FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 3

SANTA CRUZ COUNTY, CALIFORNIA

AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
CAPITOLA, CITY OF	060354
SANTA CRUZ, CITY OF	060355
SANTA CRUZ COUNTY UNINCORPORATED AREAS	060353
SCOTTS VALLEY, CITY OF	060356
WATSONVILLE, CITY OF	060357

FEMA

REVISED PRELIMINARY

OCT 31, 2016

REVISED:

FLOOD INSURANCE STUDY NUMBER
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TABLE OF CONTENTS
Volume 1

Figures

Page

Tables

Page

TABLE OF CONTENTS
Volume 2

Tables

Volume 2
<u>Exhibits</u>

Volume 3
<u>Exhibits</u>

Published Separately

FLOOD INSURANCE STUDY REPORT
SANTA CRUZ COUNTY, CALIFORNIA

SECTION 1.0 – INTRODUCTION

1.1 The National Flood Insurance Program

The National Flood Insurance Program (NFIP) is a voluntary Federal program that enables property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their contents caused by floods.

For decades, the national response to flood disasters was generally limited to constructing flood-control works such as dams, levees, sea-walls, and the like, and providing disaster relief to flood victims. This approach did not reduce losses nor did it discourage unwise development. In some instances, it may have actually encouraged additional development. To compound the problem, the public generally could not buy flood coverage from insurance companies, and building techniques to reduce flood damage were often overlooked.

In the face of mounting flood losses and escalating costs of disaster relief to the general taxpayers, the U.S. Congress created the NFIP. The intent was to reduce future flood damage through community floodplain management ordinances, and provide protection for property owners against potential losses through an insurance mechanism that requires a premium to be paid for the protection.

The U.S. Congress established the NFIP on August 1, 1968, with the passage of the National Flood Insurance Act of 1968. The NFIP was broadened and modified with the passage of the Flood Disaster Protection Act of 1973 and other legislative measures. It was further modified by the National Flood Insurance Reform Act of 1994 and the Flood Insurance Reform Act of 2004. The NFIP is administered by the Federal Emergency Management Agency (FEMA), which is a component of the Department of Homeland Security (DHS).

Participation in the NFIP is based on an agreement between local communities and the Federal Government. If a community adopts and enforces floodplain management regulations to reduce future flood risks to new construction and substantially improved structures in Special Flood Hazard Areas (SFHAs), the Federal Government will make flood insurance available within the community as a financial protection against flood losses. The community's floodplain management regulations must meet or exceed criteria established in accordance with Title 44 Code of Federal Regulations (CFR) Part 60.3, *Criteria for land Management and Use*.

SFHAs are delineated on the community's Flood Insurance Rate Maps (FIRMs). Under the NFIP, buildings that were built before the flood hazard was identified on the community's FIRMs are generally referred to as "Pre-FIRM" buildings. When the NFIP was created, the U.S. Congress recognized that insurance for Pre-FIRM buildings would be prohibitively expensive if the premiums were not subsidized by the Federal Government. Congress also recognized that most of these floodprone buildings were built by individuals who did not have sufficient knowledge of the flood hazard to make informed decisions. The NFIP requires that full actuarial rates reflecting the complete flood risk be charged on all buildings constructed or substantially improved on or after the effective date of the initial FIRM for the community or after December 31, 1974, whichever is later. These buildings are generally referred to as "Post-FIRM" buildings.

1.2 Purpose of this Flood Insurance Study Report

This Flood Insurance Study (FIS) report revises and updates information on the existence and severity of flood hazards for the study area. The studies described in this report developed flood hazard data that will be used to establish actuarial flood insurance rates and to assist communities in efforts to implement sound floodplain management.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive than the minimum Federal requirements. Contact your State NFIP Coordinator to ensure that any higher State standards are included in the community's regulations.

1.3 Jurisdictions Included in the Flood Insurance Study Project

This FIS Report covers the entire geographic area of Santa Cruz County, California.

The jurisdictions that are included in this project area, along with the Community Identification Number (CID) for each community and the 8-digit Hydrologic Unit Codes (HUC-8) sub-basins affecting each, are shown in Table 1. The Flood Insurance Rate Map (FIRM) panel numbers that affect each community are listed. If the flood hazard data for the community is not included in this FIS Report, the location of that data is identified.

Table 1: Listing of NFIP Jurisdictions

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Capitola, City Of	060354	18060015	06087C0351E 06087C0352F 06087C0353F 06087C0354F 06087C0356F	
Santa Cruz, City Of	060355	18050006, 18060015	06087C0219E 06087C0238E 06087C0327E[1] 06087C0329F 06087C0331E 06087C0332E 06087C0333F 06087C0334F 06087C0351E	
Santa Cruz County, Unincorporated Areas	060353	18050003, 18050006, 18060002, 18060015	06087C0025E[1] 06087C0050E[1] 06087C0075E[1] 06087C0080E[1]	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Santa Cruz County, Unincorporated Areas	060353	18050003, 18050006, 18060002, 18060015	06087C0082E[1] 06087C0083E[1] 06087C0084E 06087C0090E[1] 06087C0092E 06087C0094E 06087C0095E 06087C0105E[1] 06087C0110E[1] 06087C0113E 06087C0115E 06087C0120E 06087C0150E[1] 06087C0156F 06087C0157F 06087C0159F 06087C0167F 06087C0180E 06087C0185E[1] 06087C0186F 06087C0187F 06087C0188F 06087C0189F 06087C0193F 06087C0195F 06087C0201E 06087C0202E 06087C0203E 06087C0204E 06087C0206E 06087C0207E 06087C0208E 06087C0209E 06087C0211E[1] 06087C0212E 06087C0213E[1] 06087C0214E[1] 06087C0216E 06087C0217E 06087C0218E 06087C0219E	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Santa Cruz County Unincorporated Areas, continued	060353	18050003, 18050006, 18060002, 18060015	06087C0226E[1] 06087C0227E[1] 06087C0228E 06087C0229E[1] 06087C0235E 06087C0236E 06087C0237E 06087C0238E 06087C0239E 06087C0245E 06087C0275E 06087C0300E[1] 06087C0306F 06087C0307F 06087C0309F 06087C0326F 06087C0327E[1] 06087C0328F 06087C0329F 06087C0331E 06087C0332E 06087C0334F 06087C0351E 06087C0352F 06087C0353F 06087C0354F 06087C0356F 06087C0357F 06087C0358F 06087C0359F 06087C0378F 06087C0380F 06087C0381E 06087C0382E 06087C0383E 06087C0384E 06087C0386F 06087C0387F[1] 06087C0388F 06087C0389F 06087C0391E	

Community	CID	HUC-8 Sub-Basin(s)	Located on FIRM Panel(s)	If Not Included, Location of Flood Hazard Data
Santa Cruz County, Unincorporated Areas	060353	18050003, 18050006, 18060002, 18060015	06087C0392E 06087C0393E 06087C0394E 06087C0403E 06087C0405E 06087C0410E[1] 06087C0411E 06087C0412E 06087C0416E 06087C0417E 06087C0418E 06087C0419E 06087C0430E[1] 06087C0440E 06087C0452F 06087C0456F	
Scotts Valley, City Of	060356	18060015	06087C0209E 06087C0216E 06087C0217E 06087C0218E 06087C0219E 06087C0228E 06087C0236E	
Watsonville, City Of	060357	18060002	06087C0275E 06087C0381E 06087C0383E 06087C0384E 06087C0387F[1] 06087C0391E 06087C0392E 06087C0393E 06087C0394E 06087C0411E 06087C0413E	

[1]Panel Not Printed

1.4 Considerations for using this Flood Insurance Study Report

The NFIP encourages State and local governments to implement sound floodplain management programs. To assist in this endeavor, each FIS Report provides floodplain data, which may include a combination of the following: 10-, 4-, 2-, 1-, and 0.2-percent annual chance flood elevations (the 1% annual chance flood elevation is also referred to as the Base Flood Elevation

(BFE)); delineations of the 1% annual chance and 0.2% annual chance floodplains; and 1% annual chance floodway. This information is presented on the FIRM and/or in many components of the FIS Report, including Flood Profiles, Floodway Data tables, Summary of Non-Coastal Stillwater Elevations tables, and Coastal Transect Parameters tables (not all components may be provided for a specific FIS).

This section presents important considerations for using the information contained in this FIS Report and the FIRM, including changes in format and content. Figures 1, 2, and 3 present information that applies to using the FIRM with the FIS Report.

- Part or all of this FIS Report may be revised and republished at any time. In addition, part of this FIS Report may be revised by a Letter of Map Revision (LOMR), which does not involve republication or redistribution of the FIS Report. Refer to Section 6.5 of this FIS Report for information about the process to revise the FIS Report and/or FIRM.

  It is, therefore, the responsibility of the user to consult with community officials by contacting the community repository to obtain the most current FIS Report components. Communities participating in the NFIP have established repositories of flood hazard data for floodplain management and flood insurance purposes. Community map repository addresses are provided in Table 31, “Map Repositories,” within this FIS Report.

- New FIS Reports are frequently developed for multiple communities, such as entire counties. A countywide FIS Report incorporates previous FIS Reports for individual communities and the unincorporated area of the county (if not jurisdictional) into a single document and supersedes those documents for the purposes of the NFIP.

  The initial Countywide FIS Report for Santa Cruz County became effective on March 2, 2006. Refer to Table 28 for information about subsequent revisions to the FIRMs.

- FEMA does not impose floodplain management requirements or special insurance ratings based on Limit of Moderate Wave Action (LiMWA) delineations at this time. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. If the LiMWA is shown on the FIRM, it is being provided by FEMA as information only. For communities that do adopt Zone VE building standards in the area defined by the LiMWA, additional Community Rating System (CRS) credits are available. Refer to Section 2.5.4 for additional information about the LiMWA.

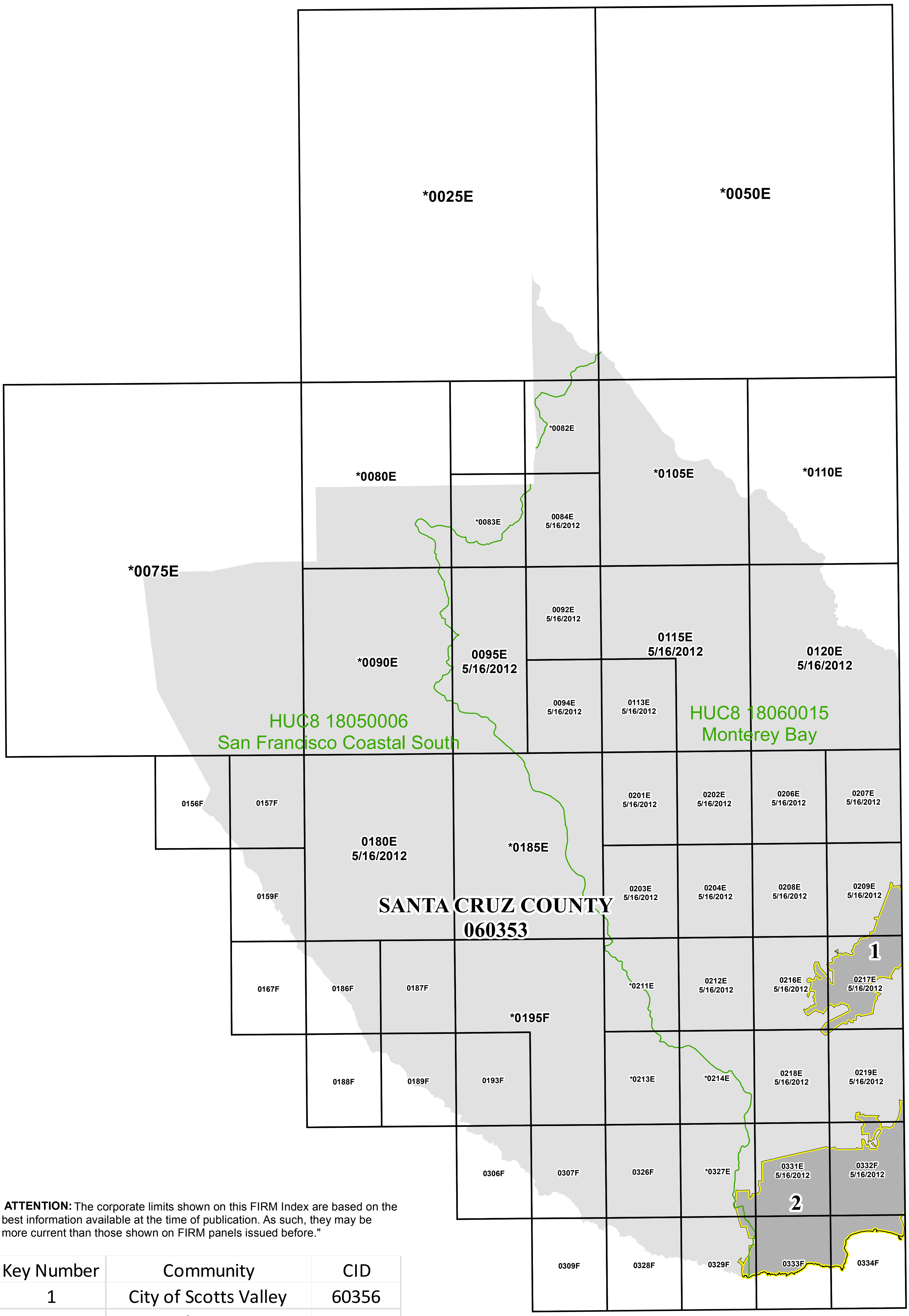
  The CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Visit the FEMA Web site at www.fema.gov/national-flood-insurance-program-community-rating-system or contact your appropriate FEMA Regional Office for more information about this program.

- Previous FIS Reports and FIRMs may have included levees that were accredited as reducing the risk associated with the 1% annual chance flood based on the information available and the mapping standards of the NFIP at that time. For FEMA to continue to accredit the identified levees, 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.”

Since the status of levees is subject to change at any time, the user should contact the appropriate agency for the latest information regarding levees presented in Table 9 of this FIS Report. For levees owned or operated by the U.S. Army Corps of Engineers (USACE), information may be obtained from the USACE national levee database (nld.usace.army.mil). For all other levees, the user is encouraged to contact the appropriate local community.

- FEMA has developed a *Guide to Flood Maps* (FEMA 258) and online tutorials to assist users in accessing the information contained on the FIRM. These include how to read panels and step-by-step instructions to obtain specific information. To obtain this guide and other assistance in using the FIRM, visit the FEMA Web site at www.fema.gov/online-tutorials.

The FIRM Index in Figure 1 shows the overall FIRM panel layout within Santa Cruz County, and also displays the panel number and effective date for each FIRM panel in the county. Other information shown on the FIRM Index includes community boundaries, flooding sources, watershed boundaries, and United States Geological Survey (USGS) Hydrologic Unit Code-8 (HUC-8) codes.



ATTENTION: The corporate limits shown on this FIRM Index are based on the best information available at the time of publication. As such, they may be more current than those shown on FIRM panels issued before."

Key Number	Community	CID
1	City of Scotts Valley	60356
2	City of Santa Cruz	60355

N

1 inch = 12,500 feet 1:150,000

0 3,500 7,000 14,000 21,000 28,000 feet

Map Projection:
Universal Transverse Mercator Zone 10 North;
North American Datum 1983

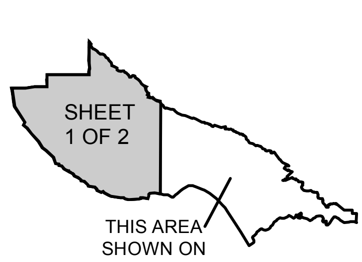
THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTP://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

* PANEL NOT PRINTED - NO SPECIAL FLOOD HAZARD AREAS

SANTA CRUZ COUNTY, CA
INDEX LOCATOR DIAGRAM



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX

SANTA CRUZ COUNTY, CALIFORNIA and Incorporated Areas

PANELS PRINTED:

0084, 0092, 0094, 0095, 0113, 0115, 0120, 0156, 0157, 0159, 0167, 0180, 0186, 0187, 0188, 0189, 0193, 0201, 0202, 0203, 0204, 0206, 0207, 0208, 0209, 0212, 0216, 0217, 0218, 0219, 0228, 0235, 0236, 0237, 0238, 0239, 0245, 0275, 0306, 0307, 0309, 0326, 0328, 0329, 0331, 0332, 0333, 0334, 0351, 0352, 0353, 0354, 0356, 0357, 0358, 0359, 0378, 0380, 0381, 0382, 0383, 0384, 0386, 0388, 0389, 0391, 0392, 0393, 0394, 0403, 0405, 0411, 0412, 0413, 0416, 0417, 0418, 0419, 0440, 0452, 0456

U.S. DEPARTMENT OF HOMELAND SECURITY

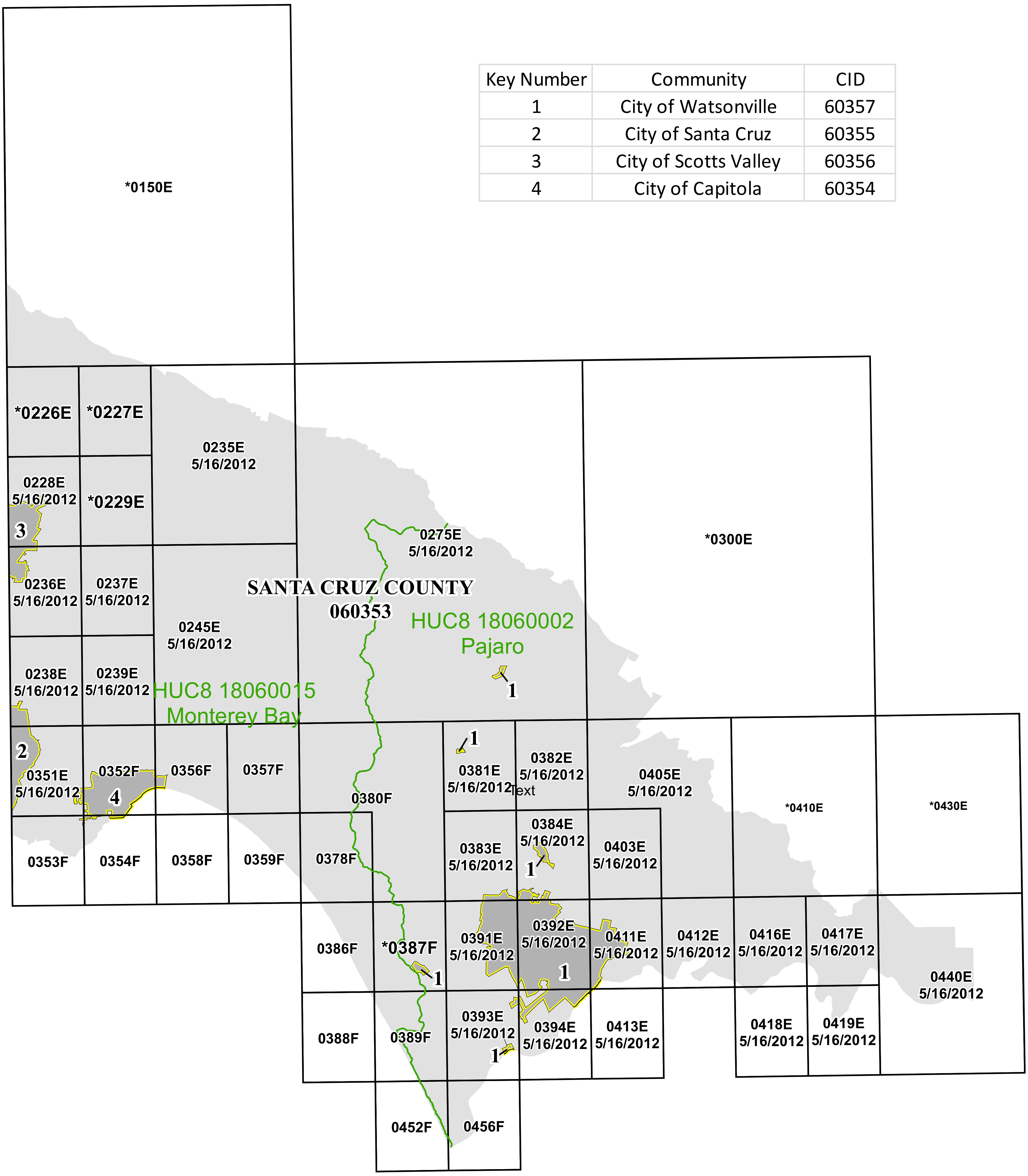
FEMA

PRELIMINARY

MAP NUMBER
06087CIND1

MAP REVISED

Key Number	Community	CID
1	City of Watsonville	60357
2	City of Santa Cruz	60355
3	City of Scotts Valley	60356
4	City of Capitola	60354



ATTENTION: The corporate limits shown on this FIRM Index are based on the best information available at the time of publication. As such, they may be more current than those shown on FIRM panels issued before."

