FLOOD INSURANCE STUDY

VOLUME 1 OF 3

ALAMEDA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

Community Name	Community Number
ALAMEDA COUNTY (UNINCORPORATED AREAS)	060001
ALAMEDA, CITY OF	060002
ALBANY, CITY OF	060003
BERKELEY, CITY OF	060004
DUBLIN, CITY OF	060705
EMERYVILLE, CITY OF	060005
FREMONT, CITY OF	065028
HAYWARD, CITY OF	065033
LIVERMORE, CITY OF	060008
NEWARK, CITY OF	060009
OAKLAND, CITY OF	065048
* PIEDMONT, CITY OF	060011
PLEASANTON, CITY OF	060012
SAN LEANDRO, CITY OF	060013
UNION CITY, CITY OF	060014

* Non Flood–Prone Community

REVISED
DECEMBER 21, 2018

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
06001CV001B

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.

This FIS report was revised on October 21, 2018. Users should refer to Section 10.0, Revisions Description, for further information. Section 10.0 is intended to present the most up-to-date information for specific portions of this FIS report. Therefore, users of this FIS report should be aware that the information presented in Section 10.0 supersedes information in Sections 1.0 through 9.0 of this FIS report.

Initial Countywide FIS Effective Date: August 3, 2009

Revised Countywide FIS Date: December 21, 2018

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FLOOD INSURANCE STUDY

ALAMEDA 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 Alameda County, California, including: the Cities of Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Oakland, Piedmont, Pleasanton, San Leandro, and Union City, and the unincorporated areas of Alameda County (hereinafter referred to collectively as Alameda 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 Alameda 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.

Please note that the City of Piedmont has no mapped special flood hazard areas.

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, Alameda 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.

Alameda County (Unincorporated Areas):	The hydrologic and hydraulic analyses from the FIS report dated February 9, 2000, were performed by Development and Resources Corporation, for the Federal Emergency Management Agency (FEMA), under Contract No. H-3682. That study was completed in March 1976.

Alameda, City of: The hydrologic and hydraulic analyses from the FIS report dated July 16, 1991, were performed by the U.S. Army Corps of Engineers (USACE), San Francisco District, for FEMA, under Interagency Agreement No. EMW-88-E-2768. That study was completed in September 1989.

Albany, City of: The hydrologic and hydraulic analyses from the FIS report dated August 1979 were performed by the Development and Resources Corporation for the Federal Insurance Administration (FIA), under Contract No. H-4095. That work, which was completed in September 1977, covered all significant flooding sources affecting the City of Albany.

Berkeley, City of: The hydrologic and hydraulic analyses from the FIS report dated March 1978 were performed by the USACE, San Francisco District, for the FIA, under Inter-Agency Agreement Nos. IAA-H-273, IAA-H-19-74, and IAA-H-16-75, Project Order Nos. 9, 15, and 22, respectively. That work, which was completed in October 1975, covered all significant flooding sources affecting the City of Berkeley.

Dublin, City of: The hydrologic and hydraulic analyses from the FIS report dated September 17, 1997, were performed by Borcalli and Associates, for FEMA, under Contract No. EMW-93-C-4211. The initial study was completed in March 1976.

Fremont, City of: The hydrologic and hydraulic analyses from the FIS report dated February 9, 2000, were performed. by PRC Toups, for FEMA, under Contract No. H-4721. That work, which was completed in December 1980, covered all significant flooding sources affecting the City of Fremont.

Hayward, City of: The hydrologic and hydraulic analyses from the FIS report dated February 9, 2000, were performed by Development and Resources Corporation, for the FIA, under Contract No. H4095. That work, which was completed in August 1978, covered all significant flooding sources affecting the City of Hayward.

Livermore, City of: The hydrologic and hydraulic analyses from the FIS report dated September 17, 1997, were performed by the USACE, San Francisco District, for FEMA, under Inter-Agency Agreement Nos. IAA-H-19-74 and IAA-H-16-75 and Project Order Nos. 17 and 14, respectively. The initial study was completed in March 1976.

The hydrologic and hydraulic analyses for the streams which were added from the Alameda County FIS were performed by Development and Resources Corporation for

FEMA, under Contract No. H-3682. The streams added are as follows: a portion of Arroyo Mocho, a portion of Arroyo Las Positas, a portion of Altamont Creek, a portion of Arroyo Seco, a portion of Arroyo Las Positas Relocation, Arroyo Del Valle, Cayetano Creek, and Collier Creek. That study was completed in March 1976.

Newark, City of:	The hydrologic and hydraulic analyses from the FIS report dated February 9, 2000, were performed by the Development and Resources Corporation, for the FIA, under Contract No. H4095. That work, which was completed in May 1977, covered all significant flooding sources affecting the City of Newark.
Oakland, City of:	The hydrologic and hydraulic analyses from the FIS report dated August 1982, were performed by PRC Toups, for FEMA, under Contract No. H4721. That work, which was completed in December 1980, covered all significant flooding sources affecting the City of Oakland.
Pleasanton, City of:	The hydrologic and hydraulic analyses from the FIS report dated September 30, 1997, were performed by Development and Resources Corporation, for FEMA, under Contract No. H4095. That study was completed in 1978.
San Leandro, City of:	The hydrologic and hydraulic analyses from the FIS report dated February 9, 2000, were performed by Development and Resources Corporation, for the FIA, under Contract No. H4095. That work, which was completed in October 1977, covered all significant flooding sources affecting the City of San Leandro.
Union City, City of:	The hydrologic and hydraulic analyses from the FIS report dated February 9, 2000, were performed by the USACE, Sacramento District, for the FIA, under Inter-Agency Agreement Nos. IAA-H-19-74 and IAA-H-16-75, Project Order No. 22. That work, which was completed in December 1976, covered all significant flooding sources affecting the City of Union City. Revised hydrologic and hydraulic information for Alameda Creek - Line A and Line D was used to bring the Union City FIS into agreement with the FIS for Hayward, California (FEMA, 1981).

The authority and acknowledgments for the City of Emeryville and City of Piedmont are not available because no FIS reports were ever published for those communities.

The detailed coastal analyses north of the San Mateo Bridge (Route 92) for the December 21, 2018 coastal study were performed by BakerAECOM under Contract No. HSFEHQ-09-D-0368, Task Order No. HSFE09-12-J-0005. This work, which was completed in

2014, incorporates regional-scale wave and hydrodynamic modeling performed by DHI Water & Environment, and covers the portions of the San Francisco Bay shoreline of Alameda County south of the San Mateo Bridge (Route 92).

On selected FIRM panels, planimetric base map information was provided in digital format. These files were compiled at scales of 1:1,200, 1:2,400 and 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.

For this Physical Map Revision ("PMR"), base map information was derived from Coastal California LiDAR and digital imagery dated 2011. USDA NAIP 2012 imagery is used in areas not covered by the Coastal California digital imagery.

The coordinate system used for the production of this FIRM is Universal Transverse Mercator (UTM), North American Datum of 1983 (NAD 83), Geodetic Reference System 1980 (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 Alameda County and the incorporated communities within its boundaries are shown in Table 1, "Initial and Final CCO Meetings."

Table 1: Initial and Final CCO Meeting Dates

Community Name	For FIS Dated	Initial CCO Date	Final CCO Date
Alameda County (Unincorporated Areas)	October 15, 1981 September 17, 1997 February 9, 2000 August 3, 2009 December 21, 2018	* January 22, 1993 January 22, 1993 June 8, 2004 *	January 9, 1976 * July 17, 1997 January 29, 2008 May 27, 2015
Alameda, City of	July 16, 1991 August 3, 2009 December 21, 2018	September 1988 June 8, 2004 *	July 17, 1990 January 29, 2008 May 27, 2015

Table 1: Initial and Final CCO Meeting Dates, continued

Community Name	For FIS Dated	Initial CCO Date	Final CCO Date
Albany, City of	August 1979	February 2, 1976	December 11, 1978
	August 3, 2009	June 8, 2004	January 29, 2008
	December 21, 2018	*	May 27, 2015
Berkeley, City of	March 1978	June 8, 1973'	July 29, 1975
	August 3, 2009	June 8, 2004	January 29, 2008
	December 21, 2018	*	May 27, 2015
Dublin, City of	September 1997	June 22, 1993	April 5, 1996
	August 3, 2009	June 8, 2004	January 29, 2008
	December 21, 2018	*	May 27, 2015
Fremont, City of	May 2, 1983	March 1978	March 24, 1982
	February 9, 2000	January 22, 1993	July 16, 1997
	August 3, 2009	June 8, 2004	January 29, 2008
Hayward, City of	September 16, 1981	January 13, 1977	November 6, 1979
	February 9, 2000	*	July 15, 1997
	August 3, 2009	June 8, 2004	January 29, 2008
	December 21, 2018	*	May 27, 2015
Livermore, City of	September 17, 1997	January 22, 1993	*
	August 3, 2009	June 8, 2004	January 29, 2008
Newark, City of	December 1, 1978	September 7, 1976	November 17, 1977
	February 9, 2000	January 22, 1993	July 16, 1997
	August 3, 2009	June 8, 2004	January 29, 2008
	December 21, 2018	*	May 27, 2015
Oakland, City of	August 16, 1982	*	March 24, 1982
	August 3, 2009	June 8, 2004	January 29, 2008
	December 21, 2018	*	May 27, 2015
Pleasanton, City of	December 16, 1980	January 13, 1977	October 19, 1978
	September 30, 1997	January 22, 1993	*
	August 3, 2009	June 8, 2004	January 29, 2008
San Leandro, City of	March 18, 1980	January 30, 1976	October 16, 1978
	February 9, 2000	*	July 17, 1997
	August 3, 2009	June 8, 2004	January 29, 2008
	December 21, 2018	*	May 27, 2015
Union City, City of	December 1, 1978	March 21, 1975	September 12, 1977
	February 9, 2000	January 22, 1993	July 15, 1997
	August 3, 2009	June 8, 2004	January 29, 2008

[1] Notified by letter

* Date not available

2.0 AREA STUDIED

2.1 Scope of Study

This F1S covers the geographic area of Alameda 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

- Agua Fria Creek
- Alameda Creek (Line A Zone 3A)
  - Line A (Zone 4)
  - Line A-2 (Zone 3A)
  - Line B-2-1
  - Line C (Zone 3A)
  - Line D
  - Line D (Zone 6) (Agua Fria Creek)
  - Line E (Zone 3A)
  - Line E (Sausel Creek)
  - Line F (Peralta Creek)
  - Line G (Zone C)
  - Line H
  - Line I (Seminary Avenue Drain)
- Alamo Canal
- Alamo Creek
- Altamont Creek
- Arroyo De La Laguna
- Arroyo del Agua Caliente Creek
- Arroyo Del Valle
- Arroyo Las Positas
- Arroyo Las Positas Relocation
- Arroyo Mocho
- Arroyo Seco
- Canada del Aliso
- Cayetano Creek
- Cayetano Creek (West Branch)
- Cerrito Creek
- Chabot Canal (Line G)
  - Line J (Zone 6) (Canada Del Aliso)
  - Line K (Arroyo Viejo Creek)
  - Line K (Zone 5) (Crandall Creek)
  - Line L (Zone 6) (Mission Creek)
  - Line N (Stonehurst Creek)
  - Line P (San Leandro Creek)
- Codornices Creek and Bypass
- Collier Creek
- Cottonwood Creek
- Crandall Creek
- Dublin Creek
- Harwood Creek
- Hewlett Canal
- Laguna Creek
- Lake Elizabeth
- Marin Avenue Trunk
- Middle Creek
- Mission Creek
- Morrison Canyon
- Pleasanton Canal
- San Leandro Creek (Line B, Zone 9)
  - Line C (Zone 9)
  - Line D (Zone 9)
- Scott Creek
- South San Ramon Creek
- Strawberry Creek
- Sulphur Creek
- Tassajara Creek
- Torges Creek
- Village Creek
- Ward Creek (Line B, Zone 3A)

This FIS also incorporates the determinations of Letters of Map Change issued by FEMA since the last Countywide Revision to this FIS, as shown in Table 3, "Letters of Map Change."

Table 3: Letters of Map Change

Community	Flooding Source(s) / Project Identifier	Date Issued	Type
City of San Leandro	Heron Bay Development, 10-09-0887P	January 08, 2010	LOMR

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. 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 Alameda County.

2.2 Community Description

Alameda County, located in west-central California, lies adjacent to the Counties of Santa Clara, San Mateo, San Francisco, Contra Costa, and San Joaquin. Along its western side, Alameda County is bordered by San Francisco Bay.

The Alameda Creek basin covers an area of approximately 700 square miles within Alameda, Santa Clara, and Contra Costa Counties. Alameda Creek originates in Santa Clara County and flows northwesterly through the hills of the Coast Range in Alameda County, crosses the flat San Francisco Bay plain, and discharges into San Francisco Bay. Major water bodies in this basin include Del Valle, Calaveras, and San Antonio Reservoirs. In Alameda County, the Alameda Creek basin has a maximum elevation of approximately 3,800 feet; the lowest elevation is at sea level where the creek discharges into San Francisco Bay. Tributaries in the Alameda Creek basin within the study area flow through narrow canyons in the hills, traverse the Livermore-Amador Valley, and empty into Arroyo De La Laguna. Arroyo De La Laguna carries the combined flows into Alameda Creek, which it joins near Sunol.

Northwest of the Alameda Creek watershed, the San Lorenzo Creek basin drains a fan-shaped area of approximately 60 square miles within Alameda and Contra Costa Counties. Major tributaries to San Lorenzo Creek and their combined waters flow westerly into San Francisco Bay. No major bodies of water lie in the San Lorenzo Creek basin. The upper portion of the San Lorenzo Creek basin contains narrow, relatively steep valleys carved by tributaries. Ridges, ranging from 200 to 1,850 feet, divide the valleys. At its lower reach, San Lorenzo Creek crosses the San Francisco Bay plain, which descends gradually from an elevation of 100 feet at the foot of the Coast Range to sea level at San Francisco Bay.

The climate in Alameda County is characterized by warm, dry summers and mild, wet winters. The City of Livermore, in the Livermore-Amador Valley, has an average annual temperature of approximately 59 degrees Fahrenheit (USACE, 1961). Rainfall is the chief form of precipitation in the basins, although at higher elevations snow falls occasionally. Precipitation in the Alameda and San Lorenzo Creek basins ranges from 12 to 36 inches (USACE, 1961), varying by location with respect to the mountains which channel rain-producing air currents. The heaviest annual precipitation occurs in the southeastern corner of the county.

Natural vegetation in Alameda County consists chiefly of grasses, with oak trees found in valleys and hillside gullies, and on north- and east-facing slopes. Laurel and alder trees are abundant in canyon bottoms, and willows are common along watercourses. Chaparral and thick growths of oak trees are found in the southeastern corner of the county.

The historical development of Alameda County is typical of west-central California. Alameda County was once occupied by Indians of the Penutian family. In the early 19th century, ranches and farms were established by Spanish and Mexican settlers. In the mid-1800s, some of the immigrants initially drawn to California by the gold rush started small villages in the area, and in 1853 Alameda County was founded. The population of Alameda County has increased from 1,443,741 in 2000 to 1,461,030 in 2003; during the 10 years from 1990 to 2000, the population increased by 10.7% (U.S. Bureau of the Census, 2005). According to www.city-data.com/county/Alameda_County-CA.html, the population in 2012 was 1,554,720.

The floodplains of the Alameda Creek watershed, in unincorporated portions of the Livermore-Amador Valley, are used for housing, parks and recreational areas, industry, and agriculture. In the hills surrounding the Livermore-Amador Valley, floodplains are chiefly contained within narrow, undeveloped canyons. Floodplain land in the unincorporated areas within the San Lorenzo Creek watershed is devoted principally to residential development, with some commercial use. Public utilities, roads, highways, and railroads have been constructed throughout the floodplains of the Alameda Creek and San Lorenzo watersheds. Without controls, further development of the floodplains can be expected.

2.3 Principal Flood Problems

Factors that induce flooding in Alameda County are winter storms of heavy rainfall, a steep topography, and constricted floodways. Storms of wide areal distribution originate over the Pacific Ocean in winter and develop with the frontal lifting of air masses along the hills of the Coastal Range.

Concentration of storm runoff is rapid in the areas of steep slope found in the middle and upper portions of the Alameda and San Lorenzo Creek basins. Many tributaries through the two basins are ephemeral and have narrow channels that cannot accommodate higher flows. Numerous stream crossings have been built that also constrict heavy flows. In some parts of the Alameda and San Lorenzo Creek watersheds, buildings have encroached upon the floodplains. Floodplain development and constriction of channels cause elevated floodflows that result in increased flood damage.

Large floods occurred in the Alameda Creek watershed in 1862 and 1911. More recently, large floods took place in 1950, with damage estimated at $1,100,000; in 1952, with damage estimated at $1,500,000; in 1955, with damage estimated at $3,700,000; and in 1958, with damage estimated at $1,850,000 (George P. Miller, 1960). Numerous less-damaging floods took place from 1863 to 1888. From 1889 to 1910, five major floods and five less-damaging floods occurred. Between 1912 and 1945 two major floods and 16 less-damaging floods occurred.

Historical accounts indicate that major flooding of San Lorenzo Creek took place in the winters of 1861-62, 1866-67, 1871-72, and 1880-81 (USACE, 1958).

More recent major floods of San Lorenzo Creek occurred in January 1911, January 1916, February 1919, February 1925, December 1931, February 1940, January 1942, December 1950, December 1955, and April 1958 (USACE, 1958).

Flood damages still occur along major tributaries of Alameda and San Lorenzo Creeks. In 1962, flooding in the unincorporated areas of Alameda County, in combination with mud slides and gale winds, caused the region to be declared an emergency area. A later flood was described in a newspaper account from the Hayward Daily Review, December 23, 1964 (Hayward Daily Review, 1964), as having knocked out power, flooded homes, and closed roads after a heavy storm dropped 3 inches of rain on Alameda County.

In January 1970, flooding throughout Alameda County closed roads and caused creek banks to erode in the unincorporated areas.

Effects of floods that currently threaten unincorporated areas of Alameda County are traffic congestion and damages to buildings, utilities, crops, roads, and highways.

In the City of Alameda, in general, drainage systems are adequate to carry low-frequency runoff. However, during 1-percent annual chance (100-year) and larger storms flooding can occur within the Webster Street and Bay Farm Island drainages. Main Street near Oakland Inner Harbor is also subject to flooding during 1-percent annual chance tidal events.

In the City of Albany, there is a little record of past flooding. The principal flood problems have been local flooding from blocked culverts, drain inlets, or bridges. Streams in Albany are ephemeral and flow in narrow channels. When floodflows exceed the channel capacity, the excess flows into the city streets, where considerable flow attenuation takes place.

Many areas in Albany are subject to street flooding that is broad, shallow, overland flooding generally less than 2 feet deep. This flooding is characterized by unpredictable flow paths or is confined to the streets. The water-surface elevations of flooding in these areas are essentially independent of those along the adjacent leveed channels and are affected principally by obstructions in the flooded area.

In the City of Berkeley, as is typical of many urban areas, streams are difficult to follow; extensive reaches are completely contained by culverts, and many bridges and short culverts segment the open reaches. There is little record of flooding. The principal flood problem has been local flooding from blocked culverts or bridges. Streams in Albany are ephemeral and flow in narrow channels. When floodflows exceed the channel capacity, the excess flows into the city streets, where considerable flow attenuation takes place. Recent landfills were noted in some of the stream channels, marking the need for a channel control ordinance.

In the City of Dublin, flood problems are similar to that of Alameda County.

In the City of Fremont, in the past, the majority of the flooding problems have been caused by flows in Alameda Creek that overflowed the confines of that watercourse. The construction of the Alameda Creek Federal Project by the USACE has eliminated this as a flooding problem, with the channel now thought to be capable of passing the 1- and 0.2-percent annual chance (500-year) floods.

In the City of Hayward, flood-producing rainfall occurs during the winter in the east bay area. Storm runoff is concentrated rapidly by the network of tributaries in the coastal hills that discharge into the channels flowing through Hayward to San Francisco Bay. The channels are designed to contain a flow that does not exceed the 1-percent annual chance flood. During storms greater than the design storm for the channels, flooding results. This flooding generally concentrated at structural crossings of embankments that block the flow.

The flooding threats within Hayward are restricted to localized shallow overflow flooding that can cause road damage, traffic congestion, destruction of personal property, and erosion along the channel banks.

The channels that flow through the City of Hayward are affected at their outlets by the variation in water surface in San Francisco Bay. The tidal flats along the bay are subject to tidal flooding.

There is little record of past flooding in the City of Hayward. The last recorded flood occurred on Alameda Creek - Line A (Zone 3A) before channelization, on January 29, 1963, and had a peak discharge of 13,400 cubic feet per second and a recurrence interval of 15 years.

In the City of Livermore, flood-producing rainfall occurs during the winter months in the Livermore Valley. Storm runoff is concentrated rapidly by the network of tributaries that discharge through the hills into the major streams. The tributaries have carved well-defined courses through the hills; but, upon reaching the flat Livermore Valley, the channels become shallow and inadequate for lower return-frequency flows. Constriction of Arroyo Seco flows at the Western Pacific and Southern Pacific Railroad crossings of the creek forces lower-frequency floodflows to spread out from these points. Another constricting hydraulic factor is a length of channel along Arroyo Las Positas upstream from Airway Boulevard. Rapid runoff rates, inadequate channels, and constricting structures combine with the development of some floodplain areas to make the City of Livermore susceptible to damage when large rainstorms occur.

