



Zone 7 Water Agency

Flood Management Plan

Phase I

August 2022



Executive Summary

Zone 7 manages a 37-mile flood protection system in the Livermore-Amador Valley area. In recent years, relatively minor flood events have caused widespread damage such as channel bank erosion and sedimentation in channels which, in turn, have led to costly repairs. Major stressors contributing to flood system management challenges include urbanization, channelization, population growth, climate change, aging flood infrastructure, and changing environmental regulations. Under the guidance of [District Act 205](#) [Alameda County District, 1949], as amended by Assembly Bill 1125 [2003] and Zone 7's Strategic Plan, and informed by prior planning efforts, this Flood Management Plan (FMP) initiates the long-term process of improving flood management in the Livermore-Amador Valley area, including the Zone 7 flood protection system.

The FMP describes a high-level strategy for flood management for the Zone 7 service area. This inaugural version of the FMP will be updated every 5 years or as conditions dictate.

The FMP is based on the following guiding principles for flood management:

1. **Align with Zone 7's Strategic Plan.** The FMP will be consistent with the agency's integrated water resource goals and initiatives.
2. **Foster proactive public engagement.** The FMP will promote open communication with community partners and stakeholders.
3. **Do what is needed and practical to manage risks associated with flood management in the Zone 7 service area.** The FMP will be developed with an approach that prioritizes projects in the Zone 7 service area that can be funded, implemented, and sustained.
4. **Incorporate climate change uncertainty.** The FMP will be based on well-supported analysis of future watershed conditions.
5. **Be risk-informed.** The FMP will support risk-informed decision making and communication through evaluation of both a flood's likelihood of occurrence as well as its consequences.
6. **Advance collaboration within the watershed.** Successful implementation of the FMP is dependent on active participation among multiple agencies with flood management responsibility and/or impact.
7. **Consider Multi-Benefit Solutions.** The FMP will support the implementation of multi-benefit projects where flood risk reduction can enable the accomplishment of compatible water resources goals.

To develop the FMP, existing flood risk was evaluated through review of modeled and actual storm events, literature research, workshops, interviews, and qualitative risk analyses. Goals and objectives were then established to mitigate identified risks. Specific, measurable, and actionable objectives fall within seven goal areas:

Flood risk is defined in this FMP as the combination of likelihood and magnitude of consequences resulting from flood inundation or other adverse impacts of floodwaters.

- **Flood Control Channel System**—Develop the framework to provide flood protection to a level as high as reasonably practicable using a risk-informed process.
- **Relationships with Partner Agencies**—Foster and participate in productive relationships with land use agencies to improve flood management.
- **Capital Improvement**—Develop a capital improvement program to support effective flood management projects and programs.
- **Operations and Maintenance**—Operate and maintain the flood control channel system where Zone 7 has fee title, easement, or agreement.
- **Technical Excellence**—Use the best available resources to achieve flood management projects and programs.
- **Communication and Engagement**—Effectively communicate and engage with the public and other stakeholders to deliver Zone 7’s flood management projects and programs.
- **Resource Agency Permitting**—Obtain permits in a timely manner to deliver flood management projects and programs.

The FMP is the product of Phase I of a two-phased planning process. The FMP describes at a high level “what” needs to be accomplished to reduce flood risk; Phase II will describe “how” to do it. To advance FMP objectives into actual and necessary projects and programs, Phase II will encompass the following:

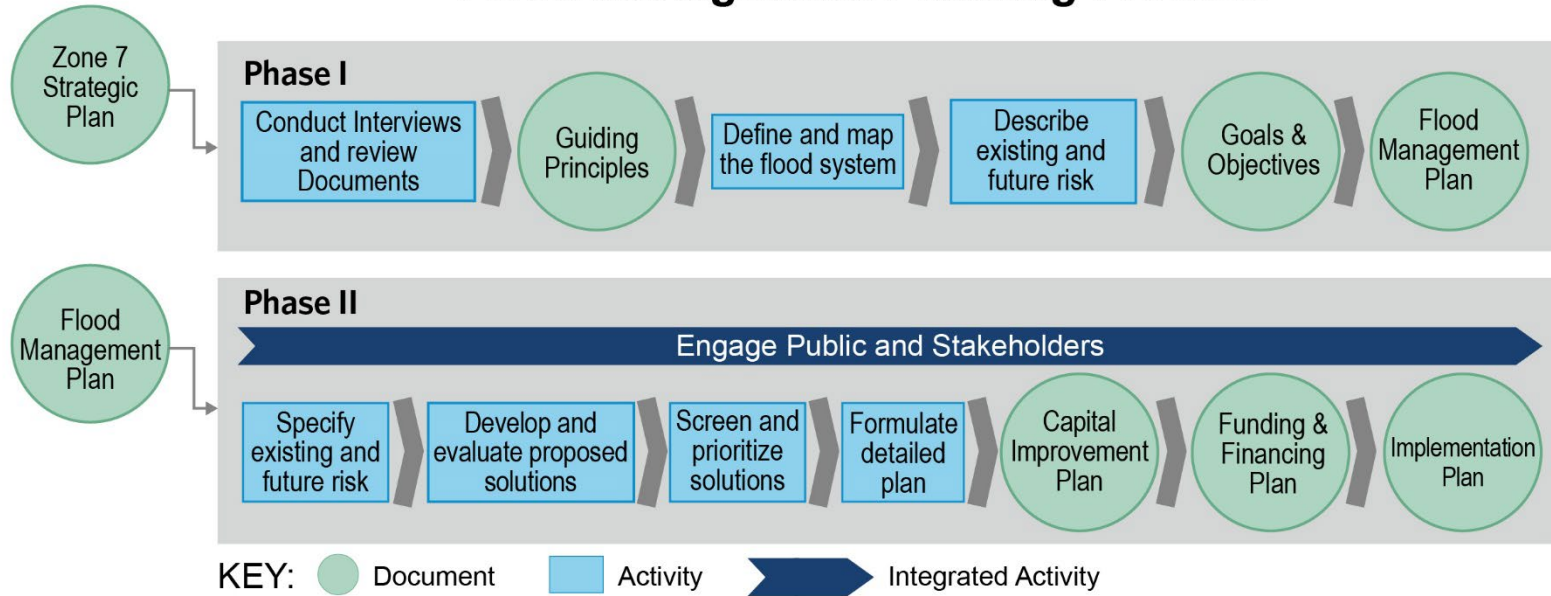
- A **Capital Improvement Plan** (CIP) that facilitates annual Zone 7 budgeting for large projects and purchases. The CIP will be founded on a watershed-based, risk-informed, systemwide evaluation that incorporates floodplain management and improvements to the existing flood protection system.
- A long-term **Funding/Financing Plan** that forms the basis for the CIP and Implementation Plan.
- A **Public and Stakeholder Engagement Plan**:

- The public will be engaged in the planning process through various modalities including a dedicated website, in-person public forums, and social media platforms.
- Stakeholder engagement with resource agencies, land use agencies, the cities, the county, community groups, and business organizations will be conducted throughout the planning process.
- An **Implementation Plan** that describes the logic, schedule, and resources required for implementation of the CIP as well as achievement of interrelated goals and objectives of the FMP. The Implementation Plan will be tactical, dynamic, and adaptive.

The two phases of Zone 7's flood management planning process are summarized in the figure below. While this process focuses on capital improvement, equally important are the full suite of interrelated goals and objectives to resource and operate the Agency. As shown, Zone 7's Strategic Plan, which is informed by other significant prior planning documents, is the input to Phase I of the planning process; this FMP is the product of Phase I of the planning process.

The FMP provides the foundation for achieving long-term, sustainable flood management for the Zone 7 service area.

Flood Management Planning Process



The two phases of Zone 7's flood management planning process



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1 INTRODUCTION

1.1 Background

The Alameda County Flood Control and Water Conservation District (Alameda County Flood Control District) was created in 1949. It is charged with protecting “all waterways, watersheds, harbors, and public highways, as well as lives and property, from damage or destruction caused by flood and storm waters” ([District Act 205](#) [Alameda County District, 1949], as amended by Assembly Bill 1125 [2003]).

The enabling legislation provided for the establishment of zones (roughly corresponding to watershed boundaries) and the implementation of projects for the specific benefit of one or more zones. This provision allowed the more populous and developed areas in western Alameda County and more rural, agricultural areas in eastern Alameda County to each pursue flood protection projects appropriate to their diverse needs. In 1957, following the historic and devastating floods of 1955, residents of the Livermore-Amador Valley voted to establish Zone 7 Water Agency (Zone 7) and place water management, including flood protection, under local control through a locally-elected board of directors known as the Zone 7 Board of Directors. In addition to Zone 7’s programs for flood protection, Zone 7 provides water supply, water quality services, and groundwater management. These water services are integrated.

Zone 7’s 1966 Flood Control Master Plan was state-of-the-art for its time, envisioning a 120-mile network of trapezoidal channels in the Upper Alameda Creek Watershed to convey drainage and flood flows out of the system quickly and safely. In the years that followed, much of the Zone 7 flood protection system was developed based on this approach, in concert with new urban development. The 2006 SMMP updated the 1966 Flood Control Master Plan and described a multi-benefit program for stream management throughout the Zone 7 service area. This Flood Management Plan (FMP) updates and refines the approach described in the SMMP and includes updated goals and objectives as approved by the Zone 7 Board of Directors on March 2, 2022.

Changes in population, land use, environmental regulation, and climate over the last half-century have resulted in conditions that call for a change in Zone 7’s approach to flood management. Urbanization, channelization, and population growth have increased pressure on the flood protection system and reduced risk tolerance at the same time that climate change is increasing the intensity of storms. The need to maintain, update, and replace portions of the flood protection system presents great opportunity, such as shifting emphasis from flood conveyance to on- and off-channel storage, land use policies, floodplain management, multi-benefit projects, and other strategies to reduce risk.

In its 2020-2024 Strategic Plan, Zone 7 identified the need to adapt its approach and committed to a thorough review and update of its flood protection strategy. Initiative #10: “Update the flood protection strategy” was adopted alongside 23 other initiatives to support Zone 7’s mission to “deliver safe, reliable, efficient, and sustainable water and flood protection services.” In accord with these initiatives, Zone 7 has prepared this first edition of the FMP.

Significant flood events that have occurred in the Zone 7 service area, as well as prior flood management planning documents developed by Zone 7, are summarized in the timeline shown in **Appendix B**.

1.2 Purpose of the Flood Management Plan

The FMP describes a high-level strategy for flood management within the Zone 7 service area. The FMP will be implemented and referenced by the Zone 7 Board of Directors and staff to inform and promote alignment in its flood management strategy with partner agencies and the interested public. The FMP is a strategic, standalone document that will be updated every 5 years or as conditions dictate.

Figure 1 depicts Zone 7’s two-phase flood management planning process. As shown, Zone 7’s Strategic Plan, which is informed by other significant prior planning documents, is an input to Phase I of the planning process; the FMP is the product of Phase I of the planning process. Phase I is the strategic phase that looks more broadly at **what** will reduce flood risk by:

Flood risk is defined in this FMP as the combination of likelihood and magnitude of consequences resulting from flood inundation or other adverse impacts of floodwaters.

- Describing the existing Zone 7 flood protection system and protected areas.
- Describing existing and future flood risk posed to the system and protected areas.
- Establishing goals and measurable objectives to reduce flood risk.

Phase II more specifically addresses **how** flood risk will be reduced by:

- Developing and evaluating watershed-based, systemwide improvements that incorporate floodplain management and improvements to the existing flood protection system.
- Focusing on capital improvements to the existing flood protection system through development of three plans:
 - A Capital Improvement Plan (CIP) that supports annual budgeting for large projects and purchases.

- A Funding and Financing Plan that describes a long-term strategy to fund and finance the CIP.
- An Implementation Plan that describes the logic, schedule, and resources required for implementation of the CIP and achievement of interrelated goals and objectives of the FMP. The Implementation Plan will be tactical, dynamic, and adaptive.
- Public and stakeholder engagement:
 - The public will engage in the planning process through various modalities including a dedicated website, in-person public forums, and social media.
 - Stakeholder engagement—including with resource agencies, land use agencies, the cities, the county, community groups, and business organizations—will be conducted throughout the planning process.

Phase I and Phase II of Zone 7’s flood management planning process are summarized in **Figure 1**.

