Sonoma County
Hazard Mitigation Plan

FLOOD HAZARDS

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FLOOD HAZARDS
TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FLOOD HAZARDS

Hazard Description

Floods are the most frequent natural hazard impacting Sonoma County, causing the greatest property losses and accounting for the highest number of local, Gubernatorial, and Presidential disasters. The Sonoma county Operational Area Emergency Operations Center (EOC) has been activated nine times due to flood related local emergencies since 1995.

A flood occurs when the existing stream channels cannot contain excess runoff from rainfall resulting in overflow onto adjacent lands. Flooding can result from storm surges, excessive rainfall, tsunamis, dam failure, and sea level rise. Drought conditions can cause isolated flooding in the estuary of the Russian River due to excess sand disposition at the bar of the estuary, blocking the path the Pacific Ocean.

A “floodplain” is the area adjacent to a watercourse or other body of water that is subject to recurring inundation from floods. Floods on small streams usually peak and recede quickly, while floods on the lower Russian River may not peak for two days or more after the start of a storm and may exceed flood stage for four days or more.

Damaging floods occur most frequently along the Russian River, Petaluma River, and Sonoma Creek; and the tributaries in these watersheds. Floods in Sonoma County occur during the winter months, develop within 24 to 48 hours after the storm event, and recede within three days after the end of the storm. In the southwest segment of the Russian River, aka Lower Russian River, floods are characterized by high velocity and significant depth of flow due to the relatively narrow floodplain. The frequency of flooding in this portion of the river causes repetitive flood losses to occur in the residential and commercial districts of Mirabel Park, Duncans Mills, Monte Rio, Rio Nido and Guerneville.

The United States Geological Survey (USGS) has maintained stream-gaging stations to record flow levels on the Russian River since 1911. The gages are located in the communities of Cloverdale (USGS gauge #11463000), Healdsburg (USGS gauge #11464000), and Guerneville (USGS gauge # 11467000). The drainage area monitored by these gaging station is about 1,340 square miles, of which 235 square miles are in the drainage areas behind either the Warm Springs Dam or the Coyote Valley Dam. The Guerneville gauge monitors peak discharge approximately, 4.3 miles upstream from the Guerneville Bridge and 20.8 miles upstream from the mouth of the Russian River. For County emergency response purposes a staff gauge on the Guerneville Bridge is used to monitor flood elevation levels and risk to the community of Guerneville. This gauge does not measure or record flow levels and is not an official USGS gaging station. Table FH-1 shows the relationship between flood elevations and gauge height measured at the Guerneville gauge located at the Guerneville Bridge.

The National Weather Service considers the Russian River at flood stage when it reaches a height of 32 feet at the Guerneville Bridge. Floods reaching a gauge height of less than 34 feet at the Guerneville Bridge are a common inconvenience that often occur during a typical winter.

High water less than 34 feet does not usually present a significant problem for the community or emergency service organizations.

Table FH-1: Russian River Flood Elevations at the Guerneville Bridge Gauge, Guerneville, California

Recurrence Interval	Elevation (feet)	Equivalent Staff Gauge Height (feet)
Water Surface	11.53	0
Monitor Level	40.86	29.00
Flood Level	43.86	32.00
10 Year Flood	49.86	38.00
50 Year Flood	57.36	45.50
100 Year Flood	59.86	48.50
500 Year Flood	62.89	51.60

Note: As of 2008, the flood elevations indicated in the FEMA Flood Insurance Study for Sonoma County have been referenced to the NAVD88 datum. Equivalent Staff Gauge Height is the Sonoma County Staff Gauge at Guerneville Bridge.

Sonoma Creek frequently floods during relatively small winter storm events that cause flows to overtop the banks. The flooding is of short duration, but may last several days. The bordering low lands are most impacted, as a result of storm water runoff from the upper watershed (SRCD 2016).

Petaluma River floods after multi-day storm events due to inadequate storm water infrastructure. Flooding along this river mainly occurs in the Payran area, between Denman Flat and the confluence of Lynch Creek; and the Penngrove area. Between 1997 and 2008, the City of Petaluma significantly reduced their flood exposure in the Payran area by completing $40 million in improvements to flood control infrastructure, including 3,600 linear feet of channel widening and floodwalls, pump stations, two vehicular bridge replacements, and two railroad bridge replacements.

Areas along the Pacific Ocean coastline are typically not subject to river flooding, except at the mouth of the Russian River. The coastline is subject to tidal surges and wave action during coastal storms as well as tsunamis during seismic events. These areas will be impacted by sea level rise; see a separate discussion later in this report.

Dam Failure Inundation Zones: Flooding can result from dam failure. A Dam Failure Inundation Zone is the specific area that has potential for inundation. The current mapping of dam failure inundation zones is shown in Figure 8.7.

FEMA Flood Insurance Rate Maps

The most readily available source of information regarding the 100-year flood is the Flood Insurance Rate Maps (FIRMs) prepared by FEMA to support the National Flood Insurance Program (NFIP). The standard for floodplain management in the United States is to delineate

and address flood risks within the area inundated by the 100-year flood or base flood. Floods may be quantified in terms of flow (cubic feet per second (CFS), water elevation, inundated area, and reoccurrence interval. For instance, a 100-year flood has a 1-percent chance of occurring in any given year. Although the recurrence level is based on statistical averages, the actual occurrence of events varies and could occur at shorter intervals or even within the same year.

FEMA prepared a Flood Insurance Study (FIS) for the County of Sonoma to identify and map the flood hazard areas in the County. The FIS was last updated in October 2015 and a map of the flood hazard areas are available in the Public Safety Element of the Sonoma County General Plan 2020, Figure PS-1e. The FIS, FIRMs, and all subsequent amendments and/or revisions, are hereby adopted by reference and declared to be a part of this chapter. The FIS, FIRMs, and Flood Boundary and Floodway Maps are on file at the Permit and Resource Management Department, 2550 Ventura Avenue, Santa Rosa CA 95403. Figure 8.5 displays the location of the 100-year floodplain for Sonoma County using the latest FIRM.

In areas where FEMA has studied SFHAs by detailed methods, the FIRMs show Base Flood Elevations (BFEs). The computed elevation to which floodwater is anticipated to rise during the base flood. Base Flood Elevations are shown on Flood Insurance Rate Maps and on the flood profiles. The BFE is the regulatory requirement for the elevation of floodproofing of structures. The relationship between the BFE and a structure's elevation determines the flood insurance premium.

The land area covered by the floodwaters of the base flood is the Special Flood Hazard Area (SFHA) on NFIP maps. The FIS contains technical data hydraulic analyses used to prepare the FIRM including discharge data and flood elevation profiles for the 10-, 50-, 100-, and 500-year floods. The area inundated by the 100-year flood is referred to as the Special Flood Hazard Area (SFHA). Flood insurance is mandatory for properties in a SFHA. The SFHA is the area where the National Flood Insurance Program's (NFIP's) floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies. The SFHA includes Zones A, AO, AH, A1-30, AE, A99, AR/A1-30, AR/AE, AR/AO, AR/AH, AR/A, VO, V1-30, VE, and V.

- FIRM Zone A – Areas with a 1% annual chance of flooding (i.e.: Parcels within the 100-year flood plain). No depths or base flood elevations are shown within these zones because detailed analyses are not performed.
- FIRM Zone AE – Areas with a 1% annual chance of flooding (i.e.: Parcels within the 100-year flood plain) where base flood elevations are provided.
- FIRM Zone AH – Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
- FIRM Zone AO – River or stream flood hazard areas, and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life

of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.

- FIRM Zone AR – Areas with a temporarily increased flood risk due to the building or restoration of flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements will apply, but rates will not exceed the rates for unnumbered A zones the structure is built or restored in compliance with Zone AR floodplain management regulations.
- FIRM Zone A99 – Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.

The FEMA designated floodway is the channel of a watercourse and portion of the adjacent floodplain that is needed to convey the base flood without increasing flood levels by more than a specified amount (typically, 1 foot). A "floodway" may be designated within the 100 year flood plain where water is likely to be deepest, highest velocity flow, and any infrastructure will be at risk. Floodways should be kept free of obstructions and development to allow floodwaters to move downstream unobstructed. Any development in the floodway is subject to severe damage and high risks for occupants and emergency responders.

The areas zoned AE on the FIRM maps are zoned in the F1 (Floodway Combining District) in the County's Zoning Ordinance. Under the minimum floodplain management criteria of the NFIP, communities must restrict development within the floodway.

The area that is within the 100-year SFHA but outside of the floodway is referred to as the "floodway fringe". These areas are zoned in the F2 (Floodplain Combining District) in the County's Zoning Ordinance. Communities may permit development within these areas but place conditions on the construction to comply with NFIP requirements and County code. For example, new residential construction is only allowed if the first floor elevation is at least one-foot above the projected elevation of the 100-year flood.

Flood damage may occur outside of SFHAs. FEMA typically does not designate SFHAs for areas subject to flooding from local drainage problems, particularly in urban areas; drainage basins of less than 1 square mile in area; or hillside areas subject to runoff, erosion, and mudflow. FEMA does not map flooding along the length of all streams or in areas that are undeveloped.

Factors Affecting the Level of Flooding

Precipitation

Sonoma County's Mediterranean climate is characterized by a summer dry season followed by a winter rainy season, generally extending from November to April. Precipitation in the Russian River is distinctly seasonal, 93 percent occurs during November through March (NOAA 2013). The bulk of the precipitation occurs during moderate storms of over several days. Rainfall varies throughout the county from 70 to 20 inches annually in the north central and the southeastern sections of the County.

The intensity, distribution and duration of rainfall are the most important factors in determining the magnitude of floods. If a storm event extends many hours or days, flooding can be enhanced as soils become saturated, reservoirs full and runoff from the upland and upstream areas accumulates downstream. Table FH-2 indicates the projected rainfall levels that are expected to fall in the low and high rainfall areas of the county during recurring storms based on data from the NOAA's Western Regional Climate Center. Drainage and flood control measures should be designed and sized to accommodate the large runoff flows expected in each area to minimize the risk of flooding.

Table FH-2: Rainfall Intervals Associated with 24 Hour Storm Event in Sonoma County

Average Recurrence Interval	Southeast County (inches)	North Central County (inches)
2-year	3.0	7.5
10-year	3.5	11
25-year	4.0	13
50-year	4.5	14
100-year	5.0	15

Source: Western Precipitation Frequency Maps; NOAA

A meteorological phenomena termed "atmospheric river" increases the intensity and frequency of rain events and flooding in Sonoma County. Atmospheric rivers are narrow bands, two hundred miles wide and twelve hundred miles or more long, that transport water vapor from the tropics toward the poles (NOAA 2013). Sonoma County's wintertime precipitation comes from atmospheric rivers, and these events have been found to cause 87 percent of the floods in the Russian River from 1948 to 2011. The amount and intensity of precipitation depends greatly on whether these atmospheric rivers make landfall in California, a phenomenon that is difficult to predict and model.

Climate change is also influencing the intensity and frequency of storm events. Sonoma County PRMD is collaborating with the Sonoma County Water Agency (SCWA), several resource agencies and researchers to ascertain the best available science to inform Climate Change scenarios and policies for Sonoma County.

Watershed Size

The runoff from an entire watershed has a cumulative combined effect which is directly linked to the magnitude of flooding that occurs downstream. In general, a larger watershed concentrates more runoff and results in higher flood levels than a smaller watershed. Sonoma County falls almost entirely within four major watersheds: Russian River, Gualala River, San Pablo Bay, and Coastal (a collection of small watersheds draining to the Pacific Ocean). These watersheds are shown in Figure 8.4; drainage basin areas are provided in Table FH-3.