The largest flood recorded at the City of Livermore occurred in January 1952, doing damage to railroads, bridges, roads, utilities, and the Coast Manufacturing and Supply

Company (now the Hexcel Corporation) that was estimated at $100,000 (Tri-Valley Herald, 1952, et cetera). Damages were caused by floodwaters from Arroyo Seco, which backed up at the Western Pacific Railroad trestle and spread out over the flat land. The following paragraph, from the January 17, 1952, edition of the Tri-Valley Herald describes some of these damages.

Widespread storm damage in the Livermore area was highlighted early Saturday by $15,000 in losses occasioned to the Coast Manufacturing and Supply Company plant by a flash flood of Las Positas Creek. Waters raced through the company property with such speed that employees could not stop them from entering the basement of the mill building, where, said President Ralph E. Merritt, considerable quantities of raw materials and finished goods were stored.

In the short space of 30 minutes, sufficient water entered the basement to cause the $15,000 losses.

In 1937, floodwaters damaged parts of U.S. Highway 50 (now Interstate Highway 580 also), which traverse the northern portion of the city. Before better storm drains were installed, water frequently ponded in the streets of the central area of the city.

Along Arroyo Las Positas, the flooding at Airway Boulevard is caused by severe upstream channel constrictions. During the 1-percent annual chance storm, 20 percent of the flow leaves the channel and crosses over Airway Boulevard, bypassing the bridge structure. Sheet flooding occurs in this area. Downstream from Airway Boulevard, the golf course has been designed for bypass and passage of the 1-percent annual chance flood.

Potential flooding along Arroyo Las Positas downstream from Bluebell Road is a result of backwater created by undersized channel and culvert structures in the downstream segments located outside the city limits.

Another potential flood problem stems from Arroyo Seco along the southern edge of the Southern Pacific Railroad tracks. A complex division of flows at the Western Pacific and Southern Pacific Railroad crossings of Arroyo Seco directs flow along the tracks and into the City of Livermore.

In the City of Newark, the channels that flow through are affected at their outlets by the variation of tidal elevations in San Francisco Bay.

Thornton Avenue and the Southern Pacific Railroad embankments act as dikes to protect the city from high tides. The areas on the bay side of these dikes are subject to tidal flooding.

The channels that flow under Thornton Avenue are cut off from the effects of tidal flooding by flap-gated culverts. These culverts are a major cause of flooding in Newark at the time of high water elevations in San Francisco Bay.

In the City of Oakland, many of the storm drain facilities are natural creeks meandering through residential areas. Natural vegetation growth; man-deposited debris;

and encroachment of buildings, bridges, and other structures into the floodway contribute to the flood problems.

In general, the drainage systems are adequate to carry low frequency storm runoff. However, with larger storms, general flooding occurs.

There is little record of past flooding. Principal flood problems are due to inadequate capacity of the open channel or underground conduit, or debris-plugged culverts and bridges. Generally, shallow flooding results, occurring primarily in the lower residential and industrial areas close to the shoreline.

Lake Merritt tidal lagoon was a source of flooding in the past. However, since the construction of the 7th Street Pump Station, the 1-percent annual chance flood is contained.

In the City of Pleasanton, the main flooding problem is currently caused by the low capacity of the lower reaches of Arroyo De La Laguna, which causes backwater flooding in its tributary channels.

Relatively frequent and substantial flooding has occurred in the Amador Valley in the past. The Pacific Ocean storms which bring the winter rains are capricious, fluctuating in size from year to year and from storm to storm, occasionally bringing heavy rainfall in short periods of time.

When substantial rainfall does occur, the runoff is rapid and heavy, causing streamflows to exceed the normal stream courses' capacities and inundate large areas of the flat valley floor. Flooding is not limited to occasions of intense precipitation, however. Flooding may occur following low-intensity precipitation spread over several days, as occurred in the storms of 1955 and 1958.

In the City of San Leandro, areas are subject to street flooding that has broad, shallow, overland flooding that is generally less than 2.0 feet deep. This flooding is characterized either by unpredictable flow paths or by confinement to the streets.

Damage from floods on San Leandro Creek was caused by inundation from overbank flow. The historic flood of April 1958 had a peak discharge of 1,700 cfs and a recurrence interval of 6 years. This flood inundated 115 acres and isolated approximately 150 residences, requiring emergency evacuation (USACE, 1958). As most of the residences in the area have raised foundations, damage was confined to basements, yards, and outbuildings; heavy deposits of silt were left on gardens and lawns. In the industrial area, the yards of a dredge and rigging company and a highway express firm were inundated. Damages from the April 1958 flood were estimated at $340,000 (at 1969 prices).

In the City of Union City, the principal flooding problems are caused by sheet flow and interior drainage.

Interior drainage (ponding) flood problems and small drainage basins were not analyzed. Considerable sheet flooding, shallow in nature, could occur fairly frequently.

Before construction of the Alameda Creek Flood Control Project, the relatively flat, western portion of the city was highly susceptible to flooding. The most recent and most devastating flooding occurred in 1955 and 1958.

The flooding that occurred on December 23, 1955, the largest recorded, was mainly produced by overflow from Alameda Creek. The estimated peak discharge of 21,000 cfs on Alameda Creek near Niles District exceeded the previous maximum of 18,500 cfs, recorded in January 1952. It is probable that the discharge exceeded the legendary flood of 1862. Residential damage was greatest in the community of Niles east of the Union City corporate limits. Flooding in the city approached an average depth of 1.5 feet and caused little residential damage.

2.4 Flood Protection Measures

In Alameda County, the USACE has constructed local flood-control projects that include improvements along Alameda and San Lorenzo Creeks. Both projects involve construction of concrete channel, riprap-lined channel, graded earth channel, and levee sections. The design capacities of the 12-mile Alameda Creek Project are 51,000 cubic feet per second (cfs) from the mouth of Niles Canyon downstream to Dry Creek and 52,000 cfs from Dry Creek to the San Francisco Bay. The San Lorenzo Creek Project is a 7-mile-long channel improvement that protects the City of Hayward and the Village of San Lorenzo from flooding. The design capacities of the channel are 9,200 cfs from the upper limits of the project at B Street, downstream to Castro Valley Creek and 10,000 cfs from Castro Valley Creek to the San Francisco Bay.

The Del Valle Dam, located on Arroyo Del Valle, a tributary of Alameda Creek, was completed in 1968 by the California Department of Water Resources as a part of the South Bay Aqueduct Project. This earth dam receives runoff from an area of approximately 150 square miles. The maximum spillway peak discharge is at 7,000 cfs.

Since the 1958 floods, both Alameda and San Lorenzo Creeks have been channelized along their lower reaches and impoundments have been constructed to reduce flooding. The Alameda County Flood Control and Water Conservation District owns and operates dams in the Alameda and San Lorenzo Creek watersheds and maintains a number of flood-control channels. In 1963, the district constructed a dam and channel improvements on Cull Creek, a tributary of San Lorenzo Creek. The dam now controls sedimentation and lowers flood peaks from a 6 square mile area. Don Castro Dam, which receives runoff from an area of 20 square miles in the San Lorenzo Creek watershed, was built by the district in 1964. The spillway crest elevation is 230.0 feet. The maximum peak discharge is approximately 3,175 cfs.

The Bockman Canal system was constructed by the district to drain portions of San Leandro. The canal, which drains into San Francisco Bay, consists of earth and concrete trapezoidal channels.

Calaveras Dam was built on Calaveras Creek, a tributary to Alameda Creek, by the City of San Francisco in 1925. The Calaveras Dam Reservoir controls runoff from a total area of 100 square miles and receives diverted water from upper Alameda Creek via the Upper Alameda Creek Diversion Dam. The spillway crest elevation of the Calaveras

Dam is 752.6 feet. In 1964, the City of San Francisco constructed a dam on San Antonio Creek, a tributary of Alameda Creek. The resulting San Antonio Reservoir impounds drainage water from a 40 square mile area. The spillway crest elevation is 468.0 feet with a design discharge of 13,500 cfs.

Numerous small livestock pond dams throughout the county retain runoff water, and local levees have been constructed along waterways and tidal land. Such flood-control measures have been largely carried out by private landowners.

Two regional parks have been established on floodplains in Alameda County by the East Bay Regional Planning District. The Coyote Hills-Alameda Creek Aquatic Park, completed in 1967, is located near the mouth of Alameda Creek at San Francisco Bay. The land, leased from the Alameda County Flood Control and Water Conservation District, occupies an area of approximately 950 acres that was once subject to flooding by Alameda Creek. Flood-control works now protect the land from Alameda Creek floodwater, although local runoff creates flood conditions as it drains into the park. Shadow Cliff Regional Park, completed in 1974, features water-based recreation. The 260-acre park is located east of Pleasanton on Arroyo Del Valle.

The Alameda County Planning Commission will soon consider draft amendments to the General Plan that include policies for curbing development of floodplains in the county. Policies have already been adopted by the commission to discourage development of county open space land, including some of the floodplain areas. The Planning Commission has designated portions of the floodplains of most creeks in the study as "connecting open space corridors" (Alameda County Planning Commission, 1973). Such corridors, generally strips of land along streams, are to be set aside for scenic driving routes or trails.

In the City of Alameda, flood protection is provided by the City of Alameda.

Drainage systems with pump stations have been constructed to lessen the severity of flooding at several locations; however, these stations have not been certified to withstand the 1-percent annual chance event.

Improvements to the Webster Street drainage include pumping stations with a capacity of 175 cfs and extensive storm sewer construction.

Improvements to the Bay Farm Island drainage include a pumping station with a 31 cfs capacity.

In the City of Albany, no Federal or California Flood Control District flood control measures have been instituted. Channel improvements have been carried out by local interests in their normal maintenance programs. Many stream segments have been placed in underground conduits.

In the City of Berkeley, no Federal flood control measures have been instituted. Channel improvements have been carried out by local interests in their normal maintenance program. Many stream reaches have been placed in underground conduits.

In the City of Dublin, the USACE has constructed local flood control projects that include channel improvements.

The Alameda County Flood Control and Water Conservation District owns and operates dams in the Alameda Creek watershed and maintains a number of flood-control channels.

Alamo Canal, an unlined trapezoidal channel along the lower 2.6 miles of Alamo Creek, was constructed by the district in 1965 and extended after 1970. The design capacity of this canal is 9,400 cfs. The South San Ramon Canal, a 1.1 mile unlined trapezoidal channel that empties into Alamo Canal, was also built by the district. The design discharge at U.S. Highway 50 is 5, 900 cfs.

In the City of Fremont, flood protection is provided by the Alameda County Flood Control and Water Conservation District, Zones 5 and 6. The flood-control facilities for the most part are lined and unlined open channels designed to carry 25-year floodflows.

Development along waterways is subject to approval from the City of Fremont and review by the Alameda County Flood Control and Water Conservation District.

In the City of Hayward, flood protection is provided by Alameda County Flood Control and Water Conservation District Zones 2, 3, and 4. The flood protection facilities include the flood control channels and storm sewers within the city. The channels are designed to contain flows of a magnitude less than the 1-percent annual chance flood. Most of the tidal flats adjacent to the bay have been diked. These dikes and levees prevent bay waters from washing over the tidal and marsh areas, but have no mitigating effect on the 1-percent annual chance flooding.

There is a floodplain management ordinance in effect in Hayward, which is Chapter 9, Article 4 of the Hayward Municipal Code. Chapter 9, Article 4, was last amended by Ordinance No. 00-01, adopted on February 1, 2000.

The City of Livermore has purchased an easement for a strip of undeveloped floodplain along Arroyo Mocho in the southwestern part of the city, which will be preserved as open space. The easement will accommodate the 1-percent annual chance flooding of Arroyo Mocho.

Along Arroyo Las Positas, a swale with primary and secondary channels, four wood bridges, and four double-corrugated metal pipe culverts has been designed to convey floodflows through the Las Positas Golf Course. Upstream, from the Airway Boulevard Bridge to the Kittyhawk Road low-water crossing, a trapezoidal channel has been constructed.

A flood overflow area, through which Las Positas Creek crosses the Springtown Golf Course, was enlarged to carry greater flows. Through the Springtown Homes area, the Arroyo Las Positas watercourse has been graded to form a broad trapezoidal earth channel.

Two segments of the Arroyo Seco channel have been altered to contain the 1-percent annual chance flood. One segment extends from the crossing of the Western Pacific Railroad over Arroyo Seco to the confluence of Arroyo Seco and Arroyo Las Positas, a distance of 1.25 miles. This improved reach includes a leveed trapezoidal channel section with a multiple-box culvert at each of the two highway crossings. The other improved reach of Arroyo Seco covers a length of 0.5 mile from just below Lucille Street to just above Charlotte Way. This reach has a supercritical, concrete-lined, trapezoidal channel with bridge and drop structures.

Altamont Creek has two lengths of constructed channel within Livermore. One is an earthen trapezoidal channel and the other is a concrete trapezoidal channel. Three concrete culverts are associated with these channels.

In the City of Newark, flood protection is provided by the Alameda County Flood Control and Water Conservation District Zone 5. The flood protection facilities include flood control channels, storm sewers within the City of Newark, bay dikes, and the Alameda Creek Flood Control Project (USACE, 1964). Some open channels and most storm sewers are not designed to pass the 1-percent annual chance flood.

The City of Newark has adopted an ordinance consistent with the NFIP for floodplain management purposes.

In the City of Oakland, flood protection is provided by Alameda County Flood Control and Water Conservation District, Zone 12. This local zone was set up in 1963 to cover the Cities of Oakland and Emeryville as a result of flood damage caused by the runoff from heavy rainfall of the storm of October 12 and 13, 1962.

Development along waterways is subject to approval by the City of Oakland and review by the Alameda County Flood Control and Water Conservation District.

In the City of Pleasanton, Special Drainage District Number 7 of the Alameda County Flood Control and Water Conservation District (Zone 7) was set up to improve flood control in the valley. Streambed channelization along Arroyo De La Laguna, Alamo Canal, Arroyo Mocho, Hewlett Canal, Chabot Canal, Pleasanton Canal, Tassajara Creek, and Lines G-3 and B-2-1 has substantially reduced the possibility of extensive flooding, especially by reducing the time of ponding. A major dam on Arroyo Del Valle which controls flooding on that waterway has been constructed by the State.

In the City of San Leandro, flood protection is provided by the Alameda County Flood Control and Water Conservation District. The city is included in three flood protection zones. They are Zone 2, which includes San Leandro-Line A; Zone 9, which includes San Leandro-Lines B, C, D, F, and H; and Zone 13, which includes San Leandro-Lines A, B, and P. The flood protection facilities include the flood control channels, storm sewers, and bay dikes.

San Leandro has a floodplain ordinance along the San Leandro Creek which prohibits the construction of structures, fill, grading, or otherwise obstructing the designated floodway. This ordinance was passed and adopted April 26, 1971 (City of San Leandro, 1971).

In the City of Union City, in April 1965, the USACE began construction on the Alameda Creek Flood Control Project. The work is now essentially complete. The flood control works provide protection from flow in excess of the 1-percent annual chance event and probably for the 0.2-percent annual chance event (USACE, 1964; USACE, Design Memorandum No. 2; USACE, 1968; USACE, 1966; USACE, 1969; USACE, Design Memorandum No. 6, 1968). The project diverts potential floodflow from Alameda Creek southwestward from a point east of the Nimitz Freeway to San Francisco Bay. The original Alameda Creek channel traverses the community from southeast to northwest and now serves as a local drainage channel.

The Alameda County Flood Control and Water Conservation District has performed channel improvements on most of the other streams within the corporate limits. The capacities vary, but many are capable of transmitting the 1-percent annual chance event with minimal outflow (Alameda County Flood Control and Water Conservation District, 1958; 1960; 1963; 1965; 1968; 1970; 1973; 1969; 1975; ...Improvement Plans - Union City Industrial Park).

Embankments and levees that protect low-lying areas from tidal inundation are generally not well documented. Levees that are under the jurisdiction of the Alameda County Flood Control and Water Conservation District are maintained on a regular basis, or as needed; embankments of the saltponds, formerly used to evaporate seawater to mine salt, are not currently maintained by the authority of any municipal agency.

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

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

In Alameda County, two main stream basins and several hundred square miles of drainage area are included. Different procedures were used in different parts of the county to arrive at adopted stream discharges. The procedure adopted depended on the availability of data and previous studies in the particular area. In general, the priority of approach was to examine completed flood hydrology studies first. Streamflow gage records were then analyzed. Finally, the derivation of unit hydrographs at streamflow gage locations and the application of rainfall-runoff relationships using the HEC-1 computer program completed the analyses (USACE, 1973).

The results of hydrologic analyses generally reflect the 1975 level of development in the county. Significant changes in land use will require some updating of peak discharges.

The hydrologic data for the San Lorenzo Creek and Alameda Creek basins were developed as follows:

a. Within the San Lorenzo Creek basin, hydrologic studies were required on Palomares, Cull, Crow, Chabot, and Castro Valley Creeks. A USGS streamflow gage on San Lorenzo Creek at B Street in Hayward was used as a control point. A peak-flow frequency curve prepared by the USACE, San Francisco District, was adopted for this location.

   In the Crow and Cull Creek basin and the Palomares basin, unit hydrographs were derived using regional data and a rainfall-runoff model was developed. Storms of various frequencies were applied to the model, and the model was adjusted so that the 1-percent annual chance storm would produce a 1-percent annual chance frequency flow at the B Street gage, the control point.

   Other frequency storms were calculated in the same manner. Flow frequency curves derived in this manner for each subbasin are consistent with the adopted frequency curve at the control point.

   The flow in Cull Creek is controlled by a flood detection reservoir, and the operating curve for this reservoir was used to define outflow.

   Chabot Creek and its tributary, Castro Valley Creek, drain into San Lorenzo Creek in the City of Hayward. Castro Valley is highly urbanized and is situated on a relatively steep slope. A USGS streamflow gage is located near the mouth of Castro Valley Creek. This gage, with 4 years of record, is inadequate for use in developing peak-flow frequency curves. Using recorded runoff data and measured precipitation for actual storms that occurred between 1971 and 1973, a unit hydrograph was derived for the gage location. This unit hydrograph was used in conjunction with regional relationships developed by the USACE to define unit hydrographs at selected points throughout the basin. A rainfall-runoff model was developed, storms of various frequencies were applied, and peak-flow frequency curves were developed at each selected point.

b. The previous work of the USACE on the Alameda Creek basin was reviewed and a frequency curve was developed for Alameda Creek upstream of the mouth of Niles Canyon, using the 84 years of recorded data at the USGS gage. The adopted frequency curve differs from the gage frequency curve because of the adjustment for the construction of Del Valle Reservoir upstream and greater urbanization of the Livermore Valley.

The Arroyo De La Laguna basin constitutes the northern portion of the Alameda Creek basin upstream of Sunol. All of the remaining streams studied in detail are located in the Arroyo De La Laguna basin.

In the Arroyo De La Laguna basin, streamflow gage records were insufficient to develop peak-flow frequency curves. The procedure followed was to use the available gages on Arroyo De La Laguna at Verona and on Arroyo Mocho at Livermore and Pleasanton as control points. Through the use of historical storms, unit hydrographs were derived at each of these locations. Then, using regional relationships of the lag-to-basin physical parameters, unit hydrographs were derived at all locations where flow frequency curves were desired.

Loss rates were derived for each storm in accordance with the Alameda County Flood Control and Water Conservation District procedures. The range of losses are as follows:

10-percent annual chance flood	0.30 to 0.14 inches per hour
2-percent annual chance flood	0.23 to 0.13 inches per hour
1-percent annual chance flood	0.22 to 0.12 inches per hour
0.2-percent annual chance flood	0.16 to 0.06 inches per hour

Rainfall frequency data developed by the California Department of Water Resources were used and a rainfall-runoff model was developed using the computer program HEC-1. Applying the derived unit hydrographs, the adopted loss rates, and rainfall for storms with frequencies of 10-, 2-, 1-, and 0.2-percent annual chance floods, a peak-flow frequency curve was developed at each of the selected locations. Frequency curves were first adopted for the control points at the streamflow gages and frequency curves for adjacent subbasins were smoothed so as to result in a family of frequency curves for each basin.

c. The previous work of the USACE on the frequency of occurrence of high tides in the San Francisco Bay was reviewed and the 10-, 2-, 1-, and 0.2-percent annual chance high tides were established for flooding at the lower end of Bockman Canal and in the vicinity of Line N-3.

These tide heights were compared with tsunami wave runups, which were obtained from data developed for the San Francisco Bay, and the highest value was used.

The hydrologic analysis for Ward Creek - Line B (Zone 3A) was developed using a USACE regionalized procedure for ungaged basins which analyses runoff-rainfall phenomena peculiar to the San Francisco Bay area (USACE, 1974). The rainfall-frequency data were obtained from a California Department of Water Resources publication (California Department of Water Resources, 1974).

From these data, the watersheds contributing to the waterways to be studied and the key points on the streams where discharge-frequency relationships could be established were determined. Watershed characteristics of land coverage and runoff effect of lag and storage were also developed from these data.

The loss rates were then subtracted from the rainfall data, and rainfall hydrographs for the 10- and 1-percent annual chance recurrence events were established. This rainfall Was then applied to each subbasin using a ratio of mean annual precipitation of the watershed to the mean annual precipitation at the closest nearby rainfall gage in the unincorporated areas of the City of Niles. The HEC-1 computer program (USACE, 1973) was then used to model the basin and produce a hydrograph.

