

Chapter 9 Flood Management

9.0 Introduction

The watersheds of the Feather, Yuba, and Bear Rivers are capable of generating rapid and extreme peak flows during certain Pacific storm events from the southwest that bring high winds and torrential rains (Kelley 1989), especially when combined with large snowmelt volumes from high elevations of the Sierra Nevada. This weather pattern can result in extensive and persistent flooding in the Yuba County IRWMP region. Flooding occurs in many forms in Yuba County: *riverine*, *urban*, and *flash* flooding. The best known causes of flooding result from excess rainfall or snowmelt, especially for riverine or flash flooding, but other causes include dam or levee failure, or in the case of urban flooding, a storm drainage system overload (Yuba County Hazard Mitigation Plan 2009).

Flooding and flood management have been identified as major issues by stakeholders in the Yuba County IRWMP region, especially in the valley where most of the region's population resides and where agricultural production is vulnerable. Flooding has been recurrent and often extensive, and has had significant social and economic impacts, including loss of life, property damage, and loss of economic production. This chapter examines the history of regional flooding, flood management infrastructure, the multi-purpose and multi-jurisdictional planning undertaken to address regional flooding, and the social and economic impacts of regional flooding.

9.1 Yuba County IRWMP Region Flood Management History

The Yuba County Multi-Jurisdictional Multi-Hazard Mitigation Plan (2009) lists flooding (and attendant levee failure) as the “greatest natural disaster to the County.” For centuries, developed lands along the Yuba and Feather Rivers have been subject to periodic flooding. Large floods in the Yuba County IRWMP region vicinity were frequent in the nineteenth century, with 12 high-water events recorded for the Sacramento Valley between 1850 and 1893 (Kelley 1989). Large floods continued into the twentieth century as well, including 1902, 1907, 1909, 1928, 1937, 1940, 1942, 1950, 1955, 1964, 1986, and 1997.¹ The major flood events that occurred in the last century impacted Marysville and Yuba City and low-lying valley areas below the confluence of the Yuba and Feather Rivers. The five most recent flood events and the resultant damages are described in **Table 9-1**.

¹ Draft Feather River Flood Management Plan (October 2013)

Table 9-1. Summary of Major Floods on the Yuba and Feather Rivers						
Flood Event	Cause/Location	Affected Area	Acres Inundated	Number of Homes Flooded	Lives Lost	Total Damage (\$ for Period)
Nov. 1950	Training levee failure/south bank of Yuba River near Hammonton	Hammonton, Linda, and Olivehurst	43,000	Undetermined	Undetermined	\$4 M
Dec. 1955	Levee failure/west bank of Feather River, 3 miles south of Yuba City	Yuba City	100,000	3,300	38	\$50.5 M
	Levee failure/east bank of Feather River near Nicolaus	Nicolaus	35,000	Undetermined	None	
Dec. 1964	High flows/Yuba and Feather River floodways	Floodway areas within levees	25,000 (within floodways)	Undetermined	None	\$5 M
Feb. 1986	Levee failure/south bank of Yuba River at Linda	Linda and Olivehurst	7,000	3,000	None	\$450 M *
Jan. 1997	Levee failure/east bank of Feather River, 6 miles south of Olivehurst	Arboga, Linda, and Olivehurst	16,000	840	3	\$150 M *

*Settlement Amounts

Source: Yuba County IRWMP 2008

Early efforts to protect nearby communities often involved the construction of levees along the major rivers. However, numerous levees failed due to greater-than-anticipated flood events, poor levee construction, insufficient levee materials, or a combination of these. Moreover, the natural flood threat was greatly exacerbated by hydraulic mining from the Gold Rush era, which sent millions of cubic yards of gravel, sand, and clay downstream to choke the channels of the Feather, Yuba, and Bear Rivers, and spread deep layers of sterile sediment over the fertile floodplains adjacent to the river channels where they emerged from the foothills.² This continued until January 7, 1884, when Judge Lorenzo Sawyer's decision handed down what is now known as the Sawyer Decision. This decision did not stop miners from using the big water cannons, but it did prohibit the discharge of debris in the Sierra Nevada region. It imposed strict laws regarding any debris sent downstream and it did close all loopholes. In essence, the ruling stated that "all tailings must stop."³ Still, the accumulation of hydraulic mining debris raised the river channel bottoms and created higher floodwater stages. In 1940 and 1941, in an effort to control this mining

² Draft Feather River Regional Flood Management Plan (July 2014)

³ http://malakoffdigginsstatepark.org/?page_id=568

debris, the US Army Corps of Engineers (USACE), through the California Debris Commission, constructed Englebright Dam and reconstructed Daguerre Point Dam.

