and ponding in low areas before the waters find their way to the Santa Ana River.

Many of the minor flood channels discharging into the Santa Ana River either originate as interior drainage or collect overflow created by the many small streams debouching from the hills. Flooding problems in such areas are primarily caused by the inability of the floodwater to get to the channels rather than by the channel not being capable of carrying the flow; therefore, they are not of great depths or velocities.

Although most of the streams have dams and controlling reservoirs near the base of the hills which are designed to contain the 1-percent annual chance flood, local drainage below the dams provides significant additional runoff. Thus, complete protection is not fully afforded below the dam, even for small magnitude floods. Flooding frequently causes damage at various locations along unregulated streams such as Santa Ana River, Spring Brook Wash, University Wash, and Box Springs Wash.

It is not possible to compare computed flooding levels and limits with historical flood data. Flood damage reports were prepared by both the State Department of Water Resources and the USACE for the 1969 floods, the only significant flooding in the last 35 years. Flooding in Riverside during that flood, however, was not severe and few flood marks were available.

Most of the major floods in the county have occurred as a result of general winter storms. However, serious flooding has also occurred as a result of summer thunderstorms, particularly in the desert areas.

Western Riverside County is characterized by the numerous brush-covered hills and mountains that extend abruptly from the alluvial valley floor where the majority of the development is located. Most of the rainfall occurs during the winter months as a result of storms. Due to orographic effects, rainfall quantities increase rapidly with elevation. Higher elevations receive more than twice the precipitation received by the valley floors. A combination of steep slopes and high rates of rainfall results in a rapid concentration of runoff causing flows with high velocities and large peaks.

As peak floodflows reach the valley floor, large amounts of debris (which are transported from the hills) are deposited and compound the flooding problem.

The major rivers in the western portion of the county are the Santa Ana River, the San Jacinto River, the San Gorgonio River, Temescal Wash, and Murrieta Creek. These rivers constitute flood threats to the developments within the floodplain during general storms of long duration.

The San Jacinto River has flooded several times since 1900. These floods occurred during 1916, 1927, 1931, 1937, 1938, 1966, 1969, and 1980. The largest flood of record, which occurred on February 16, 1927, had an estimated peak discharge of 45,000 cfs near the City of San Jacinto. Agricultural, railway, and highway properties were extensively damaged.

Eight major floods have been recorded for Murrieta Creek. These floods occurred during 1862, 1884, 1916, 1938, 1943, 1969, 1978, and 1980.

Tributaries to the major rivers present additional flood hazards. Flooding in these streams is caused mostly by local thunderstorms. Floodflows are characteristically of short duration, but can cause extensive damages due to the high velocities generally associated with these tributaries.

The Perris Valley Storm Drain and the San Jacinto River are the major sources of flooding in the vicinity of the City of Perris. The Greater Perris Valley is extremely flat, causing floodwaters to move slowly and to spread out over a broad area. The expanse of flooding is further affected by the sudden constriction of floodflows presented by the entrance to the upper end of Railroad Canyon, which is located south of the City of Perris. This restriction of flow causes a ponding situation which, due to the flat topography of the Greater Perris Valley, causes floodflows to back up for a distance of 7 miles upstream.

The Perris Valley Storm Drain, which drains the March Air Force Base/Sunnymead area to the north, generates flooding similar in nature to that of the San Jacinto River. These two flooding sources inundate primarily agricultural lands east and southeast of the City of Perris.

The desert areas extending to the east from the vicinity of Palm Springs suffer principally from sheetflow flooding, with depths of flow generally less than 2.0 feet. Flows leaving the mouths of canyons often follow unpredictable paths.

Mission Creek and Big Morongo Wash, along with several smaller canyons that drain the eastern and southern slopes of the San Bernardino Mountains, form a large alluvial plain that extends southeasterly from State Highway 62, approximately 4 miles west of the City of Desert Hot Springs, to a point where Big Morongo Wash joins the Whitewater River. This plain is supplemented by many alluvial cones from smaller canyons that drain the Little San Bernardino Mountains. The City of Desert Hot Springs is situated on an alluvial bench formed by several such cones and is, therefore, subject to flooding from Big Morongo Wash and its tributaries.

When major floods occur in the Whitewater River basin, the tributaries that experience heavy rainfall and resultant flooding do not usually extend over large drainage areas. Even in the Thanksgiving Flood of 1965, during which the peak flow in the Whitewater River was 15,000 cfs, the floodwater originated in just a few tributary canyons. This situation has resulted in extensive flood damage to property on the alluvial fans from the canyon mouths to the Whitewater River. As in the City of Desert Hot Springs, most development in the Upper Coachella Valley has been on alluvial fans.

During major floods, floodwater carries heavy debris loads and causes considerable damage from deposition, in addition to that caused by erosion and scouring from high-velocity flow. Although routing and location of floodwater cannot be determined with absolute accuracy, it can be expected that approximately the same amount of damage will occur with storms of the same magnitude even though the route of floods will vary substantially as the water emanating from the canyon mouths is directed from one point to another on the debris cones.

In order to provide a general indication of the relative severity of historical floods, peak discharge data have been compiled from gaging stations spread throughout the county. The locations, periods of record, and peak discharges at these gages are shown in Table 3, "Historical Flooding."

TABLE 3 – HISTORICAL FLOODING

Location	Drainage Area (Square Miles)	Period of Record	Date	Peak Discharge (cfs)
San Jacinto River Near San Jacinto	141	1920-Present	February 16, 1927	45,000
			February 21, 1980	17,300
			March 2, 1938	14,300
			February 6, 1937	14,000
			January 25, 1969	7,410
			November 22, 1965	6,300
Bautista Creek Near Hemet	39.4	1947-1959	April 3, 1958	1,440
			July 19, 1955	1,170
			February 25, 1969	650
Bautista Creek At Valle Vista	47.2	1969 to present	February 21, 1980	11,400
			March 28, 1980	1,390
			August 17, 1977	1,050

Peak elevation data have also been kept on Lake Elsinore as a further record of the flood history of Riverside County. The highest lake levels for the period 1916 to 1983 are as follows:

Date	Elevation of Lake Elsinore (feet)-NGVD29
April 1980	1,265.7
April 1916	1,265.6
April 1917	1,260.7
May 1922	1,259.7
May 1927	1,259.0
May 1938	1,258.9
April 1918	1,258.7

Numerous reports have been published recounting the extent and severity of the historical floods in Riverside County. The following brief descriptions of some of the major events since 1969 provide an indication of the flood damages suffered.

Two distinct periods of heavy rain struck Riverside County during January and February of 1969, producing the greatest amount of runoff since March of 1938. Four persons lost their lives and an estimated $40 million damage to public and private property was reported throughout the county (Riverside County Flood Control and Water Conservation District, 1970).

An extremely high-intensity thunderstorm in October of 1974 resulted in widespread flooding and property damage in the area between Long Canyon, Wide Canyon, and Willow Hole.

On September 10 and 11, 1976, the southwestern side of the Coachella Valley was subjected to the intense rainfall of Tropical Storm Kathleen, causing $14.6 million damage in Cathedral City, Rancho Mirage, Palm Desert, La Quinta, and Oasis (USACE, 1977). Localized thunderstorms struck many of the same areas again on September 23-24, causing $4.4 million of additional damage.

Tropical Storm Doreen caused residential and business flooding in Indio, Palm Desert, Thousand Palms, and Desert Hot Springs during its passage over the Coachella Valley in August 1977, but an emergency was not declared in the county. Imperial County was much more severely affected than the communities within Riverside County (California Department of Water Resources, 1978; USACE, 1978; Riverside County Flood Control and Water Conservation District, 1982).

A series of winter storms between December 1977 and March 1978 brought near-record rainfall and major flows to numerous areas in Riverside County.

During February and March of 1978 several successive periods of heavy rain resulted in $9 million in flood damage within Riverside County (USACE, 1978). The regions suffering the greatest damage included the Palm Springs area adjacent to the Whitewater River; the Corona Area; Murrieta Creek and Delux Canyon within the Santa Margarita River basin; and widespread streams throughout the Santa Ana River basin.

Intense local thunderstorms in the hills above Rancho Mirage and Cathedral City on July 20, 1979, caused the flooding of 130 homes and $6.4 million in damage (USACE, December 1983). One man was killed at the State Highway 111 bridge over the Magnesia Spring Channel.

Three distinct periods of flooding combined to affect much of the state of California in January and February of 1980 (Wahl, K. L., 1980). Floods in mid-February caused damage in Riverside County, specifically in the Santa Margarita and Santa Ana River basins. Peak discharges at gaging stations within the Santa Margarita River basin, including Murrieta Creek, were generally the highest in the last 50 years. The total volumes of runoff on streams in the Santa Ana River basin were especially large during the 1980 floods, resulting in the highest recorded elevation of Lake Elsinore. Numerous homes and facilities around the lake were inundated as a result of the peak lake level of 1,265.7 feet on March 20-21, 1980 (Wahl, K. L., 1980).

On September 7, 1981, a local thunderstorm in the Lakeview Mountains resulted in interior damage to 16 residences due to the flooding on Lakeview Wash. In addition to mapping the path of the floodflow down the wash, the RCFCWCD estimated the peak discharge at roughly 800 cfs.

There are no records of major flooding to San Jacinto from Bautista Wash. However, major flooding to the city, generated from the San Jacinto River, occurred during 1965 and 1969. The 1969 flood resulted from failure of the levees along the San Jacinto River.

The major rivers in the western portion of Riverside County are the Santa Ana River, the San Jacinto River, the San Gorgonio River, Temescal Wash, and Murrieta Creek. These rivers constitute flood threats to the developments within the floodplain during general storms of long duration.

Eight major floods have been recorded for Murrieta Creek. These floods occurred during 1862, 1884, 1916, 1938, 1943, 1969, 1978, and 1980.

In order to provide a general indication of the relative severity of historical floods, peak discharge data have been compiled from gaging stations spread throughout Riverside County. The locations, periods of record, and peak discharge of the gages for flooding sources affecting the City of Temecula are shown below.

Location	Drainage Area (square miles)	Period of Record	Date	Peak Discharge (cfs)
Murrieta Creek	222	1924-1980	January 4, 1916	23,300*
			February 21, 1980	21,800
			January 23, 1943	17,500
			March 2, 1938	16,800
			March 1, 1978	14,800
			February 25, 1969	10,400
Temecula Creek Near Aguanga	131	1957-1980	April 3, 1958	3,540
			February 21, 1980	3,420
			January 29, 1980	2,640
			January 25, 1969	2,550
			February 25, 1969	2,550

*Estimate

For information on flooding related to the Colorado River, the reader should refer to pages 195 and 196.

2.4 Flood Protection Measures

Most of the larger watercourses traversing developed areas in Riverside County have been improved to control flooding. A major flood-control dam, Prado Dam, has been constructed on the Santa Ana River near the western county line. There are a number of smaller flood-control dams, water-conservation dams, debris basins, retarding basins, and water-spreading facilities that have significant flood-control functions. A series of dams along the Colorado River has eliminated the major flood hazards along the Colorado River Valley. Channel improvements are listed below by the general type and degree of improvement. The rivers and streams that are listed more than once have significant reaches of different types of channel improvements along the reach studied.

The following are concrete-lined channels with capacities equal to or greater than the 1-percent annual chance flood:

Bautista Creek
Bly Channel
Calismesa Channel
Cherry Valley Creek
El Cerrito Channel
Murrieta Hot Springs
Noble Creek
Pyrite Channel
Sun City Channel C-C
Sun City Channel H-H
Sun City Channel X-X
Sun City Southeast Tributary
Sunnyslope Channel
West Pershing Creek
Wide Canyon Wash

The following are channels with revetted levees designed to contain the 1-percent annual chance or greater flood:

Bear Creek
San Jacinto River
Salt Creek
Santa Ana River
San Sevaine Creek

The following are stable, graded channels designed to contain the 1-percent annual chance or greater flood:

Salt Creek
Sun City Channel A-A
Sun City Southeast Tributary
Tri-Palm Estates Channel
Tri-Palm Estates Middle Tributary
Tri-Palm Estates East Tributary

The following are unstable, graded channels designed to contain the 1-percent annual chance or greater flood:

Bautista Creek
Mission Creek
Whitewater River

The following are concrete-lined channels designed to contain the 10-percent annual chance or greater flood which have capacities inadequate for containing the 1-percent annual chance flood:

Edgemont B North Fork	San Sevaine Channel
Romoland Wash	Sunnymead Storm Channel

The following are improved channels designed to contain 10-percent annual chance or greater floods whose capacities are inadequate for containing the 1-percent annual chance flood:

Bear Creek	Noble Creek
Cherry Valley Creek	Ferris Lateral A
Day Creek	Ferris Lateral B
El Cerrito Channel	Ferris Valley Storm Drain
Kalmia Street Tributary	Reche Canyon
Lakeland Village Channel	Salt Creek
Little San Gorgonio Creek	Santa Ana River
Murrieta Creek	West San Sevaine Creek

The following are natural watercourses with minor stabilization improvements:

Country Club Creek	Little Morongo Wash
Country Club Creek Tributary	Murrieta Hot Springs
Edgemont A	White House Canyon
Garden Air Golf Course	

There are no flood-control structures on Lake Elsinore. Railroad Canyon Reservoir on the San Jacinto River is not operated for flood-control purposes. A preliminary flood mitigation assessment is currently being conducted by the USACE calling for an improved outflow channel to reduce future flood heights on Lake Elsinore (USACE, 1983).

There are no flood-control structures on Lakeview Wash.

The RCFCWCD has a coordinated plan for controlling flooding within the Bautista Wash basin. At present, flood-control benefits are afforded by the Fairview Channel, a concrete diversion channel that collects runoff from the watershed above Fairview Avenue and deposits it within the levees of Bautista Creek. The Park Hill Detention Basin reduces peak discharges on Park Hill Drain downstream of Devonshire Avenue. The final flood-control structure within the Bautista Wash basin is the San Jacinto Drain, an improved channel between State Street and Seventh Street designed to convey a portion of the floodwater of Bautista Wash.

Two flood-control structures have been proposed for future construction in the watershed of Bautista Wash. The Meridian Street Drain will divert large additional quantities of runoff from both Bautista Wash and Park Hill Drain. Plans have also been formulated for the building of the Buena Vista Retention Basin on Bautista Wash just upstream of the Atchison, Topeka, and Santa Fe Railroad crossing. The

Meridian Street Drain and the Buena Vista Retention Basin have not yet been constructed and they are therefore not considered in the hydrologic analyses.

No effective flood-control structures are located along Pechanga Creek or within the shallow flooding area on the north side of Wolf Valley. Unarmored sand levees have been placed adjacent to Pechanga Creek, but high-velocity floodwater will make these levees ineffective in mitigating flood hazards. Where the North Side Wolf Valley enters Temecula Creek, local interests have attempted to channelize the runoff by placing levees adjacent to an existing ditch. Due to the threat of damage to the levees from the floodwater of Temecula Creek, they were not considered in the hydraulic computations.

The detailed-study area near Thousand Palms receives some protection from flooding as a result of the construction of West Wide Canyon Dam. This structure, built in 1968, is located northeast of Desert Hot Springs in the Little San Bernardino Mountains. The detention of runoff from the East and West Wide Canyon watersheds is of sufficient duration that flood hazards from the 33 square miles upstream are effectively eliminated. The hydrologic calculations do not include any runoff contribution from the drainage area controlled by this dam.

In 1948-49, the U.S. Bureau of Reclamation constructed the northern segment of the East Side Dike System which extends into the Coachella Valley study area (Coachella Valley County Water District, 1964). This dike system provides protection to the Coachella Canal and consists of a long basin formed by dikes about 30 feet high which run between existing sandhills. Located at the base of the Indio Hills, the diked area stores and then directs runoff into the Coachella Valley Stormwater Channel. The dikes begin at a point below Macomber Palms and continue beyond the eastern edge of the detailed-study area. Floodwater from some of the alluvial fans being studied in this report will be diverted to the east by the U.S. Bureau of Reclamation dikes.

In the community of Thousand Palms, local interests have constructed various masonry walls and sand levees in an attempt to control flooding. The design of these structures does not adequately account for both the high velocities of flow and large quantities of sediment that are characteristic of alluvial fan floods. Therefore, no flood protection benefits have been attributed to them in these analyses.

Mission Creek, in the vicinity of Desert Hot Springs, drains a large area of the eastern slope of the San Gorgonio Mountains and flows across the same alluvial plain onto which Big and Little Morongo Canyons flow. A 250-foot-wide, graded, trapezoidal channel has been constructed, with the flowline between 3 and 4 feet below grade and sand dikes of 5 to 6 feet high. Because of lack of upstream control, high-velocity flows, and unpredictable patterns of alluvial flow, this channel does not contain the 1-percent annual chance flood.

Riverside County has a subdivision ordinance which requires that all new development in the unincorporated areas of the county be protected from the 1-percent annual chance flood. The RCFCWCD reviews all proposed development plans and advises the Riverside County Planning Commission, which approves the plans for compliance with the flood protection provisions of this ordinance.

The county has also zoned the flooding areas along a number of the larger watercourses in the county as "Watercourse Areas." Development of permanent, inhabitable structures is prohibited within the zoned areas. Some uses, compatible with occasional flood conditions, are prescribed for this zone.

Other than the emergency ordinance developed for participation of communities in the NFIP, the City of Banning has not adopted a zoning ordinance that either delineates areas of flood hazard or regulates development on floodplains. The city does, however, consult the Riverside County Flood Control and Water Conservation District for technical advice on subdivisions and open-space zoning.

The Riverside County Flood Control District has constructed a number of flood protection and control facilities in the City of Banning in the past 20 years. These are the Sidney Street Channel, Montgomery Creek Channel, San Gorgonio River-Banning Levee, West Pershing Channel, Highland Springs Channel, Gilman Home Channel, and Smith Creek bank protection. Other flood control channels within the city consist of the old, substandard Work Progress Administration channels.

The Montgomery Creek Channel is a 1-percent annual chance design channel which eliminates the special flood hazards along this watercourse down to Ramsey Street. The Gilman Home Channel-Stage I improvements are also of 1-percent annual chance capacity, although they do not fully eliminate flooding in this area, which results from overflow and sheet flooding from East Gilman Home Channel. Montgomery Creek Channel, Pershing Channel, Sidney Street Channel, and the San Gorgonio River-Banning Levee are flood protection facilities which performed well in minimizing flood damages during the 1969 storms.

Highland Springs Channel is a 1-percent annual chance design improvement, but suffers from a lack of inlet capacity to the subterranean box culvert below Wilson Street. Consequently, below this point, Highland Springs Avenue still suffers from sheet flow flooding.

West Pershing Channel is a 1-percent annual chance design channel throughout its improved segment. It empties into the natural streambed below Wilson Street.

East Gilman Home Channel from George Street to 1,000 feet upstream of Gilman Street is a 5-foot deep Works Progress Administration rubble trapezoidal channel with a 3-foot bottom width and a 7-foot top width.

Gilman Home Channel from Westward Avenue to Interstate Highway 10 is a 1-percent annual chance design channel. From Interstate Highway 10 to George Street, it is an old, 5-foot deep trapezoidal channel with a 3-foot bottom width and a 7-foot top width. From George Street to 1,000 feet downstream of Wilson Street, it is a 7-foot wide by 6-foot high concrete rectangular channel. From 1,000 to 400 feet downstream of Wilson Street, it is a 5-foot deep concrete trapezoidal channel with a 5-foot bottom width and 20-foot top width.

Highlands Springs Channel from Fifth Street to Eight Street (Wilson Street) is a 6-foot high, 6-foot wide, reinforced-concrete box.

From 8th to 12th Streets, Highland Springs Channel is a 5.5-foot deep concrete trapezoidal channel with a 5-foot bottom width and a 21.5-foot top width. No portion of Highland Springs Channel is located within the corporate limits of Banning; however, overflow from the channel enters the city, so it was included in the study.

Indian Canyon Channel, from Wilson Street to 400 feet north of Indian School Lane, is a 5-foot deep Works Progress Administration rubble channel with a 3-foot bottom width and 7-foot top width. Montgomery Creek Channel is a 6-foot high, 10-foot wide reinforced-concrete box culvert under Interstate Highway 10 and Ramsey Street. From Ramsey to Nicolet Streets, it is a 6-foot high, 10-foot wide reinforced-concrete rectangular channel. From Nicolet to Wilson Streets, it is a 5.5-foot deep concrete trapezoidal channel with a 3-foot bottom width and a 19.5-foot top width. From Wilson Street to Sunset Avenue, it is a 5-foot deep concrete trapezoidal channel with a 3-foot bottom width and an 18-foot top width.

Ramsey Street Drain is a 4-foot high, 8-foot wide reinforced-concrete box culvert under Interstate Highway 10. From Interstate Highway 10 to Ramsey Street, it is a 6-foot deep concrete trapezoidal channel with a 3-foot bottom width and a 27-foot top width. From Ramsey Street to 300 feet northwest of the intersection of Ramsey and Alola Streets, it is a 4-foot high reinforced-concrete box that is 5.5 feet wide. From 300 feet northwest of the intersection of Ramsey and Alola Streets to 200 feet downstream of San Gorgonio Avenue, it is a 5-foot deep Works Progress Administration rubble channel with a 3-foot bottom width and a 7-foot top width. From 200 feet downstream of San Gorgonio Avenue to the upstream face of San Gorgonio Avenue crossing, it is a 60-inch reinforced-concrete pipe. From the upstream face of San Gorgonio Avenue crossing to Wilson Street, it is a 5-foot deep Work Progress Administration rubble channel with a 3-foot bottom width and a 7-foot top width.

On the San Gorgonio River, 900 feet northeast of the intersection of Banning Canyon Road and Summit Drive, is 700 lineal feet of rock and wire mesh levee. From Wilson Street to 300 feet south of an extension of the centerline of Pendleton Road, Sidney Street Channel is a 2-foot deep concrete trapezoidal channel with a 3-foot bottom width and a 9-foot top width. From 30 feet south to 80 feet north of an extension of the centerline of Pendleton Road, it is a 3-foot deep concrete trapezoidal box with a 2.5-foot bottom width and a 4-foot top width. From 80 feet north of an extension of centerline of Pendleton Road to the intersection of Repplier Road and Sidney Street, it is a 2-foot deep concrete trapezoidal channel with a 3-foot bottom width and a 9-foot top width. From the intersection of Repplier Road and Sidney Street to 880 feet north at the mouth of the canyon, there are 280 lineal feet of 3.6-inch reinforced-concrete pipe, 432 lineal feet of 42-inch reinforced-concrete pipe, and 160 lineal feet of 48-inch reinforced-concrete pipe, in that order.

On Smith Creek, upstream from the banning Sewage Disposal Plant, there are 1,500 lineal feet of concrete slope protection along the north bank.

West Pershing Channel is a 5-foot high and 600-foot wide reinforced-concrete box culvert under Wilson Street. From Wilson Street to 400 feet north of the corporate limits it is a 5-foot deep concrete trapezoidal channel with a 5-foot bottom width and a 20-foot top width.

Other than the emergency ordinance developed for participation of communities in the NFIP, the City of Beaumont has no zoning ordinance that either delineates areas of flood hazard or regulates development on floodplains.

The only flood protection and control measure constructed by the Riverside County Flood Control District in the City of Beaumont is the Cherry Avenue Channel. This channel, while it does not contain the 1-percent annual chance discharge, does keep the flooding down to shallow sheet flow, except in a low-lying residential area west of the channel, below 8th Street.

A full listing of flood protection measures resulting from channel improvements is given below for Cherry Avenue Channel:

> A double 6-foot wide by 3-foot high reinforced concrete box culvert under Interstate Highway 10; from Interstate Highway 10 to 6th Street, an 8-foot wide by 5-foot high earth channel; from 6th Street to 8th Street, an 8-foot bottom width, 16-foot top width, 4-foot deep concrete trapezoidal channel; from 8th Street to 200 feet to the north, an 8-foot wide by 5-foot deep earthen channel; from 200 feet north of 8th Street to 400 feet north of its intersection with Cherry Avenue, a pipe and wire revetted earthen dike.

Numerous levee systems have been constructed along the various drainages leading into Cathedral City. The oldest and most developed portion of the city is built on the alluvial fan formed at the outlet of Cathedral Canyon which drains into the southernmost part of the city. This area lies between East, West, and North Cathedral Channels, and is essentially surrounded by levees and storm channels which prevent floodflows from the above-mentioned flooding sources.

Revetted levees run along the east side of West Cathedral Channel and the west side of East Cathedral Channel. The levees begin a few hundred feet downstream of Foothill Road and extend downstream past State Highway 111. Here the levees merge with, and are connected by, the concrete-lined channel that contains drainage from North Cathedral Channel. These levees contain both 1- and 0.2-percent annual chance flooding.

In 1979, an improvement was made to North Cathedral Channel upstream of the confluence with West Cathedral Channel. A trapezoidal concrete-lined channel 6 to 7 feet in depth was built from just above the confluence with West Cathedral Channel to 2,040 feet upstream. The channel was constructed for the Riverside

County Flood Control District and is designed to contain a 1-percent annual chance flow of 2,300 cubic feet per second (cfs).

Levees along the Whitewater River essentially consist of large sandpiles with no reinforcement. These levees are easily eroded and thus require periodic maintenance. The Coachella Valley Water District has overseen the most recent restorations to portions of the levees between 34th Avenue and Ramon Road. In many locations, the Whitewater River levees conform to FEMA standards (3 feet of freeboard with respect to the 1-percent annual chance flood) for 1-percent annual chance flood protection; however, the instability of sand over time and during severe flooding places limitations on the dependability of that protection.

The City of Corona, in conjunction with the Riverside County Flood Control District, requires all new development to provide protection from the 1-percent annual chance flood, either by design or channel improvements.

Main Street and Arlington Channels are fully improved 1-percent annual chance design channels. These improvements eliminate the special flood hazards adjacent to the channels. In addition, there is a debris basin and outlet control at the upstream limit of Main Street Channel.

On Mangular Channel, several segments have been improved. The segment from the confluence with Oak Street Channel to Ontario Avenue is a fully improved 1-percent annual chance design channel. However, until the upstream portions are completed, this channel does not provide effective control. A debris basin with 1-percent annual chance flood control has been built at the mouth of Mabey Canyon, the major tributary to Mangular Channel. In conjunction with this basin, a fully improved channel with 1- to 0.2-percent annual chance flood control has been built from the spillway downstream for approximately 1,500 feet. The remaining 4,000 feet between the downstream limit of this segment and Ontario Avenue is uncontrolled flow on an alluvial cone. A 4-foot-high structural wall has been built along the segment of channel improvement adjacent to Border Avenue. This wall provides control and defines the eastern edge of Border Avenue as the limit of the special flood hazard in the reach of Mangular Channel.

The Temescal Wash channel contains the 1-percent annual chance flood discharge between Cota Street and the Atchison, Topeka & Santa Fe Railway crossing just downstream of Riverside Freeway.

The Riverside County Flood Control and Water Conservation District reviews all proposed developments within the city for potential flood hazards and flood-control requirements. Those developments under review were considered during the preparation of this study.

The RCFCWCD has made channel improvements in Desert Hot Springs, but none provide complete protection from the 1-percent annual chance flood.

Blind Canyon Channel drains an area north of the city in the Little San Bernardino Mountains. At the northern corporate limits, the drainage is collected and routed into a dirt-graded, trapezoidal-shaped channel, which is 100 feet wide and 8 feet deep, and has 1-percent annual chance capacity below ground level. At 16th Street, a concrete drop structure regulates large flood flows.

Desert Hot Springs Channel has a 48-inch reinforced-concrete pipe at the Verbera Drive Crossing, a double 10-foot by 5-foot reinforced-concrete box under Palm Drive, and a reinforced-concrete channel from 12th to 8th Streets.

Mission Creek drains a large area of the eastern slope of the San Gorgonio Mountains and flows across the same alluvial plain onto which Big and Little Morongo Canyons flow. A 250-foot wide, graded, trapezoidal channel has been constructed, with the flowline between 3 and 4 feet below grade and sand dikes of 5 to 6 feet high. Because of lack of upstream control, high-velocity flows, and unpredictable patterns of alluvial flow, this channel does not contain the 1-percent annual chance flood.

Development within the Salt Creek floodplain has been very conscientiously controlled by the City of Hemet, on recommendations by the RCFCD. The Seven Hills region between Lyon and Sanderson Avenues is an illustration of this effort. Increased pressure for development in this area resulted in an in-depth hydraulic study of Salt Creek by the RCFCD (Riverside County Flood Control and Water Conservation District, Hydraulic Analysis, Seven Hills Area of Salt Creek Floodplain). Results of their study were used to mandate flood protection measures associated with developments, and a beneficial consequence of these controls is that, under present conditions, the 1-percent annual chance flow in Salt Creek can be confined through this reach.

The RCFCD is in the process of developing plans for a 400-foot-wide earthen channel for Salt Creek through the study area to accommodate the 1-percent annual chance flow. Although the new channel design and alignment have been proposed, construction plans have not been prepared; therefore, they were not considered in the determination of water-surface elevations and flood boundary limits in this study. However, at the request of the flood control district, the proposed alignment was used for the determination of the floodway (see Section 4.2).

Flood protection measures for Hemet include a 1-percent annual chance capacity primary drainage system. This system includes Hemet Storm Channel and the downstream reaches of Acacia Street Drain, Whittier Channel, and Stetson Avenue Channel. All of these channels collect runoff generated in the Hemet watershed between Florida and Stetson Avenues, with Hemet Storm Channel acting as the main conveyance structure that transmits flow collected in the other channels to Salt Creek. The Park Hill Detention Basin reduces peak discharges on Park Hill Drain downstream of Devonshire Avenue.

Other than the emergency ordinance developed for participation of communities in the NFIP, the City of Indian Wells has not adopted an ordinance that delineates areas of flood hazards or regulates development on floodplains, nor does the Coachella Valley County Water District review proposed developments within the city for potential flood hazards and flood protection measures.

The Whitewater River Channel in the vicinity of Indian Wells is a manmade channel that generally follows the traditional path of the Whitewater River. Its gradient as it passes adjacent to Indian Wells averages 20 feet per mile, and its average cross section in the city has a 250-foot bottom width, is 30 feet deep, and has 3:1 sideslopes. It is an unlined channel that was excavated from natural material.

Areas of the Deep Canyon debris cone upstream of the City of Indian Wells which are subject to sheet flooding have not been improved and the flows are not channelized in this area. Flows coming from the west and southwest through Haystack Channel and Palm Desert Channel, respectively, and from the south through the Deep Canyon debris cone are directed into the Deep Canyon Storm Water Channel by a sand levee extending in an easterly direction. Additionally, flows from the hills in the south-central portion of the city are controlled by a check dam and retention basin. This basin is created naturally by the topography, and the dam is created by a natural rock outcropping extending between two knobs to form the check dam and its spillway.

The Deep Canyon Storm Water Channel through the developed portion of the city is a below-grade, grass-lined channel. It has a bottom width of 60 to 80 feet, is 18 feet deep, and has 4:1 sideslopes. This channel section has been raised an average of 2 feet since tropical storm Kathleen occurred. These improvements provide adequate control of the 1-percent annual chance frequency flood through this segment of the channel.

The City of Indio has adopted a zoning ordinance that regulates development on floodplains, and the CVWD reviews proposed developments within the city for potential flood hazards and flood protection measures.

The Whitewater River from Happy Point to the Salton Sea, including that portion passing through Indio, is a manmade channel generally following the traditional path of the Whitewater River and is known as the Coachella Valley Stormwater Channel. From Indio to the Salton Sea, its gradient averages 13 feet per mile. This is an unlined channel whose average cross section has a bottom width of 250 feet and is 30 feet deep with its 4:1 sideslope levees extending 10 feet above the surrounding ground. The CVWD performs maintenance on this channel and makes improvements, such as straightening and grading of the hydraulic section of the channel, strengthening of levees, and repair of dip crossings. The levees provide adequate protection from a 1-percent annual chance flood.

A levee system designed to protect the All American Canal from damage due to sheet flooding from the hills to the north also protects the northern portions of the City of Coachella from this same source of flooding. This levee system retains floodflows and then discharges them through a series of concrete waterway channels that extend from the levees under the All American Canal and thence downstream to the Whitewater River.

The Whitewater River from Happy Point to the Salton Sea, including that portion passing through the City of La Quinta, is a manmade channel generally following the traditional path of the Whitewater River and is known as the Coachella Valley Stormwater Channel. This is an unlined channel whose average cross section has a bottom width of 250 feet and is 30 feet deep with its 4:1 sideslope levees extending 10 feet above the surrounding ground. The Coachella Valley County Water District performs maintenance on this channel and makes improvements such as straightening and grading of the hydraulic section of the channel, strengthening of levees and repair of dip crossings. The levees provide adequate protection from a 1-percent annual chance flood.

The Upper Bear Creek System consists of the Upper Bear Creek Training Dike, the Upper Bear Creek Detention Basin, Bear Creek and Bear Creek Channel, and four side-drainage inlets. The Upper Bear Creek Training Dike diverts the 1-percent annual chance stormwater runoff from 1.7 square miles of drainage area south of it, to Bear Creek, and then to the Upper Bear Creek Detention Basin. Riprap slope protection is provided to prevent erosion of the dike embankment. The Upper Bear Creek Detention Basin has a storage capacity of 752 acre-feet for temporary detention of storm runoff and debris. The basin is approximately 700 feet wide and 1,350 feet long, with its bottom set at about elevation 320 feet NGVD. Basin side slopes vary from 2.5:1 in soil to 1.5:1 along the existing rock surface. Flows from Bear Creek will enter the basin via a 5:1 sloped inlet protected by one-quarter to one-ton riprap. Attenuated by temporary basin storage, outflows from the basin will enter the Bear Creek Channel via a rectangular concrete spillway in the basin embankment. After a storm event, stormwater detained in the basin will continue to drain to the Bear Creek Channel until the basin is empty. The 2.5 mile long Bear Creek Channel is a soil cement lined, trapezoidal channel with a 40-foot constant bottom width and 2:1 side slopes except for the last 400 feet, which has a 70-foot constant bottom width and 1.5:1 side slopes. The upper 2.0 mile channel reach has a steep gradient of about 0.028, starting from the spillway of the Upper Bear Creek detention basin. The lower 0.5 mile reach is on a mild gradient of 0.0015, and contains a drop structure upstream of the outlet into the Oleander Reservoir. Channel bank heights were selected to contain the 1-percent annual chance flood within the channel. The four side drain inlets along the west bank of the 2.5 mile channel control the introduction of the runoff from the surrounding drainage areas into the channel and store debris carried by a major storm event. The Oleander Reservoir will collect storm runoff from the Bear Creek system and the drainage areas north and west of the reservoir and discharge it to the Coachella Valley Storm Channel via the La Quinta Evacuation Channel. During a 1-percent annual chance storm, the water level in the reservoir will rise to about elevation 44 feet NGVD.

The La Quinta Evacuation Channel is about 3.5 miles long and consists of two distinct reaches. The lower 2.4 mile reach is a trapezoidal earthen channel, 50 feet wide with 3.5:1 side slopes. The upper 1.1 mile reach is an irregularly shaped grass-lined channel.

The East La Quinta Channel intercepts runoff from the drainage area in the foothills east of Avenida Bermudas and conveys it, with the low level outlet releases from the Calle Tecate Detention Basin, to the Avenida Bermudas Detention Basin. The East

La Quinta Channel is trapezoidal with 2.5:1 side slopes and full riprap lining which follows the existing natural drainage channel at the toe of the foothills, from the outlet of the spillway at the Calle Tecate Detention Basin to the Avenida Bermudas Detention Basin. The Avenida Bermudas Detention Basin is designed to handle runoff and retain debris from the drainage area in the foothills to the south and from the presently developed area to the southwest of the basin. Runoff to the basin will be conveyed by the East La Quinta Channel to a riprap-protected inlet at the upper end of the basin. The basin outlets into a riprap lined channel at the north end.

The East La Quinta System consists of collection and detention facilities for the drainage areas east and south of the presently developed areas of La Quinta and the presently developed area south of Calle Sonora. During a 1-percent annual chance flood, the runoff from this system will discharge directly into the La Quinta Evacuation Channel via a 60-inch reinforced concrete buried conduit. The conduit inlet is located within the Heritage Club development; the outlet is located in the south bank of the La Quinta Evacuation Channel. The channel runoff will discharge into a large detention basin in the Heritage Club area.

Other than the emergency ordinance developed for participation of communities in the NFIP, the City of Lake Elsinore has not adopted a zoning ordinance that delineates areas of flood hazard or that precludes development in these areas. The city currently utilizes a policy of allowing only recreational facilities to be constructed below an elevation of 1,265 feet. Lake Elsinore has no system of flood protection that would retard rising floodwaters.

Leach Canyon Channel, Channel H, Ortega Channel, and Lime Street Channel are all fully improved, 1-percent annual chance design channels. These improvements extend from the outfall of each channel into Lake Elsinore, when the lake elevation is 1,265 feet, upstream toward the corporate limits.

Flood protection measures resulting from channel improvements are listed below by flooding source.

Channel H, from 840 feet downstream of Riverside Drive to 790 feet downstream of Riverside Drive, is a riprap trapezoidal channel that is capable of containing up to a 1-percent annual chance flow. A concrete trapezoidal channel with a 1-percent annual chance flood capacity is located from 790 feet downstream of Riverside Drive to the corporate limits at Grand Avenue.

Floodwaters collected in the Elsinore Mountains are conveyed across the corporate limits by the 1-percent annual chance design capacity of Channel H. At the upstream face of Grand Avenue, a 2.8-foot headwall provides sufficient headwater to generate 1-percent annual chance flood capacity in the 6-foot by 4-foot concrete box culverts that runs beneath Grand Avenue. After passing through this box culvert, the flow continues toward Lake Elsinore and is contained by the concrete trapezoidal channel.

From 1,300 feet downstream of Riverside Drive to 1,350 feet upstream of Riverside Drive, Leach Canyon Channel is a 1-percent annual chance design capacity channel.

The Lime Street Channel, from 1,190 feet to 1,110 feet downstream of Grande Avenue, is a riprap trapezoidal channel capable of containing a 1-percent annual chance flow. From 1,110 feet to 40 feet downstream of Grande Avenue, there is a concrete trapezoidal channel that is capable of channeling a 1-percent annual chance flood. From 40 feet downstream of Grand Avenue to 40 feet upstream of Grand Avenue, there is an 8-foot wide, 3.66-foot high concrete box culvert.

Flows are properly controlled at the canyon mouth and directed into the flood structure so that the 1-percent annual chance discharge is contained in the channel.

The Ortega Channel, from 1,140 feet to 1,040 feet downstream of Grand Avenue, is a riprap trapezoidal channel that is capable of channeling a 1-percent annual chance flood. From 1,040 feet to 40 feet downstream of Grand Avenue, there is a concrete trapezoidal channel capable of containing a 1-percent annual chance flow.

For stream reaches where the debris potential was determined to be high, the bridge geometry was adjusted by the same criteria listed above and, in addition, peak discharges were bulked by a factor of 1.1 to 1.5 based on an individual analysis of the flooding source.

Debris potentials were considered to be medium for Arroyo Del Toro, Elsinore Spillway Channel, San Jacinto River, Stovepipe Canyon Creek, Temescal Wash, and Wasson Canyon Creek. Debris potentials were determined to be high for Channel H, Leach Canyon, Lime Street Channel, Ortega Channel, and Rice Canyon.

Most of the watercourses in Moreno Valley have undergone channel improvements to control flooding. Portions of Sunnymead Storm Channel are concrete-lined with capacity greater than the 1-percent annual chance flood, while other portions can carry the 10-percent annual chance flood but not the 1-percent annual chance flood. Edgemont Storm Channel B North Fork and Pigeon Pass Channel have sections that are concrete-lined channels designed to contain the 10-percent annual chance flood but not the 1-percent annual chance flood. Edgemont Storm Channel B East Fork, Kitching Drain, and Perris Valley Drain have improved channels designed to contain the 10-percent annual chance flood but not the 1-percent annual chance flood. Edgemont Storm Channel A is a natural watercourse with minor stability improvements.

Prior to the incorporation of the City of Murrieta, flood-control facilities were approved and maintained by the RCFCWCD. Since incorporation, all channels and/or pipe facilities that are Master Planned in Murrieta by the RCFCWCD are larger than 36 inches in diameter and are under jurisdiction of the RCFCWCD, including plan review, plan approval, inspection, and maintenance. All catch basins and connector pipe will be maintained by the City. All channels and pipe facilities that are not on a Master Plan will be the responsibility of the City.