N

1 inch = 13,308 feet 1:159,693

0 3,750 7,500 15,000 22,500 30,000 feet

Map Projection:
Universal Transverse Mercator Zone 10 North;
North American Datum 1983

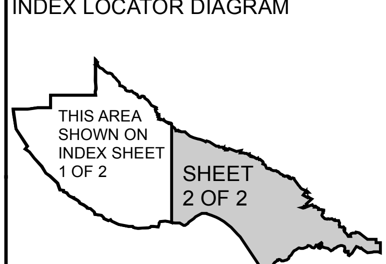
THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT

HTTP://MSC.FEMA.GOV

SEE FLOOD INSURANCE STUDY FOR ADDITIONAL INFORMATION

* PANEL NOT PRINTED - NO SPECIAL FLOOD HAZARD AREAS

SANTA CRUZ COUNTY, CA
INDEX LOCATOR DIAGRAM



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX

SANTA CRUZ COUNTY, CALIFORNIA and Incorporated Areas

PANELS PRINTED:

0084, 0092, 0094, 0095, 0113, 0115, 0120, 0156, 0157, 0159, 0167, 0180, 0186, 0187, 0188, 0189, 0193, 0201, 0202, 0203, 0204, 0206, 0207, 0208, 0209, 0212, 0216, 0217, 0218, 0219, 0228, 0235, 0236, 0237, 0238, 0239, 0245, 0275, 0306, 0307, 0309, 0326, 0328, 0329, 0331, 0332, 0333, 0334, 0351, 0352, 0353, 0354, 0356, 0357, 0358, 0359, 0378, 0380, 0381, 0382, 0383, 0384, 0386, 0388, 0389, 0391, 0392, 0393, 0394, 0403, 0405, 0411, 0412, 0413, 0416, 0417, 0418, 0419, 0440, 0452, 0456

FEMA

PRELIMINARY

MAP NUMBER
06087CIND2B

MAP REVISED

Each FIRM panel may contain specific notes to the user that provide additional information regarding the flood hazard data shown on that map. However, the FIRM panel does not contain enough space to show all the notes that may be relevant in helping to better understand the information on the panel. Figure 2 contains the full list of these notes.

Figure 2: FIRM Notes to Users

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products, or the National Flood Insurance Program in general, please call the FEMA Flood Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Flood Map Service Center website or by calling the FEMA Map Information eXchange.

Communities annexing land on adjacent FIRM panels must obtain a current copy of the adjacent panel as well as the current FIRM Index. These may be ordered directly from the Flood Map Service Center at the number listed above.

For community and countywide map dates, refer to Table 28 in this FIS Report.

To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

PRELIMINARY FIS REPORT: FEMA maintains information about map features, such as street locations and names, in or near designated flood hazard areas. Requests to revise information in or near designated flood hazard areas may be provided to FEMA during the community review period, at the final Consultation Coordination Officer's meeting, or during the statutory 90-day appeal period. Approved requests for changes will be shown on the final printed FIRM.

The map is for use in administering the NFIP. It may not identify all areas subject to flooding, particularly from local drainage sources of small size. Consult the community map repository to find updated or additional flood hazard information.

BASE FLOOD ELEVATIONS: For more detailed information in areas where Base Flood Elevations (BFEs) and/or floodways have been determined, consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables within this FIS Report. Use the flood elevation data within the FIS Report in conjunction with the FIRM for construction and/or floodplain management.

Coastal Base Flood Elevations shown on the map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Coastal flood elevations are also provided in the Coastal Transect Parameters table in the FIS Report for this jurisdiction. Elevations shown in the Coastal Transect Parameters table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on the FIRM.

Figure 2. FIRM Notes to Users

<u>FLOODWAY INFORMATION</u>: Boundaries of the floodways were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the FIS Report for this jurisdiction.
<u>FLOOD CONTROL STRUCTURE INFORMATION</u>: Certain areas not in Special Flood Hazard Areas may be protected by flood control structures. Refer to Section 4.3 "Non-Levee Flood Protection Measures" of this FIS Report for information on flood control structures for this jurisdiction.

<u>PROJECTION INFORMATION</u>: The projection used in the preparation of the map was Universal Transverse Mercator (UTM) Zone 10**.** The horizontal datum was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

<u>ELEVATION DATUM</u>: Flood elevations on the FIRM are referenced to the North American Vertical Datum of 1988**.** These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988**,** visit the National Geodetic Survey website at www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

Local vertical monuments may have been used to create the map. To obtain current monument information, please contact the appropriate local community listed in Table 31 of this FIS Report.

<u>BASE MAP INFORMATION</u>: Base map information shown on the FIRM was derived from Coastal California LiDAR and digital imagery dated 2011. USDA NAIP imagery dated 2014 is used in areas not covered by the Coastal California digital imagery. For information about base maps, refer to Section 6.2 “Base Map” in this FIS Report.

The map reflects more detailed and up-to-date stream channel configurations than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map.

Corporate limits shown on the map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after the map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Figure 2. FIRM Notes to Users

NOTES FOR FIRM INDEX REVISIONS TO INDEX: As new studies are performed and FIRM panels are updated within Santa Cruz County, California, corresponding revisions to the FIRM Index will be incorporated within the FIS Report to reflect the effective dates of those panels. Please refer to Table 28 of this FIS Report to determine the most recent FIRM revision date for each community. The most recent FIRM panel effective date will correspond to the most recent index date.
SPECIAL NOTES FOR SPECIFIC FIRM PANELS This Notes to Users section was created specifically for Santa Cruz County, California**,** effective <date>. FLOOD RISK REPORT: A Flood Risk Report (FRR) may be available for many of the flooding sources and communities referenced in this FIS Report. The FRR is provided to increase public awareness of flood risk by helping communities identify the areas within their jurisdictions that have the greatest risks. Although non-regulatory, the information provided within the FRR can assist communities in assessing and evaluating mitigation opportunities to reduce these risks. It can also be used by communities developing or updating flood risk mitigation plans. These plans allow communities to identify and evaluate opportunities to reduce potential loss of life and property. However, the FRR is not intended to be the final authoritative source of all flood risk data for a project area; rather, it should be used with other data sources to paint a comprehensive picture of flood risk.

Each FIRM panel contains an abbreviated legend for the features shown on the maps. However, the FIRM panel does not contain enough space to show the legend for all map features. Figure 3 shows the full legend of all map features. Note that not all of these features may appear on the FIRM panels in Santa Cruz County.

Figure 3: Map Legend for FIRM

SPECIAL FLOOD HAZARD AREAS: *The 1% annual chance flood, also known as the base flood or 100-year flood, has a 1% chance of happening or being exceeded each year. Special Flood Hazard Areas are subject to flooding by the 1% annual chance flood. The Base Flood Elevation is the water surface elevation of the 1% annual chance flood. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. See note for specific types. If the floodway is too narrow to be shown, a note is shown.*

	Special Flood Hazard Areas subject to inundation by the 1% annual chance flood (Zones A, AE, AH, AO, AR, A99, V and VE)
Zone A	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. No base (1% annual chance) flood elevations (BFEs) or depths are shown within this zone.
Zone AE	The flood insurance rate zone that corresponds to the 1% annual chance floodplains. Base flood elevations derived from the hydraulic analyses are shown within this zone, either at cross section locations or as static whole-foot elevations that apply throughout the zone.
Zone AH	The flood insurance rate zone that corresponds to the areas of 1% annual chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the hydraulic analyses are shown at selected intervals within this zone.
Zone AO	The flood insurance rate zone that corresponds to the areas of 1% 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 hydraulic analyses are shown within this zone.
Zone AR	The flood insurance rate zone that corresponds to areas that were formerly protected from the 1% annual chance flood 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% annual chance or greater flood.
Zone A99	The flood insurance rate zone that corresponds to areas of the 1% 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 flood depths are shown within this zone.
Zone V	The flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations are not shown within this zone.
Zone VE	Zone VE is the flood insurance rate zone that corresponds to the 1% annual chance coastal floodplains that have additional hazards associated with storm waves. Base flood elevations derived from the coastal analyses are shown within this zone as static whole-foot elevations that apply throughout the zone.

Figure 3: Map Legend for FIRM

	Regulatory Floodway determined in Zone AE.
OTHER AREAS OF FLOOD HAZARD	
	Shaded Zone X: Areas of 0.2% annual chance flood hazards and areas of 1% annual chance flood hazards with average depths of less than 1 foot or with drainage areas less than 1 square mile.
	Future Conditions 1% Annual Chance Flood Hazard – Zone X: The flood insurance rate zone that corresponds to the 1% annual chance floodplains that are determined based on future-conditions hydrology. No base flood elevations or flood depths are shown within this zone.
	Area with Reduced Flood Risk due to Levee: Areas where an accredited levee, dike, or other flood control structure has reduced the flood risk from the 1% annual chance flood. See Notes to Users for important information.
OTHER AREAS	
	Zone D (Areas of Undetermined Flood Hazard): The flood insurance rate zone that corresponds to unstudied areas where flood hazards are undetermined, but possible.
NO SCREEN	Unshaded Zone X: Areas of minimal flood hazard.
FLOOD HAZARD AND OTHER BOUNDARY LINES	
(ortho) (vector)	Flood Zone Boundary (white line on ortho-photography-based mapping; gray line on vector-based mapping)
	Limit of Study
	Jurisdiction Boundary
	Limit of Moderate Wave Action (LiMWA): Indicates the inland limit of the area affected by waves greater than 1.5 feet
GENERAL STRUCTURES	
Aqueduct Channel Culvert Storm Sewer	Channel, Culvert, Aqueduct, or Storm Sewer
Dam Jetty Weir	Dam, Jetty, Weir

Figure 3: Map Legend for FIRM

	Levee, Dike, or Floodwall accredited or provisionally accredited to reduce the flood risk from the 1% annual chance flood.
	Levee, Dike or Floodwall not accredited to reduce the flood risk from the 1% annual chance flood.
Bridge	Bridge
COASTAL BARRIER RESOURCES SYSTEM (CBRS) AND OTHERWISE PROTECTED AREAS (OPA): *CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas..*	
CBRS AREA 09/30/2009	Coastal Barrier Resources System Area: Labels are shown to clarify where this area shares a boundary with an incorporated area or overlaps with the floodway.
OTHERWISE PROTECTED AREA 09/30/2009	Otherwise Protected Area
REFERENCE MARKERS	
22.0	River mile Markers
CROSS SECTION & TRANSECT INFORMATION	
B 20.2	Lettered Cross Section with Regulatory Water Surface Elevation (BFE)
5280 21.1	Numbered Cross Section with Regulatory Water Surface Elevation (BFE)
17.5	Unlettered Cross Section with Regulatory Water Surface Elevation (BFE)
8	Coastal Transect
	Profile Baseline: Indicates the modeled flow path of a stream and is shown on FIRM panels for all valid studies with profiles or otherwise established base flood elevation.
	Coastal Transect Baseline: Used in the coastal flood hazard model to represent the 0.0-foot elevation contour and the starting point for the transect and the measuring point for the coastal mapping.
513	Base Flood Elevation Line (shown for flooding sources for which no cross sections or profile are available)
ZONE AE (EL 16)	Static Base Flood Elevation value (shown under zone label)

Figure 3: Map Legend for FIRM

ZONE AO (DEPTH 2)	Zone designation with Depth
ZONE AO (DEPTH 2) (VEL 15 FPS)	Zone designation with Depth and Velocity
BASE MAP FEATURES	
Missouri Creek	River, Stream or Other Hydrographic Feature
234	Interstate Highway
234	U.S. Highway
234	State Highway
234	County Highway
MAPLE LANE	Street, Road, Avenue Name, or Private Drive if shown on Flood Profile
RAILROAD	Railroad
	Horizontal Reference Grid Line
	Horizontal Reference Grid Ticks
+	Secondary Grid Crosshairs
Land Grant	Name of Land Grant
7	Section Number
R. 43 W. T. 22 N.	Range, Township Number
$^{42}76^{000m}E$	Horizontal Reference Grid Coordinates (UTM)
365000 FT	Horizontal Reference Grid Coordinates (State Plane)
80° 16’ 52.5”	Corner Coordinates (Latitude, Longitude)

SECTION 2.0 – FLOODPLAIN MANAGEMENT APPLICATIONS

2.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1% annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2% annual chance (500-year) flood is employed to indicate additional areas of flood hazard in the community.

Each flooding source included in the project scope has been studied and mapped using professional engineering and mapping methodologies that were agreed upon by FEMA and Santa Cruz County as appropriate to the risk level. Flood risk is evaluated based on factors such as known flood hazards and projected impact on the built environment. Engineering analyses were performed for each studied flooding source to calculate its 1% annual chance flood elevations; elevations corresponding to other floods (e.g. 10-, 4-, 2-, 0.2-percent annual chance, etc.) may have also been computed for certain flooding sources. Engineering models and methods are described in detail in Section 5.0 of this FIS Report. The modeled elevations at cross sections were used to delineate the floodplain boundaries on the FIRM; between cross sections, the boundaries were interpolated using elevation data from various sources. More information on specific mapping methods is provided in Section 6.0 of this FIS Report.

Depending on the accuracy of available topographic data (Table 23), study methodologies employed (Section 5.0), and flood risk, certain flooding sources may be mapped to show both the 1% and 0.2% annual chance floodplain boundaries, regulatory water surface elevations (BFEs), and/or a regulatory floodway. Similarly, other flooding sources may be mapped to show only the 1% annual chance floodplain boundary on the FIRM, without published water surface elevations. In cases where the 1% and 0.2% annual chance floodplain boundaries are close together, only the 1% annual chance floodplain boundary is shown on the FIRM. Figure 3, "Map Legend for FIRM", describes the flood zones that are used on the FIRMs to account for the varying levels of flood risk that exist along flooding sources within the project area. Table 2 and Table 3 indicate the flood zone designations for each flooding source and each community within Santa Cruz County, California, respectively.

Table 2, "Flooding Sources Included in this FIS Report," lists each flooding source, including its study limits, affected communities, mapped zone on the FIRM, and the completion date of its engineering analysis from which the flood elevations on the FIRM and in the FIS Report were derived. Descriptions and dates for the latest hydrologic and hydraulic analyses of the flooding sources are shown in Table 13. Floodplain boundaries for these flooding sources are shown on the FIRM (published separately) using the symbology described in Figure 3. On the map, the 1% annual chance floodplain corresponds to the SFHAs. The 0.2% annual chance floodplain shows areas that, although out of the regulatory floodplain, are still subject to flood hazards.

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. The procedures to remove these areas from the SFHA are described in Section 6.5 of this FIS Report.