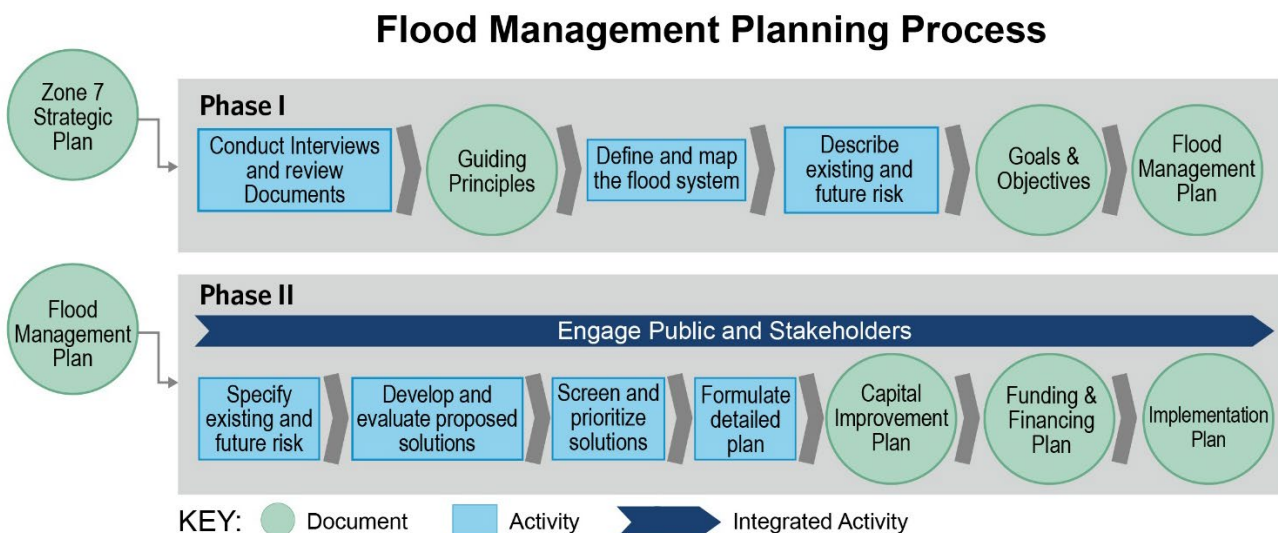


Figure 1. The two phases of Zone 7’s flood management planning process

The process above results in an improved flood protection system over time. While this process focuses on capital improvement, equally important are the full suite of interrelated goals and objectives to resource and operate the Agency. In particular, sustainable O&M requires thoughtful allocation of Zone 7 resources and productive relationships with stakeholders and the land use agencies that comprise the Zone 7 service area. Integration

of capital improvements, sustainable O&M, and management of the protected floodplain will reduce overall system risk.

1.3 Guiding Principles

The Guiding Principles are concise statements that direct the agency's conduct of flood management work and form the conceptual basis for the FMP. The Guiding Principles are founded on Zone 7's 2020-2024 Strategic Plan. On July 21, 2021, Zone 7's Board of Directors adopted the following seven guiding principles for flood management (Zone 7 2021b):

1. **Align with Zone 7's Strategic Plan.** The FMP will be consistent with the agency's integrated water resource goals and initiatives.
2. **Foster proactive public engagement.** The FMP will promote open communication with community partners and stakeholders.
3. **Do what is needed and practical to manage risks associated with flood management in the Zone 7 service area.** The FMP will be developed with an approach that prioritizes projects in the Zone 7 service area that can be funded, implemented, and sustained.
4. **Incorporate climate change uncertainty.** The FMP will be based on well-supported analysis of future watershed conditions.
5. **Be risk-informed.** The FMP will support risk-informed decision making and communication through evaluation of both a flood's likelihood of occurrence as well as its consequences.
6. **Advance collaboration within the watershed.** Successful implementation of the FMP is dependent on active participation among multiple agencies with flood management responsibility and/or impact.
7. **Consider Multi-Benefit Solutions.** The FMP will support the implementation of multi-benefit projects where flood risk reduction can enable the accomplishment of compatible water resources goals.

In addition to forming the basis for the FMP, these principles will guide Zone 7 as it maintains the flood protection system and reduces risk from future flood events.

1.4 Update Process

The FMP should be updated on a recurring basis as conditions change in the future, using the same or similar processes included herein. Updates should include the following:

- Progress on actions undertaken since adoption or prior update of the FMP; changes to flood management requirements, challenges, and constraints; new opportunities; and changes in flood hazard due to population, land use changes, and/or climate change.
- Measurement of progress to achieve goals and objectives and/or a determination if updates to goals and objectives are needed.
- Consistency with the current FMP.
- Alignment with the Guiding Principles for flood management and the current Strategic Plan.

1.5 Organization of the Flood Management Plan

The FMP is organized into eight chapters:

- **Chapter 1** provides background information on Zone 7 as a flood control agency and describes the purpose of this FMP.
- **Chapter 2** provides an overview of flood protection in the Zone 7 service area, including the Zone 7 flood protection system and the flood management roles and responsibilities of local, regional, state, and federal partner agencies.
- **Chapter 3** describes historical storms and associated damages that have occurred within the Zone 7 service area.
- **Chapter 4** provides an overview of the people, property, and environmental setting at risk due to storm events and flooding within the Zone 7 service area.
- **Chapter 5** describes existing risks to the flood protection system and the agency.
- **Chapter 6** describes future risks to the flood protection system under status quo conditions and factors that may contribute to changes in future risks.
- **Chapter 7** lays out Zone 7's goals and objectives for flood management.
- **Chapter 8** lists references for the sources cited in this FMP.

2 FLOOD MANAGEMENT CONTEXT

2.1 Zone 7 Service Area

The Zone 7 service area, shown in **Figure 2**, is located about 40 miles southeast of San Francisco and encompasses approximately 425 square miles of the eastern portion of Alameda County. The service area includes the cities of Dublin, Livermore, and Pleasanton in the Livermore-Amador Valley. The service area also covers the town of Sunol and small portions of the cities of Fremont, Hayward, and Union City.

2.2 Contributing Watershed

The drainage area contributing to runoff and flooding in the Zone 7 service area is the upper Alameda Creek Watershed, shown in **Figure 3**, which encompasses approximately 622 square miles.¹ The majority of the watershed (55 percent) is located within Alameda County, with the remainder in Santa Clara County to the south (35 percent) and Contra Costa County to the north (10 percent). Approximately 11 percent of the watershed is developed, while the remainder is agricultural/open space (62 percent), forested (25 percent), or water (2 percent). The vast majority of development is located in the cities of Dublin, Livermore, and Pleasanton in the northern half of the watershed.

Major waterways within the upper Alameda Creek Watershed include:

- Altamont Creek
- Arroyo Seco
- Arroyo Las Positas
- Arroyo Mocho
- Arroyo del Valle
- Tassajara Creek
- Alamo Creek
- South San Ramon Creek
- Arroyo de la Laguna
- Alameda Creek

¹ The far northeastern portion of the Zone 7 service area drains east toward the San Joaquin Valley and does not contribute flow to the Zone 7 flood protection system.

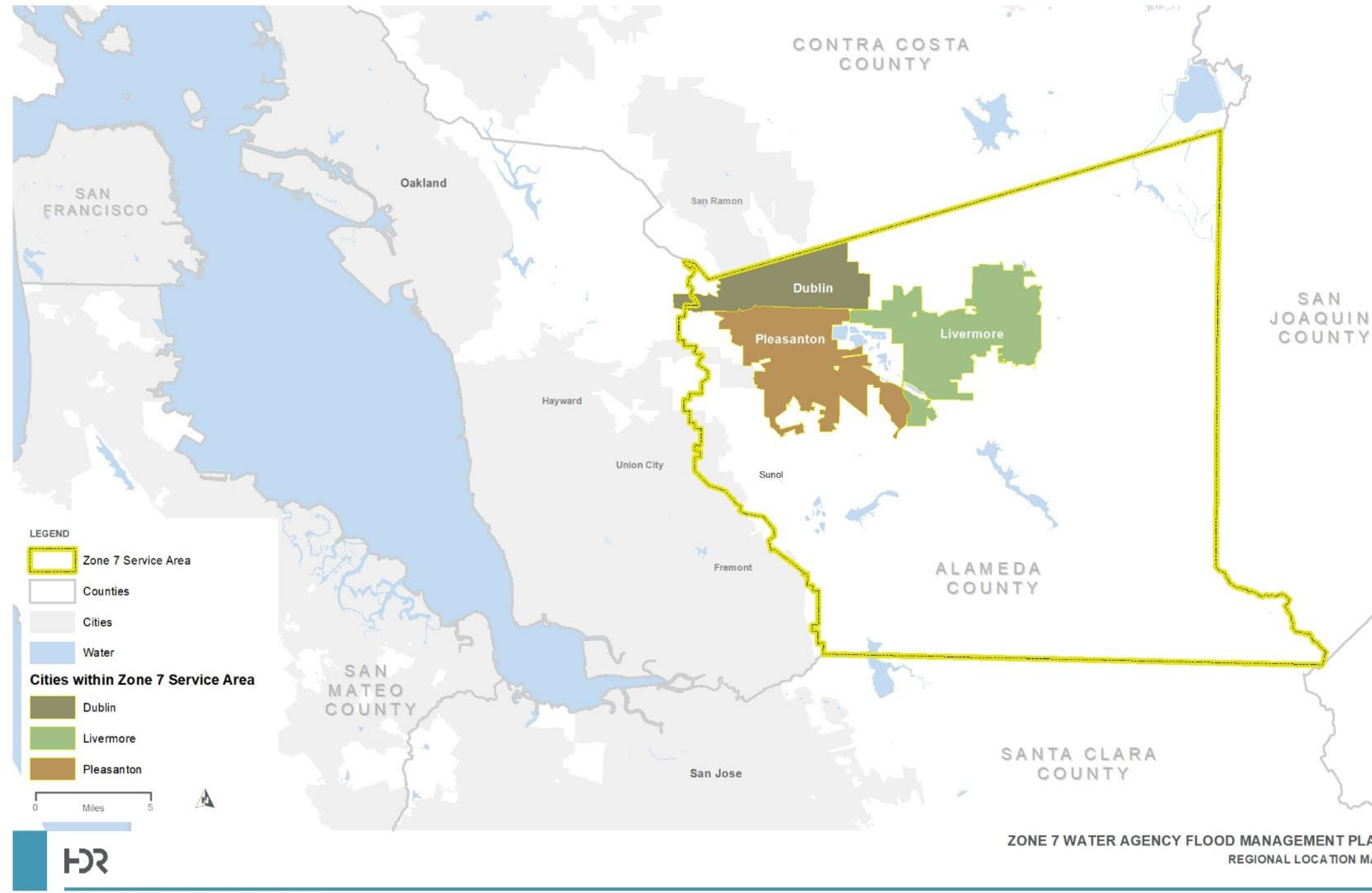


Figure 2. Zone 7 regional location map

Altamont Creek, Arroyo Seco, Arroyo Las Positas, and Arroyo Mocho drain the northeastern and southeastern hills, and Arroyo del Valle drains the southern hills. These arroyos converge with Arroyo de la Laguna, collecting the flows of Tassajara, Alamo, and South San Ramon creeks from the northern hills. These flows run south through Arroyo de la Laguna into Alameda Creek, ultimately draining into the San Francisco Bay.

2.3 Stormwater Contribution

During a storm event, precipitation infiltrates into the ground, or if the ground is saturated or impermeable, runs off the land surface and enters lakes, streams, ditches, and channels. Runoff flows across impermeable surfaces such as parking lots, streets, or sidewalks and typically enters a stormwater system which routes runoff through an underground network of pipes that drain to flood protection channels. Stormwater enters the Zone 7 flood protection system through city- and county-owned local stormwater systems and other watercourse outfalls.

2.4 Physical Description of the Flood Protection System

In this FMP, Zone 7's flood protection system is defined as the network of flood control channels that it owns, operates, and maintains in the cities of Livermore, Dublin, and Pleasanton, as well as unincorporated areas in Alameda County. For the purposes of the FMP, the term "flood control channel system" is used interchangeably with "flood protection system." A flood control channel is defined as the channel from the invert to the top of the channel bank, which may or may not be owned by Zone 7. The flood control channel system includes the flood control channels, maintenance access roads, and/or recreational trails, and is often, but not always, delimited by a fence line.

While there are over 200 miles of streams and tributaries in the Livermore-Amador Valley, the Zone 7 flood protection system is composed of approximately 37 miles of a combination of earthen-lined and concrete-lined channels, storm drains, outfalls from connecting drainage systems, and canals. Most of these flood protection facilities have been constructed to Zone 7 standards and ownership acquired over time, beginning in the 1960s through present day, through collaboration with new development and implementation by Zone 7. The composition of the channels and canals is not continuous, with various sections of earthen-lined and engineered concrete-lined reaches throughout Zone 7's service area. The majority of the channels are earthen-lined. Typical cross sections of earthen-lined and concrete-lined channels within the Zone 7 service area are shown in **Figure 4**, **Figure 5**, and **Figure 6** respectively.