The resulting 10- and 1-percent annual chance discharges were plotted for each key point on log probability paper to determine the flow-frequency curve. This curve was interpolated to determine the discharge for the 2-percent annual chance flood and extrapolated to determine the discharge for the 0.2-percent annual chance flood.

A portion of the floodflow is diverted from the Ward Creek - Line B (Zone 3A) floodplain into Line C (Zone 3A) upstream of the junction of Ward Creek - Line B (Zone 3A) with Line E (Zone 3A) in the City of Hayward.

In the City of Alameda, peak discharges for the Webster Street and Bay Farm Island drainages were calculated using unit hydrograph methods.

Ponding elevations were calculated for the Webster Street and Bay Farm Island drainages using unit reservoir routing methods.

Peak discharge-drainage area relationships for Webster Street and Bay Farm Island are shown in Table 4.

Elevations for floods of the selected recurrence intervals for shoreline reaches influenced by tidal events are shown in Table 5.

The City of Albany is bordered on the east and south by the City of Berkeley, which receives its accumulated runoff from the Berkeley hills to the east. These flows are passed through the channels in the City of Albany. The values determined for the discharge-drainage area relationships used in the City of

Berkeley FIS (U.S. Department of Housing and Urban Development, 1976) were used for determining peak discharges of additional drainage areas in Albany, because the hydrologic analysis for this study involves adding incremental areas to the Berkeley drainage basins.

Using the discharge-drainage area relationships of the various waterways, a plot was prepared to determine the total 10- and 1-percent annual chance flows. These flows were then plotted on log-probability paper to determine the 10-, 2-, 1-, and 0.2-percent annual chance discharges for the key points on the streams studied in detail. Peak discharge-drainage area relationships for Codornices, Cerrito, Village, and Middle Creeks, and the Marin Avenue Trunk are shown in Table 3.

The 1- and 0.2-percent annual chance high tides in San Francisco Bay at Albany were taken from data prepared by the USACE on the frequency of occurrence of high tides in San Francisco Bay (USACE, San Francisco Bay Data). The tide heights for the 1- and 0.2-percent annual chance tides were then compared with the tsunami wave runups and the highest value was used.

In the City of Berkeley, physical characteristics of each stream such as drainage area, length of stream, and slope of the stream were determined by field or office investigation.

Unit hydrographs, which represent the response of the basin to runoff-producing rainfall, were developed by the USACE using the physical characteristics and unit hydrograph relationships, relating time to runoff.

The standard project storm was developed, prior to determining the standard project flood. The standard project storm represents the time and spatial distribution of a severe storm which has occurred near the study area. Such storms have occurred locally in December 1955 and October 1962. The October 1962 storm, which was centered in Berkeley Hills near Orinda, when it moved over the Berkeley area, became the standard project storm.

Annual maximum peak discharges recorded by USGS stream-gaging stations on streams in or near the study area were tabulated and statistically analyzed. Peak discharge-frequency curves, which represent the expected frequency of occurrence of a given discharge, were developed from the recorded discharges using the standard log-Pearson Type III method outlined by the Water Resources Council (U.S. Water Resources Council, 1967). Due to the short periods of record at the stream-gaging stations near the study area, the standard project flood peak discharges were used as a guide in positioning the upper end of each frequency curve.

San Francisco Bay tidal elevations were established by extrapolating tidal records at nearby tidal gages, using the highest estimated tide to position the upper limits of the curve. Tidal elevations have an accuracy of plus or minus 0.5 foot and do not include local setup or rideup that would accompany high winds. Tidal elevations for floods of the selected recurrence intervals for San Francisco Bay are listed below:

Frequency	Elevation (Feet NAVD)
10-percent	9.8
2-percent	9.9
1-percent	10.2
0.2-percent	10.3

In the City of Dublin, the HEC-1 computer program of the USACE was used to establish peak discharge-frequency relationships for the 10-, 2-, 1-, and 0.2-percent annual chance recurrence intervals for the study streams. The 1- and 0.2-percent annual chance peak flows were used in the hydraulic analysis.

The temporal distribution and duration of the design storms was based on the analysis of hourly data form three NOAA gages (Berkley, Hayward, and Oakland) with 40 years of records. The recurrence intervals of the events analyzed ranged from 5 to 100 years. The HEC-1 default balanced rainfall distribution was found to be representative of the analyzed data. Depending upon the basin lag time of the area of interest, 6-hour and 24-hour design storm durations were adopted.

The Snyder Unit Hydrograph was used for the rainfall/runoff modeling in the HEC1 program. Unit hydrograph parameters are based upon the calibration analysis of 14 catchments. Peak discharge-frequency relationships for the study streams are shown in Table 4.

In the City of Fremont, a regional relationship, as presented in the USGS report Suggested Criteria for Hydrologic Design of Storm Drainage Facilities in the San Francisco Bay Region (U.S. Department of the Interior, 1971), was the principal hydrologic method used in the study. This method provides for the computation of peak discharges using multiple regression equations. These equations relate peak discharge for drainage area, mean annual precipitation, and urbanization.

Additional computations were performed for streams where potential storage of floodwaters could occur due to flood-control structures, such as reservoirs or retarding basins, or to railroad or highway embankments. These computations were facilitated by use of the USACE HEC-1 computer program (USACE, 1985). The program provides a runoff hydrograph based on specified rainfall distribution patterns and rates. Input parameters for rainfall and loss rates were taken from a USGS publication (U.S. Department of the Interior, 1971). Unit hydrograph parameters were provided by the USACE, San Francisco District. The effects of storage were considered by use of the modified puls reservoir routing subroutine.

A stream gage analysis was not performed for this study as none of the streams studied are gaged.

The discharges, computed using the above-described methods, reflect conditions existing at the time of the study. The discharges have been reviewed by the

USACE, the Alameda County Flood Control District, the USGS, and the City of Fremont.

Tidal elevations for San Francisco Bay were developed by the USACE (USACE, Estimation of the 100-Year Tide for Flood Insurance Studies; USACE, 1975).

Peak discharges and flood elevations for Lake Elizabeth were determined using the USACE HEC-1 computer program (USACE, 1985), based on historical flood data provided by the Alameda County Flood Control District.

In the City of Hayward, there are no stream gage or rainfall gage records for any stream within the study area, and, consequently, no direct means to establish hydrologic relationships. Therefore, synthetic hydrologic procedures were used.

The USACE has developed a regionalized procedure for ungaged basins which was utilized in this study (USACE, 1974). The procedure analyzes runoff-rainfall phenomena peculiar to the San Francisco Bay area. The rainfall-frequency data were obtained from a California Department of Water Resources publication (California Department of Water Resources, 1974).

Topographic information for the basins within the study limits was acquired from USGS maps (U.S. Department of the Interior, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 5 feet, 1959; U.S. Department of the Interior, 7.5- Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 20 feet, 1959; U.S. Department of the Interior, 1961; U.S. Department of the Interior, 15-Minute Series Topographic Maps, 1959), previous hydrologic studies prepared by the Alameda County Flood Control and Water Conservation District (Alameda County Flood Control and Water Conservation District, 1975), and the City of Hayward.

From these data, the watersheds contributing to the waterways to be studied and the key points on the streams where discharge-frequency relationships could be established were determined. Watershed characteristics of land coverage and runoff effect of lag and storage were also developed from these data.

The loss rates were then subtracted from the rainfall data, and rainfall hydrographs for the 10- and 1-percent annual channel recurrence events were established. This rainfall was then applied to each subbasin using a ratio of mean annual precipitation of the watershed to the mean annual precipitation at the closest nearby rainfall gage in the unincorporated areas of the City of Niles. The HEC-1 computer program (USACE, 1985) was then used to model the basin and produce a hydrograph.

The resulting 10- and 1-percent annual chance discharges were plotted for each key point on log probability paper to determine the flow-frequency curve. This curve was interpolated to determine the discharge for the 2-percent annual chance flood and extrapolated to determine the discharge for the 0.2-percent annual chance flood. The results were then compared with other studies completed for nearby communities and were found to be reasonable (FEMA, April 1981; U.S. Department of Housing and Urban Development, 1978; U.S. Department of Housing and Urban Development, 1977; FEMA, 1982; U.S. Department of Housing and Urban Development, 1978).

A portion of the floodflow is diverted from the Sulphur Creek - Line K (Zone 2) floodplain down Second Street through a 78-inch diameter culvert. The discharges presented in Table 4 reflect this flow diversion; the presented drainage areas differentiate between portions of the watershed above and below this diversion.

A portion of the floodflow is also diverted from the Ward Creek - Line B (Zone 3A) floodplain into Line C (Zone 3A) upstream of the junction of Ward Creek - Line B (Zone 3A) with Line E (Zone 3A).

Due to the configuration of the channels, and due to overbank storage which can cause floods to pond or break away from the channels, an inverse discharge-drainage area relationship exists along Line A (Zone 4) and Line A-2 (Zone 3A).

Data on the frequency of occurrence of high tides in the San Francisco Bay have been prepared by the USACE. From these data, the 1- and 0.2-percent annual chance high tides at Hayward were established.

The tsunami wave runup heights were established from data published in a report prepared for the FIA (USACE, 1975).

The tide heights for the 1- and 0.2-percent annual chance tides were compared with tsunami wave runups, and the highest value was used.

The procedures that were adopted for establishing the 1- and 0.2-percent annual chance flood elevations are as follows:

1. The flood elevations that result from the 10-percent annual chance flow in the channel and the 1- and 0.2-percent annual chance highwater heights in the bay were established.

2. The flood elevations that result from the 1- and 0.2-percent annual chance flows in the channels and the mean annual high water in the bay were established.

3. The maximum flood elevations established in the first two procedures yield the final flood elevations.

In the City of Livermore, one streamflow gage exists on the streams studied. The USGS installed one in 1963 on Arroyo Mocho near Pleasanton, 1 mile downstream from the western city limits. A flow-frequency curve was developed for the 11 years of published record using the log-Pearson Type III method as prescribed by the Water Resources Council (U.S. Water Resources Council, 1967). Since 11 years is too brief a period from which to develop an accurate flow-frequency curve, a partial duration series curve was developed. The combination of the two curves gives a good indication of the flow-frequency curve at the gage, with the flows of a recurrence interval of more than 10 percent being better defined than those less frequent. The developed flow-frequency curve is not considered to be representative for flows greater than 1,000 cfs.

Flood peaks from the Arroyo Mocho and the Arroyo Las Positas watersheds will be substantially attenuated because of the limited channel capacity of both upstream channels. Both channels have sections a short distance upstream of the gage with flow capacities of less than 500 cfs.

With the lack of gage data, it was decided to use the Arroyo Mocho watershed above the gage as a control basin, and to develop unit hydrographs and loss rates that would serve as the basis for developing parameters for use in each of the study's subbasins. A second basin, Arroyo Mocho above Isabel Avenue, was also analyzed since the USACE, San Francisco District, had previously determined a peak-flow frequency curve at that location.

Unit hydrographs were developed for each of the two watersheds using lag relationships developed by the USACE, San Francisco District (USACE, Hydrology Report).

Using the developed unit graph for the gaged basin, the storms of January and November 1970 were reconstituted using the computer program Flood Hydrograph Package, HEC-1 (USACE, 1973). Judgment was used in selecting the rainfall totals and distributions to be used for the two storms from the rain gage records. The computer program's standard loss rate function was used in the reconstitutions, with the function's individual parameters varied to arrive at the best reproduction of the recorded hydrographs. Valid reconstitutions were achieved for both storms.

The loss rates determined in the reconstitution process were then compared with the USACE time-interval-step method for reducing loss rates. The comparison of the loss rates by both methods indicated that the ones determined in the storm reconstitutions were reasonable with respect to USACE experience in the area.

Good reproduction of the gaged hydrographs confirmed the selection of the initially developed unit graph and the subsequently determined loss rates.

Hypothetical storm rainfall amounts for the study area for several durations and several rainfall intensities were determined in terms of percent of normal annual precipitation (NAP), using data developed by the California Department of Water Resources (DWR) in 1974. Stations near the study area for which statistical rainfall data had been developed were used to develop rainfall data for the study area. The stations used were Walnut Creek 2ENE, Niles 1SW, Upper San Leandro Filters, Orinda Filters, and Hayward 6ESE. Statistical rainfall amounts were taken from the DWR data for several durations for each rainfall intensity studied and were converted to percent of NAP at each station. The values calculated for each of the five stations were then averaged to establish the rainfall intensity-frequency-duration data used in the study. The following tabulation presents the rainfall amounts, in percent of NAP, that were used for this study:

	Duration (hours)				
Event	**1**	**6**	**12**	**24**	**72**
10-percent annual chance	4.2	10.5	14.9	21.3	30
1-percent annual chance	6.0	15.1	22.2	33.5	47
0.5-percent annual chance	7.2	17.7	26.4	40.4	52

Loss rates were derived for each storm in accordance with USACE procedures. The range of losses is as follows:

Storm Frequency	**Inches per hour**
10-percent annual chance	0.30 to 0.14
2-percent annual chance	0.23 to 0.13
1-percent annual chance	0.22 to 0.12
Standard Project Flood	0.18 to 0.08
0.2-percent annual chance	0.16 to 0.06

Rainfall and loss rates were tabulated and the excess rainfall was determined. The excess rainfall was then used as input data for the HEC-1 computer program. The unit graph multiplied by the excess then gave the resulting hydrograph.

The 10- to 2-percent annual chance flows at the gage on Arroyo Mocho near Pleasanton were then plotted on lot-probability paper and a best-fit, straight line was drawn through them. The Standard Project Flood (SPF) value was plotted at the 250-year (0.4-percent) return frequency. The hypothetical flows for the index point at Isabel Avenue were then plotted and a line parallel to the gage flow-frequency line was drawn through the SPF value at 0.4 percent. This straight line was a good fit for the plotted values. It was then concluded that the flow-frequency curve for each subbasin in the study would be represented by drawing a parallel line to that drawn at the gage near Pleasanton through the subbasin's SPF value plotted at the return frequency of 0.4 percent.

The SPF was computed for each subbasin and the values were plotted. The subbasin flow-frequency curves were then drawn and the flows were tabulated.

In the City of Newark, the rainfall-frequency data were obtained from the publication, Summary of Short Duration Precipitation Frequency in the San Francisco Bay Area (State of California Resources Agency, 1974).

Topographic information for the basins within the study limits was acquired from USGS maps (U.S. Department of the Interior, 1959), previous hydrologic studies by the Alameda County Flood Control and Water Conservation District (Alameda County Flood Control and Water Conservation District, 1968), and from the City of Newark (Development and Resources Corporation, 1976).

From these data, the watersheds contributing to the waterways to be studied and the key points on the streams where discharge-frequency relationships would be established were determined. Watershed characteristics, such as drainage area, average slope, and length of channel, were also determined from these data.

Using the USACE's lag relationship and S-curve hydrograph (USACE, 1974), unit hydrographs that take into account watershed characteristics of land coverage, and runoff effects of lag and storage were developed.

Infiltration losses were then subtracted from the rainfall data, and rainfall hyetographs for the 10- and 1-percent annual chance recurrence events were established. This rainfall was then applied to each subbasin using a ratio of mean annual precipitation of the watershed to the mean annual precipitation at the rainfall gage on Alameda Creek in Niles, California. The HEC-1 computer program (USACE, 1985) was then used to model the basin and produce hydrographs for the 10- and 1-percent annual chance events.

The resulting 10- and 1-percent annual chance discharges were plotted for each key point on log probability paper to determine the flow frequency curve. This curve was extrapolated to determine the discharge for the 0.2-percent annual chance storm.

In the City of Oakland, a regional relationship as presented in the U.S. Geological Survey report Suggested Criteria for Hydrologic Design of Storm Drainage Facilities in the San Francisco Bay Region was the principal hydrologic methods used in the study. This method provides for the computation of peak discharges using multiple regression equations. These equations relate peak discharge to drainage area, mean annual precipitation, and urbanization.

The discharges reflect conditions existing at the time of the study and have been reviewed by the USACE, the Alameda County Flood Control District, the USGS and the City of Oakland.

Peak discharge-drainage area relationships for flooding sources in Oakland are shown in Table 4. Elevations for floods of the selected recurrence intervals on San Francisco Bay and Lake Merritt are shown in Table 5.

In the City of Pleasanton, the discharge-frequency relationships for the major streams flowing through the city (Arroyo De La Laguna, Arroyo Del Valle, and Arroyo Mocho) were obtained from a previous FIS. Flow-frequency curves for these streams were determined for the FIS for the Unincorporated Areas of Alameda County, California (FEMA, 1981). For the smaller watershed basins within the city, a synthetic hydrologic procedure was utilized to determine peak floodflow frequency relationships for these streams.

There are no stream gage or rainfall gage records for any of the smaller basins within the study area; consequently, there are no direct means to establish hydrologic relationships for these streams. It was, therefore, necessary to use a synthetic hydrologic procedure as developed by the USACE, San Francisco District. This is a regionalized hydrologic procedure for ungaged basins, which represents the rainfall-runoff phenomena peculiar to the San Francisco Bay area. This procedure has been used successfully in other FISs within Alameda County.

The rainfall-frequency data were obtained from the State of California, Department of Water Resources publication, Summary of Short Duration Precipitation Frequency in the San Francisco Bay Area (State of California Resources Area, 1974). The Mocho Well No. 1 rainfall station is within the City of Pleasanton and statistical rainfall data for this station were utilized in the study.

Topographic information for watershed drainage area tributary to streams within the study limits was acquired from USGS maps at a scale of 1:24,000, with a contour interval of 20 feet (U.S. Department of the Interior, 1975), previous hydrologic studies by the Alameda County Flood Control and Water Conservation District, and the City of Pleasanton Public Works Department (Development and Resources Corporation, 1976).

Key points along the streams were identified where discharge-frequency relationships would be established through the use of this topographic data. The physical runoff characteristics, such as drainage area, average slope, and length of channel, were then determined for the defined tributary watersheds.

Unit hydrographs were developed that take into account watershed characteristics of land coverage and runoff effects from lag and storage through the use of the USACE procedure for the smaller basins.

Rainfall loss rates were obtained from previous hydrologic investigations performed in the Livermore Valley and Alameda County. The loss rates were then subtracted from the rainfall data, and rainfall hyetographs for the 10- and 1-percent annual chance recurrence events were established. The rainfall was then applied to each tributary watershed using a ratio of the mean annual precipitation of the watershed to the mean annual precipitation at the nearby Mocho Well No. 1 rainfall gage. The HEC-1 computer program (USACE, 1985) was then used to model each basin and produce hydrographs for the 10- and 1-percent annual chance events. The resulting 10- and 1-percent annual chance discharges for each key point were plotted on log probability paper to determine the discharge for the 0.2-percent annual chance event.

Interpolations were also made to determine the 50-year discharge. The results were then compared with other studies completed in the area and found to be reasonable.

In the City of San Leandro, there are no gage records of flow for any stream within the study area; therefore, loss rates and runoff parameters, as developed by the USACE for similar east bay area watersheds, were applied to watersheds in San Leandro. These parameters were adjusted to account for urbanization in San Leandro.

The following were utilized to develop the frequency curves for these watersheds:

1. Using USGS topographic maps at a scale of 1:24,000, with a contour interval of 20 feet (USACE, 1959) and drainage facilities maps prepared by the Alameda County Flood Control and Water Conservation District and the City of San Leandro at a scale of 1:4,800 (Alameda County Flood Control and Water Conservation District, 1976), the streams and tributaries to be studied were located, stream reaches where hydrology was required were identified, and index nodal points for which flood-flow frequency curves are to be developed were located.

2. Watersheds tributary to each index point were defined, and physical characteristics of the watersheds were determined.

3. Unit hydrograph parameters for each watershed were determined, and the water's unit hydrograph was computed utilizing S-curve hydrograph procedures and lag relationships (USACE, 1974).

4. Typical rainfall distributions for the 10- and 1-percent annual chance storms in the study area were determined, and loss rates were applied to determine the distribution of excess rainfall amounts.

5. The typical storm excess was proportioned to the excess within each watershed by the ratio of the mean annual precipitation of the watershed to the mean annual precipitation of the typical storm excess.

6. Rainfall-runoff models were formulated for all watersheds studied for use with the HEC-1 computer program for all watersheds studied (USACE, 1985).

7. Using the HEC-1 computer program, hydrographs and peak flows at all index points were computed for each hypothetical storm event by combining the watershed unit hydrograph and the rainfall excess.

8. Floodflow-frequency curves were developed and used to determine the 10-, 2-, and 0.2-percent annual chance floods for all index points.

9. Curves of peak flow per square mile were developed for the 10- and 1-percent annual chance floods.

Peak discharge-drainage area relationships for San Leandro-Lines A, B, C, D, and P (San Leandro Creek) are shown in Table 3.

Data concerning the frequency of occurrence of high tides in the San Francisco Bay area have been prepared by the USACE. From these data, the 1- and 0.2-

percent annual chance tides were compared with the tsunami wave runups and the highest value was used.

In the City of Union City, hydrologic data stations in or near the study area are limited. There are three weather stations maintained by the National Weather Service in the vicinity of the study area: Oakland, Hayward, and Newark. The stations at Oakland and Hayward include recording rain gages. The Hayward station, in the upper portion of the Dry Creek watershed, is the only station in the study area. Three USGS stream gaging stations in the Alameda Creek basin are in the vicinity of the study area: on Alameda Creek, near Niles District; on Patterson Creek, near Union City; and on Dry Creek, at Union City. Only data from the gaging station on Dry Creek at Union City were used for this study, and have been collected since 1960.