Table 2: Flooding Sources Included in this FIS Report

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Aptos Creek	Santa Cruz County, Unincorporated Areas	Approximately 60 feet upstream of the confluence with the Pacific Ocean	Approximately 1,720 feet upstream of Soquel Drive	18060015	1.0		Y	VE, AE	
Aptos Creek	Santa Cruz County, Unincorporated Areas	Approximately 1,720 feet upstream of Soquel Drive	Approximately 4,410 feet upstream of Soquel Drive	18060015	0.5		N	A	
Arana Gulch	Santa Cruz County, Unincorporated Areas	Approximately 3,000 feet downstream of Capitola Road	Approximately 100 feet upstream of Brookwood Drive	18060015	1.3		Y	AE	
Baldwin Creek	Santa Cruz County, Unincorporated Areas	Confluence with Pacific Ocean	At Coast Road	18050006	0.3		N	A	
Bean Creek	Santa Cruz County, Unincorporated Areas; Scotts Valley, City of	Confluence with Zayante Creek	Approximately 87 feet upstream of Bean Creek Road	18060015	4.2		N	A	
Bear Creek	Santa Cruz County, Unincorporated Areas	Confluence with San Lorenzo River	Approximately 3,400 feet upstream of Amber Ridge Loop	18060015	4.4		N	A	

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Boulder Creek	Santa Cruz County, Unincorporated Areas	Confluence with San Lorenzo River	Approximately 2,720 feet upstream of Big Basin Highway	18060015	5.0		N	A	
Branciforte Creek	Santa Cruz, City of; Santa Cruz County, Unincorporated Areas	Confluence with San Lorenzo River	Approximately 530 feet upstream of Wild Flower Lane	18060015	7.4		N	A, AE	
Browns Creek	Santa Cruz County, Unincorporated Areas	Confluence with Corralitos Creek	Approximately 1,950 feet upstream of Via del Sol	18060002	0.7		N	A	
Carbonera Creek	Scotts Valley, City of	Confluence with Branciforte Creek	Approximately 50 feet upstream of Carbonera Drive	18060015	1.2		Y	AE	
Carbonera Creek	Scotts Valley, City of	Approximately 1,400 feet downstream of State Highway 17	Approximately 6,000 feet upstream of State Highway 17	18060015	4.0		Y	AE	
Carbonera Creek	Scotts Valley, City of	Approximately 50 feet upstream of Carbonera Drive	Approximately 1.25 miles upstream of Carbonera Drive	18060015	1.3		N	A	
Carbonera Creek	Scotts Valley, City of	Approximately 3,950 feet downstream of State Highway 17	Approximately 1,400 feet downstream of State Highway 17	18060015	0.5		N	A	
Carbonera Creek	Scotts Valley, City of	Approximately 1.1 miles upstream of State Highway 17	Approximately 1.2 miles upstream of State Highway 17	18060015	0.04		N	A	

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Carbonera Creek	Scotts Valley, City of	Approximately 1.3 miles upstream of State Highway 17	Approximately 1.5 miles upstream of State Highway 17	18060015	0.1		N	A	
College Lake	Santa Cruz County, Unincorporated Areas	Confluence with Corralitos Creek	Approximately 2,600 feet upstream of Paulsen Road	18060002	0.9		N	AE	
Corralitos Creek	Santa Cruz County, Unincorporated Areas	Lake Avenue	Approximately 3,034 feet upstream of Browns Valley Road	18060002	7.4		Y	AE	
Corralitos Creek	Santa Cruz County, Unincorporated Areas	Confluence of Browns Creek	Approximately 355 feet upstream of confluence of Mormon Gulch	18060002	1.5		N	A	
Coward Creek	Santa Cruz County, Unincorporated Areas	Confluence with the Pajaro River	Approximately 4,450 feet upstream of Riverside Road	18060002	1.0		N	AE	
Drew Lake	Santa Cruz County, Unincorporated Areas	At College Road	Approximately 3,320 feet upstream of College Road	18060002		0.015	N	A	
Gallighan Slough	Santa Cruz County, Unincorporated Areas	Confluence with Harkins Slough	Approximately 2,460 feet upstream of confluence with Harkins Slough	18060002	0.5		N	AE, A	

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Hanson Slough	Santa Cruz County, Unincorporated Areas	Confluence with Watsonville Slough	Approximately 1 mile upstream of confluence with Watsonville Slough	18060002	1.1		N	AE, A	
Hare Creek	Santa Cruz County, Unincorporated Areas	Confluence with Boulder Creek	Approximately 2,974 feet upstream of confluence with Boulder Creek	18060015	0.5		N	A	
Harkins Slough	Santa Cruz County, Unincorporated Areas	Confluence with Watsonville Slough	Approximately 4,500 feet upstream of State Highway 1	18060002	3.5		Y	AE	
Harkins Slough	Santa Cruz County, Unincorporated Areas	Approximately 84 feet upstream of Buena Vista Drive	Approximately 3,530 feet upstream of Dunlap Lane	18060002	2.8		N	A	
Hopkins Gulch	Santa Cruz County, Unincorporated Areas	Confluence with Bear Creek	Approximately 23 feet upstream of Wicket Road	18060015	0.3		N	A	
Kelly Lake	Santa Cruz County, Unincorporated Areas	At College Road	Approximately 4,020 feet upstream of College Road	18060002		0.07	N	A	
Kings Creek	Santa Cruz County, Unincorporated Areas	Confluence with San Lorenzo River	Approximately 4,000 feet upstream of Highway 9	18060015	0.8		N	A	

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Laguna Creek	Santa Cruz County, Unincorporated Areas	Confluence with Pacific Ocean	Approximately 3,040 feet upstream of confluence with Pacific ocean	18060006	0.6		N	A	
Lake Tynan	Santa Cruz County, Unincorporated Areas	Approximately 4,500 feet upstream of Riverside Road	Approximately 900 feet downstream of Lakeview Road	18060002	0.4		N	AE	
Loch Lomond Reservoir	Santa Cruz County, Unincorporated Areas	Approximately 200 feet upstream of Newell Creek Road	Approximately 2.4 miles upstream of Newell Creek Road	18060015	0.2		N	A	
Love Creek	Santa Cruz County, Unincorporated Areas	Approximately 900 feet upstream of Brookside Avenue	Approximately 1,560 feet upstream of Love Creek Road	18060015	1.6		N	A	
Majors Creek	Santa Cruz County, Unincorporated Areas	Confluence with Pacific Ocean	Approximately 780 feet upstream of State Highway 1	18060006	0.6		N	A, VE	
Mill Creek	Santa Cruz County, Unincorporated Areas	Confluence with Scott Creek	Approximately 880 feet upstream of Swanton Road	18060006	0.3		N	A	
Molino Creek	Santa Cruz County, Unincorporated Areas	Confluence with Pacific Ocean	Approximately 3,154 feet upstream of Swanton Road	18060006	1.0		N	A, VE	

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Moore Creek	Santa Cruz County, Unincorporated Areas	Confluence with the Pacific Ocean	At Meder Street	18060015	2.4		Y	AE, A	
Moran Lake	Santa Cruz County, Unincorporated Areas	At East Cliff Drive	Approximately 1,447 feet upstream of East Cliff Drive	18060015	0.3		N	A	
Newell Creek	Santa Cruz County, Unincorporated Areas	Confluence with San Lorenzo River	At Loch Lomond Reservoir	18060015	1.8		N	A	
Nobel Creek	Capitola, City of	Confluence with Soquel Creek	At Kennedy Drive	18060015	0.9		Y	AE	
Old Dairy Gulch	Santa Cruz County, Unincorporated Areas	Confluence with Pacific Ocean	Approximately 1,775 feet upstream of Union Pacific Railroad	18060006	0.7		N	A	
Pacific Ocean	Santa Cruz County, Unincorporated Areas	North Monterey County border	South San Mateo County Border	18060002 18060006 18060015	38.4		N	VE	
Pajaro River	Santa Cruz County, Unincorporated Areas; Watsonville, City of	Approximately 800 feet downstream of the confluence with Watsonville Slough	Approximately 5,100 feet upstream of Rogge Lane	18060002	16.0		Y	VE, AE	

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Pajaro River	Santa Cruz County, Unincorporated Areas	Approximately 5,100 feet upstream of Rogge Lane	Approximately 4,070 feet upstream of Riverside Drive	18060002	3.4		N	A	
Pinto Lake	Santa Cruz County, Unincorporated Areas; Watsonville, City of	Approximately 1,088 feet upstream of Green Valley Road	Approximately 1 mile upstream of Green Valley Road	18060002		0.2	N	A	
Rodeo Creek Gulch	Santa Cruz County, Unincorporated Areas	East Cliff Drive	Approximately 1,600 feet upstream of Soquel Drive	18060015	2.6		Y	VE, AE	
Rose Reservoir	Santa Cruz County, Unincorporated Areas	Approximately 730 feet upstream of Casserly Road	Approximately 1,390 feet upstream of Casserly Road	18060002	0.1		N	A	
Salsipuedes Creek	Santa Cruz County, Unincorporated Areas; Watsonville, City of	Confluence with the Pajaro River	College Lake Outlet	18060002	2.5		N	AE	
San Lorenzo River	Santa Cruz, City of; Santa Cruz County, Unincorporated Areas	Approximately 400 feet upstream of the confluence with the Pacific Ocean	Approximately 1,800 feet upstream of Ocean Street	18060015	4.7		Y	VE, AE	

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
San Lorenzo River	Santa Cruz County, Unincorporated Areas	Approximately 5,120 feet downstream of North Big Trees Park Road	Approximately 3,100 feet upstream of McGaffigan Mill Road	18060015	18.5		Y	AE	
San Lorenzo River	Santa Cruz County, Unincorporated Areas	Approximately 1,800 feet upstream of Ocean Street	Approximately 1,200 feet upstream of Union Pacific Railroad	18060015	3.6		N	A	
San Lorenzo River	Santa Cruz County, Unincorporated Areas	Approximately 3,100 feet upstream of McGaffigan Mill Road	Approximately 215 feet upstream of Highway 9	18060015	0.3		N	A	
San Vicente Creek	Santa Cruz County, Unincorporated Areas	Confluence with the Pacific Ocean	Approximately 3,700 feet upstream of State Highway 1	18050006	0.8		Y	VE, AE	
San Vicente Creek	Santa Cruz County, Unincorporated Areas	Approximately 3,700 feet upstream of State Highway 1	Approximately 5,060 feet upstream of State Highway 1	18050006	0.2		N	A	
Schwans Lagoon	Santa Cruz County, Unincorporated Areas	Approximately 350 feet downstream of East Cliff Drive	Approximately 1,700 feet upstream of East Cliff Drive	18060015	0.4		N	AE	
Scott Creek	Santa Cruz County, Unincorporated Areas	At Coast Road	Approximately 2,835 feet upstream of Purdy Ranch Road	18050006	5.5		N	A	

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Soquel Creek	Santa Cruz County, Unincorporated Areas	Approximately 500 feet downstream of Stockton Avenue	Approximately 1,700 feet upstream of Soquel Creek Road	18060015	7.5		Y	VE, AE	
Soquel Creek	Santa Cruz County, Unincorporated Areas	Approximately 1,700 feet upstream of Soquel Creek Road	Approximately 2 miles upstream of Hinckley Basin Road	18060015	4.0		N	A	
Struve Slough	Santa Cruz County, Unincorporated Areas; Watsonville, City of	Confluence with Watsonville Slough	Near the concrete culvert outlet at South Green Valley Road	18060002	2.5		Y	AE	
Thomasello Creek	Santa Cruz County, Unincorporated Areas	Approximately 1,000 feet upstream of the confluence with the Pajaro River	Approximately 1,000 feet upstream of State Highway 129	18060002	0.8		N	AE	
Thompson Creek	Santa Cruz County, Unincorporated Areas	Confluence with the Pajaro River	Approximately 3,800 feet upstream of Carlton Road	18060002	2.1		N	AE	
Two Bar Creek	Santa Cruz County, Unincorporated Areas	Confluence with San Lorenzo River	Approximately 3, 110 feet upstream of Highway 9	18060015	0.6		N	A	
Waddell Creek	Santa Cruz County, Unincorporated Areas	Confluence with Pacific Ocean	Approximately 2.8 miles upstream of Coast Road	18060006	2.9		N	VE, A	

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Watsonville Slough	Santa Cruz County, Unincorporated Areas; Watsonville, City of	Confluence with the Pajaro River	Northwest corner of Watsonville Pioneer Cemetery	18060002	6.7		Y	AE	
West Branch Struve Slough	Santa Cruz County, Unincorporated Areas; Watsonville, City of	Confluence with Struve Slough	Approximately 1,460 feet upstream of Harkins Slough Road	18060002	0.9		N	A	
Wilder Creek	Santa Cruz County, Unincorporated Areas	Confluence with Pacific Ocean	Approximately 1,720 feet upstream of Coast Road	18060006	1.4		N	VE, A	
Zayante Creek	Santa Cruz County, Unincorporated Areas	Confluence with the San Lorenzo River	Approximately 4,500 feet upstream of Western States Road	18060015	4.9		Y	A	
Zayante Creek	Santa Cruz County, Unincorporated Areas	Approximately 4,500 feet upstream of Western States Road	Approximately 2,066 feet upstream of East Zayante Road	18060015	1.0		N	A	

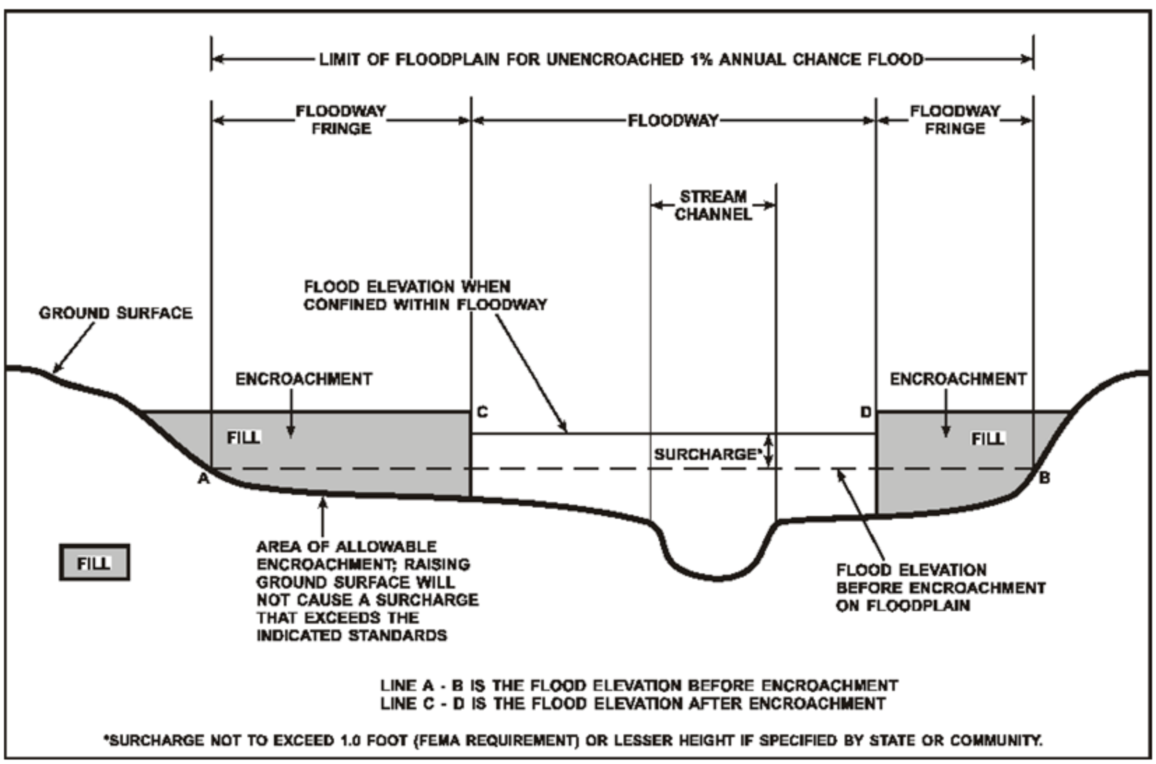
2.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard.

For purposes of the NFIP, a floodway is used as a tool to assist local communities in balancing floodplain development against increasing flood hazard. With this approach, the area of the 1% annual chance floodplain on a river is divided into a floodway and a floodway fringe based on hydraulic modeling. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment in order to carry the 1% annual chance flood. The floodway fringe is the area between the floodway and the 1% annual chance floodplain boundaries where encroachment is permitted. The floodway must be wide enough so that the floodway fringe could be completely obstructed without increasing the water surface elevation of the 1% annual chance flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 4.

To participate in the NFIP, Federal regulations require communities to limit increases caused by encroachment to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this project are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway projects.

Figure 4: Floodway Schematic



Floodway widths presented in this FIS Report and on the FIRM were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. For certain stream segments, floodways were adjusted so that the amount of floodwaters conveyed on each side of the floodplain would be reduced equally. The results of the floodway computations have been tabulated for selected cross sections and are shown in Table 24, "Floodway Data."

All floodways that were developed for this Flood Risk Project are shown on the FIRM using the symbology described in Figure 3. In cases where the floodway and l% annual chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown on the FIRM. For information about the delineation of floodways on the FIRM, refer to Section 6.3.

2.3 Base Flood Elevations

The hydraulic characteristics of flooding sources were analyzed to provide estimates of the elevations of floods of the selected recurrence intervals. The Base Flood Elevation (BFE) is the elevation of the 1% annual chance flood. These BFEs are most commonly rounded to the whole foot, as shown on the FIRM, but in certain circumstances or locations they may be rounded to 0.1 foot. Cross section lines shown on the FIRM may also be labeled with the BFE rounded to 0.1 foot. Whole-foot BFEs derived from engineering analyses that apply to coastal areas, areas of ponding, or other static areas with little elevation change may also be shown at selected intervals on the FIRM.

Cross sections with BFEs shown on the FIRM correspond to the cross sections shown in the Floodway Data table and Flood Profiles in this FIS Report. BFEs are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM.

2.4 Non-Encroachment Zones

Some States and communities use non-encroachment zones to manage floodplain development. For flooding sources with medium flood risk, field surveys are often not collected and surveyed bridge and culvert geometry is not developed. Standard hydrologic and hydraulic analyses are still performed to determine BFEs in these areas. However, floodways are not typically determined, since specific channel profiles are not developed. To assist communities with managing floodplain development in these areas, a "non-encroachment zone" may be provided. While not a FEMA designated floodway, the non-encroachment zone represents that area around the stream that should be reserved to convey the 1% annual chance flood event. As with a floodway, all surcharges must fall within the acceptable range in the non-encroachment zone.

General setbacks can be used in areas of lower risk (e.g. unnumbered Zone A), but these are not considered sufficient where unnumbered Zone A is replaced by Zone AE. The NFIP requires communities to ensure that any development in a non-encroachment area causes no increase in BFEs. Communities must generally prohibit development within the area defined by the non-encroachment width to meet the NFIP requirement.

Non-encroachment determinations may be delineated where it is not possible to delineate floodways because specific channel profiles with bridge and culvert geometry were not developed. Any non-encroachment determinations for this Flood Risk Project have been tabulated for selected cross sections and are shown in Table 25, "Flood Hazard and Non-Encroachment Data for Selected Streams." Areas for which non-encroachment zones are provided show BFEs and the 1% annual chance floodplain boundaries mapped as zone AE on the FIRM but no floodways.

2.5 Coastal Flood Hazard Areas

For most areas along rivers, streams, and small lakes, BFEs and floodplain boundaries are based on the amount of water expected to enter the area during a 1% annual chance flood and the geometry of the floodplain. Floods in these areas are typically caused by storm events. However, for areas on or near ocean coasts, large rivers, or large bodies of water, BFE and floodplain boundaries may need to be based on additional components, including storm surges and waves. Communities on or near ocean coasts face flood hazards caused by offshore seismic events as well as storm events.

Coastal flooding sources that are included in this Flood Risk Project are shown in Table 2.

2.5.1 Water Elevations and the Effects of Waves

Specific terminology is used in coastal analyses to indicate which components have been included in evaluating flood hazards.

The stillwater elevation (SWEL or still water level) is the surface of the water resulting from astronomical tides, storm surge, and freshwater inputs, but excluding wave setup contribution or the effects of waves.

- *Astronomical tides* are periodic rises and falls in large bodies of water caused by the rotation of the earth and by the gravitational forces exerted by the earth, moon and sun.
- *Storm surge* is the additional water depth that occurs during large storm events. These events can bring air pressure changes and strong winds that force water up against the shore.
- *Freshwater inputs* include rainfall that falls directly on the body of water, runoff from surfaces and overland flow, and inputs from rivers.

The 1% annual chance stillwater elevation is the stillwater elevation that has been calculated for a storm surge from a 1% annual chance storm. The 1% annual chance storm surge can be determined from analyses of tidal gage records, statistical study of regional historical storms, or other modeling approaches. Stillwater elevations for storms of other frequencies can be developed using similar approaches.

The total stillwater elevation (also referred to as the mean water level) is the stillwater elevation plus wave setup contribution but excluding the effects of waves.