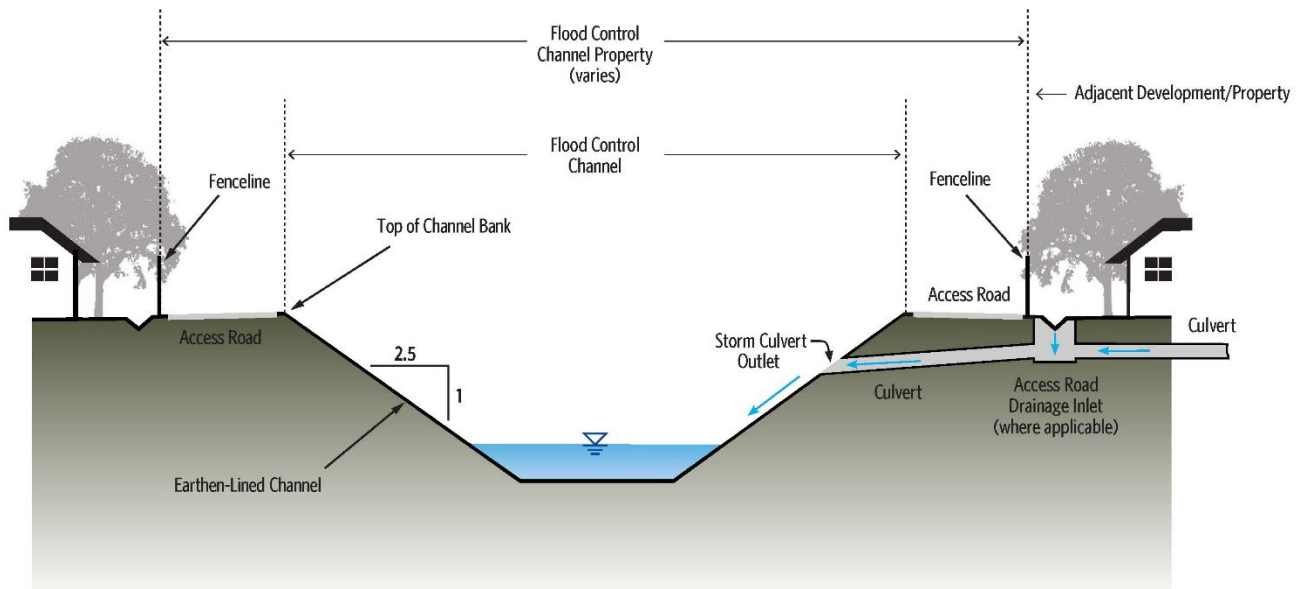


Figure 4. Typical cross-section of an engineered earthen-lined channel

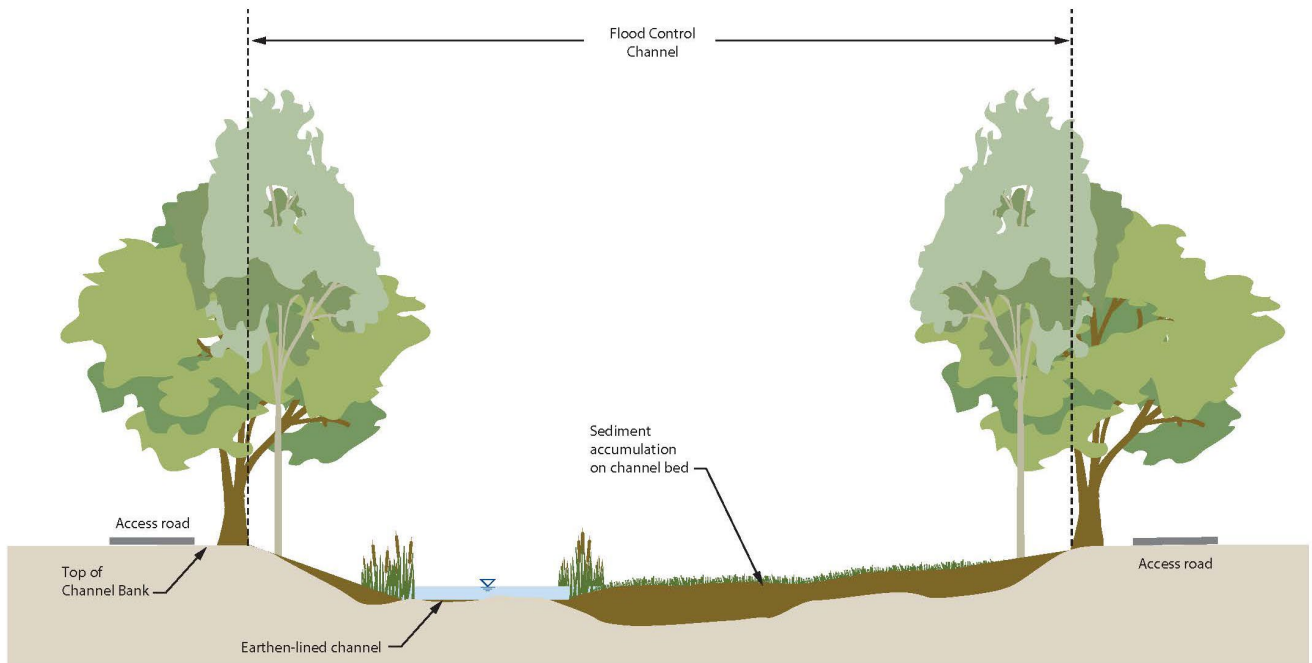


Figure 5. Typical cross-section of a nonengineered, earthen-lined channel

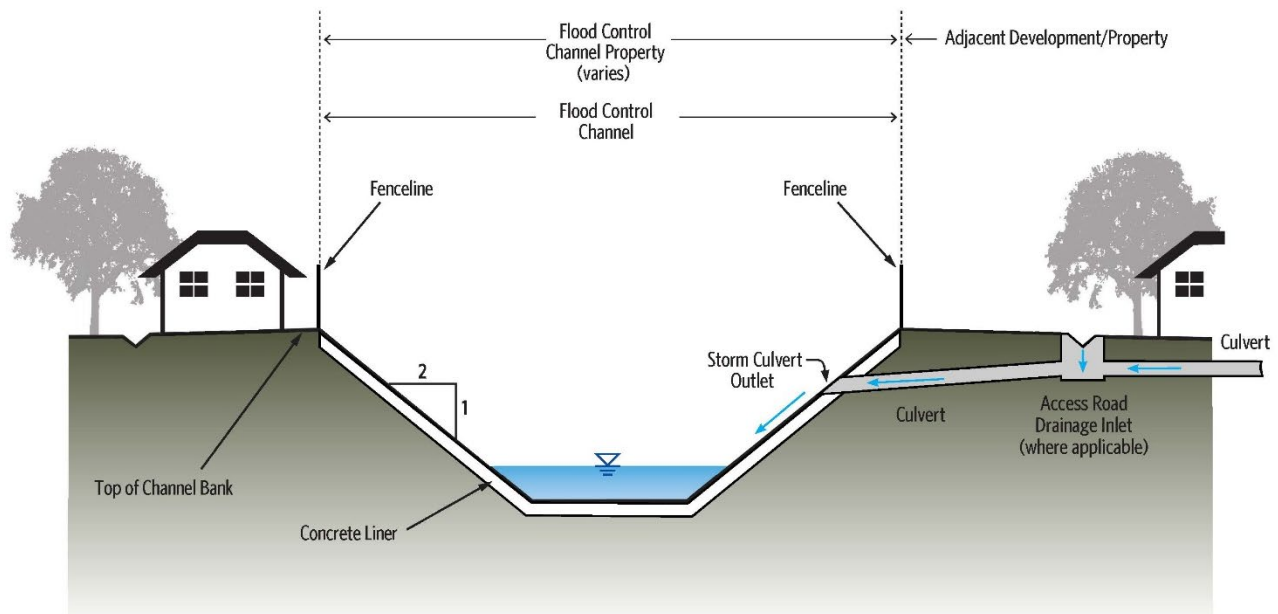


Figure 6. Typical cross-section of an engineered concrete-lined channel

2.5 Flood Protection System Performance

Flood protection system performance is commonly quantified by the channel capacity, or the amount of flow each reach can convey. While much of the current flood protection system performs as designed, performance has been degraded at many locations throughout the system due to:

- Areas of sediment accumulation.
- Areas of vegetation growth.
- Areas where high flows exceed hydraulic design capacity.
- Undersized culverts, bridges, and other constrictions.
- Areas of slope instability and erosion (over-steepened slopes, erosive soil conditions).
- Aging flood protection infrastructure requiring extensive repair, rehabilitation, or replacement.

Examples of areas where performance has been degraded are shown in **Figure 7** and **Figure 8**.



Figure 7. Vegetation growth and sedimentation accumulation in Altamont Creek channel, Line R (left), and vegetation growth including invasive species (*Arundo donax*) in Alamo Creek channel, Line J (right)



Figure 8. Typical concrete-lined channels requiring repair, rehabilitation, or replacement

2.6 Ownership and Maintenance of the Flood Protection System

Ownership and O&M of the channels and adjacent lands are discontinuous. Zone 7's channel ownership, and therefore O&M responsibility, typically extends beyond the top of channel bank and includes O&M maintenance access roads and/or recreational trails along one or both sides of the channel. However, some reaches, particularly within the City of Dublin, are limited to the top width of the channel (bank to bank) due to existing buildout of adjacent parcels. In some instances, Zone 7 maintains ownership of only one side of the channel, but not the other. For areas not owned by Zone 7, the channels are owned either privately or by other public agencies, with the owner entity bearing sole responsibility for maintenance. O&M is further complicated by varying terms of easements. A map of the flood protection system illustrating the various ownerships within the system is shown in **Figure 9**.

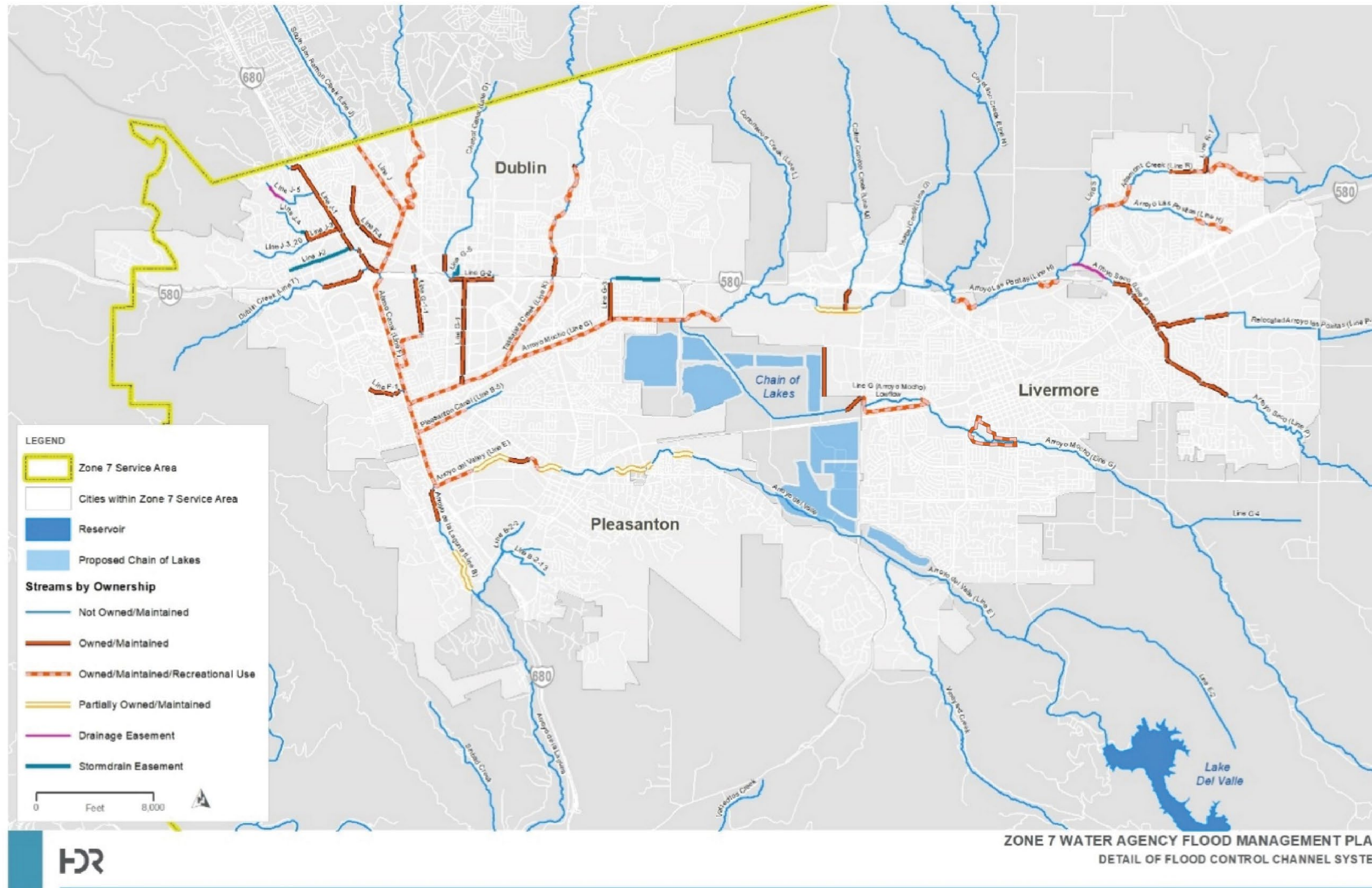


Figure 9. Channel ownership within the cities of Dublin, Livermore, and Pleasanton and unincorporated areas of Alameda County within the Zone 7 service area