Annual maximum peak discharges were analyzed using techniques presented in Statistical Methods in Hydrology, by L. R. Beard (USACE, 1962). Statistics developed by an analysis of the 15-year period of record included a large negative skew coefficient. To verify the validity of the statistics derived from the recorded data, extended statistics were developed, using data from a nearby watershed which is hydrologically similar to the Dry Creek basin. The number of stream gaging stations near Union City that are on hydrologically similar streams is limited. The USGS station on San Lorenzo Creek at Hayward is the closest and most representative. The San Lorenzo Creek at Hayward station, which collects data from a 37.5 square mile drainage area, is approximately 8 miles north of the study area and has been in operation since 1947. San Lorenzo Creek peak discharges were statistically analyzed and were used to develop extended statistics at Dry Creek and M-Line Channel.

Synthetic hydrologic procedures were used to determine the discharges for Alameda Creek - Line A and Line D.

Countywide Analyses

The Alameda County Public Works Agency (ACPWA) conducted a study along Chabot Creek (Line G) and Castro Valley Creek (Lines I and J), located in Castro Valley, an unincorporated area of Alameda County. The combined watershed area is approximately 5.6 square miles and is predominantly urban. The Army Corps of Engineers' (AOCE) hydrologic simulation software HEC-1 was used to calculate the flow rate from each sub-basin as well as the combined flow rate at confluence points along the flow path. The hydrologic model and parameter calculation methods were taken from a regional calibrated hydrologic model and the criteria that were developed in 1995. The hydrologic model was developed from the rainfall/runoff calculations off several significant storms for 19 watersheds in Alameda County and vicinity. The hydrologic parameters were adjusted until the model produced an "average" best fit wit the discharge frequency curves for applicable gages streams studied.

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 (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
ALAMEDA CREEK	630	12,500	25,000	32,000	51,000
ALAMEDA CREEK LINE A (ZONE 3A)					
At Control Channel	21.55	*	*	2,815[1]	2,885[1]
At Southern Pacific Railway	20.48	*	*	3,420[1]	3,565[1]
Upstream of Old Alameda Creek	16.65	*	*	2,960[1]	3,170[1]
At Interstate 880	14.74	*	*	3,700[1]	4,800[1]
At limit of detailed study	4.33	1,100	1,600	1,700	1,800
ALAMO CANAL					
At confluence with Arroyo Mocho	44.50	3,100	6,300	8,100	13,300
At Interstate Highway 580	39.90	3,100	6,300	8,050	13,200
ARROYO DE LA LAGUNA					
Downstream of Arroyo Del Valle	426.60	7,000	13,500	17,000	28,000
Downstream of Arroyo Mocho	232.30	6,000	12,000	15,000	25,000
ARROYO DEL VALLE					
Upstream of Arroyo De La Laguna	174.30	1,860	4,150	7,000	9,080
ARROYO LAS POSITAS					
Upstream of confluence with Arroyo Mocho[1]	77.05	1,800	1,800	1,800	1,800
At Gage (USGS No. 11176145)	50.90	2,000	4,200	5,000	6,700
ARROYO MOCHO					
Upstream of Arroyo De La Laguna	175.39	4,520	11,500	13,700	20,600
Upstream of Chabot Canal	170.19	4,450	11,450	13,600	20,300
Upstream of Tassajara Creek	141.39	5,300	10,300	12,400	16,700
Downstream of Arroyo Las Positas	134.30	5,200	10,200	12,300	16,500
At USGS Gage No. 11176000	38.7	2,100	3,800	4,500	5,900

[1]Decrease in flow with increase in area is result of spill

*Data not available

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
ARROYO MOCHO, continued					
Upstream of Arroyo Las Positas	[1]	1,900	1,900	1,900	1,900
Near Garden Circle[2]	[1]	5,000	7,800	9,100[3]	11,900
Upstream of Tassajara Creek	[1]	5,100	7,900	9,200[3]	12,100
CASTRO VALLEY CREEK (LINE I)					
Upstream confluence with Line J	0.64	282	418	471	586
Downstream confluence with Line J	2.12	551	903	1,046	1,351
Upstream confluence with Line G	2.45	597	978	1,132	1,464
CASTRO VALLEY CREEK (LINE J)					
Upstream Seaview Avenue	0.90	307	489	559	708
Downstream James Avenue	1.22	348	572	659	843
Downstream Castro Valley Boulevard	1.43	382	633	730	936
CERRITO CREEK					
At Southern Pacific Railroad	3.48	1,690	2,500	2,940	3,900
CHABOT CANAL					
At confluence with Arroyo Mocho	5.20	730	1,260	1,560	2,430
CHABOT CREEK (LINE G)					
Upstream confluence with Line F	1.06	435	660	745	932
Downstream Lake Chabot Road	2.23	942	1,425	1,604	1,944
Upstream Nobridge Avenue	2.86	1,112	1,712	1,944	2,427
Downstream Grove Way	3.12	1,165	1,807	2,055	2,571
Downstream confluence with Line I	5.59	1,748	2,749	3,144	3,985

[1]Not applicable

[2]Decrease in 10-, 2-, 1-, and 0.2-percent annual chance flood flows in downstream direction is due to overbank losses

[3]Base flood elevations in the improved reach of Arroyo Mocho between Santa Rita and El Charm Roads are based upon peak flows of 12,400 cfs at Santa Rita Road and 12,300 cfs at Garden Circle. These flows do not reflect overbank losses. The design flow for this reach of Arroyo Mocho is 12,500 cfs.

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
COLLIER CANYON CREEK					
Near North Canyon Parkway	4.15	470	990	1,200	1,600
Downstream of Tributary	4.09	470	990	1,200	1,600
Upstream of Tributary	3.11	390	810	980	1,300
COLLIER CANYON TRIBUTARY	0.98	180	410	500	680
CORDORNICES CREEK					
At Southern Pacific Railroad	1.46	660	960	1,100	1,420
At Atchison, Topeka & Santa Fe Railway	1.09	550	810	920	1,210
At corporate limits	0.92	520	760	888	1,180
HEWLETT CANAL					
At confluence with Chabot Canal	0.75	186	331	400	614
LINE A (ZONE 4)					
At Outfall Channel	2.82	650	1,100	1,310	1,900
Downstream of junction with Line E	2.45	600	1,000	1,190	1,700
Upstream of junction with Line E	1.72	410	680	820	1,200
At Southern Pacific Railroad crossing	1.53	430	720	840	1,220
At Eden Avenue downstream of Line A-3	0.87	310	480	570	780
LINE A (ZONE 6) (SCOTT CREEK)					
At Nimitz Freeway	2.1	200	480	680	1,300
At Western Pacific Railroad	1.8	170	420	600	1,100
At Interstate Highway 680	0.9	90	230	330	680
LINE A-2 (ZONE 3A)					
At junction with Alameda Creek — Line A (Zone 3A)	2.25	470	800	960	1,400
Downstream of junction with Line A-3	2.04	540	890	1,050	1,500
Upstream of junction with Line A-3	1.31	390	600	680	920
At Arf Avenue	1.06	330	530	630	880

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
LINE B					
At Mowry Slough	7.26	*	*	1,020	1,140
Approximately 2,300 feet above Mowry Landing Road	4.64	*	*	1,040	1,110
At Southern Pacific Railroad	4.20	*	*	840	910
At Birch Street	3.24	*	*	750	790
At Interstate 880	3.24	*	*	1,200	1,400
LINE B (ZONE 5)					
Upstream of Interstate 880	2.87	*	*	740	880
At Blacow Road	2.70	*	*	515[1]	570[1]
Downstream of Line B-3 (Zone 6)	2.24	*	*	570	680
Upstream of Line B-3 (Zone 6)	1.76	*	*	320	350
At Hastings Street	1.45	*	*	220	280
Outflow from Tule Pond	1.2	20	35	40	70
LINE B (ZONE 6)					
Downstream of confluence with Line C (Zone 5) (Torges Creek)	5.6	520	1,300	1,500	2,500
At confluence with Line C (Zone 5) (Torges Creek)	1.2	120	300	440	850
At Warm Springs Boulevard	1.0	100	260	380	760
At Interstate Highway 680	0.8	85	210	310	630
LINE B-1 (ZONE 6)					
At Nimitz Freeway	0.3	45	95	140	300
At Western Pacific Railroad	0.2	30	60	90	180

[1]Decrease in flow without change in area is result of spill

*Data not available

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second)			
		10-percent	2-percent	1-percent	0.2-percent
LINE B-2-1					
At Interstate Highway 680	4.72	830	1,500	1,840	2,850
Upstream of Western Pacific Railroad	3.84	680	1,210	1,500	2,060
Upstream of confluence with Line B-2-3	1.27	230	420	520	800
LINE B-3 (ZONE 5)					
At confluence with Line B (Zone 5)	0.4	50	100	120	180
At Fremont Boulevard	0.3	40	70	90	140
LINE C (ZONE 3A)					
At junction with Ward Creek — Line B (Zone 3A)	8.82	350	570	640	950
LINE C (ZONE 5)					
Upstream of confluence with Line D (Zone 5)	1.3	200	360	440	670
At Logan Drive	0.9	150	280	340	520
LINE C (ZONE 6) (TORGES CREEK)					
Downstream of Interstate 880	1.69	*	*	510	535
At Interstate 880	1.55	*	*	470	490
At Southern Pacific Railroad	1.47	*	*	460	490
At Fortner Street	1.39	*	*	450[1]	490[1]
Upstream of Hoyt Street	1.10	*	*	560	740
At Interstate 680	1.03	*	*	550	730
LINE D					
Upstream of confluence with Line B	3.64	440	795	980	1,490
At Southern Pacific Railroad	3.34	430	765	940	1,400

[1]Decrease in flow without change in area is result of spill

*Data not available

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
LINE D (ZONE 3A)					
Upstream of Line M	5.50	*	*	1,610[1]	1,620[1]
Upstream of Southern Pacific Railroad	3.86	*	*	1,681[1]	1,895[1]
LINE D (ZONE 5)					
Downstream of confluence with Line C (Zone 5)	2.4	320	570	700	1,060
Upstream of confluence with Line C (Zone 5)	1.1	180	320	390	590
At Blacow Road	0.9	160	290	350	530
At Argonaut Way	0.5	100	190	230	350
LINE D (ZONE 6) (AGUA FRIA CREEK)					
At confluence with Line C (Zone 6) (Torges Creek)	2.4	250	600	780	1,500
Upstream of Interstate Highway 680	1.7	190	460	600	1,100
LINE E (ZONE 3A)					
At Southern Pacific Railroad crossing	1.00[2]	300	680	910	1,580
LINE E (ZONE 6) (LAGUNA CREEK)					
At mouth					
Upstream of Line F (Zone 6)	25.03	*	*	3,100	3,290
At Cushing Road	22.31	*	*	2,400[3]	2,490[3]
Downstream of Line G (Zone 6)	22.16	*	*	2,540[3]	2,770[3]
Upstream of Line G (Zone 6)	21.25	*	*	2,720[3]	3,060[3]

[1]Decrease in flow with increase in area is result of spill.

[2] The drainage area shown does not include the drainage area upstream of the junction with Line E (Zone 3A). The discharges shown include the effects of the flow diversion.

[3] Decrease in flow with increase in area is result of spill

*Data not available

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second)			
		10-percent	2-percent	1-percent	0.2-percent
LINE E (ZONE 6) (LAGUNA CREEK), continued					
Downstream of Line J (Zone 6)	17.65	*	*	1,970	2,100
At Fremont Boulevard	16.32	*	*	1,830[1]	1,885[1]
Downstream of Line I (Zone 6)	15.96	*	*	1,875	1,970
Upstream of Line I (Zone 6)	15.36	*	*	1,575[1]	1,670[1]
Downstream of Line K (Zone 6)	14.97	*	*	1,790	1,920
Downstream of Adams Street	11.75	*	*	230	280
LINE F (ZONE 6) (AGUA CALIENTE CREEK)					
At Interstate 880	2.63	*	*	940[1]	975[1]
At Western Pacific Railroad	2.47	*	*	945[1]	1,025[1]
At Interstate 680	2.11	*	*	1,000	1,300
Upstream of Curtner Road	2.04	*	*	1,000	1,300
LINE F-1					
At confluence with Plummer Creek	2.14	*	*	530	*
At Southern Pacific Railroad	1.35	*	*	475	*
Immediately downstream of Interstate 880	0.89	*	*	450	*
LINE G (ZONE 6)					
Upstream of confluence with Line E (Zone 6) (Laguna Creek)	13.0	350	960	1,300	2,400
At Durham Road	12.6	320	900	1,200	2,200
At Blacow Road	11.2	280	660	860	1,500
LINE G-3					
At confluence with Arroyo Mocho	3.93	540	970	1,190	1,800

[1] Decrease in flow with increase in area is result of spill

* Data not available

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second)			
		10-percent	2-percent	1-percent	0.2-percent
LINE H					
At Thornton Avenue	2.00	295	510	610	890
Upstream of confluence with Line H-1	0.84	155	255	307	435
LINE H (ZONE 6)					
At confluence with Line E (Zone 6) (Laguna Creek)	1.3	120	320	450	900
At Interstate Highway 680	0.8	90	220	340	650
LINE I					
At Thornton Avenue	1.51	240	420	510	740
LINE J (ZONE 6) (CANADA DEL ALISO)					
At confluence with Line E (Zone 6) (Laguna Creek)	1.6	160	380	550	1,000
LINE K (ZONE 5) (CRANDALL CREEK)					
At mouth	4.0	760	1,300	1,600	2,900
Upstream of Newark Boulevard	2.7	630	1,000	1,200	2,300
Downstream of confluence with Line K-4 (Zone 5)	2.5	620	980	1,200	2,200
At Nimitz Freeway	1.9	490	770	980	1,900
At Decoto Road	1.6	480	680	920	1,700
At Fremont Boulevard	0.8	200	280	380	740
LINE K (ZONE 6)					
Downstream of Line K-1 (Zone 6)	3.22	*	*	1,670[1]	1,800[1]
Upstream of Line K-1 (Zone 6)	2.14	*	*	1,795	2,000
At Interstate 680	2.04	*	*	1,200	1,500

[1]Decrease in flow with increase in area is result of spill

*Data not available

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
LINE K (ZONE 6), continued					
Upstream of Interstate 680	1.75	*	*	1,200	1,400
Upstream of Osgood Road	1.70	*	*	1,200	1,400
At Paseo Padre Parkway	1.60	*	*	1,100	1,400
LINE L (ZONE 6) (MISSION CREEK)					
Downstream of confluence with Line L-1 (Zone 6)	10.2	990	2,000	2,500	4,200
Upstream of confluence with Line L-1 (Zone 6)	9.3	860	1,800	2,300	3,700
Downstream of confluence with Line M (Zone 6) (Morrison Canyon)	8.7	790	1,700	2,200	3,400
Upstream of confluence with Line M-1 (Zone 6)	7.5	710	1,500	2,000	3,100
At Driscoll Road	5.4	510	1,100	1,500	2,500
Downstream of confluence with Line L-7 (Zone 6)	4.9	420	980	1,300	2,200
At Mission Boulevard	2.7	250	600	830	1,500
LINE L-1 (ZONE 6)					
At confluence with Line L (Zone 6) (Mission Creek)	0.9	270	400	530	1,100
At Driscoll Road	0.5	160	240	340	680
LINE L-7 (ZONE 6)					
At confluence with Line L (Zone 6) (Mission Creek)	2.0	190	430	640	1,200

* Data not available

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
LINE M (ZONE 5)					
At Alameda Creek (Flood Control Channel)	3.29	*	*	1,050	*
Downstream of Royal Ann Drive	3.10	*	*	960	*
Downstream of Decoto Road	2.87	*	*	850	*
Upstream of Union Square	2.44	*	*	748	*
Approximately 800 feet upstream of Southern Pacific Railroad	2.09	*	*	720	*
LINE M (ZONE 6) (MORRISON CANYON)					
At mouth .	1.0	100	270	330	750
LINE N, N-2 (ZONE 6)					
At Southern Pacific Railroad	2.4	340	610	750	1,270
Downstream of Nimitz Freeway	0.4	70	130	170	360
LINES N-6 (ZONE 5), N-7 (ZONE 5), N-8 (ZONE 5), AND N-10 (ZONE 5)					
At confluence with Alameda Creek	0.8	100	250	330	680
At Mission Boulevard	0.6	70	180	280	500
LINE 0					
At Altamont Creek	5.22	610	1,300	1,600	2,200
LINE P (SAN LEANDRO CANAL)	*	800	2,000	2,800	4,800
LINE P (ZONE 6)					
At Mission Reservoir	0.3	30	80	110	230
LINE Q (ZONE 6)					
Upstream of confluence with Line K (Zone 6)	0.9	90	240	340	680

* Data not available

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
LOCALIZED RAINFALL					
Webster Street	0.80	224	359	444	543
Bay Farm Island	0.73	157	258	314	414
MARIN AVENUE TRUNK					
At West Side State Highway 17	0.71	390	610	690	850
At San Pablo Avenue	0.56	330	510	580	750
MIDDLE CREEK					
At confluence with Cerrito Creek	0.90	460	700	810	1,090
At Atchison, Topeka & Santa Fe Railway	0.69	390	580	670	900
At corporate limits	0.47	290	440	510	680
PLEASANTON CANAL					
At confluence with Arroyo Del La Laguna	1.28	280	480	580	850
SAN LEANDRO LINE A (ZONE 2)					
At San Francisco Bay	9.30	*	*	3,600	3,800
At Southern Pacific Railroad	8.90	*	*	3,600[1]	3,800[1]
Upstream of Line D	5.70	*	*	3,200[1]	3,900[1]
At Nimitz Freeway	4.80	*	*	3,000[1]	3,600[1]
At Hesperian Boulevard	4.10	*	*	3,200[1]	3,900[1]
At upstream corporate limits	3.00	*	*	2,500[1]	3,100[1]
SAN LEANDRO-LINE B (ZONE 9)					
At upstream side of confluence with San Leandro-Line D	1.2	198	327	372	463

[1]Decrease in flow without change in area is result of spill

*Data not available

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
SAN LEANDRO-LINE C (ZONE 9)					
At upstream side of confluence with San Leandro-Line D	1.3	335	550	655	930
SAN LEANDRO-LINE D (ZONE 9)					
At upstream side of confluence with San Leandro-Line A	2.7	726	1,200	1,437	2,080
At downstream side of confluence with San Leandro-Line C	2.4	697	1,150	1,373	1,980
At upstream side of confluence with San Leandro-Line C	0.6	348	570	674	970
At downstream side of confluence with San Leandro-Line B	1.1	341	560	662	940
SAN LORENZO CREEK LINE B (ZONE 2)					
At San Francisco Bay	[1]	*	*	7,615[2]	7,660[2]
Just upstream of Washington Boulevard	48.23	*	*	9,940[3]	10,065[3]
At confluence of Castro Valley Creek	38.85	*	*	10,200	12,400
SULPHUR CREEK — LINE K (ZONE 2)					
At end of study reach	4.33	*	*	1,200[3]	1,374[3]
At Southern Pacific Railroad	3.90	*	*	740[3]	768[3]
At west side of airport	3.66	*	*	740[3]	768[3]
Upstream of Line K-1	2.63	*	*	867[3]	984[3]
At Thelma Street	2.19	*	*	411[3]	461[3]

[1]Not applicable

[2]Decrease in flow without change in area is result of spill

[3]Decrease in flow with increase in area is result of spill

*Data not available

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent	2-percent	1-percent	0.2-percent
TASSAJARA CREEK					
At confluence with Arroyo Mocho	28.80	1,540	3,200	4,140	6,900
VILLAGE CREEK					
At West Side State Highway 17	0.27	190	280	330	440
At San Pablo Avenue	0.17	130	200	230	310
WARD CREEK — LINE B (ZONE 3A)					
Upstream of Line D	8.93	*	*	1,367[1]	1,367[1]
At Southern Pacific Railroad	6.00	*	*	2,000[1]	2,400[1]
Downstream of junction with Line E (Zone 3A) (at Southern Pacific Railroad crossing)	5.99	1,110	1,900	2,380	3,500
Downstream of junction with Line C (Zone 3A)	3.09[1]	810	1,300	1,470	1,920
Upstream of junction with Line C (Zone 3A)	1.27[1]	500	850	1,010	1,500
At Mission Boulevard	0.63	480	760	900	1,250
Upstream of junction with Line A (Zone 3A)	1.95	480	820	980	1,500

[1]Decrease in flow with increase in area is result of spill

*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

Alameda

Flooding Source and Location	Elevation (feet NAVD[1])			
	10-Percent	2-Percent	1-Percent	0.2-Percent
LAKE MERRITT	5.8	5.8	7.5	8.3
LAKE ELIZABETH AT FREEMONT	54.5	56.1	56.9	59.8
LINE M (ZONE 5) (UPSTREAM OF SOUTHERN PACIFIC RAILROAD)	N/A	N/A	49.7	50.2
SAN FRANCISCO BAY				
At Point Isabel	8.4	8.7	8.9	9.1
At Berkeley	9.8	9.9	10.2	10.3
At Oakland	8.8	9.1	9.3	9.5
Main Street near Oakland Inner Harbor	8.8	9.3	9.4	9.7
Webster Street	8.8	9.3	9.4	9.7
At Oakland Municipal Airport	9.3	N/A	9.8	10.1
At City of Hayward Northern Corporate Limits	N/A	N/A	9.9	10.2
West Jackson Street to South Corporate Limits	9.4	9.7	9.8	10.0
North Corporate Limits to West Jackson Street	8.8	9.1	9.3	9.5
Vicinity of Union City	N/A	N/A	10.0	10.3
At Newark	10.3	N/A	10.8	11.1
SAN FRANCISCO BAY ADJOINING FREMONT				
Corporate Limits at Mouth of Alameda County Flood Control Channel South to Thornton Road (Route 84)	N/A	N/A	9.8	N/A
Thornton Road (Route 84) to Coyote Railroad Crossing	N/A	N/A	10.8	N/A
Coyote Creek Southern Pacific Railroad Crossing East to Corporate Limits	N/A	N/A	11.8	N/A

[1] North American Vertical Datum of 1988

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.