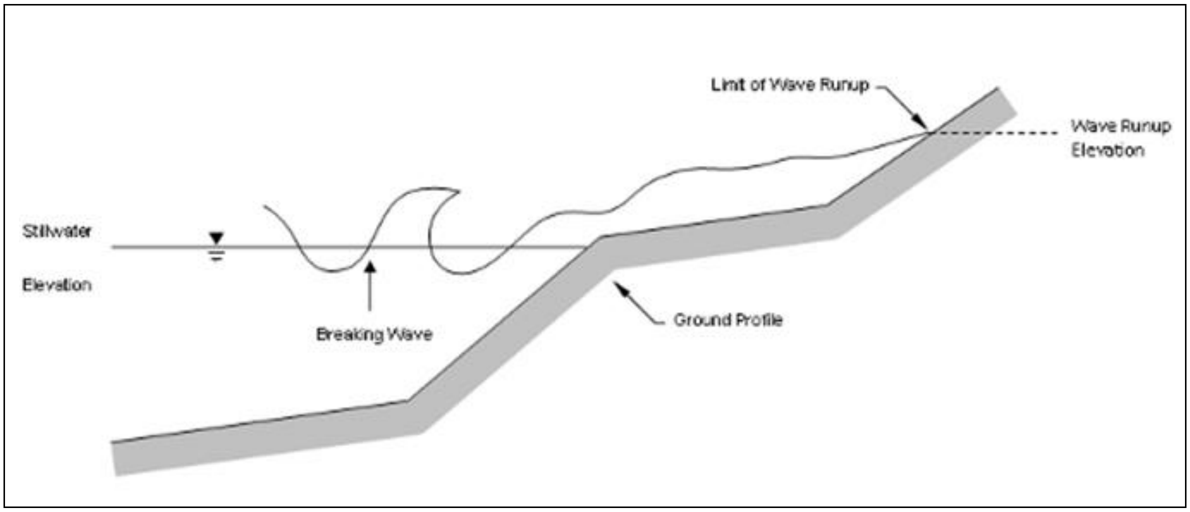
- *Wave setup* is the increase in stillwater elevation at the shoreline caused by the reduction of waves in shallow water. It occurs as breaking wave momentum is transferred to the water column.

Like the stillwater elevation, the total stillwater elevation is based on a storm of a particular frequency, such as the 1% annual chance storm. Wave setup is typically estimated using standard engineering practices or calculated using models, since tidal gages are often sited in areas sheltered from wave action and do not capture this information.

Coastal analyses may examine the effects of overland waves by analyzing storm-induced erosion, overland wave propagation, wave runup, and/or wave overtopping.

- *Storm-induced erosion* is the modification of existing topography by erosion caused by a specific storm event, as opposed to general erosion that occurs at a more constant rate.
- *Overland wave propagation* describes the combined effects of variation in ground elevation, vegetation, and physical features on wave characteristics as waves move onshore.
- *Wave runup* is the uprush of water from wave action on a shore barrier. It is a function of the roughness and geometry of the shoreline at the point where the stillwater elevation intersects the land.
- *Wave overtopping* refers to wave runup that occurs when waves pass over the crest of a barrier.

Figure 5: Wave Runup Transect Schematic



2.5.2 Floodplain Boundaries and BFEs for Coastal Areas

For coastal communities along the Atlantic and Pacific Oceans, the Gulf of Mexico, the Great Lakes, and the Caribbean Sea, flood hazards must take into account how storm surges, waves, and extreme tides interact with factors such as topography and vegetation. Storm surge and waves must also be considered in assessing flood risk for certain communities on rivers or large inland bodies of water.

Beyond areas that are affected by waves and tides, coastal communities can also have riverine floodplains with designated floodways, as described in previous sections.

Floodplain Boundaries

In many coastal areas, storm surge is the principle component of flooding. The extent of the 1% annual chance floodplain in these areas is derived from the total stillwater elevation (stillwater elevation including storm surge plus wave setup) for the 1% annual chance storm. The methods that were used for calculation of total stillwater elevations for coastal areas are described in Section 5.3 of this FIS Report. Location of total stillwater elevations for coastal areas are shown in Figure 8, "1% Annual Chance Total Stillwater Levels for Coastal Areas."

In some areas, the 1% annual chance floodplain is determined based on the limit of wave runup or wave overtopping for the 1% annual chance storm surge. The methods that were used for calculation of wave hazards are described in Section 5.3 of this FIS Report.

Table 26 presents the types of coastal analyses that were used in mapping the 1% annual chance floodplain in coastal areas.

Coastal BFEs

Coastal BFEs are calculated as the total stillwater elevation (stillwater elevation including storm surge plus wave setup) for the 1% annual chance storm plus the additional flood hazard from overland wave effects (storm-induced erosion, overland wave propagation, wave runup and wave overtopping).

Where they apply, coastal BFEs are calculated along transects extending from offshore to the limit of coastal flooding onshore. Results of these analyses are accurate until local topography, vegetation, or development type and density within the community undergoes major changes.

Parameters that were included in calculating coastal BFEs for each transect included in this FIS Report are presented in Table 17, "Coastal Transect Parameters." The locations of transects are shown in Figure 9, "Transect Location Map." More detailed information about the methods used in coastal analyses and the results of intermediate steps in the coastal analyses are presented in Section 5.3 of this FIS Report. Additional information on specific mapping methods is provided in Section 6.4 of this FIS Report.

2.5.3 Coastal High Hazard Areas

Certain areas along the open coast and other areas may have higher risk of experiencing structural damage caused by wave action and/or high-velocity water during the 1% annual chance flood. These areas will be identified on the FIRM as Coastal High Hazard Areas.

- *Coastal High Hazard Area (CHHA)* is a SFHA extending from offshore to the inland limit of the primary frontal dune (PFD) or any other area subject to damages caused by wave action and/or high-velocity water during the 1% annual chance flood.
- *Primary Frontal Dune (PFD)* is a continuous or nearly continuous mound or ridge of sand with relatively steep slopes immediately landward and adjacent to the beach. The PFD is subject to erosion and overtopping from high tides and waves during major coastal storms.

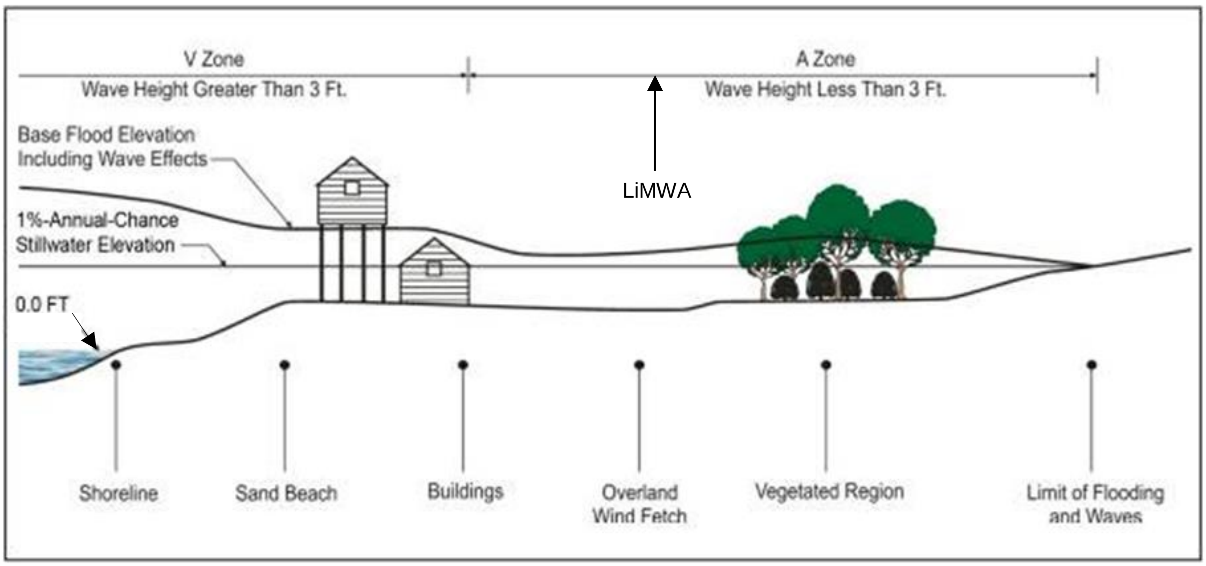
CHHAs are designated as "V" zones (for "velocity wave zones") and are subject to more stringent regulatory requirements and a different flood insurance rate structure. The areas of greatest risk are shown as VE on the FIRM. Zone VE is further subdivided into elevation zones and shown with BFEs on the FIRM.

The landward limit of the PFD occurs at a point where there is a distinct change from a relatively steep slope to a relatively mild slope; this point represents the landward extension of Zone VE. Areas of lower risk in the CHHA are designated with Zone V on the FIRM. More detailed information about the identification and designation of Zone VE is presented in Section 6.4 of this FIS Report.

Areas that are not within the CHHA but are SFHAs may still be impacted by coastal flooding and damaging waves; these areas are shown as "A" zones on the FIRM.

Figure 6, "Coastal Transect Schematic," illustrates the relationship between the base flood elevation, the 1% annual chance stillwater elevation, and the ground profile as well as the location of the Zone VE and Zone AE areas in an area without a PFD subject to overland wave propagation. This figure also illustrates energy dissipation and regeneration of a wave as it moves inland.

Figure 6: Coastal Transect Schematic



Methods used in coastal analyses in this Flood Risk Project are presented in Section 5.3 and mapping methods are provided in Section 6.4 of this FIS Report.

Coastal floodplains are shown on the FIRM using the symbology described in Figure 3, "Map Legend for FIRM." In many cases, the BFE on the FIRM is higher than the stillwater elevations shown in Table 17 due to the presence of wave effects. The higher elevation should be used for construction and/or floodplain management purposes.

2.5.4 Limit of Moderate Wave Action

This section is not applicable to this Flood Risk Project.

SECTION 3.0 – INSURANCE APPLICATIONS

3.1 National Flood Insurance Program Insurance Zones

For flood insurance applications, the FIRM designates flood insurance rate zones as described in

Figure 3, "Map Legend for FIRM." Flood insurance zone designations are assigned to flooding sources based on the results of the hydraulic or coastal analyses. Insurance agents use the zones shown on the FIRM and depths and base flood elevations in this FIS Report in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

The 1% annual chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (e.g. Zones A, AE, V, VE, etc.), and the 0.2% annual chance floodplain boundary corresponds to the boundary of areas of additional flood hazards.

Table 3 lists the flood insurance zones in Santa Cruz County.

Table 3: Flood Zone Designations by Community

Community	Flood Zone(s)
Capitola, City of	AE, VE, X
Santa Cruz, City of	A, AE, A99, VE, X
Santa Cruz County, Unincorporated Areas	A, AE, AH, AO, VE, X
Scotts Valley, City of	A, AE, X
Watsonville, City of	A, AE, AH, AO, X

3.2 Coastal Barrier Resources System

This section is not applicable to this Flood Risk Project.

Table 4: Coastal Barrier Resources System Information

[Not Applicable to this Flood Risk Project]

SECTION 4.0 – AREA STUDIED

4.1 Basin Description

Table 5 contains a description of the characteristics of the HUC-8 sub-basins within which each community falls. The table includes the main flooding sources within each basin, a brief description of the basin, and its drainage area.

Table 5: Basin Characteristics

HUC-8 Sub-Basin Name	HUC-8 Sub-Basin Number	Primary Flooding Source	Description of Affected Area	Drainage Area (square miles)
Pajaro	18060002	Pajaro River	Drainage basin encompasses an area including the major communities of the City of Watsonville, and the Towns of Corralitos, Freedom, Pajaro, and Watsonville Junction. The Pajaro River, the principal stream in the Pajaro Valley, flows along the southeastern edge of the City of Watsonville.	1,300
San Francisco Coastal South	18050006	Pacific Ocean	*	*
Monterey Bay	18060015	San Lorenzo River	The largest basin contained within the county is the San Lorenzo River basin which begins at the confluence of Monterey Bay at the Pacific Ocean and extends approximately 20 miles north from the river mouth into the coastal mountains.	137

*Data not available

4.2 Principal Flood Problems

Table 6 contains a description of the principal flood problems that have been noted for Santa Cruz County by flooding source.

Table 6: Principal Flood Problems

Flooding Source	Description of Flood Problems
All sources	The wet season in Santa Cruz County generally extends from October through May, but most flooding has occurred from December through March. In all streams except the Pajaro River, flood flow stages can rise from normal flow to extreme flood peaks in a few hours with high velocities in the main channels. Flood peaks at the lower end of the Pajaro River, however, occur approximately 24 hours after the flood-producing rainfall, mainly because of its large drainage area (USACE June 1963). Flooding is most severe when antecedent rainfall has produced saturated ground conditions. Flooding has occurred in Santa Cruz County at various times throughout the last 100 years. Major storms are known to have occurred during March 1899, December 1937, February 1940, January 1943, November 1950, January 1952, December 1955, April 1958, January 1963, January 1967,

Flooding Source	Description of Flood Problems
	and January 1982. The most significant floods occurred in 1955 and 1982 (USACE June 1963, USACE 1973(a), USACE 1973(b), USACE 1976).
All Sources Within the City of Watsonville	In the City of Watsonville, storms of flood-producing magnitude occur most often during the months of December through April, although they can occur as early as September and as late as May. Storms occurring early in the rainfall season are unlikely to result in excessive runoff since infiltration and surface-storage capacities are high. Some flooding occurred along the southeastern perimeter of Watsonville on January 4, 1982. The flooding resulted from the overflow of Corralitos Creek and produced shallow flooding in a 200- to 1,000-foot-wide strip along Bridge Street and Riverside Drive. Several homes near the eastern end of Tuttle Avenue adjacent to Salsipuedes Creek were damaged because of the ponding of this overflow. No other major damage resulted in Watsonville from this storm. In general, the following three principal flood problems can affect the City of Watsonville: 1. Inadequate interior drainage can create shallow flooding conditions from the accumulation of surface runoff. 2. Flood damage can come from the overtopping of the Salsipuedes Creek or Pajaro River levees. The USACE has indicated that it is reasonable to assume that the Pajaro River levees would fail during a major event, such as the 1- percent-annual-chance flood, when flows significantly exceed the channel capacity. The Salsipuedes Creek levees may remain intact during the 1- percent-annual-chance event because of the limited overflow volume and duration. 3. The overflow of Corralitos Creek upstream of the levees can cause flooding in the eastern half of the city. Flow which overtops Corralitos Creek is unable to re-enter downstream because of the levees.
All Sources Within the City of Scotts Valley	In Scotts Valley, significant flooding problems were experienced during the first week of January 1982. In addition, flooding is thought to have occurred in the Scotts Valley area in December 1955; however no detailed information recounting the extent and location of flood damage in 1955 was found. Because there are no gages on the creeks in Scotts Valley, the recurrence interval of these floods could not be estimated. Heavy rain caused flash flooding in January 2008 that closed many roads including Highway 9 and submerged the hardwood gym floor at Scotts Valley High School causing $300,000 in damage (Commerce 2010). Because the watershed is heavily wooded, other debris problems occurred in the City of Scotts Valley. For example, a log jam occurred at the Glen Canyon Road Bridge at the southern end of the city. In one case, a car was carried into Camp Evers Creek but was removed before it obstructed a bridge.
All Sources Within the City of Santa Cruz	The City of Santa Cruz was not inundated as it was in 1955 because of the protection afforded by the levees, but damage upstream of the City of Santa Cruz along the San Lorenzo River was extensive. The damage was most extensive in the area between the upstream corporate limits and Felton, and in the Towns of Paradise Park, Gold Gulch, and Felton Grove. In the Felton Grove area, floodwaters in the overbanks reached depths of 3 to 7 feet and

Flooding Source	Description of Flood Problems
	inundated 50 homes and cabins. An additional 60 to 70 homes and businesses were flooded between Felton and Ben Lomond.
Aptos Creek	In the Aptos Creek basin just east of the Soquel basin, only minor damage resulted from the December 1955 storm (USACE 1956). A total of 140 acres of land was inundated by floodwaters, which caused $62,000 in damage. Four homes along Moosehead Drive experienced flooding, while the Valencia Road crossing was heavily damaged. Other bridges receiving minor damage included the bridge on Aptos Creek, just south of the confluence with Valencia Creek, and the Southern Pacific Railroad (SPRR) Bridge (USACE July 1973 (a.)). Similar flooding was experienced in the Aptos Creek basin during the January 1982 storm. The estimated peak discharge on Aptos Creek on January 3, 1982, was 3,950 cfs, in contrast to the December 1955 peak flow of 3,500 cfs. The 1982 peak flow corresponded to a 2.50-percent-annual-chance recurrence interval, as measured at the Aptos gage. Heavy damage resulted from the 1982 storm. At least seven homes along Moosehead and Spreckels Drives between the State Highway 1 and Spreckels Drive bridges suffered major damage (Briggs 1982). Further downstream damage resulted to major portions of two streets paralleling Aptos Creek.
Carbonera Creek	Damage from the January 1982 flood occurred in a number of different locations in Scotts Valley. Significant damage was sustained to a home and to channel banks near the confluence of Camp Evers and Carbonera Creeks. According to city officials, some flooding occurs at this location approximately 3 out of every 10 years. Floodwaters along Carbonera Creek also damaged bridges. Parts of an abandoned bridge on Bob Jones Lane and all of the Carbonera Creek Industrial Park Bridge were washed out. Extensive bank erosion occurred around the El Pueblo Road Bridge, as well as just downstream of the bridge behind a lumberyard. Bank erosion also produced loss of land in various other locations along Carbonera Creek. Because the watershed is heavily wooded, other debris problems occurred in the City of Scotts Valley. For example, a log jam occurred at the Glen Canyon Road Bridge at the southern end of the city. In one case, a car was carried into Camp Evers Creek but was removed before it obstructed a bridge.
Corralitos Creek	Significant flooding along Corralitos and Salsipuedes Creeks also occurred in December 1955 and April 1958. Peak discharges for Corralitos Creek at Green Valley Road have been estimated from high-water elevations (USACE 1956). The estimated discharges for the 1955 and 1958 floods are 3,620 cfs and 2,680 cfs, which correspond to 8.33- and 14.29-percent-annual-chance recurrence intervals, respectively. The overflow of Corralitos Creek upstream of the leveed section on Salsipuedes Creek flooded 29 blocks within the City of Watsonville during the December 1955 flood (USACE 1956). The 1-percent-annual-chance discharge for Corralitos Creek at Green Valley is 7,900 cfs.
San Lorenzo River	While the rainy season for the City of Santa Cruz extends from October through May, flooding has occurred primarily in December, January, and February. The City of Santa Cruz has a history of periodic flooding, particularly from the San Lorenzo River. News-papers report early floods in January 1862, January 1869, January 1890, January 1895, January 1909,