The 24-foot-high Daguerre Point Dam, owned by the USACE, was built on the Yuba River in Yuba County in 1906 to prevent hydraulic-mining debris from washing into the Feather and Sacramento Rivers. The dam was equipped with two fish ladders in 1937 that, under certain flow conditions, are difficult for Chinook salmon and steelhead locating and navigating. The dam was rebuilt in 1964 following damage from floods. The dam currently provides hydraulic head for upstream diversions.⁴

In 1959, the California State Legislature enacted legislation to form the Yuba County Water Agency (YCWA) and declared flood control to be one of its principal purposes. Following state approval of water rights and feasibility studies, the citizens of Yuba County approved a \$185 million bond issue by an 11-to-1 margin. The program funded by these bonds included construction of New Bullards Bar Dam and Reservoir for flood control, water supply, power development, and recreation; canal systems to deliver irrigation water; diversions from the Middle Yuba River at Our House and Log Cabin Dams through tunnels and the New Colgate Tunnel and Powerhouse; and construction of the Narrows II Powerhouse at Englebright Dam. New Bullards Bar Dam was completed in 1969.⁵

More recent major flooding events over the last 50 years demonstrate the deficiencies of current flood management infrastructure. In addition, future floods may also occur more frequently than past events due to climate change. For example, levee breaks on the Yuba River in 1986 and the Feather River in 1997 flooded large parts of the southern Yuba County area. To address these concerns, in 1997, YCWA initiated a phased approach to planning and financially supporting other local agencies to implement additional flood control measures. The Feather-Yuba region includes major streams and flood control infrastructure that span a spatially large area, and cover numerous jurisdictions at various levels of government. Effective flood management over this large and complex area requires participation and coordination between all local emergency personnel and state and federal agencies across the entire region.

9.2 Regional Flood Management Plans

To better address the regionwide flood management issues and concerns, a number of stakeholders in the Feather River Basin recently partnered with the California Department of Water Resources (DWR) to develop the Feather River Regional Flood Management Plan (FRRFMP). The FRRFMP addresses flood management for 302,000 acres of levee-protected lands within Sutter, Butte, and Yuba Counties and a small portion of Placer County along the Bear River near Wheatland. The region addressed by the FRRFMP has an estimated population of 135,300 within an area that extends about 56 miles from north to south and between 5 and 17 miles from west to east. Approximately 76 percent of the land area within the region is actively farmed agricultural land, 16 percent is native vegetation or grazing land, and 8 percent is urban and otherwise developed land. The portion of the Yuba County IRWM Plan Area that overlaps with the FRRFMP boundary represents approximately one-fifth of the total regional flood management area.

⁴ www.water.ca.gov/fishpassage/projects/daguerre.cfm

⁵ Yuba Region IRWMP (2008)

Partnering Yuba County FRRFMP stakeholders, who will communicate flooding concerns back to the RWMG, include: YCWA, Three Rivers Levee Improvement Authority (TRLIA), the Marysville Levee Commission, and the Sutter Butte Flood Control Agency, which is outside the Yuba County IRWMP region. The FRRFMP incorporates the concerns and priorities of various interests in the Feather River Basin, including local Levee Maintaining Agency representatives, elected officials, property owners, businesses, interested individuals, small community representatives, Native American Tribes, and non-governmental organizations.

The FRRFMP establishes the flood management priorities of the Feather River Basin and is intended to facilitate future funding and implementation of much-needed flood risk reduction projects throughout the basin. This regional approach allows for improved coordination with state and federal agencies in the planning and implementation of flood management strategies, which increases the local benefit of program implementation while reducing local cost share.

The FRRFMP is currently in progress, and the latest Final Draft version was posted to the document website in August 2014. The FRRFMP is designed in accordance with the recently adopted 2012 Central Valley Flood Protection Plan (CVFPP), which provides a broad vision to manage flood risks in the Central Valley and to guide regional- and state-level financing plans for investments which are anticipated in the range of \$14 billion to \$17 billion over the next 20 to 25 years. The CVFPP proposes a system-wide investment approach for sustainable, integrated flood management in areas currently protected by facilities of the State Plan of Flood Control (SPFC). The CVFPP will be updated every five years, with each update providing support for subsequent policy, program, and project implementation. The FRRFMP is designed to inform the 2017 Five-Year Update of the CVFPP with more detailed information about the needs of the Feather River Basin.

The objectives of the regional (Feather River Basin) planning process are founded on, and consistent with, the goals of the 2012 CVFPP as described below:

Primary Goal of the Regional Flood Management Plan

Improve Flood Risk Management – Reduce the chance of flooding, and damages once flooding occurs, and improve public safety, preparedness, and emergency response through the following:

- identifying, recommending, and implementing structural and nonstructural projects and actions that benefit lands currently receiving protection from facilities of the SPFC; and
- formulating standards, criteria, and guidelines to facilitate implementation of structural and nonstructural actions for protecting urban areas and other lands of the Sacramento and San Joaquin River basins and the Delta.

Supporting Goals

- Improve operations and maintenance
- Promote ecosystem functions
- Improve institutional support
- Promote multi-benefit projects

This chapter is based largely on information from the Draft Final FRRFMP (August 2014) and the 2012 CVFPP. The reader is referred to the FRRFMP for extensive information on flood management regulatory agencies, relevant laws and regulations, and detailed descriptions of flood operations and infrastructure

in the entire Feather River basin. The most recent version of the Plan can be found at <http://frfmp.com/documents/>.

As summarized in the FRRFMP (2014), there are several important connections between flood management and water quality:

“Most importantly, floods are capable of mobilizing enormous sediment loads and any included contaminants, carrying them downstream, and then sorting and re-depositing them. The rivers and streams of the region were heavily impacted by gold mining in the Feather, Yuba, and Bear River basins. As a result, large amounts of mercury were released into the stream system, mainly due to its use in capturing gold from sluice boxes during the Gold Rush. Mercury poses major obstacles to sediment management and ecosystem restoration where it occurs in large concentrations. The potential for mobilization of mercury is a consideration for any channel modification or levee construction project in the region.

When levees fail, the inundation of homes, farms, businesses, and industries often results in the release and dispersion of highly toxic chemicals, which can have far reaching health and economic effects. All of these water quality concerns will continue to affect flood management programs by requiring that contaminants and toxics be addressed in the planning, design, construction, and maintenance phases of flood management projects, most likely intensifying in the future.”

9.3 FEMA Floodplain Mapping in the Region

Mapping of the Yuba County IRWMP region’s floodplains has proven to be expensive, political, and controversial. When the Federal Emergency Management Agency’s (FEMA’s) National Flood Insurance Program (NFIP) was first established in 1968, areas protected by USACE levees were presumed to meet 100-year criteria (a 100-year flood is one that has a one percent chance of reaching a certain flood stage in any given year). As a result, most of the floodplains in the region protected by the levees of the SPFC were mapped with 100-year ratings. High flows and levee failures during February 1986 and again in January 1997 led to recognition that the levee system may provide less than 100-year protection, particularly in the Sacramento area, where portions of the levee system were de-certified, and the floodplain was re-mapped as a high-hazard area.

FEMA is currently working nationwide to re-map levee-protected regions across the country, using current engineering standards and data. The net effect in many areas, including the Yuba County IRWMP region, will be de-certification of levee systems previously deemed adequate. The revised flood hazard ratings will in turn have significant economic impacts on affected areas, due to increased flood insurance costs, limitations on economic development, and the need to fund additional levee improvements.

The State of California has also set its own new standards for floodplain mapping with the passage of Senate Bill 5 in 2007. Senate Bill 5 sets 200-year flood protection as the minimum standard for urban areas, which is a significant increase over the 100-year level of protection required by FEMA. According to the FRRFMP 2013, these increasingly stringent standards create a difficult challenge for rural areas, including most of the Yuba County flood management areas, in that there are a multitude of levee sites which need to be repaired to restore the historic design function. The new standards, largely established

to meet urban requirements, would result in repairs which are too expensive for the rural levee maintaining agencies to afford. The region is supportive of current efforts by DWR to work with the flood management community to develop rural levee repair standards that will facilitate affordable repairs of multiple sites.

DWR has completed three selected special studies to support floodplain evaluation and delineation. Example studies include:

- Sacramento and San Joaquin River Basins Comprehensive Study (2002): This study was a joint effort by the State of California Reclamation Board and USACE in coordination with federal, state, and local agencies. It provides a Comprehensive Plan for Flood Damage Reduction and Ecosystem Restoration within the two river basins, and a strategy for implementation. Numerous technical analyses were performed for this study using computer modeling tools developed by the USACE and DWR to simulate the hydrology, hydraulics, ecosystem function, flood risk, and associated economic damages in the Sacramento and San Joaquin River systems. DWR, USACE, and others will use these models in developing future flood management and environmental improvement projects in the Sacramento and San Joaquin River basins.
- The Upper Feather River Floodplain Mapping Study (2002, updated 2008): DWR commissioned USACE to prepare a floodplain mapping study along the Feather River. The study extends from the mouth of the Yuba River upstream to Oroville Dam, approximately 44 miles in length. The study delineates the 100-, 200-, and 500-year floodplains along the Feather River between the Yuba River and Oroville Dam.
- The Lower Feather River Floodplain Mapping Study (2005): DWR commissioned USACE to prepare a floodplain mapping study along the Lower Feather River. This study addresses flooding from the Feather River downstream from the Yuba River confluence to the mouth of the Feather River at Sacramento River. It also addresses flooding from the Bear River downstream of Highway 65 and several tributaries to the Bear River.

Relevant agencies will be delineating the 200-year floodplain within Yuba County, and the results of that mapping will be included in future updates of this IRWMP.

9.3.1 Flood Insurance Costs

Even more controversial than floodplain mapping for landowners in the Yuba County IRWMP region, both FEMA and USACE have implemented policies and programs that will likely result in increasing the cost of mandatory flood insurance policies for floodplain homes and businesses and increasing the cost of repairs after a levee failure. For example, FEMA's flood risk map digitizing and risk reassessment efforts will result in re-mapping of much of the region as providing less than 100-year flood protection. As a result, development in these areas will be more expensive, difficult to insure, and subject to flood-proofing or elevation requirements.

In July 2012, the United States Congress passed the Biggert-Waters Flood Insurance Reform Act of 2012 (BW-12), which calls on FEMA and other agencies to make a number of changes to the way the NFIP is run. This Act would result in significant insurance rate hikes for many landowners in the Yuba County IRWMP region. The Biggert-Waters law was intended to help reduce the debt of the NFIP, a debt now estimated at more than \$25 billion, by bringing rates more in line with the risk and losses in flood-prone areas. Recent legislation passed in 2013 calls for a four-year delay in most rate increases and requires FEMA to complete an affordability study and propose regulations that address affordability issues.

Another problem with FEMA’s NFIP rates is they are based on damages that would be expected in a riverine flooding environment and do not consider the benefit that existing uncertified levees provide. This results in NFIP insurance rates that over-predict the probability of a property experiencing a claim and therefore set a higher rate than a true actuarial rate would require.

9.4 Overview of Yuba County IRWMP Region Flood Management

Snowmelt flows by themselves and without a rain-flood increment generally do not present a flood threat to the downstream areas because the river channels have the capacity to safely pass flows far in excess of the maximum historical snowmelt. Similarly, longer duration storms or a storm sequence can be more easily controlled by the basin reservoirs in combination with the large channel capacities within the leveed channels.⁶

In contrast, the flood-producing storms are generally of relatively short duration (two to five days) with an occasional longer storm that follows. The Yuba and Feather Rivers have a “flashy” hydrograph that quickly responds to storm events—the rivers quickly rise and recede in the upper watersheds and canyons. For example, during the January 1997 flood, inflow to Lake Oroville increased tenfold—from about 30,000 cubic feet per second (cfs) on December 29, 1996, to 300,000 cfs on January 1, 1997. The following sections present an overview of the flood management infrastructure, systems, and challenges in the region as well as opportunities for improvement as outlined in the FRRFMP.

9.4.1 Flood Management Infrastructure⁷

The flood management infrastructure that currently provides protection to the Yuba County IRWMP region includes upstream reservoirs with active flood control space, levees along the major flood control channels, and drainage facilities that pump interior runoff and seepage from levee-protected areas back into the flood-control channels. These facilities are part of a vast system of multipurpose reservoirs, leveed stream channels, weirs, and overflow structures constructed to reduce flooding in the Sacramento Valley over the past 160 years.

Reservoirs in the region with an active flood control function include Lake Oroville on the Feather River, operated by DWR, and New Bullards Bar Reservoir on the Yuba River, operated by YCWA. Camp Far West Reservoir on the Bear River, operated by South Sutter Water District, does not provide any dedicated flood control storage and is typically full and spilling during flood events. However, the existence of the water supply facility does serve to attenuate a portion of the peak flow as it passes through the reservoir.

Most of the populated valley areas are surrounded by an extensive levee system, maintained by independent local levee districts and reclamation districts, and overseen by USACE and the Central Valley Flood Protection Board. Much of the floodplain areas of the Yuba County IRWMP region are protected by SPFC levees. Levees along the Feather, Yuba, and Bear Rivers were authorized for federal construction as

⁶ Yuba Region IRWMP (2008).

⁷ This section is based largely on information from the Draft Feather River Management Plan (October 2013) and Yuba County IRWMP (2008).

part of the Sacramento River Flood Control Project in 1917.⁸ In the northern part of the region, this includes levees along Honcut Creek and the Feather River. Both banks of the Yuba River have levees from the confluence with Feather River to high ground along the Gold Fields. The City of Marysville is protected by a ring levee around the entire city. Levees are present along the entire left bank of the Feather River between the Yuba and Bear Rivers. This levee continues along the right bank of the Bear River upstream to the Western Pacific Interceptor Canal (WPIC) that drains to the Bear River and along Dry Creek.

Within Yuba County, levee maintenance is the responsibility of the Reclamation Districts (RDs) shown on **Figure 9-1**.⁹ Reclamation District 10, located along the eastern bank of the Feather River between Honcut Creek and the City of Marysville was created by a special act of the California State Legislature on August 10, 1913. RD No. 784 was formed under general RD laws on May 6, 1908, and is located east of the Feather River south of the City of Marysville. RD No. 817, along the north bank of the Bear River east of the WPIC was formed under general reclamation laws on November 4, 1910. RD No. 2103, generally between the right bank of the Bear River and Dry Creek, is east of RD 817. Both RD 817 and RD 2103 are either located within or portions at least border the City of Wheatland Sphere of Influence.

Local Maintaining Agency	County	Streams	Square Miles
Reclamation District No. 10	Yuba	Feather River and Honcut Creek	21.93
Reclamation District No. 784/Plumas Lake	Yuba	Yuba River LB, Feather River LB, Bear River RB, Dry Creek RB and Western Pacific Interceptor RB and LB Canal, plus 60 miles of ditches, canals, detention basins	38.43
Reclamation District No. 817, Carlin	Yuba	Bear River RB and Dry Creek RB and LB	9.19
Reclamation District No. 2103, Wheatland Vicinity	Yuba	Bear River RB and Dry Creek LB	9.77
Marysville Levee District	Yuba	Feather River LB, Yuba River RB, and Jack Slough LB	11.38

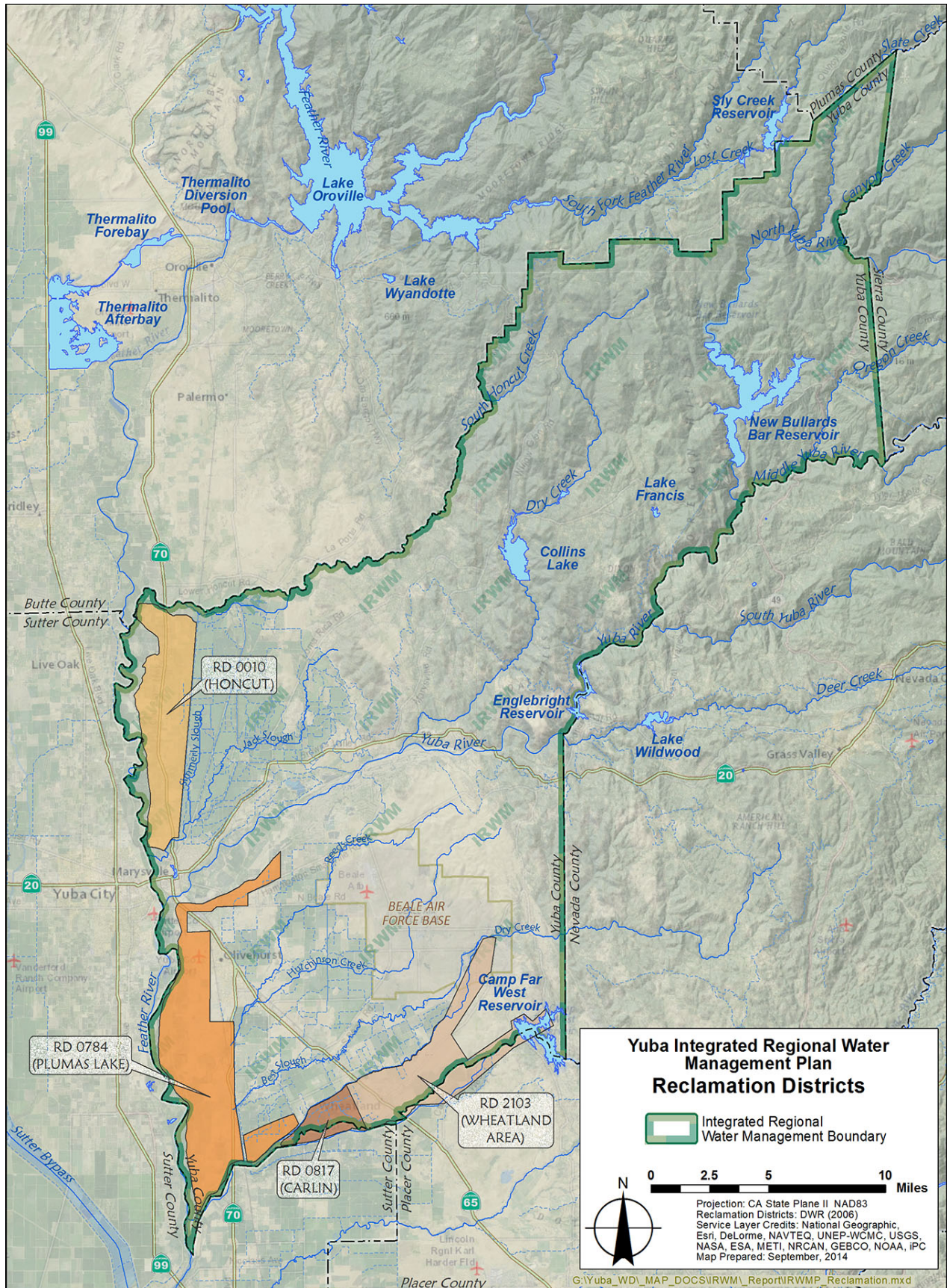
Source: FRMP 2013
 Maintenance provided by the Sutter Maintenance Yard, DWR
 DWR 2010 Inspection Report of the Central Valley State-Federal Flood Protection System
 LB= left bank, RB=right bank, when looking downstream in direction of flow

⁸ Flood Operations Branch Fact Sheet, Sacramento Flood Control Project Weirs and Flood Relief Structures, DWR (2010).

⁹ Yuba County IRWMP (2008).

¹⁰ Feather River Regional Flood Control Plan

Figure 9-1



9.4.2 Flood Management Systems

The Yuba County IRWMP region flood management system is operated to safely convey flood flows through the coordinated efforts of local, state, and federal agencies. Flood control system operations include the operation and maintenance of the multipurpose reservoirs protecting the region; operating and maintaining the levee system; hydrologic monitoring and flood forecasting; and coordinated flood operations under the Standardized Emergency Management System.

Non-structural flood risk management elements include a wide range of measures that limit the risk of flood damage primarily by avoiding or reducing the exposure to damaging flood waters rather than by confining those flood waters with larger and stronger hydraulic structures. These elements include raising and waterproofing structures so that they will be above anticipated flood levels or unharmed by flood waters, purchasing and relocating at-risk structures, limiting development in floodplains through the acquisition of agricultural conservation easements, establishing open space easements, regulatory constraints, and incentive programs. Restoration of floodplains where feasible, to provide additional flood channel storage and conveyance capacity, is often regarded as a non-structural element because it reduces rather than increases the confinement of floodwaters in existing channels.

9.4.3 Flood Management Channel Capacities

Approximately 45 percent of the average annual runoff occurs in the rain- and flood-producing months of December through March; about 35 percent of the runoff is generated in the snowmelt months of April through June, although earlier snowmelt has been documented in recent decades as the climate warms. Levees are designed to provide specific channel capacities. The design flows for various locations are shown in **Table 9-3**.

Location	Design Flow, cfs
Feather River at Yuba City	210,000 cfs
Yuba River at Marysville	120,000 to 180,000 cfs*
Feather River below the Yuba River	300,000 cfs
Feather River below the Bear River	320,000 cfs
Bear River below WPIC	40,000 cfs

*Combined Feather River and Yuba River flows should not exceed 300,000 cfs.

The combined capacity of the channels of the Feather and Yuba Rivers upstream of the mouth of the Yuba River can safely carry more water than the Feather River channel downstream of the Yuba River. The flood system downstream of the Yuba is constrained by the limited channel capacity of the Feather River. Similarly, the combined design capacity of the Feather River and Bear River could exceed the capacity of the Feather River below the Bear River. However, the peak flows in the Bear River normally

¹¹ Yuba County IRWMP (2008)

occur earlier than the peak flows in the Feather River. Exceeding the Yuba channel capacity can be an issue because the Middle Yuba and South Yuba are uncontrolled rivers for flood management purposes.

9.4.4 Summary of Flood Management Challenges and Opportunities

The following excerpt from the FRRFMP makes clear the existing challenges with the Yuba County IRWMP region's existing flood management systems.

Broadly stated, the levees that were originally constructed to protect largely agricultural areas are inadequate to protect developing areas. Although the regional flood management system has prevented millions of dollars in flood damages since its construction, a better understanding of the risk assessment and engineering standards has made it clear that some of the regional levee segments face an unacceptably high chance of failure. This, combined with growth in the region has increased the estimated level of flood risk. While the chance and frequency of flooding has decreased since construction of the region's levees and multipurpose reservoirs, the damages that would occur if a levee were to fail in one of these areas are much greater, resulting in a net long-term increase in cumulative damages if no further action is taken to improve the flood management system or to limit further development in these areas.

The multitude of state and federal agencies, programs, policies, and procedures profoundly affect how future regional flood management elements are designed, financed, and constructed, how the system is operated and maintained, and how the economic stability and environmental quality of the region are improved over time. The specific flood management challenges in the Feather River basin are outlined in the FRRFMP as follows:

Levees: *The regional levee system was built over many years using available materials. While substantial work has been completed to upgrade urban levees in the region, portions of the levee system suffer from structural instability, erosion, settlement, inadequately designed or decaying penetrations, excessive vegetation, rodent damage, and encroachments. Meanwhile, the number of people and the importance of the infrastructure they protect have grown tremendously, with a resultant high risk to life and property in the region. Appendix A [in the FRRFMP] includes a detailed discussion of the specific levee deficiencies which have been identified based on operational experience during floods and technical studies such as DWR's Urban Levee Evaluation Program and Non-Urban Levee Evaluation Program.*

Channels: *Channels in the region must be managed to address the impacts of localized erosion, sedimentation, and vegetative growth, which both impedes floodwater capacity and provides critically important wildlife habitat. Improved collaboration among maintaining and regulatory agencies, combined with flood corridor planning, offers the opportunity to optimize channel benefits of flood conveyance and wildlife habitat. From a regional perspective it is critically important that flood conveyance capacity continues to be the top management priority.*

Reservoirs: *Reservoirs in the region, such as Lake Oroville and New Bullards Bar Reservoir meet many important regional and [s]tate water management objectives.*

However, with current flood storage, release capabilities, and operational criteria, storms larger than the 1997 flood would likely result in flows that exceed channel capacities. There are opportunities to make both operational and structural improvements which can substantially improve their effectiveness in reducing flood risk, including structural improvements, Forecast Coordinated Operations, and Forecast Based Operations.

Fisheries and Wildlife Habitat: *Fisheries and [w]ildlife habitat have been substantially altered and degraded over the past 160 years through the construction of flood control levees, dams, and diversion structures, as well as land use changes across the region. There are opportunities to improve these habitats as part of multi-objective flood risk management projects, consistent with the goals of the CVFPP and the regional objectives. The region seeks to integrate agricultural land preservation, habitat enhancement, and restoration opportunities where feasible. The Flood Management Plan describes strategies for preserving agricultural lands along flood corridors in ways that are wildlife friendly, describes habitat enhancement and restoration opportunities, and explores environmental compliance and mitigation solutions.*

Operation and Maintenance: *Operation and [m]aintenance constraints have increased costs and made it progressively more difficult to meet levee maintenance standards. Complex, time consuming, and expensive permitting processes create hurdles for Local Maintaining Agencies which have historically had the freedom and license to clear vegetation, repair erosion sites, restore levee sections, and resurface roads from late spring through fall. The region is now working with a multitude of [s]tate and federal agencies to develop management tools and practices which can achieve both operational efficiency and flood risk management goals.*

Flood Risks and Levee Performance Evaluation: *Flood risk is the combined effect of the chance of flooding and the consequences of flooding. As development occurs within levee-protected areas, flood risk increases as well. Climate change is likely to result in more extreme rain floods, which will increase the chance of overwhelming the regional flood management system. Meanwhile, in the aftermath of major flooding elsewhere in the country, such as the 2005 flooding of New Orleans, USACE has been creating a more conservative framework for risk assessment, with the net effect of downgrading the flood protection ratings of flood protection facilities.*

9.5 Summary of Yuba County IRWMP Region Flood Impacts

According to the Yuba County *Multi-Jurisdictional Multi-Hazard Mitigation Plan* (2009) (MJMHP), roughly one-third of the county's population lives in the 500-year floodplain, along with emergency evacuation routes, sewer and water treatment plants and other infrastructure, and numerous critical community facilities. Floods in 1986 and 1997, exacerbated by levee failures on the Yuba and Feather Rivers, inundated large areas south of Marysville in the Linda and Olivehurst communities. Levees are instrumental in protecting vulnerable populations in Marysville, Wheatland, and an area of RD 10 as well. At higher elevations, damage to roadways occurred from landslides and debris flows.

The cost of flood and levee failure is estimated at over \$487 million for a 100-year event and at over \$648 million for a 500-year event.¹² Over four percent of all jurisdictional critical facilities are located in the 100-year floodplain in Yuba County, while 14 percent of such facilities are exposed to 500-year events. About 15,000 people were located in the 100-year floodplain in 2000, and of these, 2,300, or 15 percent were severely disadvantaged (annual incomes under \$10,000).¹³ Increased potential for flood risk due to intense storm events and higher peak flows could result in loss of life, damage to critical facilities, property damage, and loss of business and tax receipts.

9.5.1 Localized Flooding from Severe Winter Storm Events

Localized flooding from severe winter storms also occurs along roads throughout Yuba County. Several neighborhoods are prone to localized flooding during significant rainfall events. Floods also occur due to debris accumulation in storm drains and in flood control channels and basins. This is referred to as *ponding* or *urban flooding* (Yuba County 2009). The MJMHP identifies the following areas as at-risk in Yuba County due to localized flooding:

- Highway 70 at McGowan Parkway
- Hamonton–Smartsville Road at Brophy Road
- Area off Arboga Road at Buttercup and Butterfly Lanes
- Mage Avenue in Olivehurst
- Magnolia Avenue off Highway 70
- Ramirez Road
- Iowa City Road
- Fruitland Road
- Simpson Lane

The problem areas noted above are considered to be a hazard in their specific location and are not expected to threaten or endanger the lives of persons in the surrounding areas.

FEMA has identified eleven repetitive loss properties within Yuba County.¹⁴ Nine of these properties are within Olivehurst, one is in Marysville, and one in Camptonville. These properties have been subject to repeated flooding during high water periods. The cause of most of the above properties' repetitive losses has been issues involving internal drainage.

The MJMHP states:

During the 2005-2006 winter season Yuba County experienced a significant storm event that caused widespread damage across the County. Documented damage assessments resulting from the storm event totaled over \$5,325,000 across all of Yuba County and its special districts. Typical damage resulting from the storm included abundant damage to roadways from debris falls and slipouts, water overflow resulting in debris on the roadway, pothole damage, fallen trees, crop damage, and localized flooding of homes. Rainfall accumulations of 20 to 24 inches during the storm event in the Feather River basin make the storm event the fourth wettest December on record since 1920 (http://www.cnrfc.noaa.gov/storm_summaries/dec2005storms.php).

¹² Yuba County Multi-Jurisdictional Multi-Hazard Mitigation Plan (2009).

¹³ Yuba County Multi-Jurisdictional Multi-Hazard Mitigation Plan (2009).

¹⁴ Ibid.

Other historic events, such as the 1986 severe winter storms which resulted in \$95 million in losses, and the 1997 severe winter storm event which resulted in \$358 million, indicate the wide range of potential losses that could result from future large storm events. Typical winter storms do not usually approach the magnitude of the 2005-2006 storm event, but the county can expect thousands to hundreds of thousands of dollars of damage each year from severe storm events. More difficult to quantify but nonetheless important is the potential loss that results from the population being unable to work because of road conditions or storm-related power outages.

9.5.2 Recent Major Flood Events

1986 Flood

A massive flood in 1986 triggered a levee break along the Yuba River and water quickly inundated developed areas such as Olivehurst and Linda. Flood waters were 10 feet high in some places. The MJMHP summarizes the breakout damage from the 1986 flood as follows:

Breakout of Damage in Dollars for the 1986 Flood in Yuba County

There was a total of \$95,000,000 in damage to buildings, equipment, and land.

Structures:

3,000+ homes damaged

1 death

10,700 acres flooded

1997 Flood

In 1997, the Arboga area was inundated by floodwaters when a levee broke on January 2 (the Country Club break). Another levee gave way three weeks later, causing additional flooding in some of the same areas (the Bear River break). These levee breaks occurred in areas scheduled for repair, having been identified as deficient following the 1986 flood (Be Prepared Yuba 2013).

The organization known as “Be Prepared Yuba” summarizes some of the impacts on their website stating:

Homes closest to the breaks were destroyed by the force of the rushing water, with some reports indicating flood depths of 30 feet. Farther from the levee breaks, many homes were damaged beyond repair due to water depths of 10 feet. In total, 38,000 Yuba County residents were evacuated, including almost everyone in Marysville. Three people lost their lives. Portions of the communities are still trying to recover today, more than 20 years later.

The MJMHP summarizes the breakout damage from the 1997 flood as follows:

Break out of Damage in Dollars for the 1997 Flood in Yuba County:

There was a total of \$358,637,000 in damage to buildings, equipment, and land.

Structures and Infrastructure:

Roads, Bridges, and Drainage - \$13,077,000

Levee damage:

Reclamation Districts - \$20,000,000

Marysville - \$5,000,000

Residential:

Homes - \$50,000,000

Mobiles - \$5,000,000

Agricultural:

Buildings and Equipment - \$40,850,000

Crops - \$17,583,100

Livestock - \$2,417,000

Nurseries - \$60,000

As summarized above, floods result in significant short-term damage, but long-term economic effects are also significant. Businesses often temporarily or permanently close as a result of flood damage, causing loss of revenue and increasing unemployment. Critical facilities such as utilities (electric, telephone, water and sewer, gas/oil pipelines) and roadway and airport infrastructure are often disrupted, and the subsequent clean-up and reconstruction can take years to complete.¹⁵

9.6 Recent Flood Protection Efforts

Recent efforts by YCWA, Yuba County, TRLIA, RDs 784, 817, and 2103, the City of Marysville, the State of California, and USACE have greatly reduced the flood risk. The organization *Be Prepared Yuba* is a collaborative effort to assist residents to prepare for disasters. They estimate that since 2007, almost a half billion dollars have been spent on repairs to dozens of miles of levees protecting Marysville, Wheatland, Linda, Olivehurst, Arboga, and Plumas Lake. The following summary of these efforts is based on information provided on the *Be Prepared Yuba* website.

Levee System Evaluation Project

Following the 1986 flood, USACE partnered with the State of California and RD 784 and the Marysville Levee Commission in an effort to repair and strengthen levees with the “Levee Systems Evaluation Project.” Despite another levee failure in 1997, the Corps maintained that the repairs would provide the much-needed flood protection. Meanwhile, DWR and the Corps initiated a study to determine the ability of the levees to withstand a 100-year flood event, a flood that has a one percent chance of occurrence in any given year. FEMA imposes development restrictions and flood insurance requirements on communities that do not provide this minimal level of protection.

The following paragraphs describe some flood control projects in the Yuba County IRWMP Region. In addition to the projects described below, RD 817 and Yuba County have invested in flood related projects at the airport and in Olivehurst and Linda. These and other proposed flood control projects are described in detail in **Appendix 14-1**.

Three Rivers Levee Improvement Authority

¹⁵ Yuba County Multi-Jurisdictional Multi-Hazard Mitigation Plan (2009).

In 2004, Yuba County and RD 784, the agency responsible for levee maintenance on behalf of the state, created the Three Rivers Levee Improvement Authority (TRLIA). The joint powers agency was given a mission to finance and construct levee improvements on RD 784 levees, with the goal of achieving 100-year and 200-year flood protection. System improvements began in 2004 and early public-private partnerships with local developers provided resources for the initial investment in levee improvements. By the end of 2006, significant work had been completed on Yuba River, Western Interceptor Canal, and Bear River levees.

The highlight of the initial work was the Bear River Setback Levee, considered an example of civil engineering excellence and the subject of several prestigious awards from professional engineering associations. In partnership with River Partners the project also resulted in the planting of one million shrubs and trees in the setback area, and created 600 acres of wildlife habitat benefiting several threatened and endangered species, such as Swainson's hawk and the valley elderberry longhorn beetle. The preserve provides shaded riverine aquatic habitat and valley oak riparian forest components that enhance habitat for fish species, including Central Valley salmon species and steelhead. Dense clusters of a variety of shrub species are included to support a diversity of migratory songbirds.

By late 2006, TRLIA's levee improvement program expanded to four phases covering 29 miles of levees, including 13 miles along the Feather River. In May 2008, TRLIA broke ground on the program's highly acclaimed engineering accomplishment, the six-mile-long Feather River Setback Levee, the largest of its kind in the state. Like its counterpart along the Bear River, the Feather River Setback Levee provides significant benefits for regional flood protection. In fact, it is expected to lower water levels in the Yuba and Feather Rivers by more than 1.5 feet during large flood events, taking pressure off levees in Marysville and Sutter County. The setback area, which required the acquisition of 1,600 acres of land, is being evaluated for recreational, agricultural, and environmental uses. A regional trail system may someday run along the top of the levee, much like the one along the American River in Sacramento. To date, the project has earned several awards from the American Society of Civil Engineers, and most recently the Floodplain Management Association. The Upper Yuba Levee Improvement Project was completed in October 2011.

In 2011, interest was renewed in understanding the flood risk associated with the Gold Fields. Located northeast of Marysville, the Gold Fields is a nearly 10,000-acre area that has been mined for gold and aggregate for more than 100 years. In 1950, a mining operation created a manmade breach in Yuba River south bank in the Gold Fields. A subsequent early-season, high-water event led to flooding in south Yuba County.

The Corps studied flood risk in the Gold Fields as part of its Yuba Basin Feasibility Study and concluded that the Gold Fields did present a risk of flooding to South Yuba County from a 200-year flood event, but not a 100-year event. TRLIA conducted a more detailed hydraulic analysis, the results from which are being used to make improvements and reduce the flood risk in this area.

Marysville Ring Levee Work Underway

The City of Marysville, in partnership with the Central Valley Flood Protection Board and the Corps, is constructing repairs and improvements to the 7.6-mile ring levee that surrounds the city. Although a Marysville levee has not failed in 135 years, four miles of the levee system need improvements to meet the state's 200-year levee design criteria. A four-phase, \$90 million project to prevent seepage through the levee, or under-seepage below the levee, is underway with a goal for completion in 2020, depending

on the level of appropriations from Congress. More than \$10 million in stimulus funds approved by Congress in 2009, and a \$2 million line of credit from YCWA, helped jumpstart work on Phase I in 2010. A large share, approximately \$90 million, will be covered by current and future federal funding.

Reclamation District 2103 (Wheatland)

RD 2103 maintains portions of the Bear River and Dry Creek Project levees. These levees protect the City of Wheatland and surrounding agricultural land from winter storm runoff. In 2006, problems with the Bear River levee were identified and a \$14.7 million project was planned and constructed to make the needed repairs. The levee has received accreditation from FEMA as providing protection against a 100-year flood event.