Cross sections were determined from topographic maps and field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. All topographic mapping used to determine cross sections are referenced in Section 4.1.

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, Alameda County, has a previously printed FIS report. The hydraulic analyses described in those reports have been compiled and are summarized below.

In Alameda County, the procedure used in the hydraulic analyses began with analyzing available mapping, including maps prepared by county and private agencies and USGS topographic maps. From this data, a preliminary map study was made of the streams to be studied in detail.

Next, a field reconnaissance was conducted to investigate stream channels, obvious problem areas, channel and overbank roughness, flow restrictions, and structures such as bridges, culverts, and levees.

Topographic data and mapping, including stream-channel cross sections and structure dimensions and elevations were compiled from a variety of sources, and additional field surveys were conducted where necessary. Then, as-built construction plans for all water-control structures, channel modifications, bridges, culverts, and related facilities were compiled and reviewed.

A physical description of each channel was prepared and the invert and bank profiles were plotted. Controlling water-surface elevations were then determined. From these, water-surface profiles for events of 10-, 2-, 1-, and 0.2-percent annual chance were calculated using standard engineering procedures, including the use of the HEC-2 computer model (USACE, 1973), where applicable.

Channel cross sections used to define the flood water-surface profiles are delineated on the Flood Boundary and Floodway Map (FBFM) (Exhibit 2). Additional cross sections were used to define bridges, culverts, and certain channel locations. These are not shown on the map.

Water-surface profiles were computed using the USACE HEC-2 computer program (USACE, 1973). Use of the computer model was replaced or supplemented with hand calculations in certain areas and situations where such methods were considered to be more suitable.

The Manning's flow formula was used in the computation of flow profiles. Channel roughness factors for channel and overbank areas (Manning's "n") were estimated based on field observations, review of photographs, review of previous studies, and comparison with other areas. Roughness coefficients vary widely throughout the study area. Channel configuration (whether natural or manmade), vegetation, land use in the overbank area adjacent to the channel, and other physical parameters all have an effect on flow. Values for roughness coefficients ranged from 0.014 for efficient concrete-lined channels to 0.045 for difficult natural channels with extensive undergrowth and from 0.035 to 0.050 for overbank areas.

No profiles are shown for Bockman Canal and Lines N-2 and N-3 because these areas are under tidal influence from the San Francisco Bay.

Along Arroyo Mocho, the flows between cross sections H and J are influenced by the levees. Consequently, elevations inside the levees are slightly different from those shown outside the levees.

In the City of Alameda, water-surface elevations of floods for the selected recurrence intervals were computed for each basin studied by reservoir routing methods through the use of the USACE HEC-1 computer program (USACE, 1985). Backwater calculations and channel profiles were not computed because flooding in the areas studied is caused by ponding of water that exceeds basin pump capacity, not stream overbank flooding or sheetflow. Flood elevations along the shoreline of Alameda for the 10-, 2-, 1-, and 0.2-percent annual chance events are presented in Table 5, "Summary of Stillwater Elevations," and were obtained from a statistical analysis of available tide gage data in San Francisco Bay (USACE, 1984). The stillwater tidal elevations used for this study reflect the increase of the elevation in San Francisco Bay due to storms (storm surge). The results presented in this study do not include any contribution to the elevation along the shoreline due to wave action or wave runup.

In the City of Albany, available mapping, including maps prepared by Alameda County and private agencies (Development and Resources Corporation, 1976), and USGS topographic maps (U.S. Department of the Interior, 1959), were reviewed and a preliminary map study was made of the streams to be studied.

A field reconnaissance was conducted to investigate stream channels; obvious problem areas; channel and overbank roughness values; flow restrictions; and structures, such as bridges, culverts, and levees. As-built construction plans for all water control structures, channel modifications, bridges, culverts, and related facilities were compiled and reviewed.

Cross-section data for streams in the area were obtained from field surveys and from topographic data and mapping (Development and Resources Corporation, 1976).

Values for roughness coefficients used were 0.014 for efficient concrete-lined channels, 0.025 for natural unlined channels, and from 0.035 to 0.050 for overbank areas.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals for Cerrito Creek (Exhibit 1). Profiles are not shown for the remaining streams due to the shallow sheet flow nature of flooding in these areas. Profiles are also not shown for the lower segment of Codornices Creek since elevations in this area are controlled by the San Francisco Bay.

Starting water-surface elevations for Cerrito Creek were based on the San Francisco Bay mean high tide elevations.

The San Francisco Bay 1- and 0.2-percent annual chance flood levels were established based on several steps. The flooding levels that result from the 10-percent annual change flow in Cerrito Creek and the 1- and 0.2-percent annual chance high tide in San Francisco Bay were established. The flooding level that resulted from the 1- and 0.2-percent annual chance flows in the channels and the mean annual high water in the bay were established. The maximum levels of flooding established above were used and reflected in the Flood Profiles (Exhibit 1). Shallow flood zones (AO) were determined by routing discharges that are greater than the carrying capacity of the channel and taking average depths through the use of city maps (Development and Resources Corporation, 1976).

In the City of Berkeley, the flow profiles for precipitous areas were determined to be contained within the banks. The slopes are steep, and they range from 4 percent to over 25 percent in grade. The velocities are in excess of 5 feet per second; however, no significant bank erosion was observed.

In the City of Dublin, cross sections for Lines J-1 between Dublin Boulevard and a point approximately 4,200 feet upstream were compiled photogrammetrically. Cross sections for the remainder of the study reach were developed using as-built construction plans and field measurements provided by the Alameda County Flood Control & Water Conservation District (Zone 7).

Cross sections for Line J-2 were developed with as-built construction plans provided by Zone 7.

Cross sections for Line J-3 were compiled photogrammetrically from the confluence with Line J-1 up to San Ramon Road. Field-surveyed cross sections provided by Zone 7 were used upstream of that point.

Cross sections for Line J-4 were compiled photogrammetrically.

Cross sections for Line J-2 and Dublin Creek were developed with as-built construction plans provided by Zone 7.

The hydraulic analyses for this study 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.

In the City of Fremont, cross-section geometry for the HEC-2 analyses were taken from topographic maps (PRC Toups, 1980) developed from aerial photography (PRC Toups, 1978) flown on October 23, 1978. Alameda County Flood Control District improvement plans were used to supplement existing topographic maps. Cross sections in all detailed studies were located at close intervals above and below bridges in order to compute the significant backwater effects of these structures. Bridges were field checked to verify elevation data and structural geometry.

Flood profiles are not applicable for areas of shallow hooding or for streams where the 1-percent annual chance flood is contained in the channel or in a culvert; therefore, no profiles are shown for Lines B (Zone 5), B-3 (Zone 5), C (Zone 5), D (Zone 5), N-6 (Zone 5), N-7 (Zone 5), N-8 (Zone 5), N-10 (Zone 5), B (Zone 6), B-1 (Zone 6), C (Zone 6), E (Zone 6), F (Zone 6), H (Zone 6), L-7 (Zone 6), M (Zone 6), P (Zone 6), and Q (Zone 6).

A brief discussion of the hydraulic analysis of the flooding sources follows:

Line B (Zone 5)

There is 1-percent annual chance flooding for this channel upstream of the Nimitz Freeway. The box culvert at the Nimitz Freeway is under capacity for the 1-percent annual chance discharge. This results in a ponded water-surface elevation of approximately 32 feet. The flood zone designation is Zone AO, with an average depth of 1 foot.

The 1-percent annual chance flood is contained in the channel for the remainder of the study reach.

Line B-3 (Zone 5)

This channel contains the 1-percent annual chance flood along the entire study reach.

Line C (Zone 5)

This channel contains the 1-percent annual chance flood along the entire study reach.

Line D (Zone 5)

This channel contains the 1-percent annual chance flood along the entire study reach.

Line K (Zone 5) (Crandall Creek)

There is 1-percent annual chance flooding in this channel from the downstream limit of detailed study to upstream of the Southern Pacific Railroad crossing. This flooding is due to inadequate channel capacity. There is extensive overbank flooding downstream of the Southern Pacific Railroad crossing and a limited amount of overbank flooding upstream of the Southern Pacific Railroad.

There is a significant amount of new home construction upstream of the Southern Pacific Railroad and adjacent to the 1-percent annual chance floodplain.

The 1-percent annual chance flood is contained in the channel for the remainder of the study reach.

Line N-6 (Zone 5), Line N-7 (Zone 5), Line N-8 (Zone 5), Line N-10 (Zone 5)

This flood-control system consists of several underground pipelines in parallel which discharge to the Alameda Creek Federal Project. According to the Alameda County Flood Control District, Line N-6 (Zone 5) is plugged and not operative. The inlet to this storm drain system is at the mouth of a small canyon. The capacity of the storm drain is limited by inlet conditions, resulting in sheetflow that is less than 1 foot deep.

Line A (Zone 6) (Scott Creek)

Downstream of Milmont Street, 1-percent annual chance flooding is controlled by the stillwater elevations of the San Francisco Bay. Upstream of Milmont Street, the 1-percent annual chance flooding is contained within the channel.

Upstream of the Western Pacific Railroad, a Zone AH with a base flood elevation of 17 feet results from a combination of inadequate culvert capacity and overflow from Line B (Zone 6) to the north. Approximately 200 cfs flow moves overland south, paralleling the Western Pacific Railroad to Line A (Zone 6). The overland flow is sheetflow with an average depth less than 1 foot.

The 1-percent annual chance flood is contained in the channel for the remainder of the study reach upstream to Interstate Highway 680. At the entrance to the Interstate Highway 680 culvert, upstream of the limit of detailed study, approximately 75 cfs of sheetflow flows to the southeast, paralleling the freeway, and does not return to the channel.

Line B (Zone 6)

This channel contains the 1-percent annual chance flood except for a short reach of channel just upstream of the Western Pacific Railroad. At this location, the culvert under the railroad is silted up and limits the discharge through it. As a result, a flow of approximately 200 cfs breaks out of the channel and flows south, paralleling the railroad to Line A (Zone 6).

Line B-1 (Zone 6)

This channel contains the 1-percent annual chance flood along the entire study reach.

Line C (Zone 6) (Torges Creek)

This channel contains the 1-percent annual chance flood along the entire study reach.

Line D (Zone 6) (Agua Fria Creek)

There is 1-percent annual chance flooding for this channel at the Western Pacific Railroad and Southern Pacific Railroad crossings. The flooding is a result of inadequate culvert capacity, which results in flooding upstream of the culverts.

Line E (Zone 6) (Laguna Creek)

Behind the Nimitz Freeway, 1-percent annual chance flooding occurs due to the inadequate capacity of the Nimitz Freeway box culvert. Zone B sheet flooding occurs in both the right and left overbanks upstream of the Nimitz Freeway. Between Grimmer Boulevard and Line H (Zone 6), Zone B sheet flooding occurs in the west overbank due to inadequate channel capacity.

Line F (Zone 6) (Arroyo del Agua Caliente Creek)

Behind the Nimitz Freeway and Kato Road crossings, 1-percent annual chance flooding occurs. The flooding between the Nimitz Freeway and Kato Road occurs in a swale-type depression that parallels the Nimitz Freeway to the north. The flooding upstream of Kato Road is the result of inadequate culvert capacity.

Upstream of the Western Pacific Railroad, 1-percent annual chance flooding also occurs due to inadequate culvert capacity.

Line G (Zone 6)

Upstream of the Nimitz Freeway, 1-percent annual chance flooding occurs in conjunction with flooding from Line E (Zone 6). This flooding is the result of inadequate culvert capacity at the Nimitz Freeway. Upstream of the Durham Road culvert, 1-percent annual chance flooding also occurs due to inadequate culvert capacity.

Line H (Zone 6)

Behind the Western Pacific Railroad, 1-percent annual chance flooding occurs due to inadequate culvert capacity. The overflow from this flooding combines with flooding from Line J (Zone 6), resulting in a ponded water surface behind the Western Pacific Railroad and Southern Pacific Railroad embankments, with Zone B shallow flooding downstream of the railroad embankment. This shallow flooding is picked up by Line H (Zone 6) and Line J (Zone 6), both of which have 1-percent annual chance capacity.

Line J (Zone 6) (Canada del Aliso)

Behind the Western Pacific Railroad embankment, 1-percent annual chance flooding occurs due to inadequate culvert capacity. This combines with flooding from Line H (Zone 6), resulting in a ponded water surface behind the railroad embankment. Weir flow occurs across the railroad embankments and result in shallow flooding downstream.

Line K (Zone 6)

Shallow flooding in the south overbank occurs upstream of the Western Pacific Railroad due to inadequate channel capacity. Upstream of Interstate Highway 680, 1-percent annual chance floodplain widths are less than 50 feet. Approximately 3,000 feet downstream of Mission Boulevard, floodplain widths increase to nearly 200 feet. This flooding continues to the limit of detailed study upstream of Mission Boulevard.

Line L (Zone 6) (Mission Creek), Line L-7 (Zone 6), and Lake Elizabeth

Upstream of Paseo Padre Parkway, 1-percent annual chance flooding occurs at Lake Elizabeth. The 1-percent annual chance water-surface elevation was determined by hand calculations comparing the storage capacity of the lake to total runoff volume. The 1-percent annual chance ponded water-surface elevation is approximately 54 feet. Upstream of the Southern Pacific Railroad crossing, both overbanks are subject to shallow flooding due to inadequate channel capacity. Upstream of Driscoll Road, the 1-percent annual chance flood is contained within the channel. Upstream of Mission Boulevard, the channel is not defined and flooding topwidths increase to approximately 100 feet. Line L-7 (Zone 6) has 1-percent annual chance capacity along its entire study reach.

Line L-1 (Zone 6)

Upstream of the confluence with Line L (Zone 6), flooding occurs due to overflow from Lake Elizabeth. Upstream of the Southern Pacific Railroad, overbank flooding occurs due to inadequate channel capacity. Upstream of the Paseo Padre Parkway, Line L-1 (Zone 6) is an underground storm drain. The storm drain is undersized to handle the 1-percent annual chance flood, which results in shallow flooding from the vicinity of Driscoll Road to Paseo Padre Parkway. This flooding includes two adjacent areas with a difference in flood elevation of 4 feet. This difference is due to fill between Gomez Road and the Parkway.

Line M (Zone 6) (Morrison Canyon)

Line M (Zone 6) (Morrison Canyon) has 1-percent annual chance capacity from approximately 1,400 feet from its confluence with Line L (Zone 6) to the end of the open channel just downstream of Mission Boulevard. However, upstream channel conditions prevent the 1-percent annual chance flood from entering the main channel. At its mouth, the flow enters a recently constructed 60-inch reinforced-concrete pipe storm drain that discharges into an open channel just upstream of the Western Pacific Railroad. At this point, the open channel continues for approximately 700 feet to a drop inlet for an underground storm drain. Both the channel and inlet capacity are limited, resulting in 1-percent annual chance sheet flooding across the Western Pacific Railroad to the west. The sheet flooding proceeds southerly, paralleling Line M (Zone 6) (Morrison Canyon) and the Western Pacific Railroad. Sheet flooding continues to the confluence with Line L (Zone 6).

Line N, N-2 (Zone 6)

The channel generally has sufficient capacity for the 1-percent annual chance flood; however, shallow flooding occurs in both overbanks from the mouth to approximately 900 feet downstream of Nimitz Freeway.

Line P (Zone 6), and Line Q (Zone 6)

Both of these storm drains are underground pipes and are inadequate to contain the 1-percent annual chance flood; consequently, 1-percent annual chance shallow flooding results.

San Francisco Bay

A detailed study was conducted along the shoreline fronting on San Francisco Bay. Information for this analysis was obtained from two studies by the USACE (Estimation of the 100-Year Tide for Flood Insurance Studies; USACE, 1975). Based on these reports, 1-percent annual chance flooding from San Francisco Bay inundates to an elevation of 7.0 feet along the City of Fremont shoreline.

The boundary between the VE and AE Zones for San Francisco Bay was determined using USGS topographic maps (U.S. Department of the Interior, 1973) and based on methodology described in the USACE's Shore Protection Manual (USACE, 1977).

For streams with outlets to San Francisco Bay, starting water-surface elevations were taken from an unpublished USACE report (USACE, Estimation of the 100-Year Tide for Flood Insurance Studies). Starting water-surface elevations for tributaries were developed from normal depth calculations. Starting water-surface elevations for San Francisco Bay were also taken from the USACE report (USACE, Estimation of the 100-Year Tide for Flood Insurance Studies). Starting water-surface elevations for Lake Elizabeth were provided by the Alameda County Flood Control District.

Areas of shallow flooding were determined using the HEC-2 computer program (USACE, 1976) and topographic maps (PRC Toups, 1980).

Approximate flood boundaries for lines M and M-5 in the area between Mission Boulevard, King Street, and the Southern Pacific Railway were delineated using information from the FIS for Union City (U.S. Department of Housing and Urban Development, 1978).

In the City of Hayward, water-surface elevations were computed through the use of the HEC-2 computer program (USACE, 1973). Use of the computer model was replaced or supplemented with hand calculation for certain areas and when such methods were deemed more suitable.

Cross-section data for streams in the area were obtained from aerial strip mapping (The Spink Corporation, 1977), USGS topographic maps (U.S. Department of the Interior, 1959; U.S. Department of the Interior, 1961), and as-built drawings (Alameda County Flood Control and Water Conservation District, 1978).

The Manning's flow formula was used in the computation of flow profiles. Roughness factors for channels and overbank areas (Manning's "n") were estimated based on field observations, review of photographs, review of previous studies (FEMA, 1981; U.S. Department of Housing and Urban Development, 1978; U.S. Department of Housing and Urban Development, 1977; FEMA, unpublished; U.S. Department of Housing and Urban Development, 1978), and comparison with other areas. Roughness coefficients vary widely throughout the study area. Channel configuration (whether natural or manmade), vegetation, land use in the overbank area adjacent to the channel, and other physical parameters all have an effect on flow. Values for roughness coefficients ranged from 0.014 for efficient, concrete-lined channels to 0.045 for inefficient, natural channels with extensive undergrowth, and from 0.035 to 0.050 for overbank areas.

Starting water-surface elevations for Sulphur Creek - Line K (Zone 2) and Alameda Creek - Line A (Zone 3A) were obtained from the San Francisco Bay mean high tide elevations.

Starting water-surface elevations for Line A-2 (Zone 3A), Line D (Zone 3A), and Ward Creek - Line B (Zone 3A) were obtained at the confluence points with Alameda Creek - Line A (Zone 3A).

Starting water-surface elevations for Line C (Zone 3A) and Line E (Zone 3A) were obtained at the confluence points with Ward Creek - Line B (Zone 3A).

Starting water-surface elevations for Line A (Zone 4) were obtained at the confluence points with Line E (Zone 4).

Elevations of downstream portions of Sulphur Creek - Line K (Zone 2) and Alameda Creek - Line A (Zone 3A) are controlled by San Francisco Bay.

Many areas in Hayward are subject to sheet flooding that can be described as broad, shallow, overland flooding that is generally less than 1 foot deep. This flooding is characterized by unpredictable flow paths or is confined to the streets. The water-surface elevations of flooding in these areas are essentially independent of those along the adjacent leveed channels, and are affected principally by obstructions in the flooded areas.

Water-surface elevations used for areas subject to shallow flooding were determined from backwater analyses and related to ground surface elevations to determine the depth of flooding.

Upstream of Fuller Avenue, Sulphur Creek - Line K (Zone 2) produces only sheet flooding; therefore, no profiles are presented for this stream segment.

For that portion of Sulphur Creek - Line K (Zone 2) and Line C (Zone 3A) studied by approximate methods, the approximate 1-percent annual chance flood elevation was determined by extrapolating from the detailed area in conjunction with engineering judgment.

In the City of Livermore, each of the streams within the city was analyzed to determine the flood water profile or water-surface elevation at peak flow for floods with recurrence intervals of 10-, 2-, 1-, and 0.2-percent annual chance. In the hydraulic analyses, the following steps were taken:

1. A field reconnaissance was conducted to investigate stream channels, obvious problem areas, channel and overbank roughness, flow restrictions, and structures such as bridges, culverts, and levees.

2. Available topographic mapping and stream cross sections were reviewed and additional field surveys were conducted where necessary to adequately define the stream channels and adjacent lands.

3. As-built construction plans for all water control structures, channel modifications, bridges, culverts, and other facilities were compiled.

4. A complete physical description of each stream channel was prepared.

5. Controlling water-surface elevations were determined.

6. Water-surface profiles were computed for each of the recurrence intervals.

Additional cross sections were used to define bridges, culverts, and certain channel constrictions. They are not shown on the map.