Flooding Source	Description of Flood Problems
	January 1911, and December 1931 (Santa Cruz County, Office of Watershed 1979). Since the USGS stream gage on the San Lorenzo River was installed at Felton in 1937, damaging floods have been recorded in February 1940, December 1955, April 1958, and January 1982, with peak discharges of 24,000 cfs, 30,400 cfs, 17,200 cfs, and 19,700 cfs, respectively. In the San Lorenzo River basin, a total of $8.7 million in damages resulted from intense rainfall between December 21 and 24, 1955, with $7.6 million in damages occurring in the City of Santa Cruz (USACE 1979). Flooding reached depths as high as 6.5 feet on Front Street and inundated 410 acres in the city. Five people in the city were killed and 2,400 people were displaced by the floods. The most extensive damage in the county occurred in the Felton, Ben Lomond, and Boulder Creek areas where over 300 people were displaced or evacuated. At Ben Lomond, the San Lorenzo River remained above its banks for 83 hours. Severe local flooding occurred because of logjams that diverted high- velocity flows, damaging bridges, private developments, and other lands. A total of 1,765 acres was flooded and two lives lost in the county portion of the basin. The estimated peak discharge for the San Lorenzo River at the Big Trees gaging station was 30,400 cubic feet per second (cfs) which corresponds to a 3.33-percent-annual-chance recurrence interval. On January 3 and 4, 1982, high flows occurred on the San Lorenzo River. These flows, however, did not cause heavy damage to the City of Santa Cruz due to the construction of a flood-control project in 1958. The estimated flow for the January 1982 storm, 29,700 cfs at the Big Trees gage, was similar to the December 1955 event. These floods each had a 3.33-percent-annual-chance recurrence interval. The levees were not overtopped during the storm, but floodwaters rose to within 3 or 4 feet of the levee tops at peak flow (approximately 35,000 to 37,000 cfs) to downstream of the confluence with Branciforte Creek (Briggs 1982). These high stages occurred even though the estimated flow was considerably lower than the design flow of 53,000 cfs (USACE General Design Memorandum). Branciforte Creek at the confluence with the San Lorenzo River was filled to capacity during the storm. Significant scour occurred in the downtown reach of the San Lorenzo River because of high channel velocities. Scour damaged the Riverside Avenue Bridge and undermined one pier on the Soquel Avenue Bridge, causing on pan to collapse. Cost for bridge repairs was estimated at $1.75 million (Otto Water Engineers, Inc. 1984). Two cranes worked throughout the flood peak removing logs at bridges, thereby preventing major logjams.
Soquel Creek	While the rainy season for Soquel Creek generally extends from October through May, the bulk of flooding has occurred in December, January, and February. Floods in the Soquel Creek basin are normally of short duration, lasting approximately 6 to 24 hours. They develop rapidly, with the peak being reached in approximately 4 hours after occurrence of a flood-producing storm. The Soquel Creek basin, particularly the City of Capitola and the Town of Soquel, experienced major flooding in December 1955. In a 72-hour period during December 21- 24, 1955, storm rainfall equivalent to 35 percent of the normal annual precipitation fell on the basin (USACE 1965). A major logjam

Flooding Source	Description of Flood Problems
	occurred at the Soquel Avenue Bridge, causing a severe backwater condition. In Soquel, eight city blocks were inundated, displacing 350 persons. Just upstream of the confluence with Hinckley Creek, floodwaters in the overbanks reached depths of 5 to 6 feet. Total damage in the Soquel Creek basin was estimated at $831,000. The estimated peak flow for Soquel Creek at the Soquel gage was 15,800 cfs, which corresponds to a 1.43-percent-annual-chance recurrence interval. In Capitola, some damage was done to commercial and residential property adjacent to Soquel Creek. The damage resulted from bank erosion and deposition of debris, but the majority of damage caused by the overflow of Soquel Creek occurred outside of Capitola. During the January 1982 flood, the Soquel Creek basin experienced major flooding in the vicinity of the Soquel Avenue Bridge. A massive logjam, which included a four-bedroom house and for auto-court apartments, diverted flow down the main street of the Town of Soquel. The floodwaters rose rapidly along Soquel Creek and caused major damage to two mobile home parks adjacent to the stream. The United States Geological Survey (USGS) estimate for the peak discharge at the Soquel Creek gage was 9,700 cfs, which corresponds to a 6.67-percent-annual-chance recurrence interval. Overflow of Soquel Creek during the January 1982 storm flooded one home on the eastern bank just south of State Highway 1 and eroded the banks of some homes along Riverview Drive in Capitola. According to city officials, however, the most significant damage in Capitola resulted from the flooding of Nobel Creek. The capacity of the long culvert extending from Bay Avenue under the mobile home park and into Soquel Creek was exceeded. Excess flow lifted the manholes in the park and produced shallow flooding conditions. A large portion of this flow passed over Riverview Drive and caused minor damage to about 20 homes south of Riverview before entering Soquel Creek. Other flow traveled south on Capitola Avenue and caused shallow flooding. The Cities of Capitola, Scotts Valley, and Watsonville were also affected by the January 1982 flood. In Capitola, the USGS preliminary estimate of peak flow for Soquel Creek was approximately 9,700 cfs, which is equivalent to 6.67-percent-annual-chance recurrence interval. Although the USGS January 1982 flow estimate at the Soquel gage was 6,100 cfs lower than the December 1955 event, the stage height at the gaging station was only 0.48 foot lower than the maximum height recorded for the 1955 event. The high water surface elevations (WSELs) for the 1982 storm were probably caused by the large logjam that occurred at the Soquel Avenue Bridge just downstream of the gaging station. However, it was noted that a logjam also occurred at the same bridge during the 1955 event. High-water marks downstream at the State Highway 1 Bridge were within 1 foot of each other for the two events (Briggs 1982).
Pacific Ocean	Flooding along the Pacific coast of Santa Cruz County is typically associated with the simultaneous occurrence of very high tides, large waves, and storm swells during the winter. As a result, ocean-front development has not been compatible with the natural instability of the shoreline and intense winter weather conditions. Tsunamis (sea waves generated from oceanic earthquakes, submarine

Flooding Source	Description of Flood Problems
	landslides, and volcanic eruptions) create some of the most destructive natural water waves. As tsunami waves approach shallow coastal waters, wave refraction, shoaling, and bay resonance amplify the wave heights. Storm centers from the southwest produce the type of storm pattern most commonly responsible for the majority of serious coastline flooding. The strong winds and high tides that create storm surges are also accompanied by heavy rains. In some instances, high tides back up riverflows that causes flooding at the river mouths. The most severe storms to hit the California coast occurred in 1978 and 1983 when high- water levels were accompanied by very large storm waves. The most notable events are described below. In January 1978, a series of storms emanated from a more southerly direction than normally occurs; consequently, some of the more protected beaches were also damaged. Storm incidents occurred throughout the study area. Jetties and breakwater barriers were overtopped and in some cases undermined. Direct wave damage occurred to many beachfront homes, especially in the more populated beachfront areas along Monterey Bay. Accelerated erosion coupled with rain and saturated ground conditions weakened the foundations of beach-bluff top homes in Santa Cruz County. Seawalls and temporary barriers failed to protect beachfront properties from the ravages of the 1978 storms. Significant storms and associated damage strike the Monterey Bay communities with a frequency of one large storm every 3 to 4 years. The New Brighton and Seacliff State Beach study areas, as well as the City of Capitola, are directly exposed to storm waves which approach from the west, west-southwest, and southwest across deep waters. The waves undergo little refraction before striking the coastline. Statistics show that 13 out of 20 large storms arrive from the southwest (Otto Water Engineers, Inc. 1984). Repeated damage has occurred to beachfront structures in an area of the coast between the New Brighton State Beach and Seacliff State Beach study sites. Approximately every 7 years, seawalls or bulkheads at Seacliff State Beach are damaged or destroyed. The last episode occurred in 1983 when 3,500 feet of new seawall, a restroom, and 11 recreational vehicle sites were destroyed, which amounts to $740,000 in damage. In the Seacliff State Beach area, numerous homes have been constructed on fill to raise the height of the backbench. In 1983, an existing protective riprap was overtopped and 19 of 21 homes were significantly damaged. Flooding along the Pacific coast at the Cities of Capitola and Santa Cruz is typically associated with the simultaneous occurrence of very high tides, large waves, and storm swells during the winter. As a result, ocean-front development has not been compatible with the natural instability of the shoreline and the intense winter weather conditions. Much of lower Monterey Bay is bordered by the Pajaro Dunes area, which is a series of older stabilized dunes fronted by younger active dunes. Since 1882, structures which have been constructed in the area (Camp Goodall, 1883; 1,700-foot-long wharf, 1911) were partially destroyed by storm waves. Planned lot developments have been subject to rapid beach retreat several times prior to 1968, in 1969, in 1978, and again in 1983 (Otto Water Engineers, Inc. 1984).

Flooding Source	Description of Flood Problems
Pajaro River	The Pajaro River experienced flooding events during February 1937, February 1938, March and April 1941, and February 1945, prior to levee construction; also in January 1952, December 1955, and April 1958, upstream of the leveed reaches. An inspection of rainfall records, gaging stations on other streams, and historical accounts indicates flooding also occurred during the years 1852, 1862, 1898, 1908, 1911, 1914, 1917, 1922, and 1932. In the December 1955 flood, and again in April 1958, the Pajaro River was maintained within the levees in the Watsonville area, but the levees were breached 2.1 miles upstream of the confluence with Salsipuedes Creek. Although no lives were lost, 972 people were evacuated and $1.12 million in damages were incurred. Included in these costs were monies spent to repair levees damaged by erosion. Additional levee repairs were required due to damages caused by the April 1958 flood; however, no other significant damage resulted (USACE June 1963). The 1955 and 1958 floods are the two largest on record along the Pajaro River, with associated discharges of 24,000 cfs and 23,500 cfs, respectively, at the Chittenden gage (USACE June 1963). The estimated return periods for floods of these magnitudes are 3.70- and 3.85-percent-annual-chance, respectively. In comparison, the estimated discharge at Chittenden for a 1-percent-annual-chance flood is 43,000 cfs.
West Carbonera Creek	Flooding also occurred along West Branch Carbonera Creek due to the accumulation of siltation and debris. The channel capacity was reduced as siltation clogged the stream just upstream of a drop structure at the confluence with Carbonera Creek. Siltation also blocked the culverts at the Granite Creek Road Interchange.

Table 7 contains information about historic flood elevations in the communities within Santa Cruz County.

Table 7: Historic Flooding Elevations

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
Aptos Creek	Santa Cruz County	*	1982	40	USGS gage
Corralitos Creek	City of Watsonville	*	1958	7	*
Corralitos Creek	Green Valley Road	*	1955	12	*
Pajaro River	Santa Cruz County	*	1958	26	USGS gage
Pajaro River	Santa Cruz County	*	1955	27	USGS gage

Flooding Source	Location	Historic Peak (Feet NAVD88)	Event Date	Approximate Recurrence Interval (years)	Source of Data
San Lorenzo River	City of Santa Cruz	6.5	1955	30	USGS gage
Soquel Creek	City of Capitola	5.52	1982	15	USGS gage
Soquel Creek	City of Capitola and the Town of Soquel	6.0	1955	70	USGS gage

*Data not available

4.3 Non-Levee Flood Protection Measures

Table 8 contains information about non-levee flood protection measures within Santa Cruz County such as dams, jetties, and or dikes. Levees are addressed in Section 4.4 of this FIS Report.

Table 8: Non-Levee Flood Protection Measures

Flooding Source	Structure Name	Type of Measure	Location	Description of Measure
Branciforte Creek	N/A	Channel improvements	From the confluence with the San Lorenzo River at the Soquel Avenue Bridge1 mile upstream	Rectangular concrete channel was constructed
Pacific Ocean	N/A	Jetties	Northern Monterey Bay	Seawalls, boulder-sized riprap, timber, and concrete bulkheads
Pacific Ocean	N/A	Beach Stabilization	Southern Monterey Bay	Revegetation
San Lorenzo River	N/A	Channel improvements, and bank protections	Between the SPRR Bridge and the State Highway 1 Bridge	Channel improvements, and bank protections constructed by the USACE
San Lorenzo River	N/A	Channel improvements	Upstream of State Highway 1	The modified channel was wider with a lower invert than the natural channel
Soquel Creek	N/A	Bank Protection	Along Soquel Creek	Bank protection works made of various materials, such as riprap, concrete, and timber.

4.4 Levees

For purposes of the NFIP, FEMA only recognizes levee systems that meet, and continue to meet, minimum design, operation, and maintenance standards that are consistent with comprehensive floodplain management criteria. The Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10) describes the information needed for FEMA to determine if a levee system reduces the risk from the 1% annual chance flood. This information must be supplied to FEMA by the community or other party when a flood risk study or restudy is conducted, when FIRMs are revised, or upon FEMA request. FEMA reviews the information for the purpose of establishing the appropriate FIRM flood zone.

Levee systems that are determined to reduce the risk from the 1% annual chance flood are accredited by FEMA. FEMA can also grant provisional accreditation to a levee system that was previously accredited on an effective FIRM and for which FEMA is awaiting data and/or documentation to demonstrate compliance with Section 65.10. These levee systems are referred to as Provisionally Accredited Levees, or PALs. Provisional accreditation provides communities and levee owners with a specified timeframe to obtain the necessary data to confirm the levee's certification status. Accredited levee systems and PALs are shown on the FIRM using the symbology shown in Figure 3 and in Table 9. If the required information for a PAL is not submitted within the required timeframe, or if information indicates that a levee system not longer meets Section 65.10, FEMA will de-accredit the levee system and issue an effective FIRM showing the levee-impacted area as a SFHA.

FEMA coordinates its programs with USACE, who may inspect, maintain, and repair levee systems. The USACE has authority under Public Law 84-99 to supplement local efforts to repair flood control projects that are damaged by floods. Like FEMA, the USACE provides a program to allow public sponsors or operators to address levee system maintenance deficiencies. Failure to do so within the required timeframe results in the levee system being placed in an inactive status in the USACE Rehabilitation and Inspection Program. Levee systems in an inactive status are ineligible for rehabilitation assistance under Public Law 84-99.

FEMA coordinated with the USACE, the local communities, and other organizations to compile a list of levees that exist within Santa Cruz County. Table 9, "Levees," lists all accredited levees, PALs, and de-accredited levees shown on the FIRM for this FIS Report. Other categories of levees may also be included in the table. The Levee ID shown in this table may not match numbers based on other identification systems that were listed in previous FIS Reports. Levees identified as PALs in the table are labeled on the FIRM to indicate their provisional status.

Please note that the information presented in Table 9 is subject to change at any time. For that reason, the latest information regarding any USACE structure presented in the table should be obtained by contacting USACE and accessing the USACE national levee database. For levees owned and/or operated by someone other than the USACE, contact the local community shown in Table 31.

Table 9: Levees

Community	Flooding Source	Levee Location	Levee Owner	USACE Levee	Levee ID	Covered Under PL84-99 Program?	FIRM Panel(s)
Santa Cruz, City of	San Lorenzo River	Left Bank		Yes	1901068008		06087C0332E
Santa Cruz, City of	San Lorenzo River	Right Bank		Yes	1901068010		06087C0332E
Santa Cruz, City of	San Lorenzo River	Right Bank		Yes	1901068012		06087C0332E 06087C0334F
Santa Cruz, City of	San Lorenzo River	Right Bank		Yes	1901068016		06087C0334F
Santa Cruz, City of	San Lorenzo River	Left Bank		Yes	1901068017		06087C0332E 06087C0334F
Santa Cruz County, Unincorporated Areas	College Lake	Left Bank			1901068018		06087C0403E
Santa Cruz County, Unincorporated Areas	Pajaro River	Right Bank		Yes	1901068001		06087C0411E 06087C0412E
Santa Cruz County, Unincorporated Areas	Pajaro River	Right Bank		Yes	1901068002		06087C0412E
Santa Cruz County, Unincorporated Areas	Pajaro River	Left Bank		Yes	1901068003		06087C0412E
Santa Cruz County, Unincorporated Areas	Pajaro River	Left Bank		Yes	1901068004		06087C0412E
Santa Cruz County, Unincorporated Areas	Pajaro River	Right Bank		Yes	1901068005		06087C0416E 06087C0418E
Santa Cruz County, Unincorporated Areas	Pajaro River	Right Bank		Yes	1901068019		06087C0456F

Community	Flooding Source	Levee Location	Levee Owner	USACE Levee	Levee ID	Covered Under PL84-99 Program?	FIRM Panel(s)
Santa Cruz County, Unincorporated Areas; Watsonville, City of	Pajaro River	Right Bank		Yes	1901068020		06087C0392E 06087C0393E 06087C0394E 06087C0411E 06087C0456F
Santa Cruz County, Unincorporated Areas; Watsonville, City of	Salsipuedes Creek	Right Bank		Yes	1901068000		06087C0411E
Santa Cruz County, Unincorporated Areas; Watsonville, City of;	Salsipuedes Creek	Right Bank		Yes	1901068006		06087C0411E
Santa Cruz County, Unincorporated Areas	Salsipuedes Creek	Left Bank		Yes	1901068011		06087C0411E
Santa Cruz County, Unincorporated Areas; Watsonville, City of	Salsipuedes Creek	Left Bank		Yes	1901068021		06087C0411E
Santa Cruz County, Unincorporated Areas	Salsipuedes Creek	Left Bank		Yes	1901068022		06087C0411E
Santa Cruz County, Unincorporated Areas	Soda Lake	Non-Riverine			1901068030		06087C0440E
Santa Cruz County, Unincorporated Areas	Thompson Creek	Right Bank			1901068033		06087C0412E
Santa Cruz County, Unincorporated Areas	Watsonville Slough	Left Bank			1901068031		06087C0452F 06087C0456F
Santa Cruz County, Unincorporated Areas	Watsonville Slough	Left Bank			1901068032		06087C0452F
Watsonville, City of	Salsipuedes Creek	Right Bank		Yes	1901068009		06087C0411E

SECTION 5.0 – ENGINEERING METHODS

For the flooding sources in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that are expected to be equaled or exceeded at least once on the average during any 10-, 25-, 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-, 25-, 50-, 100-, and 500-year floods, have a 10-, 4-, 2-, 1-, and 0.2% annual 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 that equals or exceeds the 100-year flood (1-percent chance of annual exceedance) during the term of a 30-year mortgage is approximately 26 percent (about 3 in 10); 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 community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

The engineering analyses described here incorporate the results of previously issued Letters of Map Change (LOMCs) listed in Table 27, "Incorporated Letters of Map Change", which include Letters of Map Revision (LOMRs). For more information about LOMRs, refer to Section 6.5, "FIRM Revisions."

5.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak elevation-frequency relationships for floods of the selected recurrence intervals for each flooding source studied. Hydrologic analyses are typically performed at the watershed level. Depending on factors such as watershed size and shape, land use and urbanization, and natural or man-made storage, various models or methodologies may be applied. A summary of the hydrologic methods applied to develop the discharges used in the hydraulic analyses for each stream is provided in Table 13. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

A summary of the discharges is provided in Table 10. Frequency Discharge-Drainage Area Curves used to develop the hydrologic models may also be shown in Figure 7 for selected flooding sources. A summary of stillwater elevations developed for non-coastal flooding sources is provided in Table 11. (Coastal stillwater elevations are discussed in Section 5.3 and shown in Table 17.) Stream gage information is provided in Table 12.