2.7 Flood Management Authority

Zone 7's regional flood management authority is established by District Act 205 (Alameda County District, 1949), as amended by Assembly Bill 1125 in 2003. District Act 205 is found in [Chapter 55 of the California Water Code Appendix](#). To carry out its flood management charge, Zone 7:

- Delivers safe, reliable, efficient, and sustainable flood protection services.
- Maintains the functional integrity and operational quality and capacity of Zone 7's flood protection system.
- Ensures stream banks and slopes are stable and manages sediment transport and deposition to maintain channel capacity (Act 205 paragraph 5.6).
- Protects and enhances the natural environment within riparian corridors (Act 205 paragraphs 5.6, 5.15).
- Conducts maintenance and repair work or improvements necessary to maintain flood protection operations and reduce the risk of flooding within Zone 7's service area (Act 205 paragraphs 5.6, 5.9, 5.15).
- Manages vegetation in and along flood protection channels and in riparian zones to maintain channel capacity and reduce risk of damage to adjacent facilities while maximizing habitat and recreational value (Act 205 paragraphs 5.6, 5.15).

2.8 Recreation Facilities within Zone 7 Service Area

Zone 7's enabling legislation authorizes it to "engage in recreational activities incidental to and in connection with the purposes of the district" (Act 205). Recreational activities in areas owned and maintained by Zone 7 provide for the safe use of open spaces that are not suitable for development and can also provide opportunities for community education and stewardship. Trails adjacent to flood control channels provide for active recreation for bicyclists and pedestrians, as well as off-street connections to East Bay Regional Parks and local parks and recreation facilities.

Zone 7 recognizes the benefits of public recreational access along the flood control channels by making facilities available for recreational activities where feasible and where those uses do not interfere with Zone 7 operations. More than 19 miles of trails exist along channels owned and maintained by Zone 7. Cities and park districts are responsible for operating and maintaining these trails (see Table 1 for roles and responsibilities). Although Zone 7 is not responsible for trail maintenance, Zone 7 proactively avoids adverse impacts to the trail system by coordinating with the cities, Livermore Area Recreation and Park



District, and East Bay Regional Parks District to account for existing and planned trails when designing and implementing capital projects or carrying out maintenance activities on the flood protection system.

2.9 Other Entities' Flood Management Roles and Responsibilities

Multiple agencies play a significant role in flood management in the Livermore-Amador Valley within and outside the Zone 7 service area. Zone 7 has long understood the necessity of partnering with other regional agencies who share common interests in managing the watershed for multiple uses, including flood control. Partnering with these agencies and enhancing effective engagement and communication builds public support and facilitates successful execution of the flood protection mission both for Zone 7 and the region. In addition to the agencies listed in **Table 1**, Zone 7 also engages with various non-profits, community groups, and individuals, as long as a nexus to flood protection exists. Further collaboration between federal, state, and local agencies and non-profit agencies with flood management responsibilities could improve overall efficiency in implementing projects, acquiring permits, and overall O&M of the system.

Table 1. Local, regional, state, and federal partner agencies

Agency Name	Role in Zone 7's Flood Protection Management
Alameda County Flood Control and Water Conservation District	Floodplain manager for unincorporated areas of Alameda County.
Alameda County Resource Conservation District (RCD)	Provides resource conservation leadership within district boundaries as authorized by Division 9 of the California Public Resources Code.
Alameda County Water District (ACWD)	No formal role in flood protection; primarily water supply role.
California Department of Fish and Wildlife (CDFW)	<ul style="list-style-type: none"> • Natural resources regulator. • Issues a Routine Maintenance Agreement for Zone 7 to conduct channel maintenance work. • Reviews and requires a Lake and Streambed Alteration (LSA) Agreement when project activity may substantially affect fish and wildlife resources under Section 1602.
California Division of Safety of Dams (DSOD)	Regulates the safety of Del Valle Dam.



Agency Name	Role in Zone 7's Flood Protection Management
California Department of Water Resources (DWR)	<ul style="list-style-type: none"> • Owns and manages the State Water Project (SWP) including Del Valle Dam and the South Bay Aqueduct. • Releases flows into Arroyo Del Valle from SWP facilities. • Manages SWP deliveries through the South Bay Aqueduct.
California Governor's Office of Emergency Services (CalOES)	<ul style="list-style-type: none"> • Supports local emergency preparedness and response efforts. • Coordinates state and federal resources during flood incidents and emergencies.
City of Dublin	<ul style="list-style-type: none"> • Land use authority and floodplain manager within city limits. • Maintains stormwater infrastructure within city limits.
City of Livermore	<ul style="list-style-type: none"> • Water retailer for portions of Livermore. • Land use authority and floodplain manager within city limits. • Maintains stormwater and some channel infrastructure within city limits.
City of Pleasanton	<ul style="list-style-type: none"> • Water retailer for Pleasanton. • Land use authority and floodplain manager within city limits. • Responsible for stormwater and some channel infrastructure within city limits.
Community Groups (Hacienda Business Park, etc.)	Organizes local residents and businesses to engage on flood protection issues.
Dublin-San Ramon Services District	<ul style="list-style-type: none"> • Water retailer for City of Dublin. • Releases flows into portions of the Zone 7 service area.
East Bay Regional Park District	Manages and preserves parks and trails throughout the Zone 7 service area for recreational use.
Federal Emergency Management Agency (FEMA)	<ul style="list-style-type: none"> • Manages the National Flood Insurance Program. • Administers hazard mitigation grant funds.



Agency Name	Role in Zone 7's Flood Protection Management
	<ul style="list-style-type: none"> Develops flood hazard maps and studies.
Livermore Area Recreation and Park District (LARPD)	Provides and maintains parks and recreation facilities adjacent to the flood control channel system (e.g., owns Arroyo Mocho in Robertson Park and Arroyo Del Valle in Sycamore Grove Park).
Natural Resources Conservation Service (NRCS)	Provides technical and financial assistance through the Emergency Watershed Protection (EWP) Program following natural disasters.
San Francisco Bay Regional Water Quality Control Board (RWQCB)	Regulates stormwater and filling of waters or wetlands for construction.
San Francisco Public Utilities Commission (SFPUC)	Owns property throughout the Zone 7 service area, primarily at/near the outlet of the Zone 7 service area.
US Army Corps of Engineers (USACE)	<ul style="list-style-type: none"> Provides emergency funding after storm-related disasters under Public Law (PL) 84-99 Federal Assistance Program. Manages design and construction of repairs for non-federally constructed flood control facilities (up to 80% of construction cost) under the PL 84-99 program. Conducts safety inspections of non-federal flood control facilities. Reviews and issues a permit for temporary or permanent construction work related to discharges of dredged or fill material under Section 404 of the Clean Water Act. Manages flood control space in Lake Del Valle.
US Environmental Protection Agency (EPA)	Provides federal grant funds to assist with planning and implementation of flood mitigation projects.



3 HISTORICAL STORMS AND DAMAGES

3.1 Historical Large Storm Events

Climate in the Zone 7 service area is characterized by dry, hot summers and moist, cool winters and is climatically intermediate between the moderate, marine Mediterranean conditions of the San Francisco Bay Area and the more distinct seasonality of the interior Central Valley. Temperatures are mild, with more extreme temperatures experienced during the winter and summer months. Most of the annual rainfall occurs from November through March. Mean annual precipitation is approximately 17 inches (Zone 7 2021a).

The most recent large storm that caused significant damage to earthen-lined flood control channels, as well as localized surface flooding, occurred when a series of storms associated with an atmospheric river impacted the region between January and February 2017. Atmospheric rivers are bands of condensed water vapor in the atmosphere that produce heavy precipitation, some of which may cause flooding and damage to life and property (NOAA 2015).

Notable storms affecting the Zone 7 service area since the 1950s are summarized in chronological order in **Table 2**. Most of the listed storms were federally declared disasters; these storms caused significant damage, prompting local and state governments to request assistance from the federal government under Public Law (PL) 84-99 or preceding PLs.

Table 2. Summary of notable storms and flooding affecting Zone 7 service area

Year	Storm Duration	Federal Declaration	Magnitude
1955	December – January	Federal Disaster No. 47 (DR-47)	<ul style="list-style-type: none"> Widespread flooding occurred across California. Considered the “Storm of Record” that initiated the formation of Zone 7. Federal repairs carried out under several public laws (PLs).
1970	February	DR-283	<ul style="list-style-type: none"> Heavy winds and flooding occurred across the Bay Area, including Alameda County. Estimated over \$27 million in damage to the Bay Area.



Year	Storm Duration	Federal Declaration	Magnitude
1983	January – March	DR-677	<ul style="list-style-type: none"> • High winds, flooding, and levee breaks occurred across California. • Estimated over \$500 million in damage to California.
1986	February – March	DR-758	<ul style="list-style-type: none"> • Flooding occurred across California. • Estimated over \$407.5 million in damage to California.
1995	January – February; February – April	DR-1044 and DR-1046	<ul style="list-style-type: none"> • Flooding and landslides occurred across California. • Estimated over \$1 billion in damage to California. • Flooding occurred in streams/creeks within the Zone 7 service area. • I-580 flooded at Chabot Canal from debris blocking bypass culvert. • Zone 7 helped residents apply for National Resources Conservation Service (NRCS) Emergency Watershed Protection (EWP) funding (for Arroyo de la Laguna, [ADLL]).
1996-1997	December – April	DR-1155	<ul style="list-style-type: none"> • Flooding, mudslides, and landslides occurred throughout Alameda County. • Estimated over \$1.8 billion in damage to California.
1998	February	N/A	<ul style="list-style-type: none"> • Flash flood event with minor flooding and damage to roads and structures within the Zone 7 service area (Arroyo Mocho flooded Stanley Blvd and structures experienced partial flooding). • Estimated \$100,000 in damage within the Zone 7 service area.
2005-2006	December – January	DR-1628	<ul style="list-style-type: none"> • Flooding, mudslides, and landslides occurred throughout the Bay Area, including Alameda County. • Estimated over \$100 million in damage to Alameda County.

Year	Storm Duration	Federal Declaration	Magnitude
2006	March – April	DR-1646	<ul style="list-style-type: none"> • Landslides and erosion of hillsides occurred throughout Alameda County. • Galaxy Court experienced street flooding from debris blocking storm drain outlet in channel.
2009	October	N/A	<ul style="list-style-type: none"> • Heavy rain and winds led to downed trees and utility lines (power) within the Zone 7 service area. • Flooding occurred at Bernal Avenue and Valley Avenue within the Zone 7 service area.
2014	November	N/A	<ul style="list-style-type: none"> • Heavy rain and winds led to downed trees within the Zone 7 service area. • Flooding on I-580 in Dublin and Livermore within the Zone 7 service area.
2017	January – February	DR-4301, DR-4305, and DR-4308	<ul style="list-style-type: none"> • Flooding, debris flows, and mudslides occurred throughout Alameda County. • Collier Canyon Creek flooded adjacent area due to debris-jammed culvert. • Flooded streets and business parks. Temporary road closures within the Zone 7 service area. • Extensive channel slope failures throughout the Zone 7 service area.