The Russian River Watershed is the largest in Sonoma County, draining a total of 1,485 square miles. It originates in Mendocino County, flows southward through eastern Sonoma County to Healdsburg, where it turns west; then flows into the Pacific Ocean at Jenner. Nearly 90 percent

of the drainage basis lies upstream of the flood-prone areas of the Russian River which includes the unincorporated communities of Monte Rio, Guerneville, Rio Nido and Forestville. The watershed comprises much of the County's prime agricultural land and has been greatly influenced by urbanization in the vicinity of Windsor and Santa Rosa. West of Forestville, the river's floodplain narrows significantly as it flows through the Coast Range to the Pacific.

Table FH-3: Sonoma County Watershed Size (square miles)

Watershed and Sub-watershed	Square Miles In County	Square Miles Outside of County	Total watershed
Gualala River	269	31	300
Russian River			
Big Sulphur Creek	80		
Maacama Creek	69		
Dry Creek	175		
Mark West Creek	83		
Laguna de Santa Rosa	89		
Green Valley / Atascadero Creeks	37		
Austin Creek	70		
Santa Rosa Creek	81		
Other subwatersheds	237		
Russian River Watershed total	921	564	1,475
Coastal			
North Coast	49		
South Coast	9		
Salmon Creek	37		
Estero Americano	50	13	
Stemple Creek	22		
Coastal Watershed total	167	13	180
San Pablo Bay			
Sonoma Creek	170		
Petaluma River	112	34	
San Pablo Bay Watershed total	282	34	316

Channel Capacity

Flood Capacities of the Russian River at bank full stage varies considerably along its length due to the wide range of channel dimensions. Sedimentation and deposition of gravels in rivers and streams can reduce channel capacity increasing flood risk.

Infiltration and Runoff Rates

The slope of the ground can affect the rate of storm water runoff; the steeper the slope, the greater the rate of runoff. The soil type also affects the rate of infiltration. The soil characteristics described by the Natural Resources Conservation Service indicates the majority of the county has soils with low permeability that limit infiltration. Once soils are saturated, the rate of infiltration decreases and the rate of runoff increases. During larger storms, the soil becomes saturated and can no longer absorb additional rainfall. Under these conditions, whether on paved surfaces or on saturated soil, run off directly becomes streamflow. The level of vegetation cover can slow the rate of runoff as water is captured on the plant surfaces and in the layer of organic matter.

Another factor that can increase local run-off rates is the amount of impervious surfaces. Urban areas can have more than twice the runoff the volume as their pre-developed state because

Another factor that can increase local run-off rates is the amount of impervious surfaces. Urban areas can have more than twice the runoff the volume as their pre-developed state because rainfall does not infiltrate impervious roads, sidewalks, parking areas and buildings. Increased runoff rates in the 1,500 square mile Russian River watershed that is urbanized is small. Local flooding can occur more frequently when increased storm water rates and volumes from urbanized areas exceed channel capacity, or increase channel velocity raising erosion potential.

Flood Plain Retention

The natural flood plains are part of the hydrological process and overflowing flood waters which are temporarily stored on the flood plain can relieve some of the flood pressure on downstream areas while depositing silt. Areas of the Alexander Valley and the Middle Russian River, Cloverdale to Windsor have broad agricultural plains which can temporally store flood water when the river channel overflows.

The Laguna de Santa Rosa in the Santa Rosa Plain is a natural overflow basin covering 254 square miles that connects Mark West Creek and other smaller creeks with the Russian River. Floods along the lower Russian River are attenuated by the Laguna de Santa Rosa. The Laguna de Santa Rosa serves as a natural detention basin that can lower the River's downstream flood levels by more than 10 feet. During floods, the Laguna de Santa Rosa acts as a huge reservoir, storing up to 80,000 acre-feet of water.

Over the last 200 years, land clearance, farming, urbanization and channelization in the Santa Rosa Creek subwatershed have accelerated erosion and sedimentation and decreased the Laguna's flood storage capacity. A 2004 report from the US Army Corps of Engineers estimated that the Laguna has filled about 1.5 feet from 1956 to 2002, representing a loss of about 54 acre feet per year (AFY). Most sediment is coming from Santa Rosa Creek, followed by the upper Laguna tributaries near Cotati.

With current deposition rates and population growth, the flood storage capacity of the Laguna de Santa Rosa may continue to decrease by approximately 50-60 acre feet per year. Projections for future sedimentation indicate that over the next 50 years, the flood elevation in the Laguna de Santa Rosa may increase by 2.5-3.0 feet. Increased sedimentation affects not only flood capacity, but also reduces the ecological function of the Laguna de Santa Rosa, which is Sonoma County's richest area of wildlife and one the most biologically diverse areas. In 2016, the County designated an addition of 159 acres as wetlands along Atascadero Creek to protect this sensitive biological community from increased urbanization.

Flood Control Structures and Operations

There are a number of engineered structures in the county that help retain runoff or control flooding. The largest dam is the 319-foot high Warm Springs Dam built in 1982 by the US Army Corps of Engineers, located 14 miles northwest of Healdsburg at the confluence of Warm Springs Creek and Dry Creek. The dam forms Lake Sonoma Reservoir which holds a water supply of 212,000 acre feet and a flood pool of 130,000 acre feet. The dam retains runoff from the Dry Creek watershed which flows into the Russian River. While the Sonoma County Water

Agency regulates summers releases for water supply, US Army Corps of Engineers determines winter releases for flood management.

There are additional dams in Mendocino County which affect downstream flood flows in Sonoma County. The largest of these is the 150-foot high Coyote Valley Dam in Mendocino County built in 1959 on the East Fork Russian River. It forms the Lake Mendocino reservoir which holds 122,400 acre feet. Flood control releases from this dam are controlled by the USACE.

Dams can be beneficial for flood management by permanently or temporarily storing water and managing releases to diminish peak flow. . Water held in reservoirs does not contribute to the flood peak and can be released later at slower rate with fewer consequences once the flood peak has passed. The drainage area of the Warm Springs Dam and the Coyote Valley Dam is 235 square miles and a combined storage capacity of 450,000 acre feet. The storage facilities of the Warm Springs Dam and Coyote Valley Dam have been credited with both reducing floodwaters by four feet in the Guerneville area during the February 1986 flood and for reducing the flood crest level by an estimated 7 to 10 feet overall.

USACE, SCWA and the California/Nevada River Forecast Center work closely together to determine pre-release flows to manage downstream water levels during peak rain periods. This pre-release program is an important aspect of flood management for the Russian River, and has been successful in reducing downstream flood levels. Officials from USACE speculate that without the dams, and the practice of controlled releases, the 2006 New Year's Flood would have exceeded the current flood crest record set in 1986.

SCWA is responsible for maintaining federal and non-federal flood management projects on the Russian River in cooperation with USACE. SCWA maintains the Central Sonoma Watershed Project, a network of 150 miles of engineered and natural drainage channels on the Santa Rosa Plains, and channel and levee maintenance activities in the upper Russian River near Cloverdale. SCWA's maintenance activities include debris removal, bank stabilization and protection, maintenance of inlet/outlet structures, silt removal, vegetation management, levee repair, service road maintenance and dam and reservoir structure maintenance.

The Central Sonoma Watershed Project includes four flood management reservoirs, including the Santa Rosa Creek Reservoir (Spring Lake), Matanzas Creek Reservoir, Piner Creek Reservoir, and the Brush Creek Middle Fork Reservoir. Each of these reservoirs are equipped with appurtenant structures, but unlike the Warm Springs and Coyote Valley dams, they are not equipped with flood gates. Instead, they operate passively either as detention basins or bypass systems.

According to information from the California Department of Water Resources, there are 64 smaller dams dispersed throughout the County that are regulated by the Division of Dam Safety. These have a total storage capacity of 18,981 acre feet.

Hazard History

Significant historic floods have occurred on the Russian River in 1955, 1964, 1986, 1995, 1997, and most recently in January of 2006 (ESA 2010). The earliest major flood recorded on the Russian River occurred in 1862. This flood predated gauge measurements of river flow, but is estimated to have had a discharge of about 100,000 cubic feet per second. The largest flood in recent history occurred between February 14 and 18, 1986, when a peak discharge of 102,000 cubic feet per second was recorded and the flood reached a gage height of 48.6 feet at Guerneville. Heavy rains from December 26, 2005, to January 3, 2006. The Russian River rose above flood stage at all USGS gaging stations in Sonoma County (NOAA 2013). Significant flooding also occurred on the Petaluma River and Sonoma Creek. At Guerneville, the river crested at 41.6 feet. The rainfall measured in the City of Santa Rosa during this storm was near record-setting at 17.6 inches (NOAA 2013). The President declared this flood a major disaster, and more than 100 roadways were blocked due to flooding or landslides. Some 2,100 business and residential properties were inundated and 50,000 residents were without power (NOAA 2013). Sonoma County business and residential damages were estimated at $104 million (NOAA 2013).

Table FH-4 provides annual peak gauge heights and discharges for the Russian River at the USGS Guerneville gage since 1955. It indicates that the peak flows exceeded flood stage at Guerneville in 34 of 59 years. The number of floods experienced may be greater as some years had more than one high flow event.

The Petaluma River has also had a history of flooding. According to USACE, floods in 1982, 1986, and 1998 caused over $34 million in damage within the City of Petaluma, particularly in the Payran area. These flood hazards have been significantly reduced by construction of flood control channels and flood walls, completed in 2008.

Table FH-4: Annual Peak Stream Flow and Gauge Height on Russian River near Guerneville

Year	Date	Gauge Height (ft)	Streamflow (cfs)	Year	Date	Gauge Height (ft)	Streamflow (cfs)
1955	Dec. 06	19.32	13,500	**1986**	Feb. 18	48.56	102,000*
1956	Dec. 23	49.70	90,100	**1987**	Mar. 13	24.34	26,000*
1957	Feb. 25	33.77	45,800	**1988**	Jan. 04	28.35	35,300*
1958	Feb. 25	42.95	68,700	**1989**	Mar. 19	25.42	23,800*
1959	Feb. 16	35.98	48,900	**1990**	Jan. 14	20.34	18,000*
1960	Jan. 31	40.80	63,100	**1991**	Mar. 04	33.32	48,500*
1961	Jan. 31	29.73	33,100	**1992**	Feb. 20	25.29	28,000*
1962	Feb. 13	28.91	57,400	**1993**	Jan. 21	37.79	55,100*
1963	Feb. 01	43.70	71,800	**1994**	Feb. 20	19.43	14,700*
1964	Jan. 21	29.88	33,400	**1995**	Jan. 09	48.01	93,900*
1965	Dec. 23	49.60	93,400	**1996**	Feb. 05	35.21	49,200*
1966	Jan. 05	45.28	77,000	**1997**	Jan. 01	44.99	82,100*
1967	Jan. 21	42.45	68,400	**1998**	Feb. 03	38.66	56,100*
1968	Jan. 30	32.22	40,600	**1999**	Feb. 09	31.86	37,800*
1969	Jan. 14	42.52	68,600	**2000**	Feb. 14	31.89	37,900*
1970	Jan. 24	43.95	72,900	**2001**	Mar. 05	24.15	24,700*
1971	Dec. 04	39.33	59,800	**2002**	Jan. 03	33.43	44,000*
1972	Dec. 27	14.71	8,990	**2003**	Dec. 16	36.48	57,600*
1973	Jan. 12	40.56	62,800	**2004**	Feb. 18	38.17	63,400*
1974	Jan. 17	43.18	74,000	**2005**	Dec.28	22.78	21,900
1975	Feb. 13	37.97	67,300	**2006**	Jan 1	42.0	86,000
1976	Mar. 01	11.74	5,260	**2007**	Feb. 11	26.42	29,800
1977	Mar. 16	7.50	1,370	**2008**	Jan. 5	29.22	36,600
1978	Jan. 17	40.73	65,200	**2009**	Feb. 24	22.99	22,400
1979	Jan. 11	24.93	26,200	**2010**	Jan.21	29.62	37,900
1980	Jan. 14	37.46	59,700	**2011**	Mar. 21	29.39	37,300
1981	Jan. 28	27.95	35,200	**2012**	Mar. 28	24.99	26,800
1982	Dec. 20	40.90	67,200*	**2013**	Dec. 24	32.79	38,400
1983	Jan. 27	41.63	71,900*	**2014**	Dec. 12	36.09	42,900
1984	Dec. 25	35.79	55,200*	**2015**	Feb. 7	25.21	21,900
1985	Feb. 08	25.10	28,500*				

Damage from Floods

Flood damage to buildings includes saturation of building materials, collapse of water-logged load bearing structures, water pressure, high water velocities washing away the structure, and flowing debris building up or demolishing structures in its path.

Impacts can range from unsightly water damage of finishes to structural collapse. Water can destroy insulation, sheet rock and flooring of houses necessitating extensive reconstruction. Water inundation can damage personal property beyond salvage such as vehicles, furniture, family mementos, food and clothing. Flood inundation can often destroy crops and the flood

waters can deposit debris and sediment on croplands. Trellis systems for vineyards can be damaged if there is a current flowing through them carrying debris.

High velocity flood flows and debris can damage roads, bridges, culverts, and other infrastructure. Debris may accumulate on bridge piers and in culverts, increasing loads on these features or causing overtopping or backwater effects. High flows cause the erosion or scouring of stream banks, roadway embankments, foundations, footings for bridge piers, and other infrastructure.

Another hazard created by floods, particularly in areas of high velocity flows, is the potential for hazardous materials releases. Releases can occur at fixed locations, such as storage facilities, or during transport. The most common type of hazardous material accident or release from flooding along the Russian River in the past occurred when propane tanks were not properly anchored and floated away, and from household hazardous materials that were swept away by flood waters. After the 1997 and 1998 floods, two of which resulting in Gubernatorial and Presidential Declarations, the County enhanced several codes requiring propane tanks to be seismically anchored have been adopted reducing this risk (2013 California Fire Code, California Plumbing Code and NFPA); the success of these codes was evented in the reduction of hazardous materials threats during the New Year's Flood of 2006.

Other releases of sewage, hazardous or toxic materials include wastewater treatment plants that are inundated, and pipelines which are severed. In rural areas, floodwaters flowing over leach fields and agricultural byproducts contain fecal bacteria from human and animal wastes. While skin contact with flood water does not pose a serious health risk, contact with contaminated water can increase chances of infection, stomach-ache, fever, vomiting and diarrhea. Inundated structures and belongings can give rise to mold issues which cause health issues. Emergency responders and citizens trying to flee rising waters are susceptible to drowning or hypothermia.

Flooded communities suffer economic losses from the closure of businesses and government facilities. Maintenance crews must be deployed to repair communication, utility systems, and infrastructure. Emergency responders provide vital stability during flood events which usually results in working overtime, causing a strain on community budgets.

There are a number of residential areas with significant populations that frequently become isolated when stretches of road become inundated. These areas include neighborhoods accessed by Neeley Road and Drake Road (both near Guerneville). If stream depths on the Russian River exceed 42 feet, important bridges and stretches of road along Highway 116 and River Road are at risk of being flooded. These roads provide vital access to the communities of Guerneville and Monte Rio. This flood level has been exceeded four times between 1984 and 2010.

Since flooding often occurs in conjunction with winter storms, there can often be additional impacts to communities concurrently with the flood events. Isolated flooding may result from clogged or blocked culverts; winds can blow down trees and limbs damaging property, blocking

roadways or down power and communication lines; and landslides or debris flows may occur blocking roadways or waterways. According to PG&E, approximately 85 percent of power outages are caused by downed trees and limbs during storms. Landslide risk increases significantly when rainfall saturates soil on steep hillsides resulting in mud or debris flows (See Chapter 5).

Table FH-5 summarizes the impacts and estimated costs of the recent federally declared flood disasters in Sonoma County.

Table FH-5: Damage and Estimated Losses from Recent Floods in Sonoma County

Date	Loss Estimates	Damage
January 8-31, 1995	$21 million	Over 50 roads closed 15,000 residents without power Total displaced persons exceeded 2,000, of which 456 flood victims were evacuated by air 13 medical cases were treated and 2 flood-related fatalities occurred
March 7-15, 1995	$13.3 million	Over 100 roads closed 45,000 residents without power At least 3,000 residents displaced Up to 30 containers of possible toxic materials identified in the flood zone
December 30, 1996-January 4, 1997	$31 million	Up to 200 roads were closed or damaged temporarily 463 homes damaged 12,000 residents without power Over 1,200 victims evacuated their residences and 2 storm-related deaths occurred Sewage and treatment plants overflowed
February 2, 1998	$28 million	200 roads were listed as flooded or closed 6,400 residents without power 250+ homes were inundated 1,200 residents voluntarily evacuated 4 storm-related deaths
December 30, 2005 – January 3, 2006	$104 million	Over 100 roads closed due to flooding and landslides Approximately 50,000 county residents without power 2106 properties inundated, 67 declared uninhabitable Unknown number of self-evacuations Laguna Wastewater Treatment Plant flooded with partially-treated sewage spill into the Laguna
December, 2014	$1.1 million	48 businesses and single family dwellings damaged along Foss Creek

Note: Dollar amounts based on year of occurrence

Future Potential

The future potential for flood frequency and intensity in the near term is expected to be similar to the observed historic probabilities. In the longer term, the effect of climate change storm intensity, frequency and flooding are unknown. The potential areas of flooding are generally expected to be those areas in the FEMA 100-year flood plain.

The probability of reoccurrence on any site depends on its elevation and location relative to the elevation of the 10, 25, 50 and 100-year flood events identified in the Sonoma County Flood Insurance Study. Although the recurrence level is based on statistical averages, the actual occurrence of events varies and could occur at shorter intervals or even within the same year. Table FH-6 shows recurrence intervals and probabilities of occurrences.

Table FH-6: Recurrence intervals and probabilities of occurrences

Recurrence interval, in years	Probability of occurrence in any given year	Percent chance of occurrence in any given year	Annual exceedance percentage (AEP)
100	1 in 100	1	1
50	1 in 50	2	0.50
25	1 in 25	4	0.25
10	1 in 10	10	0.10
5	1 in 5	20	0.05
2	1 in 2	50	0.02

Table FH-7 below shows the statistical exceedance levels at the Cloverdale gauge, the Healdsburg gauge, and the Guerneville gauge on the Russian River as statistically determined from the record of recorded flow data for each station.

Table FH-7: Flow Exceedance Levels at the Cloverdale gauge, Healdsburg gauge, and Guerneville gauge on the Russian River

USGS 11463000 RUSSIAN RIVER NEAR CLOVERDALE, CA		USGS 11464000 RUSSIAN RIVER NEAR HEALDSBURG, CA		USGS 11467000 RUSSIAN RIVER NEAR GUERNEVILLE, CA	
[WY 1952–2014]		[WY 1940–2014]		[WY 1940–2014]	
Return Period	Discharge (cfs)	Return Period	Discharge (cfs)	Return Period	Discharge (cfs)
1.2	10,100	1.2	16,000	1.2	24,500
2	20,000	2	32,100	2	46,300
5	33,100	5	53,400	5	73,600
10	40,500	10	65,100	10	88,400
20	46,400	20	74,500	20	100,000
50	52,700	50	84,200	50	112,000
100	56,400	100	89,900	100	119,000
200	59,600	200	94,500	200	124,800
500	62,900	500	99,400	500	130,800
1000	64,900	1000	102,300	1000	134,400

Flood Mapping

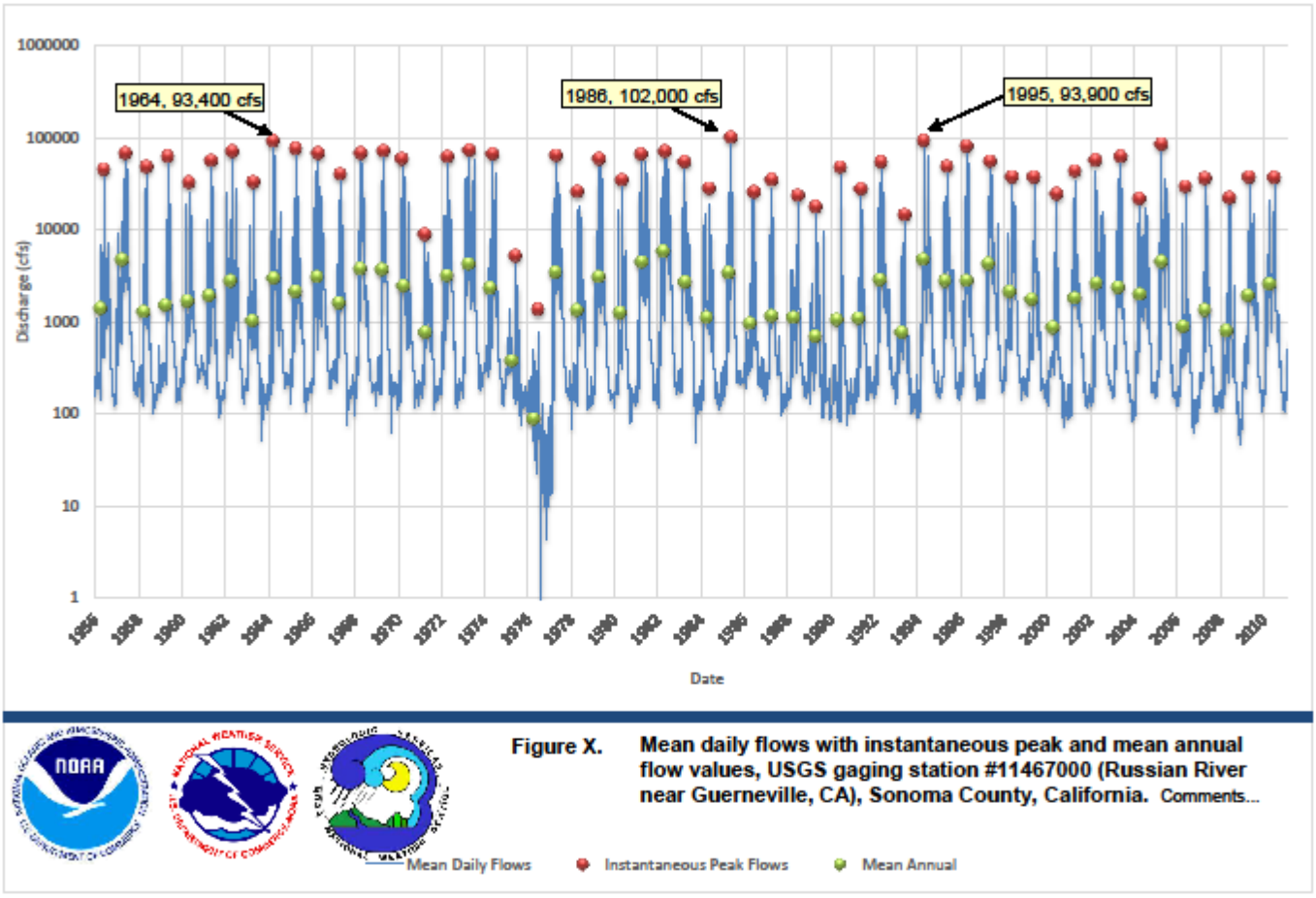
Assumptions regarding the flood flow levels and elevation levels associated with different size floods dates back to the original 1978 FIS which utilized a 1967 study prepared by US Army Corps of Engineers in conjunction with the Warm Springs Dam proposal. Though adjustments to the mapping were made in response to observations made after the 1986 flood (the largest flood of record), the FIS has never updated its analysis for the Russian River. There has been lingering debate and doubt over the accuracy of the FIS's 100-year flood delineations, the associated flow and elevation assumptions for different size floods.

A 2004 FEMA study on repetitive flood loss properties in the County indicated that out of 666 Repetitive flood loss properties approximately 227 or 34% fell outside of the SFHA. 178 of these were more than 50 feet outside of the SFHA.

The historical flow records for the USGS Guerneville gage indicates that the 50-year flood occurred five times in 50 years, and the 10 year flood occurred 19 times in 50 years. Although the recurrence level is based on statistical averages and actual occurrence of events is fully expected to vary, the frequency of higher level floods around the two major dams in the Russian River Watershed reduce the frequency and intensity of downstream flooding in the Guerneville area.

The accurate mapping of flood zones is important to disclose flood hazard risks and help prevent injury and loss. Inaccurate flood zone mapping can result in properties subject to flooding being shown outside of the mapped flood zone where flood insurance is not required. Having higher resolution topographical maps and more accurate flood flow assumptions would be useful in better defining flood boundaries for intermediate level floods 10-year, the 25 year and the 50-year. Refining risk levels in the 100-year flood plain would aid risk-based decision-making and prioritization, and would allow the flood risk and frequency of different properties to be more accurately characterized. Chapter 7 (Mitigation Strategy) calls for an update of the FIS and FIRM maps with respect to flooding along the Russian River.

Figure FH-1: Peak Annual Flows on the Russian River near Guerneville 1940-2012



Coastal Flood Hazard Concerns

Areas along the Pacific Ocean coastline may be subject to tidal surges and wave action during coastal storms as well as tsunamis during seismic events. Though at lower risk, San Pablo Bay shoreline can be affected by tsunamis, storm surges and tidal actions.

FEMA's Flood Insurance Rate Map (FIRM) delineate "Coastal High Hazard Areas" subject to high velocity waters from coastal flooding, tidal inundation, storm surges and tsunamis. However, the only area included in this study was Bodega Bay. FEMA is in the process delineating coastal high hazard areas along the entire 66 mile coastline of Sonoma County as part of the Open Pacific Coast Study. This study is in progress and revised FIRM maps showing the coastal high hazard areas should be available in late 2016.

The FIRM designates areas along coasts subject to inundation by the 1 percent flood event with additional hazards due to storm-induced surges and wave action. The FIRM maps will designate flood risk categories as zone V, where base flood elevations have not been determined; and zone VE where base flood elevations have been determined.

Most of the damage along the California coast is due to storms, particularly by the confluence of large waves, storm surges, and high tides during strong El Niño events. These storm events can result in secondary impact of coastal bluff erosion. Much of the County coastline is elevated above sea level and characterized by dramatic coastal bluffs. The bluffs are subject to erosion from winter storms, wave action, wind, and stormwater runoff and can become unstable. Bluff erosion or retreat is typically measured in inches or feet per year. Bluff retreat may occur suddenly and catastrophically through slope failure due to heavy rain, high wave action, and high tides.

The ability of coastal bluffs to withstand the continuous erosive forces over time depends on the relative resistance of the shoreline rocks. The factors which determine rock resistance are the type of rock, extent of shearing and fracturing, and inclination of the rock layers. Coastal bluffs which are comprised of native materials from the Franciscan or Merced geologic formations are the most affected by erosion.

According to the National Academy of Sciences (NAS 2012), storms and sea level rise are causing California coastal bluffs, beaches, and dunes to retreat at rates from a few inches to several feet per year. The Academy of Sciences projects that California coastal bluffs could retreat more than 100 feet by 2100.

Coastal bluff erosion is threatening existing development in some areas west of State Highway 1, such as Gleason's Beach. These structures and septic systems were built on or near the edge of coastal bluffs and on steep slopes which are eroding. Landslides, in conjunction with wave action, failure of shoreline protection measures, and changes in drainage have resulted in severe erosion, bluff failure, and loss of bluff top area. Some houses have been demolished and removed because they posed a public safety risk, and several other houses have been damaged to the extent that they are no longer habitable. Additional homes in this area are threatened. Caltrans investigations in 1998 and 2003 determined that coastal erosion rates near Gleason's Beach are about one foot per year. Coastal erosion is threatening the stability and safety of State Highway 1, and in 2016 Caltrans has begun a project to relocate State Highway 1 at Gleason's Beach.

Mitigation measure 4 calls for an update of the FIRM maps with respect to coastal high hazard areas once revised FIRM maps based on conclusions of the Open Pacific Coast Study. The Sonoma County Local Coastal Plan establishes policies and measures to address coastal hazard areas. The Hazard Mitigation Plan is incorporated by reference into the Coastal Plan Public Safety Element and Work Plan.

Sea Level Rise

The California Coastal Commission's Sea Level Rise Guidance requires that Local Coastal Plans address sea level rise. Sea level rise could magnify the impacts of high waves and storm surges on the coastline, exacerbating coastal erosion and threatening coastal infrastructure and development. Sea level rise may result in saltwater intruding into local water supply wells. Sea level rise may affect and threaten California coastal communities and infrastructure through more frequent flooding and gradual inundation, as well as increased bluff, dune, and shoreline

erosion. Future flooding and erosion could affect transportation facilities; utility systems; storm water systems; ports and harbors; large wetland areas; recreation and tourism, and coastal development, including homes and businesses.

In 2008, the California Governor issued Executive Order S-13-08 directing State agencies to consider a range of sea level rise scenarios for the years 2050 and 2100 to assess project vulnerability, reduce expected risks, and increase resiliency to sea level rise. Amendments to Government Code Section 65302 require each jurisdiction to address climate adaptation in their General Plan Safety Elements, climate adaptation plan or a hazard mitigation plan and identify the geographic areas and infrastructure at risk from climate change impacts, such as areas affected by sea level rise. These requirements are intended to help local jurisdictions meet regulatory requirements to prepare a climate change vulnerability assessment and adopt climate adaptation goals, objectives, and policies. The Sonoma County General Plan and Local Coastal Plan contain policies to consider climate change and sea level rise in planning efforts. There are a number of different estimates and scenarios for sea level rise currently available (see Appendix D). The upper estimates for the degree of sea level rise projected by the year 2100 range from 55 to 66 inches. The Local Coastal Plan policies take a conservative approach and recommend planning for 6-feet (72 inches) of sea level rise, as recommended in the Coastal Commission Guidelines. Though the full impact of sea level rise may take decades to materialize, real estate development and infrastructure decisions made today are likely to be affected by sea level rise during their economic life. It is prudent to address this emerging hazard proactively to ensure safe and orderly development.

Mitigation measure 7 calls for the completion of the above work so that it can be incorporated into Safety Elements, Coastal Plans, Hazard Mitigation plan, adaptation plans and Capital improvement plans.

Appendix D shows the areas at risk from flooding as a result of sea level rise during a 100-year storm by year 2100 based on a preliminary inventory of infrastructure, roads, and other public facilities vulnerable to sea level rise.

Exposure and Vulnerability

The term exposure refers to the number of facilities, their value, and functions that are located in the 100-year floodplain defined by FEMA. The term vulnerability refers to how likely each of those facilities is to be damaged by flooding. Whenever possible, facilities exposed to flood risk are listed and their values are presented.

Critical Facilities

Critical facilities are essential to the health and welfare of the County's population and are especially important following hazard events. Critical facilities incorporate essential facilities such as emergency operations centers, police and fire stations, hospitals and shelters; transportation systems; lifeline utility systems; high potential loss facilities, such as dams; facilities housing hazardous materials; government facilities essential to disaster response and recovery; schools and other uses that house special needs populations. All critical facilities are

discussed here, but those that are the direct responsibility of the County are examined in the most depth.

For each of the facilities examined, all available information was collected from the County and other sources, including GIS maps and databases, other forms of databases, reports, and studies. An explanation of the data sources and analysis techniques used for analyzing each type of facility is presented in Appendix G. Table FH-8 summarizes the county structures exposed to floods in Sonoma County and their economic values.

Emergency Response Buildings

No buildings owned or used by the County that are critical for emergency response activities are located in the 100-year floodplain. The Guerneville Sheriff's Substation is located in the Russian River flood area, but is situated on higher ground, in effect, becoming an island during serious flood events.. The 1986 flood, which crested at 48.9 feet, nearly reached the building. This station has carried out response functions, including rescues and maintaining security, during past floods, despite being surrounded by water.

Some emergency facilities not operated by the County are located in flood risk areas. For example, the Guerneville, Forestville and Monte Rio fire stations are located in the Russian River flood area. These stations become inaccessible during serious floods due to road closures.

Hospitals

None of the area hospital complexes are situated within a 100-year flood plain.

Shelters

The Guerneville Veteran's Building can be used by the County as a shelter and is located within the floodplain. However, alternate locations are available to provide shelter for residents displaced by flooding.

Schools

Six schools could be inundated by floods, which would lead to costly clean-up and repairs, and potential closures that could last an extended period. These schools cannot be used as shelters or gathering places if flooded.

Roads and Highways

Roads are the most commonly damaged facility in a flood event. Damage to roads may be caused by floodwaters overtopping and eroding road surfaces, shoulders, and embankment slopes. Floods can damage bridges by water overtopping the decks, erosion of the streambed under piers and abutment footings, and impact and accumulation of floating debris on the bridge structure. Culverts can be damaged by erosion or plugged by debris, impeding flows. Many roads in the County can be covered by flood waters during a flood event. Over 100 miles of County roads are located within the 100-year floodplain. The downtown areas in both Monte Rio and Guerneville are subject to frequent flooding.

The State of California has assessed some bridges in the County for their structural safety during major flood events. Approximately thirty bridges have been identified as potential concerns because rapid flood flows carrying debris could scour the bridge supports and lead to dangerous structural impacts. The County Department of Transportation and Public Works (DTPW) has determined that twenty bridges are rated scour critical. DTPW has developed a plan of action for each of the twenty bridges to provide scour protection and is in the process implementing these plans.

Airports

The County airport runway and buildings are located outside of the 100-year floodplain.

Railroads

The rail lines in the County pass through areas of flood risk in numerous locations, mostly in the northern part of the County along the Russian River. Approximately 25 miles of track are located within the 100-year floodplain. These tracks, used primarily for commercial purposes, could be temporarily incapacitated by a flood on the Russian River.

Harbors

Spud Point Marina is located on the coast in Bodega Bay. Port Sonoma Marina is located at the mouth of the Petaluma River. Both of these facilities could be subject to inundation resulting from a tsunami, sea level rise, or coastal storm event, but should not be adversely affected by river flooding. Private local marina on the Petaluma River or Russian river could be expected to be in the impact area of river flooding.

Solid Waste Facilities

No solid waste facilities are located in the flood plain.

Water Supply Infrastructure

The primary supplier of water in the county is the Sonoma County Water Agency. The SCWA water supply and transmission system is made up of transmission pipelines (aqueducts), collector wells, booster pump stations, storage tank reservoirs, and other facilities. It serves about 600,000 people in Sonoma and Marin Counties. SCWA has conducted risk assessments and prepared a hazard mitigation plan for its facilities independent of the county.

The Russian River area poses the greatest flood threat to the Agency's water supply production assets. However, most SCWA water facilities located in the Russian River floodplain have been elevated above the 100-year flood elevation, including pumping facilities and emergency generators. The seven SCWA vertical wells located in the Russian River floodplain are vulnerable to flooding, but are sealed when flood alerts are issued to prevent contamination and damage to equipment. Due to proximity to the Russian River, all six existing water collectors are subject to flooding.

The Agency's water transmission facilities with the highest risk of flooding include those located in the Mirabel and Wohler area, Ely booster station, the Sebastopol and Todd Road wells, significant sections of the Russian River-Cotati Intertie, Wohler-Forestville Pipeline and Wohler

Intertie and some portions of the Santa Rosa aqueduct. Stream crossing locations of the transmission lines located in the areas of high flood hazard are most vulnerable to damage due to flood related scour. In addition, there are some locations where a pipeline is suspended (typically from a bridge structure) at the stream crossing location and is vulnerable to damage from floating debris. The Water Agency's Hazard Mitigation Plan describes hazards and mitigation strategies in greater detail.
The State Office of Drinking Water regulates over 417 other community water supplies in the county that have 15 or more connections59. No information is available regarding the vulnerability of these systems to flooding.

Wastewater Systems

Sewage treatment systems in Sonoma County, primarily along the Russian River area, could become overwhelmed by flood waters mixing with sewage, resulting in releases of untreated sewage or creating the need for emergency treatment measures.

The Guerneville treatment plant, owned by the Russian River County Sanitation District (RRCSD,) has experienced treatment interruptions during previous many flood events. In February 1999, more than one million gallons of partially treated wastewater spilled into the Russian River after three days of flooding. Since then changes to the collection system and plant operations have greatly reduced the possibility of similar release events.

The Water Agency's multi-hazard reliability assessment for RRCSD confirmed that several of its pump stations and related equipment, including pump controls, are located near creeks and streams and within the 100-year floodplain. These areas pose the highest risk of flood damage to the RRCSD facilities. Debris in floodwaters where pipelines cross streams present a hazard. Potential for scour presents a hazard, as well as inundation of essential electrical systems.
The Sonoma Creek watershed consists of 170 square miles, which drains into the San Pablo Bay. The Sonoma Valley Community Service District (SVCSD) is located within the Sonoma Creek watershed, where Sonoma creek is the primary source of flooding. Although the SVCSD Wastewater Treatment Plant is located outside of the 100 year floodplain, the SVCSD collection system is susceptible to damage related to high stream flows that would typically occur during flooding events.

Mitigation goals, objectives and actions have been identified for both RRCSD and SVCSD to prevent impacts during future floods. Multi-hazard reliability assessments for the remaining wastewater systems managed by SCWA are not anticipated to commence until funding is available.

The wastewater treatment plant for the Graton Community was inundated in the 2006 Flood. In 2009, FEMA funded the Graton Community Services District $1.8 million to build a flood mitigation wall. The existing berm is 97 feet above sea level and the flood wall is 4 feet (total height of 101 feet). The 2006 Flood elevation was 99.7 feet.

Many residents of the County that live within the flood plain rely on septic systems for their sewer service. When flooded, septic systems can collect silt which can reduce the effectiveness of the systems. Septic tanks generally need to be pumped after floods.

Storm Sewers/Drainage Infrastructure

The County has thousands of pipes that funnel storm water under roads. Many of these pipes are undersized and do not have adequate capacity even in minor floods. During heavy rainstorms, flood waters collect on roads, causing hazardous conditions and often leading to erosion damage to the road surface or embankment. These pipes are gradually being replaced through ongoing maintenance with larger sized pipes.

A number of communities have storm drain systems that are regularly clogged with mud and cobbles that wash down from the hills during rain storms. The accumulated debris reduces the effectiveness of the systems. Clogged storm drains can lead to road washouts and localized flooding.

Other Utilities

Other utilities include electrical, natural gas and phone and cable distribution systems. Floods in conjunction with winter storms have the potential to damage utility distribution systems, substation equipment, and connections to buildings. Flood damage to these utilities can be caused by high velocity water flows, soil erosion, soil settlement, corrosion, and electrical short-circuits. Communication towers are not affected by flooding because they are typically located outside of the flood plain on higher ground. The specific vulnerability of utility systems to damage by floods within the County, such as PG&E and AT&T electric and communication lines and substations, and pipelines is not known. The County does not have authority over the utility infrastructure and relies upon those agencies to identify and mitigate their specific infrastructure vulnerabilities.

The electrical system consists of high voltage overhead and underground distribution lines and associated transformers and switchgear. Power outages are typically caused by severe weather when tree branches fall on overhead lines, vehicles collide into poles or transformer failures. The system consists of numerous circuits that can be de-energized locally to sectionalize outages to continue serving residences and businesses in the vicinity. Long-duration and regional outages are responded to by PG&E. PG&E has worked with County officials to identify specific critical infrastructure to assist in their work priorities during periods of flooding. Since flooding often occurs because of winter storms, there can be additional impacts that adversely affect the community even though they are not directly caused by flooding. For instance, wind damage from the storms can result in toppled trees which block transportation, damage buildings, and down power and communication lines. Such disruption can hamper emergency response to the flooding and can create hazardous situations which divert limited resources. PG&E has a maintenance and capital program to trim trees around the lines and replace aging poles. This program attempts to minimize the impacts from outages.

Dams

The two largest dams on the Russian River are the Warm springs Dam and the Coyote Valley Dam, which are both owned by the US Army Corps of Engineers. US Army Corps of Engineers has an ongoing Dam Safety Program which performs inspections and "Screening for Portfolio Risk Analysis" (SPRA) assessments to identify vulnerabilities and prioritize repairs.

Warm Springs Dam:
A SPRA cadre assessed the Warm Springs Dam in 2006 and, after considering probability of failure and potential failure consequences, categorized it as being in Dam Safety Action Class (DSAC) IV based upon the Dam Safety risk. Dams in Class IV are considered to be marginally safe, in that the combination of life or economic consequences with probability of failure is low. No potential failure modes were identified by the SPRA process using existing data.

Although the SPRA team did not report any potential failure modes caused by flooding, they did analyze the consequences of a dam failure. A relatively low probability of failure along with a moderate sized downstream population, residential and commercial structures including contents, roads, farm land, bridge damage, and utilities, has led to the dam's inclusion in the DSAC IV category. The consequences are judged to be similar for breaches caused by seepage, overtopping, or a seismic even. Portions of the communities of Healdsburg, Windsor, Santa Rosa, Sebastopol, and Guerneville, as well as some rural population areas in the floodplain immediately downstream of the dam, would be at risk if the dam failed as they are within the 1 to 24 hour flood wave travel time bracket. Half of the rural population immediately downstream of the dam is important as -half are within a 15 minute flood wave travel time and all are within a 1 hour flood wave travel time. Based on the 2000 Census of Population and flood inundation maps, up to 84,854 people could be impacted from a dam failure, with an estimated loss of life of up to 100 people from a maximum flood event. Damage includes industrial and residential structures and their contents, roadways, infrastructure, agriculture (mainly viticulture), and bridge damage along the Dry Creek. The estimated damages are up to $13 billion, including $219 million for repairing the dam.

Coyote Valley Dam:
A SPRA cadre assessed the Coyote Valley Dam in 2005 and, after considering probability of failure and potential failure consequences, categorized it as being in Dam Safety Action Class (DSAC) III based upon the Dam Safety risk considered as probability of failure and potential failure consequences. Dams in Class III, are considered to be Significantly Inadequate or have Moderate to High Risk in that the combination of life or economic consequences with probability of failure is moderate to high.

The SPRA found that the most likely modes of failure in order of decreasing risk for this project are:

- Seepage along the conduit leading to the formation of piping, which can quickly progress to rapid breaching of the embankment.

- Tunnel/Conduit joint failure caused by significant displacements of the shells during both the operating base earthquake (OBE) and maximum design earthquake (MDE), and intake tower stability and embankment/foundation liquefaction failures during a MDE.
- The dam will be overtopped during the probable maximum flood (PMF) event and will result in erosion of the crest and downstream slope leading to a complete breach.

In addition to the damage to the dam itself, economic losses could occur more than 50 miles downstream and in more than 10 cities and towns. They could include thousands of homes (particularly those in newer subdivisions immediately downstream of the dam and older homes in downtown Ukiah), livestock, farmland, portions of downtown Ukiah, Hopland, Cloverdale, Geyserville, Healdsburg, Windsor, Santa Rosa, Highway 101, Ukiah airport, a major north-south rail line, numerous local road and utility networks, schools, factories, a fire station, and a sewage plant. In addition, thousands of jobs would likely be lost in such an event.

County Buildings

Four County-owned and -used buildings are located within the 100-year floodplain, as shown in Table FH-8.

Table FH-8: County Owned and Used Buildings in the Floodplain

Facility	Address	Building Value (millions)	Content Value (millions)
Guerneville Vets Building	1st and Church	$1.2	$0.1
Guerneville Generator Bldg.	1st and Church	Unknown	$0.1
River Friends Library	14900 Armstrong Woods Rd.	Unknown	Unknown
DHS Mental Health	16350 Third Street	Unknown	Unknown
Totals		To be determined	To be determined

Note: This table lists insured value, which may not accurately reflect current value or replacement value.

Hazardous Materials

There are no solid waste facilities landfills or transfer stations located in the flood plain. Sites with hazardous materials within the flood plain include drycleaners, gas and service stations, agricultural sites, industrial sites, high-tech facilities, chlorination plants, and wastewater treatment plants. There are also residential homes which have household chemicals, such as fuels, pesticides, paints, cleaning supplies that could potentially lead to contamination if released by flooding. Some sites contain gases or liquids that are potentially harmful to human health. In the March 1995 flood event, approximately 30 containers of possible toxic materials were identified in the flood zone. In past floods, contaminants included household hazardous materials and propone tanks carried downstream by flood waters.

People and Private Buildings

Approximately 77 square miles, or five percent of the total unincorporated area of Sonoma County is within the 100-year flood zone designated by FEMA. A total of 8,519 Assessors

parcels are entirely or partially in the 100-year flood zone. Based on mapping analysis and assumptions described in Appendix D, there are 3,508 addressed structures within the 100-year flood zone. Of these, records indicate that 802 are all or partially in the F1 Floodway zone with the remaining 2,706 in the F2 zone.

Data from the County's electronic permit tracking system indicate that 630 permits to elevate homes have been issued countywide. Of those permits, 540 were for homes on parcels within the 100-year flood zone, and 90 on parcels outside of the flood zone.

Some parcels with multiple structures may have more than one elevation permit on record. This suggests that at least 540 of the addressed structures have mitigated flood hazards through home elevation permits to reduce their flood vulnerability. The remaining un-elevated structures are more vulnerable to flooding with the greatest risk being for those structures in the areas of high flood recurrence.

Based on existing County records, the 3,508 addressed structures in the flood zone have the following land use designations:

- 1,266 Rural Residential land use parcels typically reliant on septic systems and wells,
- 1,215 Urban Residential parcels generally with public sewer and water service,
- 438 Commercial or Industrial zoning,
- 550 Agricultural or Resource land use designations, and
- 37 Public/Quasi-Public Land Use

It is not possible to use census data to directly determine the population at risk in the flood zone since census tract and block boundaries do not coincide with flood boundaries. According to Census data the average Sonoma County household size is 2.57 persons. Though some addressed structures are commercial or industrial and do not have residential occupancy, some other addressed structures may be multi-family units which have more than one household For the purposes of estimating the population at risk, this analysis assumed 2.57 persons per addressed structure and estimates the population potentially at risk in the 100-year flood zone is 9,016 (3,508 structures x 2.57 persons per structure average). The estimated value for these structures would be almost $800 million.

In addition to those homes which are vulnerable to flood inundation a number of other neighborhoods outside of the flood plain can be isolated by impassable flooded roads. Residents in these areas must evacuate their homes or face being isolated from emergency services and other lifelines.

Repetitive Loss Properties

Sonoma County records the most National Flood Insurance Program (NFIP) repetitive losses of any area in California. Sonoma County accounts for 34 percent of the total state dollar payments for assistance, and accounts for more than 52 percent of the payments to the top ten repetitive loss communities.

Table FH-9: Top Ten California Repetitive Loss Communities

Rank	Community Name	Building Payments	Content Payments	Total Payments	Losses	Properties
1	Sonoma County	48,299,582.	12,556,340.	60,855,923.	2,674	827
2	Malibu, City of	7,863,049.	1,227,318.	9,090,368.	484	172
3	Los Angeles City	3,499,169.	647,656.	4,146,825.	354	151
4	Sacramento Co.	8,699,286.	1,543,708.	10,242,994.	373	139
5	Lake Co.	5,389,133.	512,807.	5,901,940.	304	109
6	Monterey Co	6,496,453.	797,986.	7,294,439.	240	109
7	Marin Co.	3,182,317.	748,321.	3,930,638.	232	87
8	Santa Cruz Co	3,172,201.	671,035.	3,843,237.	225	82
9	City of Napa	5,234,607.	1,747,876.	6,982,483.	211	72
10	Ventura Co	2,824,359.	1,046,430.	3,870,789.	165	63
Total of Top Ten RP		$ 94,660,160.	$ 21,499,482.	$ 116,159,642.	5,262	1,811
Total of State RP		$152,039,734.	$ 37,219,316.	$ 189,259,050.	8,968	3,262
Percent of State Total		62%	58%	61%	59%	56%

Source: Appendix P of 2010 California Multi-Hazard Mitigation Plan

Addressing the risk to repetitive loss properties is an important step in reducing the financial impact of flooding in the County. Areas of repetitive loss are high priorities for hazard mitigation funding. Repetitive losses are a drain on community, state, and national disaster management resources and are cost-effective to mitigate. The current national priority is the reduction of repetitive flood losses because these translate into a loss to the National Flood Insurance Program (NFIP).

Repetitive loss properties, as defined by FEMA, are residential buildings that have experienced one or more of the following since 1978, regardless of any changes of ownership during that period:

- Four or more paid flood losses of more than $1,000 each.
- Two paid flood losses within a 10-year period that, in the aggregate, equal or exceed the current value of the insured property.
- Three or more paid losses that, in the aggregate, equal or exceed the current value of the insured property.

The Flood Insurance Reform Act of 2004 provided a new opportunity for governments to mitigate the most flood-prone repetitive loss properties by creating a subcategory and Program for Severe Repetitive Loss (SRL) properties defined as properties which meet specific criteria based on paid flood losses since 1978.Repetitive loss properties account for 25 to 30 percent of all claims paid by the National Flood Insurance Program (NFIP), although they comprise only about one percent of insured properties. Many of the repetitive loss properties in Sonoma County have received funds from the NFIP in multiple instances that exceed the replacement value of the property and as high as 390 percent of the replacement value. A closer look at the property data for the list of 827 repetitive loss properties indicates that the majority are single-

family dwellings, both attached and detached. Some businesses are also included. About 42 percent of the repetitive loss properties do not carry flood insurance. The community with the largest number of repetitive loss properties is Guerneville, followed by Monte Rio and Forestville.

Since some parcels have more than one structure, the total number of parcels on the repetitive loss list based on FEMA records is 658. Of these, 621 parcels are in the mapped 100-year flood zone and 37 fall outside of it. The repetitive loss parcels can be categorized according to their land uses. Table FH-10 summarizes the total number of repetitive loss parcels within each land use grouping.

Table FH-10: Land Uses of Repetitive Loss Parcels

Land Use Category	Per FEMA	Per County
Rural Residential land uses (generally reliant on well and septic)	250	220
Urban Residential land uses (generally have public water and sewer)	287	332
Ag and Resource parcels	28	33
Commercial and/or Industrial parcels	82	39
Public/Quasi-Public parcels	1	0
Parcels with split designations:	16	8
Total Number of Repetitive Loss parcels in 100-year flood zone	621	630

In 2001, FEMA created a strategy to target the most frequent and costly repetitive loss properties nationwide by phasing out coverage or charging full and actuarially based rates for repetitive loss property owners who refuse to accept FEMA's offer to purchase or mitigate the affected buildings. In 2003, FEMA established a national priority to fund mitigation projects that address NFIP repetitive flood loss properties. Eligible projects include mitigation through acquisition, relocation, elevation, flood proofing, and minor structural projects.

Sonoma County's Community Development Commission has applied for and received several FEMA grants to fund the Sonoma County Flood Elevation Program. County building records indicate that this program has elevated over 300 residential structures since 1995, the majority of which were repetitive loss properties.

Historical Buildings

Eight historical buildings are located within the 100-year floodplain, listed in Table FH-11.

Table FH-11: Historical Buildings Located within 100 Year Flood Plain

Building	Location
Rose Villa (Powell's Place)	Healdsburg
Duncan Mills Historic District building	Duncan Mills
Mark West Lodge	Santa Rosa
Gaige House	Glen Ellen
Mervyn Hotel Site	Glen Ellen
Superintendent's House at Sonoma Developmental Center	Glen Ellen
Chavet Building	Glen Ellen
Stone Winery Building	Glen Ellen

Impact and Loss Estimates

Estimating losses in future floods is beyond the scope of this plan. Future floods will impact County residents and infrastructure, resulting in costly damage and disrupting daily activities. The total estimated value of assets exposed to floods (excluding County roads and historical buildings) is an estimated $2.6 billion. A single future flood would impact only a portion of these assets.

A simple way to assess the potential size of future losses from floods in Sonoma County is to look at losses from recent flood disasters. As shown in Table 3-5 floods within the past decades have caused tens of millions of dollars in economic losses, displaced thousands of residents, closed hundreds of miles of roads, left many thousands without power, and caused a handful of fatalities. This magnitude of losses is likely to occur again in the near future.

Mitigation actions taken in recent years, particularly the residential flood elevation program, reduce future losses to residential structures located in the floodplain. Elevating structures effectively reduces or eliminates flood losses to those structures. This was proven to be effective in the most recent flooding along the Russian River, where no significant damage was incurred to the 205 residences that had been elevated prior to the 2006 Flood. Other improvements in flood management have helped decrease vulnerability to floods and have reduced the potential for flood damage.

Table FH-12: Exposure of Assets in County to Flood Risk

	Asset Type	Average Replacement Value (millions)	Total in Sonoma County			Within Special Flood Hazard Areas (SFHA)		
			Number	Length (miles)	Value (millions)	Number	Length (miles)	Exposure Value (millions)
Population			113,700			12,525		
County Buildings	County Buildings	$1.18	210		$248	14		$11.4
Critical Facilities	Hospitals	$16.5	2		$33.0	0		$0
	Schools	$0.59	120		$70.8	6		$5.3
	SCWA treatment plants, and sanitation pumps	$39.0	14		$546	3		$117
	Communication Utilities	$0.12	Unknown		Unknown	2		$0.24
	Dams	$5.0	46		$23.0	1		$5.0
Infrastructure	County Roads	Unknown		2,480	Unknown		119	Unknown
	State and Federal Highways	$3.2		198	$634.94		14.6	$46.7
	Railroad tracks	$0.86		55.4	$47.6		24.6	$21.7
	Airports	$43.0	7		$301	3		$129
	Bridges	$1.86	2,685		$4,995	320		$595
Properties	Private Buildings	$0.50	57,300		$28,400	3,508		$ 768
	Repetitive Loss Properties	$0.50	827		$181	546		$120
	Historical Buildings	Unknown	189		Unknown	8		Unknown
Total			61,610*	2,738.20	$35,834.41	3,508*	157.99	$2,564.68

Note: Overall total for physical assets only. The flood exposure for hospitals within incorporated areas not assessed. Not including repetitive loss properties.

Plans

Sonoma County General Plan 2020

California State law requires each County to prepare a General Plan to set forth its community policies and objectives to guide the growth and physical development of the county and the distribution of future land uses, both public and private while protecting and maintain the public health, safety and welfare. Sonoma County adopted an updated general plan (GP2020), in September of 2008. The County's land use and development decisions, land use or zoning changes, development proposals, use permits, subdivisions, and capital improvement plans must be consistent with the General Plan before they can be approved.

The General Plan includes a Public Safety Element, which seeks to reduce damage from flood hazards and establishes the following goal:

- GOAL PS-2: Reduce existing flood hazards and prevent unnecessary exposure of people and property to risks of damage or injury from flood hazards.

The General Plan must address flood hazards in compliance with the requirements of California Government Code Section 65302 and include, or incorporate by reference:

- Flood hazard zones delineated on the National Flood Insurance Program official Flood Insurance Rate Map issued by the Federal Emergency Management Agency (FEMA) including floodways where designated.
- Dam failure inundation maps
- Historical data on flooding and sites that have been repeatedly damaged by flooding.
- Existing and planned development in flood hazard zones, including structures, roads, utilities, and essential public facilities.
- Local, state, and federal agencies with responsibility for flood protection, and
- Comprehensive goals, policies, and objectives to protect the community from the unreasonable risks of flooding and avoid or minimize the risks of flooding to new development.

The Sonoma County Hazard Mitigation Plan is incorporated by reference and integrated into the General Plan Public Safety Element to assure consistency. The Public Safety Element includes mapping of the 100-year flood hazard areas as identified in the County's Hazard Mitigation Plan consistent with FEMA's Flood Insurance Rate Maps.

The Public Safety Element recommended a number of implementation programs including: Program 7 to develop a comprehensive plan addressing flood losses in the Russian River; Program 8 to adopt a zero net fill ordinance in the 100-year flood plain; and Program 9 to identify existing risks and implement regional flood reduction projects within the Petaluma watershed. Policy PS-2d calls for the development of a long term plan for reducing repetitive

flood losses in the Russian River basin. In total the Public Safety Element sets forth 23 policies to reduce risks from flooding (see Appendix B).

The General Plan contains additional goals to minimize potential injury and property losses from flooding. For instance, the Land Use Element seeks to "Prevent unnecessary exposure of people and property to environmental risks and hazards…." (Goal LU-7) and to "Restrict development in areas that are constrained by the natural limitations of the land, including but not limited to flood hazards…" (Objective LU-7.1). It establishes the following policies to compliment those in the Public Safety Element:

- Policy LU-7a: Avoid General Plan amendments that would allow additional development in flood plains, unless such development is of low intensity and does not include large permanent structures.
- Policy LU-7b: Limit development in wetlands designated on Figure OSRC-3 of the Open Space and Resource Conservation Element.
- Policy LU-7c: Prohibit new permanent structures within any floodway. Require that any development that may be permitted within the flood plain to be raised above the 100 year flood elevation.

The General Plan further restricts land uses and density in flood hazard areas, thereby limiting the number of people and buildings exposed to hazards.

The State Flood Hazard Mitigation Plan

The state Hazard Mitigation Plan was approved by FEMA in 1996 following severe winter storms in 1995. This statewide plan lays out priorities for managing flood risk at the state level and was developed with local cooperation.

The Lower Russian River Flood Response Plan

The Lower Russian River Flood Response Plan establishes general procedures and organizational structures and agency responsibilities for emergency response to Russian River flood conditions in the Forestville to Jenner Area. The plan is based on seven stages as determined by actual and forecasted Russian River water levels and the expected activities that result.

Warm Springs Dam Failure Response Plan

The Warm Springs Dam Failure Response Plan outlines the procedures and policy for potential failure of the Warm Springs Dam and possible impacts in the north central portion of the county. The Plan identifies inundation areas, warning and evacuation procedures, and emergency contacts.

Codes and Regulations

California Environmental Quality Act (CEQA)

Prior to any action on a discretionary project subject to CEQA, the lead agency must undertake an environmental review of the proposed project, including if the project would:

- Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map;
- Place within a 100-year flood hazard area structures which would impede or redirect flood flows; or
- Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam inundation by seiche, tsunami, or mudflow.

Zoning Regulations

The Sonoma County Zoning Code establishes various base districts in the County and designates the lawful permitted uses allowed in each along with the required review and approval procedures, siting, and design criteria. It establishes several combining districts which further modify or restrict the requirements on a parcel to minimize risks from natural hazards. The ”F1" (Floodway) and the “F2" (Floodplain) combining districts are applied to different portions of the 100-year flood plain identified by FEMA. The F1 zone is the most restrictive and applies to the “floodway,” which is the channel and adjacent floodway that must be free of development so the waterway can convey the 100-year flood without raising flood levels. The F1 districts prohibits the construction, erection, moving, conversion, alteration or enlargement of any building or structure in the floodway.

The F-2 (Floodplain Combining District) is applied to the floodplain fringe. The floodplain fringe is the area outside of the floodway but within the 100-year flood zone where less frequent and severe levels of flooding typically occur. The F-2 district does not prohibit development or construction otherwise allowed by the base zoning, but it does require that any development meet the standards set forth in Chapter 7B of the County Code. These standards typically require the first floor elevation to be at least one foot above the 100-year flood elevation and includes other flood resistant design criteria.

Subdivision Regulations

The County subdivision ordinance, Chapter 25 of the Sonoma County Code, regulates the division of land in the unincorporated area of the county pursuant to Article XI, Section 7 of the California Constitution and the Subdivision Map Act. It defines minimum lot sizes, and development standards, and regulates land use in flood-prone areas. A key requirement of the State Subdivision Map Act is that a city or county must deny any tentative subdivision if the map, design, or improvements are inconsistent with the General Plan or any applicable specific plan. Because the General Plan’s Public Safety Element contains requirements to protect communities from flood hazards, any subdivision must follow these requirements. Subdivision regulations also require that tentative and final subdivision maps and approved site plans show areas subject to flooding as shown on the FEMA maps.

Drainage and Stormwater Management

Chapter 11 of the County Code sets forth grading and drainage regulations designed to maintain the free flow of flood waters through waterways and channels by restricting construction or deposition of materials that could obstruct or diminish flood flows. The County

requires that a permit be issued for any project that could potentially impair, impede, or obstruct the natural flow of storm waters or other water running in a defined channel,. The ordinance also requires a permit for any activity that deposits any material in the channel, or alters the land surface in a way that reduces the channel carrying capacity Flood Damage Prevention Ordinance.

Chapter 7b of the Sonoma County Code sets forth regulations to reduce flood hazards by regulating and restricting development in flood prone areas by establishing specific review requirements and performance standards in conformance with the National Flood Insurance program (NFIP) regulations. FEMA determined the ordinance to be NFIP-compliant in January 2004.The Sonoma County Permit and Resource Management Department (PRMD) is the governmental agency responsible for ensuring compliance with the ordinance (see Appendix X).

Mitigation Programs and Activities

Following extensive flooding in 1995, the County's Community Development Commission established the Sonoma County Flood Elevation Program to assist homeowners in repairing flood-damaged homes and in elevating of homes above the 100-year flood. As of 2015, the program has funded elevation of 287 homes, approximately 82 of these have been elevated since 2006. Since its inception, the program has received $19.5 million from FEMA grants (HMGP, FMA, and SRL). The County provided the required 25% match with local Community Development Block Grant (CDBG) funds, County Flood Zone, Transient Occupancy Tax funds, Housing and Urban Development (HUD) Disaster Recovery Initiative grants to assist low-income households, and with funds from higher income homeowners. Homes elevated under the FMA grants can receive 75% of the costs and homes elevated under the SRL grants can receive 90% of the costs. The current average cost for elevating a home is about $200,000. Elevation of homes was found to be more cost effective than buying properties in the flood plain at their full value. Homes have been elevated from 2 to 22 feet. Participation is limited to willing owners who voluntarily choose to take advantage of the program.

Property owners must carry flood insurance to participate and must continue to carry flood insurance after being elevated. Properties must be occupied on a year-round basis by either owners or tenants. Homeowners are required to provide a covenant which would preclude them from claiming losses or seeking compensation for any flood-damaged personal property stored below the 100-year flood elevation.

Lists of structures eligible for the program were developed after each flood event. The County conducted out-reach to eligible properties affected by the 1995 and 1997 floods to be elevated above the 100-year flood level. Priority was given to properties that experienced the highest flood level, had the highest percentage of damage in relation to the value of the structure, and appear on the NFIP's repetitive loss list. Though originally excluded by FEMA policy, existing homes in the floodway are now eligible to participate in the home elevation program. The success of this program in mitigating flood losses was exhibited in the 2006 Flood, as no significant damage was noted in 205 residential structures that had been elevated. Consistent with FEMA priorities of the 287 structures elevated by the program through 2015, about 200 of the structures are considered "repetitive loss properties".

In total about 237 of the 564 single family residences on the repetitive loss list have been mitigated by elevating above predicted flood levels.

California Coastal Analysis Mapping Project

FEMA has been conducting the California Coastal Analysis and Mapping Project and Open Pacific Coast (O.P.C.) study to evaluate the potential impact from coastal flooding from storm surges and wave action. The goal of the study is to evaluate and revise the location of Special Flood Hazard Areas along the coast and to update the Base Flood Elevations. The study will be used to create a more thorough and updated Flood Insurance Study and Flood Insurance Rate Map (FIRM) panels and assist communities in risk assessment and hazard mitigation planning in coastal areas.

San Francisco Bay Area Coastal Study

The Sonoma County shoreline along San Pablo Bay is part of the San Francisco Bay Area Coastal Study conducted by FEMA. Coastal flooding along the bay shoreline is a result of tides, storm surge, and riverine discharges. The Study includes modeling of the San Francisco Bay, detailed onshore coastal analysis to estimate wave runup and overtopping, and overland wave propagation. Revisions to the BFE and SFHA were incorporated into Sonoma County's FIRM panels on October 2, 2015.

Sea-Level Rise Adaptation Planning Project

Sonoma County has received a sea level rise planning grant from the Ocean Protection Council to identify the locations inundated as a result of sea level rise and assess vulnerability to sea-level rise impacts to habitats and development. The County is currently developing adaptation strategies and adaptation plans for the Jenner and Bodega Bay communities at greatest risk from seal-level rise.

The sea level rise adaptation plans are scheduled to be completed by 2018 and implementation is included in this Plan for 2016-2021.

Flood Management Projects

Existing flood management projects will be maintained to provide ongoing flood protection benefits. Flood management facilities include the Warm Springs and Coyote Dam operated by the USACE as well as reservoirs in the Central Sonoma Watershed project, 150 miles of engineered and natural channels in the Santa Rosa Plain, levees along the Middle Russian River near Cloverdale and infrastructure associated with the Petaluma Flood control project.

NOAA/NWS Flood Severity Inundation Mapping

NOAA National Weather Service (NWS) and USGS are working on guidelines and procedures for creating Flood Forecast Inundation Maps across the United States. The U.S. Geological Survey (USGS) is fielding the Flood Inundation Mapping Initiative (FIMI) to adopt NOAA NWS guidelines. The development of NOAA NWS Advanced Hydrologic Prediction Service (AHPS) Flood Inundation Maps requires the use of Digital Elevation Model (DEM) terrain data, engineering hydraulics, and Geographic Information System (GIS) tools. High resolution DEM,

derived from LIDAR data, are used to depict terrain features across the surface of the earth, river channels, and floodway characteristics, critical to the hydraulic modeling. The simulation of volumetric flows in the hydraulic model predicts water surface profiles upstream and downstream of USGS river gage given various NWS forecast scenarios. The flood profiles are then integrated with the DEM to delineate the areal extent of flooding to produce the flood depth grids and inundation digital map layers.

Modeling is used to project the area and depth of flooding in different forecasted floods. The data may be used to plot the boundaries of different magnitude floods such as the 10-year, 25 year, and 50 year flood. Inundation mapping allows better matching of regulation and insurance levels to areas based on the level of risk.

Sonoma County Russian River Flood Response Plan

Development of a Sonoma County Russian River Flood Response Plan is in process and involves conducting an aerial LiDAR (Light Detection and Ranging) survey of topography covering about 1,600 square miles. This data will inform hydrological modelling using a Digital Elevation Model (DEM) with a three foot elevation resolution. The DEM will be used to conduct an inundation analysis for various flood scenarios on the Russian River. The resultant product will be a detailed and accurate series of digital maps showing the effects of flooding at intervals of 1 foot depth at given locations. The results will be used to determine the flood risk to structures, infrastructure, and people at various flood elevations. The model can be used to support Web hosted GIS Viewers on the County website as well as automating evacuation calls based on flood level and identified buildings/structures within the flood area.

Financial Resources

National Flood Insurance Program

Flooding is the most common source of catastrophic loss for individuals and businesses in the United States and in Sonoma County. The standard homeowner policies do not include flood coverage: private insurers have historically found it unprofitable to insure low-frequency, high-severity disasters such as floods, because their future losses are difficult to measure. The National Flood Insurance Program (NFIP) enables property owners to purchase insurance for flood losses in exchange for state and community floodplain management that reduces future flood damages.

Until the establishment of the National Flood Insurance Program (NFIP), the primary recourse for flood victims was federal government disaster assistance. Congress adopted the NFIP in 1968 in response to the ongoing lack of availability of private insurance and rising cost of federal disaster assistance. The primary goals of NFIP are to: decrease the risk of flood losses; reduce the costs and adverse consequences of flooding; and reduce the demands of federal flood disaster assistance. Under this program, the Federal government makes affordable flood insurance available to homeowners, business owners, and renters in participating communities. In exchange, those communities must adopt and enforce minimum floodplain management regulations to reduce the risk of damage from future floods.

Sonoma County joined the NFIP in 1978 and received FIRM, floodway maps, and the attendant certification requirements in January 1982. The County complies with the flood plain management requirements of the NFIP through implementation of its Flood Damage Prevention Ordinance regulations set forth in Chapter 7B of the County Code. These procedures have been in place since January, 1982. The ordinance was modeled after language recommended by the NFIP and was found fully compliant by the NFIP. The County's flood zones and mapping in the General Plan Public Safety Element and other documents are based on the 100-year flood zones and floodways shown on the FIRM maps.

The County's electronic permit management system identifies all parcels in the 100-year flood zone. Once identified, review is performed on a case by case basis in accordance with the County's Flood Prevention Ordinance's. The County's Community Development Commission assists property owners in home elevation to minimize the risk (See discussion of program under Section 3.6). The Flood Disaster Protection Act of 1973 and the National Flood Insurance Reform Act of 1994 mandate that federally regulated, supervised, or insured financial institutions and lenders require flood insurance for buildings located in a participating NFIP community and in an SFHA If a property does not maintain flood insurance, the type of federal disaster aid available in the event of a flood would typically be in the form of a loan that must be repaid with interest. Between 2010 to 2014 the average residential flood claim amounted to more than $39,000. In 2014, the average flood insurance policy premium was about $700 per year. Individual rates, damage amounts, and loan values can vary. Overall, flood insurance remains a prudent economic choice for property owners to protect their property in a 100-year flood zone.

Grandfather Policies

To encourage communities to increase the effectiveness of floodplain management programs, FEMA has implemented the Community Rating System (CRS). The rating systems scores communities on a scale of one (best rating) to ten (lowest rating) based on the number of flood damage reduction measures they adopt. The CRS program has four main categories of flood mitigation activities: Public Information; Mapping and Regulations; Flood Damage Reduction; and Flood Preparedness.

The four areas are further divided into 18 subcategories under which about 75 potential actions may be adopted to earn points. The points are tallied to determine the community's rating. Every time the community collects 500 points its community rating drops to the next lower class and individuals in the community qualify for an additional 5 percent discount in insurance rate, up to a maximum discount of 45 percent.

Currently, Sonoma County does not participate in the Community Rating System; so insurance rates in the community are equivalent to a rating of "10". . Preliminary assessments by County Staff suggest that, the County may be able to qualify for a Category 5 to qualify for a 25 % reduction in flood insurance premiums.

As part of the management of the NFIP, FEMA's goal is to conduct a Community Assistance Visit (CAV) every 5 years for each community participating in the NFIP to ensure that they are

implementing the minimum floodplain management criteria of the NFIP. The California Department of Water Resources reviews the County's compliance with the minimum standards every five years for FEMA through a CAV. FEMA last performed a CAV for Sonoma County in January 2004.

Sever Repetitive Loss (SRL) Grants

The Severe Repetitive Loss (SRL) program provides funds on an annual basis to reduce the risk of flood damage to residential structures insured under the NFIP that meet the definition of "severe repetitive loss structures". SRL provides up to 90% Federal funding for eligible projects in communities that qualify for the program. CalOES has contacted communities with SRL properties informing them of the availability of the SRL program and provided information. The state coordinates with the communities that have the most Severe Repetitive Loss properties to encourage adoption and maintenance of Local Hazard Mitigation Plans (LHMPs). The identified communities are given preference in the award of LHMP and/or FMA planning grants.

Flood Mitigation Assistance Program (FMA)

FMA is a program under the National Flood Insurance Program (NFIP) that provides funding for states and communities to prepare Flood Mitigation Plans and implement measures to reduce or eliminate the long-term risk from flooding. The FMA program assists states and local communities in implementing flood hazard mitigation measures before a major disaster occurs. The program targets NFIP communities with numerous repetitive losses. There are two types of grants to local communities: planning and project grants. A community must have a Flood Mitigation Plan to receive a FMA grant, and only projects specified in that plan are eligible for grants. FEMA contributes 75 percent of a project's cost; other non-federal sources make up the remaining 25 percent matching funds. When awarded a project grant, the community has three years to complete the project with FMA grant funds.

Repetitive Flood Claims (RFC) Grant Program

The Repetitive Flood Claims (RFC) program provides funds, on an annual basis, to reduce the risk of flood damage to individual properties insured under the NFIP with one or more claim payments. RFC provides up to 100% Federal funding for eligible projects in communities that qualify for the program. RFC funds may only mitigate structures that are located within a State or community that cannot meet the requirements of the Flood Mitigation Assistance (FMA) Program (described above), for either cost share or capacity to manage the proposed projects. The long-term goal of the RFC is to reduce or eliminate claims under the NFIP through mitigation activities.

Increased Cost of Compliance (ICC)

Increased Cost of Compliance (ICC) is one of several resources for flood insurance policy holders who need additional help rebuilding after a flood. ICC provides NFIP-insured property owners with substantial flood damage up to $30,000 to bring a home or business into compliance with the local floodplain ordinance through elevation, flood proofing, relocation, or demolition Property owners may file ICC claims if: 1) the local community determines the home or business meets the substantial damage criteria (outlined in the county flood damage

protection ordinance); or, 2) the community has a repetitive loss provision in its floodplain management ordinance, determines that the home or business meets the eligibility criteria.

Urban Streams Restoration Program

This competitive grant program is administered by the Department of Water Resources to promote effective low-cost flood control projects, including stream clearance, flood mitigation, and cleanup activities. Funds are available to public agencies, nonprofit organizations, and local community groups. Public agencies must have a partnership with a nonprofit citizens group to receive funding. Individual projects are limited to a maximum of $1 million.

Flood Protection Corridor Program (FPCP)

The Flood Protection Corridor Program is a competitive grant program administered by the Department of Water Resources to provide local public agencies and nonprofit organizations for acquisition, restoration, enhancement and protection of real property while preserving sustainable agriculture and enhancing wildlife habitat in and near flood corridors. The goal of the grant program is to avoid future flood damage and correct existing risk by restoring natural flood corridors by acquiring, through easement or fee title, rights to real property that is subject to periodic flooding. By acquiring agricultural conservation, wildlife habitat preservation, and flood flow easements, and by restoring floodplain functions, floodwaters can safely spread over or move through floodplains.

Floodplain Mapping Program

The Department of Water Resources administers a flood plain mapping and grant program to assist local land use planning efforts to avoid or reduce future flood risks and damage.

Flood Control Subventions Program

The Department of Water Resources, Division of Flood Management, provides financial assistance to local agencies cooperating in the construction of federal flood control projects who may not be able to meet grant local match requirements. Assembly Bill 2140 (2006), authorizes financial incentives for local governments to integrate LHMPs with mandated general plan safety elements. In addition, $500 million of Proposition E bond funds were approved by the voters in 2006 for state flood control subventions.

Continuing Authorities Program

The US Army Corps of Engineers, San Francisco District, routinely partners with local government agencies and nonprofit organizations to carry out and help fund projects that help reduce flood risk. The USACE recently carried out six flood control projects along the Napa River. The USACE pays for about half of the project. Under the Continuing Authorities Program (CAP), some small projects and technical assistance can be approved by the USACE local San Francisco District office without the need for Congressional authorization. Projects may include design, construct, and partial funding for local flood control projects. Federal funding for an individual CAP 205 project cannot exceed $7 million; the Local Sponsor must provide matching funds.

Cooperating Technical Partners Program

The Cooperating Technical Partners (CTP) Program is an innovative approach to creating partnerships between the FEMA and participating NFIP communities that have the interest and capability to become more active participants in the FEMA flood hazard mapping program. These funds may be used to maintain and update flood hazard maps and other flood hazard information.

The purpose of the CTP Grant Program is to provide, through a Cooperative Agreement, funds to ensure that CTP can perform program management and mapping-related activities, defined in the program guidance each fiscal year. Recipients must be a partner in the CTP program, either be or represent a NFIP community in good-standing, have the capability to perform funded activities, and have existing non-Federally funded processes or systems in place to support activities that contribute to flood hazard identification.

Emergency Watershed Protection Program

The Natural Resources Conservation Service (NRCS) implements the Emergency Watershed Protection Program, in response to emergencies caused by natural disasters. The program offers emergency assistance to jurisdictions and special districts after a disaster causes impacts a watershed. The program works on a 75 percent Federal and 25 percent local match cost-sharing basis. Eligible activities include stream restoration, bank stabilization, levee and structural repair, revegetation, debris removal from stream channels, road culverts and bridge abutments.

Other Potential Funding Sources

Additional potential multi-hazard funding sources are identified in Section 7.8 of this Plan.

Stakeholders

In addition to those Local, State and Federal agencies and nongovernmental entities identified in Section 7.9, the following entities play a key role with respect to flood mitigation.

US Army Corps of Engineers (USACE)

USACE has responsibility for civil works, flood control, flood fighting, environmental restoration, and Clean Water Act regulatory activities. They are responsible for constructing, operating, and maintaining major flood control facilities, such as major dams on the Russian River and the Petaluma Flood Control project. USACE conducts studies and works with local jurisdictions proposing local flood control projects.

Department of Water Resources (DWR)

The Department of Water Resources (DWR) is the state agency with primary responsibility for water management in California, and for flood disaster preparedness and response. DWR coordinates the NFIP in the state, and the Floodplain Management Task Force. Under contract with FEMA, DWR performs Community Assistance Visits (CAVs) for certain communities. DWR conducts studies of flood hazards and assists local agencies with flood plain evaluations and delineation. DWR also provides local assistance on floodplain management The Department of

Water Resources, Division of Safety of Dams, is responsible for approving the design and inspecting dams in the County.

Natural Resources Conservation Service (NRCS)

The U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) provides outreach, management support, engineering, resource technology, technical soil services, and watershed planning technical assistance. The NRCS provides three types of technical and financial assistance programs for watersheds: Emergency Watershed Protection Program and Floodplain Easement Component; Watershed Protection and Flood Prevention Program; and Watershed Rehabilitation. NRCS develops conservation-related surveys and plans, including watershed plans, river basin surveys and studies, flood hazard analyses, and floodplain management assistance.

Other Resource Agencies

There are several federal and state resource agencies whose mission does not include flood mitigation, who have jurisdiction over riparian areas and water concerns and are considered necessary partners on flood protection projects that could affect natural habitat areas along waterways and wetlands.

The NOAA Fisheries Service (National Marine Fisheries Service) is responsible for the stewardship and management of marine resources and regulates critical habitat and recovery efforts for many threatened and aquatic endangered species. The U.S. Fish & Wildlife Service works to conserve, protect and enhance fish, wildlife, and plants and their habitats.
The California Department of Fish and Wildlife manages and protects the state's diverse fish, wildlife, plant resources, and native habitats.

The San Francisco Bay and North Coast Regional Water Quality Control Boards are primarily responsible for regulating water quality to assure safe for beneficial uses. The water boards take an active role in watershed planning and stormwater regulation which often overlaps with flood management.

The Russian River Watershed Council (RRWC) was formed through a cooperative effort between the USACE, Department of Fish and Wildlife, Sonoma County, Mendocino County, and residents in the Russian River watershed to recommend and design natural and structural solutions to enhance the biological health of the Russian River watershed. The RRWC prepared the Russian River Watershed Adaptive Management Plan.

The Flood Control Advisory Committees for the Laguna-Mark West area - Zone 1A, Petaluma Basin – Zone 2A, and Valley of the Moon – Zone 3A, were formed to advise the SCWA on stormwater management and flood control issues and provide recommendations on annual budgets involving expenditures related to flood protection, stream maintenance, and stormwater management.