Table 10: Summary of Discharges

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Aptos Creek	At mouth	24.5	3,110	*	6,550	8,280	12,700
Aptos Creek	Above confluence with Valencia Creek	12.4	1,990	*	4,340	5,540	8,670
Arana Gulch	At mouth	3.3	790	*	1,390	1,650	2,290
Carbonera Creek	At confluence with Branciforte Creek	7.2	2,250	*	3,680	4,340	5,900
Carbonera Creek	At southern corporate limits of the City of Scotts Valley	5.2	1,690	*	2,870	3,400	4,750
Carbonera Creek	Downstream of confluence of West Branch Carbonera Creek	3.0	970	*	1,710	2,070	2,930
Carbonera Creek	Upstream of confluence with West Branch Carbonera Creek	2.0	700	*	1,230	1,510	2,150
College Lake	At confluence with Corralitos Creek	20.7	650	*	2,000	2,800	5,500
Corralitos Creek	East Lake Avenue at junction with Salsipuedes Creek	24.2	3,300	*	6,640	7,930	11,730

*Not calculated for this Flood Risk Project

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Corralitos Creek	Above confluence with Browns Creek	11.0	2,030	*	4,040	5,040	7,550
Coward Creek	At confluence with Pajaro River	3.2	310	*	480	660	1,250
Harkins Slough	At confluence with Pajaro River	9.8	860	*	1,920	2,540	4,140
Harkins Slough	Above confluence with Gallighan Slough	6.3	650	*	1,380	1,800	2,760
Moore Creek	At mouth	1.8	320	*	570	690	970
Moore Creek	At State Highway 1	1.4	270	*	480	580	830
Nobel Creek	At confluence with Soquel Creek	1.2	270	*	470	560	770
Pajaro River	Downstream confluence with Salsipuedes Creek	1,275	14,250	*	32,500	43,600	76,200
Rodeo Creek Gulch	At mouth	3.0	790	*	1,290	1,540	2,130
Salsipuedes Creek	At confluence with Pajaro Creek	46.0	2,000[1]	*	4,500[1]	5,950[1]	12,500[1]
San Lorenzo River	At mouth	136.0	23,700	*	42,300	50,600	70,100

*Not calculated for this Flood Risk Project

[1]Discharge loss downstream of Corralitos Creek occurs as independent overbank flow

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
San Lorenzo River	Upstream of confluence with Branciforte Creek	118.0	22,000	*	39,600	47,600	66,500
San Lorenzo River	At City of Santa Cruz corporate limits	116.0	21,700	*	39,300	47,200	66,100
San Lorenzo River	Below confluence with Zayante Creek	106.0	18,800	*	35,000	42,600	60,700
San Lorenzo River	Below confluence with Love Creek	60.8	12,300	*	23,800	29,200	42,700
San Lorenzo River	Below confluence with Boulder Creek	51.2	9,390	*	18,800	23,400	34,800
San Lorenzo River	Below confluence with Two Bar Creek	22.9	4,640	*	9,530	11,900	18,100
San Vicente Creek	At mouth	11.3	1,240	*	2,340	2,850	4,140
Schwans Lagoon	At East Cliff Lake Drive	1.1	765	*	1,106	1,290	1,715
Soquel Creek	At mouth	42.8	8,310	*	14,700	17,500	24,300
Soquel Creek	Upstream of confluence with Nobel Creek	41.6	8,240	*	14,600	17,400	24,200

*Not calculated for this Flood Risk Project

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Struve Slough	At confluence with Watsonville Slough	2.8	240	*	540	700	1,120
Struve Slough	Downstream of Harkins Slough Road	1.5	160	*	340	440	690
Struve Slough	At Main Street	1.4	290[1]	*	470[1]	544[1]	675[1]
Struve Slough	At Firethorn Way	0.9	231[1]	*	374[1]	433[1]	536[1]
Struve Slough	Downstream of Landis Avenue	0.5	166[1]	*	269[1]	311[1]	383[1]
Thomasello Creek	At confluence with Pajaro River	3.6	370	*	590	850	1,560
Thompson Creek	At confluence with Pajaro River	5.3	520	*	700	1,000	1,870
Watsonville Slough	At confluence with Pajaro River	19.4	1,280[1]	*	2,940[1]	3,890[1]	6,580
Watsonville Slough	Below confluence with Harkins Slough	15.6	1,320	*	2,980	3,910	6,400
Watsonville Slough	Below confluence with Struve Slough	4.3	420	*	940	1,200	1,940
Watsonville Slough	At Ford Street	1.3	227[2]	*	368[2]	426[2]	529[2]

*Not calculated for this Flood Risk Project

[1]Reduction in flow due to overbank storage

[2]Flows from hydrology study using Rational Method prepared by Philip Williams and Associates, Ltd. (PWA) in 2009

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)				
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
Watsonville Slough	At Main Street	1.0	220[1]	*	356[1]	412[1]	511[1]
Watsonville Slough	NW corner of Watsonville Pioneer Cemetery	0.3	93[1]	*	151[1]	174[1]	217[1]
Zayante Creek	At confluence with San Lorenzo River	26.2	6,250	*	10,100	11,800	15,600
Zayante Creek	Below confluence with Bean Creek	26.1	6,150	*	9,990	11,700	15,500
Zayante Creek	Below confluence with Lompico Creek	14.3	3,820	*	5,420	7,580	10,300

*Not calculated for this Flood Risk Project

[1]Flows from hydrology study using Rational Method prepared by Philip Williams and Associates, Ltd. (PWA) in 2009

Figure 7: Frequency Discharge-Drainage Area Curves

[Not Applicable to this Flood Risk Project]

Table 11: Summary of Non-Coastal Stillwater Elevations

Flooding Source	Location	Elevations (feet NAVD88)				
		10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
College Lake	Santa Cruz County, Unincorporated Areas	66.9	*	72.2	72.9	74.5
Lake Tynan	Santa Cruz County, Unincorporated Areas	44.2	*	44.5	44.6	45.0
Schwans Lagoon	Santa Cruz County, Unincorporated Areas	13.5	*	15.3	15.8	16.5

*Not calculated for this Flood Risk Project

Table 12: Stream Gage Information used to Determine Discharges

Flooding Source	Gage Identifier	Agency that Maintains Gage	Site Name	Drainage Area (Square Miles)	Period of Record	
					From	To
Corralitos Creek	11159150	USGS	Near Corralitos	*	1958	1972
Corralitos Creek	11159200	USGS	Near Freedom	*	1955	1979
Green Valley Creek	11159400	USGS	Near Corralitos	*	1961	1973
Aptos Creek	11159700	USGS	At Aptos	*	1959	1972
West Branch Soquel Creek	11159800	USGS	Near Soquel	*	1959	1972
Soquel Creek	11160000	USGS	At Soquel	*	1937 1952	1937 1975
San Lorenzo River	11160020	USGS	Near Boulder Creek	*	1969	1978
Zayante Creek	11160300	USGS	At Zayante	*	1958	1978
San Lorenzo River	11160500	USGS	At Big Trees	*	1937	1978
Branciforte Creek	11161500	USGS	At Santa Cruz	*	1941 1953	1943 1968
Majors Creek	11161570	USGS	Near Santa Cruz	*	1970	1976
Laguna Creek	11161590	USGS	Near Davenport	*	1970	1976
San Vicente Creek	11161800	USGS	Near Davenport	*	1970	1978
Scott Creek	11159150	USGS	Above Little Creek near Davenport	*	1958	1972
Corralitos Creek	11159200	USGS	Near Corralitos at Freedom	*	1955	1976
Green Valley	11159400	USGS	Near Corralitos	*	1961	1973

*Data not available

5.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Base flood elevations on the FIRM represent the elevations shown on the Flood Profiles and in the Floodway Data tables in the FIS Report. Rounded whole-foot elevations may be shown on the FIRM in coastal areas, areas of ponding, and other areas with static base flood elevations. These whole-foot elevations may not exactly reflect the elevations derived from the hydraulic analyses. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS Report in conjunction with the data shown on the FIRM. 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.

For streams for which hydraulic analyses were based on cross sections, locations of selected cross sections are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 6.3), selected cross sections are also listed on Table 24, "Floodway Data."

A summary of the methods used in hydraulic analyses performed for this project is provided in Table 13. Roughness coefficients are provided in Table 14. Roughness coefficients are values representing the frictional resistance water experiences when passing overland or through a channel. They are used in the calculations to determine water surface elevations. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation.

Table 13: Summary of Hydrologic and Hydraulic Analyses

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Aptos Creek	Approximately 60 feet upstream of the confluence with the Pacific Ocean	Approximately 1,720 feet upstream of Soquel Drive	USGS Regional Regression Equation and Log-Pearson Type III	USACE HEC-2	*	VE, AE w/ Floodway	For Log-Pearson III analysis USGS regional skew estimates were used, rather than the U.S. Water Resources Council (USWRC) regional skew estimates, because the former values gave results that were more consistent for streams in the study area (USWRC 1977). Starting WSELs is mean higher high water elevation.
Arana Gulch	Approximately 3,000 feet downstream of Capitola Road	Approximately 100 feet upstream of Brookwood Drive	USGS Regional Regression Equation and Log-Pearson Type III	USACE HEC-2	*	AE w/ Floodway	For Log-Pearson III analysis USGS regional skew estimates were used, rather than the U.S. Water Resources Council (USWRC) regional skew estimates, because the former values gave results that were more consistent for streams in the study area (USWRC 1977). For urbanized watershed, results were adjusted to account for the effects of urbanization on peak flood flow. The adjustment for urbanization is a function of the percentage of basin developed and the percentage of channels for which storm sewers were constructed (DOI 1977). Adjustments for urbanization were required on Arana Gulch within Santa Cruz. Starting WSELs were based on manual computations which considered culvert and weir flow at the northern end of the small craft harbor.
Branciforte Creek	Confluence with San Lorenzo River	Approximately 1,088 feet upstream of Ocean Street	USGS Regional Regression Analysis and Log-Pearson Type III	Slope-Area Method	*	AE	Peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were determined by regional regression analysis for basins with little or no impoundment storage or regulation. The method used for regression analysis was developed by the USGS (DOI 1977).

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Branciforte Creek, continued	Confluence with San Lorenzo River	Approximately 1,088 feet upstream of Ocean Street	USGS Regional Regression Analysis and Log-Pearson Type III	Slope-Area Method	*	AE	The regression relationships predict peak flood flow for each average recurrence interval as a function of basin area, normal annual basin precipitation, and average basin elevation. Other basin characteristics were found to be statistically insignificant for prediction of peak flood flows. WSELs were calculated using the slope-area method.
Browns Creek	Confluence with Corralitos Creek	Approximately 1,950 feet upstream of Via del Sol	USACE HEC-1	USACE HEC-2	*	A	For the Pajaro Valley streams, peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Calibration of rainfall-runoff parameters employed in the HEC-1 computer model was performed using the techniques described in the HEC-1 user documentation (USACE January 1973).
Carbonera Creek	Confluence with Branciforte Creek	Approximately 50 feet upstream of Carbonera Drive	Log-Pearson Type III	HEC-2	*	AE w/ Floodway	USGS regional skew estimates were used, rather than the U.S. Water Resources Council (USWRC) regional skew estimates, because the former values gave results that were more consistent for streams in the study area (USWRC 1977). Starting WSELs were calculated using the slope-area method.
Carbonera Creek	Approximately 1,400 feet downstream of State Highway 17	Approximately 6,000 feet upstream of State Highway 17	USGS Regional Regression Analysis and Log-Pearson Type III	Slope-Area Method	*	AE w/ Floodway	For urbanized watershed, results were adjusted to account for the effects of urbanization on peak flood flow. The adjustment for urbanization is a function of the percentage of basin developed and the percentage of channels for which storm sewers were constructed (DOI 1977). Adjustments for urbanization were required on Carbonera Creek within City of Santa Cruz.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Carbonera Creek	Approximately 50 feet upstream of Carbonera Drive	Approximately 1.25 miles upstream of Carbonera Drive	USGS Regional Regression Analysis and Log-Pearson Type III	Slope-Area Method	*	A	For urbanized watershed, results were adjusted to account for the effects of urbanization on peak flood flow. The adjustment for urbanization is a function of the percentage of basin developed and the percentage of channels for which storm sewers were constructed (DOI 1977). Adjustments for urbanization were required on Carbonera Creek within City of Santa Cruz.
Carbonera Creek	Approximately 3,950 feet downstream of State Highway 17	Approximately 1,400 feet downstream of State Highway 17	USGS Regional Regression Analysis and Log-Pearson Type III	Slope-Area Method	*	A	For urbanized watershed, results were adjusted to account for the effects of urbanization on peak flood flow. The adjustment for urbanization is a function of the percentage of basin developed and the percentage of channels for which storm sewers were constructed (DOI 1977). Adjustments for urbanization were required on Carbonera Creek within City of Santa Cruz.
College Lake	Confluence with Corralitos Creek	Approximately 2,600 feet upstream of Paulsen Road	USACE HEC-1	USACE HEC-2	*	AE	Peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Calibration of rainfall-runoff parameters employed in the HEC-1 computer model was performed using the techniques described in the HEC-1 user documentation (USACE January 1973).

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Corralitos Creek	Lake Avenue	Approximately 2,000 feet upstream of Hidden Moon Road	USACE HEC-1	USACE HEC-2	*	A, AE w/ Floodway	Peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Calibration of rainfall-runoff parameters employed in the HEC-1 computer model was performed using the techniques described in the HEC-1 user documentation (USACE January 1973).
Coward Creek	Confluence with the Pajaro River	Approximately 4,450 feet upstream of Riverside Road	USACE HEC-1	USACE HEC-2	*	AE	Peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Calibration of rainfall-runoff parameters employed in the HEC-1 computer model was performed using the techniques described in the HEC-1 user documentation (USACE January 1973).
Drew Lake	At College Road	Approximately 3,320 feet upstream of College Road	USACE HEC-1	USACE HEC-2	*	A	For the Pajaro Valley streams, peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Calibration of rainfall-runoff parameters employed in the HEC-1 computer model was performed using the techniques described in the HEC-1 user documentation (USACE January 1973).

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Harkins Slough	Confluence with Watsonville Slough	Approximately 4,500 feet upstream of State Highway 1	USACE HEC-1	USACE HEC-2	*	A, AE w/ Floodway	Peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Calibration of rainfall-runoff parameters employed in the HEC-1 computer model was performed using the techniques described in the HEC-1 user documentation (USACE January 1973).
Kelly Lake	At College Road	Approximately 4,020 feet upstream of College Road	USACE HEC-1	USACE HEC-2	*	A	For the Pajaro Valley streams, peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Calibration of rainfall-runoff parameters employed in the HEC-1 computer model was performed using the techniques described in the HEC-1 user documentation (USACE January 1973).
Laguna Creek	Confluence with Pacific Ocean	Approximately 3,040 feet upstream of confluence with Pacific Ocean	USGS Regional Regression Equation and Log-Pearson Type III	*	*	A	
Lake Tynan	Approximately 4,500 feet upstream of Riverside Road	Approximately 900 feet downstream of Lakeview Road	USACE HEC-1	USACE HEC-2	*	AE	Peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Calibration of rainfall-runoff parameters employed in the HEC-1 computer model was performed using the techniques described in the HEC-1 user documentation (USACE January 1973).

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Lompico Creek	At mouth	Approximately 2.7 miles upstream from mouth	Central Coast Region USGS Regression Equations	HEC-RAS 3.1.2	*	A	An approximate study was conducted on Lompico Creek for a total of 2.7 miles from the mouth of the stream to the point at which the basin drains 1 square mile. Discharges for the 1-percent-annual-chance recurrence interval for the approximate study done on Lompico Creek was determined using the Central Coast Region USGS regression equations for California as described in the USGS Water-Resources Investigations Report 77-21 (DOI 1977). Analysis of the hydraulic characteristics of flooding for the approximate study was carried out to profile estimates of the elevations of floods of the selected recurrence intervals. Water-surface profiles were computed for enhanced approximate and approximate study streams through the use of the U.S. Army Corps of Engineers HEC-RAS version 3.1.2 computer program (USACE June 2004). Water surface profiles were produced for the 1-percent-annual-chance storms for Lompico Creek. The enhanced approximate and approximate study methodology used Watershed Information System (WISE) as a preprocessor to HEC-RAS. Tools within WISE allowed the engineer to verify that the cross-section data was acceptable (AECOM 2008). The WISE program was used to generate the input data file for cross section of the modeled stream. No floodway was calculated for Lompico Creek since it was studied by approximate methods.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Majors Creek	Confluence with Pacific Ocean	Approximately 780 feet upstream of State Highway 1	USGS Regional Regression Equation and Log-Pearson Type III	*	*	A	
Moore Creek	Approximately 2,304 feet downstream of Delaware Avenue	Approximately 920 feet upstream of State Highway 1	USGS Regional Regression Analysis	USACE HEC-2	*	AE w/ Floodway	Peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were determined by regional regression analysis for basins with little or no impoundment storage or regulation. The method used for regression analysis was developed by the USGS (DOI 1977). The regression relationships predict peak flood flow for each average recurrence interval as a function of basin area, normal annual basin precipitation, and average basin elevation. Other basin characteristics were found to be statistically insignificant for prediction of peak flood flows. A starting elevation equal to mean higher high water at Monterey Bay in the Pacific Ocean was used.
Nobel Creek	Approximately 2,920 feet downstream of Private Drive	Approximately 740 feet upstream of Private Bridge	USGS Regional Regression Analysis	Step-backwater	*	AE w/ Floodway	Peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were determined by regional regression analysis for basins with little or no impoundment storage or regulation. The method used for regression analysis was developed by the USGS (DOI 1977). The regression relationships predict peak flood flow for each average recurrence interval as a function of basin area, normal annual basin precipitation, and average basin elevation. Other basin characteristics were found to be statistically insignificant for prediction of peak flood flows.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Nobel Creek, continued	Approximately 2,920 feet downstream of Private Drive	Approximately 740 feet upstream of Private Bridge	USGS Regional Regression Analysis	Step-backwater	*	AE w/ Floodway	The WSELs from the mouth of Nobel Creek to the upstream end of the 1,700-foot culvert were computed by manual calculations using the standard step-backwater method. The starting WSEL for Nobel Creek was assumed to be the 10-percent-annual-chance elevation at the confluence with Soquel Creek.
Pajaro River	Approximately 800 feet downstream of the confluence with Watsonville Slough	Approximately 5,100 feet upstream of Rogge Lane	USACE HEC-1	USACE HEC-2	*	AE w/ Floodway	For the City of Watsonville, peak flood flows in the Pajaro River basin for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Physical characteristics and the relationships developed during calibration were used to derive Clark unit hydrograph parameters for all subbasins defined for this study. Hypothetical 1- and 0.2-percent-annual-chance rainfall hyetographs were developed using published intensity-duration-frequency curves (State of California DWR 1975)). Starting WSELs is mean higher high water elevation. Because the Pajaro River levees do not provide 3 feet of freeboard with respect to the 1-percent-annual-chance flood, WSELs were computed for two cases. In the first case, flood elevations were computed before levee overtopping begins, assuming the levees remained intact. In the second case, floods were computed after overtopping occurs, assuming the levees had failed. According to FEMA guidelines, the worst case is used to establish flood elevations in the channel and in the floodplain area.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Pajaro River, continued	Approximately 800 feet downstream of the confluence with Watsonville Slough	Approximately 5,100 feet upstream of Rogge Lane	USACE HEC-1	USACE HEC-2	*	AE w/ Floodway	In this study, WSELs along the Pajaro River before levee overtopping were always highest for the channel, while the highest elevations for the floodplain area were computed when the levees were assumed to be overtopped. The location of levee failure cannot be predicted under major floods; therefor, it was assumed that all levees fail.
Pinto Lake	Approximately 1,088 feet upstream of Green Valley Road	Approximately 1 mile upstream of Green Valley Road	USACE HEC-1	USACE HEC-2	*	A	For the Pajaro Valley streams, peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Calibration of rainfall-runoff parameters employed in the HEC-1 computer model was performed using the techniques described in the HEC-1 user documentation (USACE January 1973).
Rodeo Creek Gulch	East Cliff Drive	Approximately 1,600 feet upstream of Soquel Drive	Log-Pearson Type III	USACE HEC-2	*	VE, AE w/ Floodway	USGS regional skew estimates were used, rather than the U.S. Water Resources Council (USWRC) regional skew estimates, because the former values gave results that were more consistent for streams in the study area (USWRC 1977). Starting WSELs is mean higher high water elevation.
Rose Reservoir	Approximately 730 feet upstream of Casserly Road	Approximately 1,390 feet upstream of Casserly Road	USACE HEC-1	USACE HEC-2	*	A	For the Pajaro Valley streams, peak flood flows for the 10-, 2-, 1-, and 0.2-percent-annual-chance storm events were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Calibration of rainfall-runoff parameters employed in the HEC-1 computer model was performed using the techniques described in the HEC-1 user documentation (USACE January 1973).