Water-surface profiles were computed through the use of the HEC-2 computer program (USACE, 1985). Use of the computer model was supplemented with hand calculations in certain localized areas where such methods were considered to be more suitable.

The Manning flow formula was the basis for hydraulic computations. Channel roughness factors for channels and overbank areas (Manning's "n") were estimated based on field observations, review of photographs, review of previous studies, and comparison with other areas. Roughness coefficients used vary from 0.015 to 0.040 in channels and from 0.035 up to 0.090 in overbank areas.

Water-surface profiles for the streams in the City of Livermore are shown on the Flood Profiles (Exhibit 1).

In the City of Newark, available mapping, including maps prepared by County and private agencies and USGS topographic maps (U.S. Department of the Interior, 1959), was reviewed and a preliminary map study was made of the streams to be studied.

A field reconnaissance was conducted to investigate stream channels; obvious problem areas; channel and overbank roughness; flow restrictions; and structures, such as bridges, culverts, and levees.

Topographic data and mapping, including stream channel cross sections, and structure dimensions and elevations were compiled from a variety of sources (Development and Resources Corporation, 1976), and additional field surveys were conducted where necessary.

As-built construction plans for all water control structures, channel modifications, bridges, culverts, and related facilities were compiled and reviewed.

A physical description of each channel was prepared and the invert and bank profiles were plotted.

Controlling water-surface elevations were determined from either the San Francisco Bay tidal analysis or backwater analysis of the receiving waterways.

Water-surface profiles were computed using the HEC-2 computer program (USACE, 1973). Use of the computer model was replaced or supplemented with hand calculations in certain areas and situations where such methods were considered to be more suitable.

Channel roughness factors for channels and overbank areas (Manning's "n") were estimated based on field observations, review of photographs, review of previous studies, and comparison with other areas (U.S. Department of the Interior, 1967). Roughness coefficients vary throughout the study area. Channel configuration (whether natural or manmade), vegetation, land use in the overbank area adjacent to the channel, and other physical parameters all have an effect on flow. Values for roughness coefficients ranged from 0.014 for efficient, concrete-lined channels to 0.045 for difficult natural channels with extensive undergrowth and from 0.035 to 0.050 for overbank areas.

The analysis indicated that flood elevations along Line F-6 would be controlled by backwater from Line F-1.

The water-surface elevations in areas of shallow flooding are essentially independent of those along the adjacent leveed channels and are affected principally by obstructions in the flooded area.

In the City of Oakland, water-surface elevations of floods of the selected recurrence intervals were computed through use of the HEC-2 step-backwater computer program (USACE, November 1976) and manual calculations for some areas.

Cross-section data for the HEC-2 analyses were determined from field survey data and supplemented by topographic maps and Alameda County Flood Control District improvement plans.

Cross-sections in all detailed studies were located at close intervals above and below bridges in order to compute the significant backwater effects of these structures. Bridges were field checked to verify elevation data and structural geometry.

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 is computed (Section 4.2), selected cross section locations are also shown on the Flood Insurance Rate Map (Exhibit 2).

Hydraulic roughness coefficients (Manning's "n") used in the computations were assigned on the basis of field inspection of flood plain areas and are shown in Table 6.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

Starting water-surface elevations for streams flowing into the bay were taken from an unpublished USACE report. For non-tidal steams, starting water-surface elevations were developed from normal depth calculations. A brief discussion of the hydraulic analysis of each stream studied in detail follows:

Line A (Temescal Creek)

1-percent annual chance flooding occurs downstream of Grove Street. The 1-percent annual chance flood is contained in a culvert between Grove Street and the Lake Temescal outlet. At Lake Temescal, the 1-percent annual chance flood inundates the shoreline area of the lake. Upstream of Lake Temescal, the 1-percent annual chance flood is contained in a culvert that runs for approximately 1,500 feet upstream of the lake. Upstream of the culvert, 1-percent annual chance flooding occurs. Upstream of Thornhill Drive, sheetflow less than 1 foot deep occurs.

Line B (Glen Echo Creek)

The 1-percent annual chance flood results in shallow flooding between the mouth of the stream at Lake Merritt and 29th Street. This reach of stream is completely underground except for two short reaches of open channel, one downstream of Harrison Street and the other upstream of 27th Street. Between 29th Street and Randwick Avenue, the 1-percent annual chance flood is contained in the channel.

Line C

This steam is an underground conduit for its entire study reach. The 1-percent annual chance flood is not contained within this underground conduit, and shallow flooding results along the entire study reach.

Line D (Trestle Glen)

This stream consists of an underground conduit for its entire study reach. From its outlet at Lake Merritt to Trestle Glen Road, the conduit has less than 1-percent annual chance capacity and shallow flooding results. Upstream of Trestle Glen Road to the Piedmont corporate limits, the underground conduit contains the 1- percent annual chance flood.

Line D-1 (Lakeshore Drain)

This channel is an underground conduit for its entire study reach. From Trestle Glen Road to Kenmore Avenue, the underground conduit has less than 1-percent annual chance capacity and shallow flooding results. From Kenmore Avenue to the Piedmont corporate limits, the underground conduit contains the 1-percent annual chance flood.

Line E (Sausal Creek)

One hundred-year flooding occurs in the entire study reach. Zone A is contained in the channel from the downstream limit of detailed study to just upstream of Veteran Way. A breakout occurs starting just upstream of Veteran Way. This breakout results in shallow flooding paralleling the channel to the mouth at the Brookland Basin Tidal Channel.

Line F (Peralta Creek)

This channel contains the 100-year flood from the mouth at San Leandro Bay to the culvert outlet at 50th Avenue and Coliseum Way. From the intersection of 50th Avenue and Coliseum Way to Foothill Boulevard, the storm drain consists of parallel underground conduits with some open channel. This system does not have 1-percent annual chance capacity, and shallow flooding results from the Foothill Boulevard culvert to the Nimitz Freeway.

1-percent annual chance flooding occurs upstream of the Foothill Boulevard culvert to Ward Street. Flooding is contained in a culvert between Ward Street and School Street. 1-percent annual chance flooding occurs from School Street to MacArthur Freeway, and from Delaware Street to the upstream limit of detailed study.

Line G

This channel consists of an underground storm drain system consisting of parallel pipes from its confluence with Line F to East 14th Street. This underground system does not have 1-percent annual chance capacity and as a result shallow flooding occurs downstream to the Nimitz Freeway. Upstream of East 14th Street to Thompson Street there is 1-percent annual chance shallow flooding. Upstream of Thompson Street to the detailed study limit there is 1-percent annual chance open channel flooding.

Line I (Seminary Avenue Drain)

This channel contains the 1-percent annual chance flood from the confluence with Line F (Peralta Creek) to just upstream of Coliseum Way. Upstream of East 14th Street, the culvert has less than 1-percent annual chance capacity which results in shallow flooding in both overbanks. This shallow flooding proceeds downstream of San Leandro Boulevard where it joins shallow flooding from Lines F, G, J, and K. 1-percent annual chance open channel flooding occurs from the vicinity of Scoville Street to the limit of detailed study at Bancroft Avenue.

Line J (Lion Creek)

Shallow flooding along Line J is caused by inadequate culvert capacity at Eastlawn Street.

Line K (Arroyo Viejo Creek)

1-percent annual chance flooding occurs downstream of MacArthur Boulevard. Sheet flow (Zone B) occurs from the vicinity of 83nt street to the mouth at San Leandro Bay.

Line M (Elmhurst Creek)

This channel contains the 1-percent annual chance flood from the confluence with San Leandro Creek to Hegenberger Expressway. Upstream of Hegenberger Expressway the channel has less than 1-percent annual chance capacity. Shallow flooding in both overbanks extends downstream to San Leandro Creek.

Line N (Stonehurst Creek)

This channel has less than 1-percent annual chance capacity from the confluence with San Leandro Creek to upstream of Knight Avenue. As a result, 1-percent annual chance flooding occurs in both overbanks along this reach. Upstream of Knight Avenue the channel has 1-percent annual chance capacity.

Line P (San Leandro Creek)

This channel has less than 1-percent annual chance capacity along the entire study reach resulting in 1-percent annual chance flooding along this reach. Data for this stream were taken from a FIS for San Leandro (U.S. Department of Housing and Urban Development).

Line R (Merritt Outflow)

This channel has 1-percent annual chance capacity from Lake Merritt to the 7th Street Pump station. Downstream of 7th Street there is flooding due to 1-percent annual chance tidal inundation.

Lake Merritt

The 1-percent annual chance flood inundates Lake Merritt to an approximate Base Flood Elevation of 5.0 feet.

Flood profiles are not applicable for areas of shallow flooding or where flooding is contained in a channel or culvert. Therefore, flood profiles are not presented for Lines C, D, D-1, J, and R.

Hand calculations were used for an approximate analysis of Line K upstream of MacArthur Boulevard.

A detailed study was conducted along the shoreline fronting on San Francisco Bay. The source of information for this analysis was obtained from two studies by the USACE (USACE, unpublished; USACE, November 1975). Based upon these reports, the 1-percent annual chance San Francisco Bay flooding inundates to elevation 9.3 feet along the City of Oakland shoreline.

The boundary between the V1 and Al Zones for the bay was determined using topographic maps and based on methodology described in the USACE Shore Protection Manual (USACE, 1977).

Areas of shallow flooding, including Lake Merritt, were determined using the HEC-2 computer program and topographic maps.

In the City of Pleasanton, cross-section data for streams in the area were obtained from field surveys, topographic data, and as-built plans (Development and Resources Corporation, 1976; Bissell & Karn, Inc., 1983; Bissell & Karn, 1979; Bissell & Karn, Inc., 1981; Bissell & Karn, Inc., 1982).

For Arroyo De La Laguna, the elevations determined in the study of the unincorporated areas of Alameda County (FEMA, 1981), at the Pleasanton corporate limits, were adopted as the starting water-surface elevations. For all other watercourses studied in detail, the elevations at the confluence with the main streams were used as the starting water-surface elevations.

In the City of San Leandro, starting water-surface elevations for 1-percent annual chance flows on San Leandro-Line A (Zone 2) and Line P (San Leandro Creek) were based on the mean annual high water level for San Francisco Bay.

Starting water-surface elevations for 10-percent annual chance flows were based on 1-percent annual chance tidal elevations for San Francisco Bay. Starting water-surface elevations for San Leandro-Lines B, C, and D (Zone 9) were based on the flood elevations for San Leandro-Line A (Zone 2).

Water-surface elevations for the approximate area of Line A in Alameda County Flood Control and Water Conservation District Zone 13 were based on the inflow-outflow storage relationship upstream of the detailed analysis.

In the City of Union City, cross sections for the backwater analyses were field surveyed and were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures.

Channel roughness factors (Manning's "n" values) for these computations were assigned on the basis of field inspection of the flood plain areas. The "n" values used for channel computations were 0.035 for earthen channels, 0.016 for concrete channels, and 0.050 for overbank areas.

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are valid only if hydraulic structures remain unobstructed and other flood control structures operate properly and do not fail.

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"**
Alameda Creek – Line A (Zone 3)	0.038	0.050 - 0.060
Arroyo Las Positas	0.030 - 0.050	0.030 - 0.060
Arroyo Mocho	0.030 - 0.050	0.030 - 0.060
Collier Canyon Creek	0.055 - 0.065	0.040 - 0.065
Collier Canyon Tributary	0.055 - 0.065	0.040 - 0.065
Line A (Zone 6)	0.015 - 0.050	0.030 - 0.080
Line B	0.015 - 0.033	0.050 - 0.060
Line B (Zone 6)	0.014 - 0.040	0.100
Line B-1 (Zone 6)	0.015 - 0.06	0.055 - 0.060
Line B-3 (Zone 5)	0.014 - 0.035	0.040 - 0.080
Line C (Zone 5)	0.015 - 0.040	0.030 - 0.080
Line C (Zone 6) (Torges Creek)	0.015 - 0.055	0.055 - 0.060
Line D (Zone 3A)	0.040	0.060
Line D (Zone 5)	0.015 - 0.035	0.025 - 0.080
Line D (Zone 6) (Agua Fria Creek)	0.013 - 0.060	0.030 - 0.080
Line E (Zone 6) (Laguna Creek)	0.015 - 0.055	0.050 - 0.060
Line F (Zone 6) (Arroyo del Agua Caliente Creek)	0.015 - 0.052	0.053 - 0.060
Line F-1	0.033 - 0.034	0.050 - 0.060
Line G (Zone 6)	0.013 - 0.035	0.030 -- 0.080
Line H (Zone 6)	0.014 - 0.035	0.030 - 0.080
Line J (Zone 6) (Canada del Aliso)	0.014 - 0.060	0.035 - 0.080

Table 6: Manning's "n" Values, continued

Stream	Channel "n"	Overbank "n"
Line K (Zone 5) (Crandall Creek)	0.025 - 0.035	0.040 - 0.080
Line K (Zone 6)	0.039 - 0.062	0.052 - 0.060
Line L (Zone 6) (Mission Creek)	0.013 - 0.080	0.040 - 0.080
Line L-1 (Zone 6)	0.025 - 0.030	0.060 - 0.100
Line L-7 (Zone 6)	0.025 - 0.080	0.040 - 0.050
Line M (Zone 6) (Morrison Creek)	0.025	0.030 - 0.060
Line N, N-2 (Zone 6)	0.030 - 0.040	0.025 - 0.040
Line N-10 (Zone 5)	0.013 - 0.024	0.030 - 0.080
Line N-6 (Zone 5)	0.013 - 0.024	0.060
Line N-7 (Zone 5)	0.013 - 0.024	0.060
Line N-8 (Zone 5)	0.013 - 0.024	0.060
Line N-9 (Zone 5)	0.013 - 0.024	0.060
Line O	0.038 - 0.045	0.055
Line P (Zone 6)	0.130	0.040
Line Q (Zone 6)	0.130	0.040
San Leandro - Line A (Zone 2)	0.015 - 0.043	0.050 - 0.060
San Lorenzo Creek - Line B (Zone 2)	0.015 - 0.063	0.050 - 0.060
Sulphur Creek - Line K (Zone 2)	0.015 - 0.038	0.055 - 0.060
Ward Creek - Line B (Zone 3A)	0.015 - 0.039	0.060

Countywide Analyses

Under contract to the Alameda County Public Works Agency (ACPWA), Danish Hydraulic Institute (DHI) Water & Environment prepared a flood study of San Lorenzo Creek, San Leandro Creek Line A (Zone 2), and Bockman Canal. The study was completed in August 2007. The study was prepared using MIKE FLOOD, coupling a MIKE 11 model of the main channel of San Lorenzo Creek with a MIKE 21 model of the surrounding flooding. The study limits were between the San Francisco Bay and Cull Creek Dam along San Lorenzo Creek. Note that the analyses of flooding along San Leandro Creek Line A (Zone 2) and Bockman Canal was limited to those areas influenced by the San Francisco Bay.

The flood control reach of San Lorenzo Creek is a well-defined, engineered channel. Cross sections were surveyed at 20- to 150-foot intervals. A dense 1'x5' grid of the flood control channel was developed. Bathymetric data was obtained from the aforementioned survey data.

The MIKE 11 boundary conditions included two tributaries to San Lorenzo Creek, being Cull and Don Castro Creeks, and the mouth of the San Lorenzo Creek at the San Francisco Bay. Hydrology in the study area was based on a HEC-1 model provided by ACPWA. Manning's "n" values were calculated via three bed resistance formulations. Of 15 bridges in the study reach, only two are anticipated to block flow during larger flood events. All bridges were modeled in MIKE 11 as culverts topped by weirs. The MIKE 11 model was calibrated using two USGS stream gages in the study area.

For the MIKE FLOOD modeling, contour data provided by ACPWA was developed into a Digital Elevation Model (DEM). The DEM was modified to exclude the San Lorenzo Creek channel and buildings. Two different approaches for appropriately blocking out the San Lorenzo Creek channel in the DEM were used. A grid spacing of 5 meters was used. The only boundary condition in the MIKE 21 model was the San Francisco Bay water level; however, the Bay's water level only plays a minor role in hydraulic behavior in the study area. A San Francisco Bay MHHW of 6.29 feet NAVD 88, obtained from a Michael Love & Associates and Graham Matthews & Associates December 2003 study, was used in this study. As there are no means available to calibrate the MIKE 21 model, the model was roughly calibrated using a Manning's "n" value of 0.05 s/m1/3. Overestimating the Manning's "n" value would result in insufficient estimation of flooding, so a more conservative "n" value was used in this case.

Using MIKE FLOOD, the 6.67- (15-year), 2-, 1-, and 0.2-percent annual chance floodplains were mapped. Based on these data, approximate limits of 1-percent annual chance flooding were depicted for and are shown on the FIRM. Those reaches of the flood profiles for San Lorenzo Creek, San Leandro Creek Line A (Zone 2), and Bockman Canal that lie within areas now designated as approximate flood hazard areas were removed from the FIS.

The Alameda County Public Works Agency (ACPWA) conducted a study along Chabot Creek (Line G) and Castro Valley Creeks (Lines I and J). The HEC-RAS steady state model was used to calculate the water surface elevation for the 1- and 0.2-percent annual chance return periods. Flow rates used in the model were taken from the hydrologic analysis and adjusted for instances where water is carried off or rejoined with the main watercourses. Cross sections for reaches of concrete channel and box culvert improvements were taken from as-built (record) drawings. For unimproved creek reaches cross-sectional surveys were performed. The extensions of the channel cross sections into the floodplain were performed using the Flood Control District's 2-foot contour mapping done for the western portion of the County. In cases where the 2-foot contour mapping provided insufficient detail, the District used its very recently obtained 1.5 foot LIDAR topography containing a dense grid of elevation points.

Behind Levee Analysis

Some flood hazard information presented in prior FIRMs and in prior FIS reports for Alameda County and its incorporated communities was based on flood protection provided by levees. Based on the information available and the mapping standards of the NFIP at the time that the prior FISs and FIRMs were prepared, FEMA accredited the levees as 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."

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 documentation related to 44 CFR 65.10 is being compiled, the release of a more up-to-date FIRM 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 allow issuance of the FIS and FIRM while levee owners or communities compile full documentation required to show compliance with 44 CFR 65.10. The guidelines also explain that a FIRM 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 65.10.

FEMA contacted the communities within Alameda 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 final effective FIRM 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). Communities have two years from the date of FEMA's initial coordination to submit to FEMA final accreditation data for all PALs. Following receipt of final accreditation data, FEMA will revise the FIS and FIRM as warranted.

FEMA coordinated with local communities, the USACE, and other organizations to compile a list of levees that exist within Alameda County. Table 7 lists all levees shown on the FIRM, to include PALs, for which corresponding flood hazard revisions were made.

Table 7: List of Leeves

Community	Flood Source	Levee Inventory Identification Number	USACE Levee
City of San Leandro, Alameda County (Unincorporated Areas)	San Leandro Creek and Bockman Canal	1 and 183	No
City of San Leandro, Alameda County (Unincorporated Areas)	San Leandro Creek and Bockman Canal	110, 111, 112, and 113	Yes
City of Oakland	San Leandro Bay, Line P (San Leandro Creek Canal), and Ash Lateral 33	384 and 386	No
City of Oakland	San Leandro Bay and Line P (San Leandro Creek Canal), and Ash Lateral 33	116	Yes
City of Oakland	San Francisco Bay	342 and 343	No
City of San Leandro	Estudillo Canal	341	No
City of Fremont	Coyote Creek and Agua Fria Creek	369 and 451	Yes
City of Fremont	San Francisco Bay	376	No
City of Pleasanton	Arroyo del Valle	365	No
City of Fremont	San Francisco Bay	264	No
City of Hayward	Ward Creek Line B_(Zone 3A)	450	No
City of Hayward	Sulphur Creek Line K (Zone 2)	30 and 339	No

Approximate analyses of "behind levee" flooding were conducted for all the levees in Table 7 to indicate the extent of the "behind levee" floodplains. The methodology used in these analyses is discussed below.

Levee 450 is located along Ward Creek Line B (Zone 3A). This levee is fully accredited. The flood hazard information presented on the FIRM is consistent with that shown in Letter of Map Revision (LOMR) Case No. 02-09-0542P, dated February 10, 2003. The area protected by the levee was determined by comparing the flood hazard data from the subject LOMR and flood hazard data presented in the area of the FIRM superseded by the subject LOMR.

Levees 342 and 343 are located along the San Francisco Bay. Levees 369 and 451 are located along Coyote Creek and Agua Fria Creek. Levees 30 and 339 are located along Sulphur Creek Line K (Zone 2). All six levee segments were approved as PALs. Based upon the FIS and topographic information from the U.S. Geological Survey, approximate areas of 1-percent annual chance flooding in the event of failure of the levees were determined based on engineering judgment and mapped as areas protected from the 1-percent annual chance flood.

Levees 1, 110, 111, 112, 113, and 183 are located along San Leandro Creek and Bockman Canal. The flooding along these levees is based upon a DHI Water & Environment flood study of San Lorenzo Creek.

Levees 116, 384, and 386 are located along San Leandro Bay, Line P (San Leandro Creek Canal), and Ash Lateral 33. Levee 264 is located along the San Francisco Bay. Based upon the FIS and topographic information from the U.S. Geological Survey, areas of flooding in the event of failure of the levees were determined. These floodplains were designated as having a 1-percent annual chance flood elevation consistent with the adjacent flood hazards, which dominate flooding in the area, as no accreditation data were provided.