The Murrieta Creek Area Drainage Plan was adopted by the RCFCWCD in 1986 with appropriate area drainage fees to implement the Plan. There is currently $80,000 budgeted to expand the Master Plan in zone 7, which includes areas of

Wildomar, Murrieta, and Temecula. The Master-Planned area in Murrieta includes Murrieta Creek, Warm Springs Creek, and local lines A-P. Lines A-P are located westerly of Interstate 15. Master Planning is needed for drainage areas east of Interstate 15. The Drainage Plan outlines flood- and drainage-control problems in the Murrieta Creek Area and concludes that certain flood and drainage facilities are critically needed for an orderly and economical development of the area. This Plan is subject to change and calls for the channelization of Murrieta Creek and its major tributaries and includes several concrete-lined open channels and a small network of underground storm drains. The facilities proposed by the Plan range in size from a 450-foot-wide, 14-foot-deep Murrieta Creek channel designed to control more than 38,000 cfs, to 36-inch reinforced concrete piping. The majority of the regional facilities, as proposed in the Murrieta Creek Area Drainage Plan, remain unobstructed during the preparation of the General Plan due to lack of funds, regulatory approvals, and permits.

General Plan Goals, Objectives, and Policies

Flood protection general plan goals, objectives, and policies are as follows:

Goal S-2 Flood and Inundation

Minimize injury, loss of life, property damage, and economic and social disruption caused by man-made and natural flood and inundation hazards.

Objective S-2.1

Improve flood-control systems and provide adequate protection in areas of the City subject to inundation, while protecting the habitat, recreational, and aesthetic values of natural drainage ways where feasible.

Policies

S-2.1a Cooperate with the Riverside County Flood Control and Water Conservation District in evaluating the effectiveness of existing flood-control systems in the City and adjacent jurisdictions and improve and expand these systems as necessary to ensure that there is adequate capacity to protect existing and proposed development from stormwater runoff and flooding.

S-2.1b Identify natural drainage courses and designate drainage easements to allow for construction of drainage facilities (if needed to protect the health, safety, and welfare of the community) and/or the preservation of natural drainage courses.

S-2.1c Actively participate in and strongly promote timely completion of regional drainage plans and improvement projects which affect the City.

S-2.1d Develop and maintain floodplain inundation evacuation plans in cooperation with the Riverside County Flood Control and Water Conservation District and the Murrieta Fire Protection District.

S-2.1e All new development, including filling, grading, and construction, proposed within designated floodplains, shall require the submission of a study prepared by a qualified hydrologist or engineer that determines whether the development would significantly increase flood hazard. The study shall provide specific mitigation measures that indicate how flood hazards would be eliminated or reduced to a less-than-significant level.

S-2.1f All new construction within the 1-percent annual chance floodplain shall be flood-proofed, with building pads above 1-percent annual chance flood levels designed to allow unrestricted flow of floodwaters.

S-2.1g If any fill is placed in floodplain areas, adequate channel capacities or floodplain storage area must be provided for flood waters to off-set displacement of floodplain storage.

S-2.1h Surface-water runoff from new development shall be controlled by on-site measures, including, but not limited to, the following:

- Structural controls;
- Restricting changes in topography; and
- Limiting areas of impervious surfaces.

In the City of Norco, the only future floodplain management measures being considered are those related to the results presented in this report.

A fully improved 1-percent annual chance design channel is currently under design, with a construction schedule designating completion by December 1977 for the segment of North Norco Channel from Parkridge Avenue upstream to just above Hamner Avenue. This improvement eliminates the special flood hazards adjacent to the channel in this area. In this study, it was considered as already existing, based on preliminary design criteria provided by the Riverside County Flood Control District.

North Norco Channel, Tributary A is a fully improved, 1-percent annual chance design watercourse; but, due to the current lack of inlet capacity, shallow flooding occurs, resulting in depths of less than 1.0 foot and a moderate flood hazard to areas adjacent to the watercourse.

Flood protection measures resulting from channel improvements are listed below by flooding source.

Flooding Source	Improvement
North Norco Channel	
From Country Club Lane to River Street	Graded trapezoidal channel
From River Street to Parkridge Avenue	Natural ditch
From Parkridge Avenue to Hamner Avenue	1-percent annual chance design channel
From Hamner Avenue to Sixth Street	Graded trapezoidal channel
North Norco Channel, Tributary A	
From Valley View Avenue to 700 feet upstream	Fully improved, 1-percent annual chance design, trapezoidal channel
From 700 feet upstream of Valley View Avenue to 600 feet upstream of Corona Avenue	Reinforced concrete box culvert
From 600 feet upstream of Corona Avenue to 900 feet upstream of Temescal Avenue	Fully improved 1-percent annual chance design trapezoidal channel
From 900 feet upstream of Temescal Avenue to intersection of Hillside Avenue and Vaughn Street	66-inch diameter reinforced concrete pipe
South Norco Channel	
Entire length upstream of Hamner Avenue	Graded trapezoidal channel
South Norco Channel, Tributary B	
From confluence with South Norco Channel to between Corona and Temescal Avenues	Graded trapezoidal channel

The Riverside County Flood Control and Water Conservation District reviews all proposed developments within the city for potential flood hazards and flood control requirements. Two such developments were in the process of being recorded and were scheduled for completion by June 1978. Therefore, they were considered as existing in this FIS. One development is adjacent to North Norco Channel, just west of Sierra Avenue and just south of Smokewood Drive. The other was adjacent to South Norco Channel, Tributary A, just south of First Street and just east of Corona Avenue. In both instances, the Riverside County Flood Control and Water Conservation District required the developer to excavate the channel and raise the building pads to provide control of and protection from the 1-percent annual chance flood.

The City of Palm Desert has adopted a Drainageway, Floodway, and Watercourse Ordinance, which regulates development on floodplains by preventing construction in areas designated as flood prone. Development in these areas is only allowed after elimination of any flood hazard to that development. The Coachella Valley Water District does not review proposed developments for potential flood hazards and flood protection measures, so no other subdivision standards for flood protection exist in Palm Desert.

The Whitewater River Storm Channel in the vicinity of Palm Desert is a nonnatural channel generally following the traditional path of the Whitewater River. Its gradient as it passes through Palm Desert averages 13 feet per mile; its average cross section in the reach has a 250-foot bottom width; it is 30 feet deep; and it has 3:1 sideslopes. It is an unlined channel excavated from natural material, and provides protection from a 0.2-percent annual chance flood.

The Palm Valley Stormwater Channel and the associated Cat Canyon and Dead Indian debris basins provide 1-percent annual chance protection from floods on Cat, Dead Indian, and Carrizo Canyons.

Floodflows from the eastern half of Dead Indian Canyon are conveyed by the Dead Indian Channel to Ironwood Channel and the Living Desert debris basin. Dead Indian Channel extends from above the corporate limits downstream, connecting to a topographic knob approximately 700 feet downstream of the corporate limits. It collects flows that have been directed against the foothills on the eastern edge of the alluvial fan and conveys them around a bend and easterly to the Ironwood Channel. The levee is approximately 5 feet high, has a top width of 40 feet, and has 4:1 sideslopes on the channel side and 1.5:1 sideslopes on the outside. The dike has a 10-foot riprap keyway on the inside of a 700-foot curve that keys into a rock point as it makes its turn easterly toward Ironwood Channel and the Living Desert debris basin.

The State Highway 74 Diversion Dike on Palm Desert Channel experienced two major failures during tropical storm Kathleen. It extends from State Highway 74 to the confluence with Dead Indian Channel, a distance of approximately 1,800 feet. The levee extends parallel to, and approximately 500 feet upstream from, Portola Avenue, and is located perpendicular to the direction of flow on the Dead Indian Canyon alluvial fan, a major contributing factor to its failure during Kathleen. This levee will fail during a 1-percent annual chance event. However, flood depths would be less than 1.0 foot downslope of the dike.

Ironwood Channel conveys flows from Dead Indian Channel, Palm Desert Channel, and portions of Deep Canyon to the Living Desert debris basin. Flow from the debris basin is conveyed by an outlet channel to Deep Canyon Channel, which then conveys the flow to the Whitewater River.

Portola and Haystack Dikes, located north of the Living Desert debris basin, in Palm Desert and Indian Wells, provide flood protection by diverting flow away from populated areas toward Deep Canyon Channel.

The Riverside County Flood Control District has constructed a number of flood protection and control facilities in the City of Perris. These are the Line "J" Channel, Metz Road Basin, Third Street Basin, Metz Road Storm Drain, and Perris Valley Storm Drain.

Line "J" Channel, from Perris Valley Storm Drain to Perris Boulevard, is a 5-foot deep concrete trapezoidal channel with a 10-foot bottom width and 2:1 sideslope that is capable of channeling a 1-percent annual chance flood and allows only shallow flooding during the 0.2-percent annual chance frequency storm.

The Metz Road and Third Street Basins have a 0.2-percent annual chance flood storage capacity. The outlets of these basins are designed to create no flooding problems as they discharge downstream toward the San Jacinto River.

The Metz Road Drain, from the Perris Valley Storm Drain up to Wilson Avenue, is a 4-foot deep concrete trapezoidal channel with a 4-foot bottom width and a 1:1/2:1 sideslope. From Wilson Avenue to Perris Boulevard, the course of passage is a 3-foot deep concrete trapezoidal channel, with a 3-foot bottom width and sideslopes of 1:1 and 2:1.

The Perris Valley Storm Drain, from the confluence with San Jacinto River to 1,300 feet upstream of Rider Street, is a 5-foot deep graded trapezoidal channel. The channel has a 50-foot bottom width with a 4:1 sideslope. From 1,300 feet upstream of Rider Street to Martin Street, there is a 6-foot deep graded trapezoidal channel.

The San Jacinto Lateral, between U.S. Highway 395 and D Street, is a 24-inch diameter reinforced-concrete pipe. From D Street to Third Street Basin, there is an 18-inch diameter reinforced-concrete pipe.

Presently, the only control of occupancy on the floodplain is a Riverside County subdivision ordinance that requires protection from a 1-percent annual chance frequency storm.

The Whitewater River Channel in the vicinity of Rancho Mirage is a manmade channel generally following the traditional path of the Whitewater River. Its gradient, as it passes through Rancho Mirage, averages 23 feet per mile, and its average cross section in the reach has a 220-foot bottomwidth, is 25 feet deep, and has 4:1 sideslopes. It is an unlined channel excavated from natural material, with the exception of a 2,100-foot length of riprap bank protection on the northeast bank extending from a point 1,500 feet downstream of Frank Sinatra Drive southeasterly and 2,900-foot length of riprap on the southwest bank, downstream from Frank Sinatra Drive.

The Magnesia Springs Canyon Flood Control Project consists of the East Magnesia Stormwater Project, designed by Bechtel Corporation and the Coachella Valley Water District, and the Magnesia Springs Channel and Debris Basin, designed and built by the USACE. The 1-percent annual chance flood is contained within the channels, levees, and streets of this project.

Following is an enumeration of the locations of levees which were subsequently considered in hydraulic analyses.

East Rancho Mirage Storm Channel has built up levees which extend along the entire length of the channel from its upstream study limit downstream to State Highway 111.

Unconsolidated levees have been graded up on both sides of the Palm Valley Drain from the Rancho Mirage corporate limits downstream for a distance of approximately 700 feet on the west bank and 1,200 feet on the east bank.

Along Thunderbird Wash, a levee extends from a point approximately 200 feet upstream from the intersection of Mesa Drive and Thunderbird Road downstream to State Highway 111 along the northerly bank of the channel.

Most of the streams in the City of Riverside have controlling reservoirs which are designed to contain the 1-percent annual chance flood, as discussed in Section 2.3. In addition, the city has developed a full storm drain system and has implemented extensive floodplain improvements downstream of the reservoirs. Most of the improvement measures provide protection against the 1-percent annual chance flood.

In the City of San Jacinto, two flood control structures were built within the Bautista Wash Basin. The San Jacinto Drain between Seventh and State Streets and the Meridian Street Channel from the San Jacinto River to Burkley in Riverside County. Minimal information is available concerning the existing condition of San Jacinto Drain. Meridian Street Channel is constructed to divert runoff from Bautista Wash to the San Jacinto River. Plans have been formulated for the building of the Buena Vista Retention Basin on Bautista Wash just upstream at the Atchison, Topeka and Santa Fe Railroad crossing. Minimum information is available concerning the effects of Buena Vista Retention Basin.

The San Jacinto River and Bautista Creek are channels with revetted levees designed to contain the 1-percent annual chance flood.

In the City of Temecula, no effective flood-control structures are located along Pechanga Creek or within the shallow flooding area on the north side of Wolf Valley. Unarmored sand levees have been placed adjacent to Pechanga Creek, but high-velocity floodwater will make these levees ineffective in mitigating flood hazards. Where the North Side Wolf Valley enters Temecula Creek, local interests have attempted to channelize the runoff by placing levees adjacent to an existing ditch. Due to the threat of damage to the levees from the floodwater of Temecula Creek, they were not considered in the hydraulic computations.

For information on flood protection measures related to the Colorado River, the reader should refer to pages 195 and 196.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this FIS. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the county at the time of completion of this FIS. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for the flooding sources studied in detail affecting the county.

Precountywide Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each riverine flooding source studied by detailed methods affecting the community.

For each community within Riverside County that had a previously printed FIS report, the hydrologic analyses described in those reports have been compiled and are summarized below.

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the county.

A flood-frequency analysis was made for the streams studied as part of the initial Riverside County study by fitting a log-Pearson Type III distribution to the peak-discharge data for the stream gaging stations in the region. Coefficients of skew were computed for all stations. The resulting skew values varied widely between stations, due to their shortness of record and other factors. A value of zero was then substituted for the actual skews, as recommended in Statistical Methods in Hydrology (USACE, 1962). The results of this analysis provided peak-discharge values at the gage sites for the 10-, 2-, 1-, and 0.2-percent annual chance recurrence intervals. Peak discharges for other points along the gaged streams were computed from those of the gage sites by use of the equation:

$$Q_s = Q_g (A_s/A_g)^a$$

where Q_s = Flood at site
Q_g = Flood at gage
A_s = Drainage area at site
A_g = Drainage area at gage
a = An exponent

The exponent a was computed for streams with multiple gagings by solving the equation for a, using the known gage values for Q_s, A_g, Q_g, and A_g. A determination of the exponent a for streams with single gaging stations was made by plotting peak-discharge values for gages in similar hydrologic regions against drainage area on log-log paper and determining a as the slope of the best fit line through the points.

Stream gaging stations that were used in the initial hydrologic analysis are listed below with their gage numbers, drainage area, and length of record. With the exception of gage No. S-2707A in Reche Canyon, which is operated by the San Bernardino Flood Control and Water Conservation District, all of the gages listed are operated by the USGS. Of the gages listed, only Temescal Wash, Bautista Creek, and Reche Canyon gages were directly applicable to their respective streams.

Gage and Location	Gage No.	Drainage Area (Square Miles)	Period of Record (Years)
Cucamonga Creek at Upland	11- 734.7	101.1	43
Day Creek at Etiwanda	11- 670	4.6	45
San Antonio Creek Near Claremont	11- 730	16.5	55
San Timoteo Creek Near Redlands	11– 570	119.0	41
Mill Creek Near Yucaipa	11- 540	38.1	50
Santa Ana River at Riverside Narrows	11- 665	850.0	45
Santa Ana River at Mentone	11- 515	209.0	55
City Creek Near Highland	11- 558	19.6	53
Plunge Creek Near East Highlands	11- 555	16.9	53
East Twin Creek Near Arrowhead Springs	11- 585	8.8	53
Waterman Canyon Creek Near Arrowhead Springs	11- 586	4.7	4.9
Lytle Creek Near Fontana	11- 620	46.3	39
Cajon Creek Near Keen Brook	11- 630	40.6	52
Lone Pine Creek Near Keen Brook	11- 635	15.1	42
Devil Canyon Creek Near San Bernardino	11- 636.8	5.6	50
Bautista Creek Near Hemet	11- 700	39.4	22
Temescal Creek Near Corona	11- 720	164.0	43
San Jacinto River Near San Jacinto	11- 695	141.0	44
Palm Canyon Tributary Near Anna	10- 2581	0.5	9
South Fork San Jacinto Tributary Near Valle Vista	11- 693	2.2	9

Gage and Location	Gage No.	Drainage Area (Square Miles)	Period of Record (Years)
Whitewater River at Whitewater	10- 2560	57.4	23
Palm Canyon Near Palm Springs	10- 2585	93.3	38
Tahquitz Creek Near Palm Springs	10- 2580	16.8	25
Andreas Creek Near Palm Springs	10- 2590	8.6	23
Reche Canyon at Barton Road	S- 2702A	11.2	15

Peak discharges for streams with either poor or no stream gage records were determined by using discharge values of nearby gaged streams with similar hydrologic characteristics. Differences in drainage areas between the ungaged study stream and the nearby gaged reference stream were adjusted by use of the previously mentioned equation.

Peak discharges for two flooding sources in the vicinity of Perris, the San Jacinto River and the Perris Valley Storm Drain, were taken from a Floodplain Information report prepared by the USACE (USACE, 1970).

The 1-percent peak discharges for Desert Hot Springs Channel and Blind Canyon Channel were obtained from unpublished hydrology studies prepared by the RCFCWCD. Peak discharges for the 10-, 2-, and 0.2-percent annual chance floods in the vicinity of the City of Desert Hot Springs were computed by applying ratios to the 1-percent annual chance peak discharges. Ratios used were determined from an analysis of frequency curves taken from gaged streams near Desert Hot Springs.

The locations and lengths of record for the stream gages used are shown below.

Gage and Location	Gage No.	Drainage Area (Square Miles)	Period of Record (Years)
At Chemehuevi Wash Tributary, Near Needles	9- 4240.5	2.04	14
At Arch Creek, Near Earp	9- 4285.3	1.52	15
At Colorado River Tributary, Near Vidal	9- 4285.3	1.12	14
At Monument Wash, Near Desert Center	10- 2537.5	4.29	14
At Betz Wash, Near Salton Beach	10- 2540.2	5.95	14
At Glamis Wash, Near Glamis	10- 2544.75	0.60	14
At Cottonwood Wash, Near Cottonwood Spring	10- 2596	0.71	14

On Lakeview Wash, North Side Wolf Valley, Park Hill Drain, Interstate Highway 10 Wash, and a portion of Bautista Wash, which were studied as part of the updated study, shallow flooding analyses were applied, and only a 1-percent annual chance peak discharge was developed.

On all other detailed study areas, 10-, 2-, 1-, and 0.2-percent annual chance flood events were analyzed.

The peak discharges used for Lakeview Wash and for the numerous other streams studied in the Coachella Valley, in the vicinity of both Thousand Palms and Desert Hot Springs, were based on synthetic unit hydrograph analyses (Riverside County Flood Control and Water Conservation District, 1978). This method allows for the determination of a runoff hydrograph based on topographic, rainfall, and infiltration data specific to the study watershed. In the Coachella Valley watersheds, peak discharges for the 10-, 2-, and 1-percent annual chance flood events were generated by applying the unit hydrograph method; the 0.2-percent annual chance peak discharges were extrapolated from the 2- and 1-percent annual chance values. For the shallow flooding study on Lakeview Wash, the 1-percent annual chance peak discharge was computed using the unit hydrograph technique. Drainage area computations at the Coachella Valley detailed-study area assumed no runoff contribution from East and West Wide Canyons which are controlled by West Wide Canyon Dam.

In the unit hydrograph computations, the time-runoff relationships used were based on S-graphs shown for four types of watersheds. Rainstorms of varying durations (1, 3, 6, and 24 hours) were considered in the analysis in order to determine the critical storm duration for the peak-discharge prediction. A 1-hour storm duration was found to control peak discharges on the small fans in the Coachella Valley (drainage areas less than 8 square miles), while the critical storms for Lakeview Wash and for all other areas in the Coachella Valley study were either 3 or 6 hours in length. The precipitation-intensity patterns for the 1-, 3-, and 6-hour storms were based on the thunderstorm of September 24, 1939, at Indio. Infiltration rates used in the Coachella Valley hydrograph analyses were taken directly from an earlier flood hazard study of the area (Coachella Valley County Water District, 1964).

In the Bautista Wash watershed, hydrologic analyses were performed on both Park Hill Drain and Bautista Wash. The peak discharges for Bautista Wash at San Jacinto Avenue were taken directly from the analysis done by the USACE in connection with the FIS for the City of San Jacinto (USACE, 1973). The USACE assumed that the drainage area upstream of Charlton Avenue did not contribute to flooding downstream due to a blockage of the channel by dirt and trash, making the Charlton Avenue embankment an effective dam. In addition, it was assumed that all runoff upstream of the Fairview Channel was diverted into Bautista Wash were based upon a frequency analysis of the USGS gaging station on nearby Bautista Creek (Station No. 11070000) and the development of a synthetic unit hydrograph for the standard project flood on Bautista Wash.

The peak discharges calculated for Bautista Wash at Lyon Avenue and at the mouth of Park Hill were based on the peak-discharge data determined by the USACE for Bautista Wash at San Jacinto Avenue. The predictions by the USACE were transposed to these other sites in the watershed based on the following relationship (Waananen, A.O., 1977):

$$Q_2 = Q_1 (A_2/A_1)^b$$

where Q_1 is the peak discharge for Area 1 (A_1),
Q_2 is the peak discharge for Area 2 (A_2),
and b is a constant (for southern California b ranges from 0.79 for the 10-percent annual chance flood to 0.84 for the 0.2-percent annual chance flood).

The attenuation effects of the Park Hill Detention Basin on the runoff from its 2.8-square-mile drainage area were estimated and incorporated into the peak-discharge computations for areas downstream of the impoundment.

The initial step in determining peak discharges for the Pechanga Creek area involved the application of the synthetic unit hydrograph technique (Riverside County Flood Control and Water Conservation District, 1978) to the Pechanga Creek and North Side Wolf Valley (shallow flooding) watersheds. During the hydrograph derivation, the U.S. Forest Service was contacted for information on the hydrologic character of Cleveland National Forest, which lies within the study watershed. After determining separate peak-discharge predictions for Pechanga Creek and for the adjacent shallow flooding area, hydraulic computations were carried out to investigate the potential transfer of water between the two study areas due to an overflow of Pechanga Creek just upstream of the Pala Road crossing. The estimated amounts of transferred water (10-percent annual chance flood—50 cfs, 2-percent annual chance flood—130 cfs, 1-percent annual chance flood—180 cfs, 0.2-percent annual chance flood—320 cfs) were subtracted from the discharge predictions for Pechanga Creek and added to the peak discharge for the North Side Wolf Valley.

The adjustment of the calculated peak discharges for the bulking effects of sediment was considered and rejected after consultations with the USACE, Los Angeles District. Investigations by the USACE in the Palm Springs/Palm Desert area of the Coachella Valley found the debris production potential to be low. Based on this finding, the USACE believed that the use of bulking factors in the hydrologic analyses would not increase the accuracy or reliability of the determinations.

The drainage basins for Long Creek, Streams A, B, and C, Little Morongo Wash, Big Morongo Wash and Mission Creek were modeled using the rainfall-runoff model outlined in the RCFCWCD Hydrology Manual (Riverside County Flood Control and Water Conservation District, 1978). There are stream gages located on Mission Creek and Long Creek. The annual peak flows at each gage were plotted on log-normal probability paper and compared to the discharge-frequency relationships defined by the rainfall-runoff model. These relationships were also compared to the discharge-frequency relationships defined by the regional equations for the South Lahonton-Colorado Desert region published by the USGS (Waananen, A.O., 1977). It was noted that the more frequent flood events appeared to be overestimated by the rainfall-runoff model.

New discharge-frequency curves for Mission Creek and Long Creek were defined using the 1-percent annual chance discharge value from the rainfall-runoff model and the gage records. The gage records were used to estimate the higher frequency (2- and 5-year) discharge values. These values were used as input for the FEMA FAN model (Harty, D.S., 1982). The locations and lengths of record for the stream gages used are shown below.

Gage and Location	Gage No.	Drainage Area (Square Miles)	Period of Record (Years)
Mission Creek, near Desert Hot Springs	10257600	35.7	20
Long Creek, near Desert Hot Springs	18100200	19.4	16

There are no gage records on Big Morongo or Little Morongo Canyons. The regional equations were used to estimate the higher frequency discharges for these flooding sources. For both Big Morongo and Little Morongo Canyons the discharge-frequency curves were estimated by fitting a curve through 50-, 20-, and 1-percent annual chance discharge values. The 50-percent annual chance value was estimated by plotting the discharge-frequency curve and the discharge-frequency curve defined by the regional equations. The regional equation was used directly to compute the 20-percent annual chance discharge; and the rainfall-runoff model computed value was used for the 1-percent annual chance discharge.

The discharge values calculated by the regional equations were used for Stream A. The discharge-frequency curve for this stream was defined by a least-squares fit of the regional discharge-frequency values to a log-Pearson Type III distribution.

Dry Morongo Canyon has also been studied for this revision. Dry Morongo Canyon has a drainage area of 8.9 square miles which lies between the Mission Creek and Big Morongo basins. The discharge-frequency curve for Dry Morongo Canyon was estimated by using the regional equations in the same manner as Stream A.

The peak flood elevations for Lake Elsinore were taken directly from a study by the USACE (USACE, 1983). The 10-, 2-, 1-, and 0.2-percent annual chance peak lake elevations are based on a frequency analysis of recorded lake levels between 1916 and 1980, supplemented by the computed standard-project-flood maximum water-surface elevation. In performing the frequency analysis, the USACE converted the recorded elevations into storage volumes, ranked and plotted the storage volumes using median plotting positions, and visually fitted a smooth frequency curve to the plotted points. The storage volume generated by the standard project flood was used as a guide in deriving the frequency-elevation relationship for Lake Elsinore. The peak elevations shown below are based on existing conditions at the lake outlet.

In the City of Banning, to define discharge-frequency data for streams under study other than the 1-percent annual chance discharges on East Gilman Home Channel and portions of Montgomery Creek and Gilman Avenue Channels, a regional relationship of basin characteristics to streamflow characteristics was used (USACE, 1973). The effects of urbanization on runoff were accounted for by using the results of a USGS study (U.S. Department of the Interior, 1974).

Peak discharges at the 1-percent annual chance recurrence interval for East Gilman Home Channel and portions of Montgomery Creek and Gilman Avenue Channels were obtained from studies prepared by the Riverside County Flood Control and Water Conservation District (Riverside County Flood Control and Water Conservation District, Correspondence). Peak discharges at the 1-percent annual chance recurrence interval for Pershing and Smith Creeks were obtained from a USACE Floodplain Information report (USACE, 1973).

Peak discharges for stream studied in detail are presented in Table 4. Discharges presented have been reviewed by the USACE, the City of Banning, and the Riverside County Flood Control District. All groups involved concurred with the discharges presented.

Debris potential was considered in analysis throughout the general area of Riverside County, and specifically in the City of Banning. The current policies of several agencies with expertise in hydraulic analysis were researched, including the USACE, Hydrologic Engineering Center; the USACE, Los Angeles District office; San Bernardino County Flood Control District; and Riverside County Flood Control District.

Based on the previously mentioned data and the study contractor's own experience, criteria were adopted for consideration of the debris potential in the streams studied. The debris potential for each stream is classified as either high, medium, or low, based on historic flood data, an analysis of the characteristics of the drainage area, and a field investigation of the flooding source by hydraulic engineers. On streams with low debris potential, no provision for debris was made in the hydraulic analysis. For stream reaches where the debris potential was determined to be medium, the bridge geometry was altered using the following criteria:

1. At all reinforced-concrete box culverts and bridge crossings where the cross-sectional end area was 100 square feet or less, the pier widths were doubled. Where the crossing consisted of two or more circular pipes, the cross-sectional end area was reduced by 20 percent.

2. At all bridge crossings with cross-sectional end areas between 100 and 250 square feet, 1 foot of width was added to each pier.

3. At all bridges with cross-sectional end areas greater than 250 square feet, 2 feet of width was added to each pier.

For stream reaches where the debris potential was determined to be high, the bridge geometry was adjusted by the same criteria listed above and, in addition, peak discharges were bulked by a factor from 1.1 to 1.5, based on an individual analysis of the flooding source.

Debris potential was determined to be high for all but three flooding sources in the City of Banning; these discharges were bulked by a factor of 1.25 accordingly. Discharges for San Gorgonio River and Smith Creek were not bulked to meet

Floodplain Information report data (USACE, 1973). Debris potential for Highland Springs Channel was considered to be low.

The discharges for the following streams were bulked by a factor of 1.25 for debris consideration: East Gilman Channel; Indian Canyon Channel; Montgomery Creek; Pershing Creek; Smith Creek; West Pershing Channel; Ramsey Street Drain; Sidney Street Drain; and the lower end of Gilman Home Channel, from the confluence with Smith Creek up to Westard Avenue.

For Gilman Home Channel, any discharge in excess of the channel capacity was treated as sheet flow. At the confluence with East Gilman Home Channel, the channel reverts to the old Works Progress Administration channel, whose capacity is exceeded. From this point downstream, the capacity of this channel was calculated and the excess discharge was analyzed by the use of existing topographic mapping (Riverside County Flood Control District, 1972) and field investigation combined with top width and depth calculations based on Manning's equation. Once the overland sheet flow gets onto Interstate Highway 10, it flows east to the low points, where it joins with a portion of the overland flow from Ramsey Street Drain.

In the City of Beaumont, to define discharge-frequency data for the streams under study, a regional relationship of basin characteristics to streamflow characteristics (U.S. Department of the Interior, 1970) was used. The effects of urbanization on runoff were accounted for by utilizing the results of a USGS study (U.S. Department of the Interior, 1974), which provided a digital simulation of the effects of urbanization on runoff in the Upper Santa Ana Valley.

Significant ponding occurs along Beaumont Channel due to the high freeway embankment intersecting the channel. The effects of ponding on the peak discharges were accounted for by using the USACE's HEC-1 computer program, utilizing the Modified Puls Reservoir Routing subroutine (USACE, 1973).

In the City of Cathedral flood discharges for the Whitewater River at the confluence with Palm Canyon Wash were taken from a report prepared by Philip Abrams Consulting Engineers for the Riverside County Flood Control District (Philip Abrams Consulting Engineers, 1975).

For Palm Canyon Wash, flood discharges were taken from a hydrologic report of the Whitewater River Basin compiled for the USACE, Los Angeles District (Ken O'Brien and Associates, 1978).

These discharges were computed by log-Pearson Type III analysis as outlined by the U.S. Water Resources Council (U.S. Water Resources Council, 1976) from data collected at the following stream gages:

Gage Number	Flooding Source	Number of Years of Record
10258000	Tahquitz Creek	28
10258500	Palm Canyon Wash	40
10259000	Andreas Canyon Wash	26

All three stream gages are operated by the USGS and are located upstream of the Palm Springs corporate limits. Andreas Canyon Wash is a tributary of Palm Canyon Wash.

Discharges for Tramview Wash and Tramview Wash Tributary were computed using a generalized relationship established from discharge-frequency data developed as discussed previously. Peak flows for the 10-, 2-, 1-, and 0.2-percent annual chance events were related to the watershed drainage area, and the curve of best fit was sketched through the data. To assist in defining the relationship at drainage areas of less than approximately 10 square miles, equations developed by the USGS and shown in Water Resources Investigation 77-21 (U.S. Department of the Interior, 1977) were used.

Peak discharge-drainage area relationships for East and West Cathedral Channels were taken from the FIS for the unincorporated areas of Riverside County, California (FEMA, 1980). Peak discharge-drainage area relationships for North Cathedral Channel were taken from the FIS for the City of Palm Springs (FEMA, 1982).

Desert watercourses have the unique characteristic of decreasing in discharge as runoff progresses downstream. This is due to the high rates of percolation associated with the typical alluvial material found in the desert environment. Analysis found that tributary runoff generally offset the percolation losses and, therefore, constant discharges were used between major confluences.
In the City of Corona, flood protection measures resulting from channel improvements are shown in the following tabulation:

Flooding Source	Improvement
Arlington Channel	
From confluence with Temescal Wash to corporate limits	1-percent annual chance capacity reinforced-concrete rectangular channel
Lincoln Avenue Drain	
From confluence with Oak Street Channel to 250 feet upstream of D Street	72-inch reinforced-concrete pipe
From 250 feet upstream of D Street to Eighth Street	51-inch reinforced-concrete pipe
From Eighth Street to 1,000 feet upstream of Citron Avenue	48-inch reinforced-concrete pipe

Flooding Source	Improvement
Main Street Channel	
From confluence with Temescal Wash to upstream limit	1-percent annual chance capacity reinforced-concrete channel and debris basin
Mangular Channel	
From confluence with Oak Street Channel to Ontario Avenue	1-percent annual chance design reinforced-concrete channel
From 4,000 feet upstream of Ontario Avenue to corporate limits	1- to 0.2-percent annual chance design channel and 1,000-year control debris basin
North Norco Channel	
From Country Club Drive to River Road	Graded trapezoidal channel
Oak Street Channel	
From Atchison, Topeka & Santa Fe Railway to 400 feet upstream of confluence with Mangular Channel	Concrete channel (approximately 100-percent annual chance capacity)
From 400 feet upstream of confluence with Mangular Channel to Ontario Avenue	Post and wire revetted channel (approximately 100-percent annual chance capacity)
From Ontario Avenue to 500 feet upstream	Concrete channel (approximately 100-percent annual chance capacity)
From 500 feet upstream of Ontario Avenue to Chase Drive	Post and wire revetted channel (approximately 100-percent annual chance capacity)
Taylor Avenue Drain	
From Cota Street to intersection of Harrison and Sheridan Avenues	Reinforced-concrete channel
From intersection of Harrison and Sheridan Avenues to Grand Boulevard	7.0-foot by 8.5-foot reinforced-concrete box
From Grand Boulevard to Chicago Street	Reinforced-concrete pipes ranging from 30 to 75 inches
Temescal Wash	
From Lincoln Avenue to Atchison, Topeka & Santa Fe Railway	1-percent annual chance capacity graded trapezoidal channel
West Norco Channel	
From 500 feet above confluence with North Norco Channel upstream to corporate limits	72-inch reinforced-concrete pipe

Discharge-frequency values for Temescal Wash were based on frequency curves developed for the USGS stream gage on Temescal Wash near Corona (USACE, 1977). The gage has been operating continuously since 1928. Additional historical records on peak flows date back to 1891. Values for the 10-, 2-, 1-, and 0.2-percent annual chance flood discharges were obtained from a log-Pearson Type III distribution (U.S. Water Resources Council, 1976). The peak discharges were modified to reflect the effects of sediment load on floodflows.

To define discharge-frequency data for the other streams under study, which were ungaged and for which no previously prepared hydrology was available, a regional relationship of basin to streamflow characteristics was used (U.S. Department of the Interior, 1970). The effects of urbanization on runoff were accounted for by utilizing the results of a USGS study (U.S. Department of the Interior, 1974) that provided a digital simulation of the effects of urbanization on runoff in the Upper Santa Ana Valley.

South Norco Channel and South Norco Channel Tributary A contain large ponding areas. The effects of ponding on the peak discharges were accounted for by using the Modified Puls Reservoir Routing subroutine of the USACE HEC-1 Flood Hydrograph computer program (USACE, January 1973). Significant reductions in peak discharges were computed for these streams.

A hydrology study (USACE, 1975) prepared by the USACE provided peak discharges for Mangular Channel, Oak Street Channel, and Lincoln Avenue Drain.

In the City of Desert Hot Springs, the 1-percent annual chance peak discharges for Desert Hot Springs Channel and Blind Canyon Channel were obtained from unpublished hydrology studies prepared by the RCFCWCD.

Peak discharges for the 10-, 2-, and 0.2-percent annual chance floods were computed by applying ratios to the 1-percent annual chance peak discharges. Ratios were determined from an analysis of frequency curves taken from gaged streams near the city.

The drainage basins for Long Canyon, Streams A, B, and C, Little Morongo Wash, Big Morongo Wash, and Mission Creek were modeled using the rainfall-runoff model outlined in the RCFCWCD Hydrology Manual (Riverside County Flood Control and Water Conservation District, 1978). The time-runoff relationships used were based on S graphs. Rainstorms of 1, 3, 6, and 24 hours were analyzed to determine the critical storm duration resulting in the peak discharge prediction from each basin.

The locations and lengths of record for the stream gages used are shown in the following tabulation:

USGS Gage Number	Name and Location	Drainage Area (Square Miles)	Period of Record (Years)
9-4240.5	At Chemehuevi Wash Tributary, near Needles, California	2.04	14
9-4285.3	At Arch Creek, near Earp, California	1.52	15
9-4285.3	At Colorado River Tributary, near Vidal, California	1.12	14
10.2537.5	At Monument Wash, near Desert Center, California	4.29	14
10.2540.2	At Betz Wash, near Salton Beach, California	5.95	14
10.2544.75	At Glamis Wash, near Glamis, California	0.60	14
10-2596	At Cottonwood Wash, near Cottonwood Spring, California	0.71	14
10257600	At Mission Creek, near Desert Hot Springs	35.7	20
18100200	Long Canyon, near Desert Hot Springs	19.4	16

The precipitation-intensity patterns for the various durations were also obtained from Riverside County Flood Control and Water Conservation District, Hydrology Manual. The critical storm durations were found to be 1 hour for the three small unnamed basins, and 24 hours for the three larger basins.

There are stream gages located on Mission Creek and Long Canyon. The annual peak flows at each gage were plotted on log-normal probability paper and compared to the discharge-frequency relationships defined by the rainfall-runoff model. These relationships were also compared to the discharge frequency relationships defined by the regional equations for the South Lahonton-Colorado Desert region published by the USGS (Waananen, A.O., 1977). It was noted that the more frequent flood events appeared to be overestimated by the rainfall-runoff model.

The discharge-frequency curves for Mission Creek and Long Canyon were defined by a least-squares fit of a log-Pearson Type III distribution, the 1-percent annual chance discharge value from the rainfall-runoff model, and the (50- and 20-percent annual chance) discharge values from the gage records. These fits were computed by the FEMA FAN model (Harty, D.S., 1982).

There are no gage records on Big Morongo or Little Morongo Canyons. The regional equations were used to estimate the higher frequency discharges for these flooding sources. For both Big Morongo and Little Morongo Canyons the discharge-frequency curves were estimated by fitting a log-Pearson Type III curve through 50-, 20-, and 1-percent annual chance discharge values. The 50-percent annual chance value was estimated by plotting the rainfall-runoff model discharge-frequency curve and the discharge-frequency curve defined by the regional equations. The regional equation was used directly to compute the 20-percent annual chance discharge; and the rainfall-runoff model computed value was used for the 1-percent annual chance discharge.

The discharge values calculated by the regional equations were used for Streams A, B, and C. The discharge-frequency curves for these streams were defined by a least-squares fit of the regional discharge-frequency values to a log-Pearson Type III distribution.

Dry Morongo Canyon has also been studied for this revision. Dry Morongo Canyon has a drainage area of 8.9 square miles which lies between the Mission Creek and Big Morongo Basins. The discharge-frequency curve for Dry Morongo Canyon was estimated by using the regional equations in the same manner as Streams A, B, and C.

For the City of Hemet, to define discharge-frequency data for the streams under study, a regional relationship of basin characteristics to streamflow characteristics (Urbanonics Research Associates, 1972) was used. The effects of urbanization on runoff were accounted for by utilizing the results of a USACE study (USACE, October 1973) which provided a digital simulation of effects of urbanization on runoff in the Upper Santa Ana Valley.

A hydrology study (USACE, 1976) prepared by the USACE for Salt Creek provided 1-percent annual chance peak discharges for that stream.

Peak discharge-drainage area relationships for Stetson Avenue Channel, Whittier Avenue Channel, Salt Creek Tributary, and Salt Creek are shown in Table 4. The discharges presented here have been reviewed by the City of Hemet, the RCFCD, and the USACE, Los Angeles District Office. All groups concurred with the presented discharges.

For the City of Indian Wells, peak discharges for the Whitewater River were taken directly from a previously prepared hydrology report (Philip Abrams, Consulting Engineers, 1975). Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for the remaining streams studied in detail in the city. To define discharge-frequency data for the streams under study, a regional analysis of basin characteristics to streamflow characteristics was performed. The principal source of data used in the analyses was a USGS publication (U.S. Department of the Interior, 1973) which provided stream gaging records for seven streams in the vicinity (listing a combined total for 76 years of annual peak discharges). Other USGS publications (U.S. Department of the Interior, 1963-1976; U.S. Department of the Interior, 1966) provided stream gage records for three additional streams. A log-Pearson Type III (U.S. Water Resources Council, 1976) analysis was made with the given data and the results correlated to basin characteristics.

In September 1976, Hurricane Kathleen, which caused severe flooding in the study area, provided additional data for the hydrologic analysis. Peak discharge measurements made during the storm by local agencies were used in the analysis.

For the City of Indio, a log-Pearson Type III analysis (U.S. Water Resources Council, 1976) was performed for all gaged streams in the vicinity and within the same hydrologic region as the study site. Streams used in the study and their corresponding flow data were taken from a USGS report (U.S. Department of the Interior, 1973). The only significant basin characteristic relating to streamflow was drainage area. A peak discharge-versus-drainage area curve was developed for the indicated frequencies and used in computing discharge values for the stream studied.

Subsequent to the cited hydrologic analyses, Coachella Valley suffered a major hurricane event (Hurricane Cathleen, September 1976), which resulted in severe flooding on nearby streams. Both the USGS and the CVWD conducted field measurements and determined peak discharges resulting from the storm.

A reanalysis was made to reflect the additional water provided by this storm and was used in arriving at the final peak discharge values used in this study.

Peak discharges for the Whitewater River were obtained from a previously prepared hydrologic study (Philip Abrams Consulting Engineers, 1975).

For the City of La Quinta, peak discharges for Bear Creek with no stream gage record were determined for the original study by using discharge values of nearby gage streams with similar hydrologic characteristics.

For the restudy, Bechtel Corporation developed 1-percent annual chance flood event data as needed for the design. Unit hydrographs were derived using the average S-graph for the Whitewater River Basin given by the USACE (USACE, 1983), with the storm assumed to center over the drainage area for which the flood peak discharge was being derived. Basin lag was also estimated according to the procedures suggested by the USACE (USACE, 1983, assuming an average Manning's roughness "n" value equal to 0.035 for the drainage area. For developed areas, and areas subject to future developments, an average basin roughness factor "n" of 0.015 was used to reflect an urbanized condition. Watershed lengths and average basin slopes were obtained from topographic data developed for the project design and from USGS topographic maps (1:24,000 scale). A uniform rainfall loss of 0.020 in./hr. was adopted for design (USACE, 1983). Drainage areas presently developed and those planned for future development were assumed to be 50 percent impervious. Flood peak discharges and runoff volumes from all sub-drainage areas, based on the indicated data and assumptions, were computed with the USACE HEC-1 computer program (USACE, 1973).

Peak discharge-drainage area relationships for the Whitewater River were taken from the FIS for the City of Indio, California (FEMA, 1985).

For the City of Lake Elsinore, hydrologic studies prepared by the Riverside County Flood Control District provided 1-percent annual chance peak discharges for Channel H, Arroyo Del Toro, Lime Street Channel, Wasson Canyon Creek, and the San Jacinto River.

Discharge-frequency data for the remaining streams under study were defined by using a regional relationship of basin characteristics to streamflow characteristics (U.S. Department of the Interior, 1970).

The effects of urbanization on runoff were accounted for by utilizing the results of a USGS study (U.S. Department of the Interior, 1974) which provided a digital simulation of the effects of urbanization on runoff in the Upper Santa Ana Valley.

Historical maximum water-surface elevations dating back to 1775 combined with a volume-frequency analysis of 56 years of gage records for San Jacinto River Stream Gage (USGS No. 11-705) provided the basis for the log-Pearson Type III statistical analysis used to determine water-surface elevations for Lake Elsinore for the selected recurrence intervals. The gage is located on the right bank of the San Jacinto River, 2 miles east of Lake Elsinore, and 2.1 miles downstream of Railroad Canyon Dam.

Debris potential was considered in analysis throughout the general area of Riverside County and specifically in the City of Lake Elsinore. The current policies of several agencies with expertise in hydraulic analysis were researched. These included the USACE, Hydrologic Engineering Center; the USACE, Los Angeles District; the San Bernardino County Flood Control District; and the Riverside County Flood Control District.

Based on information obtained from these organizations and the study contractor's experience, criteria were adopted for consideration of the debris potential for the stream studied. The debris potential for each stream was classified as either high, medium, or low, based on historic flood data, an analysis of the characteristics of the drainage area, and a field investigation of the flooding source by hydraulic engineers. On streams with low debris potential, no provisions were made in the hydraulic analysis.

For the City of Norco, to define discharge-frequency data for the streams under study, a regional relationship relating basin characteristics to streamflow characteristics was used (U.S. Department of the Interior, 1970). The effects of urbanization on runoff were accounted for by utilizing the results of a USGS study (U.S. Department of the Interior, 1974), which provided a digital simulation of the effects of urbanization on runoff in the Upper Santa Ana Valley.

The South Norco Channel and South Norco Channel Tributary A contain large ponding areas. The effects of ponding on the peak discharges were accounted for by using the USACE HEC-1 Flood Hydrograph computer program (USACE, 1973), with the Modified Puls Reservoir Routing subroutine. Significant reductions in peak discharges were computed for these streams.

A hydrology study prepared by the USACE for the Santa Ana River (USACE, 1975) provided peak discharges for that stream.

For the City of Perris, retarding basins constructed by the Riverside County Flood Control District are located on both the Metz Road Storm Drain and the San Jacinto Lateral.

For the City of Riverside, hydrologic data for each of the streams were obtained from a number of different sources. On University Wash, Springbrook Wash, and Tequesquite Arroyo, wherever they were affected by improvement structures, the 1-percent annual chance peak discharges and in some instances the 10-percent annual chance peaks were determined by the Riverside County Flood Control District.

Reaches over which the 10-percent annual chance peaks were not developed by the Riverside County Flood Control District were computed by Dames & Moore using an indexing ratio developed by the Los Angeles County Flood Control District, and presented by Quinton-Budlong in an area development study at the City of Riverside (Quinton-Budlong, 1969).

On University Wash upstream of Canyon Crest Drive, hydrologic data published by the USACE were used with modifications made to account for peak reduction caused by the existence of underground drainage structures. On Box Springs Wash, the 1-percent annual chance peak discharges were taken from the Quinton-Budlong study (Quinton-Budlong, 1969) while the 10-percent annual chance peak discharges were indexed to the 1-percent annual chance values using the Los Angeles County Flood Control District ratio. Only the 10- and 1-percent annual chance frequency floods were analyzed for the streams affected by the floodplain improvements.

Long-term streamflow records for the Santa Ana River have been maintained by the USGS (U.S. Department of the Interior, 1967). Statistical analysis was made of this to determine 10-, 2-, 1-, and 0.2-percent annual chance floods. The Standard Project Flood, computed by the USACE for the Santa Ana River levees in the northern part of the city, was found to fall between the 1- and 0.2-percent annual chance floods. With the exception of the Santa Ana River, the 2-percent annual chance flood elevations were not computed due to incomplete data and are not shown on the Flood Profiles (Exhibit 1).

Flow data were not available for the remainder of the streams, and no streamflow records were available on any small streams nearby. However, computed inflow peaks and volumes of various frequencies were available at each of the reservoir locations on the main foothill streams. These were compared to flows calculated using procedures outlined by the USGS (U.S. Department of the Interior, 1967). After review to ensure their accuracy, these flows were then used as reservoir inflow hydrographs. Reservoir outflow hydrographs for the 10-, 2-, 1-, and 0.2-percent annual chance floods were calculated by computer by Puls Method routing of the inflow floods, using given reservoir storage, outlet, and spillway characteristics. Local inflow downstream of the dams was computed using rational techniques based on rainfall, infiltration, and hydrograph shapes from the Riverside County Flood Control District's drainage reports. The local inflow and reservoir outflow hydrographs were then combined, lagged, and routed downstream to obtain flood hydrographs at various locations. Where water based up behind high embankments or small culverts, detailed routing of the hydrograph was done.

For the City of San Jacinto, the hydrologic analysis for Bautista Wash was performed by the USACE in connection with the FIS for the City of San Jacinto (USACE, May 1973; USACE, 1973). The peak discharges at the Atchison, Topeka, and Santa Fe Railroad were reduced to reflect the effect of the completed Meridian Street Channel, which diverts some of peak discharges to the San Jacinto River.

The peak-discharge computations by the USACE of Bautista Wash were based upon a frequency analysis of the USGS gaging station on nearby Bautista Creek (Station No. 11070000) and the development of a synthetic unit hydrograph for the standard project flood on Bautista Wash.

For the City of Temecula, stream gaging stations that were used in the initial hydrologic analysis are listed below with their gage numbers, drainage area, and length of record. With the exception of gage No. S-2707A in Reche Canyon, which is operated by the San Bernardino Flood Control and Water Conservation District, all of the gages listed are operated by the USGS. Of the gages listed, only Temescal Wash, Bautista Creek, and Reche Canyon gages were directly applicable to their respective streams.

Gage and Location	Gage No.	Drainage Area (Square Miles)	Period of Record (Years)
Cucamonga Creek at Upland	11-734.7	101.1	43
Day Creek at Etiwanda	11-670	4.6	45
San Antonio Creek near Claremont	11-730	16.5	55
San Timoteo Creek near Redlands	11-570	119.0	41
Mill Creek near Yucaipa	11-540	38.1	50
Santa Ana River at Riverside Narrows	11-665	850.0	45
Santa Ana River at Mentone	11-515	209.0	55
City Creek near Highland	11-558	19.6	53
Plunge Creek near East Highlands	11-555	16.9	53
East Twin Creek near Arrowhead Springs	11-585	8.8	53
Waterman Canyon Creek near Arrowhead Springs	11-586	4.7	49
Lytle Creek near Fontana	11-620	46.3	39
Cajon Creek near Keen Brook	11-630	40.6	52
Lone Pine Creek near Keen Brook	11-635	15.1	42
Devil Canyon Creek near San Bernardino	11-636.8	5.6	50
Bautista Creek near Hemet	11-700	39.4	22
Temescal Creek near Corona	11-720	164.0	43

Gage and Location	Gage No.	Drainage Area (Square Miles)	Period of Record (Years)
San Jacinto River near San Jacinto	11-695	141.0	44
Palm Canyon Tributary near Anza	10-2581	0.5	9
South Fork San Jacinto Tributary near Valley Vista	11-693	2.2	9
Whitewater River at Whitewater	10-2560	57.4	23
Palm Canyon near Palm Springs	10-2585	93.3	38
Tahquitz Creek near Palm Springs	10-2580	16.8	25
Andreas Creek near Palm Springs	10-2590	8.6	23
Reche Canyon at Barton Road	S-2702A	11.2	15

Peak discharges for streams with either poor or no stream gage records were determined by using discharge values of nearby gaged streams with similar hydrologic characteristics. Differences in drainage areas between the ungaged study stream and the nearby gaged reference stream were adjusted by use of the previously mentioned equation.

Shallow flooding analyses were applied, and only a 1-percent annual chance peak discharge was developed for North Side Wolf Valley. On all other detailed study areas, 10-, 2-, 1-, and 0.2-percent annual chance flood events were analyzed.

The initial step in determining peak discharges for the Pechanga Creek area involved the application of the synthetic unit hydrograph technique (Riverside County Flood Control and Water Conservation District, 1978) to the Pechanga Creek and North Side Wolf Valley (shallow flooding) watersheds. During the hydrograph derivation, the U.S. Forest Service was contacted for information on the hydrologic character of Cleveland National Forest, which lies within the study watershed. After determining separate peak-discharge predictions for Pechanga Creek and for the adjacent shallow flooding area, hydraulic computations were carried out to investigate the potential transfer of water between the two study areas due to an overflow of Pechanga Creek just upstream of the Pala Road crossing. The estimated amounts of transferred water (10-percent annual chance flood—180 cfs, 2-percent annual chance flood—130 cfs, 1-percent annual chance flood—180 cfs, 0.2-percent annual chance flood—320 cfs) were subtracted from the discharge predictions for Pechanga Creek and added to the peak discharge for the North Side Wolf Valley.

Revised Analyses

Information on the methods used to determine peak discharge-frequency relationships for the streams restudied as part of this countywide FIS is shown below.

The hydrologic analyses for this restudy were performed for FEMA by the Riverside County Flood Control and Water Conservation District. This work was completed in March 2000.

A new hydrologic analysis was performed on Lake Elsinore because constructed facilities were designed to alter the frequency response of the lake's reservoir effect. The USACE HEC-5 program was used for the hydrologic analysis (USACE, 1999).

Peak elevation data have also been kept on Lake Elsinore as part of the record of the flood history of Riverside County. The highest levels for the period 1916 to 2000 are as follows:

DATE	LAKE ELSINORE ELEVATION (feet NGVD)
April 1916	1,265.6
April 1917	1,260.7
April 1918	1,258.7
May 1922	1,259.7
May 1927	1,259.0
May 1938	1,258.9
June 1941	1,258.6
April 1980	1,265.7
March 1983	1,263.7
March 1993	1,258.2
March 1995	1,259.0

A new hydrologic analysis was performed on Lake Elsinore because constructed facilities were designed to alter the frequency response of the lake's reservoir effect. The USACE HEC-5 program was used as the method of hydrologic analysis (USACE, 1999).

Hydrologic calculations to determine the 1-percent annual chance discharges were performed using the Riverside County synthetic unit hydrograph method from the Riverside County Hydrology Manual dated April 1978.

A summary of the drainage area-peak discharge relationships for all the streams studied by detailed methods is shown in Table 4, "Summary of Discharges."

TABLE 4 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ARROYO DEL TORO					
Within City of Lake Elsinore	5.7	*	*	2,300[2]	5,799
BAUTISTA WASH					
At Lyon Avenue	10.6[1]	200	1,550	3,200	12,100
At San Jacinto Avenue	4.4[1]	120	750	1,440	5,200
At Atchison, Topeka & Santa Fe Railroad	*	80	800	1,760	6,900
BEAR CREEK					
At Adams Street	2.2	105	540	1,420	2,348
At Avenida Bermudas	0.82	45	230	877	1,539
BEAUMONT CHANNEL					
At Sunnyslope Cemetery	1.5	650	1,000	1,200	2,200
At First Street	1.3	550	820	1,000	1,900
At Southern Pacific Railroad	1.1	460	680	820	1,600
At Pennsylvania Avenue	1.1	520	760	940	1,800
At Palm and East 5th Streets	0.4	240	340	410	780
At East 8th Street	0.3	200	270	320	600
At 12th Street	0.2	120	180	230	420
At 13th Street	0.1	50	90	130	230
BIG MORONGO WASH					
At Pierson Boulevard	41.98	1,000	6,590	11,560	31,020
BISKRA PALMS CHANNEL					
At apex	0.9	620	950	1,090	1,390
BLIND CANYON CHANNEL					
At confluence with Desert Hot Springs Channel	4.6	560	1,900	2,800	6,500

[1]Excluding Bautista Wash Non-Contributing Area (1.1 square miles)

[2]Peak discharge provided by the Riverside County Flood Control and Water Conservation District

*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
BLIND CANYON CHANNEL (continued)					
Approximately 2,500 feet upstream of West 16th Street	4.6	560	1,900	2,800	6,500
At confluence with Colorado River Aqueduct	3.2	440	1,500	2,200	5,100
BOX SPRINGS WASH					
At 12th Street	0.96[1]	0	*	427	*
At Gage Canal	0.60[1]	338	*	491	*
At Canyon Crest Drive	0.22[1]	170	*	247	*
CHANNEL A					
Approximately 2,500 feet downstream of Control Point 175	0.2	70	150	220	430
At California Avenue	0.1	40	90	120	230
CHANNEL B					
Approximately 3,200 feet downstream of Control Point 178	0.9	210	500	720	1,500
At California Avenue	0.5	130	310	450	900
At Beaumont Avenue	0.3	90	200	300	600
CHANNEL H					
Approximately 2,000 feet downstream of confluence with Wash G	1.5	220	630	990[2]	2,200
At confluence with Wash G	0.9	150	420	650	1,400
At Grand Avenue	0.3	63	170	260	540
CHERRY AVENUE CHANNEL					
At Highland Avenue	1.4	300	730	1,070	2,300
At U.S. Highway 60 culvert	1.2	270	650	950	2,000

[1]Drainage area reflects only the contributory portion of drainage basin
[2]Peak discharge provided by the Riverside County Flood Control and Water Conservation District
*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
CHERRY AVENUE CHANNEL (continued)					
At East 6th Street	1.1	250	600	880	1,900
At East 8th Street	1.0	200	530	810	1,700
At Channel Bend	0.9	180	490	740	1,600
At East 11th Street	0.6	140	350	530	1,100
At 14th Street	0.2	60	150	210	430
At 15th Street	0.1	40	80	120	230
COLORADO RIVER					
At Needles	170,600	*	*	40,000	*
At Bullhead City	169,300	*	*	40,000	*
Just downstream of Piute Wash	*	*	*	45,000	*
Just downstream of Sacramento Wash	*	*	*	49,600	*
At Parker	*	*	*	40,000	*
At Palo Verde Dam	*	*	*	40,000	*
Just downstream of Tyson Wash	*	*	*	46,400	*
Just downstream of Arroyo Salada	*	*	*	46,600	*
At I-10/Blythe	*	*	*	43,200	*
Just downstream of Trigo Wash	*	*	*	46,900	*
Just downstream of Gould Wash	*	*	*	47,000	*
At Imperial Dam	*	*	*	40,000	*
At I-8/Yuma	*	*	*	40,000	*
COUNTRY CLUB CREEK					
At confluence with Prado Impoundment	1.3	240	620	910	2,000
COUNTRY CLUB CREEK NORTH TRIBUTARY					
At Paseo Grande	0.5	100	270	400	800
DEAD INDIAN CANYON					
At Della Robia Lane	16.5	1,000	4,200	6,700	20,000
Approximately 200 feet south of Della Robia Lane	16.2	1,000	4,200	6,700	20,000

*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
DEEP CANYON CHANNEL					
Approximately 1,000 feet east of Haystack Channel Junction	63.8	2,000	8,200	13,000	40,000
At Buckboard Trail	63.1	2,000	8,200	13,000	40,000
DEEP CANYON STORM WATER CHANNEL					
At Whitewater River	68.7	2,000	8,600	14,000	40,000
At Camino Del Ray	67.4	2,000	8,600	14,000	40,000
Approximately 700 feet south of El Dorado Drive	66.2	2,000	8,200	13,000	40,000
Approximately 1,000 feet east of Haystack Channel Junction	63.8	2,000	8,200	13,000	40,000
At Buckboard Trail	63.1	2,000	8,200	13,000	40,000
DESERT HOT SPRINGS CHANNEL					
At confluence with Big Morongo Wash	8.2	600	2,000	3,000	7,000
Approximately 500 feet south of West 8th Street	7.9	600	2,000	3,000	7,000
Below confluence with Blind Canyon Channel	5.8	600	2,000	3,000	7,000
At Palm Drive	1.0	200	660	1,000	2,300
At Verbena Drive	0.5	160	330	500	1,200
DRY MORONGO WASH					
At Apex	8.91	500	3,060	5,170	12,610
EAST GILMAN HOME CHANNEL					
At confluence with Gilman Home Channel	1.1	290	690	1,000	2,000
At Canyon Base	1.0	290	690	1,000	2,000
EAST PERSHING CHANNEL					
At Ramsey Street	0.7	140	380	590	1,200
At corporate limits	0.2	70	160	240	460

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
EAST RANCHO MIRAGE STORM CHANNEL					
At confluence with Palm Valley Drain	0.9	120	510	860	2,400
Approximately 4,000 feet southwest of Indian Trail Road	0.4	70	300	500	1,400
ELSINORE SPILLWAY CHANNEL[1]					
At Flint Street	[2]	540	1,100	1,440	11,000[3]
At Lakeshore Drive	1.1	340	660	900	11,000[3]
GILMAN HOME CHANNEL					
At confluence with Smith Creek	3.0	600	850	1,000	1,700
Downstream of Interstate Highway 10	2.3	450	450	450	450
At Interstate Highway 10	2.3	660	1,400	2,000	4,100
Downstream of George Street	2.0	600	1,300	1,820	3,700
At George Street	0.9	320	700	940	1,900
Downstream of confluence of Gilman Home Channels A and B	0.7	270	560	780	1,500
GILMAN HOME CHANNEL A					
At Canyon Base	0.3	120	250	350	670
GILMAN HOME CHANNEL B					
At Canyon Base	0.4	150	320	450	860
HARGRAVE STREET DRAIN					
At Interstate Highway 10	0.4	140	270	400	750
At Gilman Street	0.2	90	160	220	410

[1]Flows going toward Lake Elsinore
[2]Flows represent 60 percent of flows leaving Wasson Canyon Creek
[3]Represents spillway flow out of Lake Elsinore

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
HAYSTACK CHANNEL					
At confluence with Deep Canyon Channel	0.70	100	440	730	2,000
At Medina Drive	0.10	30	120	200	600
Approximately 1,500 feet upstream of Medina Drive	0.05	20	80	131	400
HIGHLAND SPRINGS CHANNEL					
At Ramsey Street	1.6	270	750	1,100	2,500
At corporate limits	1.4	250	670	1,000	2,200
INDIAN CANYON CHANNEL					
At Wilson Street	0.8	170	340	590	1,400
At Canyon mouth	0.7	130	280	510	1,100
INTERSTATE 10 WASH					
At Apex	52.3[1]	3,270	7,290	9,530	17,000
LAKEVIEW WASH					
At Juniper Flat Road	6.9	*	*	2,470	*
LEACH CANYON CHANNEL					
At Machado Street	5.7	700	2,000	3,200	7,600
LIME STREET CHANNEL					
At Lake Elsinore	0.6	110	300	460[2]	983
At Lake View	0.5	96	260	400	850
LINCOLN AVENUE DRAIN					
At confluence with Oak Street Channel	2.2	380	1,300	2,000	4,500
At Citron Street	2.0	330	1,200	1,900	4,100
At Ontario Avenue	1.9	330	1,200	1,900	4,100

[1]Does not include 33.2 square miles behind West Wide Canyon Dam
[2]Peak discharge provided by the Riverside County Flood Control and Water Conservation District
*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
LITTLE MORONGO WASH					
At Pierson Boulevard	63.71	1,250	9,090	16,420	46,320
LONG CANYON					
At 2S./5E.-34 SW. corner	26.01	6,570	11,300	13,350	19,600
LONG CREEK					
At Apex	19.40	2,910	10,420	13,370	18,030
MACOMBER PALMS CHANNEL					
At Apex	2.0	870	1,330	1,530	2,040
MAGNESIA SPRINGS CHANNEL					
At confluence with Whitewater River	5.2	480	2,100	3,400	9,500
Approximately 4,000 feet southwest of Indian Trail Road	4.7	460	2,000	3,200	9,000
MANGULAR CHANNEL					
Upstream of confluence with Oak Street Channel	2.1	230	800	1,300	2,800
At Ontario Avenue	1.9	230	800	1,300	2,800
At corporate limits	1.5	190	660	1,000	2,300
MARSHALL CREEK					
Upstream of Interstate Highway 10	4.4	620	1,800	2,700	6,100
MARSHALL CREEK TRIBUTARY					
At Elm Street	0.2	80	200	240	460
At 14th Street	0.1	40	100	120	230
MARTINEZ CANYON	48.5	2,219	7,948	12,376	*

*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
McVICKER CANYON					
At mouth of canyon	2.5	*	*	1,690	*
At Lake Elsinore	*	*	*	4,060	*
MISSION CREEK					
At Highway 62	41.09	1,930	8,480	13,170	28,550
MONTGOMERY CREEK					
At confluence of Smith Creek	2.6	770	1,600	2,300	2,800
Downstream of Interstate Highway 10	2.1	660	1,300	1,880	1,900
At Ramsey Street	2.1	660	1,300	1,880	3,700
At Sunrise Avenue	1.6	540	1,100	1,500	2,900
At Sunset Avenue (at Canyon Base)	1.1	400	800	1,000	2,100
MONTGOMERY CREEK TRIBUTARY					
At confluence with Montgomery Creek Channel	0.1	33	80	120	230
MURRIETA CREEK					
At confluence	220.0	*	*	30,900	*
At Washington Avenue	48.70	*	*	9,700	*
At Lemon Street	32.80	*	*	,9700	*
At Clinton Keith Road	12.34	*	*	5,364	*
At McVicar Street	10.35	*	*	4,822	*
Approximately 1,000 feet downstream of confluence with Santa Gertrudis Creek	*	*	*	19,300	*
Approximately 3,200 feet upstream of confluence with Long Valley Creek	*	*	*	28,500	*
NORTH CATHEDRAL CHANNEL					
Downstream of confluence with Tramview Wash	3.9	400	1,550	2,600	7,400

*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
NORTH NORCO CHANNEL					
At Rincon Street	7.8	530	1,700	2,900	7,400
Downstream of confluence with West Norco Channel	7.3	500	1,700	2,800	7,000
Upstream of confluence with West Norco Channel	6.2	460	1,500	2,500	6,400
At Hamner Avenue	5.2	410	1,300	2,200	5,500
Downstream of confluence with North Norco Channel, Tributary A	4.4	360	1,200	1,900	4,800
At Fifth Street	3.2	270	850	1,400	3,400
Downstream of confluence with North Norco Channel, Tributary B	2.9	270	850	1,400	3,400
At Valley View Avenue	1.3	130	410	670	1,600
At Corona Avenue	1.0	130	350	570	1,300
NORTH NORCO CHANNEL, TRIBUTARY A					
At confluence with North Norco Channel	1.0	130	410	660	1,600
At Valley View Avenue	1.0	130	410	660	1,600
At Hillside Avenue	0.5	70	200	320	740
NORTH NORCO CHANNEL, TRIBUTARY B					
At confluence with North Norco Channel	1.0	130	350	570	1,300
At Corona Avenue	0.7	90	270	430	980
At California Avenue	0.1	20	56	86	180
NORTH NORCO CHANNEL, TRIBUTARY C					
At Valley View Avenue	1.3	130	410	670	1,600
At Corona Avenue	0.7	90	270	430	980
At California Avenue	0.3	50	140	210	470

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
NORTH SIDE WOLF VALLEY					
At mouth	2.9	*	*	1,600	*
Near AmFac Driveway	1.0	*	*	1,210	*
OAK STREET CHANNEL					
At confluence with Temescal Creek	15.8	1,100	3,700	5,500	12,000
At Riverside Freeway	11.4	1,000	3,500	5,500	12,000
Downstream of confluence with Mangular Channel	9.0	900	3,100	4,800	11,000
At confluence with Mangular Channel	6.9	900	3,100	4,500	10,000
At Ontario Avenue	6.6	900	3,000	4,500	10,000
At Chase Drive	6.2	900	3,000	4,500	9,800
ORTEGA CHANNEL					
At Grand Avenue	1.0	160	460	710	1,600
At Lake Elsinore	1.0	160	460	710	1,600
PALM CANYON WASH					
Downstream of confluence with Tahquitz Creek	138.8	4,600	17,000	25,000	81,000
PALM DESERT CHANNEL					
Downstream of confluence with Palm Desert Channel Tributary	18.0	1,000	4,400	7,000	21,000
At State Highway 74	1.40	160	800	1,250	3,500
PALM VALLEY STORMWATER CHANNEL					
At confluence with Whitewater River	9.70	700	3,000	5,000	14,000
At Park View Drive upstream of confluence with Diversion Channel	8.40	640	2,700	4,600	13,000

*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
PALM VALLEY STORMWATER CHANNEL (continued)					
At Pitahaya Street	7.90	620	2,700	4,500	12,000
At Willow Street	7.00	560	2,500	4,200	12,000
Approximately 1,500 feet southwest of State Highway 74 and Bel Air Road	6.20	520	2,400	3,800	11,000
At Starburst Drive	4.60	450	2,000	3,200	9,000
PARK HILL DRAIN					
At mouth	4.1	*	*	1,220	*
PARK HILL DRAIN BASIN					
At outlet of Park Hill Detention	2.8	*	*	700	*
PECHANGA CREEK					
At mouth	14.0	3,920[1]	5,840[1]	6,680[1]	8,980[1]
PERSHING CREEK AND SMITH CREEK					
Downstream of Southern Pacific Railroad	7.4	1,200	400	5,100	9,300
Upstream of Interstate Highway 10	7.3	1,200	4,000	6,000	13,700
PERRIS VALLEY STORM DRAIN					
At confluence with San Jacinto River	82.5	2,200	8,100	13,000	34,000
At Nuevo Road	75.7	2,200	8,100	13,000	34,000
At Rider Street	67.7	1,900	7,000	11,300	30,000
PUSHAWALLA CANYON					
At Apex	33.7	3,460	6,680	8,050	11,700

[1]Includes adjustment for flow transfer from Pechanga Creek
*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
RAMSEY STREET DRAIN					
At San Gorgonio Avenue	1.1	310	620	870	1,800
Upstream of Interstate Highway 10	0.7	210	430	600	1,200
Downstream of Interstate Highway 10	0.7	210	430	600	640
RICE CANYON					
At mouth	2.8	*	*	1,900	*
SALT CREEK					
At Lyon Avenue	42.4	1,500	5,700	9,200	24,000
SALT CREEK TRIBUTARY					
At State Street	7.0	500	1,700	2,800	7,000
SAN GORGONIO RIVER					
At San Gorgonio River-Banning Levee	22.4	2,400	8,000	12,000	28,000
SAN JACINTO RIVER[1]					
Downstream of Wash D	701.9	1,200	12,000	24,500	70,000
At Gage Station	700.3	1,200	12,000	24,500	70,000
At Spillway	692.0	1,200	12,000	24,500[2]	70,000
At Escondido Freeway	509.0	7,000	27,000	44,000	100,000
SANTA ANA RIVER					
At Hamner Avenue	963.0	22,000	102,000	175,000	340,000
SIDNEY STREET CHANNEL					
At Wilson Street	0.3	100	210	300	590
At Canyon mouth	0.1	33	80	120	230
SMITH CREEK					
At City of Banning corporate limits	29.1	3,200	11,000	16,000	37,000
Approximately 500 feet downstream of Hathaway Street	26.1	2,800	9,400	14,000	33,000

[1]Excludes 18 square miles above Pidgeon Pass and Perris Dam
[2]Peak discharge provided by the Riverside County Flood Control and Water Conservation District

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
SMITH CREEK (continued)					
At Banning Idyllwild Road	22.5	2,600	8,700	13,000	31,000
Downstream of Pershing Creek	15.5	2,000	6,700	10,000	24,000
SMITH CREEK EAST TRIBUTARY					
At confluence with Smith Creek West Tributary	0.2	56	140	210	410
At corporate limits	0.1	33	80	120	230
SMITH CREEK WEST TRIBUTARY					
At Ramsey Street	5.1	920	3,000	4,600	11,000
At corporate limits	4.5	860	2,900	4,300	10,000
SOUTH NORCO CHANNEL					
At confluence with Temescal Wash	4.3	150[1]	440[1]	1,700	4,700
At River Road	4.1	107[1]	340[1]	1,600	4,700
Approximately 4,000 feet downstream of First Street	0.8	98	300	480	1,100
At First Street	0.5	70	200	320	740
SOUTH NORCO CHANNEL, TRIBUTARY A					
Approximately 500 feet downstream of Parkridge Avenue	1.3	0	0	390	1,500
At Hamner Avenue	1.0	130	350	570	1,300
Approximately 4,000 feet downstream of First Street	0.8	98	300	480	1,100
At First Street	0.5	70	200	320	740

[1]Decrease due to storage upstream
*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
SOUTH NORCO CHANNEL, TRIBUTARY B					
At confluence with South Norco Channel	1.3	130	410	670	1,600
At Hillside Avenue	1.1	130	370	600	1,400
SPRINGBROOK WASH					
At Lake Evans	18.75	1,990	*	2,900	*
At confluence with University Wash	9.4	680	*	1,000	*
STETSON AVENUE CHANNEL					
At Hemet Storm Channel	2.5	500	850	1,100	2,600
At Palm Avenue	2.1	450	700	950	2,200
At State Street	1.9	400	650	850	2,000
At San Jacinto Street	1.3	300	490	650	1,500
STOVEPIPE CANYON CREEK					
At State Highway 71	1.3	150	460	750	1,700
STREAM A					
At 2S./5E.-29 NW. corner	0.56	440	620	740	970
TAYLOR AVENUE DRAIN					
At Cota Street	1.5	280	590	850	1,900
At Riverside Freeway	1.4	260	550	800	1,800
At Grand Boulevard	1.3	220	500	750	1,700
At Olive Avenue	0.9	160	370	550	1,200
At Citron Avenue	0.8	150	340	500	1,100
At Ontario Avenue	0.7	130	300	450	1,000
TEMECULA CREEK					
At mouth	370.0	7,500	27,000	36,000	58,000

*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
TEMESCAL WASH					
Below confluence with Arlington Channel	170.9	2,345	14,500	29,000	69,150
Above confluence with Arlington Channel	*	1,970	12,180	24,000	58,090
At Magnolia Avenue	134.0	1,800	11,700	22,000	52,000
TEQUESQUITE ARROYO					
At Tequesquite Avenue	4.89[1]	1,972	*	2,880	*
At Magnolia Avenue	3.54[1]	685	*	750	*
At Atchison, Topeka & Santa Fe Railway	3.01[1]	1,240	*	2,350	*
THOUSAND PALMS CANYON					
At Apex	84.1	5,330	11,170	14,510	24,600
THOUSAND PALMS TRIBUTARY A					
At Apex	1.4	640	980	1,160	1,650
THOUSAND PALMS TRIBUTARY B					
At Apex	0.9	560	850	1,000	1,400
THOUSAND PALMS TRIBUTARY C					
At Apex	1.1	680	1,030	1,220	1,780
THOUSAND PALMS MAIN CHANNEL					
At Apex	7.5	1,240	2,350	2,820	4,090
THUNDERBIRD WASH					
At confluence with Whitewater River	1.0	120	550	920	2,600
At Pecos Road	0.6	90	400	660	1,900
At Thunderbird Road	0.4	70	300	500	1,400

[1]Drainage area reflects only the contributory portion of drainage basin
*Data not available

TABLE 4 – SUMMARY OF DISCHARGES – continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
TRAMVIEW TRIBUTARY					
At State Highway 111	1.1	180	700	1,160	3,170
TRAMVIEW WASH					
Approximately 230 feet upstream of upstream corporate limits	1.7	240	920	1,530	4,240
UNNAMED STREAM A					
At 2S./5E.-29 NW. corner	0.56	110	470	715	1,450
UNNAMED STREAM B					
At 2S./5E.-29 S. Half	1.10	160	750	1,160	2,460
UNNAMED STREAM C					
At 2S./5^{E}.-33 NE. Quarter	0.65	120	520	790	1,620
UNIVERSITY WASH					
At confluence with Springbrook Wash	9.07	1,000	*	1,900	*
At Gage Canal crossing	3.76	500	*	1,600	*
WASH D					
At confluence with San Jacinto River	0.9	110	340	530	1,200
At State Highway 71	0.6	82	240	390	880
WASH G					
At confluence with Channel H	0.5	90	260	390	840
At Machado Street	0.2	45	120	180	380
WASH I					
At Lake Elsinore	0.5	90	240	380	890
At Grand Avenue	0.4	80	210	330	700

*Data not available

TABLE 4 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
WASSON CANYON CREEK					
At confluence with Temescal Wash	8.3[1]	580	1,900	2,400[2]	2,540
At State Highway 71	8.2[1]	580	1,900	2,400[2]	2,540
WEST MACOMBER PALMS CHANNEL					
At Apex	2.9	1,260	1,930	2,220	2,980
WEST NORCO CHANNEL					
At confluence with North Norco Channel	0.9	200	400	550	1,200
At Pine Avenue	0.5	130	250	350	740
WEST PERSHING CHANNEL					
At Ramsey Street	1.3	230	630	960	2,100
At corporate limits	0.7	140	380	580	1,200
WHITEWATER RIVER					
At Salton Sea	1,600	8,500	27,000	43,000	100,000
At Point Happy	843	8,500	27,000	43,000	100,000
Downstream of confluence with Palm Canyon Wash	743	9,000	30,000	47,000	110,000
Below Palm Valley Drain	*	8,800	28,000	46,000	106,000
WHITTIER AVENUE CHANNEL					
At Hemet Storm Channel	1.9	400	630	840	1,900
At Lyon Avenue	1.8	380	610	800	1,800
At Palm Avenue	1.3	300	460	610	1,400
At San Jacinto Avenue	0.8	200	320	410	900

[1]Flows limited by freeway culvert

[2]Peak discharge provided by the Riverside County Flood Control and Water Conservation District

*Data not available

The stillwater elevations have been determined for the 10-, 2-, 1-, and 0.2-percent annual chance floods for the flooding sources studied by detailed methods and are summarized in Table 5, "Summary of Stillwater Elevations."

TABLE 5 - SUMMARY OF STILLWATER ELEVATIONS

	ELEVATION (feet NGVD*)			
FLOODING SOURCE AND LOCATION	10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
LAKE ELSINORE				
USGS survey gage No. 11-705	1,260	1,265	1,267	1,270

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the source studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. For construction and/or floodplain management purposes, users are encouraged to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

Precountywide Analyses

Each incorporated community within, and the unincorporated areas of, Riverside County, has a previously printed FIS report. The hydraulic analyses described in those reports have been compiled and are summarized below.

Water-surface elevations of floods of the selected recurrence intervals were computed through use of the USACE HEC-2 step-backwater computer program (USACE, 1973), with the exception of Park Hill Drain and North Side Wolf Valley, for which elevations were determined through shallow flooding analyses.

Cross-sectional data for streams were obtained from topographic maps at a scale of 1:2,400, with contour interval of 2, 4, and 5 feet (Riverside County Flood Control and Water Conservation District, 1966, et cetera; Riverside County Flood Control and Water Conservation District, October 1982; Riverside County Flood Control and Water Conservation District, 1973 and 1974). Some of the smaller streams in the mountain and desert areas were field surveyed.

In the vicinity of Perris and Desert Hot Springs, in areas where there had been substantial cross-sectional changes because of development not reflected on the existing topographic maps, field-surveyed cross sections and improvement plans were also used to supplement the mapping. Cross sections in all detailed studies were located at close intervals above and below bridges to compute the significant backwater effects of these structures. All bridges were surveyed to obtain elevation data and structural geometry.

For Bautista Wash and Pechanga Creek, field surveys were performed to obtain cross-sectional data within the limits of the stream channel. Bridge and culvert data were also obtained by field surveys. The overbank portions of the cross sections were obtained from topographic maps referenced above.

Roughness coefficients (Manning's "n") used in the initial hydraulic analyses were determined by field investigations of all the streams studied in detail in combination with a review of the "n" values used on similar streams by the RCFCWCD, California Department of Water Resources, and the USACE. The following Manning's "n" values were used in this study:

Type of Surface	Range of Manning's "n"
Fully developed, concrete-lined channels	0.014
Greenbelt channels	0.020-0.060
Leveed channels, USACE levees, reinforced concrete levees, riprap	0.025-0.040
Smooth, sandy bottom channels	0.035-0.060
Rocky-canyon type natural channels	0.040-0.080
Natural channels with heavy vegetation	0.030-0.060
Sparsely developed overbank areas*	0.030-0.060
Moderately developed overbank areas*	0.060-0.100
Fully developed residential overbank areas	0.100-0.125

*For sparsely and moderately developed overbank areas, the same range was applied, independent of varying densities of vegetative cover

Roughness coefficients used in the hydraulic analyses on Bautista Wash and Pechanga Creek were estimated by field inspection. For Blind Canyon Channel, Desert Hot Springs Channel, Perris Valley Storm Drain, and San Jacinto River, roughness coefficients were assigned on the basis of field investigations of the floodplain areas and studies by the USACE (USACE, 1974; Dawdy, D.R., 1979) and the RCFCWCD (Riverside County Flood Control and Water Conservation District, 1970).

Starting water-surface elevations on Murrieta Creek at Temecula were determined from the confluence elevations on Santa Margarita River.

For Bautista Wash and Pechanga Creek, starting water-surface elevations were determined by the slope/area method, an option in the HEC-2 program (USACE, 1973). Starting water-surface elevations for Perris Valley Storm Drain and San Jacinto River were determined by normal-depth and slope/area methods.

The HEC-2 analysis on Pechanga Creek was extended beyond the upstream limit of detailed study to investigate the likelihood of flow transfer from the creek to the northern half of Wolf Valley. A field inspection of the area indicated that such a transfer was most likely near the intersection of Pala and Pechanga Roads. An eroded channel of considerable size is present at this site and appears to represent a former flow path for Pechanga Creek. The HEC-2 analysis found that the present channel was sufficiently large to contain nearly all of the flood discharge and only relatively small quantities of water overflowed into the abandoned channel. The discharge predictions on Pechanga Creek downstream of Pala Road and on the north side of Wolf Valley were adjusted to account for this minor transfer of water (see Section 3.1). Due to the unpredictability of the processes involved, this analysis did not consider the possibility of Pechanga Creek completely changing its course within Wolf Valley. Although such an event is possible, no accounts of past shifts in the course of the creek were found.

On Bautista Wash and Pechanga Creek, in areas where the backwater analyses indicated supercritical flow conditions, critical depth was assumed for the flood elevations because of the inherent instability of supercritical flow.

Debris potential was considered throughout the areas of Desert Hot Springs and Perris. The current policies of agencies with expertise in hydraulic analysis were researched, including the USACE, Hydrologic Engineering Center; the USACE, Los Angeles District; and the USACE, San Bernardino District; and the RCFCWCD.

The debris potential for each stream was classified as either high, medium, or low, based on historical data, an analysis of the characteristics of the drainage area, and a field investigation of the flooding source performed by hydraulic engineers.

The debris potential for Desert Hot Springs Channel and Blind Canyon Channel was classified as medium. For stream areas where debris potential was determined as medium, the bridge geometry was altered by adding 2 feet on each side of the piers.

For Perris Valley Storm Drain and the San Jacinto River, the debris potential was classified as low. For stream areas, where the potential was low, no provision for debris was made in the hydraulic analysis.

Blind Canyon Channel was studied by detailed methods using the HEC-2 step-backwater computer program (USACE, 1973) assuming subcritical flow for the graded dirt channel and supercritical flow at the drop structure and 16th Street crossing.

Above Casa Grande Drive dip crossing, a flowline oriented toward the northeast has been chosen to show that most of the discharge is generated from the eastern part of the drained area.

The concrete-lined channel and 8th Street were studied assuming supercritical flow. The improved channel contains the remainder of the discharges, and the effect of high velocities was taken into consideration by superelevation calculations through the 950-foot radius curve. At the outlet on 8th Street, the turn is not completed, and the 1- and 0.2-percent annual chance discharges will break out toward the south, then decrease accordingly. The sheetflow created will continue downstream to Big Morongo Wash due to additional runoff contributed by the drainage area north of the channel and west of Santa Cruz Drive.

Desert Hot Springs Channel is in the supercritical flow regime; starting water-surface elevations were determined by the slope/area method in the case of asphalt- or concrete-lined portions of the channel and by assuming critical depth in the case of the graded dirt portions of the channel.

A 10-percent annual chance flood was not computed for West San Sevaine Creek because flooding is from overflow of San Sevaine Channel.

Generally, the distances on the flood profiles correspond to distances measured along the centerline of the designated watercourses. In the vicinity of Perris, however, the meandering nature of several low-flow streambeds necessitated use of distances measured along the centerline of the 1-percent annual chance flow paths. On the maps, these flow lines, used to establish the respective profile distances, are delineated and labeled as Profile Base Lines.

In the initial FIS, shallow flooding depths were determined from normal-depth calculations, field investigations, examination of local topography, and consultation with the RCFCWCD.

In general, areas studied by shallow flooding analyses as part of this updated study were assumed to conform to one of two groups:

1. Sheet flooding areas subject to sheetflows which would spread out over wide areas.

2. Self-channelization areas where floodwater would erode a single channel of significant depth which would inundate only a limited portion of the floodplain in each flood event.

In a particular area, the type of shallow flooding that may occur depends upon the magnitude of the flood, its sediment concentration, and the slope and erodibility of the terrain that is inundated. The existence of eroded channels from past flood events was considered the strongest evidence of self-channelization.

The upper portions of Lakeview Wash (above 10th Street) were placed in the self-channelization category based on the existence of earlier eroded channels. The more developed character of Lakeview Wash downstream of 10th Street and on all of Park Hill Drain suggested that paved roads and buildings would inhibit the formation of channels, leading to sheet flooding conditions. The analysis of North Side Wolf Valley assumed that the drainage ditch adjacent to Pala Road would be the concentration point for very shallow sheetflows originating in the mountains to the north and east.

The flood depths delineated in areas of self-channelization were calculated using the following formula (USACE, 1974):

$$D = 0.07Q^{0.4} \text{ where } D = \text{depth in feet}, \quad Q = \text{discharge in cfs}$$

This equation is applicable to critical flow conditions where floodwaters are assumed to erode a single channel. The floodplains delineated include the entire area that could be flooded by a single-flow channel moving unpredictably across the wash.

The depths of flooding shown in the sheetflow areas were calculated using normal-depth analysis. The values of Manning's "n" were chosen based on field reconnaissance and ranged from 0.05 to 0.08. The normal-depth computations on Lakeview Wash between 10th Street and Yucca Avenue assumed widths of flooding equivalent to those observed during the flood of September 7, 1981. On the reaches analyzed by normal-depth techniques, cross sectional data were obtained from topographic mapping (Riverside County Flood Control and Water Conservation District, 1966, et cetera; Riverside County Flood Control and Water Conservation District, 1982), and from field surveys conducted for this report.

The Coachella Valley study areas near Thousand Palms and Desert Hot Springs are the sites of numerous alluvial fans which were studied by employing a computer solution (Harty, D.S., 1982) of the FEMA alluvial fan methodology (Dawdy, D.R., 1979). These procedures are applicable to fans exhibiting natural flow conditions. The methodology assumes that floodwater will be confined within a single channel at any particular time during the flood event and that this channel is formed by the flow itself. Further assuming that the channel can occur at random locations across the fan surface, the probability of a point being flooded in a given event decreases as one moves downfan due to an increase in the area susceptible to flooding. Therefore, the 1-percent annual chance depths and velocities determined by the FEMA methodology incorporate both the probability distribution of the flood discharges at the fan apex and the probabilistic effects of the changing width of the floodprone surface in moving downfan.

The alluvial fan methodology, expressed in equation form (Dawdy, D.R., 1979), is as follows:

$$\text{Probability of occurrence} = 0.01 = \frac{9.5\ ACP}{W}$$

where: A = Avulsion coefficient
C = Transformation coefficient
P = Probability of discharge occurrence
W = Width of fan at point of interest

In the Coachella Valley detailed-study area, some of the alluvial fans are coalescent. In order to determine the 1-percent annual chance depths and velocities at sites subject to flooding from more than one source, separate depth-frequency relationships for each source were developed and combined based on the probability of the union of independent events.

A trial-and-error solution for this equation was determined at several sites within the study area in developing the final depth and velocity zones.

Inherent in the alluvial fan methodology is the assumption that the floodwaters will be capable of eroding a channel of significant depth in the surface of the fan. Near the base of some of the fans studied, ground slopes were considered too low for this channelization to occur. The designation of these areas was primarily determined by carefully studying aerial photographs for the presence or absence of eroded channels from earlier runoff events. The eastern end of the combined flows of Interstate 10 Wash, Thousand Palms Canyon, and Pushawalla Canyon showed no evidence of eroded channels and were studied as sheetflow areas using normal-depth analysis. At the eastern end of the Thousand Palms Canyon Fan, numerous tree lines and cultivated fields combined with lowered ground slopes to encourage sheet flooding conditions. Flooding from Pushawalla Canyon could affect areas both above and below the U.S. Bureau of Reclamation levee. Water collecting behind the levee was delineated as an approximate-study area with no determination of the depth of flooding.

Aerial photographs of the floods of August 8, 1963, and October 22, 1974, on the Long Creek alluvial fan show multiple channels occurring downfan from the two hills north of Dillon Road and west of Wide Canyon Road. The multiple channel region option of the alluvial fan methodology was used to determine depths and velocities for Long Creek downfan from the two hills. The roughness value (n=0.035) used in the multiple channel region analysis was obtained from a report, entitled "Desert Hot Springs Area Flood Insurance Study" (Simons and Associates, 1986). The slope value (s=0.024) was measured from the topographic maps received from RCFCWCD (Riverside County Flood Control and Water Conservation District, 1982).

This topographic mapping indicates that an entrenched channel below the canyon mouth of Little Morongo Wash would direct flows to the southwest. For the analysis of Little Morongo Wash a flow of 9,000 cfs was chosen as the capacity of the entrenched channel based on the approximate channel depth of four feet. The entrenched channel has been extended by a channelization project to Mission Lakes Boulevard. The channel was assumed to have no effect on flows in excess of 9,000 cfs.

The effect of the dike, maintained by RCFCWCD and located on the right bank of Mission Creek approximately 0.5 mile upstream of State Highway 62, has been considered in the analysis. This dike prevents floodflows from overtopping a low area along the south side of the Wash.

The areas studied by approximate methods as part of this updated study were delineated based upon information found in previous investigations, shallow-flooding analyses, and the results of normal-depth calculations. Specifically, the 1-percent annual chance flood boundaries for the Millard Canyon and San Gorgonio River study areas were taken directly from earlier studies (USACE, 1974; USACE, 1973; PRC Toups, 1980). The floodplain boundaries observed during a September 7, 1981, thunderstorm in the Lakeview Mountains formed the basis for the approximate study results on Homeland East and West Forks. On Temecula Creek, normal-depth computations were performed using 1-percent annual chance peak discharges from the initial study and topographic maps with a contour interval of 4 feet (Riverside County Flood Control and Water Conservation District, 1966, et cetera). The approximate floodplain boundaries shown on portions of Bautista Wash and Pechanga Creek were based upon the results of HEC-2 computer backwater runs in adjacent detailed-study areas. The floodplain of Railroad Canyon Reservoir was delineated by field checking existing topography against a 1-percent annual chance water-surface elevation of 1,392.8 feet NGVD29 or 1395.2 feet NAVD88 (provided by the RCFCWCD).

The approximate study areas on Ethanac Wash, Quincy Wash, Sinclair Wash, Moreno Beach Wash, St. Johns Canyon, Avery Canyon, Cactus Valley, numerous small streams draining the Indio Hills, and on the upper watershed of Murrieta Creek (Wildomar Channel and tributaries) are all subject to the unpredictable flow paths characteristic of alluvial fans and washes. In the absence of significant entrenched channels (as seen on topographic maps (Riverside County Flood Control and Water Conservation District, 1966, et cetera), the entire surface of the fan or wash was considered within the 1-percent annual chance floodplain. On Ethanac Wash, the elevated nature of the railroad grade was assumed to control flooding. The delineation of flood hazards in the area of Wildomar was aided by unpublished data supplied by the RCFCWCD. In determining flood depths on these fans and washes, the following equation was used (Dawdy, D.R., 1979):

$$D = 0.07\ Q^{0.4}$$

where Q = discharge in cfs
D = depth in feet

Previous studies (California Department of Water Resources, 1975; FEMA, 1984; USACE, 1971) on the same or adjacent watersheds were used to estimate 1-percent annual chance peak discharges on the study streams. On those fans and washes where depths were less than 1 foot or the source of flooding drained less than 1 square mile, a Zone B designation was employed.

Water-surface elevations of floods of the selected recurrence intervals were computed through use of the USACE HEC-2 step-backwater computer program (USACE, 1973; USACE, 1976) for reaches of Gilman Home Channel, Montgomery Creek, Pershing Creek, West Pershing Channel, San Gorgonio River, Smith Creek, and Smith Creek West Tributary. For other flooding sources covered by this study, flood elevations were determined by a series of hand calculations.

Cross sections for the majority of the hydraulic analyses were taken from topographic maps at a scale of 1:2,400, with a contour interval of 4 feet, reduced by the study contractor to 1:4,800 (Riverside County Flood Control District, 1972). In areas where there had been substantial cross-sectional changes due to development not reflected on the existing topographic maps, field-surveyed cross sections and improvement plans were used to supplement the mapping. Improvement plans supplied by the Riverside County Flood Control District were used in the analyses of Gilman Home Channel – Stage I Improvements; Highland Springs Channel; Montgomery Creek Channel; Sidney Street Channel; and West Pershing Channel.

Flood profiles were drawn for the portions of the channels that were studied through use of the HEC-2 program. Portions of channels that were not studied using HEC-2 were those where the nature of flooding is shallow sheet flow. No profiles were developed for these sources of sheet flooding because flood elevations plotted along the centerline of the channel have little relevance to the condition of flooding in the overbanks. This is particularly true in Banning, as the old Works Progress Administration channels are of less than 1-percent annual chance capacity and, in their downstream portions through the center of the city, they are of only approximately 10-percent annual chance capacity.

The sheet flows are unpredictable, are determined strictly by local topography, and do not lend themselves to HEC-2 backwater analysis (USACE, 1973; USACE, 1976). Consequently, no flood profiles were developed for East Gilman Home Channel, Indian Canyon Channel, Ramsey Street Drain, and Sidney Street Drain.

Additionally, three flooding sources contain segments in which the condition of sheet flooding exists. Therefore, profiles were not developed for portions of Gilman Home, Highland Springs, and Montgomery Creek Channels.

Three of the improved channels studied have segments which are of 1-percent annual chance design. These are Gilman Home Channel – Stage I Improvements, Montgomery Creek Channel, and West Pershing Channel. These segments were studied through use of the HEC-2 program to develop a profile for the 10-, 2-, and 1-percent annual chance frequencies; however, the 0.2-percent annual chance discharge in each case would exceed the banks of the channel becoming sheet flow in the overbanks. The 0.2-percent annual chance profile in these cases was established by obtaining the depth of sheet flow, and plotting the water-surface elevation as that distance above the channel banks.

The following paragraphs are an enumeration of the flooding sources studied and the methods of hydraulic analysis used for each.

The upper reach of Gilman Home Channel from a point 300 feet downstream of Wilson Street upstream to the confluence of channels A and B, is a natural swale and was analyzed using the HEC-2 program. From 300 feet downstream of Wilson Street down to the confluence with East Gilman Home Channel, it is a 1-percent annual chance design channel. This was analyzed using the HEC-2 program. The lower end of Gilman Home Channel, from the confluence with Smith Creek up to Westward Avenue, was also analyzed using the HEC-2 program.

The lower reach of Montgomery Creek, from Smith Creek to Interstate Highway 10, was analyzed using the HEC-2 program.

For Pershing and Smith Creeks, pressure-flow calculations were used to determine ponding elevations behind the Southern Pacific Railroad embankment and in the sump area behind Interstate Highway 10, where the flows from these watercourses combine to produce a significant ponding situation.

The West Pershing Channel upstream from the ponding area behind Interstate Highway 10 was studied using the HEC-2 computer program.

The Ramsey Street Drain Channel and its overflow, from Wilson Street downstream to Interstate Highway 10, was analyzed in the same manner as the lower portion of Gilman Home Channel. Ramsey Street Drain is an old Works Progress Administration channel in which capacity is less than the 1-percent annual chance storm. Culvert capacities were also checked to determine additional overflow at street crossings.

The San Gorgonio River was analyzed using the HEC-2 program for the detailed study reach.

For Smith Creek-West Tributary above the ponding area behind Interstate Highway 10, flood elevations were also determined using the HEC-2 program.

Elevations for all streams studied by approximate methods were determined by normal depth analysis supplemented with hand calculations.

Water-surface elevations of floods of the selected recurrence intervals were computed through use of the USACE HEC-2 step-backwater computer program for portions of Marshall Creek. For other flooding sources covered by this study, flood elevations were determined by a series of hand calculations.

Cross sections for the hydraulic analyses were taken from topographic maps at a scale of 1:2,400, with a contour interval of 4 feet, furnished by the Riverside County

Flood Control District and reduced to 1:4,800 by the study contractor (Riverside County Flood Control District, 1972).

Starting water-surface elevations for Marshall Creek were determined by normal depth analysis.

Flood profiles were drawn for Marshall Creek. The HEC-2 computer program was not utilized where the capacity of the channel was exceeded; the nature of flooding is one of sheet flow for several reaches of the watercourses studied, and no profiles were developed for these flooding sources. In the case of sheet flooding, flood elevations plotted along the centerline of the channel have little relevance to the condition of flooding in the overbanks. These flows are unpredictable, and are determined strictly by local topography. This type of analysis does not lend itself to HEC-2 backwater analysis; therefore, no flood profiles were developed for Beaumont and Cherry Avenue Channels.

Debris potential was considered in analysis throughout the general area of Riverside County. The current policies of several agencies with expertise in hydraulic analysis were researched, including the USACE, Hydrologic Engineering Center; the USACE, Los Angeles District office; the San Bernardino County Flood Control District; and the Riverside County Flood Control District. Based on these data and the study contractor's experience, criteria were adopted for consideration of the debris potential in the streams studied. The debris potential for each stream was classified as either high, medium, or low based on historic flood data, an analysis of the characteristics of the drainage area, and a field investigation of the flooding source by hydraulic engineers. On streams with low debris potential, no provision for debris was made in the hydraulic analysis. For stream reaches where the debris potential was determined to be medium, the bridge geometry was altered using the following criteria:

1. At all reinforced-concrete box culverts and bridge crossings where the cross-sectional end area was 100 square feet or less, the pier widths were doubled. Where the crossing consisted of two or more circular pipes, the cross-sectional end area was reduced by 20 percent.

2. At all bridge crossings with cross-sectional end areas between 100 and 250 square feet, 1 foot of width was added to each pier.

3. At all bridges with cross-sectional end areas greater than 250 square feet, 2 feet of width was added to each pier.

The debris potential for Beaumont Channel was considered low, whereas a medium debris potential was assigned to Cherry Avenue Channel and Marshall Creek.

The upper segment of Beaumont Channel from 13th Street to Michigan Avenue is a sheet flow area through a shallow natural swale. Elevations in this area were determined by taking cross sections through the natural swale and making normal depth calculations to determine depths. The flood depths from Michigan Avenue downstream to the corporate limits were determined by a combination of normal depth calculation, topography surveys, pipe calculations for the series of 36-inch reinforced-concrete pipes under the freeway, and a weir calculation at the Southern Pacific Railroad.

Channels A and B were treated as approximate areas, and flood elevations were established by normal depth calculations at several cross sections along the channels.

Cherry Avenue Channel was studied by both detailed and approximate methods. The approximate study is from 14th Street down to a point 600 feet above the dike which runs behind the houses on the north side of 8th Street. Although the drainage area does not reach 1.0 square mile until the crossing at 8th Street, it was necessary to begin the detailed study at a point further upstream because the water would top the dike above 8th Street. A cross section was taken at the low point of the dike to determine the amount of flow that would be contained in the channel, and a weir flow calculation was done to check the depth of the AO zone downstream of the dike.

Elevations along Marshall Creek were established using the HEC-2 step-backwater computer program.

The approximate 1-percent annual chance flood elevations on Marshall Creek Tributary were established using normal depth calculations at two cross sections.

The approximate 1-percent annual chance flood elevations on Railroad Channel were determined by normal depth calculations at several cross sections along the channel.

Water-surface elevations for floods of the selected recurrence intervals on all streams except Tramview Wash and Tramview Wash Tributary were computed by the USACE HEC-2 step-backwater computer program as taken from the FIS for Riverside County.

For channelized and leveed reaches of Palm Canyon Wash and the Whitewater River, effective flow models were used in conjunction with HEC-2 analysis.

Cross sections for most of the hydraulic analyses were taken from topographic maps at a scale of 1:4,800, with a contour interval of 4 feet. These maps were a synthesis of topographic maps at a scale of 1:2,400 furnished by the Riverside County Flood Control District (Riverside County Flood Control District, 1959, et cetera) and supplemental topographic mapping at a scale of 1:2,400 produced by the study contractor (Toups Corporation, 1978). The maps were combined and then reduced to a scale of 1:4,800 for work maps.

The Coachella Valley Water District provided limited cross-sectional data along specific reaches of the Whitewater River. In other areas where substantial cross-sectional changes had occurred due to development not reflected on the existing topographic maps, field-surveyed cross sections and improvement plans were used to supplement the maps.

Starting water-surface elevations for all watercourses for which the HEC-2 computer program was utilized were determined by normal-depth calculations and the slope/area method.

A separate analysis was required for the upstream portion of North Cathedral Channel because of the channel improvement upstream of the confluence with West Cathedral Channel. Water-surface elevations for the 0.2-percent annual chance flood in this reach were not within the scope of this analysis and have, therefore, been deleted from the Flood Profiles (Exhibit 1).

Portions of channels that were not studied using the HEC-2 program were those where once the capacity of the channel is exceeded, or where no channel exists, shallow flooding results. These floodflows are unpredictable, being determined strictly by local topography and not lending themselves to HEC-2 backwater analysis. In these cases, flood elevations plotted along the centerline of the channel or wash have little relevance to the conditions of flooding in the overbanks. Consequently, no flood profiles were developed for Tramview Wash and Tramview Wash Tributary.

The shallow flooding that occurs along Tramview Wash Tributary at the junction with Tramview Wash and North Cathedral Channel continues its southeasterly flow along North Cathedral Channel. Shallow floodflow is then funneled into the improved channel with the aid of a swale located outside the Cathedral City corporate limits. The swale, which extends approximately 1,000 feet due north from the upstream end of the improved portion of North Cathedral Channel, does not hold all of the 1-percent annual chance discharge. It does serve, however, to direct floodflow into the improved channel near the corporate limits upstream of the confluence with West Cathedral Channel. North Cathedral Channel contains the 1-percent annual chance flood from that point downstream to the confluence with the Whitewater River.

Shallow-flooding depths for Tramview Wash, Tramview Wash Tributary, and North Cathedral Channel upstream of the channel improvement were determined from normal-depth calculations, field investigations, examination of local topography, and consultation with the Riverside County Flood Control District.

Statistical analyses were used to compute flood depths and velocities for the area of Tramview Wash subject to alluvial fan flooding. Channel systems on alluvial fans are unstable, and flow may occur on different parts of an alluvial fan during subsequent flood events. The depths of flooding on the alluvial fan presented in this report were computed according to the guidelines issued by FEMA (U.S. Department of Housing and Urban Development, 1979).

Hydraulic roughness coefficients (Manning's "n") used in the computations were assigned on the basis of field investigations of the floodplain areas and previous studies by the USACE and the Riverside County Flood Control District. No values are available for Taylor Avenue Drain or Country Club Creek North Tributary.

Flood profiles for Arlington Channel are based on the existing 1-percent annual chance design channel and normal-depth calculations for the water-surface elevations for the 10-, 2-, 1-, and 0.2-percent annual chance frequency discharges.

Water-surface elevations for the 10-, 1-, and 0.2-percent annual chance floods for the Prado Dam Flood Control Reservoir were provided by the USACE, Los Angeles District.

No flood profiles were developed for Lincoln Avenue Drain, Taylor Avenue Drain, and several segments of both Mangular Channel and Oak Street Channel. These watercourses comprise the major drainage courses crossing the Corona alluvial fan that are not completely contained. These flooding sources cause shallow flooding, with depths varying from less than 1 foot to greater than 3 feet.

For stream segments where the debris potential was determined to be high, the bridge geometry was adjusted by criteria listed above; in addition, peak discharges were bulked by a factor from 1.1 to 1.5, based on an individual analysis of the flooding source. A summary of the debris potential used for each of the flooding sources in the City of Corona is shown in the following tabulation:

FLOODING SOURCE	DEBRIS POTENTIAL
Arlington Channel	Low
Corona Fan (developed area)	Medium
Corona Fan (undeveloped area)	High
Country Club Creek	Low
Country Club Creek North Tributary	Low
Main Street Channel	Low
Mangular Channel	High
North Norco Channel	Medium
North Norco Channel, Tributary A	Medium
North Norco Channel, Tributary B	Medium
North Norco Channel, Tributary C	Medium
Oak Street Channel	High
Santa Ana River	Low
South Norco Channel	Medium
South Norco Channel, Tributary A	High
South Norco Channel, Tributary B	Medium
Temescal Wash	High
West Norco Channel	Low

The City of Corona is located on an alluvial fan that extends from the foothills, south of the city, to Temescal Wash. The watershed between Main Street and Lincoln Avenue is quite flat in an east-west direction; however, to the north, a consistent 4 percent slope is maintained to Temescal Wash. Runoff generated in the watershed south of Ontario Avenue, between Main Street and Lincoln Avenue, defined as Lincoln Avenue Drain and Taylor Avenue Drain for study purposes, is particularly influenced by the existing topography. As there are no defined channels, runoff through this area results in shallow flooding. Some of the shallow flooding is collected in the street system; however, a majority of the flow approaches Ontario Avenue as sheetflow at depths of less than 1.0 foot. Floodplain boundaries north of Ontario Avenue were determined by extensive study of hydrologic drainage areas, then verified and, in some cases, modified through field examination. North of Tenth Street, the flow is augmented by overflow from Oak Street Channel.

Much of the flow in Mangular Channel emanates from the mouth of Mabey Canyon. The HEC-2 step-backwater computer program (U.S. Department of the Interior, 1977) was used during the initial study, assuming subcritical flow. Due to high debris and erosion potential, this approach did not produce reasonable floodplain boundaries and realistic water-surface elevations. The runoff from Mabey Canyon flows onto the broad alluvial fan along the southern corporate limits when the channel capacity is exceeded during major floodflows. The flow escaping the channel produces shallow flooding down the alluvial fan. The result is that much of the 1-percent annual chance peak flow does not enter the inlet to Mangular Channel at Ontario Avenue. A portion of the shallow flows will pass through the orchards east of the channel and combine with overflow from Oak Street Channel, resulting in shallow flooding depths greater than 1.0 foot between the two channels. A small portion of the flow will escape to the west of Ontario Avenue, but will be confined by a structural wall along Border Avenue. The special flood hazards adjacent to the east side of the channel from Ontario Avenue to the confluence with Oak Street Channel were analyzed using the HEC-2 computer program, with the discharges bulked by a factor of 1.5 due to a high debris potential.

Flow collected in Hagador and Tin Mine Canyons is conveyed to Temescal Wash by Oak Street Channel. The study of this channel begins south of Chase Drive. As the flow progresses from the canyon mouth, existing topography allowed use of the HEC-2 step-backwater computer program for determination of water-surface elevations from the upstream limit to a point just above the confluence with Mangular Channel. Based on historical runoff data, the characteristics of the tributary drainage area, and several field investigations, it was determined that Oak Street Channel had a high debris potential, and the discharges were bulked by a factor of 1.5. Below Ontario Avenue, sheetflow occurs over the alluvial fan, resulting in an area of shallow flooding defined between the major flow paths of Oak Street Channel and Mangular Channel. This shallow flooding condition is further aggravated by the bridge structure at Ontario Avenue, which has a high potential of becoming clogged with debris as it did in 1969 during a flood, when the recorded flow was approximately 25 percent of the 1-percent annual chance flood frequency.

At the confluence of Mangular and Oak Street Channels, the two flows are confined between a structural wall on the west and a fill slope, south of Corona High School, on the east. This constriction produces flood depths of greater than 3 feet and velocities greater than 10 feet per second.

Downstream of 10th Street, the flow spreads out onto the alluvial fan and is characterized by indeterminate flow paths and shallow flooding. From 10th Street downstream to Temescal Wash, the floodplain boundaries were established by extensive field investigations, topography, and evaluation of historical flooding. The culverts at both 10th and 6th Streets were assumed clogged with debris, as both were during the floods of 1969. The channel capacity is less than 20 percent of the 1-percent annual chance flood and was rendered completely ineffective due to rock and mud deposition during the 1969 floods.

Two situations along the portion of South Norco Channel within Corona required special hydraulic analyses. First, ponding behind River Road necessitated storage capacity-discharge calculations to determine the water-surface elevations for the 10-, 2-, 1-, and 0.2-percent annual chance frequencies. Second, the segment from River Road downstream to the confluence with Temescal Wash is across a flat field and in the 1-percent annual chance floodplain of Temescal Wash. The study of South Norco Channel did not consider effects of flooding along Temescal Wash.

The flowline of South Norco Channel Tributary A passes through Corona and the City of Norco as it proceeds toward Temescal Wash. Flooding from this source produces a special situation. The natural topographic conditions create a large ponding area. This ponding area extends from just below Parkridge Avenue to Hamner Avenue. Storage capacity-discharge calculations were made to determine the water-surface elevations for each of the designated frequencies. HEC-2 analysis provided both profiles and floodplain boundaries upstream of this area.

Temescal Wash drains a large watershed to the south and southeast of Corona. The floodplain of Temescal Wash is a broad, flat, alluvial valley averaging 3,000 feet in width, whose boundaries are formed on the northeast by a range of low foothills and on the southwest by the alluvial fan upon which most of the city sits. As a result of the well-defined valley cross section, the hydraulic analysis was accomplished utilizing the HEC-2 backwater profile computations, which were used to determine all base flood elevations on Temescal Wash.

Because of the size and characteristics of the drainage area, the nature of the local soils, and historical storm data, it became apparent that Temescal Wash should be considered as having a high debris potential.

At the Riverside Freeway crossing, all frequencies but the 0.2-percent annual chance flood are contained under the freeway. The 0.2-percent annual chance flood elevations are in excess of the low point in the highway to the east of the bridge, thereby creating a weir flow condition over the freeway. To solve this problem, independent analysis of the 0.2-percent annual chance flood for this portion of Temescal Wash was done.

The 1-percent annual chance floodflows are contained within the improved Temescal Wash channel between Cota Street and the Atchison, Topeka & Santa Fe Railway bridge, located just downstream of the Riverside Freeway crossing.

Cross sections for the great majority of the HEC-2 analyses were taken from topographic maps at a scale of 1:2,400, with a contour interval of 4 feet, and reduced to 1:4,800 (Riverside County Flood Control and Water Conservation District, Topographic Maps, City of Desert Hot Springs). In areas where there had been substantial cross-sectional changes because of development not reflected on the existing topographic maps, field-surveyed cross sections and improvement plans were also used to supplement the mapping. Cross sections in all detailed studies were located at close intervals above and below bridges to compute the significant backwater effects of these structures.

The debris potential for Desert Hot Springs Channel and Blind Canyon Channel was classified as medium.

For stream areas where debris potential was determined as medium, the bridge geometry was altered by adding 2 feet on each side of the piers.

Blind Canyon Channel was studied in detail using the HEC-2 step-backwater computer program (USACE, 1973) assuming subcritical flow for the graded dirt channel and supercritical flow at the drop structure and 16th Street crossing.

Above Casa Grande Drive dip crossing, a flowline oriented toward the northeast has been chosen to show that most of the discharge is generated by the eastern part of the drained area.

At a point 2,160 feet above the confluence with Desert Hot Springs Channel, the 0.2-percent annual chance discharge breaks out toward the west. Approximately 3 percent of the discharge will concentrate in Santa Cruz Road at an average depth of 0.4 foot and flow down to West Drive.

At 16th Street, the drop structure and dip crossing were modeled assuming supercritical flow. The corrugated metal pipes were not considered, but the discharges were decreased by an amount verified as reasonable by hand calculations. Downstream of 16th Street, another 6 percent of the 0.2-percent annual chance discharge breaks out, increasing Santa Cruz Road flow to a depth of 0.9 foot.

The discharges flow supercritically in a graded dirt channel; starting water-surface elevations were determined by assuming critical depths.

Desert Hot Springs Channel was studied in detail by the HEC-2 step-backwater computer program (USACE, 1973) downstream of Verbena Drive and by hand calculations upstream of Verbena Drive. Upstream, the profiles are influenced by a backwater effect from the downstream section, and a small percentage of the 0.2-percent annual chance discharge could spill over onto Verbena Drive. At Verbena Drive, two catch basins collect runoff from an area north of the channel, but it is reasonable to believe that a percentage of the high discharges will flow down Verbena Drive past the channel. Downstream of Verbena Drive, the discharges were incrementally increased up to the confluence with Blind Canyon Channel. The 0.2-percent annual chance discharge breaks out toward the south to create a sheet flow through the city. The discharge was decreased incrementally to take into account this overflow. At Palm Drive, a percentage of the 1-percent annual chance discharge breaks out toward the south, but it is small enough to be considered as a sheet flow.

At 12th Street, the 0.2-percent annual chance discharge breaks out again toward the east, concentrates in Cactus Drive to a maximum depth of 2 feet, then spreads into a sheet flow through the city. The 0.2-percent annual chance discharge was again decreased incrementally.

The concrete-lined channel and 8th Street were studied assuming supercritical flow. The improved channel contains the remainder of the discharges, and the effect of high velocities was taken into consideration by superelevation calculations through the 950-foot radius curve. At the outlet on 8th Street, the turn is not completed, and the 1- and 0.2-percent annual chance discharges will break out toward the south, then decrease accordingly. The sheet flow created will continue downstream to Big Morongo Wash because of additional runoff concentrated by the drainage area north of the channel and west of Santa Cruz Drive.

Desert Hot Springs Channel is in the supercritical flow regime; starting water-surface elevations were determined by the slope-area method in the case of asphalt- or concrete-lined portions of the channel and by assuming critical depth in the case of the graded dirt portions of the channel.

The additional Desert Hot Springs study area consists of numerous alluvial fans that were studied by employing a computer solution (Harty, D.S., 1982) of the FEMA alluvial fan methodology (Dawdy, D.R., 1979). The FEMA procedures are applicable to fans exhibiting natural flow conditions. The methodology assumes that floodwaters will be confined within a single channel at any particular time during the flood event and that this channel is formed by the flow itself. Further assuming that the channel can occur at random locations across the fan surface, the probability of a point being flooded in a given event decreases as one moves downfan due to an increase in the area susceptible to flooding. Therefore, the 1-percent annual chance depths and velocities determined by the FEMA methodology incorporate both the probability distribution of the flood discharges at the fan apex and the probabilistic effects of the changing width of the flood-prone surface in moving downfan.

In the Desert Hot Springs area, some of the alluvial fans are coalescent. To determine the 1-percent annual chance depths and velocities at sites subject to flooding from more than one source, separate depth-frequency relationships for each source were developed and combined based on the probability of the union of independent events.

In performing the analysis of coalescent fans, the basic equation was altered to sum the effects of multiple flooding sources, yielding:

$$0.01 = 9.5 \sum_{i=1}^{n} \left\{\frac{ACP}{W}\right\} i$$

where n = Number of overlapping fans

In developing the final depth and velocity zones, a trial-and-error solution for this equation was determined at several sites within the study area.

Aerial photographs of the floods of August 8, 1963, and October 22, 1974, on the Long Canyon alluvial fan show multiple channels occurring downfan from the two hills north of Dillion Road and west of Wide Canyon Road. The multiple channel region option of the alluvial fan methodology was used to determine depths and velocities for Long Canyon downfan from the two hills. The roughness value (n=0.035) used in the multiple channel analysis was obtained from a report entitled "Desert Hot Springs Area Flood Insurance Study" (Simons and Associates, 1986). The slope value (S=0.024) was measured from the topographic maps received from RCFCWCD (Riverside County Flood Control and Water Conservation District, 1982).

This topographic mapping indicates that an entrenched channel below the canyon mouth of Little Morongo Wash would direct flows to the southwest. For the analysis of Little Morongo Wash a flow of 9,000 cfs was chosen as the capacity of the entrenched channel based on the approximate channel depth of 4 feet. The entrenched channel has been extended by a channelization project to Mission Lakes Boulevard. The channel was assumed to have no effect on flows in excess of 9,000 cfs.

The effect of the dike, maintained by RCFCWCD and located on the right bank of Mission Creek approximately 0.5 mile upstream of State Highway 62, has been considered in the analysis. The dike prevents flood flows from overtopping a low area along the south side of the Wash.

Analyses of the hydraulic characteristics of Salt Creek-Salt Creek Overflow and Salt Creek Tributary were made through use of the USACE HEC-2 computer program (USACE, 1976). The topography along both streams provide enough relief to allow use of the program; however, this amount of relief is a rare occurrence in the City of Hemet.

Cross sections used in the analyses of Salt Creek Tributary, Salt Creek Overflow and Salt Creek were taken from topographic maps at a scale of 1:3,400, with a contour interval of 4 feet, furnished by the RCFCD and reduced to a scale of 1:4,800 (USACE, May 1974).

Profile base lines, corresponding to the approximate centerline of the 1-percent annual chance flow, were used to establish stationing for Salt Creek and Salt Creek Overflow. A profile base line has been presented because grading and topography make it impossible to define a single channel as Salt Creek.

Existing flat topography and resultant shallow flooding prevented use of the HEC-2 program for the study of the upper reaches of Whittier Avenue Channel Stetson Avenue Channel. Whittier and Stetson Avenues carry the flow generated on the flat plain east of San Jacinto Street towards Hemet Storm Channel. As the flow progresses westward towards Hemet Storm Channel, it exceeds the capacity of these two streets and concentrates primarily in Johnston Avenue, resulting in widespread sheet flow and shallow ponding in sump areas. Due to existing flat topography and resultant shallow flooding, no profiles were developed.

The RCFCD performed an extensive study of the potential street flooding areas in the city north of Whittier Avenue. Flooding in these areas is characterized by sheet flow and street flooding depths of less than 1.0 foot.

The analysis of the debris potential in Hemet resulted in a low-debris potential classification for all streams studied; therefore, no provision for debris was made in the hydraulic analysis.

Cross sections for the hydraulic analyses were taken from topographic maps at a scale of 1:4,800, with a contour interval of 4 feet (Toups Corporation, Topographic Maps, Indian Wells, California), which represent a combination of mapping produced by the study contractor and mapping provided by the City of Indian Wells. Cross sections were located at close intervals above and below the State Highway 111 bridge across the Deep Canyon Storm Water Channel in order to compute the significant backwater effects of this structure. The bridge was surveyed to obtain elevation data and structural geometry.

Starting water-surface elevations for the various profiles on the Whitewater River and the Deep Canyon Storm Water Channel to be analyzed by the HEC-2 program were determined by normal depth and the slope/area method.

No profile was developed for the areas of sheet flooding caused by uncontrolled floodflows upstream of the Deep Canyon Storm Water Channel on the alluvial fan of Deep Canyon.

In the approximate study of flooding on the debris cone of Deep Canyon, flood elevations were generated through a synthesis of engineering judgments based on topography, field investigation, and historic flooding patterns.

The Coachella Valley County Water District has built and maintains a sand levee along the major flow path of the debris cone in Indian Wells. The purpose of this levee is to direct flows from Haystack Channel, Palm Desert Channel, and Deep Canyon into the Deep Canyon Storm Water Channel, whence they can be directed downstream into the Whitewater River. This levee is similar in nature to others in the areas which are intended to protect the Cities of Palm Desert and Rancho Mirage. The levees of this system in the Upper Coachella Valley consist of unconsolidated natural materials pushed up by bulldozer. It has been the study contractor's judgment, and has been demonstrated as the result of recent major floods in the area, that these levees do not provide sufficient protection from major floodflows due to the high degree of erodibility of the material, the steep gradients of the debris cones and consequent high-flow velocities, and the attack of these floodflows on the levees at points of impingement.

Consequently, the study contractor's analysis reflects the following criteria applied consistently in the study area in arriving at engineering decisions concerning containment of flows:

1. Whenever the water-surface elevation of the 1-percent annual chance flood exceeded the outside ground elevation at a point of impingement on a sand levee, it was determined that the levee would fail at that point. Topography, field investigations, and historical flooding data were then used to determine the boundaries of the resultant uncontrolled overland flow on the cone.

2. Whenever the existing levee's capacity was exceeded and the hydraulic section was inadequate to contain the 1-percent annual chance flood, it was determined that the dike would wash out, and topography, field investigation, and historical flooding were used to determine 1-percent annual chance flood elevations.

These criteria were applied at a major bend in the flow path of the Deep Canyon Storm Water Channel near Cook Street. At this point, it was found that the 0.2-percent annual chance frequency flood would break out, with the discharge not carried by the storm water channel traveling overland across the alluvial plain to the Whitewater River.

Following is an enumeration of the flooding sources studied and the methods of hydraulic analysis used for each.

Deep Canyon Channel: Even with the major loss of water experienced due to the failure of the Dead Indian Canyon Diversion dike in Palm Desert, the remaining discharge from Dead Indian Canyon combined with that from Deep Canyon creates additional flooding problems in Indian Wells. The debris load in terms of sand is tremendous, and when floodflows reach the flatter portions of Deep Canyon Storm Water Channel as it passes through Indian Wells, this silt drops out of suspension, substantially reducing channel hydraulic capacity. This lower portion of the channel passing through Indian Wells was analyzed using the HEC-2 program upstream from the Whitewater River to Cook Street. The result of this analysis, utilizing actual field cross sections provided by the Coachella Valley County Water District, was containment of the 1-percent annual chance flood, with the exception of some low areas that are in the Indian Wells country club. Additionally, the northwestern portion of the city is flooded during the 0.2-percent storm by floodflows coming off the Palm Desert cone.

Whitewater River: The HEC-2 computer program was used for the analysis of this channel. The 1- and 0.2-percent annual chance flood elevations are below the outside ground elevation in Indian Wells and the flows are contained in the channel.

The approximate elevations for the alluvial cones delineate the area from the toe of the mountains north to the southern 1-percent annual chance boundary of Deep Canyon Storm Water Channel. These approximate boundaries result in a moderate flood hazard due to the limited sizes of any one drainage area (less than 1 square mile), yet are identified due to the nature of the watershed and the geological characteristics of the alluvial cones that impart the floodflows.

Starting water-surface elevations for the Whitewater River were determined by normal-depth and the slope/area method.

The 0.2-percent annual chance flood exceeds the capacity of the channel and would inundate Indio, with the exception of the areas north of the Coachella Valley Stormwater Channel.

Flooding due to concentration of flows from the hills to the west behind the All American Canal was analyzed and found not to have any effect on the city.

Water-surface elevations of floods of the selected recurrence intervals for Bear Creek, Bear Creek Channel, and East La Quinta Channel were computed with the USACE HEC-2 step-backwater computer program (USACE, 1976).

Cross sections for the hydraulic analysis of Bear Creek Channel and East La Quinta Channel were taken from topographic maps at a scale of 1:12,000 with a contour interval of 40 feet, provided by Bechtel Civil, Inc.

Starting water-surface elevations for Bear Creek were determined by normal depth and the slope/area method.

Shallow flooding depths for overflow from Bear Creek were determined from normal-depth calculations, field investigations, examination of local topography, and consultation with the Riverside County Flood Control District.

Shallow flooding depths of runoff from streets in the City of La Quinta were computed using the USACE HEC-2 step-backwater computer program (USACE, 1976).

Cross sections for a majority of the hydraulic analyses were taken from topographic maps at a scale of 1:2,400, reduced by the study contractor to a scale of 1:4,800, with a contour interval of 4 feet (Riverside County Flood Control District, Topographic Maps, Lake Elsinore, California). In areas where there have been substantial cross-sectional changes due to development not reflected on the existing topographic map (Riverside County Flood Control District, Topographic Maps, Lake Elsinore, California), field-surveyed cross sections and improvement plans were used to supplement the maps. Improvement plans supplied by the Riverside County Flood Control District were used in the analysis of Channel H, Leach Canyon Channel, Lime Street Channel, and Ortega Channel.

For those reaches not analyzed by the HEC-2 program, elevations were determined by using normal-depth calculations in conjunction with extensive field investigations and analysis of existing topography. Flood profiles were drawn for the Elsinore Spillway Channel, San Jacinto River, Temescal Wash, and Wasson Canyon Creek.

No profiles were drawn for Channel H, Leach Canyon Channel, Lime Street Channel, and Ortega Channel as these are all 1-percent annual chance design channels.

No flood profiles were developed for the other flooding sources studied as these watercourses are not well contained in channels. These flooding sources produce shallow flooding and generally result in depths of less than 1 foot to 3 feet.

The hydraulic characteristics of the Elsinore Spillway Channel are complicated by a mild channel slope and small design capacity of the numerous culverts throughout the reach. Thus, the major portion of the flow is carried in the channel overbanks and over the crossings as weir flow. Pottery Street was treated as a weir flow crossing because the box culvert was silted full. Downstream of Graham Avenue, a backwater condition is present. The control is established by the 1-percent annual chance lake elevation, which causes inundation of the region downstream of Limited Street. This 1-percent annual chance lake elevation is presented in the respective profile.

Temescal Wash can be divided into two reaches with distinct hydraulic characteristics. The upstream reach extends from the Wasson Canyon Creek confluence to a section approximately 4,000 feet downstream of Chaney Street. As the flow enters Temescal Wash downstream of the Wasson Canyon Creek confluence, it begins to spread out, inundating large regions of the valley floor. The flow crosses Chaney Street as a combination of pressure flow through the culvert and weir flow over the road. As the flow approaches Riverside Drive, the channel slope begins to decrease rapidly, thereby reducing the hydraulic efficiency of the channel and causing flood depths to increase rapidly. Downstream of this point, a backwater condition is created due to the mild channel slope and the existence of a restrictive outfall section into Temescal Canyon at the corporate limits. This backwater condition creates base flood depths in excess of 12 feet in the lower channel reach. The width of the flow in this lower reach averages approximately 2,000 feet, attesting to the mild slope of the valley floor.

Major floodflows on Arroyo Del Toro were determined to split upstream of the corporate limits, entering the city in two distinct flow paths. Approximately 80 percent of the peak discharge is expected to flow directly overland to Temescal Wash along the north flow path. This will inundate a very broad area to an average depth of less than 1 foot.

A unique flooding pattern exists in Lake Elsinore, resulting from the following conditions: First, Lake Elsinore is the low point in a drainage basin that covers over 700 square miles. The major portion of the runoff flows down the San Jacinto River into the east end of Lake Elsinore. This causes the lake level to rise substantially to an elevation of 1,265 feet for the 1-percent annual chance frequency flood. A second contributing condition results from a high point that is located in the combined flowlines of the Elsinore Spillway Channel and Temescal Wash, approximately 500 feet southeast of the Wasson Canyon Creek confluence. The high point has an elevation which has fluctuated historically due to alternate silting and eroding. Its present elevation of Lake Elsinore exceeds this elevation, the flow in the Elsinore Spillway Channel reverses direction and flows away from Lake Elsinore toward Temescal Canyon except when the elevations of flows from Wasson Canyon exceed the coincident lake elevation. The discharge for the entire reach consisting of the combined flowlines of the Elsinore Spillway Channel and Temescal Wash was set at 11,000 cfs on the basis of a spillway-gaging study conducted by the USACE. At this flow rate, a considerable portion of the region surrounding the Elsinore Spillway Channel is inundated to depths in excess of 15 feet. After the flow crosses the outfall section into Temescal Wash at the high point in the flowline, it spreads out, creating flooding patterns that are similar to the Temescal Wash 1-percent annual chance frequency flood. The only substantial difference results from greater depths of flow which have the effect of inundating larger portions of the valley.

Cross-section data for watercourses studied in detail were obtained from topographic maps at a scale of 1:24,000 with a contour interval of 4 feet (U.S. Department of the Interior, 1967, et cetera). Some streams were field surveyed. Cross sections were located at close intervals above and below bridges and culverts in order to compute significant backwater effects at these structures.

The hydraulic analysis for Murrieta Creek was performed using the USACE HEC-2 step-backwater computer program.

The cross sections used for the analysis of Murrieta Creek were determined from 4-foot contour interval, 1:12,000-scale topographic maps developed by Aelytek, Inc. (Aelytek, Inc., 1990).

The starting water-surface elevation for Murrieta Creek was taken from a contiguous study.

Murrieta Creek has sand levees which extend along both banks from approximately 500 feet downstream of Winchester Road to approximately 900 feet downstream of Washington Avenue. These levees have not been certified by a federal agency as providing protection from the 1-percent annual chance flood. The levees are continuous with the exception of the Cherry Street dip crossing, the convergence of Warm Springs Creek, and the convergence of Santa Gertrudis Creek.

The limits of the Murrieta Creek floodplain were determined according to FEMA levee failure analysis requirements (FEMA, 1991). The floodplain limit on the left (looking downstream) side of the channel was determined by assuming that the left levee fails during the 1-percent annual chance event; the floodplain limit on the right (looking downstream) side of the channel was determined similarly. On the unprotected side (channel side) of the levees, the maximum water-surface elevations were computed generally as a result of both levees holding.

Between Cross Sections D and E, it was previously determined (FEMA, 1984) that flow can leave the Murrieta Creek channel upstream of Washington Avenue and travel in the low overbank areas adjacent to the channel. A separate HEC-2 analysis was done assuming that approximately 1,750 cfs can flow in the right overbank. The split flow option was used to allow flow to weir back into the channel over the levee if the water-surface elevation was high enough.

Profiles are not shown for the Whitewater River, Magnesia Springs Channel, East Rancho Mirage Storm Channel and the Palm Valley Drain because it was determined that the floodflow would be contained within the channel banks.

Cross sections for the original hydraulic analysis were taken from topographic maps with a scale of 1:4,800, and contour interval of 4 feet (Toups Corporation, 1976).

No profiles were developed for the areas of sheet flooding caused by uncontrolled floodflows from Thunderbird Wash downstream of State Highway 111.

The only bridge on the Whitewater River through the City of Rancho Mirage is at Bob Hope Drive. Debris criterion number 3 was applied for the analysis of this bridge.

In the study of flooding from Thunderbird Wash upstream of State Highway 111, flood depths were generated through a synthesis of hand calculations with engineering judgment based on topography, field investigation, and historical flooding patterns.

The Coachella Valley Water District has built and maintains a system of sand levees along the major flow paths of the debris cones in Ranch Mirage. It has been the study contractor's judgment and has been demonstrated as the result of recent major floods in the area, that these levees do not provide sufficient protection from major floodflows due to the high degree of erodibility of the material, the steep gradients of the debris cones, and consequent high-flow velocities, and the attack of these floodflows on the levees at points of impingement.

Due to the indeterminate nature of flow paths on an alluvial cone, the entire Rancho Mirage cone was delineated as being within the 0.2-percent annual chance flood. Following is an enumeration of the flooding sources studied and the methods of hydraulic analysis used for each.

The drainage area of Country Club Wash is less than 1 square mile. Consequently, it is delineated as an approximate study. The 1-percent annual chance flow is fully contained until it reaches a 90° bend in the channel as it parallels Camino del Cerro Drive. At this point, a breakout occurs, resulting in sheet flooding downstream to the Whitewater River. Flows in this sheet flooding are less than 1 foot in depth. Flood depths for Country Club Wash were determined from an analysis of topography in conjunction with historical flooding data.

The HEC-2 program (USACE, 1973) was used in the analysis of the Magnesia Spring Canyon Flood Control Project including Magnesia Springs Channel, East Rancho Mirage Storm Channel, Mirage, Indian trail, Dunes View and Magnesia Falls Roads, Ocotillo Drive, and the Veldt. The 1-percent flood is contained within the channels, levees and streets of the Magnesia Spring Canyon Flood Control Project.

The downstream reach of the Palm Valley Drain passes through the City of Rancho Mirage, but the flow is contained and does not create any problems in this area. The capacity of the channel to carry the flow was checked by normal depth calculations determined by topographic cross sections (Toups Corporation, 1976).

Thunderbird Wash upstream of State Highway 111 has a drainage area of less than 1 square mile and is delineated as an approximate study. This channel is defined by a system of sand dikes. In its upper reaches, both the 1- and 0.2-percent annual chance flood profiles are below the outside ground elevation and, therefore, are fully contained. Approximately 400 feet upstream of State Highway 111, the confluence of a tributary canyon from the south causes a breakout to occur during a 0.2-percent annual chance flood. The flows exiting this tributary canyon impinge directly against the sand levees, causing their failure and a breakout to the northwest. This situation is complicated by a lack of adequate capacity at the State Highway 111 bridge. This bridge will become clogged, creating a substantial backwater and resultant weir flow across the highway. Depths for the approximate study were determined by topography and manual hydraulic calculations. Downstream from State Highway 111, flood depths were determined topographically. From State Highway 111 downstream, depths are less than 1 foot.

The HEC-2 program (USACE, 1973) was used in the analysis of the Whitewater River. The channel has below-grade capacity to carry the entire 1-percent annual chance discharge through this reach defined by the City of Rancho Mirage.

Water-surface profiles were computed with the aid of the USACE backwater program (USACE, 1973), while complex hydraulic structures were analyzed using standard texts and design manuals (Horace W. King, 1976; Ven Te Chow, 1959; U.S. Department of Commerce, 1965). Cross-section data were obtained from topographic maps furnished by the city (Riverside County Flood Control and Water Conservation District, 1968) and, for improved sections of streams, from as-built construction and grading plans (Riverside County Flood Control District, 1974; Riverside County Flood Control District, 1976; Riverside County Flood Control District, Box Springs Master Drainage Plan; Riverside County Department of Public Works, 1965; Albert A. Webb Associates, 1975; Riverside County Flood Control District, 1975; Riverside County Flood Control District, 1976, University Wash Channel, Stage I; Riverside County Department of Public Works, 1959; Riverside County Flood Control District, 1979; Riverside County Department of Public Works, 1957; Riverside County Department of Public Utilities, 1974; Riverside County Department of Public Works, 1959, Plans for Construction on Stage Highway; Riverside County Department of Public Works, 1966; Riverside County Department of Public Works, 1967). In areas where flooding was not confined to the immediately adjacent channel, limits of overflow were determined by inspection of contours and by field inspection.

For the improved streams, the starting water-surface elevations used in the backwater analysis were taken as the maximum ponding elevation allowable at detention structures at the downstream limits of detailed studies. The only exception was University Wash for which the starting water-surface elevation used was the elevation on Springbrook Wash at the confluence.

On Box Springs Wash, a retention basin at the northeast corner of Pennsylvania and Kansas Avenues retains the 10-percent annual chance storm, thus eliminating flow downstream for this frequency flood.

The cross-sectional data for Bautista Wash was obtained from field surveys performed within the limits of the stream channel. Bridge and culvert data were also obtained by field surveys. The overbank portions of the cross sections were obtained from topographic maps at a scale of 1:2,400, with contour intervals of 2, 4, and 5 feet (Riverside County Flood Control and Water Conservation District. 1966, et cetera; Riverside County Flood Control and Water Conservation District, 1982; Riverside County Flood Control and Water Conservation District, 1973 and 1974).

Water-surface elevations of floods of the selected recurrence intervals were computed through use of the USACE HEC-2 step-backwater computer program (USACE, 1973), with the exception of North Side Wolf Valley, for which elevations were determined through shallow flooding analyses.

Field surveys were performed for Pechanga Creek to obtain cross-sectional data within the limits of the stream channel. The overbank portions of the cross sections were obtained from topographic maps referenced above.

Roughness coefficients used in the hydraulic analyses on Pechanga Creek were estimated by field inspection. For Pechanga Creek, starting water-surface elevations were determined by the slope/area method, an option in the HEC-2 program (USACE, 1973).

The HEC-2 analysis on Pechanga Creek was extended beyond the upstream limit of detailed study to investigate the likelihood of flow transfer from the creek to the northern half of Wolf Valley. A field inspection of the area indicated that such a transfer was most likely near the intersection of Pala and Pechanga Roads. An eroded channel of considerable size is present at this site and appears to represent a former flow path for Pechanga Creek. The HEC-2 analysis found that the present channel was sufficiently large to contain nearly all of the flood discharge and only relatively small quantities of water overflowed into the abandoned channel. The discharge predictions on Pechanga Creek downstream of Pala Road and on the North Side of Wolf Valley were adjusted to account for this minor transfer of water (see Section 3.1). Due to the unpredictability of the processes involved, this analysis did not consider the possibility of Pechanga Creek completely changing its course within Wolf Valley. Although such an event is possible, no accounts of past shifts in the course of the creek were found.

On Pechanga Creek, in areas where the backwater analyses indicated supercritical flow conditions, critical depth was assumed for the flood elevations because of the inherent instability of supercritical flow.

The analysis of North Side Wolf Valley assumed that the drainage ditch adjacent to Pala Road would be the concentration point for very shallow sheetflows originating in the mountains to the north and east.

The approximate floodplain boundaries shown on portions of Pechanga Creek were based upon the results of HEC-2 computer backwater runs in adjacent detailed-study areas.

Revised Analyses

Information on the methods used to determine peak discharge-frequency relationships for the streams restudied as part of this countywide FIS is shown below.

The 1-percent annual chance peak discharges used in the hydraulic analysis were based on values published in the effective FIS reports for the unincorporated areas of Riverside County (FEMA, 1992) and the City of Lake Elsinore (FEMA, 1990).

The hydraulic analysis for Temescal Wash was performed using the USACE HEC-2 computer program (USACE, 1973).

The cross sections used in the hydraulic analysis were obtained from topographic maps obtained from the RCFCWCD (Riverside County Flood Control and Water Conservation District, 1980) and field surveys.

The San Jacinto River was studied from the Ramona Expressway to Bridge Street. The reaches just downstream of the Ramona Expressway and just upstream of Bridge Street were studied by approximate methods.

The 1-percent annual chance peak discharges were taken from a report prepared by the RCFCWCD (Riverside County Flood Control and Water Conservation District, 1975).

The hydraulic analysis for the San Jacinto River was also performed using the HEC-2 computer program, and the cross sections used in this analysis were also taken from topographic maps supplied by the RCFCWCD (Riverside County Flood Control and Water Conservation District, 1980).

The starting water-surface elevation was determined using the slope/area method, beginning approximately 300 feet downstream of the Ramona Expressway.

The San Jacinto River was analyzed assuming the existing bank levees would be ineffective because the water-surface elevations are generally higher than the top of the levees and because, in some areas, there are no levees on the left bank.

It was also determined that a portion of the 1-percent annual chance flow would be diverted through a secondary channel around an island (San Jacinto River – Secondary Channel). Using the split-flow option, this flow was determined to be approximately 17,500 cfs.

The equal conveyance reduction method was used to determine the floodway for the main river and for the Secondary Channel.

The hydraulic analysis for Murrieta Creek was performed using the HEC-2 computer program (USACE, 1973). The cross sections used for this analysis were determined from 4-foot contour interval, 1:12,000-scale topographic maps developed by Aelytek, Inc. (Aelytek, Inc., 1990).

The starting water-surface elevation for Murrieta Creek was taken from a contiguous study.

The Martinez Canyon alluvial fan is subject to active alluvial fan flooding. The base flood discharges for Martinez Canyon were computed using regional regression equations developed by the USGS (B. E. Thomas, 1993).

The value for the 1-percent annual chance peak discharge used for the hydraulic analyses of the Whitewater River was taken from the FIS report for the City of Palm Springs, dated September 2, 1982 (FEMA, 1982), and from the previously effective version of this FIS, dated September 27, 1991.

The hydraulic analyses for the Whitewater River were performed using the USACE HEC-2 step-backwater computer program (USACE, 1973).

For the reach from approximately 1,450 feet downstream of Date Palm Road to Date Palm Road, the cross sections used for this analysis were determined from a survey performed by the Coachella Valley Water District dated February 20, 1995. For the reach from Date Palm Road to Cathedral Canyon Drive, the cross sections were determined from 2-foot contour interval, 1:2,400-scale topographic work maps developed by Cooper Aerial of Phoenix (Aelytek, Inc., 1990). For the reach from Cathedral Canyon Drive to approximately 1,950 feet downstream of 34th Avenue (Dinah Shore Drive), the cross sections used for this analysis were determined from 1-foot contour interval, 1:1,200-scale topographic work maps developed by Metrex Systems Corporation (Nolte and Associates, 1992). For the reach from approximately 1,950 feet downstream of 34th Avenue (Dinah Shore Drive) to approximately 3,800 feet upstream of Vista Chino Road, the cross sections were determined from 4-foot contour interval, 1:12,000-scale topographic maps developed by Aelytek, Inc. (Aelytek, Inc., 1990).

The starting water-surface elevation for the hydraulic analysis of the Whitewater River was determined from a contiguous study.

Channel and overbank roughness factors (Manning's "n") used in the hydraulic computations were determined from aerial photography and field observations. For the portions of the floodplain in urban areas, the "n" values were adjusted according to Hejl and Kans (Hejl, H. R., 1977). For the Whitewater River channel from approximately 1,450 feet downstream of Date Palm Road to approximately 1,800 feet downstream of 34th Avenue and from 34th Avenue to approximately 3,800 feet upstream of Vista Chino Road, an "n" value of 0.04 was used; for the channel from approximately 1,800 feet downstream of 34th Avenue to 34th Avenue, an "n" value of 0.035 was used. For the overbank areas, the "n" values range from 0.040 to 0.2.

There are levees on both the left (looking downstream) bank and right (looking downstream) bank of the Whitewater River upstream of Palm Canyon Drive. The left levee is within the City of Cathedral City with the exception of the reach just downstream of Ramon Road which is located within the Agua Caliente Indian Reservation. The Riverside County Flood Control and Water Conservation District is responsible for the maintenance of the right levee and the CVWD is responsible for the maintenance of the left levee.

The limits of the floodplain were determined according to FEMA's levee failure analysis requirements (FEMA, 1991). The levee system on the right bank has not been certified by a federal agency as providing protection from the 1-percent annual chance flood and this entire system was assumed to fail during the 1-percent annual chance flood. The CVWD has certified the portion of the right levee between Dinah Shore Road (34th Avenue) and Vista Chino Road; this reach of the right levee was assumed to hold. A floodway was determined as part of the right levee failure analysis.

The 1-percent annual chance flooding associated with Big Morongo Wash was determined using approximate methods from its confluence with the Whitewater River to I-10.

The 1-percent annual chance flow rates for Big Morongo Wash were taken from values published by the RCFCWCD (Schall, James D., 1989). Where the Southern Pacific Railroad (SPRR) crosses Big Morongo Wash, floodwater split, some following a path eastward between the I-10 and SPRR embankments and the remainder flowing south toward the Whitewater River. A HEC-2 hydraulic analysis showed that most of the floodwaters that flow toward the Whitewater River will breach the levee on the left side (looking downstream) of Morongo Wash, just downslope of the SPRR, causing overland flooding to the area south of and parallel to the SPRR.

The approximate 1-percent annual chance floodplain limits associated with the Big Morongo Wash overland flooding were determined using 2-foot contour interval, 1:2,400-scale topographic work maps developed by Cooper Aerial of Phoenix (Cooper Aerial of Phoenix, 1989).

As part of this revision, the format of the map panels has changed. Previously, flood-hazard information was shown on both the FIRM and Flood Boundary and Floodway Map (FBFM). In the new format, all base flood elevations, cross sections, zone designations, and floodplain and floodway boundary delineations are shown on the FIRM and the FBFM has been eliminated. Some of the flood insurance zone designations were changed to reflect the new format. Areas previously shown as numbered Zone A were changed to Zone AE. Areas previously shown as Zone B were changed to Zone X (shaded). Areas previously shown as Zone C were changed to Zone X (unshaded). In addition, all Flood Insurance Zone Data tables were removed from the FIS report and all zone designations and reach determinations were removed from the profile panels.

The hydraulic analysis was performed using the USACE HEC-2 computer program (USACE, 1973). Floodplain limits were delineated based on as-built construction drawings provided by the RCFCWCD (John M. Tettemer & Associates, 1995) and a 1:1,000-scale topographic map (John M. Tettemer & Associates, 1992).

The values of the 1-percent annual chance peak discharge and the starting water-surface elevation used for the hydraulic analysis of the Whitewater River were taken from the previous version of this FIS.

For the Whitewater River channel between Cathedral Canyon Drive and approximately 1,950 feet downstream of Vista Chino Road, the roughness factor (Manning's "n" value) of 0.040 was taken from the previous version of this FIS. For the overbank areas, an "n" value of 0.035 was used for the entire revised section of the river (John M. Tettemer & Associates, 1994).

A rechannelization resulted in reducing the 1-percent annual chance peak discharge on Wash D from 540 cfs to 530 cfs. The detailed study reach length is 2.3 miles, starting 5.0 miles upstream of the Lake Elsinore levee and ending 2.7 miles upstream of the Lake Elsinore levee, on the San Jacinto River. The analysis included Wash D, studied by approximate methods, at its new location just upstream from the confluence of the San Jacinto River and the Interstate 15 bridge. The study was conducted using 1-percent annual chance discharge values only. Roughness coefficients (Manning's "n") used in the computations were determined by the Cowan method (Chow, Ven Te, 1959, Computation of "n" values Using Cowan's Method, Chapter 5, Open Channel Hydraulics). A field trip to the City of Lake Elsinore was made to obtain the information needed for the selection of roughness values, which were determined to be 0.04 in both the channel and the overbank portions of the San Jacinto River which were restudied. The City of Lake Elsinore provided new topographic maps for the study area (Topographic Maps, 1987).

The USACE HEC-RAS program was used as the method of hydraulic analysis (USACE, 1998). Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data Table in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Readers should be aware of the unusual hydraulics of Lake Elsinore's outlet channel. The channel flows into the lake during low-lake levels and out of the lake during high levels. The Elsinore Spillway Channel flows from Lake Elsinore and extends to the crest, which forms a junction with Wasson Canyon Creek and Temescal Wash of the outlet channel. Flow from Wasson Canyon divides at the junction with the outlet channel; a portion will flow from the spillway to the lake and the rest will flow from Temescal Wash of the outlet channel to Walker Canyon. The 1978 FEMA study determined that 60 percent of Wasson Canyon could flow into the spillway channel and 80 percent could flow into Temescal Wash because the Temescal Wash reach is slightly steeper. However, because of established water rights, it was required that the Wasson split must be 50/50. The 50/50 split was enforced by making a 35-foot bottom in the spillway channel and a 20-foot bottom with a choke plate in the Temescal Wash.

The choke plates is located below Chaney Avenue, just above the junction with the Third Street Channel.

The hydraulic roughness factors (Manning's "n") for the new study areas have been changed to better represent the channels. Lake Elsinore Spillway has values from 0.015 to 0.028 in the channel and 0.045 for the overbank areas. The San Jacinto River has values from 0.03 to 0.04 in the channel and for the overbank areas. Temescal Wash has values from 0.028 to 0.060 in the channel and 0.035 to 0.050 for the overbank. Wasson Canyon Creek has values from 0.015 to 0.04 in the channel and 0.05 for the overbank areas.

Cross-sectional information was obtained from the Riverside County Flood Control and Water Conservation District topography maps (Riverside County Flood Control and Water Conservation District, 1964) and as-built construction drawings of recently completed subdivisions in the area.

The existing levees along the Perris Valley Storm Drain channels do not provide 1-percent annual chance flood protection for the surrounding areas, and base flood elevations were computed as if the levees did not exist. The hydraulic analysis shows that the 1-percent annual chance flood overtops the channel banks and forms a shallow, wide floodplain in the overbank areas. A large island of approximately 250 acres emerges along Perris Boulevard and splits the discharge of 6,985 cfs. The flood depths in the overbank areas average from one to two feet, and are designated Zone AH.

The 1-percent annual chance peak discharges for Murrieta Creek were based on the values published in the FIS report for the unincorporated areas of Riverside County, California (FEMA, 1984), and in California Department of Water Resources Bulletin No. 183-2 (California Department of Water Resources, 1975).

Murrieta Creek has sand levees that extend along both banks from approximately 500 feet downstream of Winchester Road to approximately 900 feet downstream of Washington Avenue. These levees have not been certified by a Federal agency as providing protection from the 1-percent annual chance flood. The levees are continuous, with the exception of the Cheery Street dip crossing, the convergence of Warm Springs Creek, and the convergence of Santa Gertrudis Creek.

The RCFCWCD performed a hydraulic analysis of Murrieta Creek from approximately 4,500 feet downstream to approximately 3,700 feet upstream of Winchester Road. This analysis revised the Manning's "n" values used by Schaaf and Wheeler and assumed simultaneous failure of the levees. Because simultaneous levee failure was deemed to be unlikely, the Schaaf and Wheeler analysis was revise by the Technical Evaluation Contractor to incorporate the Manning's "n" values from the RCFCWCD analysis. Two flooding situations were evaluated to map the

Special Flood Hazard Area (SFHA) along the right overbank of Murrieta Creek: flooding due to failure of the right levee and overflow along the right overbank. The results of the right-levee-failure analysis were used to map the right-overbank flooding, designated Zone AE. The results of the overflow analysis were used to map the right-overbank flooding, designated Zone AH. The SFHA along the left overbank was evaluated based on flooding due to failure of the left levee. A floodway configuration was also developed by the RCFCWCD and incorporated into the hydraulic model. The left floodway boundary developed by the RCFCWCD is shown on the effective FIRM.

Two Letters of Map Revision (LOMRs) were incorporated into FIRM Panels 0005 and 0010 for the City of Temecula as part of this restudy:

The LOMR issued July 19, 1994, showed the effects of a revised hydraulic analysis based on updated topographic data along Santa Gertrudis Creek from just downstream of Winchester Road to North General Kearney Road, channelization of Santa Gertrudis Creek from just upstream of North General Kearney Road to Joseph Road, and the construction of the North General Kearney Road bridge. As a result of this revision, the 1-percent annual chance floodplain decreased from approximately 900 feet downstream of Winchester Road to approximately 400 feet upstream of Joseph Road.

The LOMR issued January 25, 1996, showed the effects of updated topographic information along Temecula Creek from just upstream of Highway 79 to Butterfield Stage Road, the channelization of Temecula Creek from Butterfield Stage Road to approximately 4,200 feet downstream of Margarita Road, and the construction of bridges at Butterfield Stage and Margarita Roads. As a result of this revision, the width of the SFHA along Temecula Creek increased in some areas and decreased in others. The base flood is contained within the identified channel banks along the channelized reach of Temecula Creek from approximately 400 feet upstream to approximately 4,200 feet downstream of Margarita Road.

Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

Roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and were based on field observations of the streams and floodplain areas. Roughness factors for all streams studied by detailed methods are shown in Table 6, "Manning's "n" Values."

TABLE 6 - MANNING'S "n" VALUES

Stream	Channel "n"	Overbank "n"
Bautista Wash	0.030 – 0.080	0.065 – 0.140
Pechanga Creek	0.040 – 0.080	0.065 – 0.140
Blind Canyon Channel	0.015 – 0.035	0.035
Desert Hot Springs Channel	0.015 – 0.035	0.035

TABLE 6 - MANNING'S "n" VALUES - continued

Stream	Channel "n"	Overbank "n"
Perris Valley Storm Drain	0.030	0.030
San Jacinto River	0.025 – 0.060	0.025 – 0.060
East Gilman Home Channel	0.017	0.035
East Pershing Channel	0.040	0.040
Gilman Home Channel	0.015 – 0.035	0.030 – 0.100
Highland Springs Channel	0.015	0.040 – 0.050
Indian Canyon Channel	0.017	0.035 – 0.100
Montgomery Creek	0.015 – 0.035	0.031 – 0.100
Ramsey Street Drain	0.014 – 0.035	0.017 – 0.100
San Gorgonio River	0.035	0.040
Sidney Street Channel	0.014 – 0.020	0.035 – 0.060
Smith Creek	0.027	0.035
Smith Creek West Tributary	0.030	0.040
West Pershing Channel	0.015 – 0.040	0.030 – 0.035
Beaumont Channel	*	0.015 – 0.080
Cherry Avenue Channel	0.015 – 0.040	0.030 – 0.080
Marshall Creek	0.030 – 0.050	0.035 – 0.040
Whitewater River	0.020 – 0.400	0.030 – 0.100
West Cathedral Channel	0.014	0.014
East Cathedral Channel	0.030	0.030
Palm Canyon Wash	0.030	0.030
North Cathedral Channel downstream of confluence with West Cathedral Channel	0.014	0.050 – 0.080
North Cathedral Channel upstream of confluence with West Cathedral Channel	0.015 – 0.125	
Tramview Wash	0.015 – 0.125	
Tramview Wash Tributary	0.015 – 0.125	
Arlington Channel	0.015	0.040
Lincoln Avenue Drain	*	0.030 – 0.060
Main Street Channel	0.015	0.040 – 0.125
Mangular Channel	0.015 – 0.075	0.020 – 0.075
North Norco Channel	0.030 – 0.060	0.035 – 0.095
Oak Street Channel	0.018 – 0.065	0.030 – 0.080
South Norco Channel	0.030 – 0.050	0.035 – 0.095
South Norco Channel Tributary A	0.035 – 0.045	0.035 – 0.125
Temescal Wash	0.030 – 0.100	0.025 – 0.095
West Norco Channel	0.035 – 0.060	0.030 – 0.100
Country Club Creek	0.035 – 0.060	0.030 – 0.100
Stetson Avenue Channel	0.015	0.035 – 0.040
Whittier Avenue Channel	0.013	0.035 – 0.040
Salt Creek	0.035	0.035
Salt Creek Tributary	0.035	0.035
Deep Canyon Storm Water Channel	0.016 – 0.030	0.025 – 0.060
Elsinore Spillway Channel	0.040 – 0.060	0.035 – 0.090
Temescal Canyon	0.035 – 0.060	0.035 – 0.045

TABLE 6 - MANNING'S "n" VALUES - continued

Stream	Channel "n"	Overbank "n"
Wasson Canyon Creek	0.030 – 0.050	0.035 – 0.050
Rice Canyon	0.030 – 0.040	0.035 – 0.050
Arroyo Del Toro	0.040 – 0.045	0.045 – 0.050
Leach Canyon	0.015 – 0.040	0.030 – 0.075
Channel H	0.015 – 0.040	0.040 – 0.090
Ortega Channel	0.015 – 0.040	0.035 – 0.085
Wash D	0.024 – 0.040	0.035 – 0.050
Stovepipe Canyon Creek	0.020 – 0.030	0.020 – 0.030
Lime Street Channel	0.015 – 0.018	0.035 – 0.050
Wash I	*	0.030 – 0.090
Wash G	0.014 – 0.050	0.040 – 0.090
McVicker Canyon	0.030 – 0.040	0.035 – 0.050
Murrieta Creek	0.020 – 0.035	0.025 – 0.035
North Norco Channel, Tributary A	0.015 – 0.040	0.035 – 0.100
North Norco Channel, Tributary B	*	0.075 – 0.080
North Norco Channel, Tributary C	*	0.070
Santa Ana River	0.060	0.060
South Norco Channel, Tributary B	0.030 – 0.075	0.045 – 0.095

Levee Failure Analysis

Flood hazard information presented on the previously effective FIRM and in the FIS report is based, in some areas, on flood protection provided by the levees identified on the enclosure. Based on the information available and on the mapping standards of the National Flood Insurance Program (NFIP) at the time that the FIS was performed, FEMA accredited the levees with providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year. For FEMA to continue to accredit the identified levees with providing protection from the base flood, the levees must meet the criteria of the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10), titled "Mapping of Areas Protected by Levee Systems".

FEMA and the communities coordinated to compile a list of levees based on information from the FIRM and community information.

On August 22, 2005, FEMA issued Procedure Memorandum No. 34 - Interim Guidance for Studies Including Levees. The purpose of the memorandum was to help clarify the responsibility of community officials or other parties seeking recognition of a levee by providing information identified during a study/mapping project. Often, documentation regarding levee design, accreditation, and the impacts on flood hazard mapping is outdated or missing altogether. To remedy this, Procedure Memorandum No. 34 provides interim guidance on procedures to minimize delays in near-term studies/mapping projects, to help our mapping partners properly assess how to handle levee mapping issues.

While 44 CFR Section 65.10 documentation is being compiled, the release of more up-to-date DFIRM panels for other parts of a community or county may be delayed. To minimize the impact of the levee recognition and certification process, FEMA issued Procedure Memorandum No. 43 - Guidelines for Identifying Provisionally Accredited Levees on March 16, 2007. These guidelines will allow issuance of preliminary and effective versions of DFIRMs while the levee owners or communities are compiling the full documentation required to show compliance with 44 CFR Section 65.10. The guidelines also explain that preliminary DFIRMs can be issued while providing the communities and levee owners with a specified timeframe to correct any maintenance deficiencies associated with a levee and to show compliance with 44 CFR Section 65.10.

FEMA contacted the communities within Riverside County to obtain data required under 44 CFR 65.10 to continue to show the levees as providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year.

FEMA understood that it may take time to acquire and/or assemble the documentation necessary to fully comply with 44 CFR 65.10. Therefore, FEMA put forth a process to provide the communities with additional time to submit all the necessary documentation. For a community to avail itself of the additional time it had to sign an agreement with FEMA. Levees for which such agreements were signed are shown on the effective DFIRM as providing protection from the flood that has a 1-percent-chance of being equaled or exceeded in any given year and labeled as a Provisionally Accredited Levee (PAL).

Approximate levee failure analyses were carried out for the levees to indicate the extent of the levee failure floodplains. The methodology used in these analyses is discussed below.

Levees 1 and 2 are located on the Santa Ana River. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levee 3 is located on the Santa Ana River. A review of the topographic information found this structure is actually slope protection and not a levee. Therefore, no levee failure analysis was performed. Furthermore, the attributes of this structure in the DFIRM database were changed to not indicate this structure as a levee.

Levee 5 is located on Temescal Wash. An attempt was made to map the riverside base flood elevations on the landward side of the levee using detailed topographic data provided by Riverside County. Using the riverside base flood elevations, a levee failure floodplain could not be mapped on the landward side of the levee. Therefore, no levee failure floodplain is recommended.

Levees 6, 7, and 8 are located on Perris Valley Storm Drain Lateral "B". A review of the detailed as-built and topographic information found that the channel was incorrectly labeled as a levee on the previous FIRM. As these structures are channel not levees, no levee failure analysis was performed. Furthermore, the attributes of this structure in the DFIRM database were changed to not indicate this structure as a levee.

Levee 9 is located on Chino Canyon. For the western part of Levee 9, the levee failure floodplain was developed using Alluvial Fan analysis. A discharge of 4,000 cfs was computed for a drainage area of 49 sq. mi. using the USGS NFF equations for California. The floodplain was mapped using contours derived from detailed topographic data provided by Riverside County and USGS 10-meter DEMs. For the eastern part of Levee 9, the levee failure floodplain was developed by mapping the riverside base flood elevations on the landward side of the levee using contours derived from detailed topographic data provided by Riverside County and USGS 10-meter DEMs. The floodplain was further smoothed to follow contours.

Levees 10, 20, and 23 are located on Whitewater River. In the appeal to the flood hazards along the Whitewater River, FEMA issued an appeal resolution on December 18, 1995, that certified parts of the levees along the Whitewater River. Levees 10, 20, and 23 fall within sections of the levees that were certified by this document. Therefore, no levee failure analysis was performed for these levees.

Levee 11 is located on San Jacinto Reservoir. On reviewing the aerial imagery it was found that the embankments of the San Jacinto Reservoir were incorrectly attributed as being levees. As these structures are embankments, no levee failure analysis was performed. Furthermore, the attributes of this structure in the DFIRM database were changed to not indicate this structure as a levee.

Levees 12 and 13 are located on Tahquitz Creek Channel. A review of the detailed as-built and topographic information found that the channel was incorrectly labeled as a levee on the previous FIRM. As these structures are a channel and not levees, no levee failure analysis was performed. Furthermore, the attributes of this structure in the DFIRM database were changed to not indicate this structure as a levee.

Levee 14 is located on Palm Canyon Wash and Arenas Canyon Creek. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levee 15 is located on Palm Canyon Wash. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levee 16 is located on Tahquitz Creek. Based on engineering judgment the shaded Zone X behind these levees was modified based on contours developed from USGS 10-meter DEMs to develop the recommended levee failure floodplain.

Levees 17 and 18 are located on West Cathedral Channel. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levee 19 is located on Whitewater River. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levees 21 and 22 are located on East Cathedral Channel. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levees 24 and 25 are located on Bautista Creek. A review of the topographic information and imagery found that these structures are actually channels and not levees. As these structures are channel and not levees, no levee failure analysis was performed. Furthermore, the attributes of this structure in the DFIRM database were changed to not indicate this structure as a levee.

Levee 26 is located on the Whitewater River. A review of the contours, obtained from the USGS 10-meter DEMs, on the landward side indicated that the ground elevation was higher than the levee. No detailed topographic information was available for this area from Riverside County. As the ground elevations behind the levee were higher than the levee, no levee failure analysis was conducted.

Levee 27 is located on Palm Valley Stormwater Channel. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levee 28 is located on Whitewater River. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levees 29 and 33 are located on Palm Valley Stormwater Channel. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levee 30 is located on Whitewater River. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levees 31 and 32 are located on Whitewater River. The levee failure floodplain was developed using engineering judgment based on alluvial fan analysis concepts and contours developed from USGS 10-meter DEMs.

Levees 34 and 35 are located on Haystack Channel; Zone AO flooding. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levees 36 and 38 are located on Whitewater River. Based on engineering judgment the levee failure floodplains were delineated using contours derived from the USGS 10-meter DEMs.

Levee 37 is located on Deep Canyon Storm Water Channel. Based on engineering judgment the levee failure floodplain was delineated using contours derived from the USGS 10-meter DEMs.

Levee 39 is located on Channel A; Zone AO flooding. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levee 40 is located on Bear Creek. Based on engineering judgment the shaded Zone X behind these levees was recommended as the levee failure floodplain.

Levees 41, 42, and 43 are located on Murrieta Creek. The FISs for the City of Temecula and City of Murrieta (both dated November 20, 1996), state that the levees along Murrieta Creek were not certified and, as such, the flood hazards for Murrieta Creek were revised to reflect the levee failure conditions. Therefore, as the FIRM reflects the levee failure floodplain no levee failure analysis was performed.

Levees 44 and 45 are located on North Shore Beach Channel. The levee failure floodplain was developed using engineering judgment based on alluvial fan analysis concepts and contours developed from USGS 10-meter DEMs.

Levee 158 is located on the San Jacinto River. The levee failure floodplain was developed using engineering judgment based on alluvial fan analysis concepts and contours developed from USGS 10-meter DEMs.

Levee 184 is located on San Gorgonio River. A review of the topographic information found this structure is actually slope protection not a levee. Therefore, no levee failure analysis was performed. Furthermore, the attributes of this structure in the DFIRM database were changed to not indicate this structure as a levee.

Levee 200 is located on Big Morongo Wash. Letter of Map Revision Case Number 06-09-B312P, issued on May 30, 2006, reviewed detailed engineering information for this levee and found that the levee did provide protection from the base flood. Therefore, no failure analysis was performed.

Levee 575 does not provide protection from the base flood and therefore no failure analysis was performed.

3.3 Vertical Datum

All FISs and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FISs and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the finalization of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are being prepared using NAVD 88 as the referenced vertical datum.

Flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD 88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the NGVD and NAVD, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS 12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS provides 1-percent annual chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent annual chance flood elevations; delineations of the 1- and 0.2-percent annual chance floodplains; and 1-percent annual chance floodway. This information is presented on the FIRM and in many components of the FIS, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:2,400 with contour intervals of 2, 4, and 5 feet (USACE, 1978; Riverside County Flood Control and Water Conservation District, 1982; Riverside County Flood Control and Water Conservation District, 1973 and 1974); topographic maps at a scale of 1:4,800 with a contour interval of 4 feet (USACE, 1971); and topographic maps at a scale of 1:24,000 with contour intervals of 20 and 40 feet (U.S. Department of the Interior, 1973, 7.5-Minute Series Topographic Maps); topographic maps at a scale of 1:2,400 and 1:12,000, with a contour interval of 4 feet and 40 feet, respectively; using aerial photographs at a scale of 1:2,400 (Riverside County Flood Control District, 1974).

Processes of erosion and deposition that cannot be modeled in the HEC-2 analyses or by other computation methods are often the most damaging effects of major floods in Riverside County. On streams where these factors are of major importance, heavy reliance was placed on historical flood limits to establish floodplain boundaries.

For most of the streams studied by approximate methods, the boundary of the 1-percent annual chance flood was taken from the most reliable information available. The RCFCWCD provided floodplain boundary maps for Jenson Creek, Perris Valley Storm Drain, and Day Creek (Riverside County Flood Control and Water Conservation District, 1974). The California Department of Water Resources report, Riverside County Flood Hazard Investigation – Murrieta Creek, provided boundaries for Murrieta Creek (California Department of Water Resources, 1975). Floodplain Information reports by the USACE provided floodplain boundaries for Salt Creek (USACE, 1969), San Gorgonio River (USACE, June 1973), and San Jacinto River (USACE, 1970). On streams where no reliable floodplain boundary information was available, floodplain boundaries were determined on the basis of approximate hydrologic and hydraulic calculations in conjunction with field investigations by hydraulic engineers.

The 1- and 0.2-percent annual chance floodplain boundaries for Marshall Creek and Highland Springs Channel were taken from the FIS of the City of Beaumont (U.S. Department of Housing and Urban Development, 1978); for portions of Salt Creek, from the FIS for the City of Hemet (U.S. Department of Housing and Urban Development, 1978); for Smith Creek, from the FIS for the City of Banning (U.S. Department of Housing and Urban Development, 1978); for portions of Temescal Wash, from the FIS for the City of Corona (U.S. Department of Housing and Urban Development, 1978); for McVicker Canyon and Ortega Wash, from the FIS for the City of Lake Elsinore (U.S. Department of Housing and Urban Development, 1980); and for Desert Hot Springs Channel, from an unpublished FIS for the City of Desert Hot Springs (U.S. Department of Housing and Urban Development, unpublished).

In areas where the flood hazard consists of shallow flooding on alluvial, sloping plains, flood boundaries were determined by a combination of extensive field investigation, analysis of the latest topography, normal depth calculations, and historical flooding data.

Boundaries for the 0.2-percent annual chance storm in segments of Gilman Home Channel – Stage I Improvements, Montgomery Creek Channel, and West Pershing Channel were determined by plotting the topwidth of the discharge in excess of the channel capacity according to topography. Depths were then checked using Manning's equation.

The discharges from Ramsey Street Drain and Gilman Home Channel were combined at the point of convergence and weir calculations defined the width of the flood boundaries. The AO Zone from George Street to Livington Street on Gilman

Home Channel was determined by plotting a potential boundary according to topography, containing the flow within that boundary, and checking the depths. This AO zone represents the relatively more severe hazard close to the channel than on the fringes of the 1-percent annual chance boundary.

East Gilman Home Channel is an old Works Progress Administration rubble channel. The capacity of the channel was determined and the excess was treated as sheet flow with the limits determined by topography and field investigation and depths checked using Manning's equation.

On Highland Springs Channel at Wilson Street, where the channel becomes a subterranean reinforced-concrete box, capacity was determined and the excess discharge was treated as sheet flow with boundaries being determined by topography and field inspection. Depths were checked against top widths, using Manning's equation.

Indian Canyon Channel is another old Works Progress Administration channel and was analyzed in the same fashion as East Gilman Home Channel and the lower portion of Gilman Home Channel.

For Montgomery Creek Channel, all discharges in excess of the channel capacity were treated as sheet flow according to topography and field investigation, with depths checked against top widths for each discharge. The portion of the discharge for both the 1- and 0.2-percent annual chance frequency storms which did not make it through the Ramsey Street culvert was treated as a sheet flow analysis and followed across the freeway and along the Southern Pacific Railroad to the point where it joins the overflow from Gilman Home Channel at 8th Street.

Flood boundaries for Smith Creek were taken from the USACE Floodplain Information report for the San Gorgonio River and Smith Creek (USACE, June 1973). These were checked by obtaining the original work sheets and computer card decks and running the HEC-2 program using these decks.

On Sidney Street Channel, from the mouth of the canyon down to the confluence with Indian Canyon, the capacity of the channel was determined from the improvement plans and the excess discharge treated as overland flow with boundaries determined by topography and field investigation and depths checked by using Manning's equation.

The 1-percent annual chance frequency flood boundaries for approximate studies were determined by utilizing existing topographic mapping and by approximate hydraulic calculations. Discussion of these procedures as applied to individual watercourses follows.

The boundaries of the approximate study reaches at the lower end of Pershing Creek were delineated by topography as the channel is well incised here.

East Pershing Channel was treated as an approximate study (drainage area less than 1.0 square mile), and 1-percent annual chance flood boundaries were determined by topography and hand calculations using Manning's equation at selected cross sections.

Smith Creek East Tributary channel was treated as an approximate study (drainage area less than 1.0 square mile), and 1-percent annual chance flood boundaries were determined by topography.

The boundaries of the portion of the San Gorgonio River that were studied by approximate methods were determined by topography; depths were checked at the plotted top width.

Boundaries for Gilman Home Channels A and B, Hargrave Street Drain, Montgomery Creek Tributary, and the upper end of Sidney Street Channel were determined by approximate methods according to topography.

In the City of Beaumont, in areas where the flood hazard consists of shallow flooding on alluvial sloping plains, flood boundaries were determined by a combination of extensive field investigation, analysis of the normal depth calculations, and historical flooding data.

In all areas where the flooding was due to overland sheet flow, boundaries were determined by topography in conjunction with extensive field investigation, and depths were determined from Manning's equation according to plotted top width.

Approximate flood boundaries in some portions of the study area were taken from the Federal Insurance Administration's Flood Hazard Boundary Map (FHBM) (U.S. Department of Housing and Urban Development, 1976).

Flood boundaries for East and West Cathedral Channels and North Cathedral Channel below the confluence with West Cathedral Channel were interpolated using topographic maps at a scale of 1:24,000, with a contour interval of 10 feet.

Flood boundaries on the alluvial fan of Tramview Canyon were delineated using the topographic maps referenced above, and reduced to a scale of 1:7,200, based on the methods discussed in Section 3.2.

For other shallow flooding areas, flood boundaries were delineated on the topographic maps referenced previously, reduced to a scale of 1:4,800, based on historic flooding data and flood depths determined by the methods discussed in Section 3.2.

Floodplain boundaries determined by approximate methods for a small section of El Cerrito Channel were taken from the 1977 FHBM for the City of Corona (U.S. Department of Housing and Urban Development, 1974).

Flood boundaries for Salt Creek-Salt Creek Overflow were delineated using two sources, each applicable to specific portions of the study reach. A USACE report (USACE, 1971) was used to delineate lower portions of the study reach from stream distance 68,800 to stream distance 79,000. The portion of Salt Creek which traverses the southern boundaries of the Seven Hills development, from stream distance 79,000 to stream distance 83,640, was delineated using flood boundaries determined by the RCFCD in an in-depth study of this area (Riverside County Flood Control and Water Conservation District, unpublished).

The Hemet watershed north of Whittier Avenue and northwest of the Hemet Storm Channel was studied in detail by the RCFCD (Riverside County Flood Control and Water Conservation District, unpublished). Flooding in these areas is characterized by random street flooding resulting in the potential shallow flooding of adjacent residential structures. The flood boundaries delineated in the county's study (Riverside County Flood Control and Water Conservation District, unpublished) were used for the present study.

Although the study conducted by the RCFCD was completed in detail, flood boundaries were delineated to reflect approximate methods of determination because of the shallow depth involved. Flood boundaries were adopted with the mutual concurrence of the City and the RCFCD.

Boundaries delineating the flooding on Johnston Avenue were determined through extensive field examination, normal depth calculations at critical street cross sections, analysis of the latest topography, and historical flooding data.

For the upper reaches of Whittier Avenue Channel and Stetson Avenue Channel, an analysis which included a combination of extensive field examination of critical street cross sections, normal depth calculations, and a study of current mapping (U.S. Department of Housing and Urban Development, 1974) was used to determine flood boundaries for these two streams.

Flow from the Elsinore Spillway Channel, downstream of its confluence with Temescal Wash, is well contained in the eastern overbank by the existing topography, with shallow flooding occurring in the western overbank within limits defined by the Atchison, Topeka & Santa Fe Railway. The limits of the 1-percent annual chance flood narrow as the flow approaches Sumner Avenue due to changes in the existing topography.

Approximate 1-percent annual chance floodplain boundaries for certain streams were taken from USGS flood-prone area maps (U.S. Department of the Interior, Sunnymeade, 1974). Kitching Street and Kitching Drain were studied from Fir Avenue downstream to approximately 3,000 feet south of Filaree Avenue. The 1-percent annual chance floodplain boundaries reflect channel improvements made by the Riverside County Flood Control and Water Conservation District (Riverside County Flood Control and Water Conservation District, 1986).

Approximate flood boundaries for the 1-percent annual chance flood for the upstream reach of North Norco Channel, Tributary B were delineated using approximate hydraulic calculations in conjunction with existing topographic mapping (Riverside County Flood Control District, 1968 and 1972).

In areas of the City of Palm Desert where the flood hazard consists of flooding without a defined channel, floodplain boundaries were determined by a combination of extensive field investigation and an analysis of historical flooding data and the latest topography in conjunction with normal-depth calculations.

Boundaries for areas of shallow flooding which include Line "J" Channel and Mountain Avenue Wash above Mapes Road, were determined by a synthesis of normal depth calculations and engineering judgment based on topography and field investigation.

Boundaries for the approximate reach of Perris Valley Storm Drain were delineated using approximate elevations in conjunction with engineering judgment based on topography and field investigation.

On Mountain Avenue Wash, from 4,520 feet upstream from the San Jacinto River, only the 1-percent annual chance floodplain boundaries were delineated and were indicated as an approximate study due to the limited drainage area above that point, which is less than 1.0 square mile.

The 1- and 0.2-percent annual chance floodplain boundaries along Temecula Creek from Pala Road to the limit of detailed study, were delineated on the map at a scale of 1:1,200, with a contour interval of 1 foot (Musser Engineering Consultants, Inc., 1991).

For most of the streams studied by approximate methods, the boundary of the 1-percent annual chance flood was taken from the most reliable information

The RCFCWCD studied Cajalco Creek from the confluence with the Colorado River Aqueduct to Rider Street, approximately 6 miles. Cajalco Creek Tributaries B and C were also studied by the RCFCWCD. Tributary B was studied from the confluence with Cajalco Creek to Sage Street, approximately 1 mile, and Tributary C was studied from the confluence with Cajalco Creek to Markham Street, approximately 1 mile. The 1-percent annual chance peak discharges for Cajalco Creek and its tributaries were determined by the RCFCWCD using the Riverside County Synthetic-Unit Hydrology method described in its Hydrology Manual (Riverside County Flood Control and Water Conservation District, 1978). The hydraulic analysis for Cajalco Creek and its tributaries was performed using the HEC-2 computer program (USACE, 1973). Digitally extracted cross sections were used in the hydraulic analysis.

Mission Creek was studied from the confluence with the Whitewater River to Interstate 10, approximately 1 mile.

The 1-percent annual chance peak discharges for these streams were taken from the report entitled "Mission Creek Flow Conditions Near the I-10 Embankment" (Schall, James D., 1989).

The approximate 1-percent annual chance floodplain boundaries were determined using Manning's equation and highway culvert nomographs (U.S. Department of

Transportation, 1985). Typical channel cross sections were obtained by field measurements and Manning's "n" values were determined from field observations. Channel slopes were taken from USGS topographic quadrangles. Maps provided by the RCFCWCD (Riverside County Flood Control and Water Conservation District, 1980) were used to delineate the floodplain.

In addition, the following LOMRs were included as a part of this restudy:

- The modifications made by the LOMR issued on December 23, 1988, reflect the effects of a channel modification along Day Creek. These modifications are shown on FIRM Panel 0685. As a result of this LOMR, the 1-percent annual chance floodplain boundary delineations and zone designations have been revised along Day Creek, between Limonite and Bellegrave Avenues.

- The modifications made by the LOMR issued on January 9, 1989, reflect the effects of the channelization of Salt Creek and a revised hydraulic analysis of Sun City Channel A-A, a tributary to Salt Creek. These modifications are shown on FIRM Panels 2080, 2085, and 2090 and FBFM Panels 2080 and 2085. The channelization of Salt Creek extends from Interstate Highway 215 to Newport Road. The revised hydraulic analysis of Sun City Channel A-A extends from the confluence with Salt Creek to approximately 650 feet downstream of Sun City Boulevard. As a result of this LOMR, the base flood elevations and SFHA were decreased and the 1-percent annual chance floodway boundary delineations were revised from Interstate Highway 215 to Newport Road for Salt Creek and Sun City Channel A-A. The 1-percent annual chance floodplain and floodway boundary delineations for Salt Creek, in the revised reach, are contained within the improved channel.

- The modifications made by the LOMR issued on April 18, 1990, reflect the effects of channel improvements along Salt and Menifee Valley Creeks. These modifications are shown on FIRM Panels 2085 and 2095. The improvements along Salt Creek extend from Antelope Road to Lindenberger Road and the improvements along Menifee Valley Creek extend from the confluence with Salt Creek to just downstream of Menifee Road. As a result of this LOMR, the 1-percent annual chance flood is contained within the identified channel banks of Salt Creek from just upstream of Antelope Road to Lindenberger Road. In addition, the SFHA decreased along Menifee Valley Creek from the confluence with Salt Creek to just downstream of Menifee Road.

- The modifications made by the LOMR issued on July 17, 1990, reflect the effects of the construction of Paloma Channel from Newport Road to its downstream confluence with Salt Creek. These modifications are shown on FIRM Panels 2085 and 2095. As a result of this LOMR, the 1-percent annual chance flood discharge is contained in Paloma Channel from Newport Road to Salt Creek.

- The modifications made by the LOMR issued on May 22, 1992, reflect a revision to the corporate limits for the City of La Quinta. These modifications are shown on Riverside County FIRM Panel 2260. In addition, an SFHA was added for the Whitewater River and Canyon Wash, based on the revised corporate limits. The source of the added SFHA is the previously effective FIRM for the City of La Quinta, dated June 19, 1985.

- The modifications made by the LOMR issued on March 10, 1993, reflect the effects of the construction of a concrete-lined channel along San Sevaine Channel from approximately 350 feet downstream of San Sevaine Way to just upstream of State Highway 60. These modifications are shown on FIRM Panel 0020 and FBFM Panel 0020.

- The modifications made by the LOMR issued on June 8, 1994, reflect the relocation of Sun City Channels C-C, H-H, and I-I and Sun City Southeast Tributary and the relocation of the corresponding 1- and 0.2-percent annual chance floodplains. These modifications are shown on FIRM Panels 2080 and 2085. As a result of this LOMR, the locations of these channels and the corresponding 1- and 0.2-percent annual chance floodplains were modified. The 1- and 0.2-percent annual chance floodplain boundaries that extend from approximately 300 feet downstream to approximately 1,000 feet upstream of Encanto Drive were shifted approximately 60 feet south. Therefore, some new areas were included in the SFHA and some areas that were previously in the SFHA were removed.

- The modifications made by the LOMR issued on July 15, 1994, reflect the effects of the channelization and relocation of Day Creek from just downstream of Bellegrave Avenue to just upstream of Wineville Road. These modifications are shown on FIRM Panels 0020 and 0685. As a result of this LOMR, the 1-percent annual chance flood is contained within the identified channel banks of Day Creek Channel from just downstream of Bellegrave Avenue to just upstream of Wineville Road, resulting in a decrease in the SFHA.

- The modifications made by the LOMR issued on July 19, 1994, reflect the effects of a revised hydraulic analysis based on updated topographic information along Santa Gertrudis Creek from just downstream of Winchester Road to North General Kearney Road, channelization of Santa Gertrudis Creek just upstream of North General Kearney Road to Joseph Road, and the construction of the North General Kearney Road Bridge. These modifications are shown on FIRM Panels 2745 and 2765. As a result of this LOMR, the SFHA has decreased along the reach between approximately 200 and 3,000 feet upstream of Winchester Road and the reach between approximately 350 feet and just downstream of Joseph Road.

- The modifications made by the LOMR issued on October 23, 1995, reflect the effects of more detailed topographic information for the SFHA along Wineville Road from just upstream of Bellegrave Avenue to approximately 200 feet upstream of Riverside Drive. These modifications are shown on FIRM Panels 0020 and 0685. As a result of this LOMR, the SFHA is removed along Wineville Road for the above-mentioned reach.

- The modifications made by the LOMR issued on May 16, 1995, reflect the effects of a revised analysis of flooding associated with the following flooding sources in the Thousand Palms area; Biskra Palms, Macomber Palms, and West Macomber Palms Channels and Pushawalla and Thousand Palms Canyons. As a result of this revision, base flood depths were added in some areas and removed from others and the SFHA increased in some areas and decreased in others. In areas where the SFHA increased, the zone designation was changed from Zone B or C to Zone AO and base flood depths and velocities were added. In areas where the SFHA decreased, the zone designation was changed from Zone AO to Zone B or C and base flood depths and velocities were removed.

- The modifications made by the LOMR issued on January 25, 1996, reflect the effects of updated topographic information along Temecula Creek from just upstream of Highway 79 to Butterfield Stage Road, the channelization of Temecula Creek from Butterfield Stage Road to approximately 4,200 feet downstream of Margarita Road, and the construction of bridges at both Butterfield Stage and Margarita Roads.

- The modifications made by the LOMR issued on February 16, 1996, reflect the effects of the construction of flood-control facilities associated with Phase I of the Sun City Palm Springs development project in the Thousand Palms area. As a result of this LOMR, the floodplain boundary delineations and zone designations have been revised to credit the flood-control system with providing base-flood protection within an area subject to alluvial-fan flooding from Thousand Palms and Pushawalla Canyons. The SFHA has increased in some areas and decreased in others.

To determine the boundaries of the floodway, the FAN computer program incorporating the results of the regression equation was used (Harty, D. S., 1982). The results of this analysis were used to delineate the floodplain and assign flood zone designations (Exponent Engineering, 2001).

Additional topographic maps were used to delineate the 1-percent annual chance floodplain (U.S. Department of the Interior, 1954, et cetera). The floodway limits were determined using equal conveyance reduction.

The following seven LOMRs were incorporated into FIRM Panels 0005 and 0010 for the City of Corona as a part of this restudy:

- LOMR issued January 20, 1986, to remove the 1-percent annual chance floodplain and floodway along Country Club Creek, between approximately the Atchison, Topeka & Santa Fe Railroad and the Riverside Freeway. The 1-percent annual chance flood is now contained in an underground pipe.

- LOMR issued August 16, 1991, for the channelization (Stages III, IV A, and IV B) of Temescal Wash from its confluence with Arlington Channel to approximately 1,400 feet upstream of Magnolia Avenue; for the construction of the Temescal Channel levee collector system; and for a hydraulic analysis of Arlington Channel from its confluence with Temescal Wash to approximately

11,000 feet upstream. After completion of this project, the 1-percent annual chance flood was determined to be contained within the identified channel banks and the levee system of Temescal Wash and within the identified channel banks of Arlington Channel for the previously mentioned reaches. (A LOMR was also issued for this project on August 16, 1991, for the unincorporated areas of Riverside County; this area has since been annexed to the City of Corona.)

- LOMR issued April 21, 1992, for the construction of the Lincoln Avenue crossing and the Harrington Street berm from the intersection with Lincoln Avenue to a point approximately 1,700 feet upstream along Temescal Wash. The berm acts as a levee and prevents the 1-percent annual chance flood from crossing Harrington Street to the north. Base flood elevations increased from Lincoln Avenue to a point approximately 1,700 feet upstream.

- LOMR issued July 30, 1993, for the construction of a floodwall along the east overbank of the Oak Street Channel from approximately 2,500 feet downstream to approximately 1,200 feet downstream of Ontario Avenue. As a result of this channel modification, the 1-percent annual chance floodplain was decreased along the entire revised reach.

- LOMR issued November 9, 1994, for the construction of a concrete-lined channel along South Norco Channel from just upstream of Lincoln Avenue to just downstream of River Road, and a double 14-foot-wide by 9.5-foot-high reinforced-concrete box culvert. As a result of this channel modification, the 1-percent annual chance floodplain was decreased from just upstream to approximately 700 feet upstream of River Road.

- LOMR issued June 20, 1995, for the construction of the Oak Street Drain Channel from the existing debris basin, downstream of Chase Drive, to its confluence with Temescal Wash. As a result of this channel modification, the 1-percent annual chance floodplain was decreased and the 1-percent annual chance flood is contained within the identified channel banks of the Oak Street Channel and within the existing debris basin for the entire revised reach.

The improved concrete channel contains and relocates the 1-percent annual chance flood flow of Salt Creek through the southern portion of the community. The SFHA along Salt Creek was reduced as a result of the channelization.

This restudy was revised on August 19, 1997, to incorporate LOMR issued on June 28, 1996. The LOMR corrected mismatches between the 1-percent annual chance floodplain boundaries shown on FIRM Panel 0005 C for the City of Hemet, dated September 28, 1990, and those shown on FIRM Panel 2130 B for the unincorporated areas of Riverside County, California, dated September 30, 1988. As a result of this LOMR, the floodplain boundary delineations and zone designations were revised in the southeasternmost section of the City of Hemet, bounded approximately by Chambers Street on the north, State Street on the east, Diamond Road on the south, and Lyon Avenue on the west. In addition, annexations by the City of Hemet from Riverside County have been incorporated. These modifications are shown on FIRM Panel 0005 D.

Elsinore Spillway Channel was modified to contain the floodway and 1-percent annual chance flood from the confluence of Wasson Canyon Creek to the confluence with Lake Elsinore. The 1-percent annual chance flood level of Lake Elsinore was reduced from 1,267.0 feet to 1,263.3 feet. The 1-percent annual chance lake level was lowered because of an improved outlet channel and modified basin shape. A new river channel was constructed for the lower section of the San Jacinto River. It is designed to contain the floodway and 1-percent annual chance flood. This channel runs parallel to Lakeshore Drive. It joins the existing river channel near Elm Street and flows west, for approximately 8,400 feet, to Lake Elsinore. The Temescal Wash floodway and 1-percent annual chance flood are now contained in a channel from the confluence of Elsinore Spillway Channel downstream to Chaney Road. Wasson Canyon Creek has been modified to contain the floodway, 1-percent annual chance flood, and 0.2-percent annual chance flood. This channel runs from its confluence with Elsinore Spillway Channel, upstream approximately 3.4 miles, to the corporate limits of the City of Lake Elsinore.

The limits of the floodplain and floodway were determined according to FEMA's levee-failure-analysis requirements (FEMA, 1991). The floodplain/floodway limit on the left (looking downstream) side of the channel was determined by assuming that the left levee fails during the 1-percent annual chance event; the floodplain/floodway limit on the right (looking downstream) side of the channel was determined similarly. On the unprotected side (channel side) of the levees, the maximum water-surface elevations were computed generally as a result of both levees holding.

For the flooding sources studied by approximate methods, the boundaries of the 1-percent annual chance floodplains were delineated using topographic maps taken from the previously printed FIS reports, FHBMs, and/or FIRMs for all of the incorporated and unincorporated jurisdictions within Riverside County.

The 1- and 0.2-percent annual chance floodplain boundaries are shown on the FIRM (Exhibit 2). On this map, the 1-percent annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 0.2-percent annual chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent annual chance floodplain boundaries are close together, only the 1-percent annual chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 1-percent annual chance floodplain boundary is shown on the FIRM (Exhibit 2).

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent annual chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent annual chance flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this FIS are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this FIS were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain.

Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (Table 7). The computed floodways are shown on the FIRM (Exhibit 2). In cases where the floodway and 1-percent annual chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 7, "Floodway Data." In order to reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

No floodway data are presented, and no floodway was delineated for Desert Hot Springs channel because, for the 1-percent annual chance discharge to be contained within the channel right-of-way, substantial improvements would have to be made.

No floodways have been determined in alluvial fan and shallow flooding areas.

Initially, a floodway was determined for the Perris Valley Storm Drain using equal conveyance reduction from both sides of the channel. The result was an irregular floodway of vastly varying widths, which would be difficult to implement. Subsequently, an analysis was done using a smoother alignment determined by engineering judgment and of the same general width and alignment as the earlier one. A computer analysis of this floodway produced data consistent with Federal Insurance Administration (FIA) guidelines which was acceptable to the City of Perris and the RCFCWCD.

Equal conveyance reduction of the San Jacinto River yielded irregular results; so, a floodway was established using engineering judgment and meeting FIA criteria by the same process described for the Perris Valley Storm Drain.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
1001 Ranch Drain								
A	660[1]	130	1,270	0.4	802.4	802.4	803.4	1.0
B	1,000[1]	140	1,040	0.5	802.4	802.4	803.4	1.0
C	1,940[1]	20	50	8.6	813.5	813.5	814.5	1.0
D	2,450[1]	30	61	7.0	845.6	845.6	846.6	1.0
E	3,320[1]	26	223	2.8	853.2	853.2	853.2	0.0
F	3,670[1]	32	50	7.1	856.6	856.6	856.6	0.0
G	4,050[1]	275	619	0.5	874.6	874.6	874.8	0.2
H	4,475[1]	47	95	3.2	875.0	875.0	875.1	0.1
I	4,780[1]	53	108	2.1	881.8	881.8	882.2	0.4
J	5,370[1]	10	27	8.4	902.1	902.1	903.1	1.0
K	5,750[1]	30	55	4.2	906.4	906.4	907.4	1.0
L	6,590[1]	70	420	0.6	931.8	931.8	932.8	1.0
M	7,570[1]	40	66	1.7	974.6	974.6	975.6	1.0
1001 Ranch Drain West Tributary								
A	0[2]	140	900	0.2	802.4	802.4	803.4	1.0
B	350[2]	70	110	1.5	806.1	806.1	807.1	1.0
C	1,000[2]	40	73	2.3	827.0	827.0	828.0	1.0
D	1,100[2]	190	740	0.3	833.5	833.5	834.5	1.0
E	1,300[2]	250	1,060	0.2	844.7	844.7	845.7	1.0

[1] Feet Above Limit of Detailed Study
[2] Feet Above Confluence With 1001 Ranch Drain

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

1001 RANCH DRAIN – 1001 RANCH DRAIN WEST TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Arenas Canyon Creek								
N[2]	950							
A	3,350	760[3,4]	423	6.9	518.2	517.3[5]	517.3[5]	0.0
B	4,400	760[3,4]	515	5.6	524.8	523.8[5]	523.8[5]	0.0
C	5,270	760[3,6]	962	3.0	525.8	525.2[5]	525.4[5]	0.2
D	6,100	760[3,4]	999	2.9	525.8	525.7[5]	526.2[5]	0.5
E	6,860	760[3,4]	1,538	1.9	525.9	525.9	526.5	0.6

[1] Feet Above Mouth [2] Shared With Palm Canyon Wash-See Palm Canyon Wash for Floodway and Base Flood Water Surface Elevation Data [3] Width as Regulated by Riverside County Flood Control District [4] Width Lies Entirely Within Agua Caliente Indian Reservation [5] Elevation Computed Without Consideration of Overflow From Palm Canyon Wash [6] Width Lies Partially Within Agua Caliente Indian Reservation

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

ARENAS CANYON CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Bear Creek								
A	1,000	1,000	3,157	1.7	42.2	42.2	43.2	1.0
B	4,000	950	3,123	1.7	43.8	43.8	44.8	1.0
C	6,000	770	2,653	1.8	45.0	45.0	46.0	1.0
D	7,800	860	2,752	1.7	47.2	47.2	48.2	1.0
E	8,800	440	874	5.1	50.7	50.7	51.7	1.0
F	14,850	160	264	15.2	142.0	142.0	142.0	0.0
Bedford Canyon Wash								
A	700	127	663.5	6.6	805.6	805.6	806.4	0.8
B	3000	121	416.4	10.5	869.6	869.6	869.6	0.0
Bly Channel								
A	1,270	60	282	8.9	700.6	700.6	701.6	1.0
B	5,900	40	151	8.9	730.4	730.4	731.4	1.0
C	9,150	30	110	10.7	736.7	736.7	736.7	0.0
D	11,980	20	48	18.8	747.5	747.5	747.5	0.0
E	13,235	20	68	11.1	757.1	757.1	758.1	1.0

[1] Feet Above Limit of Detailed Study

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

BEAR CREEK – BEDFORD CANYON WASH
BLY CHANNEL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Calimesa Channel								
A	0	40	230	5.2	2,362.8	2,362.8	2,363.8	1.0
B	380	20	110	11.2	2,375.7	2,375.7	2,375.8	0.1
C	580	80	1,120	1.1	2,388.3	2,388.3	2,388.3	0.0
D	820	30	280	4.3	2,388.3	2,388.3	2,388.3	0.0
E	1,000	80	480	2.5	2,396.1	2,396.1	2,396.1	0.0
F	1,500	30	100	7.0	2,396.5	2,396.5	2,396.9	0.4
G	2,700	40	83	8.5	2,420.0	2,420.0	2,420.0	0.0
H	2,960	15	33	19.1	2,432.4	2,432.4	2,432.4	0.0
I	4,300	10	22	24.1	2,453.0	2,453.0	2,453.0	0.0
J	5,600	10	111	32.0	2,483.3	2,483.3	2,483.3	0.0
K	6,150	40	150	2.4	2,500.7	2,500.7	2,501.7	1.0
L	6,850	30	67	5.2	2,522.7	2,522.7	2,523.7	1.0
M	7,000	40	220	1.6	2,529.2	2,529.2	2,530.2	1.0
N	7,770	50	130	2.8	2,548.2	2,548.2	2,549.2	1.0

[1] Feet Above Limit of Detailed Study

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

CALIMESA CHANNEL – COUNTRY CLUB CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
RIVER MILES	DISTANCE[1]	WIDTH (FEET)[2]	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Colorado River								
107.0	107.0	199	*	*	244.7	244.7	244.7	0.0
108.0	108.0	290	*	*	245.8	245.8	245.8	0.0
109.0	109.0	196	*	*	246.9	246.9	246.9	0.0
110.0	110.0	0	*	*	248.1	248.1	248.1	0.0
111.0	111.0	315	*	*	249.3	249.3	249.3	0.0
112.0	112.0	255	*	*	250.5	250.5	250.5	0.0
113.0	113.0	328	*	*	251.9	251.9	251.9	0.0
114.0	114.0	334	*	*	253.4	253.4	253.4	0.0
115.0	115.0	249	*	*	254.9	254.9	254.9	0.0
116.0	116.0	220	*	*	256.2	256.2	256.2	0.0
117.0	117.0	202	*	*	257.5	257.5	257.5	0.0
118.0	118.0	0	*	*	258.8	258.8	258.8	0.0
119.0	119.0	510	*	*	260.2	260.2	260.2	0.0
120.0	120.0	685	*	*	261.2	261.2	261.2	0.0
121.0	121.0	410	*	*	262.7	262.7	262.7	0.0
122.0	122.0	295	*	*	263.8	263.8	263.8	0.0
123.0	123.0	99	*	*	265.4	265.4	265.4	0.0
124.0	124.0	644	*	*	266.9	266.9	266.9	0.0
125.0	125.0	473	*	*	268.5	268.5	268.5	0.0
126.0	126.0	382	*	*	270.3	270.3	270.3	0.0
127.0	127.0	496	*	*	272.1	272.1	272.1	0.0
128.0	128.0	338	*	*	273.8	273.8	273.8	0.0
129.0	129.0	509	*	*	275.4	275.4	275.4	0.0
130.0	130.0	530	*	*	277.0	277.0	277.0	0.0
131.0	131.0	441	*	*	278.7	278.7	278.7	0.0
132.0	132.0	521	*	*	280.4	280.4	280.4	0.0
133.0	133.0	204	*	*	281.8	281.8	281.8	0.0
134.0	134.0	468	*	*	282.2	282.2	282.2	0.0

[1] Miles above U.S.-Mexico Border

[2] Width inside county (on west)

* Data not available

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

COLORADO RIVER

TABLE 7

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
RIVER MILES	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Colorado River (Cont'd)								
135.0	135.0	435	*	*	288.1	288.1	288.1	0.0
136.0	136.0	563	*	*	290.5	290.5	290.5	0.0
137.0	137.0	519	*	*	292.2	292.2	292.2	0.0
138.0	138.0	850	*	*	294.5	294.5	294.5	0.0
139.0	139.0	554	*	*	296.0	296.0	296.0	0.0
140.0	140.0	530	*	*	297.0	297.0	297.0	0.0
141.0	141.0	595	*	*	298.0	298.0	298.0	0.0
142.0	142.0	436	*	*	299.3	299.3	299.3	0.0
143.0	143.0	414	*	*	300.4	300.4	300.4	0.0
144.0	144.0	502	*	*	302.9	302.9	302.9	0.0
145.0	145.0	775	*	*	304.3	304.3	304.3	0.0
146.0	146.0	304	*	*	305.6	305.6	305.6	0.0
147.0	147.0	470	*	*	306.8	306.8	306.8	0.0
148.0	148.0	232	*	*	308.3	308.3	308.3	0.0
149.0	149.0	597	*	*	309.8	309.8	309.8	0.0
150.0	150.0	415	*	*	311.1	311.1	311.1	0.0
151.0	151.0	405	*	*	312.3	312.3	312.3	0.0
152.0	152.0	658	*	*	313.6	313.6	313.6	0.0
153.0	153.0	563	*	*	215.2	215.2	215.2	0.0
154.0	154.0	354	*	*	317.1	317.1	317.1	0.0
155.0	155.0	738	*	*	318.9	318.9	318.9	0.0
156.0	156.0	922	*	*	319.8	319.8	319.8	0.0
157.0	157.0	0	*	*	321.0	321.0	321.0	0.0
158.0	158.0	277	*	*	322.7	322.7	322.7	0.0
159.0	159.0	186	*	*	324.4	324.4	324.4	0.0
160.0	160.0	480	*	*	325.5	325.5	325.5	0.0
161.0	161.0	319	*	*	327.2	327.2	327.2	0.0
162.0	162.0	449	*	*	329.3	329.3	329.3	0.0

[1] Miles above U.S.-Mexico Border
[2] Width inside county (on west)
* Data not available

TABLE 7	FEDERAL EMERGENCY MANAGEMENT AGENCY RIVERSIDE COUNTY, CA AND INCORPORATED AREAS	FLOODWAY DATA COLORADO RIVER

FLOODING SOURCE		BASE FLOOD FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
RIVER MILES	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Colorado River (Cont'd)								
163.0	163.0	476	*	*	331.5	331.5	331.5	0.0
164.0	164.0	355	*	*	333.7	333.7	333.7	0.0
165.0	165.0	324	*	*	336.0	336.0	336.0	0.0

[1] Miles above U.S.-Mexico Border
[2] Width inside county (on west)
* Data not available

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

COLORADO RIVER

TABLE 7

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Country Club Creek								
A	800[1]	100	2,210	0.4	596.5	596.5	597.5	1.0
B	2,020[1]	70	170	4.1	617.4	617.4	618.4	1.0
C	2,250[1]	80	360	1.9	625.6	625.6	626.6	1.0
D	2,430[1]	30	83	4.8	628.6	628.6	629.6	1.0
E	2,590[1]	100	700	0.6	634.0	634.0	635.0	1.0
F	2,940[1]	70	140	2.9	634.3	634.3	635.3	1.0
G	3,640[1]	30	71	5.2	648.8	648.8	649.8	1.0
H	5,120[1]	60	122	2.9	702.0	702.0	703.0	1.0
I	5,900[1]	30	78	4.5	740.5	740.5	741.5	1.0
Country Club Creek North Tributary								
A	180[2]	30	69	5.8	626.1	626.1	627.1	1.0
B	1,520[2]	20	46	8.7	652.4	652.4	653.4	1.0
C	3,160[2]	20	53	7.0	701.7	701.7	702.7	1.0
D	3,310[2]	110	760	0.5	711.4	711.4	712.4	1.0
E	3,860[2]	50	104	3.5	716.8	716.8	717.8	1.0
Day Creek								
A	600[3]	220	1,813	4.6	639.1	639.1	640.1	1.0
B	1,070[3]	300	1,713	4.8	640.5	640.5	641.5	1.0
C	1,600[3]	380	2,339	3.6	644.2	644.2	645.2	1.0
D	2,300[3]	430	1,207	8.3	649.0	649.0	650.0	1.0
E	2,800[3]	600	2,346	3.7	653.4	653.4	654.4	1.0

[1] Feet Above Limit of Detailed Study
[2] Feet Above Confluence With Country Club Creek
[3] Feet Above Point 120 Feet Downstream of Lucretia Avenue

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

COUNTRY CLUB CREEK – COUNTRY CLUB CREEK NORTH TRIBUTARY – DAY CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
East Cathedral Channel								
A	2,250[1]	140	450	7.4	326.6	326.6	327.6	1.0
B	3,250[1]	160	475	6.8	362.4	362.4	363.4	1.0
C	4,250[1]	290	690	4.6	404.2	404.2	405.2	1.0
D	5,250[1]	830	953	3.4	447.9	447.9	448.9	1.0
E	6,250[1]	280	490	3.1	495.6	495.6	496.6	1.0
F	7,250[1]	140	310	5.0	548.4	548.4	549.4	1.0
G	8,250[1]	300	590	2.6	595.4	595.4	596.4	1.0
H	9,050[1]	130	284	5.4	629.2	629.2	630.2	1.0
I	10,250[1]	300	845	5.4	684.2	684.2	685.2	1.0
El Cerrito Channel								
A	1,723[2]	20	40	32.8	789.6	789.6	789.6	0.0
B	2,118[2]	20	40	32.8	803.6	803.6	803.6	0.0
C	2,679[2]	20	31	25.0	830.1	830.1	830.1	0.0
D	3,250[2]	20	40	19.6	847.6	847.6	847.6	0.0
E	3,709[2]	20	34	23.1	853.2	853.2	853.5	0.3
F	4,077[2]	20	33	22.5	864.1	864.1	864.4	0.3
G	4,347[2]	20	35	20.8	870.0	870.0	870.8	0.8
H	4,700[2]	20	29	25.4	879.8	879.8	880.0	0.2
I	5,127[2]	20	26	28.1	893.6	893.6	893.6	0.0
J	5,621[2]	10	24	26.8	912.1	912.1	912.2	0.1
K	6,736[2]	10	32	20.3	950.4	950.4	951.4	1.0

[1] Feet Above Confluence With the Whitewater River
[2] Feet Above Temescal Wash

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

EAST CATHEDRAL CHANNEL – EL CERRITO CHANNEL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Garden Air Golf Course Wash								
A	70[1]	700	10,410	0.2	2,349.5	2,349.5	2,350.5	1.0
B	1,070[1]	70	220	7.8	2,364.9	2,364.9	2,365.9	1.0
C	2,470[1]	60	240	7.3	2,396.0	2,396.0	2,397.0	1.0
D	4,470[1]	120	230	7.8	2,467.4	2,467.4	2,468.4	1.0
E	6,470[1]	90	220	4.1	2,530.9	2,530.9	2,531.9	1.0
F	8,570[1]	110	240	3.8	2,601.0	2,601.0	2,601.7	0.7
Gilman Home Channel								
A	850[2]	60	220	10.2	2,222.0	2,222.0	2,222.0	0.0
B	1,400[2]	130	270	8.8	2,231.0	2,231.0	2,231.0	0.0
C	2,150[2]	50	190	11.3	2,245.4	2,245.4	2,245.4	0.0
D	2,750[2]	40	170	12.3	2,258.8	2,258.8	2,258.8	0.0
E	3,200[2]	30	160	12.7	2,270.8	2,270.8	2,270.8	0.0
F	9,800[2]	7	40	27.8	2,468.8	2,468.8	2,468.8	0.0
G	10,500[2]	10	58	16.7	2,492.9	2,492.9	2,492.9	0.0
H	11,350[2]	40	110	9.2	2,531.7	2,531.7	2,531.7	0.0
I	12,200[2]	60	120	8.1	2,564.0	2,564.0	2,564.0	0.0
J	12,900[2]	40	110	9.9	2,597.6	2,597.6	2,597.6	0.0

[1] Feet Above Limit of Detailed Study
[2] Feet Above Confluence With Smith Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

GARDEN AIR GOLF COURSE WASH – GILMAN HOME CHANNEL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Highland Springs Channel								
A	11,100[1]	20	45	21.6	2,603.6	2,603.6	2,603.6	0.0
B	11,800[1]	20	45	21.6	2,614.4	2,614.4	2,614.4	0.0
C	12,500[1]	20	45	21.8	2,626.1	2,626.1	2,626.1	0.0
Lakeland Village Channel								
A	400[2]	90	210	5.5	1,283.9	1,283.9	1,284.9	1.0
B	980[2]	110	279	7.1	1,304.7	1,304.7	1,305.7	1.0
C	2,030[2]	120	294	6.6	1,339.6	1,339.6	1,340.6	1.0
Marshall Creek								
A	6,400[3]	180	430	6.3	2,578.6	2,578.6	2,578.6	0.0
B	7,300[3]	120	310	9.2	2,593.8	2,593.8	2,593.8	0.0
C	8,000[3]	270	990	2.9	2,611.1	2,611.1	2,611.1	0.0

[1] Feet Above Confluence With Smith Creek
[2] Feet Above a Point 460 Feet Downstream from Grand Avenue
[3] Feet Above Confluence With San Timoteo River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

HIGHLAND SPRINGS CHANNEL – LAKELAND VILLAGE CHANNEL – MARSHALL CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Montgomery Creek								
A	650[1]	350	420	6.2	2,229.1	2,229.1	2,229.1	0.0
B	1,400[1]	520	530	5.5	2,246.5	2,246.5	2,246.5	0.0
C	2,300[1]	490	480	5.5	2,266.8	2,266.8	2,266.8	0.0
D	3,100[1]	160	340	8.5	2,284.9	2,284.9	2,284.9	0.0
E	4,000[1]	80	250	10.2	2,303.0	2,303.0	2,303.0	0.0
F	4,750[1]	160	310	7.8	2,331.2	2,331.2	2,331.2	0.0
G	5,700[1]	90	250	10.6	2,355.8	2,355.8	2,355.8	0.0
H	6,650[1]	50	210	11.2	2,381.1	2,381.1	2,381.1	0.0
I	7,450[1]	40	180	11.8	2,402.6	2,402.6	2,402.6	0.0
J	9,150[1]	10	60	31.8	2,467.2	2,467.2	2,467.2	0.0
K	9,900[1]	10	60	32.9	2,489.7	2,489.7	2,489.7	0.0
L	10,600[1]	10	40	31.6	2,511.3	2,511.3	2,511.3	0.0
M	11,650[1]	15	40	34.3	2,550.0	2,550.0	2,550.0	0.0
N	12,700[1]	15	40	32.3	2,591.2	2,591.2	2,591.2	0.0
O	13,550[1]	15	40	28.4	2,625.4	2,625.4	2,625.4	0.0
P	14,350[1]	20	80	16.2	2,656.4	2,656.4	2,656.4	0.0
Mountain Avenue Wash								
A	2,290[2]	90	121	6.6	1,423.5	1,423.5	1421.4	0.4
B	3,050[2]	78	169	4.7	1,428.1	1,428.1	1426.3	0.7
C	3,735[2]	67	84	5.1	1,431.4	1,431.4	1429.4	0.5
D	4,130[2]	61	85	3.9	1,433.9	1,433.9	1432.0	0.6

[1] Feet Above Confluence With Smith Creek
[2] Feet Above Confluence With San Jacinto River

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

MONTGOMERY CREEK – MOUNTAIN AVENUE WASH

TABLE 7

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)											
					REGULATORY			WITHOUT FLOODWAY			WITH FLOODWAY			INCREASE		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	LOB[2]	ROB[3]	CHANNEL[4]	LOB[2]	ROB[3]	CHANNEL[4]	LOB[2]	ROB[3]	CHANNEL[4]	LOB[2]	ROB[3]	CHANNEL[4]
Murrieta Creek																
A	500	205	3,954	7.8	—[5]	—[5]	991.2	—[5]	—[5]	991.2	—[5]	—[5]	992.1	—[5]	—[5]	0.9
B	2,000	240	2,913	10.6	—[5]	—[5]	994.4	—[5]	—[5]	994.4	—[5]	—[5]	994.8	—[5]	—[5]	0.4
C	4,000	230	3,081	10.0	—[5]	—[5]	998.2	—[5]	—[5]	998.2	—[5]	—[5]	999.2	—[5]	—[5]	1.0
D	6,000	215	2,784	11.1	—[5]	—[5]	1,001.8	—[5]	—[5]	1,001.8	—[5]	—[5]	1,002.8	—[5]	—[5]	1.0
E	7,200	190	2,586	11.9	—[5]	—[5]	1,004.8	—[5]	—[5]	1,004.8	—[5]	—[5]	1,005.7	—[5]	—[5]	0.9
F	8,000	160	2,666	11.6	—[5]	—[5]	1,007.4	—[5]	—[5]	1,007.4	—[5]	—[5]	1,007.4	—[5]	—[5]	0.0
G	9,980	360	5,126	6.0	—[5]	—[5]	1,009.8	—[5]	—[5]	1,009.8	—[5]	—[5]	1,010.6	—[5]	—[5]	0.8
H	12,000	467	4,451	6.9	1,012.8	1,012.8	1,012.8	1,012.8	1,012.8	—[6]	1,012.8	1,012.8	—[6]	0.0	0.0	—[6]
I	14,400	533	4,268	7.2	1,016.1	1,016.1	1,016.1	1,016.1	1,016.1	—[6]	1,016.1	1,016.1	—[6]	0.0	0.0	—[6]
J	16,140	465	2,661	10.8	1,018.7	1,018.6	1,018.7	1,018.7	1,018.6	—[6]	1,018.7	1,018.6	—[6]	0.0	0.0	—[6]
K	17,740	290	2,750	10.0	1,022.4	1,022.3	1,022.0	1,022.4	1,022.3	—[6]	1,022.4	1,022.3	—[6]	0.0	0.0	—[6]
L	19,522	549	2,309	9.2	1,025.5	1,025.4	1,025.0	1,025.5	1,025.4	—[6]	1,025.6	1,025.5	—[6]	0.1	0.1	—[6]
M	20,567	700	2,779	8.8	1,027.7	1,026.7	1,027.0	1,027.7	1,026.7	—[6]	1,027.7	1,027.3	—[6]	0.0	0.6	—[6]
N	22,187	1,383	5,034	6.2	1,030.7	1,030.8	1,028.8	1,030.7	1,030.8	—[6]	—[6]	1,030.8	—[6]	?	0.0	—[6]
O	23,707	1,167	3,550	8.3	1,031.7	1,034.8	1,033.7	1,031.7	1,034.8	—[6]	—[6]	1,034.8	—[6]	?	0.0	—[6]
P	25,727	138	845	12.3	1,036.6	1,037.4	1,037.7	1,036.6	1,037.4	—[6]	—[6]	1,037.4	—[6]	?	0.0	—[6]
Q	27,292	144	1,053	9.2	1,042.3	1,042.5	1,042.5	1,042.3	1,042.5	—[6]	—[6]	1,042.5	—[6]	?	0.0	—[6]
R	28,807	145	999	9.8	1,045.4	1,045.5	1,045.5	1,045.4	1,045.5	—[6]	—[6]	1,045.5	—[6]	?	0.0	—[6]
S	29,907	187	1,405	7.0	1,049.3	1,049.3	1,049.3	1,049.3	1,049.3	—[6]	—[6]	1,049.3	—[6]	?	0.0	—[6]
T	31,482	124	759	12.8	1,055.1	1,055.1	1,055.1	1,055.1	1,055.1	—[6]	—[6]	1,055.1	—[6]	?	0.0	—[6]
U	34,110	290	1,910	5.1	—[5]	—[5]	1,067.5	—[5]	—[5]	1,067.5	—[5]	—[5]	1,067.8	—[5]	—[5]	0.3
V	35,750	250	1,870	5.1	—[5]	—[5]	1,072.5	—[5]	—[5]	[illegible]	—[5]	—[5]	1,072.8	—[5]	—[5]	0.3
W	37,670	180	1,120	8.7	—[5]	—[5]	1,082.8	—[5]	—[5]	1,082.8	[illegible]	[illegible]	1,083.8	—[5]	—[5]	1.0
X	39,180	290	1,880	5.2	—[5]	—[5]	1,090.5	—[5]	—[5]	1,090.5	—[5]	—[5]	1,091.5	—[5]	—[5]	1.0
Y	40,880	550/250[7]	1,980	6.1	—[5]	—[5]	1,095.5	—[5]	—[5]	1,095.5	—[5]	—[5]	1,096.2	—[5]	—[5]	0.7
Z	43,900	220	1,376	7.0	—[5]	—[5]	1,109.5	—[5]	—[5]	1,109.5	—[5]	—[5]	1,110.2	—[5]	—[5]	0.7
AA	45,245	265	1,925	5.0	—[5]	—[5]	1,115.9	—[5]	—[5]	1,115.9	—[5]	—[5]	1,116.4	—[5]	—[5]	0.5
AB	46,505	248	2,101	4.8	—[5]	—[5]	1,121.2	—[5]	—[5]	1,121.2	—[5]	—[5]	1,122.1	—[5]	—[5]	0.9

[1]Feet above confluence with Santa Margarita River
[2][illegible] left levee fails
[3][illegible] assuming right levee fails
[4]Channel elevation assuming both levees hold
[5]Not applicable; there are no levees in this reach
[6]Not computed
[7]Left channel/right channel

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

MURRIETA CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)											
					REGULATORY			WITHOUT FLOODWAY			WITH FLOODWAY			INCREASE		
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	LOB[2]	ROB[3]	CHANNEL[4]	LOB[2]	ROB[3]	CHANNEL[4]	LOB[2]	ROB[3]	CHANNEL[4]	LOB[2]	ROB[3]	CHANNEL[4]
Murrieta Creek (Cont'd)																
AC	48,367	285	1,779	5.5	_[5]	_[5]	1,131.3	_[5]	_[5]	1,131.3	_[5]	_[5]	1,132.3	_[5]	_[5]	1.0
AD	49,997	220	1,316	7.9	_[5]	_[5]	1,141.9	_[5]	_[5]	1,141.9	_[5]	_[5]	1,142.8	_[5]	_[5]	0.9
AE	51,667	540	2,333	4.2	_[5]	_[5]	1,150.5	_[5]	_[5]	1,150.5	_[5]	_[5]	1,151.5	_[5]	_[5]	1.0
AF	53,132	195	1,213	8.0	_[5]	_[5]	1,164.6	_[5]	_[5]	1,164.6	_[5]	_[5]	1,165.5	_[5]	_[5]	0.9
AG	53,747	210	1,412	6.9	_[5]	_[5]	1,168.5	_[5]	_[5]	1,168.5	_[5]	_[5]	1,169.0	_[5]	_[5]	0.5

[1]Feet above confluence with Santa Margarita River
[2]Left (looking downstream) overbank elevation assuming left levee fails
[3]Right (looking downstream) overbank elevation assuming right levee fails
[4]Channel elevation assuming both levees hold
[5]Not applicable; there are no levees in this reach

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

MURRIETA CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Murrieta Creek (Cont'd)								
AH	55,037	311	1,912	6.0	1,174.6	1,174.6	1,175.2	0.6
AI	56,347	427	1,815	7.1	1,181.2	1,182.4	1,183.4	1.0
AJ	58,379	313	1,334	4.0	1,193.4	1,193.4	1,193.8	0.4
AK	59,899	457	1,214	4.4	1,199.6	1,199.6	1,199.8	0.2
AL	60,969	331	1,166	4.6	1,206.3	1,206.3	1,206.4	0.1
AM	62,099	347	811	6.6	1,209.0	1,209.0	1,209.9	0.9
AN	63,481	223	519	9.3	1,219.5	1,219.5	1,219.5	0.0

[1]Feet Above Confluence With Santa Margarita River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

MURRIETA CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
North Cathedral Channel								
A	1,100	60	290	12.9	290.5	290.5	291.5	1.0
B	2,100	60	400	9.1	292.7	292.7	293.7	1.0
C	3,100	60	410	9.0	293.8	293.8	294.8	1.0
D	3,850	60	340	10.8	294.2	294.2	295.2	1.0
E	4,780	50	340	10.8	300.0	300.0	301.0	1.0
F	5,200	50	290	7.9	301.9	301.9	302.9	1.0

[1] Feet Above Confluence With the Whitewater River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

NORTH CATHEDRAL CHANNEL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
North Norco Channel								
A	4,700	110	415	6.0	557.3	557.3	558.3	1
B	5,640	70	542	4.6	572.3	572.3	573.2	0.9
C	6,192	150	1,400	1.9	577.7	577.7	576.8	-0.9
D	7,257	40	200	12.6	578.0	578.0	578.0	0.0
E	22,810	80	263	4.7	630.0	630.0	630.0	0.0
F	23,950	80	333	2.7	631.9	631.9	631.5	-0.4

[1] Feet Above Confluence With Temescal Wash

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

NORTH NORCO CHANNEL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Palm Canyon Wash								
A	1,970	367	2,375	10.6	326.8	326.8	326.8	0.0
B	3,135	430	3,418	7.4	334.7	334.7	334.7	0.0
C	4,330	415	2,724	9.3	339.9	339.9	339.9	0.0
D	5,230	432	2,032	12.4	343.9	343.9	343.9	0.0
E	6,200	409	2,634	9.6	349.2	349.2	349.2	0.0
F[2]	7,650	545	4,315	5.8	354.6	354.6	354.6	0.0
G[2]	8,850	860[3]	2,446	10.3	358.6	358.6	358.6	0.0
H	10,240	1,133[3]	2,660	8.7	368.9	368.9	368.9	0.0
I	11,740	314[4]	1,742	13.3	388.4	388.4	388.4	0.0
J	13,070	363	2,034	11.4	404.8	404.8	404.8	0.0
K	14,590	502	2,035	11.4	425.5	425.5	426.5	1.0
L	15,700	401	1,886	12.3	445.8	445.8	445.8	0.0
M	17,120	309	1,724	13.5	467.3	467.3	467.3	0.0
N[5]	18,780	677	2,252	10.3	489.2	489.2	489.2	0.0
O	20,900	468	2,006	11.7	519.2	519.2	519.2	0.0
P	22,000	478	2,048	11.5	529.4	529.4	529.4	0.0
Q	23,100	289	2,998	7.8	538.5	538.5	538.5	0.0
R	23,800	317	2,021	11.1	548.4	548.4	548.4	0.0

[1]Feet Above Mouth [2]Shared With Tahquitz Creek [3]Width Lies Partially Within Agua Caliente Indian Reservation
[4]Width Lies Entirely Within Agua Caliente Indian Reservation [5]Shared With Arenas Canyon Creek

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

PALM CANYON WASH

TABLE 7

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Pechanga Creek								
A	1,005	100	641	10.4	1,007.4	1,007.4	1,008.1	0.7
B	1,672	70	457	14.6	1,014.4	1,014.4	1,014.6	0.2
C	1,832	70	740	9.0	1,019.2	1,019.2	1,019.2	0.0
D	3,232	112	535	12.5	1,028.1	1,028.1	1,028.1	0.0
E	4,810	65	505	13.2	1,046.7	1,046.7	1,046.7	0.0
F	6,075	160	1,040	6.4	1,054.9	1,054.9	1,055.5	0.6
G	6,865	143	580	11.5	1,059.5	1,059.5	1,059.5	0.0
H	7,688	140	740	9.0	1,068.5	1,068.5	1,068.7	0.2
I	8,745	124	600	11.1	1,079.5	1,079.5	1,079.6	0.1

[1] Feet Above Confluence With Temecula Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

PECHANGA CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Perris Valley Storm Drain								
A	6,000	1,415	9,804	1.3	1,422.2	1,422.2	1,423.2	1.0
B	7,000	1,150	6,484	2.0	1,422.2	1,422.2	1,423.2	1.0
C	8,000	1,100	5,084	2.6	1,422.2	1,422.2	1,423.2	1.0
D	8,910	1,150	4,614	2.8	1,422.2	1,422.2	1,423.2	1.0
E	10,160	1,000	2,336	5.6	1,423.2	1,423.2	1,424.0	0.8
F	10,490	2,060	8,651	1.5	1,426.1	1,426.1	1,427.0	0.9
G	10,990	1,360	5,482	2.3	1,426.1	1,426.1	1,427.0	0.9
H	11,490	870	3,304	3.8	1,426.2	1,426.2	1,427.1	0.9
I	11,990	590	2,219	5.7	1,426.8	1,426.8	1,427.4	0.6
J	12,490	495	2,173	5.8	1,427.5	1,427.5	1,428.3	0.8
K	13,000	490	2,077	5.9	1,428.2	1,428.2	1,429.0	0.8
L	13,620	505	2,137	5.7	1,429.3	1,429.3	1,430.0	0.7
M	14,120	525	2,214	5.5	1,429.7	1,429.7	1,430.6	0.9
N	14,620	560	2,191	5.6	1,430.4	1,430.4	1,431.3	0.9
O	15,120	600	2,140	5.7	1,431.1	1,431.1	1,432.0	0.9
P	15,750	628	1,640	7.1	1,432.3	1,432.3	1,432.7	0.4
Q	16,150	690	2,321	5.0	1,433.5	1,433.5	1,434.1	0.6
R	16,650	650	2,132	5.5	1,434.4	1,434.4	1,435.0	0.6
S	17,050	570	2,149	5.5	1,435.0	1,435.0	1,435.6	0.6
T	17,600	455	2,073	5.7	1,435.8	1,435.8	1,436.4	0.6
U	18,030	400	1,876	6.2	1,436.3	1,436.3	1,436.9	0.6
V	18,450	375	1,877	6.0	1,437.2	1,437.2	1,437.6	0.4
W	18,950	308	1,623	7.0	1,437.7	1,437.7	1,438.3	0.6
X	19,450	340	1,630	6.9	1,439.0	1,439.0	1,439.2	0.2
Y	19,750	420	1,706	6.6	1,439.4	1,439.4	1,439.8	0.4
Z	20,250	550	1,773	6.4	1,440.2	1,440.2	1,440.8	0.6
AA	20,750	765	1,970	5.7	1,441.6	1,441.6	1,442.2	0.6
AB	21,633	1,051	3,424	3.3	1,443.0	1,443.0	1,443.7	0.7

[1] Feet Above Confluence With San Jacinto River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

PERRIS VALLEY STORM DRAIN

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Perris Valley Storm Drain								
AC	22,132	1,045	3,254	3.5	1,443.3	1,443.3	1,444.2	0.9
AD	22,526	1,174	2,745	4.1	1,445.9	1,445.9	1,446.0	0.1
AE	22,902	1,247	5,363	2.1	1,446.1	1,446.1	1,446.8	0.7
AF	23,460	1,284	6,057	1.9	1,446.3	1,446.3	1,447.0	0.7

[1] Feet Above Confluence With San Jacinto River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

PERRIS VALLEY STORM DRAIN

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Pigeon Pass Channel								
A	400[1]	30	80	16.0	1,618.1	1,618.1	1,618.1	0.0
B	950[1]	30	90	14.8	1,622.0	1,622.0	1,622.1	0.1
C	1,380[1]	30	70	17.8	1,623.0	1,623.0	1,623.0	0.0
D	2,010[1]	30	80	17.5	1,628.1	1,628.1	1,628.1	0.0
E	2,270[1]	20	110	11.1	1,632.8	1,632.8	1,632.8	0.0
F	2,670[1]	180	500	2.6	1,635.7	1,635.7	1,636.7	1.0
G	3,300[1]	20	110	11.5	1,645.1	1,645.1	1,645.1	0.0
Pyrite Channel								
A	400[2]	165	335	3.4	776.0	776.0	777.0	1.0
B	1,730[2]	20	56	20.3	791.7	791.7	791.7	0.0
C	2,050[2]	20	53	20.6	796.7	796.7	796.7	0.0
D	2,475[2]	20	55	20.1	802.6	802.6	802.6	0.0
E	3,100[2]	20	51	21.6	811.3	811.3	811.3	0.0
F	3,775[2]	20	45	24.0	825.3	825.3	825.3	0.0
G	4,575[2]	20	53	20.0	841.2	841.2	841.2	0.0
Reche Canyon								
A	0[3]	60	188	9.5	1,332.0	1,332.0	1,333.0	1.0
B	1,000[3]	80	208	8.5	1,355.3	1,355.3	1,356.3	1.0
C	2,000[3]	60	196	8.7	1,379.0	1,379.0	1,380.0	1.0
D	3,000[3]	110	154	7.2	1,405.1	1,405.1	1,406.1	1.0
E	4,000[3]	70	206	8.0	1,431.1	1,431.1	1,432.1	1.0
F	5,500[3]	50	198	8.1	1,473.6	1,473.6	1,474.6	1.0
G	6,000[3]	90	188	8.9	1,484.6	1,484.6	1,485.6	1.0
H	6,800[3]	60	146	8.9	1,515.0	1,515.0	1,516.0	1.0
I	7,600[3]	60	150	8.3	1,535.9	1,535.9	1,536.9	1.0

[1] Feet Above Confluence With Sunnymead Storm Channel
[2] Feet Above Limit of Detailed Study
[3] Feet Above County Limits

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

PIGEON PASS CHANNEL - PYRITE CHANNEL - RECHE CANYON

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Salt Creek								
A	10,163[1]	692	3,774	3.5	1,408.8	1,408.8	1,408.9	0.1
B	14,763[1]	471	2,389	5.5	1,413.6	1,413.6	1,413.6	0.0
C	18,163[1]	449	2,264	5.8	1,418.1	1,418.1	1,418.1	0.0
D	75,500[1]	450	1,560	5.89	1,522.3	1,522.3	1,522.3	0.0
E	76,000[1]	250	1,574	5.79	1,523.2	1,523.2	1,523.2	0.0
F	77,000[1]	250	1,483	6.14	1,524.2	1,524.2	1,524.2	0.0
G	78,000[1]	250	1,434	6.35	1,525.3	1,525.3	1,525.3	0.0
H	79,500[1]	250	1,070	8.49	1,527.4	1,527.4	1,527.4	0.0
Salt Creek Tributary								
A	500[2]	230	670	4.20	1,589.7	1,589.7	1,590.0	0.3
B	1,450[2]	380	790	4.10	1,597.2	1,597.2	1,597.3	0.1

[1] Feet Above Stream Gage at Upper Limits of Railroad Canyon Reservoir
[2] Feet Above Corporate Limits

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SALT CREEK – SALT CREEK TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
San Gorgonio River								
A[2]	82,100	1,680	1,660	7.6	2.401.8	2.401.8	2.401.8	0.0
B	83,200	900	1,250	9.6	2.434.2	2.434.2	2.434.2	0.0
C	84,200	400	1,100	11.0	2.459.7	2.459.7	2.459.7	0.0
D	85,100	360	1,170	10.3	2.494.2	2.494.2	2.494.2	0.0
E	86,150	290	1,100	11.0	2.547.3	2.547.3	2.547.3	0.0
F	87,250	190	950	12.7	2.597.5	2.597.5	2.597.5	0.0
G	88,400	630	1,350	9.3	2.654.9	2.654.9	2.654.9	0.0
H	89,550	690	1,430	8.4	2.707.8	2.707.8	2.707.8	0.0

[1] Feet Above Confluence With Whitewater River
[2] Cross Section "A" is Not Included on the Effective FIRM

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SAN GORGONIO RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
San Jacinto River								
A	975	293	2,350	10.4	1,265.9	1,265.9	1,265.9	0.0
B	1,475	293	2,556	9.6	1,267.3	1,267.3	1,267.3	0.0
C	1,968	293	2,673	9.2	1,268.3	1,268.3	1,268.3	0.0
D	2,056	270	2,688	9.1	1,268.5	1,268.5	1,268.5	0.0
E	2,535	440	3,196	7.7	1,271.5	1,271.5	1,271.5	0.0
F	2,936	275	2,791	8.8	1,272.3	1,272.3	1,272.5	0.2
G	3,211	216	2,330	10.5	1,273.8	1,273.8	1,273.9	0.1
H	3,638	260	3,013	8.1	1,276.4	1,276.4	1,276.4	0.0
I	3,929	210	3,022	8.1	1,276.6	1,276.6	1,276.9	0.3
J	4,087	250	2,756	8.9	1,276.8	1,276.8	1,277.2	0.4
K	4,615	240	2,266	10.8	1,278.7	1,278.7	1,278.9	0.2
L	5,021	350	4,169	5.9	1,284.4	1,284.4	1,284.4	0.0
M	5,423	320	3,036	8.1	1,284.5	1,284.5	1,284.5	0.0
N	5,824	340	3,596	6.8	1,285.4	1,285.4	1,285.5	0.1
O	6,225	325	2,872	8.5	1,285.8	1,285.8	1,285.9	0.1
P	6,627	270	2,799	8.8	1,286.5	1,286.5	1,286.8	0.3
Q	6,966	252	2,149	11.4	1,286.7	1,286.7	1,286.7	0.0
R	7,542	231	2,060	11.9	1,289.7	1,289.7	1,289.7	0.0
S	8,070	258	2,723	9.0	1,292.3	1,292.3	1,292.7	0.4
T	8,598	271	2,548	9.6	1,293.9	1,293.9	1,294.3	0.4
U	9,126	292	2,554	9.6	1,295.9	1,295.9	1,296.1	0.2
V	9,654	354	3,347	7.3	1,297.8	1,297.8	1,298.3	0.5
W	10,182	183	1,861	13.2	1,298.5	1,298.5	1,298.6	0.1
X	10,710	395	3,413	7.2	1,301.9	1,301.9	1,302.5	0.6
Y	11,238	340	2,750	8.9	1,303.3	1,303.3	1,303.6	0.3
Z	11,766	277	2,039	12.0	1,305.4	1,305.4	1,305.5	0.1
AA	12,294	200	2,383	10.3	1,308.5	1,308.5	1,308.5	0.0
AB	12,822	294	3,005	8.2	1,310.0	1,310.0	1,310.5	0.5

[1] Feet Above the Crest of Lake Elsinore Weir

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

SAN JACINTO RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
San Jacinto River (Cont'd)								
AC	13,350[1]	165	2,027	12.1	1,310.9	1,310.9	1,311.2	0.3
AD	60,820[2]	440	5,584	7.7	1,420.3	1,420.3	1,421.2	0.9
AE	61,350[2]	510	6,950	6.3	1,421.0	1,421.0	1,421.8	0.8
AF	61,880[2]	850	11,388	3.9	1,421.3	1,421.3	1,422.3	1.0
AG	62,410[2]	1,507	17,261	2.5	1,421.3	1,421.3	1,422.2	0.9
AH	62,940[2]	1,346	16,558	2.6	1,421.3	1,421.3	1,422.3	1.0
AI	63,470[2]	1,301	18,650	2.3	1,421.3	1,421.3	1,422.3	1.0
AJ	64,000[2]	1,647	16,540	2.6	1,421.4	1,421.4	1,422.3	0.9
AK	70,435[2]	6,658	63,463	0.7	1,421.6	1,421.6	1,422.6	1.0
AL	72,070[2]	7,250	61,918	0.7	1,421.6	1,421.6	1,422.6	1.0
AM	73,920[2]	5,800	54,526	0.8	1,421.7	1,421.7	1,422.7	1.0
AN	74,500[2]	6,600	62,414	0.7	1,421.7	1,421.7	1,422.7	1.0
AO	77,120[2]	6,410	58,064	0.7	1,421.7	1,421.7	1,422.7	1.0
AP	77,860[2]	6,760	56,402	0.8	1,421.7	1,421.7	1,422.7	1.0
AQ	78,930[2]	6,915	56,707	0.8	1,421.7	1,421.7	1,422.7	1.0
AR	79,315[2]	7,750	61,464	0.7	1,421.7	1,421.7	1,422.7	1.0
AS	111,240[2]	2,775	20,702	2.2	1,429.9	1,429.9	1,430.9	1.0
AT	111,370[2]	2,800	22,083	2.6	1,430.8	1,430.8	1,431.6	0.8
AU	112,170[2]	2,666	22,071	2.7	1,431.0	1,431.0	1,431.8	0.8
AV	113,545[2]	3,547	32,840	1.8	1,431.2	1,431.2	1,432.1	0.9
AW	114,985[2]	3,863	35,103	1.7	1,431.3	1,431.3	1,432.2	0.9
AX	116,485[2]	4,516	37,307	1.6	1,431.4	1,431.4	1,432.3	0.9
AY	117,385[2]	5,177	37,937	1.5	1,431.5	1,431.5	1,432.4	0.9
AZ	118,125[2]	5,762	35,631	1.6	1,431.5	1,431.5	1,432.4	0.9
BA	119,625[2]	2,966	21,048	1.9	1,431.7	1,431.7	1,432.6	0.9
BB	121,125[2]	3,563	22,701	1.8	1,431.9	1,431.9	1,432.8	0.9
BC	122,575[2]	4,330	24,826	1.6	1,432.1	1,432.1	1,433.0	0.9
BD	124,075[2]	3,686	22,562	1.8	1,432.3	1,432.3	1,433.2	0.9

[1] Feet Above Lake Elsinore Levee

[2] Feet Above Confluence With Lake Elsinore

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

SAN JACINTO RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[2]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
San Jacinto River (Cont'd)								
BE	125,575	9,055	48,585	1.2	1,432.5	1,432.5	1,433.4	0.9
BF	127,085	9,883	65,125	0.9	1,432.6	1,432.6	1,433.5	0.9
BG	128,565	11,664	116,596	0.5	1,432.7	1,432.7	1,433.6	0.9
BH	130,015	7,221	64,206	0.9	1,432.7	1,432.7	1,433.6	0.9
BI	131,490	7,108	62,402	0.9	1,432.8	1,432.8	1,433.7	0.9
BJ	132,990	8,642	66,033	0.9	1,432.8	1,432.8	1,433.7	0.9
BK	133,715	7,928	45,788	1.3	1,432.9	1,432.9	1,433.8	0.9
BL	134,615	5,991	26,887	2.2	1,434.6	1,434.6	1,434.7	0.1
San Jacinto River Secondary Channel								
A	119,825	2,013	15,738	1.1	1,431.7	1,431.7	1,432.6	0.9
B	121,065	1,631	11,248	1.5	1,431.8	1,431.8	1,432.7	0.9
C	122,305	1,286	8,300	2.1	1,432.0	1,432.0	1,432.9	0.9
D	124,155	1,195	10,401	1.7	1,432.3	1,432.3	1,433.3	1.0
E	126,255	1,080	9,010	1.9	1,432.5	1,432.5	1,433.5	1.0

[2] Feet Above Confluence With Lake Elsinore

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

SAN JACINTO RIVER –
SAN JACINTO RIVER SECONDARY CHANNEL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
San Sevaine Channel								
A-J[2]								
K	12,578.26	220	285	28.0	739.3	739.3	739.3	0.0
L	14,988.52	100	390	21.0	767.4	767.4	767.4	0.0
M	17,200.94	120	611	12.8	780.2	780.2	780.2	0.0
N	18,292.93	100	740	10.6	796.9	796.9	797.9	1.0
O	20,294.18	130	840	9.3	815.4	815.4	816.4	1.0
P	23,090.20	150	1,020	7.7	851.3	851.3	852.3	1.0

[1] Stream Distance 600 Feet Downstream of Limonite Avenue

[2] Contained in Channel

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SAN SEVAINE CHANNEL

TABLE 7

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Santa Ana River								
A	175,000	1,900	22,400	7.8	558.9	558.9	559.9	1.0
B	178,200	2,640	30,000	5.9	571.0	571.0	571.8	0.8
C	181,200	2,300	17,697	9.9	578.7	578.7	579.3	0.6
D	182,200	1,694	23,524	7.4	586.3	586.3	586.8	0.5
E	183,400	3,500	51,124	3.4	596.6	596.6	596.6	0.0
F	186,350	1,680	29,129	6.0	601.8	601.8	602.2	0.4
G	189,050	3,259	38,826	4.5	605.1	605.1	606.0	0.9
H	194,160	2,770	20,545	8.5	615.6	615.6	615.6	0.0
I	199,800	3,100	24,800	7.0	631.3	631.3	632.3	1.0
J	204,410	3,180	27,500	6.4	644.7	644.7	645.7	1.0
K	213,200	1,030	13,900	12.6	680.9	680.9	680.9	0.0
L	220,500	740	12,100	14.5	708.7	708.7	708.7	0.0
M	225,990	580	13,200	13.2	731.6	731.6	731.6	0.0
N	226,600	1,230	31,200	5.6	739.9	739.9	739.9	0.0
O	228,700	3,670	74,300	2.4	740.7	740.7	741.7	1.0
P	233,100	3,210	26,090	6.7	746.8	746.8	747.8	1.0
Q	240,200	900	13,500	13.0	778.7	778.7	779.7	1.0
R	251,600	980	10,300	17.0	821.5	821.5	822.5	1.0

[1] Feet Above Mouth

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SANTA ANA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Smith Creek								
A	10,200	420	1,520	10.8	2,061.2	2,061.2	2,061.2	0.0
B	11,200	330	1,840	10.0	2,077.1	2,077.1	2,077.1	0.0
C	12,000	480	1,530	10.6	2,086.9	2,086.9	2,086.9	0.0
D	12,850	500	1,670	10.2	2,100.2	2,100.2	2,100.4	0.2
E	13,700	590	1,800	9.7	2,110.4	2,110.4	2,110.5	0.1
F	14,800	260	990	14.1	2,123.8	2,123.8	2,124.0	0.2
G	15,750	270	1,130	12.6	2,134.4	2,134.4	2,135.1	0.7
H	16,750	330	1,420	11.1	2,144.6	2,144.6	2,144.6	0.0
I	17,800	280	1,190	11.8	2,153.8	2,153.8	2,153.8	0.0
J	18,800	250	1,170	12.3	2,165.2	2,165.2	2,165.2	0.0
K	19,800	90	820	17.1	2,177.4	2,177.4	2,177.4	0.0
L	21,300	310	1,300	10.9	2,189.9	2,189.9	2,189.9	0.0
M	22,400	230	2,730	4.9	2,207.8	2,207.8	2,207.8	0.0
N	23,500	400	1,300	10.1	2,212.4	2,212.4	2,212.4	0.0
O	24,750	230	930	11.4	2,224.3	2,224.3	2,224.3	0.0
P	25,650	390	1,190	9.1	2,231.6	2,231.6	2,231.6	0.0
Q	26,450	390	1,170	9.3	2,239.6	2,239.6	2,239.6	0.0
R	27,550	870	1,460	6.9	2,248.6	2,248.6	2,248.6	0.0
S	28,550	670	1,280	7.9	2,260.4	2,260.4	2,260.4	0.0

[1] Feet Above Confluence With San Gorgonio River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SMITH CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Smith Creek West Tributary								
A	44,700	260	730	9.5	2.512.0	2.512.0	2.512.0	0.0
B	48,650	70	520	10.7	2.526.0	2.526.0	2.526.0	0.0
C	49,650	80	370	14.1	2.542.5	2.542.5	2.542.5	0.0
D	50,900	100	430	11.8	2.560.1	2.560.1	2.560.1	0.0
E	51,450	220	600	9.5	2.578.3	2.578.3	2.578.3	0.0
F	52,400	610	1,210	4.5	2.590.7	2.590.7	2.590.7	0.0

[1] Feet Above Confluence With San Gorgonio River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SMITH CREEK WEST TRIBUTARY

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
South Norco Channel								
A	400[1]	77[2]	55[2]	3.1	566.6	566.6	566.6	0.0
B[3]								
C[3]								
D	2,870[1]	100	173	7.5	571.9	571.9	572.2	0.3
E	3,800[1]	64	279	4.7	581.5	580.7	579.7	1.0
F	4,810[1]	90	299	4.2	586.0	586.0	586.1	0.1
G	5,730[1]	120	259	4.9	595.3	595.3	595.3	0.0
H	7,200[1]	120	241	7.5	607.3	607.3	607.5	0.2
I	12,600[1]	60	63	5.1	644.8	644.8	644.8	0.0
J	13,730[1]	60	58	5.5	651.2	651.2	651.2	0.0
K	14,800[1]	60	59	5.5	656.5	656.5	656.5	0.0
L	16,000[1]	60	60	5.3	660.7	660.7	661.1	0.4
South Norco Channel Tributary A								
A	3,600[4]	104	663	0.9	601.2	601.2	602.2	1.0
B	4,615[4]	70	89	6.5	602.3	602.3	602.3	0.0
C	5,439[4]	68	107	5.4	610.8	610.8	610.8	0.0
D	6,983[4]	40	137	4.1	625.0	625.0	623.9	0.7

[1] Feet Above Confluence With Temescal Wash
[2] Width Excluding Influence From Temescal Wash
[3] Data Not Available
[4] Feet Above Confluence With South Norco Channel

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

TABLE 7

FLOODWAY DATA

SOUTH NORCO CHANNEL – SOUTH NORCO CHANNEL TRIBUTARY A

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
South Norco Channel Tributary B								
E	4,055[1]	80	138	4.4	707.1	707.1	707.2	0.1
Spring Brook Wash								
AC	14,286[2]	140	259	1.1	852.9	852.9	853.9	1.0
AD	15,435[2]	38	85	3.3	862.4	862.4	863.4	1.0
AE	16,234[2]	24	56	5.0	874.4	874.4	875.4	1.0

[1]Feet Above Confluence With South Norco Channel
[2]Feet Above Dexter Drive

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

SOUTH NORCO CHANNEL TRIBUTARY B – SPRING BROOK WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Sun City Channel A-A								
A	1,000[1]	154	1,053	2.7	1,411.5	1,411.5	1,412.5	1.0
B	2,990[1]	95	537	5.0	1,412.7	1,412.7	1,413.4	0.7
C	4,900[1]	200	1,021	2.2	1,416.0	1,416.0	1,417.0	1.0
D	6,200[1]	120	1,698	3.2	1,416.1	1,416.1	1,417.1	1.0
E	8,100[1]	300	1,626	1.4	1,419.1	1,419.1	1,420.1	1.0
F	9,100[1]	250	1,071	1.1	1,419.3	1,419.3	1,420.3	1.0
G	10,100[1]	40	199	6.0	1,419.3	1,419.3	1,420.3	1.0
Sun City Channel H-H								
A	3,050[2]	20	72	7.0	1,433.0	1,433.0	1,434.0	1.0
B	3,530[2]	30	100	5.0	1,436.4	1,436.4	1,437.4	1.0
C	3,900[2]	20	79	6.3	1,440.4	1,440.4	1,441.4	1.0
D	4,500[2]	10	46	10.9	1,445.1	1,445.1	1,446.1	1.0

[1] Feet Above Confluence With Salt Creek
[2] Feet Above Confluence With Sun City Channel A-A

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

SUN CITY CHANNEL A-A – SUN CITY CHANNEL H-H

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Sunnymead Storm Channel								
A	195	27	95	22.4	1,570.6	1,570.6	1,570.6	0.0
B	1,258	27	100	21.2	1,580.2	1,580.2	1,580.2	0.0
C	1,400	27	118	17.9	1,583.3	1,583.3	1,583.3	0.0
D	1,872	27	104	20.0	1,585.1	1,585.1	1,585.1	0.0
E	3,040	30	110	17.8	1,591.3	1,591.3	1,591.3	0.0
F	3,530	30	110	18.1	1,593.9	1,593.9	1,593.9	0.0
G	4,330	30	180	10.4	1,601.0	1,601.0	1,602.0	1.0
H	4,770	40	140	13.6	1,604.0	1,604.0	1,604.0	0.0
I	5,270	40	130	14.2	1,607.1	1,607.1	1,607.1	0.0
J	6,250	30	80	17.7	1,611.2	1,611.2	1,611.2	0.0
K	6,640	20	40	19.4	1,616.1	1,616.1	1,616.1	0.0
L	7,030	20	40	19.8	1,620.7	1,620.7	1,620.7	0.0
M	7,900	20	30	25.5	1,633.1	1,633.1	1,633.1	0.0
N	8,720	20	40	21.7	1,653.9	1,653.9	1,654.1	0.2
O	9,630	30	50	4.1	1,682.8	1,682.8	1,683.1	0.3

[1]Feet Above Limit of Detailed Study

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

SUNNYMEAD STORM CHANNEL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Sunnyslope Channel								
A	2,450[1]	30	68	26.4	762.5	762.5	762.5	0.0
B	2,850[1]	30	64	28.1	768.4	768.4	768.4	0.0
C	3,130[1]	30	82	21.8	783.8	783.8	783.8	0.0
D	3,930[1]	30	79	22.7	791.5	791.5	791.5	0.0
E	4,170[1]	30	94	18.0	796.9	796.9	796.9	0.0
F	4,750[1]	30	82	20.7	799.9	799.9	799.9	0.0
G	6,000[1]	30	124	12.6	814.1	814.1	814.1	0.0
H	8,000[1]	30	57	23.5	819.2	819.2	819.2	0.0
I	8,500[1]	30	60	22.2	826.2	826.2	826.2	0.0
J	8,890[1]	30	64	20.9	832.1	832.1	832.1	0.0
K	9,180[1]	30	56	23.8	839.5	839.5	839.5	0.0
L	9,660[1]	30	66	20.3	847.6	847.6	848.0	0.4
M	9,900[1]	30	77	17.4	850.7	850.7	851.7	1.0
Tahquitz Creek								
F[3]	500[2]							
G[3]	1,850[2]							
A	4,000[2]	515	1,260	5.3	367.8	367.8	367.8	0.0
B	5,420[2]	560	1,243	5.4	374.9	374.9	375.6	0.7
C	7,000[2]	600[4]	1,419	5.6	382.7	382.7	382.9	0.2
D	8,600[2]	850	1,506	5.3	390.0	390.0	390.0	0.0
E	10,560[2]	220[5]	828	9.7	398.6	398.6	399.4	0.8

[1] Feet Above Confluence With Rubidoux Creek
[2] Feet Above Mouth [3] Shared With Palm Canyon Wash-See Palm Canyon Wash for Floodway and Base Flood Water Surface Elevation
[4] Width Lies Partially Within Agua Caliente Indian Reservation [5] Width Lies Entirely Within Agua Caliente Indian Reservation

TABLE 7	FEDERAL EMERGENCY MANAGEMENT AGENCY RIVERSIDE COUNTY, CA AND INCORPORATED AREAS	FLOODWAY DATA SUNNYSLOPE CHANNEL – TAHQUITZ CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Temecula Creek								
A	0	240	4,380	8.2	990.3	990.3	991.3	1.0
B	700	220	4,050	8.9	990.6	990.6	991.6	1.0
C	1,450	1,070	12,660	2.8	992.2	992.2	993.2	1.0
D	2,275	800	3,249	11.1	993.0	993.0	993.0	0.0
E	3,075	766	5,678	6.3	998.0	998.0	998.1	0.1
F	3,855	350	4,462	8.1	1,002.5	1,002.5	1,002.5	0.0
G	4,716	675	6,111	5.9	1,010.2	1,010.2	1,010.4	0.2
H	5,981	625	7,491	4.8	1,015.5	1,015.5	1,016.3	0.8
I	6,501	700	5,470	6.6	1,016.3	1,016.3	1,016.9	0.6
J	7,121	800	3,140	11.5	1,020.4	1,020.4	1,020.7	0.3
K	8,371	825	4,712	7.6	1,027.8	1,027.8	1,028.5	0.7

[1] Feet Above Confluence With Murrieta Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

TEMECULA CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Temescal Wash								
A	9,160	1,320	4,750	8.6	552.2	552.2	552.2	0.0
B	10,010	930	5,310	7.4	555.8	555.8	556.3	0.5
C	10,945	1,200	5,000	8.7	560.0	560.0	560.2	0.2
D	12,160	970	4,336	8.7	566.5	566.5	566.5	0.0
E	12,925	217	2,431	13.6	571.5	571.5	571.5	0.0
F	14,710	150	1,559	18.6	574.2	574.2	574.2	0.0
G	15,650	125	1,027	28.2	574.8	574.8	574.8	0.0
H	16,410	125	1,025	28.3	579.2	579.2	579.2	0.0
I	17,245	125	1,026	28.3	583.6	583.6	583.6	0.0
J	17,950	127	1,086	26.7	587.9	587.9	587.9	0.0
K	19,160	127	1,101	26.3	594.3	594.3	594.3	0.0
L	20,070	127	1,117	26.0	598.4	598.4	598.4	0.0
M	21,160	130	1,236	23.5	605.0	605.0	605.0	0.0
N	30,915	110	1,263	19.3	655.4	655.4	655.4	0.0
O	32,565	867	8,828	2.8	662.0	662.0	662.0	0.0
P	33,385	580	4,382	5.6	662.1	662.1	662.1	0.0
Q	34,400	1,098	2,632	9.3	680.8	680.8	680.8	0.0
R	35,425	960	5,060	4.8	685.3	685.3	685.5	0.2
S	36,325	99	4,388	5.6	687.9	687.9	688.1	0.2
T	38,166	541	4,245	5.7	698.6	698.6	698.6	0.0
U	40,116	279	1,725	14.1	707.8	707.8	707.8	0.0
V	41,116	470	3,725	6.6	717.4	717.4	717.5	0.1
W	43,051	425	2,948	8.3	737.0	737.0	737.0	0.0
X	45,016	371	3,445	7.1	749.5	749.5	749.5	0.0
Y	46,166	599	4,652	5.2	756.1	756.1	756.1	0.0
Z	47,916	580	3,816	6.4	767.1	767.1	767.1	0.0
AA	49,916	231	2345	10.4	786.3	786.3	787	0.7
AB	50,376	185	2612	8.7	792.4	792.4	793	0.6

[1] Feet Above Confluence With Santa Ana River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

TEMESCAL WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Temescal Wash								
AC	51,226	274	4,004	6.1	797.5	797.5	798.4	0.9
AD	52,626	260	2,297	10.6	805.2	805.2	805.2	0.0
AE	53,676	200	2,073	11.8	812.1	812.1	812.4	0.3
AF	54,676	110	1,318	18.5	817.7	817.7	818.3	0.6
AG	55,576	194	1,699	14.4	831.7	831.7	832.3	0.6
AH	56,276	159	2,084	11.7	837.6	837.6	838.2	0.6
AI	57,550	111	1,345	18.1	844.9	844.9	845.1	0.2
AJ	58,573	160	1,994	9.7	851.4	851.4	851.8	0.4
AK	59,723	190	1,680	11.6	859.5	859.5	859.8	0.3
AL	61,013	790	3,031	6.4	872.8	872.8	873.0	0.2
AM	62,073	480	2,424	8.0	879.1	879.1	879.1	0.0
AN	63,173	269	2,260	8.6	884.7	884.7	884.8	0.1
AO	64,323	537	5,331	3.6	887.1	887.1	887.4	0.3
AP	65,323	286	1,476	13.1	891.0	891.0	891.0	0.0
AQ	66,473	743	2,731	7.1	902.2	902.2	902.4	0.2
AR	67,548	465	2,564	7.6	910.0	910.0	910.0	0.0
AS	68,448	315	1,986	9.8	916.8	916.8	916.8	0.0
AT	70,193	379	3,000	5.3	932.0	932.0	932.0	0.0
AU	71,893	290	1,305	12.2	937.2	937.2	937.2	0.0
AV	72,643	554	2,406	6.6	945.6	945.6	945.6	0.0
AW	74,155	243	1,736	9.0	959.0	959.0	959.6	0.6
AX	75,605	386	3,130	5.1	969.1	969.1	969.3	0.2
AY	76,855	689	3,643	4.4	971.3	971.3	972.1	0.8
AZ	78,955	410	1,861	8.5	987.7	987.7	987.7	0.0
BA	79,955	291	1,312	12.1	995.4	995.4	995.4	0.0
BB	80,955	390	2,108	7.5	1,004.3	1,004.3	1,004.3	0.0
BC	83,505	527	1,396	9.0	1,026.4	1,026.4	1,026.4	0.0
BD	84,655	464	2,681	4.7	1,039.2	1,039.2	1,040.0	0.8

[1] Feet Above Confluence With Santa Ana River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

TEMESCAL WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Temescal Wash								
BE	85,655	334	1,366	9.2	1,048.2	1,048.2	1,048.7	0.5
BF	86,895	415	2,550	4.9	1,061.9	1,061.9	1,061.9	0.0
BG	88,145	549	1,426	8.8	1,075.0	1,075.0	1,075.1	0.1
BH	89,095	302	1,805	6.9	1,093.5	1,093.5	1,093.5	0.0
BI	90,395	535	1,339	7.8	1,112.0	1,112.0	1,112.0	0.0
BJ	91,045	218	3,488	3.0	1,156.7	1,156.7	1,156.7	0.0
BK	91,945	904	17,276	0.6	1,156.9	1,156.9	1,156.9	0.0
BL	93,145	1,331	25,244	0.4	1,156.9	1,156.9	1,156.9	0.0
BM	94,945	665	4,808	2.2	1,156.9	1,156.9	1,155.9	-1.0
BN	95,795	612	3,599	2.9	1,157.6	1,157.6	1,157.7	0.1
BO	96,645	383	1,119	9.3	1,159.9	1,159.9	1,159.9	0.0
BP	100,145	541	2,188	4.8	1,172.8	1,172.8	1,172.9	0.1
BQ	101,245	492	2,379	4.4	1,175.5	1,175.5	1,175.8	0.3
BR	102,297	399	1,899	5.5	1,179.4	1,179.4	1,179.5	0.1
BS	104,686	769	2,645	3.9	1,191.2	1,191.2	1,191.4	0.2
BT	105,986	317	1,179	8.8	1,200.3	1,200.3	1,200.3	0.0
BU	106,936	423	2,176	4.8	1,205.6	1,205.6	1,206.3	0.7
BV	108,500	534	3,780	2.8	1,216.0	1,216.0	1,216.2	0.2
BW	109,400	590	3,402	3.1	1,217.2	1,217.2	1,217.5	0.3
BX	111,034	148	923	9.0	1,228.0	1,228.0	1,228.0	0.0
BY	112,034	96	952	8.7	1,230.8	1,230.8	1,231.7	0.9
BZ	113,184	257	2,343	3.5	1,233.5	1,233.5	1,233.9	0.4
CA	115,184	283	853	9.7	1,236.8	1,236.8	1,236.8	0.0
CB	116,134	286	1,144	7.3	1,245.9	1,245.9	1,245.9	0.0
CC	117,134	234	1,710	4.9	1,249.5	1,249.5	1,249.9	0.4
CD	118,084	280	1,619	4.3	1,251.6	1,251.6	1,252.3	0.7
CE	119,034	321	3,237	2.2	1,252.6	1,252.6	1,253.3	0.7
CF	120,034	249	1,832	3.8	1,253.2	1,253.2	1,253.9	0.7

[1] Feet Above Confluence With Santa Ana River

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

TEMESCAL WASH

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Temescal Wash								
CG	121,234[1]	228	1,715	4.1	1,255.7	1,255.7	1,256.0	0.3
CH	122,234[1]	225	2,184	3.2	1,257.0	1,257.0	1,257.3	0.3
CI	123,309[1]	188	1,970	3.6	1,257.8	1,257.8	1,258.3	0.5
CJ	124,259[1]	189	1,390	4.2	1,258.7	1,258.7	1,259.3	0.6
CK	125,131[1]	261	2,579	2.2	1,259.7	1,259.7	1,260.4	0.7
CL	126,150[1]	931	7,677	0.7	1,260.6	1,260.6	1,261.5	0.9
CM	128,750[1]	1,114	13,262	0.3	1,260.6	1,260.6	1,261.5	0.9
CN	131,368[1]	1,393	6,850	1.7	1,261.2	1,261.2	1,261.9	0.7
CO	134,924[1]	189	965	2.9	1,262.6	1,262.6	1,263.0	0.4
Warm Spring Creek								
A	7,777[2]	255	1,468	6.5	1066.3	1066.3	1066.3	0.0
B	8,500[2]	175	1,285	7.5	1068.5	1068.5	1068.5	0.0

[1] Feet Above Confluence With Santa Ana River
[2] Feet Above Confluence With Murrieta Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

TEMESCAL WASH – WARM SPRING CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
West Cathedral Channel								
A	730[1]	160	332	4.5	304.2	304.2	305.2	1.0
B	2,010[1]	150	320	4.7	339.3	339.3	340.3	1.0
C	2,900[1]	150	320	4.7	377.3	377.3	378.3	1.0
D	3,800[1]	280	488	3.1	411.7	411.7	412.7	1.0
E	4,620[1]	150	302	5.0	444.2	444.2	445.2	1.0
F	6,120[1]	330	238	1.9	512.1	512.1	513.1	1.0
G	7,020[1]	180	228	2.0	571.3	571.3	572.3	1.0
H	8,020[1]	70	137	3.3	632.0	632.0	633.0	1.0
I	9,020[1]	110	171	2.6	689.6	689.6	690.6	1.0
J	9,775[1]	250	453	2.9	739.9	739.9	740.9	1.0
West Norco Channel								
A	1,170[2]	70	454	1.2	576.0	576.0	576.0	0.0
B	2,270[2]	120	368	1.0	576.1	576.1	576.1	0.0
C	3,010[2]	40	62	5.6	582.1	582.1	582.3	0.2
West Pershing Channel								
A	19,250[3]	20	30	21.8	2,565.2	2,565.2	2,565.2	0.0
B	20,150[3]	20	40	18.8	2,584.3	2,584.3	2,584.3	0.0

[1] Feet Above Confluence With North Cathedral Channel
[2] Feet Above Confluence With Temescal Wash
[3] Feet Above Confluence With Smith Creek

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

WEST CATHEDRAL CHANNEL – WEST NORCO CHANNEL – WEST PERSHING CHANNEL

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Whitewater River								
A	190,742	442	3,311	14.2	309.4[4]	309.4	309.4	0.0
B	192,077	501	3,949	11.9	317.1[4]	317.1	317.1	0.0
C	192,662	690	5,179	9.1	319.8	319.8	319.8	0.0
D	193,650	710	--[3]	--[3]	323.6[4]	323.6	323.6	0.0
E	194,850	600[2]	3,597	13.1	331.0	331.0	331.0	0.0
F	195,990	750	5,511	8.5	337.7[4]	337.7	337.7	0.0
G	197,110	850	5,032	9.3	342.6[4]	342.6	342.6	0.0
H	198,230	930	4,810	9.8	348.6[4]	348.6	348.6	0.0
I	199,330	970	4,816	9.8	356.0	356.0	356.0	0.0
J	200,430	980	5,309	8.9	363.1	363.1	363.1	0.0
K	201,870	1,100	5,244	9.0	371.5[4]	371.5	371.5	0.0
L	202,970	1,190	5,163	9.1	379.2[4]	379.2	379.2	0.0
M	204,120	1,310	7,069	6.6	386.2[4]	386.2	386.2	0.0
N	205,220	1,405	6,548	7.2	391.5[4]	391.5	391.5	0.0
O	206,300	1,460[2]	4,222	11.1	400.5	400.5	400.5	0.0
P	207,320	1,585[2]	4,785	9.8	407.9	407.9	407.9	0.0
Q	208,340	1,640[2]	5,015	9.4	414.2	414.2	414.2	0.0
R	209,370	1,710	5,582	8.4	422.0[4]	422.0	422.0	0.0
S	210,430	1,710	5,688	8.3	429.8[4]	429.8	429.8	0.0
T	211,470	1,760	6,560	7.2	438.7[4]	438.7	438.7	0.0
U	212,525	1,780	6,223	7.7	446.2	446.2	446.2	0.0

[1]Feet Above Mouth
[2]Lies Entirely Outside City Limits
[3]Data Not Available
[4]Channel Elevation Assuming Both Levees Hold

TABLE 7

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

FLOODWAY DATA

WHITEWATER RIVER

After consultation with representatives of the RCFCWCD, county officials selected floodways for portions of Sunnymead Storm Channel and Kalmia Street Wash, based on existing legal, economic, and political factors. The selected floodways met applicable land use standards of both the RCFCWCD and FEMA.
The floodways presented in this report were developed through a series of procedural steps that included an evaluation of equal conveyance reduction from each side of the floodplain, negotiation and coordination with local and regional agencies, review of existing hydraulic data, analysis of design criteria of existing and proposed structural improvements, and application of the natural topography and the practicality of access to flood fringe areas.

Three distinct types of situations which allow the delineation of a floodway occur in the City of Banning. These are broad, well-defined floodplains; well-incised natural channels containing the 1-percent annual change discharge; and fully improved channels of 1-percent annual chance capacity.

The first of these situations occurs along Smith Creek at the southern extremity of the city. Smith Creek is the only flooding source within the city for which delineation of a floodway serves any practical use for floodplain management. This flooding source lends itself well to development of a floodway by means of equal conveyance reduction. After a floodway was initially developed by this process, it was found that, in some reaches, although the elevation surcharge was not more than 1.0 foot, bank velocities had become hazardous, making delineation of a floodway purely by equal conveyance reduction impractical. Subsequently, the floodway boundary was modified in these areas until bank velocities were brought within reasonable limits. The floodway delineated for Smith Creek is the result of this process.

The second situation allowing delineation of a floodway is that of well-incised natural channels containing the 1-percent annual chance frequency discharge. In these areas, the channels in the Banning area are generally deeply incised and rectangular in cross sections having steep, near-vertical, banks. Because the 1-percent annual chance storm is contained well within these channels, any encroachment would be narrow, require extensive fills, and present problems of access. Consequently, the floodway in these cases is delineated by the 1-percent annual chance flood boundary. Channels in the City of Banning which are of this type are the Gilman Home Channel at the confluence with Smith Creek to Westward Avenue, Montgomery Creek at the confluence with Smith Creek to Southern Pacific Railroad, and West Pershing Channel from Ramsey Street to Wilson Street.

Another channel which meets this criterion, with the added complication of having a broad, flat floodplain with braided flow paths is the San Gorgonio River.

The final situation lending itself to delineation of a floodway is that of a 1-percent annual chance design channel. Because the 1-percent annual chance discharge is fully contained within the channel banks, they become the boundaries of this already operational floodway. Watercourses which meet this criterion are the Gilman Home

Channel – Stage I Improvements, starting at the confluence with East Gilman Home Channel to 300 feet downstream from Wilson Street; Highland Springs Channel from Wilson Street north; Montgomery Creek at Ramsey Street to the northerly corporate limits; and West Pershing Channel from Wilson Street to the northerly corporate limits.

An additional area where the floodway is delineated as the 1-percent annual chance boundary is the ponding areas on Smith and Pershing Creeks behind the Southern Pacific Railroad and Interstate Highway 10 embankment. A floodway is delineated here in order to preclude further development within this serious flood hazard area.

Aside from the aforementioned cases where delineation of a floodway was deemed appropriate, no other floodways were delineated. The 1-percent annual chance flooding for all other reaches studied is that of sheet flooding on an alluvial cone and in previously developed areas. Delineation of a floodway in these areas is not appropriate.

The Marshall Creek floodplain was studied with respect to the possibility of delineating a floodway based on equal conveyance reduction. Upon investigation, however, it was found that any encroachment caused excessive and hazardous bank velocities. In addition, the 1-percent annual chance flood is contained within the well-incised channel and access to any floodway fringe areas created would be difficult and they would be so narrow as to be useless. Consequently, the floodway was delineated as the 1-percent annual chance flood boundary.

The 1-percent annual chance flooding for all other areas studied is that of sheet flooding on an alluvial cone and in previously developed areas. Delineation of a floodway in these areas is not appropriate.

For the channelized and leveed reaches of East, West, and North Cathedral Channels, floodway boundaries were set at the channel banks or outside toe of the levee. They represent the existing 1-percent annual chance boundary and, by their nature, preclude further encroachment.

In cases of flooding on debris cones and dry desert washes, flow paths are highly unpredictable and subject to sudden changes in direction. Because this type of flooding is overland without a stable and consistent flow path to serve as a point of orientation around which to establish land-use control areas, and because the flooding travels through already developed areas, delineation of a floodway meeting FEMA criteria is not possible. Therefore, no floodways were developed for Tramview Wash, Tramview Wash Tributary, the Whitewater River, and areas of shallow flooding on North Cathedral Channel upstream of the improved channel.

The floodways for North Norco Channel, South Norco Channel Tributary A, West Norco Channel, and Country Club Creek were computed on the basis of equal-conveyance reduction from each side of the floodplain. The floodway for both South Norco Channel and South Norco Channel Tributary A have significant portions that are defined by large ponding areas. On South Norco Channel, this situation occurs behind River Road; for South Norco Channel Tributary A, it occurs from just below Parkridge Avenue and extends upstream to just below Hamner Avenue.

Arlington Channel is a 1-percent annual chance design channel and, therefore, was adopted as the floodway. This provides a 50-foot-wide floodway that extends the entire length of the channel under study.

Main Street Channel is a 1-percent annual chance design channel and, therefore, was adopted as the floodway. This resulted in a uniform 15-foot-wide floodway throughout the entire length of the watercourse.

No floodways have been delineated for Oak Street Channel and Mangular Channel due to the lack of adequate upstream control, limited existing channelization, the hydraulic characteristics of an active alluvial cone with a large drainage area, high-velocity flows, high potential for debris obstruction and distribution on the cone, and the resulting unpredictability of flow paths that prevent applicable use of floodway criteria.

Lincoln Avenue Drain and Taylor Avenue Drain are the principal facilities that drain the alluvial fan. These facilities, along with the street system, provide adequate flood protection for low flows. However, during storms of long duration and high intensity, the existing runoff collection systems become inadequate and the flow paths become unpredictable, resulting in shallow flooding. Therefore, no floodways were determined for either Lincoln Avenue Drain or Taylor Avenue Drain because of this shallow flooding analysis and the extent of community development below Ontario Avenue on the Corona fan.

A floodway generally is not appropriate in areas such as those that may be inundated by floodwaters from the Prado Dam Flood Control Reservoir. Thus, no floodway was delineated for the lower portions of Temescal Wash and North Norco Channel where the flooding limits are predicted on the high levels of the Prado Dam basin rather than from high streamflow.

The floodway for Temescal Wash was initially developed using equal-conveyance reduction. Several coordination meetings with the City of Corona, the Riverside County Flood Control District, and the study contractor were held. Additional hydraulic data representing previous analysis, existing floodway limits, and updated field cross-sectional information were provided during these coordination meetings. Additional data resulted in an acceptable negotiated floodway that was hydraulically analyzed and found to be consistent with current FEMA floodway criteria. The floodway is contained in the improved channel between Cota Street and the Atchison, Topeka & Santa Fe Railway.

Arlington Channel and its resultant flood hazard, identified in this study, are adjacent to the City of Riverside. This flood hazard is not identified in the FISs for the City of Riverside (FEMA, 1983) or Riverside County (FEMA, 1984). No other flooding source in either this study or the FIS for the City of Riverside has been identified along their common corporate limits.

Two information brochures for the Santa Ana River basin have been published by the USACE, Los Angeles District. The first, Flood Control and Recreation Development, Santa Ana River Basin and Orange County Main Stem Santa Ana River, was published in August 1974 (USACE, August 1974), and the second, Recommended Plan of Improvement for Flood Control and Allied Purposes (All-River Plan), Santa Ana River, Santiago Creek, and Oak Street Drain (USACE, November , 1975), was published in November 1975. No water-surface profiles are included in either report. Only the latter report indicates any runoff quantities or flooding limits, and the hydrology used in this study is compatible with those data.

The Riverside County Flood Control and Water Conservation District published Report on 1969 Storms in Riverside County, dated October 1970 (Riverside County Flood Control and Water Conservation District, 1970). The report does not include water-surface profiles for those storms, but does include thorough photographic documentation, a comprehensive record of precipitation, and stream gaging. The hydrology used in this study is compatible with those data.

No floodways were developed for channels in the City of Desert Hot Springs.

The 1-percent annual chance discharge is contained within Blind Canyon Channel. Because of the difficulty of access and the narrow floodway that would result, no floodway was developed.

FEMA criteria are not applicable to Desert Hot Springs channel, one section of which is in a developed area. For the 1-percent annual chance discharge to be contained within the channel right-of-way, substantial improvements would have to be made; therefore, no floodway was delineated.

Because of the nature of alluvial fans, no floodways have been determined for alluvial fan flooding in the Desert Hot Springs area.

The floodway for Salt Creek and Salt Creek Overflow was evaluated based on criteria established by the RCFCD and the City of Hemet. Briefly, the criteria required the south bank of the alignment of the proposed new channel to be the southern boundary of the floodway. To create a consistent 1.0-foot rise in the base flood water-surface elevation throughout the study reach, the northern boundary of the base flood was moved south, encroaching upon the channel, until a 1.0-foot rise was achieved. Existing flat topography allowed use of this criteria for the determination of the north floodway boundary below Sanderson Avenue; however, between Sanderson and Lyon Avenues, the City has adopted the base flood boundaries as floodway boundaries upon recommendations from the RCFCD prior to the initiation of this study.

Information report (USACE, 1971) was based on topographic mapping that was prepared by the RCFCD in September 1953 and 1962. The current mapping (Riverside County Flood Control District, 1972), also prepared by the RCFCD, was completed in December 1972 and reflected changes in the Salt Creek floodplain. Although the current mapping for Salt Creek has not caused a dramatic revision or alteration of the results published by the USACE, portions of the Salt Creek topography in the City of Hemet have changed and did merit additional study. A hydraulic analysis was conducted by Toups Corporation to examine the hydraulic properties of Salt Creek that reflected current topography. Upon completion of the analysis, water-surface elevations were verified by the USACE in a meeting at the Los Angeles District office in July 1977. Due to the minor changes in water-surface elevation and scale of topographic mapping used, flood boundary delineations were adopted directly from the Floodplain Information report in several areas.

Toups Corporation completed an unpublished FIS for the unincorporated areas of Riverside County, California. Flood boundary delineations for the unincorporated study concur with results of this study, except where subsequent developments have altered the flood boundaries.

The RCFCD has compiled Flood Zone Boundary Maps (Riverside County Flood Control District, Flood Zone Boundary Maps, 1974) for most of the flood hazard areas within the district. These maps are based on all available information, including the above-mentioned reports plus other published and unpublished data by the USACE and the RCFCD. No water-surface profiles are included.

The reach of Salt Creek between Lyon and Sanderson Avenues, immediately adjacent to the Seven Hills Golf Course, was studied by the RCFCD as a result of increased pressure for development in this area (Riverside County Flood Control and Water Conservation District, Hydraulic Analysis, Seven Hills Area of Salt Creek Floodplain). This study was conducted recognizing data determined previously by the USACE study, while reflecting changes to specific portions of the study reaches. This resulted in continuity between individual study delineations in the USACE study (USACE, 1971), the RCFCD study ((Riverside County Flood Control and Water Conservation District, Hydraulic Analysis, Seven Hills Area of Salt Creek Floodplain), and the present study.

Due to the nature of flooding in the City of Indian Wells, delineation of floodways meeting FIA criteria is either inappropriate or impossible.

Because 1-percent annual chance flooding is contained within the excavated channel on the Whitewater River, delineation of a floodway would serve no practical purpose for floodplain management or land use controls and is, therefore, inappropriate.

In the lower reach of the Deep Canyon Storm Water Channel upstream to Cook Street, delineation of a floodway is unnecessary as the only overflow of the channel occurs on golf course land and would create no problems for developed areas. Other than this minor overflow, 1-percent annual chance flooding is fully contained in the channel; therefore, no floodway was delineated.

In the case of shallow flooding in the upper reach of the Deep Canyon study on its debris cone, flow paths are highly unpredictable and subject to sudden changes in direction. Because this type of flooding is overland without a stable and consistent flow path to serve as a point of orientation around which to establish land use control areas, and because the flooding travels through already developed areas, delineation of a floodway meeting FIA criteria is impossible.

A floodway for Whitewater River was not computed, because the 1-percent annual chance flood is contained within the Coachella Valley Stormwater Channel.

No floodways were computed for flooding sources studied by detailed methods in the City of La Quinta due to the effects of the flood protection measures described in Section 2.4.

The floodways for Elsinore Spillway Channel, Temescal Wash, San Jacinto River, and Wasson Canyon Creek were computed on the basis of equal conveyance reduction from each side of the floodplain.

No floodways were delineated for Channel H, Lime Street Channel, Ortega Channel, and Leach Canyon Channel because these are all improved channels capable of containing up to a 1-percent annual chance flood. Floodways were not determined for the upstream reaches of these channels due to the lack of adequate upstream control and limited existing channelization. No floodways were delineated for Stovepipe Canyon Creek, Arroyo Del Toro, Rice Canyon, McVicker Canyon, Leach Canyon, Wash G, and Wash I, due to the unpredictability of flow paths and the presence of low-velocity, irregular sheetflow; all of which prevent applicable use of floodway criteria.

The City of Norco has adopted a zoning ordinance that delineates the channel right-of-way as a floodway for several major watercourses. This ordinance prevents any development within the floodway strip. Typically, the right-of-way strip is 60 feet wide, with the flowline located at the centerline of the strip.

For North Norco Channel, the floodway from Temescal Wash to Parkridge Avenue was determined by equal conveyance reduction. From Parkridge Avenue to Hamner Avenue, the new 1-percent annual chance design channel was adopted as the floodway. The floodway for the study segment upstream of Hamner Avenue to the study limit was initially computed on the basis of equal conveyance reduction from each side of the floodplain. However, hazardous velocities resulted from this approach. Floodway limits were finally determined by establishing the floodway limits at the channel right-of-way boundaries. This approach did not produce substantial increases in the base flood elevations, but it did reduce the hazardous velocities to provide a floodway meeting the required criteria.

North Norco Channel, Tributary A has several structural improvements, including a fully improved, reinforced concrete channel and section of reinforced concrete box channels, which are designed to carry the 1-percent annual chance flow. The channel has an inadequate inlet capacity at present, and the resulting flooding is shallow flooding at depths of less than 1.0 foot. Therefore, the floodway adopted is confined to the channel and not shown on the FBFM (Exhibit 2).

The Santa Ana River floodway was initially developed using equal conveyance reduction, resulting in a floodway fringe at the base of the south bluffs of the river.

During one of the coordination meetings with the City of Norco, the Riverside County Flood Control District, and the study contractor, it was felt that it would be an impractical application of floodplain management to leave the defined floodway fringe area below the bluffs. It would have created problems of access, narrowness of the developable strip, and potentially hazardous bank velocities. Consequently, it was agreed to define the bluff line as the southern boundary of the floodway. This "negotiated" floodway was hydraulically analyzed and found to be consistent with current FIA floodway criteria.

From the downstream limit of study to the confluence with South Norco Channel, Tributary B, the South Norco Channel floodway was defined by the actual channel bank; but, this floodway, developed by equal conveyance reduction, produced hazardous velocities that could cause degradation of the banks of the graded trapezoidal channel. Therefore, the channel right-of-way, which is zoned as a floodway by the City of Norco, was adopted as the floodway boundary. An analysis of this floodway indicated water-surface increases and velocities within the acceptable criteria for a designated floodway, while allowing for erosion and subsequent reconstruction of the channel cross section. Immediately upstream of Hamner Avenue and between Parkridge Avenue and River Road, the floodway widens considerably due to the ponding that occurs behind the respective crossings. Above the confluence with South Norco Channel, Tributary B, the floodway is defined by the equal conveyance reduction method.

The floodway for South Norco Channel, Tributary A was developed by equal conveyance reduction and is significant between Parkridge and Hamner Avenues, where it is defined by a large ponding area.

The floodway for South Norco Channel, tributary B from the confluence with South Norco Channel to Temescal Avenue was developed by adopting the zoned floodway at the channel right-of-way, due to hazardous velocities as indicated for several other flooding sources in the community. Upstream from Temescal Avneue to the study limit, equal conveyance reduction was used to develop the floodway.

North Norco Channel, Tributaries B and C are two principal tributaries that drain the hills east of the City of Norco. As these watercourses progress from the toe of the foothills, they traverse an alluvial cone that extends to the North Norco Channel. Due to the undefined flow paths and resulting shallow flooding characteristic of alluvial flow, a floodway is inappropriate and none was developed for these two flooding sources.

The floodway for Mountain Avenue Wash was developed by means of equal conveyance reduction from each side of the floodplain.

Initially, a floodway was determined for the Perris Valley Storm Drain using equal conveyance reduction from both sides of the channel. The result was an irregular floodway of vastly varying widths, which would be difficult to implement. Subsequently, an analysis was done using a smoother alignment determined by engineering judgment and the same general width and alignment as the earlier one. A computer analysis of this floodway produced data consistent with FEMA guidelines and acceptable to the City of Perris and the Riverside County Flood Control District.

Equal conveyance reduction of the Jacinto River yielded irregular results; so, a floodway was established using engineering judgment and meeting FEMA criteria by the same process described for the Perris Valley Storm Drain.

On the San Jacinto Lateral, no floodway was delineated for this source as the flooding consists of shallow sheetflow in an already developed area.

No floodway was developed for Orange Lateral because the nature of flooding is shallow sheetflow with no defined flow line. Consequently, due to the lack of a defined flow path and the broad expanse of shallow inundation, delineation and implementation of a floodway would be impractical.

On Line "J" Channel, no floodway is indicated, as the 1-percent annual chance discharge is contained within the channel downstream to the point where sheetflow from Orange Lateral intersects the channel. From that point downstream to the Perris Valley Storm Drain, the flooding is broad, shallow sheetflow which does not lend itself to delineation of a floodway.

No floodways were computed for flooding sources studied by detailed methods in the City of Rancho Mirage due to the nature of the flooding in the area.

In the case of the Whitewater River, the 1-percent annual chance flood is contained within the excavated channel. In the case of the Magnesia Springs Canyon Flood Control Project, the 1-percent annual chance flood is contained within the channels, levees, and streets of the project. The delineation of the channels or streets as floodways, would not serve any practical purpose for floodplain management or land use controls and is, therefore, inappropriate.

In the case of shallow flooding on a debris cone, flow paths are highly unpredictable, subject to sudden changes in direction, and develop graded flow paths down the debris cone. Because this type of flooding is overland without a stable and consistent flow path to serve as a point of orientation around which to establish land use control areas, and because the flooding travels through already developed areas, delineation of a floodway is impossible.

Except for the Santa Ana River, the development of floodways was not within the scope of this study.

No floodway was delineated for Bautista Wash because the concept of floodway does not apply for this Wash.

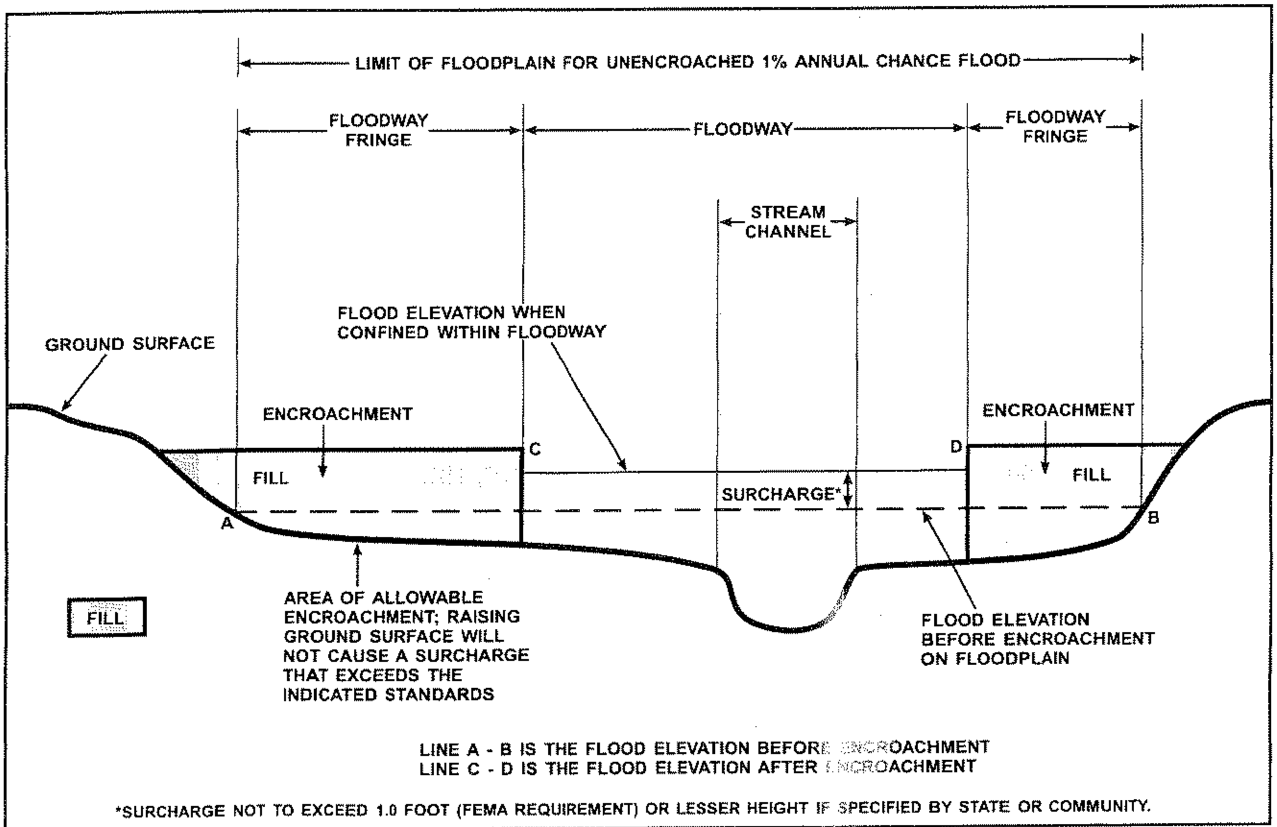
The FIRM for Riverside County and incorporated areas reflects flood hazard data produced as a result of the Colorado Floodway Protection Act passed by Congress in 1986 (Public Law 99-450). The act was passed to establish a floodway along the Colorado River from Davis Dam to the U.S. – Mexico border. The hydrologic and hydraulic analyses and floodway mapping for the Colorado River were prepared by the Colorado River Floodway Task Force and the U.S. Bureau of Reclamation (USBR).

A hydrologic analysis was performed to determine 1% annual chance peak discharges at points along the Colorado River from Davis Dam to the U.S. – Mexico border. Runoff from above Hoover Dam is typically the dominant contributing factor for flood flows, although combinations of releases from Davis and Parker Dams with flash floods originating from downstream watersheds also contribute to flood flows into the Colorado River and are significant in determining peak 1% annual chance discharges. Details regarding the methods used to calculate the peak discharges along the Colorado River are outlined in the USBR report titled "Flood Frequency Determinations for the Lower Colorado River," Volume I, Supporting Hydrologic Documents of the Colorado River Floodway Protection Act of 1986, dated March 1989.

Hydraulic routing was completed using the DWOPER computer program. The Base (1% annual chance) Flood Elevations (BFEs) along the Colorado River were computed by assuming that the floodway fringe would not convey any portion of the flood flow. Cross sections used in the hydraulic computer model include both channel and overflow areas and reflect hydrographic surveys taken by USBR. The DWOPER hydraulic model was calibrated using known hourly flow values from Davis and Parker Dams and the observed gage records below the two dams resulting from the known flows. Final maps of the Colorado River Floodway were published by USBR at a scale of 1"=2,000' with 1% annual chance flood elevations in NGVD29. These flood elevations have been converted to NAVD88 for the FIRM and this report using a conversion offset of 2.2 foot.

The flood hazard data produced as part of Public Law 99-450 is summarized for river mile markers in the Floodway Data Table for the Colorado River. Peak discharges are listed in Table 4. Flood profiles for the Colorado River are not included because the available flood elevation data is included in the Floodway Data tables. Flood insurance is not available for structures in the Colorado River Floodway built or substantially improved on or after April 8, 1987.

The area between the floodway and 1-percent annual chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent annual chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1.



FLOODWAY SCHEMATIC Figure 1

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 1-percent annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 1-percent annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone AR

Area of special flood hazard formerly protected from the 1-percent annual chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1-percent annual chance or greater flood event.

Zone A99

Zone A99 is the flood insurance rate zone that corresponds to areas of the 1-percent annual chance floodplain that will be protected by a Federal flood protection system where construction has reached specified statutory milestones. No base flood elevations or depths are shown within this zone.

Zone V

Zone V is the flood insurance rate zone that corresponds to the 1-percent annual chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no base flood elevations are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent annual chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent annual chance floodplain, areas within the 0.2-percent annual chance floodplain, and to areas of 1-percent annual chance flooding where average depths are less than 1 foot, areas of 1-percent annual chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-

percent annual chance flood by levees. No base flood elevations or depths are shown within this zone.

Zone D

Zone D is the flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent annual chance floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent annual chance floodplains. Floodways and the locations of selected cross sections used in the hydraulic analyses and floodway computations are shown where applicable.

The current FIRM presents flooding information for the entire geographic area of Riverside County. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each identified flood-prone incorporated community and the unincorporated areas of the county. This countywide FIRM also includes flood hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community, up to and including this countywide FIS, are presented in Table 8, "Community Map History."

7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Riverside County has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS Reports, FHBMs, FBFMs, and FIRMs for all of the incorporated and unincorporated jurisdictions within Riverside County.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this FIS can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, 1111 Broadway, Suite 1200, Oakland, California 94607-4052.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Agua Caliente Band of Cahuilla Indian Reservation	May 1, 1985		May 1, 1985	
Banning, City of	March 15, 1974		October 17, 1978	
Beaumont, City of	April 5, 1974		October 17, 1978	
Blythe, City of[1]				
Calimesa, City of				
Canyon Lake, City of	April 15, 1980		April 15, 1980	
Cathedral City, City of	May 1, 1985		May 1, 1985	
Coachella, City of				
Colorado River Indian Reservation	March 18, 1996		March 18, 1996	
Corona, City of	May 24, 1974		May 15, 1978	
Desert Hot Springs, City of	May 24, 1974		April 2, 1979	
Hemet, City of	May 24, 1974		September 29, 1978	
Indian Wells, City of	June 28, 1974		September 14, 1979	
Indio, City of	May 31, 1974		September 14, 1979	

[1]Non-floodprone community

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Lake Elsinore, City of	June 28, 1974		September 17, 1980	
La Quinta, City of	June 19, 1985		June 19, 1985	
Moreno Valley, City of	June 18, 1987		June 18, 1987	
Murrieta, City of	April 15, 1980		April 15, 1980	
Norco, City of	May 17, 1974		February 15, 1979	
Palm Desert, City of	June 14, 1977		April 15, 1980	
Palm Springs, City of	June 21, 1974		March 2, 1983	
Perris City of	September 6, 1974		April 16, 1979	
Rancho Mirage, City of	September 14, 1979		September 14, 1979	
Riverside, City of	September 14, 1979		January 6, 1983	
Riverside County (Unincorporated Areas)	April 15, 1980		April 15, 1980	
San Jacinto, City of	September 28, 1973		September 28, 1973	
Temecula, City of	September 2, 1993		September 2, 1993	

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERSIDE COUNTY, CA AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

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