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Salsipuedes Creek	Confluence with the Pajaro River	College Lake Outlet	Rational and Regional Regression Methods	HEC-RAS 4.0 (USACE March 2008)	*	AE	Peak discharges for Salsipuedes Creek were utilized from the published FIS and no new hydrology analysis was conducted. The downstream boundary water surface elevations were determined from the effective HEC-2 study. No upstream boundary conditions were included in the hydraulic modeling because all events were modeled using a subcritical flow regime. Because the Salsipuedes Creek levees do not provide 3 feet of freeboard with respect to the 1-percent-annual-chance flood, WSELs were computed for two cases. In the first case, flood elevations were computed before levee overtopping begins, assuming the levees remained intact. In the second case, floods were computed after overtopping occurs, assuming the levees had failed. According to FEMA guidelines, the worst case is used to establish flood elevations in the channel and in the floodplain area. In this study, WSELs along the Salsipuedes Creek before levee overtopping were always highest for the channel, while the highest elevations for the floodplain area were computed when the levees were assumed to be overtopped. The location of levee failure cannot be predicted under major floods; therefor, it was assumed that all levees fail.
San Lorenzo River	Approximately 400 feet upstream of the confluence with the Pacific Ocean	Approximately 1,800 feet upstream of Ocean Street	USGS Regional Regression Equation Analysis and Log-Pearson Type III	USACE HEC-2	*	AE w/ Floodway	USGS regional skew estimates were used, rather than the U.S. Water Resources Council (USWRC) regional skew estimates, because the former values gave results that were more consistent for streams in the study area (USWRC 1977). A starting elevation equal to mean higher high water at Monterey Bay in the Pacific Ocean was used.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
San Lorenzo River, continued	Approximately 400 feet upstream of the confluence with the Pacific Ocean	Approximately 1,800 feet upstream of Ocean Street	USGS Regional Regression Equation and Log-Pearson Type III	USACE HEC-2	*	AE w/ Floodway	Because the San Lorenzo River levees do not provide 3 feet of freeboard with respect to the 1-percent-annual-chance flood, WSELs were computed for two cases. In the first case, flood elevations were computed before levee overtopping begins, assuming the levees remained intact. In the second case, floods were computed after overtopping occurs, assuming the levees had failed. According to FEMA guidelines, the worst case is used to establish flood elevations in the channel and in the floodplain area. In this study, computed WSELs along the San Lorenzo River before levee overtopping were the highest for the channel except for a section between Riverside Drive and the mouth. Highest WSELs for this section of the channel and all floodplain areas were computed when the levees were assumed to be overtopped.
San Lorenzo River	Approximately 5,120 feet downstream of North Big Trees Park Road	Approximately 3,100 feet upstream of McGaffigan Mill Road	USGS Regional Regression Equation and Log-Pearson Type III	USACE HEC-2	*	AE w/ Floodway	USGS regional skew estimates were used, rather than the U.S. Water Resources Council (USWRC) regional skew estimates, because the former values gave results that were more consistent for streams in the study area (USWRC 1977).
San Vicente Creek	Confluence with the Pacific Ocean	Approximately 3,700 feet upstream of State Highway 1	USGS Regional Regression Equation and Log-Pearson Type III	USACE HEC-2	*	AE w/ Floodway	USGS regional skew estimates were used, rather than the U.S. Water Resources Council (USWRC) regional skew estimates, because the former values gave results that were more consistent for streams in the study area (USWRC 1977). The starting WSEL for San Vicente Creek was determined by critical-depth computations.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Schwans Lagoon	Approximately 350 feet downstream of East Cliff Drive	Approximately 1,700 feet upstream of East Cliff Drive	Log-Pearson Type III	USACE HEC-2	*	AE	USGS regional skew estimates were used, rather than the U.S. Water Resources Council (USWRC) regional skew estimates, because the former values gave results that were more consistent for streams in the study area (USWRC 1977). Starting WSELs for Schwans Lagoon were based on manual computations which considered culvert and weir flow at East Cliff Drive.
Scott Creek	At Coast Road	Approximately 2,835 feet upstream of Purdy Ranch Road	USGS Regional Regression Equation and Log-Pearson Type III	*	*	A	
Soquel Creek	Approximately 500 feet downstream of Stockton Avenue	Approximately 1,700 feet upstream of Soquel Creek Road	USGS Regional Regression Equation and Log-Pearson Type III	USACE HEC-2	*	AE w/ Floodway	USGS regional skew estimates were used, rather than the U.S. Water Resources Council (USWRC) regional skew estimates, because the former values gave results that were more consistent for streams in the study area (USWRC 1977). The flows on Soquel Creek resulting from the regression equations were adjusted to correspond with the flows predicted form the data at two gages. The starting WSEL for Soquel Creek was assumed to equal the mean higher high water elevation at Monterey Bay in the Pacific Ocean.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Struve Slough	Confluence with Watsonville Slough	Near the concrete culvert outlet at South Green Valley Road	Rational Method	HEC-RAS 4.0 (USACE March 2008)	*	AE w/ Floodway	New hydrologic analysis was carried out to establish peak discharge-frequency relationships. Peak flood discharges for the 10-, 2-, 1-, and 0.2- percent annual-chance storm events were calculated using the Rational Method and also using Regional Regression equations, then both sets of values were compared to the peak discharges obtained from the published FIS or from the effective hydraulic models. The peak discharges determined by the Rational Method were found to be the most appropriate for the study locations and closest to the published flows. The hydraulic model boundary conditions were established without regard for the regulatory Pajaro River floodplain. Given the variation in watershed size between the Pajaro River and the study flood sources, it was determined that peak flooding would not be coincident. Water surface elevations for the downstream end were determined from location hydraulics studies conducted for Harkins Slough Road bridge crossings.
Thomasello Creek	Approximately 1,000 feet upstream of the confluence with the Pajaro River	Approximately 1,000 feet upstream of State Highway 129	USACE HEC-1	USACE HEC-2	*	AE	Peak flows were based on rainfall-runoff computations using the USACE HEC-1 computer model (USACE 1968). Calibration of rainfall-runoff parameters employed in the HEC-1 computer model was performed using the techniques described in the HEC-1 user documentation (USACE January 1973).

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Thompson Creek	Confluence with the Pajaro River	Approximately 3,800 feet upstream of Carlton Road	Log-Pearson Type III	USACE HEC-2	*	AE	USGS regional skew estimates were used, rather than the U.S. Water Resources Council (USWRC) regional skew estimates, because the former values gave results that were more consistent for streams in the study area (USWRC 1977). On gaged stream, peak flows generated from the regional regression analysis were adjusted to match the USGS log-Pearson Type III estimates at the gage. On ungagged streams, the peak flows generated from the regional regression analysis were used without adjustment.
Watsonville Slough	Confluence with the Pajaro River	Northwest corner of Watsonville Pioneer Cemetery	Rational Method	HEC-RAS 4.0 (USACE March 2008)	*	AE w/ Floodway	New hydrologic analysis was carried out to establish peak discharge-frequency relationships for Watsonville Slough. Peak flood discharges for the 10-, 2-, 1-, and 0.2-percent annual-chance storm events were calculated using the Rational Method and also using Regional Regression equations, then both sets of values were compared to the peak discharges obtained from the published FIS or from the effective hydraulic models. The peak discharges determined by the Rational Method were found to be the most appropriate for the study locations and closest to the published flows. The hydraulic model boundary conditions were established without regard for the regulatory Pajaro River floodplain. Given the variation in watershed size between the Pajaro River and the study flood sources, it was determined that peak flooding would not be coincident. Water surface elevations for the downstream end were determined from location hydraulics studies conducted for Harkins Slough Road bridge crossings. WSELs, south of Ford Road, are influenced by those on the Pajaro River.

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Zayante Creek	Confluence with the San Lorenzo River	Approximately 4,500 feet upstream of Western States Road	Regional Regression Equation and Log-Pearson Type III	USACE HEC-2	*	A, AE w/ Floodway	USGS regional skew estimates were used, rather than the U.S. Water Resources Council (USWRC) regional skew estimates, because the former values gave results that were more consistent for streams in the study area (USWRC 1977). On gaged stream, peak flows generated from the regional regression analysis were adjusted to match the USGS log-Pearson Type III estimates at the gage. On ungagged streams, the peak flows generated from the regional regression analysis were used without adjustment.

*Data not available

Table 14: Roughness Coefficients

Flooding Source	Channel "n"	Overbank "n"
Arana Gulch	0.040 – 0.050	0.060 – 0.100
Branciforte Creek	0.040 – 0.050	0.060 – 0.100
Carbonera Creek	0.050	0.10
Corralitos Creek	0.040 – 0.050	0.045 – 0.100
Moore Creek	0.040 – 0.050	0.060 – 0.100
Nobel Creek	0.035	0.100
Pajaro River	0.015 – 0.050	0.045 – 0.100
Salsipuedes Creek	0.040 – 0.050	0.045 – 0.100
San Lorenzo River	0.020 – 0.040	0.100
Soquel Creek	0.040	0.100
Struve Slough	0.025 – 0.068	0.022 – 0.068
Watsonville Slough	0.015 – 0.045	0.045 – 0.100

5.3 Coastal Analyses

For the areas of Santa Cruz County that are impacted by coastal flooding processes, coastal flood hazard analyses were performed to provide estimates of coastal BFEs. Coastal BFEs reflect the increase in water levels during a flood event due to extreme tides and storm surge as well as overland wave effects.

The following subsections provide summaries of how each coastal process was considered for this FIS Report. Greater detail (including assumptions, analysis, and results) is available in the archived project documentation. Table 15 summarizes the methods and/or models used for the coastal analyses. Refer to Section 2.5.1 for descriptions of the terms used in this section.

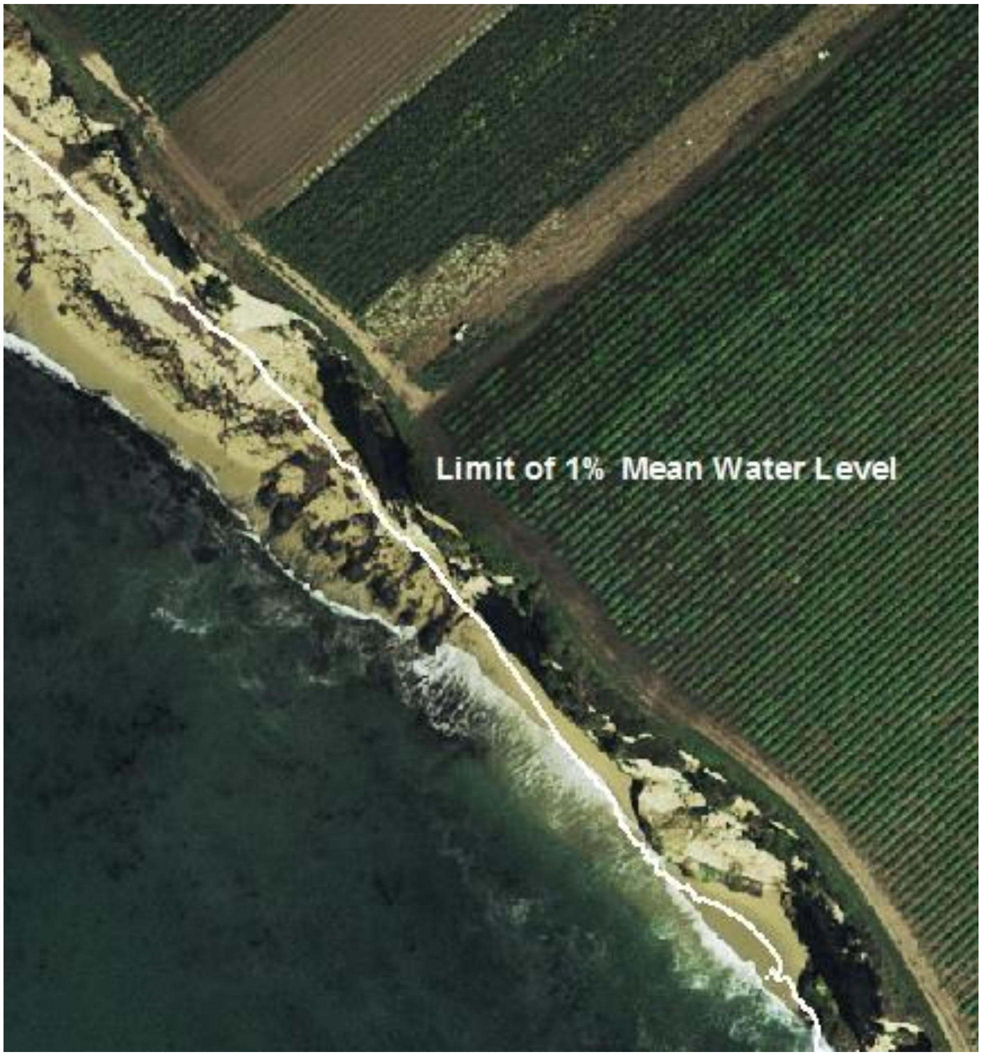
Table 15: Summary of Coastal Analyses

Flooding Source	Study Limits From	Study Limits To	Hazard Evaluated	Model or Method Used	Date Analysis was Completed
Pacific Ocean	South San Mateo County Border	North Monterey County Border	Wave Runup	FEMA Pacific Guidelines (2005), Stockdon, DIM, and TAW	8/9/2013

5.3.1 Total Stillwater Elevations

The total stillwater elevations (stillwater including storm surge plus wave setup) for the 1% annual chance flood were determined for areas subject to coastal flooding. The models and methods that were used to determine storm surge and wave setup are listed in Table 15. The stillwater elevation that was used for each transect in coastal analyses is shown in Table 17, “Coastal Transect Parameters.” Figure 8 shows the total stillwater elevations for the 1% annual chance flood that was determined for this coastal analysis.

Figure 8: 1% Annual Chance Total Stillwater Elevations for Coastal Areas



Astronomical Tide

Astronomical tidal statistics were generated directly from local tidal constituents by sampling the predicted tide at random times throughout the tidal epoch.

Storm Surge Statistics

Storm surge is modeled based on characteristics of actual storms responsible for significant coastal flooding. The characteristics of these storms are typically determined by statistical study of the regional historical record of storms or by statistical study of tidal gages.

When historic records are used to calculate storm surge, characteristics such as the strength, size, track, etc., of storms are identified by site.

Tidal gages can be used instead of historic records of storms when the available tidal gage record for the area represents both the astronomical tide component and the storm surge component. Table 16 provides the gage name, managing agency, gage type, gage identifier, start date, end date, and statistical methodology applied to each gage used to determine the stillwater elevations.

Table 16: Tide Gage Analysis Specifics

Gage Name	Managing Agency of Tide Gage Record	Gage Type	Start Date	End Date	Statistical Methodology
San Francisco (9414290)	NOAA	Tide	1854	Present	GEV
Monterey (9413450)	NOAA	Tide	1973	Present	GEV

Wave Setup Analysis

Wave setup was computed during the storm surge modeling through the methods and models listed in Table 15 and included in the frequency analysis for the determination of the total stillwater elevations.

5.3.2 Waves

An integral component of the transect-based TWL analysis is an accurate determination of the offshore and nearshore wave climate. A continuous 50-year hourly deep-water wave hindcast was developed by Oceanweather Inc. using reanalysis of historical wind fields. Three nested model grid components of sequentially higher resolution were used to resolve wave conditions of varying spatial scales, including basin (global), regional (Northeast Pacific Ocean), and coastal (California) grids.

The deep-water dataset was further transformed to reflect nearshore conditions at the edge of the surf zone in approximately 33-49 feet water depth. The nearshore wave transformation component was carried out by the Scripps Institute of Oceanography (SIO) Coastal Data Information Program (CDIP) research group in collaboration with BakerAECOM using the SIO SHELF model. The output from this wave transformation model provides the input conditions for the 1-D transect-based coastal hazard analysis used to calculate BFEs.

5.3.3 Coastal Erosion

A single storm episode can cause extensive erosion in coastal areas. Storm-induced erosion was evaluated to determine the modification to existing topography that is expected to be associated with flooding events. Erosion was evaluated using the methods listed in Table 15.

5.3.4 Wave Hazard Analyses

Overland wave hazards were evaluated to determine the combined effects of ground elevation, vegetation, and physical features on overland wave propagation and wave runup. These analyses were performed at representative transects along all shorelines for which waves were expected to be present during the floods of the selected recurrence intervals. The results of these analyses were used to determine elevations for the 1% annual chance flood.

Transect locations were chosen with consideration given to the physical land characteristics as well as development type and density so that they would closely represent conditions in their locality. Additional consideration was given to changes in the total stillwater elevation. Transects were spaced close together in areas of complex topography and dense development or where total stillwater elevations varied. In areas having more uniform characteristics, transects were spaced at larger intervals. Transects shown in Figure 9, "Transect Location Map," are also depicted on the FIRM. Table 17 provides the location, stillwater elevations, and starting wave conditions for each transect evaluated for overland wave hazards. In this table, "starting" indicates the parameter value at the beginning of the transect.

Wave Height Analysis

Wave height analyses were performed to determine wave heights and corresponding wave crest elevations for the areas inundated by coastal flooding and subject to overland wave propagation hazards. Refer to Figure 6 for a schematic of a coastal transect evaluated for overland wave propagation hazards.

Wave heights and wave crest elevations were modeled using the methods and models listed in Table 15, "Summary of Coastal Analyses".

Wave Runup Analysis

Wave runup analyses were performed to determine the height and extent of runup beyond the limit of stillwater inundation for the 1% annual chance flood. Wave runup elevations were modeled using the methods and models listed in Table 15.

Table 17: Coastal Transect Parameters

Transect	X,Y Coordinates (Meters, NAD83 UTM Zone 10)		Total Water Elevation (feet NAVD88)[1]					Zone	BFE (ft)
	X	Y	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance		
1	562936.73	4106694.48	17.5	18.7	19.5	20.4	22.5	VE	20
2	563586.36	4105987.25	27.9	31.9	34.9	37.9	45.0	VE	38
3	563826.60	4105660.35	18.7	20	21.0	22.0	24.4	VE	22
4	564022.10	4105394.81	17.9	19	19.8	20.6	22.4	VE	21
5	564204.34	4104894.05	14.7	15.7	16.4	17.1	18.9	VE	17
6	565252.66	4103498.33	15.4	16.4	17.2	18.0	19.7	VE	18
7	566962.16	4101097.64	14.8	16.4	17.9	19.7	25.2	VE	20

Transect	X,Y Coordinates (Meters, NAD83 UTM Zone 10)		Total Water Elevation (feet NAVD88)[1]					Zone	BFE (ft)
	X	Y	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance		
8	568374.41	4099482.18	20.6	21.6	22.4	23.1	24.8	VE	23
9	569548.78	4097659.85	18.5	19.5	20.3	21.2	23.2	VE	21
10	571136.08	4096365.59	14.9	15.7	16.3	16.8	17.9	VE	17
11	573130.75	4094677.48	16.5	17.4	18.0	18.6	20.0	VE	19
12	574942.89	4093240.53	16.6	17.7	18.6	19.5	21.7	VE	19*
13	576345.12	4092435.27	18.3	19.4	20.1	20.9	22.7	VE	21
14	576544.20	4092230.22	20.7	22.7	24.4	26.3	31.7	VE	26
15	578249.49	4091095.24	16.4	17.3	18.1	18.9	20.6	VE	19

Transect	X,Y Coordinates (Meters, NAD83 UTM Zone 10)		Total Water Elevation (feet NAVD88)[1]					Zone	BFE (ft)
	X	Y	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance		
16	580194.09	4090186.00	18.5	21.6	24.2	27.1	35.2	VE	27
17	582017.76	4089940.50	14.3	15.3	16.2	17.1	19.7	VE	17
18	583253.50	4089443.20	25.7	28.1	29.9	31.6	35.5	VE	32
19	583604.68	4089552.88	18.4	20.3	22.0	24.0	29.9	VE	24
20	583753.29	4089592.24	26.6	28.9	30.5	32.1	35.5	VE	32
21	584187.36	4089571.50	32.0	34.3	36.0	37.6	41.3	VE	38
22	584556.42	4089558.15	23.1	26.0	28.2	30.5	36.2	VE	31
23	585274.17	4089821.31	17.6	20.7	23.7	27.3	38.8	VE	27

Transect	X,Y Coordinates (Meters, NAD83 UTM Zone 10)		Total Water Elevation (feet NAVD88)[1]					Zone	BFE (ft)
	X	Y	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance		
24	585745.78	4089959.83	28.9	30.8	32.2	33.6	36.7	VE	34
25	586279.01	4089793.87	28.8	30.5	31.6	32.6	34.4	VE	33
26	586870.63	4090093.24	20.2	21.8	23.0	24.3	27.2	VE	24
27	586910.31	4090285.03	24.0	26.0	27.6	29.3	33.3	VE	29
28	586897.42	4090545.40	25.7	28	29.9	32.0	37.8	VE	32
29	586886.12	4090787.46	11.1	11.7	12.2	12.9	14.5	VE	13
30	587218.06	4091071.50	15.3	16.1	16.8	17.6	19.5	VE	18
31	587631.98	4091125.40	15.0	16.2	17.2	18.4	21.8	VE	18

Transect	X,Y Coordinates (Meters, NAD83 UTM Zone 10)		Total Water Elevation (feet NAVD88)[1]					Zone	BFE (ft)
	X	Y	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance		
32	588567.66	4091047.06	16.7	17.6	18.4	19.1	21.0	VE	19
33	589197.35	4090964.21	16.2	17.2	18.0	18.8	21.0	VE	19
34	589411.81	4090857.97	17.2	18.3	19.3	20.4	23.1	VE	20
35	589548.14	4090775.33	14.5	15.5	16.3	17.1	19.4	VE	17
36	589697.61	4090720.08	24.6	26.8	28.7	30.8	36.4	VE	31
37	590256.59	4090733.74	15.7	16.8	17.8	18.8	21.6	VE	19
38	590410.56	4090641.77	15.8	16.6	17.3	18.0	19.7	VE	18
39	590679.46	4090498.35	17.7	18.6	19.4	20.1	21.9	VE	20

Transect	X,Y Coordinates (Meters, NAD83 UTM Zone 10)		Total Water Elevation (feet NAVD88)[1]					Zone	BFE (ft)
	X	Y	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance		
40	590857.98	4090378.16	17.2	18.1	18.8	19.5	21.1	VE	20
41	590981.63	4090274.63	25.5	27.9	29.7	31.4	35.5	VE	31
42	591426.12	4090200.99	35.7	38.3	40.0	41.7	45.2	VE	42
43	591826.55	4090457.09	18.3	20.2	21.6	23.0	26.5	VE	23
44	591959.32	4090562.18	28.8	31.0	32.7	34.5	39.0	VE	35
45	592639.73	4091255.58	24.9	26.7	28.0	29.4	32.8	VE	29
46	592953.67	4091676.44	13.2	14.1	14.9	15.7	17.9	VE	16
47	593197.20	4091993.83	16.0	17.0	17.7	18.5	20.2	VE	18*

Transect	X,Y Coordinates (Meters, NAD83 UTM Zone 10)		Total Water Elevation (feet NAVD88)[1]					Zone	BFE (ft)
	X	Y	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance		
48	593415.36	4092091.33	16.5	17.7	18.6	19.6	22.0	VE	20
49	593577.47	4092157.36	17.7	19.9	21.8	24.1	30.5	VE	24
50	593953.81	4092427.56	18.2	19.7	20.9	22.3	25.6	VE	22
51	594561.05	4092826.06	16.9	18.0	18.9	19.7	21.7	VE	20
52	595109.81	4092850.91	20.0	21.3	22.3	23.2	25.3	VE	23
53	595289.68	4092802.42	16.6	17.7	18.5	19.2	21.0	VE	19
54	595655.96	4092678.76	21.6	23.0	24.0	25.1	27.4	VE	25
55	596354.80	4092332.23	19.4	20.8	22.0	23.2	26.0	VE	23

Transect	X,Y Coordinates (Meters, NAD83 UTM Zone 10)		Total Water Elevation (feet NAVD88)[1]					Zone	BFE (ft)
	X	Y	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance		
56	597307.01	4091831.29	21.1	22.9	24.3	25.7	29.1	VE	26
57	597560.42	4091676.22	18.1	19.4	20.4	21.4	23.7	VE	21
58	597861.90	4091430.35	17.9	19.1	20.0	21.0	23.1	VE	21
59	598300.38	4091050.13	18.4	19.7	20.8	21.9	24.6	VE	22
60	599003.53	4090354.47	16.7	17.8	18.7	19.6	21.7	VE	20
61	599290.49	4090051.14	18.2	19.4	20.3	21.2	23.2	VE	21
62	600293.13	4088874.83	20.2	21.3	22.0	22.7	24.2	VE	23
63	600854.39	4088094.31	16.3	17.1	17.6	18.1	19.2	VE	18

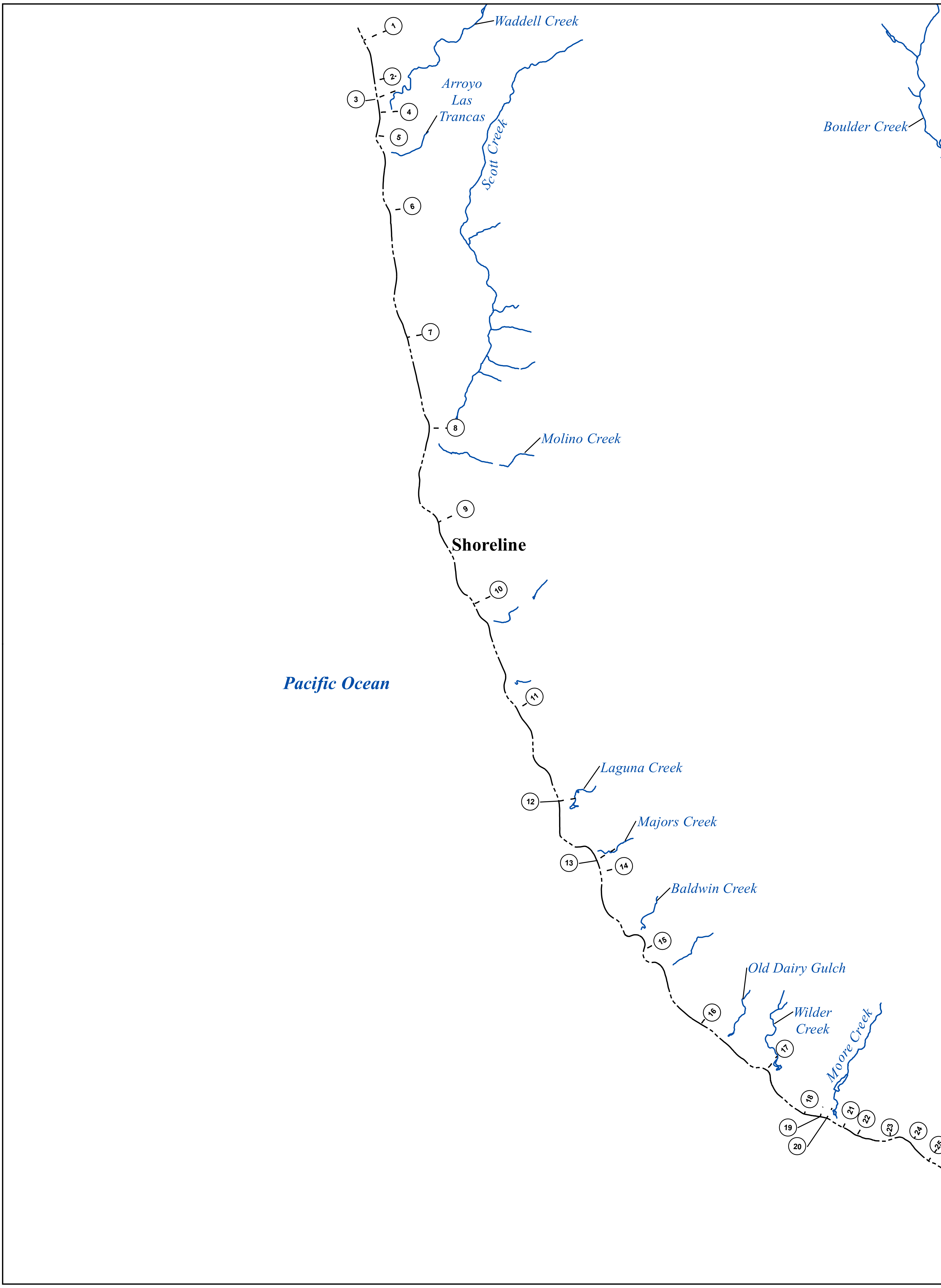
Transect	X,Y Coordinates (Meters, NAD83 UTM Zone 10)		Total Water Elevation (feet NAVD88)[1]					Zone	BFE (ft)
	X	Y	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance		
64	601418.44	4087289.01	18.5	19.5	20.3	21.1	23.1	VE	21
65	601790.27	4086590.05	14.1	14.8	15.3	15.8	16.8	VE	16
66	601987.16	4086233.17	16.9	17.9	18.8	19.6	21.7	VE	20
67	602726.73	4084816.27	17.8	18.7	19.3	19.9	21.1	VE	20
68	603504.06	4083420.77	17.1	17.8	18.3	18.8	19.7	VE	19
69	604261.08	4082016.35	16.0	16.8	17.5	18.2	19.7	VE	18
70	604779.25	4080941.63	16.5	17.4	18.2	19.0	20.8	VE	19
71	605303.08	4079865.63	19.0	20.3	21.3	22.1	23.8	VE	22

Transect	X,Y Coordinates (Meters, NAD83 UTM Zone 10)		Total Water Elevation (feet NAVD88)[1]					Zone	BFE (ft)
	X	Y	10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance		
72	605694.94	4079029.13	18.4	19.7	20.5	21.2	22.6	VE	21

[1]North American Vertical Datum of 1988

*Value has been rounded to the nearest tenth of a foot – precision of results to the hundredths of a foot resulted in rounding the BFE on the FIRM down to the nearest whole foot.

Figure 9: Transect Location Map



1 inch = 8,333 feet 1:100,000

N

0 2,400 4,800 9,600 14,400 19,200 Feet

Map Projection:
Universal Transeverse Mercator Zone 10 North;
North American Datum 1983

NATIONAL FLOOD INSURANCE PROGRAM

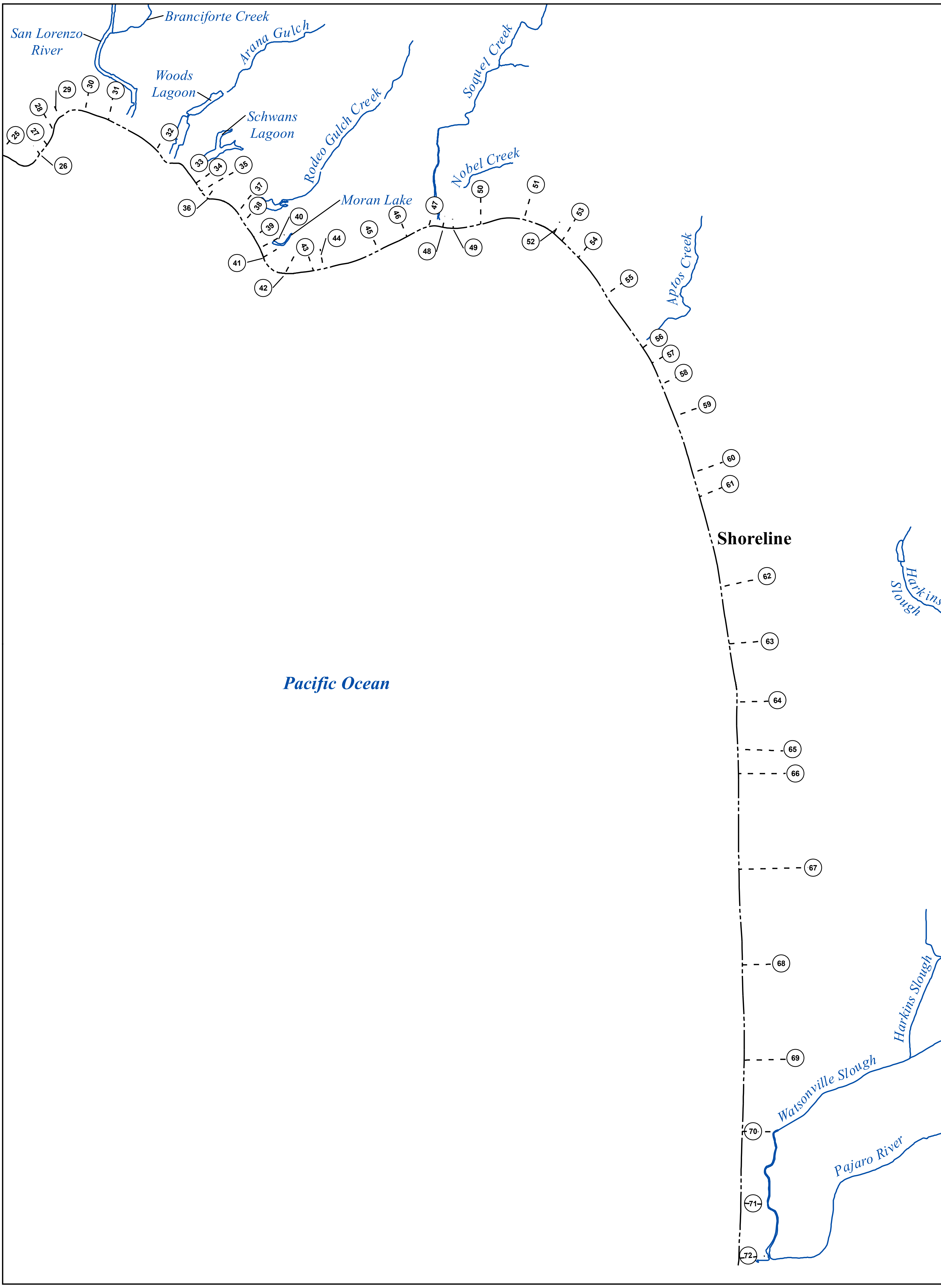
Transect Location Map

PANELS WITH TRANSECTS:

0156F, 0157F, 0159F, 0186F, 0189F, 0306F, 0307F, 0328F, 0329F, 0333F, 0334F, 0352F, 0353F, 0354F, 0356F, 0357F, 0358F, 0359F, 0378F, 0386F, 0388F, 0389F, 0452F, 0456F

FEMA

Figure 9: Transect Location Map, continued



N

1 inch = 6,055 feet 1:72,661

0 1,750 3,500 7,000 10,500 14,000 Feet

Map Projection:
Universal Transeverse Mercator Zone 10 North;
North American Datum 1983

COUNTY LOCATOR

NATIONAL FLOOD INSURANCE PROGRAM

Transect Location Map

PANELS WITH TRANSECTS:

0156F, 0157F, 0159F, 0186F, 0189F, 0306F, 0307F, 0328F, 0329F, 0333F, 0334F, 0352F, 0353F, 0354F, 0356F, 0357F, 0358F, 0359F, 0378F, 0386F, 0388F, 0389F, 0452F, 0456F

FEMA

5.4 Alluvial Fan Analyses

This is section is not applicable to this Flood Risk Project.

Table 18: Summary of Alluvial Fan Analyses
[Not Applicable to this Flood Risk Project]

Table 19: Results of Alluvial Fan Analyses
[Not Applicable to this Flood Risk Project