Levee 341 is located along Estudillo Canal. Levee 376 is located along San Francisco Bay. Based upon the FIS and topographic information from the U.S. Geological Survey, approximate areas of 1-percent annual chance flooding in the event of failure of the levees were determined based on engineering judgment and designated as such as no accreditation data were provided.

Levee 365 is located along Arroyo del Valle. Based upon the FIS, topographic information from the USGS, and a hydraulic analysis of 1-percent annual chance water-surface elevations in the area prepared using the USACE HEC-RAS model, an area of flooding in the event of failure of the levees was determined.

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.

All flood elevations shown in this FIS report and on the FIRM are referenced to NAVD 88. Structure and ground elevations in the community must, therefore, be referenced to NAVD 88. It is important to note that adjacent communities may be referenced to NGVD 29. This may result in differences in base flood elevations across the corporate limits between the communities.

Prior versions of the FIS report and FIRM were referenced to NGVD 29. When a datum conversion is effected for an FIS report and FIRM, the Flood Profiles, base flood elevations (BFEs) and ERMs reflect the new datum values. To compare structure and ground elevations to 1-percent annual chance flood elevations shown in the FIS and on the FIRM, the subject structure and ground elevations must be referenced to the new datum values.

As noted above, the elevations shown in the FIS report and on the FIRM for Alameda County are referenced to NAVD 88. Ground, structure, and flood elevations may be compared and/or referenced to NGVD 29 by applying a standard conversion factor. The conversion factor to NGVD 29 is 2.76 feet.

For more information on NAVD 88, see Converting the National Flood Insurance Program to the North American Vertical Datum of 1988, FEMA Publication FIA20/June 1992, or contact the Spatial Reference System. Division, National Geodetic Survey, NOAA, Silver Spring Metro Center, 1315 East-West Highway, Silver Spring, Maryland 20910 (Internet address http://www.ngs.noaa.gov).

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

In Alameda County, to provide a national standard without regional discrimination, the 1-percent annual chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance flood is employed to indicate additional areas of flood risk in the county. For the streams studied in detail, the 1- and 0.2-percent annual chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using a wide variety of topographic information assembled in a way to adequately define elevations along the channels and in the floodplains. Mapping and as-built channel data were obtained from the files of the Alameda County Flood Control and Water Conservation District; channel data obtained from the USACE; strip mapping obtained from the California Department of Transportation; development mapping obtained from private owners, USGS quadrangle maps, park districts; and detail mapping from the State of California, Department of Water Resources data, the cities within the county, and field surveys by two survey contractors. From these major sources of information, sufficient data were established to determine the channel flood profiles and the limits of flooding. Once the required profiles and flooding limits were established and confirmed using the accurate channel data, the flooding limits were transferred to the work maps at a scale of 1:12,000. A detailed list of the data sources for each channel appears in Sources of Channel Data (Development and Resources Corporation, 1976). A detailed listing of mapping sources can also be found in this data.

For the areas along Arroyo De La Laguna, north of Bernal Avenue and east of Foothill Road, flood boundaries were delineated using topographic maps at scales of 1:4,800; 1:1,200; and 1:480, with contour intervals of 1 foot, 2 feet, and 1 foot, respectively (Bissell & Karn, Inc., 1983; Aero-Geodetic Corporation, 1982; AeroGeodetic Corporation, 1983).

For the areas along Ward Creek, flood boundaries were delineated using topographic maps at a scale of 1:24,000, with contour intervals of 10 and 20 feet, and aerial strip mapping at a scale of 1:4,800 with a contour interval of 1 foot (Development and Resources Corporation, 1963; U.S. Department of the Interior, 1959, et cetera).

In the City of Albany, between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:6,000, with a contour interval of 20 feet (City of Albany, 1977). Boundaries for San Francisco Bay were also delineated on the topographic maps (City of Albany, 1977) using the elevations determined for Section 3.2.

The boundaries for the AO Zones (Shallow Flood) were delineated through the use of topographic maps and other data provided with the supplemental channel data (Development and Resources Corporation, 1976).

In the City of Berkeley, for each steam studied in detail, the boundaries of the land 0.2-percent annual chance flood 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 1:24,000, with a contour interval of 10 feet (U.S. Department of Interior). In cases where the land 0.2-percent annual chance flood boundaries are close together, only the 1-percent annual chance boundary has been shown. Flood boundaries for the 1- and 0.2-percent annual chance floods are shown on the FIRM (Exhibit 2).

For steams studied through approximate methods, the boundaries of the 1-percent annual chance flood have been delineated using the above mentioned maps and based upon elevations derived from field surveys of the area.

Small areas within the flood boundaries may lie above the flood elevations, and therefore, not be subject to flooding; owing to limitations of the map scale, such areas are not shown.

In the City of Dublin, for the streams studied by approximate methods, only the 1-percent annual chance floodplain boundary is shown on the Flood Insurance Rate Map (Exhibit 2).

Approximate 1-percent annual chance floodplain boundaries in some portions of the study area were taken directly from the FIRM for Alameda County, California (FEMA, 1980).

In the City of Fremont, between cross sections, the boundaries were determined using topographic maps at a scale of 1:4,800, with a contour interval of 2 feet (PRC Toups, 1980), developed from aerial photography (PRC Toups, 1978). Flood boundaries were established in conjunction with field investigations by hydraulic engineers.

Flood boundaries for areas subject to flooding from San Francisco Bay and for Lines M and M-5 were determined using USGS topographic maps at a scale of 1:24,000, with contour intervals of 5 and 20 feet (U.S. Department of the Interior, 1973).

Approximate flood boundaries in some portions of the study area were taken from the Flood Hazard Boundary Map (FHBM) (U.S. Department of Housing and Urban Development, 1977).

In the City of Hayward, between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24,000, with a contour interval of 5 feet (U.S. Department of the Interior, 1959); 1:24,000, with a contour interval of 20 feet (U.S. Department of the Interior, 1959 et cetera); 1:24,000, with a contour interval of 40 feet (U.S. Department of the Interior, 1961); and 1:62,500, with a contour interval of 80 feet (U.S. Department of the Interior, 1959). Aerial strip mapping at a scale of 1:4,800, with a contour interval of 1 foot (The Spink Corporation, 1977) and construction as-built drawings (Alameda County Flood Control and Water Conservation District, 1978) were also used in the interpolation.

Areas studied by approximate methods were delineated using the determined elevations and the previously cited mapping (U.S. Department of the Interior, 1959; U.S. Department of the Interior, 1959 et cetera; U.S. Department of the Interior, 1961; U.S. Department of the Interior, Scale 1:62,500, 1959; The Spink Corporation, 1977; Alameda County Flood Control and Water Conservation District, 1978).

For San Francisco Bay, the boundaries of the 1- and 0.2-percent annual chance floods were delineated using study contractor work maps at a scale of 1:2,400, with a contour interval of 10 feet (Development and Resources Corporation, 1963) in conjunction with topographic maps (U.S. Department of the Interior, 1959; U.S. Department of the Interior, 1959 et cetera; U.S. Department of the Interior, 1961; U.S. Department of the Interior, Scale 1:62,500, 1959); construction as-built drawings (Alameda County Flood Control and Water Conservation District, 1978); and computed flood elevations.

In the City of Newark, boundaries for San Francisco Bay were also delineated on the topographic maps, using the elevations determined in the hydraulic analyses. The flood limits established for flooding from the channels and from San Francisco Bay were compared and the maximum limits of flooding are presented as the final flood boundaries.

In areas where the flood hazard consists of shallow flooding, flood boundaries were determined by extensive field investigation.

In the City of Oakland, flood boundaries for areas studied by approximate methods were developed using topographic maps at a scale of 1:24,000, with contour intervals of 10 and 20 feet (U.S. Department of Interior, 1973).

In the City of Pleasanton, for each stream studied in detail, the 1- and 0.2-percent annual chance 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 scales of 1:4, 800; 1:2,400; 1:1,200; and 1:480, with contour intervals of 1, 10, 2, and 1 feet, respectively. Flood boundary delineations were supplemented by survey spot elevations and as-built plans (Bissell & Karn, Inc.).

In the City of San Leandro, the criteria that were adopted for the analysis that led to the establishment of the 1- and 0.2-percent annual chance flood limits are as follows:

1. The flooding limits that result from the 10-percent annual chance flow in the channel and the 1- and 0.2-percent annual chance high tides in the bay were established.

2. The flooding limits that result from the 1- and 0.2-percent annual chance flows in the channels and the mean annual high water in the bay were established.

3. The maximum limits of flooding established in the two steps mentioned above are the adopted flood levels.

The approximate boundaries for the upstream portion of San Leandro Line A (Zone 13) were delineated using the elevations determined in Section 3.2 in conjunction with topographic information (Development and Resources Corporation, 1977).

In the City of Union City, areas zoned as Al are not open to direct tidal action; inundation may result from breached levees or overtopping due to wind-driven waves. Elevations reflect only the estimated 1-percent annual chance tide because there is no process that will provide an analytical solution to the hazard.

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 Alameda 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 NW', 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 8). 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.

In Alameda County, no floodways were computed for Bockman Canal and San Francisco Bay because of its tidal influence.

On Ward Creek - Line B (Zone 3A), the 1-percent annual chance flood is confined to the channel; therefore, no floodway was computed.

Along Arroyo Mocho, where the flood levels are influenced by levees, separate flows exist. Therefore, separate floodway widths are shown in Table 8.

In the City of Albany, the floodway for Cerrito Creek was computed on the basis of equal conveyance reduction from each side of the floodplain. The floodway developed for Cerrito Creek is contained in the channel within Albany; therefore, no floodway is shown.

In the areas of the city influenced by tidal action of the San Francisco Bay, a floodway determination is not appropriate. Therefore, no floodway is shown on the outlet end of any of the channels. Floodways are also not appropriate, or shown, for areas of shallow sheetflow flooding.

Because the City of Berkeley is fully urbanized and lies not in a valley but on coastal plain bound by steep hills, stream flood flows may leave the channel and spread out through city streets towards the San Francisco Bay as shallow flooding. Floodways for Codornices, Schoolhouse, Cerrito, and Harwood (Claremont) Creeks are not applicable.

The only area in which the floodway could be reasonably established without greatly increasing the potential damage would be in the Strawberry Creek on the University of California campus.

In the City of Dublin, no floodway was determined for Alamo Canal; South San Ramon Creek; Alamo Creek; Lines J-2, J-4, J-5, and F-4; and Dublin Creek because 100-year flooding is contained within the channel banks. No floodway was shown for Line J-1, Line J-3, and Chabot Canal because the computed floodway was found to be coincident within the channel.

Floodway data for Tassajara Creek was incorporated into this revised FIS because the area encompassing the Tassajara Creek floodplain was annexed from Alameda County.

In the City of Fremont, the floodways presented in this study were developed through a series of procedural steps that included:

1. Evaluation of equal conveyance reduction from each side of the floodplain.

2. Negotiation and coordination with local and regional agencies.

3. Review of existing hydraulic data.

4. Consideration of the topography and channel right-of-way.

Floodways were determined only for open channels for which there was 1-percent annual chance flooding. These channels are:

Line K (Zone 5)
Line A (Zone 6)
Line D (Zone 6)
Line G (Zone 6)
Line J (Zone 6)
Line K (Zone 6)
Line L (Zone 6)

In the City of Hayward, on Line D (Zone 3A) and the lower reaches of Ward Creek - Line B (Zone 3A), the 1-percent annual chance flood is confined to channels; therefore, a floodway was not computed.

In the City of Livermore, upstream of cross section I, floodwaters are controlled by the Stanley Boulevard Bridge. Therefore, no floodway was determined for this reach.

Floodway area is also limited in Arroyo Las Positas. Restriction in channel capacity upstream from Airway Boulevard forces the flow to bypass the bridge into a golf course.

Consequently, no floodway was determined downstream from cross section B. High-velocity flow in portions of Arroyo Seco precludes floodway determination.

The City of Livermore has purchased, for open space reserve, a strip of land along one side of Arroyo Mocho. The floodway area included in this strip meets FEMA floodway criteria. From Holmes Street to South L Street, the City has purchased or is purchasing property along Arroyo Mocho. From South L Street to the eastern corporate limits, the stream traverses the City-owned Robertson Park.

In the City of Oakland, the floodways presented in this report were developed through a series of procedural steps that included:

1. Evaluation of equal conveyance reduction from each side of the flood plain.

2. Negotiation and coordination with local and regional agencies

3. Review of existing hydraulic data

4. Consideration of the topography and channel right-of-way

Floodways were determined only for open channels for which there was 100-year flooding. These channels are Lines A, E, F, I, K, M, N, and P.

It was determined that the floodways for Lines A and M are contained in the channel; therefore, no floodway data are presented for these streams.

In the City of Pleasanton, no floodway data have been shown for Alamo Canal, Arroyo Del Valle, Arroyo Mocho, Chalot Canal, Pleasanton Canal, Tassajara Creek, Hewlett Canal, and Line G-3 because it was determined that the floodway was confined to the channel. For Arroyo De La Laguna, Arroyo Las Positas, and Line B2-1, floodway data are only shown for those cross sections where the floodway limits are not confined to the channel.

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 8, "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.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Alameda Creek								
A	97,300	450	7,112	4.5	238.0	238.0	238.1	0.1[2]
B	102,100	163	6,289	2.2	244.2	244.2	245.0	0.8
C	107,400	1,200	3,773	2.2	257.7	257.7	258.4	0.7
Alameda Creek (Line A Zone 3A)								
A	23,640		*	*	10.6	*	*	*
B			*	*	*	*	*	*
C			*	*	*	*	*	*
Alamo Canal								
A	39,325	92	*	*	322.0	322.0	*	*
B	41,500	87	*	*	324.1	324.1	*	*
C	44,500	112	*	*	326.6	326.6	*	*
D	45,800	120	*	*	327.9	327.9	*	*
E	47,490	135	*	*	329.6	329.6	*	*
F	48,240	123	*	*	330.5	330.5	*	*
Altamont Creek								
A	200	103	501	3.0	499.9	499.9	500.8	0.9
B	550	102	500	3.0	500.2	500.2	501.0	0.8
C	770	174	889	1.7	500.5	500.5	501.2	0.7
D	1,201	170	867	1.7	500.8	500.8	501.5	0.7
E	1,711	620	1,475	1.0	504.5	504.5	505.2	0.7
F	2,533	865	442	3.4	505.1	505.1	505.7	0.6
G	3,733	1,380	511	2.9	508.3	508.3	508.8	0.5
H	4,828	1,090	238	6.3	511.5	511.5	511.9	0.4

[1] Feet above mouth
[2] Overbank velocity excessive
* Data Not Available

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

ALAMEDA CREEK – ALAMEDA CREEK (LINE A ZONE 3A) – ALAMO CANAL – ALTAMONT CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Altamont Creek (continued)								
I	5,341[2]	26	139	10.8	513.8	513.8	513.8	0.0
J	6,146[2]	24	119	12.6	515.0	515.0	515.0	0.0
K	7,237[2]	33	121	10.9	521.4	521.4	521.4	0.0
L	7,907[2]	110	2,184	3.9	527.1	527.1	527.7	0.6
M	8,535[2]	80	151	4.8	531.4	531.4	531.7	0.3
N	9,011[2]	106	194	3.7	533.6	533.6	534.0	0.4
O	10,175[2]	88	157	4.6	541.5	541.5	541.8	0.3
P[1]	10,951[2]	38	125	5.8	545.2	545.2	545.6	0.4
Q[1]	12,530[2]	102	328	2.2	554.7	554.7	555.6	0.9
R	13,750[2]	30	92	7.8	561.4	561.4	561.9	0.5
S	15,950[2]	198	386	1.9	570.0	570.0	570.2	0.2
T	17,550[2]	61	210	3.4	580.8	580.8	581.4	0.6
Arroyo De La Laguna								
A	1,900[3]	480	8,391	2.0	238.4	238.4	239.4	1.0
B	3,560[3]	497	6,034	2.8	245.7	245.7	246.5	0.8
C	6,720[3]	155	2,300	7.4	256.9	256.9	257.9	1.0
D	8,520[3]	230	3,304	5.1	263.3	263.3	264.2	0.9
E	9,760[3]	300	3,030	5.6	266.7	266.7	267.7	1.0
F	10,455[3]	184	2,529	6.7	268.5	268.5	269.3	0.8
G	11,040[3]	292	3,930	4.3	270.0	270.0	270.9	0.9
H	14,990[3]	235	3,348	5.1	280.3	280.3	280.8	0.5
I	18,139[3]	160	3,217	5.3	290.4	290.4	290.6	0.3
J	20,862[3]	160	3,307	5.1	293.7	293.7	294.0	0.3
K	23,513[3]	158	2,857	6.0	300.1	300.1	300.7	0.6
L	24,471[3]	144	2,135	8.0	301.9	301.9	302.9	1.0
M	31,836[3]	227	3,285	5.2	318.2	318.2	319.0	0.8

[1] Floodway is confined to main channel
[2] Feet above mouth
[3] Feet above confluence with Alameda Creek

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

ALTAMONT CREEK – ARROYO DE LAGUNA

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Arroyo De La Laguna (continued)								
N	35,530[2]	*	*	*	319.8	*	*	*
O	38,920[2]	*	*	*	320.2	*	*	*
Arroyo Del Valle								
A-G*								
H	14,150	124	824	8.5	351.5	351.5	351.5	0.0
I*								
J	20,650	430	*	*	*	*	*	*
K	28,950	405	*	*	*	*	*	*
L	32,250	435	*	*	*	*	*	*
M	39,250	150	769	9.1	445.8	445.8	446.5	0.7
N	42,550	350	1,327	5.3	463.9	463.9	464.9	1.0
O	44,750	320	1,905	3.7	479.3	479.3	480.3	1.0
P	48,250	510	1,400	5.0	497.3	497.3	498.1	0.8
Q	55,850	155	1,149	6.1	548.8	548.8	549.6	0.8
R	57,550	135	1,116	6.3	559.5	559.5	560.5	1.0

[1] Feet above confluence with Arroyo De La Laguna
[2] Feet above confluence with Alameda Creek
* Data not available

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
ALAMEDA COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

ARROYO DE LAGUNA – ARROYO DEL VALLE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[2]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Arroyo Las Positas								
A-E	*	*	*	*	*	*	*	*
F	9,525	790	4,162	1.4	374.4	374.4	375.4	1.0
G	20,100	173	1,047	5.2	403.3	403.3	403.7	0.4
H	21,200	140	988	5.6	405.1	405.1	405.9	0.8
I	22,400	123	767	7.2	407.6	407.6	408.6	1.0
J	39,340	154	711	3.2	497.1	497.1	498.1	1.0
K	40,163	70	640	3.6	498.2	498.2	499.2	1.0
L	41,259	68	583	3.9	498.8	498.8	499.7	0.9
M	42,839	223	1,586	1.1	499.5	499.5	500.3	0.8
N	43,039	234	1,626	1.1	499.5	499.5	500.3	0.8
O	43,839	180	1,343	1.3	499.6	499.6	500.4	0.8
P	44,589	332	1,271	1.4	500.0	500.0	500.7	0.7
Q	45,776	77	421	0.9	504.1	504.1	504.8	0.7
R[1]	46,286	75	224	1.7	504.1	504.1	505.1	1.0
S[1]	48,043	30	52	7.3	508.2	508.2	508.2	0.0

[1] Floodway contained in channel
[2] Feet above mouth
* Data not available

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

ARROYO LAS POSITAS

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Arroyo Las Positas Relocation								
A[1]	970[2]	44	163	5.0	537.6	537.6	537.6	0.0
B[1]	1,740[2]	43	148	5.6	540.5	540.5	540.5	0.0
C[1]	2,990[2]	41	138	6.0	574.5	574.5	547.5	0.0
D	3,970[2]	42	155	5.3	553.2	553.2	553.2	0.0
E	8,300[2]	150	225	3.6	578.1	578.1	579.1	1.0
F	10,300[2]	17	79	10.4	592.2	592.2	593.2	1.0
G	17,100[2]	*	*	*	685.7	*	*	*
H	18,500[2]	*	*	*	716.8	*	*	*
Arroyo Mocho								
A-N	*	*	*	*	*	*	*	*
O	20,014[3]	1,116	4,607	2.2	359.3	359.3	360.2	0.9
P	22,047[3]	1,459	5,477	2.0	364.1	364.1	364.4	0.3
Q	24,650[3]	1,050	2,196	2.5	365.8	365.8	366.8	1.0
R (Right Bank)	27,633[3]	880	1,372	3.0	376.8	376.8	377.6	0.8
R (Main Channel)	27,633[3]	80	500	2.4	377.8	377.8	378.8	1.0
S (Right Bank)	29,300[3]	700	2,493	0.7	381.3	381.3	382.2	0.9
S (Main Channel	29,300[3]	100	295	4.0	382.8	382.8	382.8	0.0
T (Right Bank)	32,152[3]	1,006	633	2.5	391.8	391.8	392.7	0.9

[1] Floodway contained in channel (cross sections not shown on map)
[2] Feet above mouth
[3] Feet above confluence with Arroyo De La Laguna & Alamo Canal
* Data not available

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
ALAMEDA COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