Sources: [1] Zone 7 staff [2] Tri-Valley Local Hazard Mitigation Plan (HMP) Tetra Tech 2018

3.2 Historical Damage to the Flood Protection System from Large Storms

Historically, the flood control channel system within the Zone 7 service area suffers some degree of damage (slumping, sloughing, erosion, etc.) or loss of capacity from sedimentation during or after most large storm events. (In this FMP, the term “large storm event” refers either to one major storm or a series of storms that cumulatively causes notable consequences to the flood control channel system.) The most recent large storm event to cause significant damage to the flood control channels within the Zone 7 service area occurred in early 2017 (winter 2016-2017). Prolonged rain throughout the Zone 7

service area led to over 200 slope failures along channel banks. Damaged areas were primarily in the western portion of the flood control channel system as shown in **Figure 10**. In addition to slope failures, damage to concrete structures, maintenance roads, and critical infrastructure occurred. Estimated costs to repair storm damage was over \$40M and took four construction seasons to repair. Since 2017, significant progress has been made to repair the damaged areas with nine sites left to complete in 2022. Sites with major damage from the 2017 storms are shown in **Figure 11** and **Figure 12**. This storm event and associated damages highlight not only existing flood management challenges but vulnerabilities that will worsen with a rapidly changing climate (as discussed in **Chapter 6**).

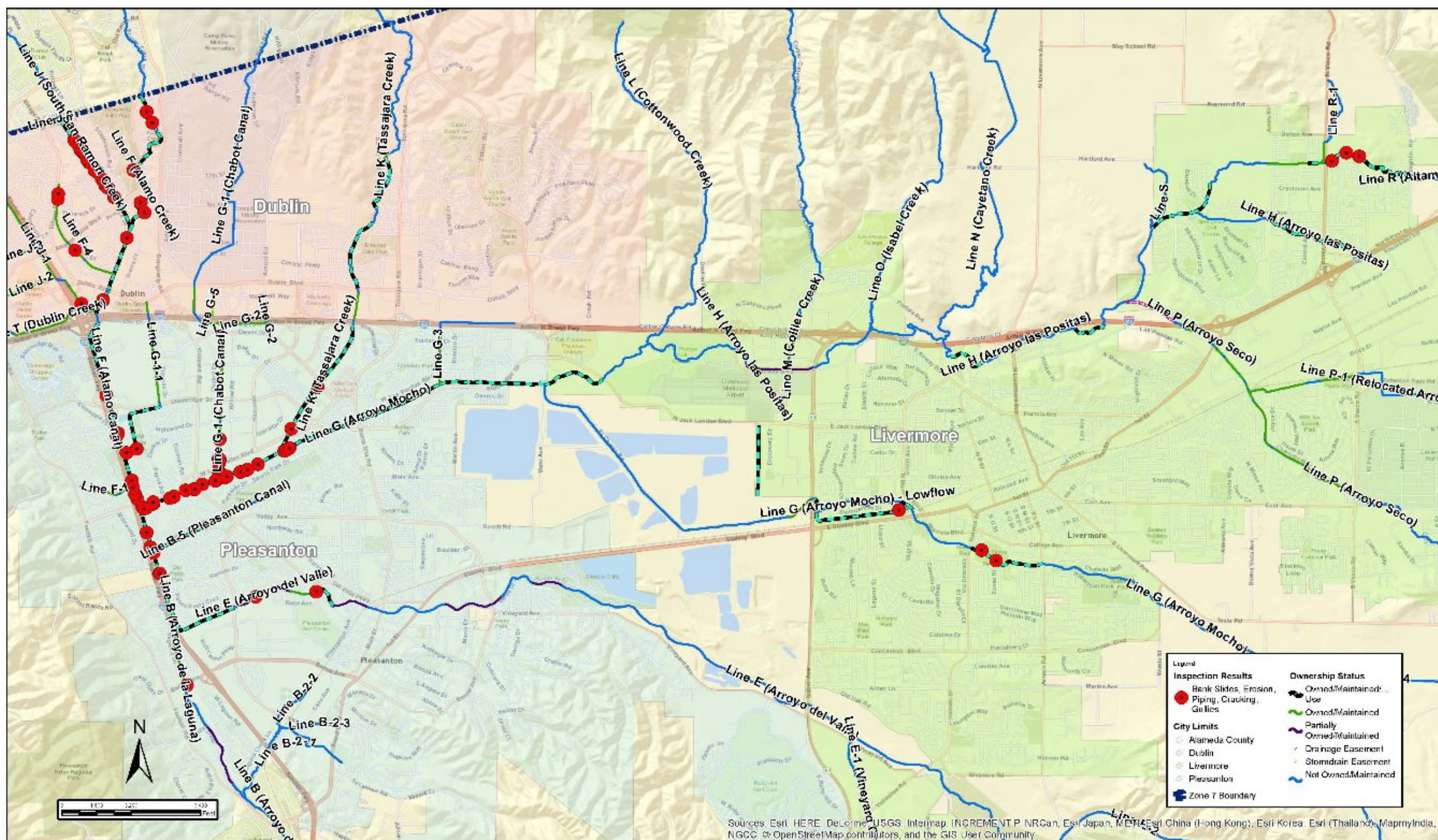


Figure 10. 2017 channel bank failures on Zone 7 owned property noted as red circles (Source: Zone 7)



Figure 11. Slope failure (left) and emergency repairs (right) along Arroyo Mocho channel during 2017 storms



Figure 12. Sewer main pipeline erosion (left) and emergency repair (right) along Alamo Canal and Arroyo de la Laguna channels during 2017 storms

3.3 Contributing Factors to Storm-Induced Flood Control Channel Damage and Reduced Performance

Many of the channels damaged from the 2017 storm event are located in areas that were historically large wetland complexes at low points in the valley (**Figure 13**) and are characterized by poor soils. These areas are:

- Springtown Alkali Sink – northeast of Livermore
- Pleasanton Marsh Complex – northwest part of Pleasanton near the Interstate 580 (I-580) and Interstate 680 (I-680) interchange

Soils that have a high expansion potential and that are more prone to erosion pervade these areas. Expansive soil swells upon wetting, such as from precipitation and rises in groundwater and channel water levels, and shrinks upon drying. Where expansive soil is located on a slope, repeated shrinking/swelling cycles can lead to downhill creep of the surficial soil (Cal Engineering and Geology [CE&G] 2015). Over time, this downhill creep leads to weakening of the channel banks and contributes to instability and slumping along the channels.

The Zone 7 flood control channel system performance is also affected by channelization and by resulting sediment transport and deposition. Soils eroding from the East Bay Hills, Mount Diablo, and Altamont Hills transport sediments to the valley floor through the flood control channel system. In combination with in-channel sources of sediment, these sediments build up within the channels, thereby reducing a channel's conveyance capacity and impacting overall performance of the system.

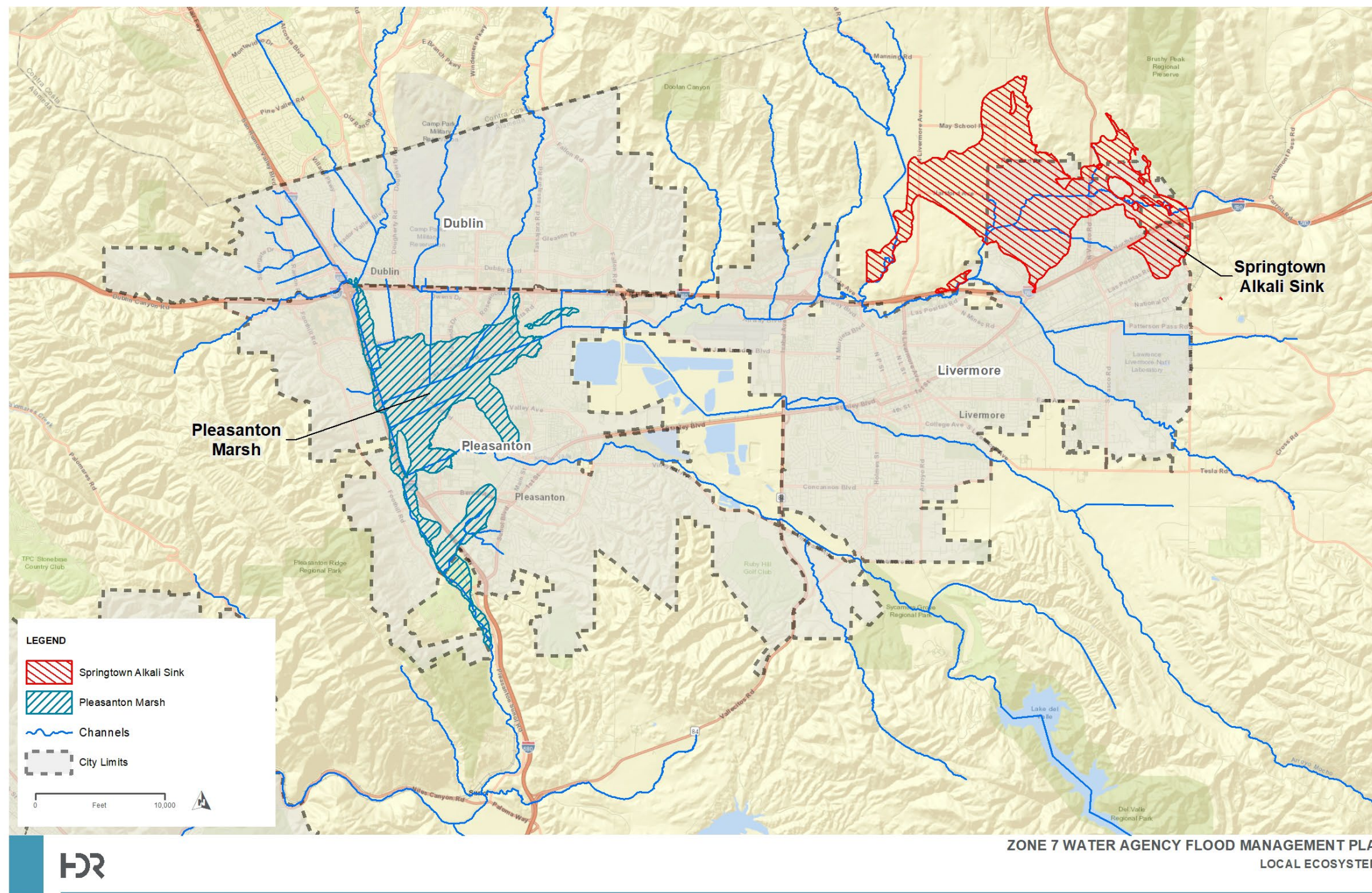


Figure 13. Historical wetland complexes within Zone 7 service area

4 PEOPLE, PROPERTY, AND ENVIRONMENTAL RESOURCES PROTECTED BY ZONE 7 FLOOD MANAGEMENT

4.1 Population and Property within Zone 7 Service Area

The Zone 7 service area includes the cities of Dublin, Livermore, and Pleasanton, and unincorporated areas within Alameda County. As of 2020, the estimated population within the Zone 7 service area is 266,000 (Zone 7 2021a). **Table 3** provides population, economic, and education demographic information of the Zone 7 service area.

Table 3. Zone 7 service area population, economic, and education demographics

Information type	Value ^{1,2}
Population and age	
Population	266,000
Persons under 5 years	6%
Persons under 18 years	25%
Persons 65 years and over	13%
People with disabilities, under 65 years	4%
Economic	
Average number of people per household	2.9
Median household income	\$148,366
Owner-occupied housing unit rate	68%
Median value of owner-occupied housing units	\$932,233
Median gross rent	\$2,503
Labor force participation rate	69%
Persons in poverty	4%
Education	
High school graduate or higher	95%
Bachelor's degree or higher	59%

Sources: [1] Zone 7 Urban Water Management Plan 2021 [2] US Census Bureau 2020 for the cities of Dublin, Livermore, and Pleasanton

Table 4 lists the number of critical facilities and infrastructure within the Zone 7 service area. Critical facilities include police and fire stations, schools, hospitals, and emergency

operations centers. Critical infrastructure includes important roads and bridges necessary for emergency vehicle access, as well as the utilities that provide water, electricity, and communication services to the community.

Table 4. Zone 7 critical infrastructure and facilities

Facility	Quantity of Facilities in City		
	Dublin	Livermore	Pleasanton
Medical and Health Services	5	11	9
Emergency Services	10	9	7
Educational Facilities	16	26	20
Government	11	11	7
Utilities	3	28	101
Transportation Infrastructure	26	61	62
Hazardous Materials	2	16	7
Total	73	162	213

Source: Tri-Valley Local HMP Tetra Tech 2018

4.2 People and Property Subject to Flood Inundation within Zone 7 Service Area

Only a portion of the people and property located within the Zone 7 service area is subject to flood inundation. To illustrate this, flood risk modeling tools have been used to estimate the geographic extent of flood inundation due to a storm with a 1 in 25 chance of occurring in any given year (i.e., 25-year storm) and a storm with a 1 in 100 chance of occurring in any given year (i.e., the 100-year storm). A detailed description of the modeling and maps are included in **Appendix A**. For context, the Zone 7 service area has not experienced a 100-year storm during the modern period for which weather records have been kept. The last major storm event, which occurred in 2017, is estimated to have been approximately a 25-year event.

For the simulated 25-year storm event, Arroyo Mocho produces maximum depths in Livermore from 0 feet to approximately 2 feet, primarily exhibited as street flooding. For the simulated 100-year storm event, maximum depths in this same area range from 0 feet to approximately 4 feet with a larger geographic extent than the 25-year storm event. Additional flooding occurs in Pleasanton in the 100-year event near the confluence of Arroyo Mocho and Arroyo de la Laguna with flood depths up to approximately 3 feet.

The significance of potential flooding in these areas extends beyond water inundation.

Channel bank erosion, sloughing, and failure of saturated channel banks commonly occur as a result of high velocity water, rapid drawdown, hydrostatic pressure, poor soils, or over-steepened slopes; the consequences of these types of ground failures are often more damaging than flooding in and of itself. For example, channel slope failures may damage or cause blockage of water and sewer systems within a channel right-of-way, causing health and public safety issues. Other underground utilities could also be damaged. Channel access for inspections, maintenance, and repair may also be impeded by slope damage that affects maintenance roads.

Critical transportation facilities are subject to flood risk. Roads or railroads that are blocked or damaged from flooding could isolate residents and prevent access throughout the service area. This could affect emergency service provider access to vulnerable populations or Zone 7 staff access to emergency repair sites. Bridges over waterways could be impacted during floods and are often the vulnerable hydraulic restrictions—choke points—that become blocked by sediment or debris. Major roads within the Zone 7 service area that are impacted by the simulated 25-year and 100-year storms are listed below and shown in **Figure 14**.

- State Highway 84 / Isabel Ave (Livermore)
- Airway Blvd (Livermore)
- East Jack London Blvd (Livermore)
- 1st Street (Livermore)
- Murietta Blvd (Livermore)
- Holmes Street (Livermore)
- East Stanley Blvd (Livermore, Pleasanton)

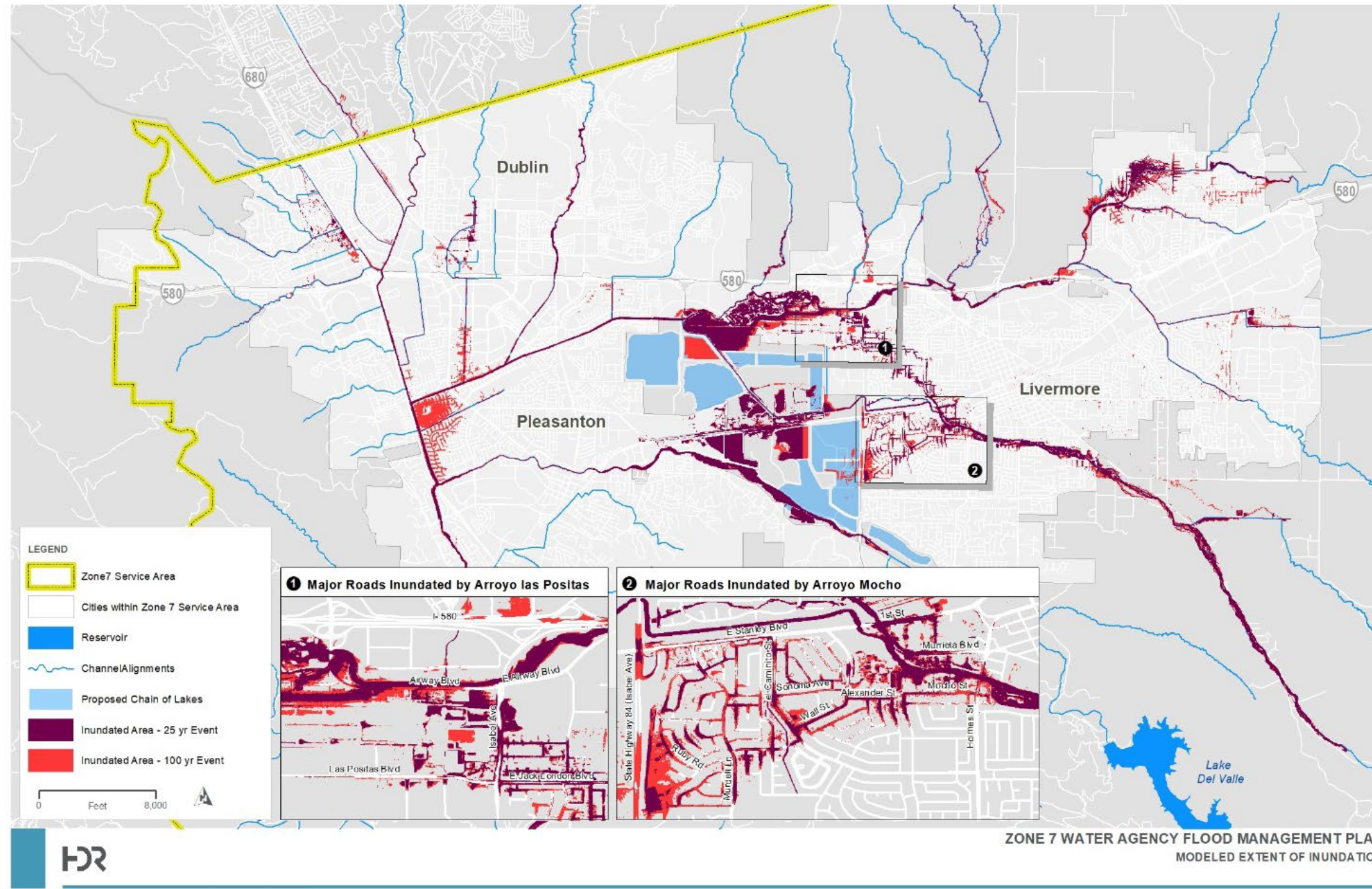


Figure 14. Major roads impacted by the 25-year and 100-year storm events

4.3 Environmental and Regulatory Setting within Zone 7 Service Area

The 37 miles of natural and engineered channels that comprise the flood protection system owned, operated, and maintained by Zone 7 also provide important environmental functions, including:

- Nutrient recycling
- Water purification
- Flood attenuation
- Groundwater recharge
- Habitat for multiple special-status species

These environmental functions are protected by Sections 404 and 401 of the Clean Water Act, state, and federal Endangered Species Acts, as well as multiple sections of the California Fish and Game Code. As a result of this regulatory setting, many operations, maintenance, and capital improvement projects conducted by Zone 7 require permits and authorizations from the U.S. Army Corps of Engineers, San Francisco Bay Regional Water Quality Control Board, California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and in some cases the National Marine Fisheries Service. Obtaining multiple permits and authorizations on a case-by-case basis for necessary improvements to the flood control channel system can be costly and time consuming. Delays of necessary repairs on the flood control channel system resulting from lengthy regulatory agency approval timelines further exacerbate Zone 7's ability to optimally perform its required missions.

5 EXISTING RISKS TO FLOOD MANAGEMENT

5.1 Flood Protection System and Associated Flood Risk

Flood risk is defined in this FMP as the combination of likelihood and magnitude of consequences resulting from flood inundation or other adverse impacts of floodwaters. Several factors influence flood risk including, but not limited to, storm magnitude, condition of the flood protection system, development in the floodplain, geomorphic processes, and O&M of flood infrastructure. For example, any storm can cause damage in limited areas, but large, infrequent storms can have disastrous consequences to entire regions (DWR 2013).

In the Zone 7 service area, more than 266,000 people and approximately 450 critical assets as well businesses and regional infrastructure are potentially exposed to hazards of flooding or other adverse impacts from floodwaters. While catastrophic flooding events have been infrequent, historical events at a local, county, regional, and state level have resulted in costly and significant damage. Notably, the flood protection system has evolved over many decades under an array of institutional, environmental, and changing regulatory factors; therefore, flood risk has also evolved, and will continue to evolve, over time.

As described in **Section 1.2**, the risk-informed, system-focused planning process used to develop this FMP included first identifying the existing problems/issues/needs, constraints, challenges, and opportunities. Once identified, the risk posed by these problems/issues/needs was evaluated. Through review of modeled and actual storm events, literature research, workshops, interviews, and technical analyses, potential risks associated with the Zone 7 flood protection system for existing and future conditions were identified and evaluated qualitatively. A range of storm events and associated potential consequences were considered to depict flood risk throughout the Zone 7 service area.

5.2 Potential Flood Consequences

Potential flood consequences to the Zone 7 service area and the flood protection system itself were grouped as follows:

1. **Public safety**, which includes:
 - a. Loss of life and/or serious injury.
 - b. Damage to critical infrastructure/disruption to community lifelines (Zone 7's or others).

2. **Financial impacts** to Zone 7, including damage to Zone 7's property, legal costs, regulatory fines, and diversion of staff time and other agency resources generally leading to an inability to perform required agency missions.
3. **Economic damage** to those other than Zone 7, but within the Zone 7 service area, such as residents, businesses, and other government agencies.
4. **Environmental and regulatory impacts**, including adverse impacts to protected species and habitat.
5. **Water quality and contamination**, including impacts to groundwater.
6. **Other**, which includes:
 - a. Effects on flood system reliability and resilience.
 - b. Effects on the agency, e.g., staff morale and retention, ability to fulfill Agency mission, reputational damage/loss of standing or influence.

The identified problems/issues/needs, constraints, and challenges as well as the evaluated risks posed by these problems/issues/needs broadly fit into the following seven themes of flood management:

1. Roles and responsibilities within the flood control channel system (Zone 7 as well as the cities, county, and other partner agencies).
2. Relationships with partner agencies (including the cities, county, state, federal, and other local agencies).
3. Capital improvement specific to flood management (physical improvements to the flood protection system).
4. Operations and maintenance (routine O&M activities, including emergency response).
5. Technical excellence (high-quality resources and tools—technical expertise, data, models, analyses).
6. Communication and engagement (keeping stakeholders and the public informed and engaged).
7. Resource agency permitting (including federal, state, and other local requirements).

These flood management themes also encompass future risks, as described in the following chapter. **Table 5** summarizes the identified problems/issues/needs, constraints and challenges, and potential flood consequences by flood management theme.

Table 5. Summary of identified problems/issues/needs, constraints, and challenges by flood management theme

<p>Flood Management Theme</p>	<p>Description of Problems/Issues/Needs/Constraints/Challenges to the Zone 7 Service Area and Flood Protection System</p>
<p>Flood Control Channel System</p>	<ul style="list-style-type: none"> • Earthen-lined channels located in historical marshland soils are susceptible to slumping and erosion which may lead to damage to adjacent properties, critical infrastructure, and utilities. • Other than emergency operations, there is no current federal interest (USACE authority) identified for the flood protection system, reducing federal funding opportunities. • Physical configuration of the channels (e.g., lack of maintenance access roads along channels, lack of room to widen channels, property boundaries) may lead to inability to properly maintain or make needed improvements. • Potential legal disputes related to erosion/slope stability may consume Zone 7 financial resources otherwise dedicated to flood protection. • Lack of Zone 7 land use authority and other means of influencing floodplain management decisions limits Zone 7's ability to mitigate regional flood risk. • The wide age variance and design standards (many of which are obsolete) across flood protection system components render systematic O&M and capital improvement decisions more complex, increasing risk of inconsistency and poor systemwide performance. • Portions of Zone 7's service area lie within the FEMA 100-year floodplain. Zone 7 is not the floodplain manager within the service area, and as a result, Zone 7 has no direct administrative or regulatory role to manage the floodplain and reduce flood risk. • Portions of the flood protection system are used for recreation by the public through agreements with cities and parks districts, and in some cases, the city standards for trails differ from Zone 7's standards for maintenance access roads. This dual use requires coordination of flood system use/access with multiple agencies. • Limited channel capacity may lead to flood damage to nearby residents, businesses, roads, and infrastructure, disrupting local economic activity and reducing revenue to fund flood management. • Repairs and improvements of channels in sensitive environments within the service area require additional environmental compliance and mitigation, adding to cost and complexity.



Flood Management Theme	Description of Problems/Issues/Needs/Constraints/Challenges to the Zone 7 Service Area and Flood Protection System
	<ul style="list-style-type: none"> • Sediment and debris reduce conveyance channel capacity and may cause water quality/contamination issues, increasing risk to the public and sensitive species.
Relationships with Partner Agencies	<ul style="list-style-type: none"> • Lack of formal and consistent agreements with the cities and county on regional flood management may cause disagreement between agencies and inefficient use of limited funds. • Lack of clarity regarding the fundamental flood management roles and responsibilities—primarily those of Zone 7, cities, and county—may lead to disagreements and reputational damage.
Capital Improvement	<ul style="list-style-type: none"> • Lack of a policy or an approach to land acquisitions or maintenance easements may limit Zone 7’s ability to plan flood protection system improvements or maintenance. • An outdated capital improvement plan and funding program for flood management may reduce Zone 7’s ability to improve the flood protection system. • Variations and deficiencies in the physical configuration of the channels (e.g., lack of maintenance access road along channels, lack of room to widen or reconfigure channels) may complicate needed improvements to the flood protection system.
Operations and Maintenance (O&M)	<ul style="list-style-type: none"> • Lack of a formal, clearly defined O&M program limits Zone 7’s ability to identify and secure appropriate funding and effectively maintain the flood protection system. • A reactive O&M approach to channel repairs impacts strategic, long-term planning and increases costs. • Lack of clear policies and limited autonomy for staff to make decisions regarding emergency flood system repairs, routine maintenance, and long-term rehabilitation and replacement may result in delayed decisions and increased costs. • Lack of a formal Asset Management Plan prevents lifecycle management of the flood protection system, incurring O&M challenges and potential hazards. • Discontinuous ownership and/or easement throughout the system and land adjacent to the channels limits Zone 7’s ability to effectively maintain the flood protection system. • Zone 7’s ability to perform O&M and exert management control beyond the physical or legal limits of the flood protection system inhibits optimal system O&M.



<p>Flood Management Theme</p>	<p>Description of Problems/Issues/Needs/Constraints/Challenges to the Zone 7 Service Area and Flood Protection System</p>
<p>Technical Excellence</p>	<ul style="list-style-type: none"> • Current level of flood protection and channel capacities are unknown for some channels due to changing conditions, which may reduce Zone 7's ability to plan system improvements, reduce costs, and maintain public confidence. • Hydraulic models include stormwater system contributions to the flood control channels. A lack of routine local agency coordination regarding stormwater systems introduces uncertainty into these models, resulting in increased flood risk.
<p>Communication and Engagement</p>	<ul style="list-style-type: none"> • Many residents are not aware of potential adverse impacts from their individual actions adjacent to or within the channels, which may reduce performance of the flood protection system and increase flood risk. • Lack of coordination and engagement between Zone 7 and partner agencies regarding comprehensive flood risk communication reduces the effectiveness of emergency preparedness measures. • Lack of public understanding of Zone 7's flood management role and responsibilities may adversely impact Zone 7's ability to execute its flood mission and raise funds.
<p>Resource Agency Permitting</p>	<ul style="list-style-type: none"> • Private owners of portions of the channel may attempt to remediate channel erosion on their property, which may lead to environmental or erosion damage to other reaches in the system owned by Zone 7. Accordingly, Zone 7 may face unforeseen regulatory and permitting challenges related to O&M and post-storm repair activities within the flood control channel system. • Difficulties garnering regulatory permits for non-emergency O&M and new projects impact Zone 7's ability to perform strategic and timely maintenance, repairs, and improvements. • Special status plant and animal species as well as protected habitat within the Zone 7 service area may complicate permitting.

6 FUTURE RISKS TO FLOOD MANAGEMENT

6.1 Potential Trends in Future Risk

If Zone 7 continues to maintain, operate, and repair its flood control channel system as in the past, with no major enhancements to the system, the system will continue to deteriorate due to age and other factors. Under a changing climate, storm-induced hazards and consequences will occur more frequently and will be of greater magnitude, further increasing costs and rate of deterioration. Finally, land use changes, which Zone 7 has no control over, will further degrade and stress the system, resulting in higher O&M costs and increasing the likelihood of significant or even catastrophic failures throughout the system.

6.2 Factors Contributing to Future Risk to Zone 7 Flood Management

6.2.1 Climate Change

Climate change models predict that the Bay Area will see large storms more frequently, and the intensity of precipitation (i.e., the amount of rainfall in a given time period) is predicted to increase, potentially causing greater consequences, primarily from runoff. For example, a storm lasting 24 hours that currently has a 1 in 20 chance of occurring in a given year (the 20-year storm) will become a 7-year (or more frequent) storm by the end of the century (Ackerly et al. 2018); furthermore, that same 7-year storm will bring more rainfall in 24 hours than the current 20-year storm does. Climate change affects dry periods as well as wet periods: the ratio of dry years to wet years is expected to increase, as well as the duration of dry periods between storms. Warm and dry conditions will also increase the likelihood of wildfires, which can drastically alter watershed runoff patterns and cause larger, flashier floods in downstream areas.

6.2.2 Land Use Authority

Without a collaborative, regional process to analyze and lessen the flood risks and manage the floodplain, future development will increase the flood hazard, the people and property exposed to the hazard, and the magnitude of the consequences should flooding occur. The flood hazard will increase due to expanded impervious surfaces from the conversion of open space to developed areas, causing increased runoff. Development may also increase the population at risk of flooding. For example, the General Plans of cities in the Livermore-Amador Valley show the potential for planned development. At the same time, cities have historically pursued unanticipated future opportunities for economic development as they arise. This increased likelihood of future flood hazard combined with more vulnerable assets and population will lead to increased flood consequences.

7 ZONE 7 GOALS AND OBJECTIVES FOR FLOOD MANAGEMENT

The FMP goals and objectives presented in **Table 6** were developed by evaluating the existing and future risks to flood management within Zone 7’s service area and organizing those risks according to the flood management themes. Goals and objectives provide the actionable and strategic bases for Phase 2 of the planning process as described above. All goals are interdependent and supporting objectives of any one goal must be accomplished before that goal is achieved.

Table 6. Goals and objectives for flood management

Goal Statement	Objectives
Goal 1 – Flood Control Channel System	
Develop the framework to provide flood protection to a level as high as reasonably practicable using a risk-informed process.	<ol style="list-style-type: none"> 1. By 2023, identify the regional institutional framework necessary to effect adequate flood management for areas protected by the flood control channel system. 2. By 2024, conduct a risk-informed, watershed-based evaluation of the flood control channel system.
Goal 2 – Relationships with Partner Agencies	
Foster and participate in productive relationships with land use agencies to improve flood management.	<ol style="list-style-type: none"> 1. By 2023, identify common flood management interests of agencies with a flood management role or impact in the watershed. 2. By 2024, propose agreements with agencies who share flood management interests in the watershed.
Goal 3 – Capital Improvement	
Develop a capital improvement program to support effective flood management projects and programs.	<ol style="list-style-type: none"> 1. By 2025, prepare a Capital Improvement Program (CIP) based on the outcomes of the systemwide evaluation (Objective 1.2). 2. By 2025, develop a CIP funding and financing plan. 3. By 2026, prepare a CIP implementation plan.



Goal Statement	Objectives
Goal 4 – Operations and Maintenance	
Operate and maintain the flood control channel system where Zone 7 has fee title, easement, or agreement.	<ol style="list-style-type: none"> 1. By 2022, prepare an O&M program for the existing flood control channel system. 2. By 2023, prepare a right-of-way management plan for the flood control channel system and associated floodplain. 3. By 2024, prepare an asset management plan for the existing flood control channel system. 4. By 2024, prepare a funding/financing plan for O&M and Asset Management programs.
Goal 5 – Technical Excellence	
Use the best available resources to achieve flood management projects and programs.	<ol style="list-style-type: none"> 1. By 2023, develop and initiate a plan to enhance Zone 7 flood management expertise. 2. By 2024, explore and establish resource sharing agreements with partner agencies. 3. By 2025, implement enterprise-wide GIS-based solutions to support Zone 7 goals, including flood management.
Goal 6 – Communication and Engagement	
Effectively communicate and engage with the public and other stakeholders to deliver Zone 7’s flood management projects and programs.	<ol style="list-style-type: none"> 1. Develop a flood management communication and engagement plan integrated with Agency functions by 2024. 2. By 2023, enhance and establish communication protocols and associated agreements for flood emergency response with partner agencies. 3. By 2022, enhance communication protocols for routine flood O&M activities.



Goal Statement	Objectives
Goal 7 – Resource Agency Permitting	
<p>Obtain permits in a timely manner to deliver flood management projects and programs.</p>	<ol style="list-style-type: none"> 1. By 2022, participate in, or convene, a natural resources coordinating body for regional agencies with flood management impacts or roles. 2. By 2026, adopt and implement a regional programmatic approach to routine O&M with the resource agencies. 3. By 2026, prepare a programmatic EIR to support the CIP (Objective 3.1).

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APPENDIX A

Hydrologic and Hydraulic Analyses

Introduction

To study the potential impacts of large storms, Zone 7 has developed hydrologic and hydraulic models to simulate storm events, watershed response, and channel conveyance to support planning level analyses. Hydrologic and hydraulic models are used by Zone 7 to estimate potential flood hazards that could affect properties adjacent to the flood control channel system. Simulated results are used to evaluate various storm events, land use conditions, and proposed flood risk reduction projects and identify areas where the flood control channel system capacity is exceeded.

Hydrologic models simulate a watershed's response to a design storm, resulting in an amount of overland flow that either infiltrates into the ground, or if the ground is saturated, results in runoff conveyed to the flood control channel system. Hydraulic models simulate flow through the channels and estimate water surface elevations within the channel, or if channel capacity is exceeded, the extent and depth of flooding.

Design Storm Events

In Zone 7's most recent flood risk modeling work, Alameda County Public Works Agency's Hydrology and Hydraulics Manual methodologies were followed to develop a design rainfall event for the 100-year, 24-hour design storm. Design storms are developed from a statistical analysis of local precipitation records. The design storm concept assumes a precipitation event of a particular frequency will produce a runoff event of the same frequency. The design storm is a distribution of rainfall depths over a time increment for a given storm duration and frequency. Design storm events were developed to include events likely to occur over the lifecycle of a given project. Specifically, 10-, 25-, 50-, 100-, and 500-year events were developed and evaluated. The available models do not consider the integrity of the stormwater system that conveys water into the flood control channel system nor do these models account for climate change under current methodologies.

Hydraulic Modeling

The best available evaluation of current flood control channel system performance is Zone 7's valley-wide hydraulic model, originally prepared as part of updating the Stream Management Master Plan. The hydraulic model uses a hybrid 1D/2D HEC-RAS hydraulic model that incorporates an updated watershed-wide hydrology, contemporary topography from 2014 LiDAR scan of eastern Alameda County, and calibrated parameters based on the Alameda County Hydrology and Hydraulics Manual. This modeled channel capacity differs from the intended, or historical, 1966 Master Plan and also differs from values used by the Federal Emergency Management Agency (FEMA) to administer the National Flood

Insurance Program (NFIP). These differences in modeled results are due to Zone 7’s more recent use of updated technology and datasets. To illustrate these differences, representative locations (nodes) that coincide with stream gages in the flood control channel system are shown in **Figure A-1** and respective channel capacities for 100-year event flows (in cubic feet per second [cfs]) are compared in **Table A-1**. It is important to note that the referenced 100-year storm was computed using past and existing data, therefore as more data are collected and improved climate science is considered, the level of the 100-year storm will change.

Floodplain results from the 25-year and 100-year events are shown in **Figure A-2**. Additional flooding south of Arroyo Mocho and to the east of the proposed Chain of Lakes can be seen for the 100-year storm event. The 100-year storm event causes flooding at the confluence of Arroyo Mocho and Arroyo de la Laguna. Other shallow flooding is observed on other reaches of the system for both the 25-year and 100-year storms.

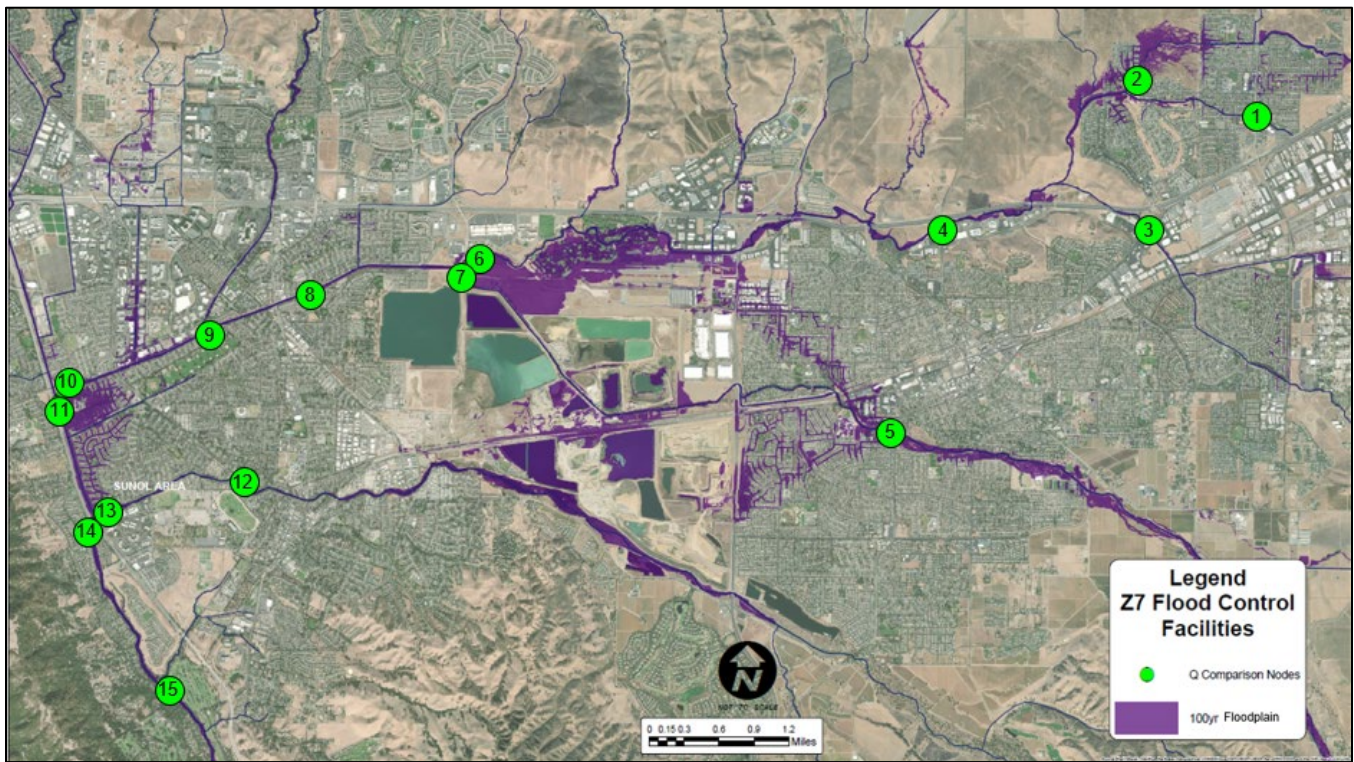


Figure A-1. 100-year floodplain with flow comparison nodes

Table A-1. 100-year event flows for representative channel reaches

Node	Stream	Channel Reach	100-year event flows (cfs)		
			1966 Master Plan Design	FEMA	Zone 7 Hydraulic Model
1	Arroyo las Positas	Upstream of Vasco Road	2,500	380	850
2	Altamont Creek	At Bluebell Drive	2,100	1,510	2,270 ¹
3	Arroyo Seco	At First Street	3,150	N/A	3,080
4	Arroyo las Positas	At North Livermore Avenue	4,800	5,000	6,710
5	Arroyo Mocho	At Holmes Street	4,580	5,350	5,230 ¹
6	Arroyo las Positas	At El Charro Road	9,700	N/A	6,440
7	Arroyo Mocho	At El Charro Road	5,190	5,200	3,280
8	Arroyo Mocho	Arroyo Mocho at Pleasanton	12,400	12,300	10,250
9	Arroyo Mocho	Upstream of Tassajara Creek	12,400	12,400	10,270
10	Arroyo Mocho	Upstream of Arroyo de la Laguna	15,600	13,700	12,430 ¹
11	Arroyo de la Laguna	Downstream of Arroyo Mocho	21,000	15,000	15,620 ¹
12	Arroyo Del Valle	Arroyo Del Valle at Pleasanton	7,000	7,000	2,210
13	Arroyo Del Valle	Upstream of Arroyo de la Laguna	7,000	7,000	2,220
14	Arroyo de la Laguna	Downstream of Arroyo Del Valle	22,000	17,000	18,120
15	Arroyo de la Laguna	Downstream of Line B-2-1	23,000	16,930	18,450

Source: Zone 7

1. Flows exceed channel bank elevation.

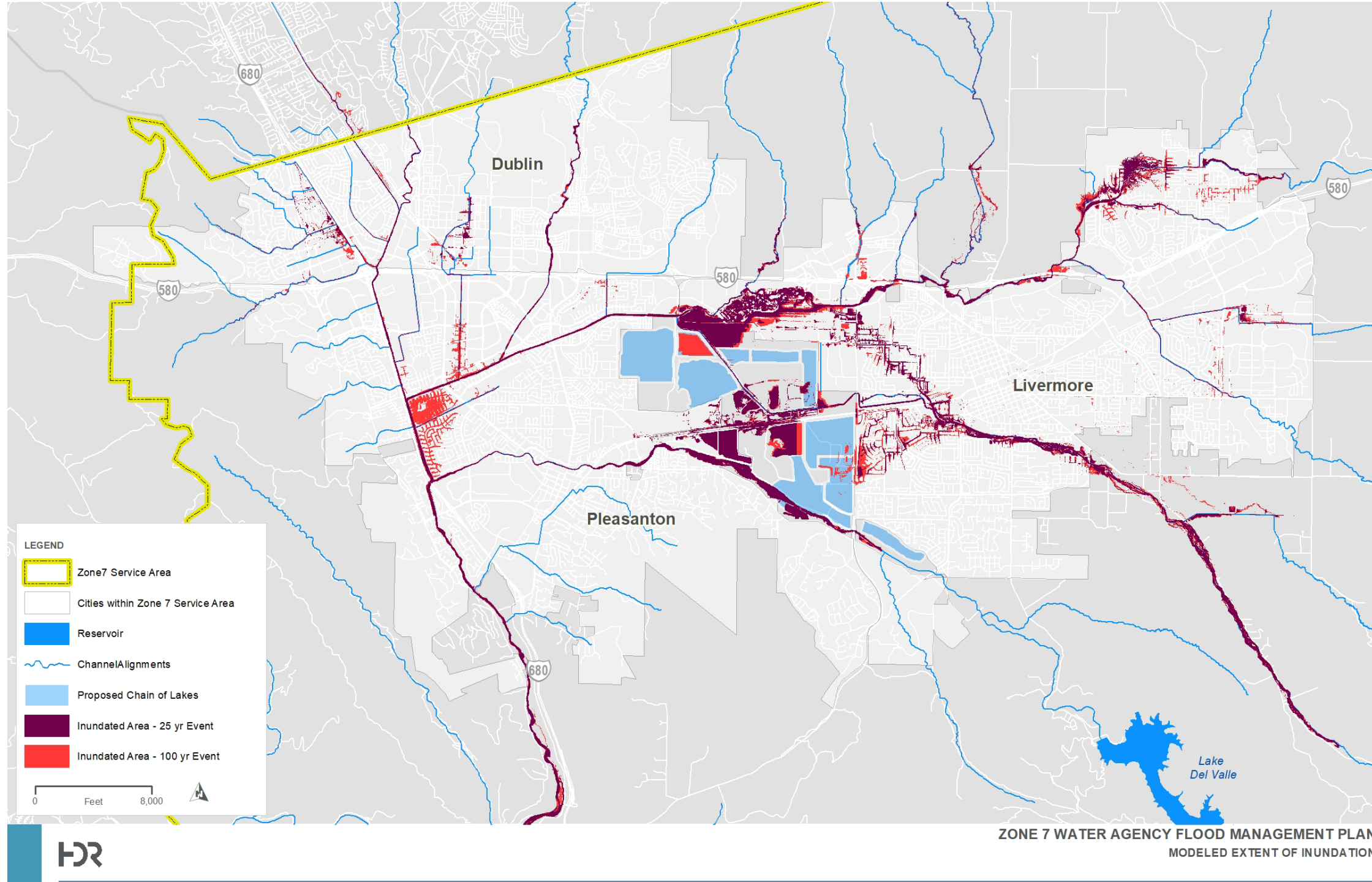
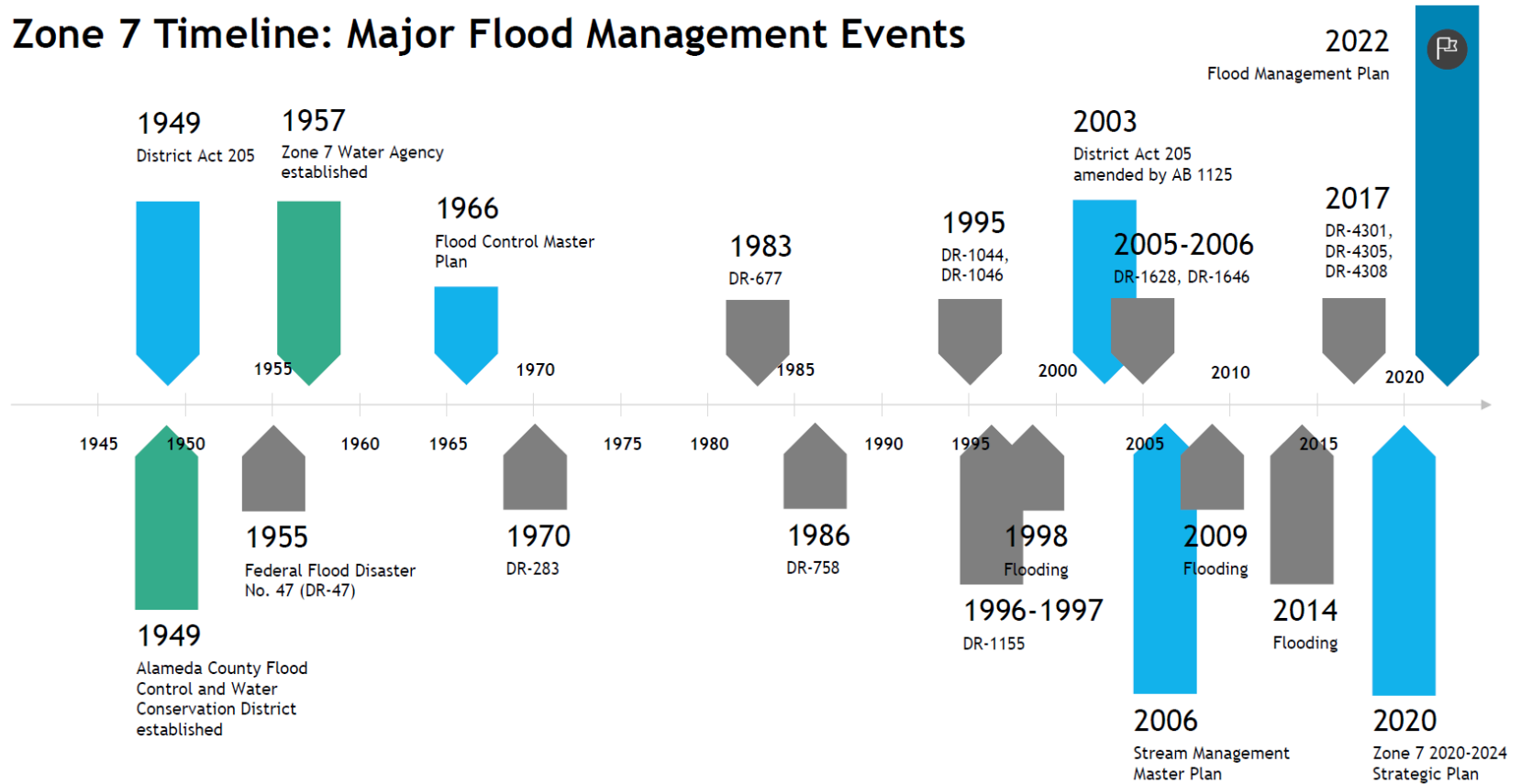


Figure A-2. 25-year and 100-year extent of inundation

APPENDIX B

Timeline of major flood events and planning efforts

Zone 7 Timeline: Major Flood Management Events



Notes:

1. DR is a FEMA disaster declaration event.
2. Blue represents prior flood management planning documents by Zone 7; Green represents the establishment of Alameda Flood Control and Zone 7; and gray represents significant flood events that have occurred in the Zone 7 service area.