ARROYO LAS POSITAS RELOCATION – ARROYO MOCHO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Arroyo Mocho (continued)								
T (Left Bank)	32,152	186	189	3.7	394.1	394.1	394.6	0.5
T (Main Channel)	32,152	80	550	5.7	399.0	399.0	399.0	0.0
U	33,350	850	3,042	1.7	405.0	405.0	406.0	1.0
V	41,783	154	1,100	4.8	460.8	460.8	460.8	0.0
W	53,500	618[2]	1,329	4.1	544.7	544.7	544.7	0.0[3]
X	54,660	520[2]	1,493	3.1	554.4	554.4	555.4	1.0[3]
Y	55,700	425	1,038	4.5	564.3	564.3	564.3	0.0[2]
Z	56,725	281	561	8.6	576.3	576.3	576.7	0.4[2]
AA	59,045	88	624	7.5	600.5	600.5	601.1	0.6
AB	59,775	77	462	9.8	604.2	604.2	604.8	0.6
AC	60,775	83	468	9.7	612.4	612.4	612.6	0.2
AD	61,725	124	557	8.2	619.7	619.7	619.7	0.0
AE	62,675	155	473	9.6	631.3	631.3	631.3	0.0

[1] Feet above confluence with Arroyo De La Laguna & Alamo Canal
[2] Overbank velocity excessive
[3] Floodway stays outside of main channel

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

ARROYO MOCHO

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Arroyo Seco								
A[1]	7,332[2]	5	311	7.0	530.7	530.7	530.7	0.0
B[1]	8,667[2]	65	199	6.9	540.7	540.7	540.7	0.0
C[1]	9,700[2]	44	167	8.3	544.3	544.3	544.3	0.0
Castro Valley Creek (Line I)								
A	350[3]	*	*	*	*	*	*	*
B	1,290[3]	*	*	*	*	*	*	*
C	3,962[3]	*	*	*	*	*	*	*
Cayetano Creek								
A	5,670[2]	89	145	6.6	482.0	482.0	482.0	0.0
B	9,000[2]	89	217	4.4	508.0	508.0	509.0	1.0[6]
C	14,800[2]	44	152	6.3	540.6	540.6	541.4	0.8[6]
D	16,551[2]	40	197	4.8	559.5	559.5	560.2	0.7
E	17,650[2]	239	570	1.7	564.2	564.2	565.2	1.0[6]
F	21,500[2]	152	100	2.4	588.0	588.0	588.1	0.1[6]
Cayetano Creek (West Branch)								
A	2,000[4]	118	59	4.1	605.9	605.9	605.9	0.0[7]
Chabot Creek (Line G)								
A	228[5]	*	*	*	*	*	*	*
B	2,626[5]	*	*	*	*	*	*	*
C	4,084[5]	*	*	*	*	*	*	*
D	6,028[5]	*	*	*	*	*	*	*
E	7,449[5]	*	*	*	*	*	*	*
F	8,675[5]	*	*	*	*	*	*	*

[1] Floodway contained in channel (cross sections not shown on map)
[2] Feet above confluence with Arroyo Las Positas
[3] Feet above confluence with Chabot Creek (Line G)
[4] Feet above mouth
[5] Feet above confluence with San Lorenzo Creek (Line B Zone 2)
[6] Floodway stays outside main channel
[7] Floodway is confined to main channel
* Data not available

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

ARROYO SECO – CASTRO VALLEY CREEK (LINE I) – CAYETANO CREEK – CAYETANO CREEK (WEST BRANCH) – CHABOT CREEK (LINE G)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Line A (Zone 4)								
A	64[1]	37	162	5.1	11.5	11.5	11.5	0.0
B	1,020[1]	28	104	9.8	13.4	13.4	14.4	1.0
C	3,00[1]	31	165	5.1	21.2	21.2	21.2	0.0
D	4,299[1]	36	144	5.9	23.4	23.4	23.4	0.0
E	7,818[1]	28	136	6.2	35.4	35.4	35.5	0.1
Line A-2 (Zone 3A)								
A	300[1]	81	451	1.6	12.0	12.0	12.0	0.0
B	2,000[1]	79	447	1.7	12.0	12.0	12.0	0.0
C	4,900[1]	32	146	1.1	12.3	12.3	12.7	0.4
D	5,550[1]	16	80	2.0	12.4	12.4	12.9	0.5
Line B-2-1								
A	175[2]	62	211	8.7	308.3	308.3	309.2	0.9
B*								
C	2,000[2]	48	287	6.4	312.3	312.3	313.3	1.0
D	2,700[2]	49	251	6.0	312.9	312.9	313.7	0.8
E*								
F*								

[1] Feet above mouth
[2] Feet above confluence with Arroyo De La Laguna
* Floodway contained in channel

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
ALAMEDA COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

LINE A (ZONE 4) – LINE A-2 (ZONE 3A) – LINE B-2-1

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Line C (Zone 3A)								
A	500[1]	19	62	10.3	55.0	55.0	55.0	0.0
B	728[1]	22	83	7.8	55.7	55.7	55.8	0.1
C	1,516[1]	22	105	6.1	69.1	69.1	69.1	0.0
D	2,395[1]	16	59	10.9	82.1	82.1	82.1	0.0
Line D								
A	1,700[1]	34	344	2.73	12.4	12.4	13.4	1.0
B	2,512[1]	52	324	2.90	12.6	12.6	13.6	1.0
C	2,665[1]	88	418	2.34	14.6	14.6	15.6	1.0
D	2,675[1]	88	418	2.34	14.6	14.6	15.6	1.0
E	4,515[1]	30	120	8.17	17.5	17.5	17.5	0.0
F	5,275[1]	30	117	8.67	19.8	19.8	20.1	0.3
G	5,900[1]	30	119	8.24	22.3	22.3	22.3	0.0
H	6,650[1]	34	137	7.15	24.8	24.8	24.8	0.0
I	7,200[1]	17	111	8.83	27.0	27.0	27.0	0.0
J	7,900[1]	40	205	4.78	28.9	28.9	28.9	0.0
K	8,900[1]	37	169	5.80	29.9	29.9	29.9	0.0
Line D (Zone 6) (Aqua Fria Creek)								
A	4,845[2]	10	75	8.0	43.5	43.5	43.5	0.0
B	5,174[2]	20	155	3.5	50.7	50.7	51.6	0.9

[1] Feet above mouth
[2] Feet above confluence with Line C (Zone 6)

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

LINE C (ZONE 3A) - LINE D - LINE D (ZONE 6) (AQUA FRIA CREEK)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Line E (Zone 3A)								
A	100[1]	57	128	7.1	49.8	48.8[3]	49.8	1.0
B	1,373[1]	24	83	11.0	51.8	51.8	51.8	0.0
C	2,400[1]	50	129	7.1	60.0	60.0	60.3	0.3
D	2,750[1]	50	125	7.3	61.8	61.8	62.1	0.3
E	3,165[1]	50	127	7.2	65.1	65.1	65.7	0.6
F	4,023[1]	50	119	7.6	70.1	70.1	70.9	0.8
G	4,712[1]	36	90	10.1	74.5	74.5	74.5	0.0
Line E (Sausal Creek)								
A	16,440[1]	38	204	6.4	213.2	213.2	213.7	0.5
Line F (Peralta Creek)								
A	10,150[1]	100	325	3.1	60.4	60.4	60.4	0.0
B	13,820[1]	24	118	4.5	101.7	101.7	101.7	0.0
C	17,640[1]	92	97	5.5	165.8	165.8	166.1	0.3
D	19,280[1]	38	126	4.2	201.6	201.6	201.6	0.0
Line G (Zone 6)								
A	6,004[2]	55	428	2.2	28.4	28.4	28.4	0.0
B	7,000[2]	50	357	2.7	28.6	28.6	28.7	0.1

[1] Feet above mouth
[2] Feet above confluence with Line E (Zone 6)
[3] Elevation Computed Without Consideration of Backwater Effects from Ward Creek – Line B (Zone 3A)

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

LINE E (ZONE 3A) - LINE E (SAUSAL CREEK) - LINE F (PERALTA CREEK) - LINE G (ZONE 6)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Line H								
A- B	*	*	*	*	*	*	*	*
C	2,800[1]	70	428	1.43	12.8	12.8	13.8	1.0
D	3,200[1]	475	708	0.85	13.0	13.0	13.8	0.8
E	3,600[1]	38	226	2.70	13.1	13.1	13.8	0.7
F	4,270[1]	14	81	7.53	13.4	13.4	13.4	0.0
G	4,500[1]	38	223	2.73	13.6	13.6	14.1	0.5
H	5,135[1]	26	191	2.83	17.9	17.9	18.1	0.2
I	6,000[1]	38	227	1.35	18.0	18.0	18.2	0.2
J	6,542[1]	40	154	2.00	18.1	18.1	18.2	0.1
K	7,550[1]	47	175	1.75	18.1	18.1	18.2	0.1
L	8,750[1]	32	139	2.21	18.1	18.1	18.3	0.2
Line I (Seminary	2,264[2]	45	228	3.2	10.0	10.0	10.0	0.0
Avenue Drain)	7,600[2]	24	110	3.4	43.0	43.0	43.5	0.5
A								
B								
Line J (Zone 6) (Canada Del Aliso)								
A	5,220[3]	16	36	8.3	76.5	76.5	76.5	0.0
B	7,140[3]	33	87	3.4	139.6	139.6	140.1	0.5
C	9,300[3]	20	32	6.2	191.7	191.7	191.8	0.1

[1] Feet above mouth
[2] Feet above confluence with Line F (Peralta Creek)
[3] Feet above confluence with Line E (Zone 6)
[4] Floodway contained in culvert (cross sections not shown on map)
* Data not available

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

LINE H – LINE I (SEMINARY AVENUE DRAIN) – LINE J (ZONE 6) (CANADA DEL ALIZO)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Line K (Arroyo Viejo Creek)								
A	16,845[1]	42	291	6.9	72.2	72.2	73.2	1.0
Line K (Zone 5) (Crandall Creek)								
A	7,610[2]	54	322	3.7	14.6	14.6	14.6	0.0
B	8,270[2]	142	669	1.9	14.8	14.8	14.9	0.1
C	9,303[2]	102	578	2.1	15.0	15.0	15.0	0.0
D	9,728[2]	100	560	2.1	15.1	15.1	15.1	0.0
E	10,485[2]	78	395	3.0	15.2	15.2	15.2	0.0
F	11,257[2]	84	400	3.0	15.5	15.5	15.5	0.0
G	11,900[2]	99	516	2.3	15.8	15.8	15.8	0.0
H	12,857[2]	100	558	2.2	16.7	16.7	16.7	0.0
Line L (Zone 6)								
A	16,700[3]	102	207	4.0	306.9	306.9	306.9	0.0
Line N (Stonehurst								
A	357[4]	22	172	3.8	19.8	19.8	20.8	1.0
B	1,612[4]	31	161	2.9	21.5	21.5	22.5	1.0

[1] Feet above mouth
[2] Feet above confluence with Alameda County Flood Control Channel
[3] Feet above confluence with Line E (Zone 6)
[4] Feet above confluence with Line P (San Leandro Creek)

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

LINE K (ARROYO VIEJO CREEK) – LINE K (ZONE 5) (CRANDALL CREEK) – LINE L (ZONE 6) (MISSION CREEK) – LINE N (STONEHURST CREEK)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Line P (San Leandro Creek)								
A	8,098	95	522	5.4	15.2	15.2	15.7	0.5
B	9,445	177	1,024	2.7	19.1	19.1	20.1	1.0
C	10,100	481	1,060	2.6	19.9	19.9	20.9	1.0
D	10,900	79	681	4.1	26.0	26.0	26.6	0.6
E	11,900	77	709	4.0	28.5	28.5	29.2	0.7
F	13,888	54	521	5.4	33.2	33.2	34.0	0.8
G	14,392	135	1,048	2.7	35.2	35.2	35.6	0.4
H	15,500	69	652	4.3	39.7	39.7	39.9	0.2
I	16,350	43	322	8.7	41.6	41.6	41.8	0.2
J	16,760	68	977	2.9	44.7	44.7	44.9	0.2
K	18,000	76	1,033	2.7	45.5	45.5	46.5	1.0
L	19,250	65	830	3.4	46.3	46.3	47.2	0.9
M	20,300	61	686	4.1	47.2	47.2	47.9	0.7
N	21,580	67	600	4.7	49.0	49.0	49.5	0.5
O	22,347	65	463	6.1	53.3	53.3	54.3	1.0
P	23,500	54	517	5.4	57.4	57.4	57.6	0.2
Q	24,500	55	559	5.0	59.4	59.4	59.5	0.1

[1] Feet above mouth

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

LINE P (SAN LEANDRO CREEK)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
San Leandro-Line B (Zone 9)								
A	18	28	125	3.0	12.1	12.1	13.1	1.0
B	800	16	41	9.1	14.6	14.6	14.6	0.0
C	1,400	16	41	9.1	16.8	16.8	16.8	0.0
D	2,223	16	41	9.1	19.9	19.9	19.9	0.0
E	2,975	16	50	7.4	21.5	21.5	21.5	0.0
F	3,746	18	47	7.9	22.7	22.7	22.7	0.0
San Leandro-Line C (Zone 9)								
A	32	500	1,154	0.6	11.8	11.8	12.8	1.0
B	694	29	142	4.6	11.8	11.8	12.7	0.9
C	774	27	139	4.7	12.1	12.1	13.0	0.9
D	1,531	25	82	8.0	12.2	12.2	12.8	0.6
E	2,375	21	76	8.6	15.0	15.0	15.0	0.0
F	3,000	19	69	8.1	16.6	16.6	16.6	0.0
G	3,675	18	66	8.5	17.3	17.3	17.3	0.0
H	4,146	17	64	7.4	18.9	18.9	18.9	0.0
I	4,383	15	47	10.2	19.9	19.9	19.9	0.0
J	5,353	17	50	9.7	22.4	22.4	22.4	0.0

[1] Feet above confluence with San Leandro-Line D (Zone 9)

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

FLOODWAY DATA

SAN LEANDRO-LINE B (ZONE 9) - SAN LEANDRO-LINE C (ZONE 9)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
San Leandro-Line D (Zone 9)								
A[2]								
B	300	62	393	3.7	11.3	10.8[3]	11.7	0.9
C	900	61	372	3.9	11.3	10.9[3]	11.8	0.9
D	1,382	60	379	3.6	11.7	11.7	12.5	0.8
E	2,516	32	207	3.3	11.9	11.9	12.6	0.7
F	2,900	32	201	3.4	11.9	11.9	12.7	0.8
G	3,500	34	193	3.5	12.0	12.0	12.7	0.7
H	4,416	39	165	4.1	12.1	12.1	12.8	0.7

[1] Feet above confluence with San Leandro-Line D (Zone 9)
[2] Cross section not included
[3] Elevation computed without consideration of backwater effects from San Leandro Creek – Line A (Zone 2)

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
ALAMEDA COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

SAN LEANDRO-LINE D (ZONE 9)

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NAVD 88)	WITHOUT FLOODWAY (FEET NAVD 88)	WITH FLOODWAY (FEET NAVD 88)	INCREASE (FEET)
Strawberry Creek								
A	12,010	30	52	16.3	200.9	200.9	201.0	0.1
B	12,480	40	102	12.0	217.6	217.6	218.0	0.4
C	13,010	23	65	9.1	227.0	227.0	227.4	0.4
D	13,450	35	51	11.6	238.9	238.9	238.9	0.0
E	14,000	11	35	16.9	257.7	257.7	258.7	1.0
F	14,490	9	39	15.1	273.0	273.0	273.1	0.1
G	14,990	11	39	15.1	285.2	285.2	286.2	1.0
H	15,510	14	49	12.0	300.6	300.6	301.0	0.4
I	15,990	5	19	31.1	313.4	313.4	314.4	1.0
J	16,260	15	74	8.0	329.9	329.9	330.0	0.1
Tassajara Creek								
A-F*								
G	7,965[2]	80	668	6.4	353.2	353.2	354.1	0.9
H	11,000[2]	60	388	11.1	366.9	366.9	366.9	0.0
I	11,398[2]	33	385	11.2	372.3	372.3	372.7	0.4
J	12,105[2]	70	497	8.7	379.1	379.1	379.9	0.8
Ward Creek – Line B (Zone 3A)								
A-R	*	*	*	*	*	*	*	*
S	14,105	22	89	11.4	51.4	51.4	51.5	0.1
T	15,135	24	89	11.4	55.4	55.4	55.4	0.0
U	16,547	38	136	7.4	58.9	58.9	58.9	0.0
V	17,786	28	140	7.2	68.4	68.4	69.1	0.7
W	18,757	39	114	8.9	82.1	82.1	82.2	0.1

[1] Feet above mouth
[2] Feet above confluence with Arroyo Mocho
* Data not available

TABLE 8

FEDERAL EMERGENCY MANAGEMENT AGENCY
ALAMEDA COUNTY, CA
AND INCORPORATED AREAS

FLOODWAY DATA

STRAWBERRY CREEK – TASSAJARA CREEK – WARD CREEK-LINE B (ZONE 3A)

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.

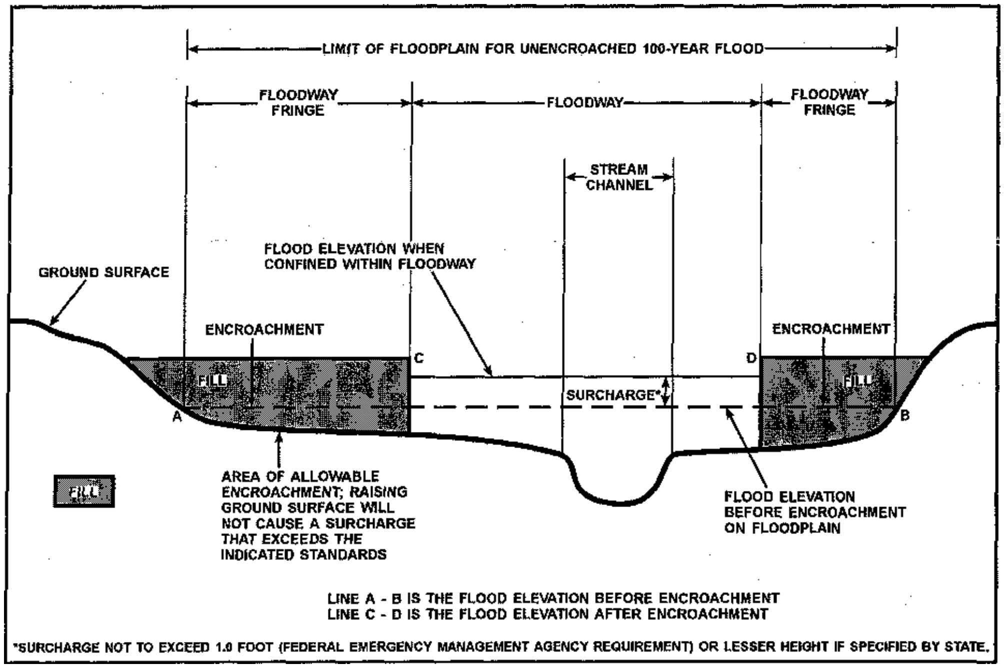

Figure 1. Floodway Schematic

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 Alameda 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 FLRM 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 9, "Community Map History."

7.0 OTHER STUDIES

FISs have been completed for the Cities of Livermore (U.S. Department of Housing and Urban Development, 1977), Pleasanton (FEMA, 1982), Fremont (FEMA, 1983), Hayward (FEMA, 1981), Oakland (FEMA, 1982), Berkeley (U.S. Department of Housing and Urban Development, 1978), Union City (U.S. Department of Housing and Urban Development, 1978), Dublin (FEMA, 1983), Alameda (Federal Insurance Administration, 1978), Newark (U.S. Department of Housing and Urban Development, in progress), San Leandro (U.S. Department of Housing and Urban Development, in progress), the unincorporated areas of Alameda County (FEMA, 1981). A FIS has also been prepared for the City of El Cerrito in Contra Costa County by the U.S. Soil Conservation Service (U.S. Department of Housing and Urban Development, 1977).

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Alameda 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 Alameda County.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Alameda County (Unincorporated Areas)	November 1, 1974	None	April 15, 1981	February 19, 1986 December 17, 1987 September 17, 1997 February 9, 2000
Alameda, City of	May 24, 1974	None	August 1, 1978	July 16, 1991
Albany, City of	November 19, 1976	None	February 1, 1980	None
Berkeley, City of	December 7, 1973	None	September 1, 1978	None
Dublin, City of	November 1, 1974	None	August 18, 1983	September 17, 1997
Emeryville, City of[1]	N/A	None	None	None
Fremont, City of	February 14, 1975	June 21, 1977	May 2, 1983	July 16, 1987 February 9, 2000
Hayward, City of	February 14, 1975	February 4, 1977	September 30, 1980	September 16, 1981 February 19, 1986 February 9, 2000

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA

AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Livermore, City of	August 13, 1976	None	July 5, 1977	July 3, 1990
Newark, City of	February 22, 1974	January 16, 1976	December 1, 1978	January 3, 1983 July 16, 1987 September 30, 1988 February 9, 2000
Oakland, City of	January 3, 1975	February 9, 1982	September 30, 1982	None
Piedmont, City of[1,2]	N/A	None	N/A	None
Pleasanton, City of	June 28, 1974	October 29, 1976	December 16, 1980	August 31, 1982 September 19, 1984 September 30, 1997
San Leandro, City of	June 7, 1974	September 3, 1976	March 18, 1980	February 9, 2000
Union City, City of	July 11, 1975	None	December 1, 1978	August 17, 1982 February 9, 2000

[1]This community does not have map history prior to first countywide mapping.
[2]No Special Flood Hazards Identified.

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

ALAMEDA COUNTY, CA
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY