Annex S Delta Annex

S.1 Introduction

This Delta Annex details the hazard mitigation planning elements specific to that portion of the Sacramento-San Joaquin River Delta located within unincorporated Sacramento County. This portion of the Delta includes six (6) unincorporated communities, known as legacy communities, and the City of Isleton (also defined as a legacy community) as well as various other reclamation Districts. The purpose of this Annex is to provide an umbrella document that includes descriptions, data, and information on the Delta common to all LHMP participating jurisdictions from this region. This Annex is not intended to be a standalone document, but appends to and supplements the information contained in the Base Plan document. As such, all sections of the Base Plan, including the planning process and other procedural requirements apply to and were met by all participating jurisdictions included in this Delta Annex. This Annex provides information specific to participating Delta jurisdictions, with a focus on the risk assessment and mitigation strategy for each jurisdiction.

S.2 Participating Jurisdictions

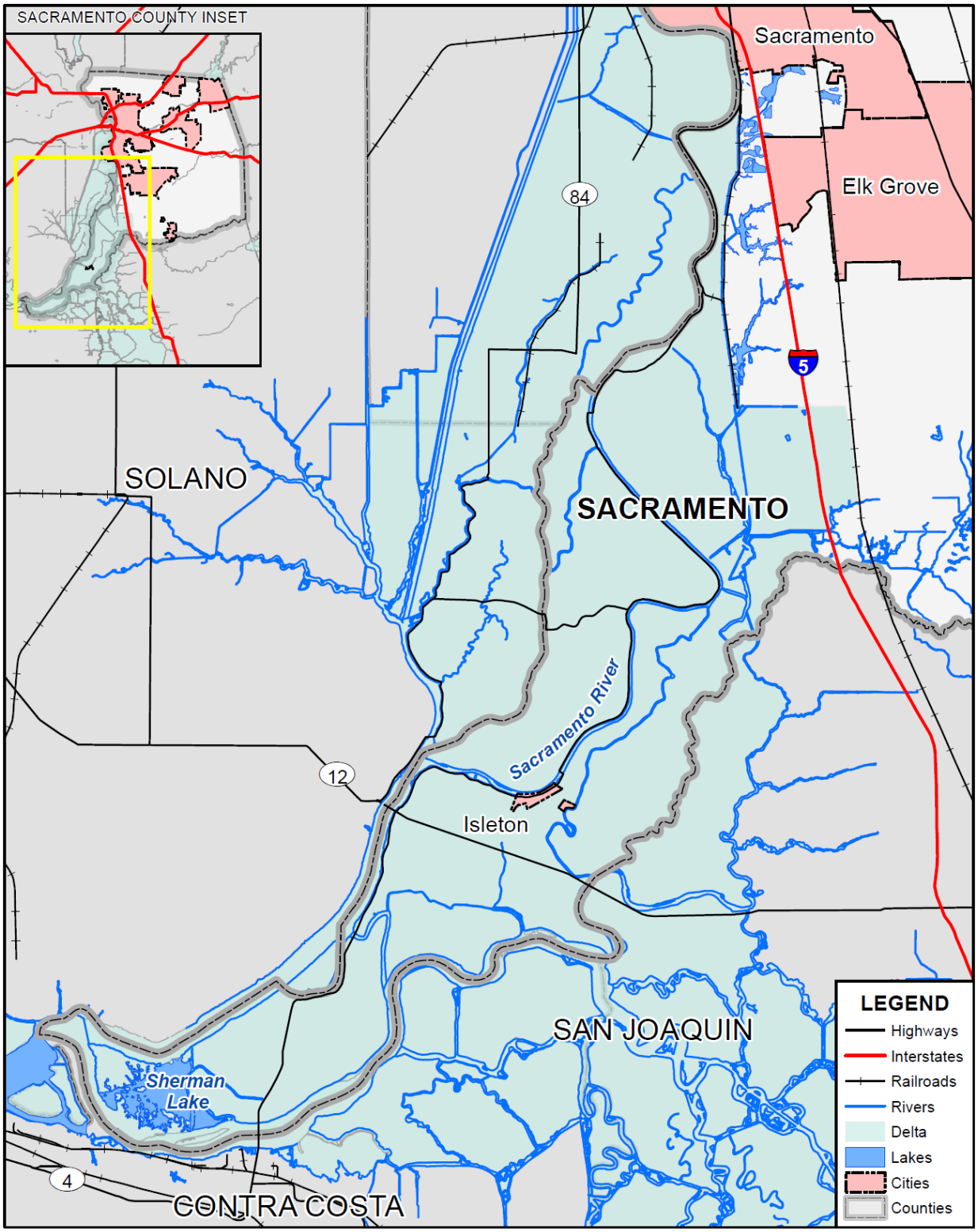
As described in the Base Plan document, the 2021 Sacramento LHMP Update is a multi-jurisdictional plan that geographically covers the entire area within Sacramento County's jurisdictional boundaries (i.e. the Sacramento County Planning Area). This Delta Annex provides a framework for the region's participating jurisdictions to this 2021 LHMP Update. The following agencies/organizations participated in the overall planning process and are seeking FEMA approval of this 2021 LHMP Update:

- City of Isleton
- Brannan Andrus Levee District (Reclamation Districts #317, #407, #2067)
- Reclamation District #3
- Reclamation District #341
- Reclamation District #349
- Reclamation District #369
- Reclamation District #551
- Reclamation District #554
- Reclamation District #556
- Reclamation District #563
- Reclamation District #1002
- Reclamation District #1601
- Reclamation District #2111

S.3 Community Profile

The community profile for the Sacramento Delta is further detailed in the following sections. Figure S-1 displays a map and the location of the Delta within Sacramento County.

Figure S-1 Sacramento County Delta Area



Data Source: Sacramento County GIS, Cal-Atlas; Map Date: 09/2020.

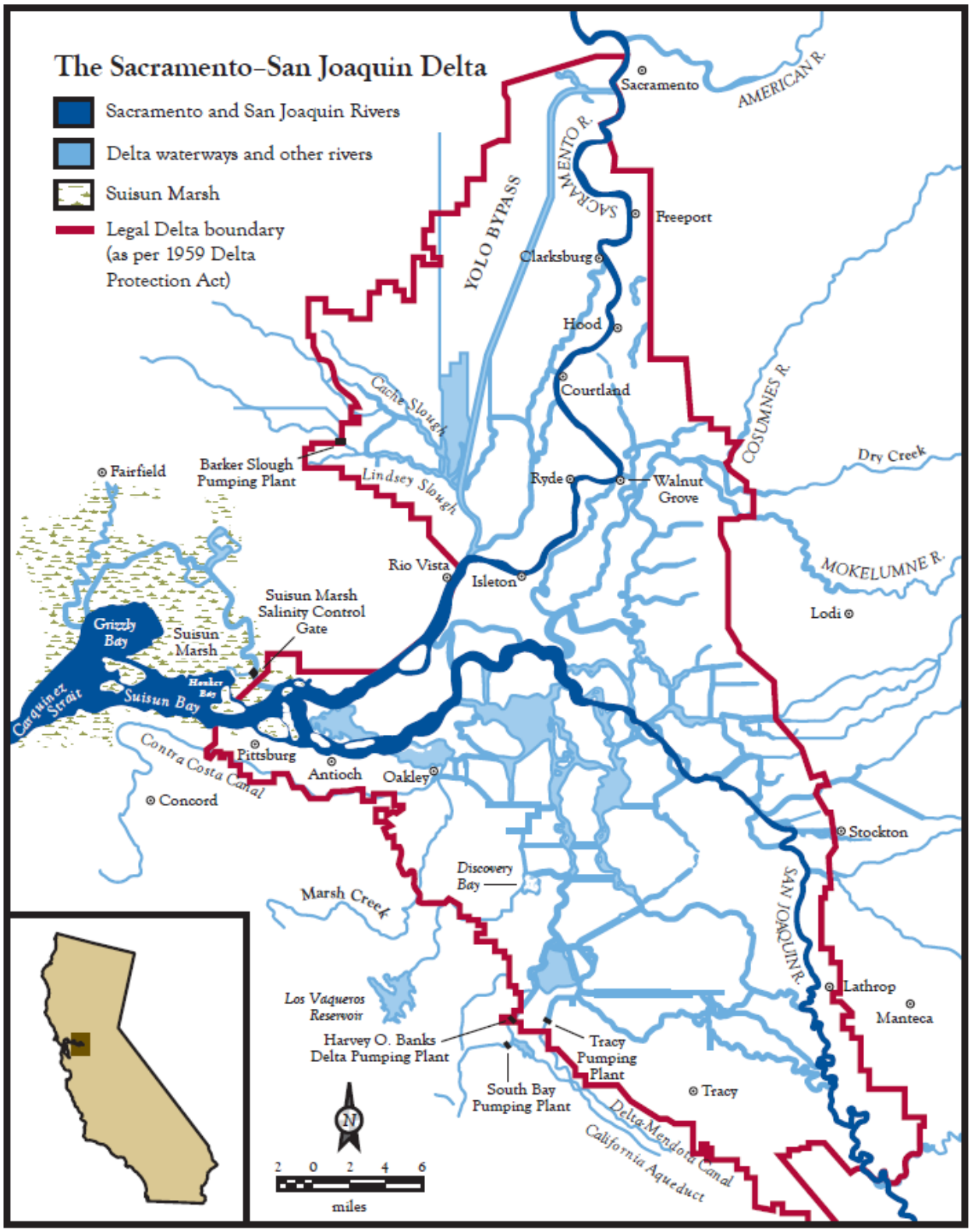
S.3.1. Geography and Climate

The Sacramento River Delta, in the southwest corner of Sacramento County, is interlaced with numerous tidal sloughs that include a number of peat islands reclaimed for agriculture by an extensive levee system. These waterways provide important fisheries and aquatic ecosystems, water for Delta farms and are important recreational areas. The climate of the Delta is much like the Mediterranean climate of Sacramento County. The Delta sits at or below sea level.

The Delta is located in Northern California, inland of the San Francisco Bay going towards Sacramento. Highways 80 and 5 run north-south, bordering the Delta and Highway 12 runs east to west crossing the Delta about midway. The Delta boundaries were legislatively defined by the Federal and State governments as part of the "New Deal" Central Valley Project after the Depression. The Primary and Secondary Zones of the legal Delta include land in six counties (although one area in Alameda County is very small), and portions of the cities of, Sacramento, West Sacramento, Stockton and Antioch along the periphery of the Delta. The smaller cities of Rio Vista and Isleton along with unincorporated communities of Byron, Ryde, Hood, Locke, Walnut Grove, Freeport, Clarksburg, and Courtland are located in the heart of the Delta. Comprising over 700,000 acres, this region includes 62 major named islands and hundreds of smaller islands. (see Figure S-2).

As described in the County's floodplain management ordinance, that portion of the Delta located within unincorporated Sacramento includes that area south of the Delta of Sacramento to the tip of Sherman Island protected from flooding by levees as bound by Reclamation District numbers: 3, 317, 341, 349, 369, 407, 551, 554, 556, 563, 744, 746, 755, 813, 1002, 1601, 2067, 2110, and 2111. This legal boundary is the Delta region used throughout this Annex.

Figure S-2 Sacramento–San Joaquin Delta Legal Boundaries



Source: Delta Protection Commission

The Delta region is one of the County's most fertile areas and accounts for much of the $470 million in agricultural production in the County. The Delta communities have a quiet rural lifestyle and is unique as a getaway from the hurried pace of much of the remainder of Sacramento County. This 162 square mile area (of Sacramento County) is crisscrossed by numerous waterways, which divide the land into distinct islands or tracts which includes the incorporated City of Isleton and the legacy communities of Locke, Ryde, Courtland, Freeport, Hood and Walnut Grove where roughly 6,000 residents live.

S.3.2. History

Originally, the Delta was a shallow wetland with water covering the area for many months of the year. Natural levees, created by deposits of sediment, allowed some islands to emerge during the dry summer months. Salinity would fluctuate, depending on the season and the amount of precipitation in any one year, and the species that comprised the Delta ecosystem had evolved and adapted to this unique, dynamic system.

The federal Swamp Land Act of 1850 set the stage for property ownership in the Delta. State legislation followed in 1861, which is approximately the same period in which the 1,000+ mile levee system began to take shape.

In 1933, the Legislature approved the California Central Valley Project Act, which relied upon the transfer of Sacramento River water south through the Delta and maintenance of a more constant salinity regime by using upstream reservoir releases of freshwater to create a hydraulic salinity barrier. As a result of the operations of state and federal water projects, the natural salinity variations in the Delta have been altered.

Fast forward to the November 2009 enactment of the Sacramento-San Joaquin Delta Reform Act. The Act resulted in a lengthy list of changes to the Delta's regulatory and governance framework and specifically identified a key statutory objective of ensuring for a safe and reliable water supply for the State, while preserving and enhancing the Delta's ecosystem. These "coequal" goals are now defined in California Water Code section 85054.

Today

The Delta, at 1,300 square miles, is the largest estuary and wetland ecosystem on the west coasts of both North and South America, and home to more than 500,000 people and 200,000 jobs. Further, the economic health of California, to the tune of $400B, is heavily reliant on existing communications, energy, and transportation facilities/infrastructure that are located in and traverse the Delta.

In spite of acknowledged water system and ecosystem degradation, the Delta remains a unique and critically important natural resource for California, as well as the entire nation. It serves as the hub of California's water supply system, which plays a vital role in supporting the basic economies of several major regions within the State, which are dependent on the ability of water exporters to access and transport water from the Delta watershed. This is evidenced by the fact that more than two-thirds of the State's residents (25 of 39 million) and more than three million acres of highly productive farmland receive water exported from the Delta watershed.

S.3.3. Current Delta Issues

As stated previously, the enactment of the 2009 Delta Reform Act resulted in a "re-set" of the Delta's regulations and governance. As an example, the Delta Stewardship Council (DSC) and the Sacramento-San Joaquin Delta Conservancy Board (SSJDCB) were created, and Delta Protection Commission (DPC) membership was reduced in size. However, without question the proposed CA WaterFix (formerly the Bay Delta Conservation Plan {BDCP]) has the greatest potential to result in immitigable and irreversible impacts to/on the Delta. The "California Water Fix" is now essentially a massive public works project. The "preferred alternative" continues to consist of an isolated water conveyance facility similar in design and operation to the "preferred alternative" described in the draft BDCP. The basic system design and operational protocol remains unchanged from the draft BDCP's preferred alternative. As a result, approval and implementation of the projects could result in a long list of significant and unavoidable impacts including, but not limited to, impacts to land use, water management and water quality, transportation, and socioeconomics.

S.4 Hazard Identification

Based on information provided by the participating jurisdictions within the Delta Area, in conjunction with input from Sacramento County, hazards that affect the Delta are summarized, including information on their frequency of occurrence, spatial extent, potential magnitude, and significance specific to the Delta Area (see Table S-1). Additional hazard information specific to each of the participating Delta jurisdictions is included in the Chapters to this Annex.

Table S-1 Sacramento County Delta —Hazard Identification Assessment

Hazard	Geographic Extent	Likelihood of Future Occurrences	Magnitude/ Severity	Significance	Climate Change Influence
Climate Change	Significant	Likely	Significant	Medium	–
Dam Failure	Limited	Unlikely	Negligible	Low	Medium
Drought & Water Shortage	Significant	Likely	Significant	Medium	High
Earthquake	Significant	Occasional	Limited	Low	Low
Earthquake Liquefaction	Limited	Occasional	Critical	High	Low
Floods: 1%/0.2% annual chance	Limited	Unlikely	Critical	High	Medium
Floods: Localized Stormwater	Significant	Likely	Critical	Medium	Medium
Landslides, Mudslides, and Debris Flow	Limited	Unlikely	Negligible	Low	Medium
Levee Failure	Significant	Occasional	Critical	High	Medium
Pandemic	Extensive	Likely	Limited	Low	Medium
Severe Weather: Extreme Cold and Freeze	Extensive	Occasional	Critical	Low	Medium
Severe Weather: Extreme Heat	Extensive	Likely	Critical	Low	High
Severe Weather: Heavy Rains and Storms	Extensive	Likely	Limited	Medium	Medium
Severe Weather: Wind and Tornado	Limited	Occasional	Negligible	Medium	Low
Subsidence	Significant	Likely	Critical	Medium	Medium
Volcano	Limited	Unlikely	Negligible	Low	Low
Wildfire	Limited	High	Limited	Low	High

Geographic Extent
Limited: Less than 10% of planning area
Significant: 10-50% of planning area
Extensive: 50-100% of planning area

Likelihood of Future Occurrences
Highly Likely: Near 100% chance of occurrence in next year, or happens every year.
Likely: Between 10 and 100% chance of occurrence in next year, or has a recurrence interval of 10 years or less.
Occasional: Between 1 and 10% chance of occurrence in the next year, or has a recurrence interval of 11 to 100 years.
Unlikely: Less than 1% chance of occurrence in next 100 years, or has a recurrence interval of greater than every 100 years.

Magnitude/Severity
Catastrophic—More than 50 percent of property severely damaged; shutdown of facilities for more than 30 days; and/or multiple deaths
Critical—25-50 percent of property severely damaged; shutdown of facilities for at least two weeks; and/or injuries and/or illnesses result in permanent disability
Limited—10-25 percent of property severely damaged; shutdown of facilities for more than a week; and/or injuries/illnesses treatable do not result in permanent disability
Negligible—Less than 10 percent of property severely damaged, shutdown of facilities and services for less than 24 hours; and/or injuries/illnesses treatable with first aid

Significance
Low: minimal potential impact
Medium: moderate potential impact
High: widespread potential impact

Climate Change Influence
Low: minimal potential impact
Medium: moderate potential impact
High: widespread potential impact

S.5 Hazard Profile and Vulnerability Assessment

The intent of this section is to profile the Delta's hazards and assess the Delta's vulnerability separate from that of the Sacramento County Planning Area as a whole, which has already been assessed in Section 4.3 Hazard Profiles and Vulnerability Assessment in the Base Plan. The hazard profiles in the Base Plan discuss overall impacts to the Sacramento County Planning Area and describes the hazard problem description, hazard location and extent, magnitude/severity, previous occurrences of hazard events and the likelihood of future occurrences. Hazard profile information specific to the Delta is included in this Annex. This vulnerability assessment analyzes the property, population, critical facilities, and other assets at risk to hazards ranked of medium or high significance specific to the Delta (as identified in the Significance column of Table S-1). For more information about how hazards affect the County as a whole, see Chapter 4 Risk Assessment in the Base Plan.

S.5.1. Hazard Profiles

The intent of this section is to profile the Delta's hazards and assess the region's vulnerability separate from that of the Planning Area as a whole, which has already been assessed in Section 4.3. of the Base Plan. Hazard profile information specific to the Delta as an area is included in this Annex (specific risks and vulnerabilities to each reclamation district and the City of Isleton can be found in their chapters to this Annex). This vulnerability assessment analyzes the property, population, critical facilities, and other assets at risk to hazards ranked from medium to high significance and also includes a vulnerability assessment to the flood, levee failure, and wildfire hazards.

S.5.2. Vulnerability Assessment and Assets at Risk

Each hazard vulnerability assessment in Section S.5.3, includes a hazard profile/problem description as to how each medium or high significant hazard affects the Delta and includes information on past hazard occurrences and the likelihood of future hazard occurrence. The intent of this section is to provide jurisdictional specific information on hazards and further describes how the hazards and risks differ across the Planning Area.

This section identifies the Sacramento Delta's assets at risk, including values, populations, critical facilities and infrastructure, cultural and historic assets, and growth and development trends.

Values at Risk

The following data from the Sacramento County Assessor's Office is based on the 2020 Assessor's data. The methodology used to derive property values is the same as in Section 4.3.1 of the Base Plan. This data should only be used as a guideline to overall values in the County, as the information has some limitations. The most significant limitations are created by Proposition 13 and the Williamson Act as detailed in the Base Plan. With respect to Proposition 13, instead of adjusting property values annually, the values are not adjusted or assessed at fair market value until a property transfer occurs. As a result, overall value information is most likely low and does not reflect current market value of properties within the County. It is also important to note, in the event of a disaster, it is generally the value of the infrastructure or improvements to the land that is of concern or at risk. Generally, the land itself is not a loss. However,

depending on the type of hazard and impact of any given hazard event, land values may be adversely affected; thus, land values are included as appropriate.

Table S-2 shows the 2020 Assessor's values (e.g., the values at risk) broken down by property type for the Delta (both the City of Isleton and unincorporated areas). Table S-3 shows the 2020 Assessor's values (e.g., the values at risk) broken down by property type for the Delta (the unincorporated area). A break down by property type for the City of Isleton is included in its Chapter to this Delta annex.

Table S-2 Sacramento Delta Total Values at Risk by Jurisdiction

Jurisdiction	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Contents Value	Total Value
Delta (Isleton)	536	338	$22,717,211	$41,268,279	$26,053,556	$90,039,044
Delta (Unincorporated)	2,681	1,735	$356,415,352	$417,944,098	$332,799,400	$1,107,158,865
Grand Delta Total	3,217	2,073	$379,132,563	$459,212,377	$358,852,956	$1,197,197,909

Source: Sacramento County 2016 Parcel/2015 Assessor's Data

Table S-3 Sacramento Delta –Total Values at Risk by Property Use

Property Use / Delta Area	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
Delta (City of Isleton)						
Agricultural	1	0	$32,472	$0	$0	$32,472
Care / Health	0	0	$0	$0	$0	$0
Church / Welfare	8	8	$208,114	$1,009,072	$1,009,072	$2,226,258
Industrial	5	5	$2,126,988	$1,224,909	$1,837,364	$5,189,260
Miscellaneous	20	0	$884,138	$0	$0	$884,138
Office	5	4	$447,754	$693,344	$693,344	$1,834,442
Public / Utilities	28	1	$44,163	$32,966	$32,966	$110,095
Recreational	0	0	$0	$0	$0	$0
Residential	260	257	$13,055,718	$31,636,760	$15,818,384	$60,510,861
Retail / Commercial	60	58	$2,600,078	$6,662,426	$6,662,426	$15,924,930
Unknown	0	0	$0	$0	$0	$0
Vacant	149	5	$3,317,786	$8,802	$0	$3,326,588
Delta (City of Isleton) Total	**536**	**338**	**$22,717,211**	**$41,268,279**	**$26,053,556**	**$90,039,044**
Delta (Unincorporated Sacramento County)						
Agricultural	754	493	$199,504,595	$206,511,135	$206,511,135	$612,526,865
Care / Health	3	0	$859	$0	$0	$859

Property Use / Delta Area	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
Church / Welfare	10	6	$103,775	$475,422	$475,422	$1,054,619
Industrial	43	31	$5,113,310	$7,870,799	$11,806,197	$24,790,308
Miscellaneous	216	5	$762,047	$13,642	$13,642	$789,331
Office	19	16	$1,465,592	$2,163,860	$2,163,860	$5,793,312
Public / Utilities	72	0	$27	$0	$0	$27
Recreational	69	45	$13,195,423	$17,433,420	$17,433,420	$48,062,263
Residential	1,098	1,032	$114,578,203	$166,468,908	$83,234,454	$364,281,578
Retail / Commercial	78	73	$5,629,637	$11,161,270	$11,161,270	$27,952,177
Unknown	1	1	$36,466	$131,696	$0	$168,162
Vacant	318	33	$16,025,418	$5,713,946	$0	$21,739,364
Delta (Unincorporated Sacramento County) Total	**2,681**	**1,735**	**$356,415,352**	**$417,944,098**	**$332,799,400**	**$1,107,158,865**
Grand Total	**3,217**	**2,073**	**$379,132,563**	**$459,212,377**	**$358,852,956**	**$1,197,197,909**

Source: Sacramento County 2020 Parcel/Assessor's Data

Critical Facilities and Infrastructure

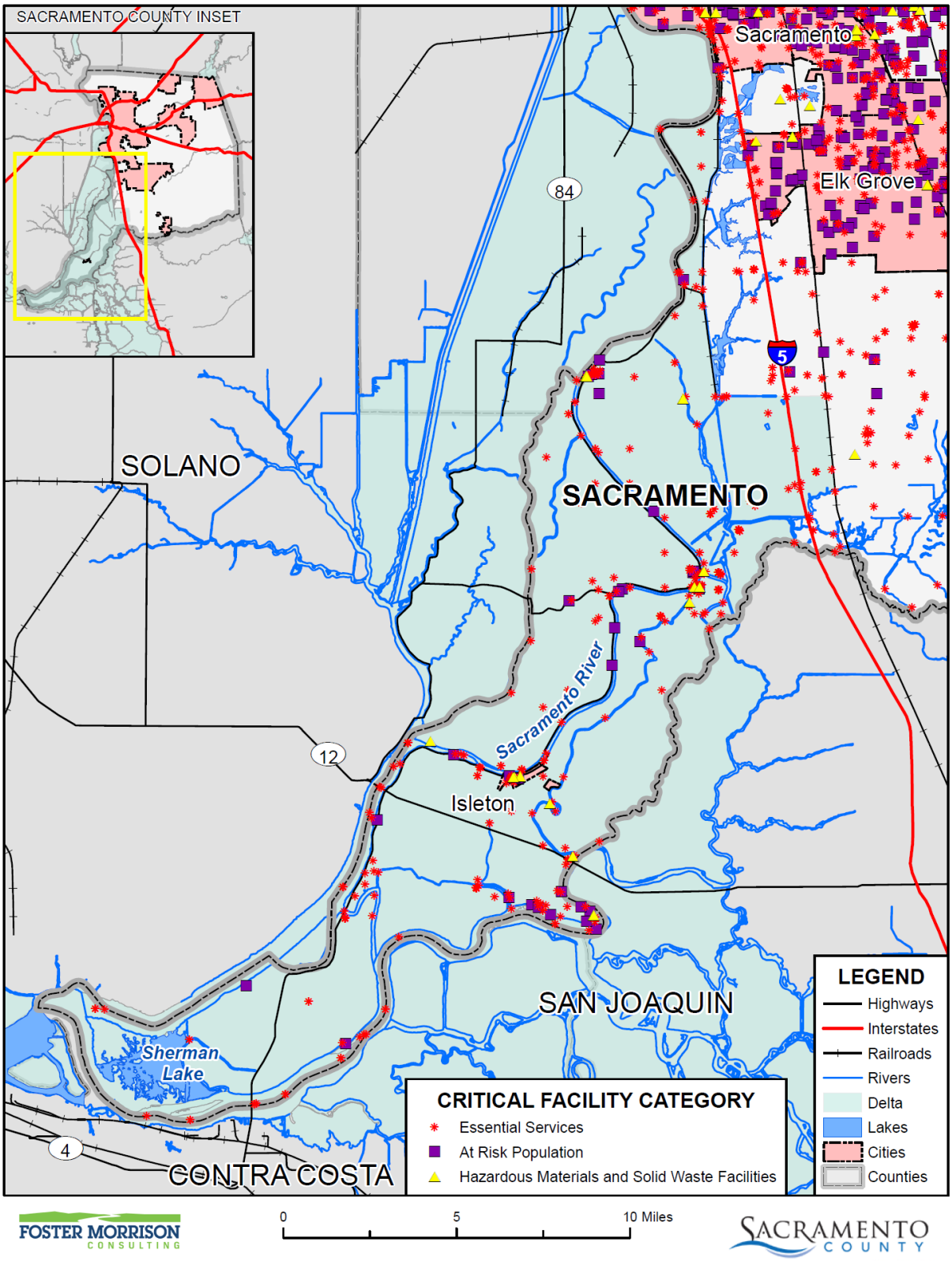
For purposes of this plan, a critical facility is defined as:

> ***Any facility, including without limitation, a structure, infrastructure, property, equipment or service, that if adversely affected during a hazard event may result in severe consequences to public health and safety or interrupt essential services and operations for the community at any time before, during and after the hazard event.***

A critical facility is classified by the following categories: (1) Essential Services Facilities, (2) At-risk Populations Facilities, (3) Hazardous Materials and Solid Waste Facilities.

An inventory of critical facilities in the Delta from Sacramento County GIS is shown on Figure S-3. Details of critical facility definition, type, name, address, and jurisdiction by hazard zone are listed in Appendix F.

Figure S-3 Sacramento County Delta– Critical Facilities



‘ Data Source: Sacramento County GIS, Cal-Atlas; Map Date: 08/2021.

Natural Resources

The Delta ecosystem is the lower drainage area of the vast Central Valley of California. It is inextricably linked to the Sacramento and San Joaquin River watersheds as a recipient of flows and constituents from natural and man caused activities and events upstream. It is distinguished by various aquatic ecosystems that host rare native fish, and by several distinct terrestrial and wetland habitats that support abundant bird and animal life. These key habitats include tidal marshes, managed freshwater wetlands, in-channel fresh and brackish water habitats, open water habitats, seasonal wetlands, riparian forest, and grasslands, among others. In all of these habitats there exist both resident and migratory species of great conservation value. This means that Delta ecosystem management must consider not only localized contexts but also the way that Delta habitats fit within regional, watershed, and even continental-scale ecosystems.

Importantly, some Delta agricultural lands also provide rich seasonal wildlife habitat. Thousands of acres are shallowly flooded after harvest and provide feeding and resting areas for resident and migratory birds and other wildlife. This practice of seasonal flooding is one example of a management practice that supports both the Delta ecosystem and the economy.

The Delta is also the single most important link in California's water supply system. Two of the state's biggest water projects – the State Water Project and the federal Central Valley Project – depend on Delta waterways to convey water from Northern California rivers to pumping facilities in the southern Delta. Delta levees play a critical role in preventing salty water from San Francisco Bay from intruding into critical parts of the Delta and contaminating the fresh water that supplies communities and farms.

While the California WaterFix includes ecosystem/habitat mitigation measures for the severe environmental impacts it causes the habitat restoration component of the prior habitat conservation plan (i.e., the BDCP) has been divorced from the project. Proposed mitigation, termed "environmental commitments" in the revised documents, include 2,100 acres of habitat repair along the footprint of the conveyance project,

"California EcoRestore" now proposes the creation/enhancement of approximately 30,000 acres of habitat; significantly reduced from the 153,000 acres previously identified in the draft BDCP. As proposed, EcoRestore will restore these 30,000 acres to habitat, primarily floodplain and tidal marsh, by 2020. As part of this effort EcoRestore will develop an adaptive management program (aka: the EcoRestore Adaptive Management Program) to achieve its habitat restoration goals and increase restoration success for the benefit of the long-term health of the Sacramento-San Joaquin Delta and Suisun Marsh's native fish and wildlife species.

In addition, the California Department of Fish and Wildlife is developing the "Delta Conservation Framework" that will work in tandem with EcoRestore. As proposed, the Framework will identify a 25-year vision for Delta-wide ecosystem conservation consistent with and in the context of the Delta as a place, and act to backfill the conservation measures) lost (or significantly eroded) when BDCP morphed into the Cal WaterFix and EcoRestore.

Historic and Cultural Resources

There is rich historic and cultural heritage in the Delta. It is home to several historically significant legacy communities, including Bethel Island, Clarksburg, Courtland, Freeport, Hood, Isleton, Knightsen, Locke, Rio Vista, Ryde, and Walnut Grove. Locke, the largest remaining town built by early Chinese immigrants to the United States, is a National Historic Landmark District. More information can be found in the Base Plan, as well as in the City of Isleton's and each reclamation district's chapters of this Annex.

Growth and Development Trends

Major planning activities are occurring in the Delta by the state and federal Governments related to water supplies and environmental issues. This effort's co-equal goals are water reliability and habitat restoration while still protecting, enhancing and sustaining the unique cultural, historical, recreational, agricultural and economic values of the Delta, and addressing flood protection, continued socio-economic sustainability of agriculture and its infrastructure, and legacy communities in the Delta. The outcomes of these planning actions are likely to shape the future of the County's Delta community, including any new development in the Delta.

Future Development

The 2030 Sacramento County General Plan estimated future populations for the Delta Area of the County. These are shown below.

- 2005 – 6,109
- 2010 – 6,442
- 2015 – 6,789
- 2020 – 7,023
- 2025 – 7,250

S.5.3. Vulnerability to Specific Hazards

This section provides the vulnerability assessment, including any quantifiable loss estimates, for those hazards identified above in Table S-1 as high or medium significance hazards. Impacts of past events and vulnerability of the Delta to specific hazards are further discussed below (see Section 4.1 Hazard Identification in the Base Plan for more detailed information about these hazards and their impacts on the Sacramento County Planning Area). Methodologies for evaluating vulnerabilities and calculating loss estimates are the same as those described in Section 4.3 of the Base Plan.

An estimate of the vulnerability of the Delta to each identified priority hazard, in addition to the estimate of likelihood of future occurrence, is provided in each of the hazard-specific sections that follow. Vulnerability is measured in general, qualitative terms and is a summary of the potential impact based on past occurrences, spatial extent, and damage and casualty potential. It is categorized into the following classifications:

- **Extremely Low**—The occurrence and potential cost of damage to life and property is very minimal to nonexistent.

- **Low**—Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.
- **Medium**—Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.
- **High**—Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have occurred in the past.
- **Extremely High**—Very widespread with catastrophic impact.

Depending on the hazard and availability of data for analysis, this hazard specific vulnerability assessment also includes information on values at risk, populations at risk, critical facilities and infrastructure, and future development.

Power Outage/Power Failure

An impact of almost all hazards below relates to power shortage and/or power failures. The US power grid crisscrosses the country, bringing electricity to homes, offices, factories, warehouses, farms, traffic lights and even campgrounds. According to statistics gathered by the Department of Energy, major blackouts are on the upswing. Incredibly, over the past two decades, blackouts impacting at least 50,000 customers have increased 124 percent. The electric power industry does not have a universal agreement for classifying disruptions. Nevertheless, it is important to recognize that different types of outages are possible so that plans may be made to handle them effectively. In addition to blackouts, brownouts can occur. A brownout is an intentional or unintentional drop in voltage in an electrical power supply system. Intentional brownouts are used for load reduction in an emergency. Electric power disruptions can be generally grouped into two categories: intentional and unintentional. More information on types of power disruptions can be found in Section 4.3.2 of the Base Plan.

Public Safety Power Shutoff (PSPS)

A new intentional disruption type of power shortage/failure event has recently occurred in California. In recent years, several wildfires have started as a result of downed power lines or electrical equipment. This was the case for the Camp Fire in 2018. As a result, California's three largest energy companies (including PG&E and SMUD), at the direction of the California Public Utilities Commission (CPUC), are coordinating to prepare all Californians for the threat of wildfires and power outages during times of extreme weather. To help protect customers and communities during extreme weather events, electric power may be shut off for public safety in an effort to prevent a wildfire. This is called a PSPS. More information on PSPS criteria can be found in Section 4.3.2 of the Base Plan.

It should be noted that to date, there have been no PSPS events in the Delta .

Climate Change

Likelihood of Future Occurrence–Likely
Vulnerability–High

Hazard Profile and Problem Description

Climate change adaptation is a key priority of the State of California. The 2018 State of California Multi-Hazard Mitigation Plan stated that climate change is already affecting California. Sea levels have risen by as much as seven inches along the California coast over the last century, increasing erosion and pressure on the state's infrastructure, water supplies, and natural resources. The State has also seen increased average temperatures, more extreme hot days, fewer cold nights, a lengthening of the growing season, shifts in the water cycle with less winter precipitation falling as snow, and earlier runoff of both snowmelt and rainwater in the year. In addition to changes in average temperatures, sea level, and precipitation patterns, the intensity of extreme weather events is also changing.

Location and Extent

Climate change is a global phenomenon. It is expected to affect the whole of the Delta, Sacramento County, and State of California. There is no scale to measure the extent of climate change. Climate change exacerbates other hazards, such as drought, extreme heat, flooding, wildfire, and others. The speed of onset of climate change is very slow. The duration of climate change is not yet known, but is feared to be tens to hundreds of years.

Past Occurrences

Climate change has never been directly linked to any declared disasters. While the Delta noted that climate change is of concern, no specific impacts of climate change could be recalled. The Delta and HMPC members noted that the strength of storms does seem to be increasing and the temperatures are getting hotter.

Vulnerability to and Impacts from Climate Change

The California Adaptation Planning Guide (APG) prepared by California OES and CNRA was developed to provide guidance and support for local governments and regional collaboratives to address the unavoidable consequences of climate change. California's APG: Understanding Regional Characteristics has divided California into 11 different regions based on political boundaries, projected climate impacts, existing environmental setting, socioeconomic factors and regional designations. Sacramento County falls within the North Sierra Region characterized as a sparsely settled mountainous region where the region's economy is primarily tourism-based. The region is rich in natural resources, biodiversity, and is the source for the majority of water used by the state. This information can be used to guide climate adaptation planning in the Delta and the Sacramento County Planning Area.

The 2014 California APG: Understanding Regional Characteristics identified the following impacts specific to the North Sierra region in which the Sacramento County Planning Area is part of:

- Temperature increases
- Decreased precipitation
- Reduced snowpack
- Reduced tourism
- Ecosystem change

- Sensitive species stress
- Increased wildfire

Future Development

The Delta could see population fluctuations as a result of climate impacts relative to those experienced in other regions, and these fluctuations are expected to impact demand for housing and other development. While there are currently no formal studies of specific migration patterns expected to impact the Delta and County region, climate-induced migration was recognized within the UNFCCC Conference of Parties Paris Agreement of 2015 and is expected to be the focus of future studies.

Drought & Water Shortage

Likelihood of Future Occurrence–Likely
Vulnerability–Medium

Hazard Profile and Problem Description

Drought is a complex issue involving many factors—it occurs when a normal amount of precipitation and snow is not available to satisfy an area's usual water-consuming activities. Drought can often be defined regionally based on its effects. Drought is different than many of the other natural hazards in that it is not a distinct event and usually has a slow onset. Drought can severely impact a region both physically and economically. Drought affects different sectors in different ways and with varying intensities. Adequate water is the most critical issue and is critical for agriculture, manufacturing, tourism, recreation, and commercial and domestic use. As the population in the area continues to grow, so will the demand for water.

Location and Extent

Drought and water shortage are regional phenomenon. The whole of the County, as well as the whole of the Delta, is at risk. The US Drought Monitor categorizes drought conditions with the following scale:

- None
- D0 – Abnormally dry
- D1 – Moderate Drought
- D2 – Severe Drought
- D3 – Extreme drought
- D4 – Exceptional drought

Drought has a slow speed of onset and a variable duration. Drought can last for a short period of time, which does not usually affect water shortages and for longer periods. Should a drought last for a long period of time, water shortage becomes a larger issue. Current drought conditions in the Delta and the County are shown in Section 4.3.8 of the Base Plan.

Past Occurrences

There have been two state and one federal disaster declaration from drought. This can be seen in Table S-4.

Table S-4 Sacramento County – State and Federal Drought Disaster Declarations 1950-2020

Disaster Type	State Declarations		Federal Declarations	
	Count	Years	Count	Years
Drought	2	2008, 2014	1	1977

Source: Cal OES, FEMA

Since drought is a regional phenomenon, past occurrences of drought for the Delta are the same as those for the County and includes 4 multi-year droughts since 1950. Details on past drought occurrences can be found in Section 4.3.8 of the Base Plan.

Vulnerability to and Impacts from Drought and Water Shortage

Based on historical information, the occurrence of drought in California, including the Delta, is cyclical, driven by weather patterns. Drought has occurred in the past and will occur in the future. Periods of actual drought with adverse impacts can vary in duration, and the period between droughts can be extended. Although an area may be under an extended dry period, determining when it becomes a drought is based on impacts to individual water users.

The vulnerability of the Delta to drought is Delta-wide, but impacts may vary and may include reduction in water supply and an increase in dry fuels. The potential for a reduction in water supply during drought conditions generally leads to both mandated and voluntary conservations measures during extended droughts. During these times, the costs of water can also increase.

Other qualitative impacts associated with drought in the Delta and Sacramento County Planning Area are those related to water intensive activities such as, municipal usage, commerce, tourism, recreation and agricultural use. Drought conditions can also cause soil to compact and not absorb water well, potentially making an area more susceptible to flooding.

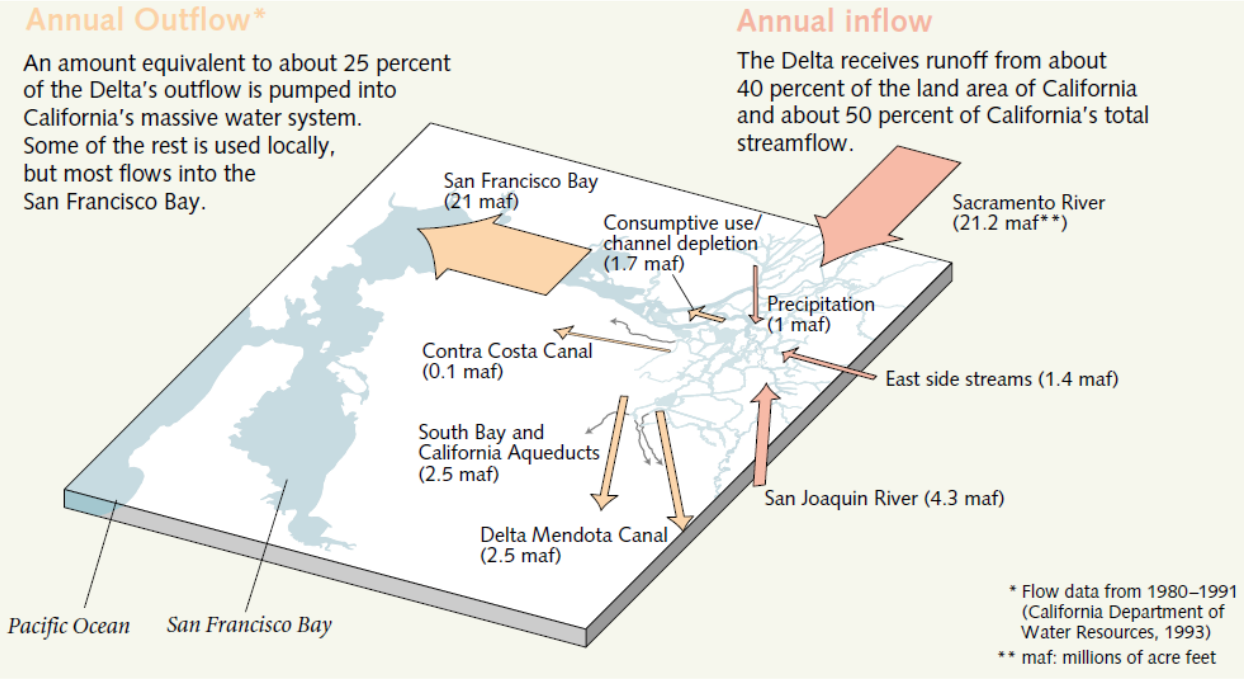
With more precipitation likely falling as rain instead of snow in the Sierra's, and warmer temperatures causing decreased snowfall to melt faster and earlier, water supply is likely to become more unreliable. In addition, drought and water shortage is predicted to become more common. This means less water available for use over the long run, and additional challenges for water supply reliability, especially during periods of extended drought.

In the Delta, drought has multiple effects. It has an economic effect on the agricultural industry, as high value crops are raised on many of the Delta islands. Prolonged drought can also exacerbate subsidence in the Delta.

There are also issues posed to the State of California from drought in the Delta. The Delta receives runoff from about 40 percent of the land area of California and about 50 percent of California's total streamflow,

as shown in Figure S-4. It is the heart of a massive north-to-south water-delivery system whose giant engineered arterials transport water southward. State and Federal contracts provide for export of up to 7.5 million acre-feet per year from two huge pumping stations in the southern Delta near the Clifton Court Forebay. About 83 percent of this water is used for agriculture and the remainder for various urban uses in central and southern California. Two-thirds of California's population (more than 20 million people) gets at least part of its drinking water from the Delta.

Figure S-4 The Delta and California's Water System



Source: USGS Publication "Sacramento-San Joaquin Delta: The Sinking Heart of the State." Report FS-005-00. Retrieved 4/30/2021

Future Development

The Delta has large amounts of surface water available. However, population growth in the County will add additional pressure to water companies during periods of drought and water shortage.

Earthquake: Liquefaction

Likelihood of Future Occurrence–Occasional
Vulnerability–Extremely High

Hazard Profile and Problem Description

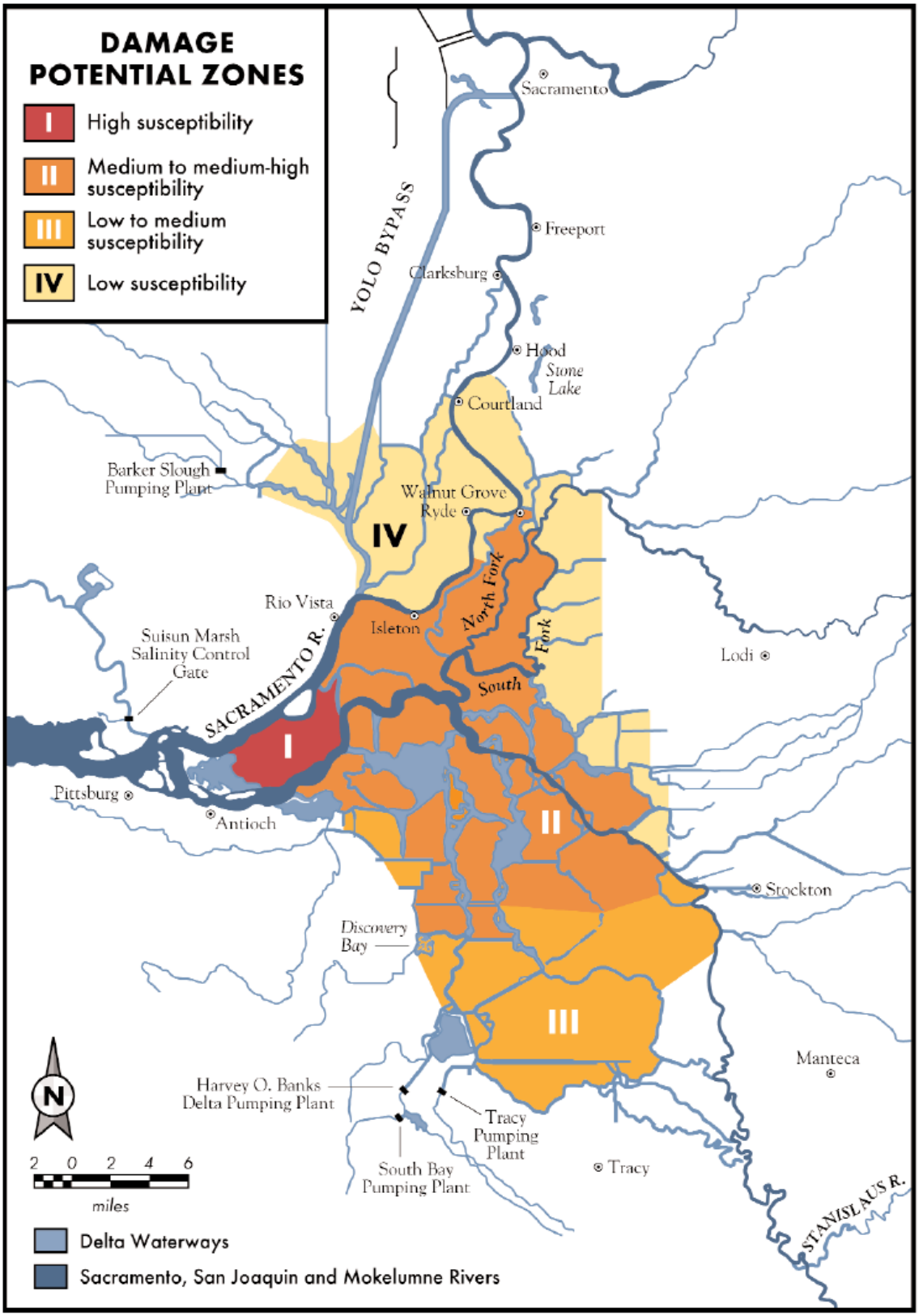
The Delta sits atop a blind fault system on the western edge of the Central Valley. Moderate earthquakes in 1892 near Vacaville and in 1983 near Coalinga demonstrate the seismic potential of this structural belt. The increasing height of the levee system has prompted growing concern about the seismic stability of the levees. The concern is based on the proximity of faulting, the nature of the levee foundations, and the

materials used to build the levees. Many levees consist of uncompacted weak local soils that may be unstable under seismic loading. The presence of sand and silt in the levees and their foundations indicates that liquefaction is also a possibility.

Although there have been no significant quakes in or closely adjacent to the Delta since high levees were originally constructed, there are at least five major faults within the vicinity of the Delta capable of generating peak ground acceleration values that would likely lead to levee failures.

A preliminary analysis of the risk of levee failure due to seismicity was prepared for the CALFED Levee System Integrity Program. Based on standard methods and local expertise, it estimated the magnitude and recurrence intervals of peak ground accelerations throughout the Delta. Two competing fault models were evaluated for this study, producing a wide range of potential accelerations. Then, based on local knowledge and limited geotechnical information, Damage Potential Zones were established for the Delta (Figure S-5). The zones of highest risk lie in the central and west Delta where tall levees are constructed on unstable soils that are at high risk of settling or liquefaction during an earthquake.

Figure S-5 Delta Area – Potential Damage Due to Liquefaction and Levee Collapse



Source: CALFED, 2014

This report estimated recurrence intervals for ground accelerations and the number of potential levee failures in each Damage Potential Zone. It is useful to examine their estimates of the number of failures that might occur during a 100-year event, or an event with a 0.01 probability of being equaled or exceeded in any given year. Based on their estimates, it is a roughly 50-50 chance that 5 to 20 levee segments will fail during a 100-year event in the Delta. This does not imply that 5 to 20 islands will flood, but just that 5 to 20 levee segments will fail. The loss of 5 to 20 levee segments in the Delta constitutes considerable and abrupt landscape change since island flooding is likely to be widespread and persistent for a long period of time.

In sum, liquefaction has not been observed as a result of recent seismic activity (including recent, nearby 1989 and 2014 events); however, it is recognized as a potential risk. In the event it does occur, liquefaction may pose a serious threat to levees, especially as levees are built larger and higher to deal with continuing island subsidence. Levee failure, depending on the extent, could have disastrous effects on agriculture, natural gas supply, fisheries, and saltwater intrusion of the San Francisco Bay. Water supply to California could be affected for years.

Past Occurrences

Although no historic examples of seismically induced levee failure are known in the Delta, the modern levee network has not been subjected to strong shaking. Levees were either smaller or non-existent in 1906 when the region was strongly shaken by the great San Francisco earthquake. In addition, the levees performed well during the 1989 earthquake in San Francisco and the 2014 earthquake in south Napa. Neither earthquake caused liquefaction problems to Delta levees.

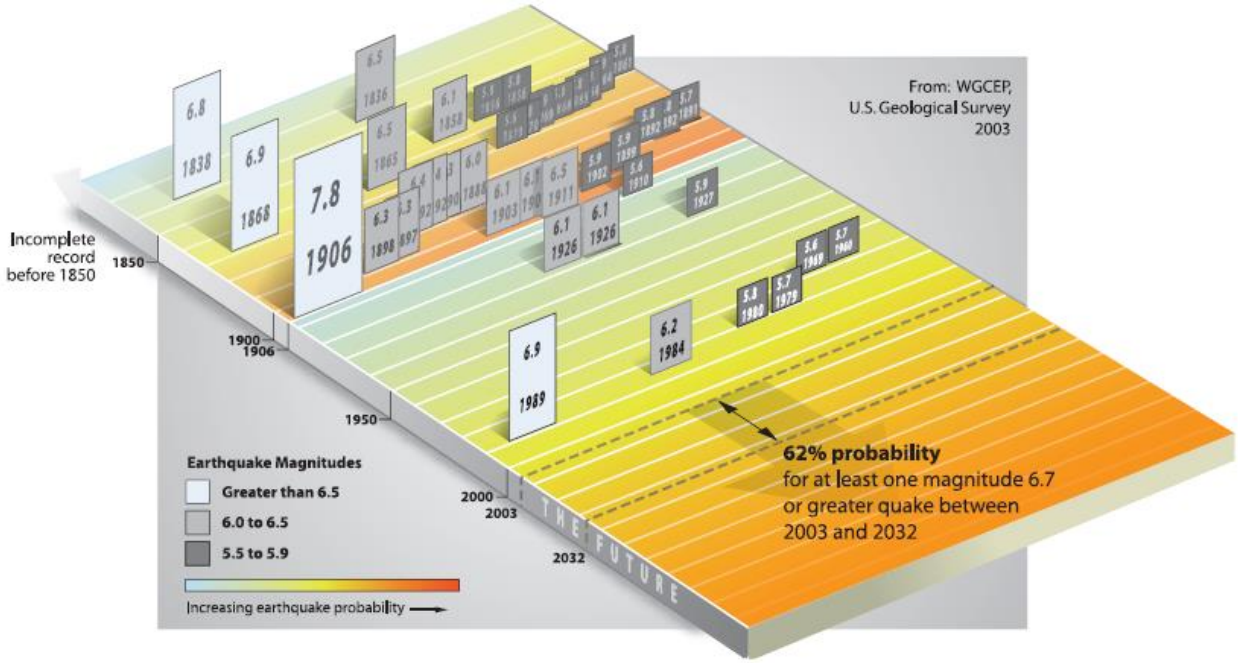
Vulnerability to Earthquake: Liquefaction

Historically, there have been 165 Delta and Suisun Marsh flood-induced levee failures leading to island inundations since 1900. Most of these failures occurred prior to 1990. Also, many of these failures were outside of Sacramento County. Since that time, there have been few levee failures due to improvements on the levee system in Sacramento as a whole.

No reports could be found to indicate that seismic shaking had ever induced significant damage or were the cause of the levee failures mentioned above. However, the lack of historical damage is not a reliable indicator that Delta levees are not vulnerable to earthquake shaking. Furthermore, the present-day Delta levees, at their current size, have not been significantly tested by moderate to high seismic shaking.

The U.S. Geological Survey estimates that an earthquake of magnitude 6.7 or greater has a 62 percent probability of occurring in the San Francisco Bay Area between 2003 and 2032 (see Figure S-6). Such an earthquake is capable of causing multiple levee failures in the Delta Region which could result in fatalities, extensive property damage and the interruption of water exports from the Delta for an extended period of time. Potential earthquakes on the Hayward, Calaveras or San Andreas faults pose the highest risk to Delta Region levees.

Figure S-6 Past and Future Earthquakes in the San Francisco Bay Area and the Delta



Source: DRMS Risk Report (URS/JBA 2008c) Figure 13-8. Retrieved 4/30/2021

The largest earthquakes experienced in recent history in the region include the 1906 Great San Francisco Earthquake and the 1989 Loma Prieta Earthquake. The 1906 earthquake occurred while the levees were in their early stages of construction. They were much smaller than they are today, and were not representative of the current configuration. The epicenter of the 1989 Loma Prieta earthquake was too distant and registered levels of shaking in the Delta too small to cause perceptible damage to the levees. In 2009, the California Department of Water Resources, in their document titled Delta Risk Management Strategy, performed a special simulation analysis of the 1906 Great San Francisco Earthquake to evaluate the potential effects of that event on the current levees.

In addition to the simulation of these largest regional earthquakes, recent smaller and closer earthquakes were also evaluated. They include: the 1980 Livermore Earthquake (M 5.8) and the 1984 Morgan Hill Earthquake (M 6.2). Except for the 1906 earthquake, which would have caused deformations of some of the weakest levees, the other earthquakes were either too small or too distant to cause any significant damage to the Delta levees. These results are consistent with the seismic vulnerability prediction model developed for this study.

General seismic performance observations were:

- The areas most prone to liquefaction potential are in the northern region and the southeastern region of the Delta. The central and western regions of the Delta and Suisun Marsh show discontinuous areas of moderate to low liquefaction potential.
- The vulnerability classes 1 through 4 are the most vulnerable levees to seismic loading. These include islands with liquefiable levee fill, and peat/organic soil deposits and potentially liquefiable sand deposits in the foundation. Such islands include but are not limited to Sherman, Brannan-Andrus, Twitchel, Webb, Venice, Bouldin, and many others.

- The majority of the islands have at least one levee reach in vulnerability classes 1 to 4,
- Levees composed of liquefiable fill are likely to undergo extensive damage as a result of a moderate to large earthquake in the region.
- The median probabilities of failure for classes with no liquefiable foundation sand and no liquefiable levee fill increase with peat thickness under the levee. When peat is absent, generally the probabilities of failure are small (less than 22 percent) for the largest ground motions of 0.5g. However, the probabilities of failure at the locations of the thickest peat (more than 25 feet) range from 30 percent to 60 percent for a PGA of 0.5g.
- Levees founded on liquefiable foundations are expected to experience large deformations (in excess of 10 feet) under a moderate to large earthquake in the region.

Flooding Risk

A major earthquake can cause extensive damage to large sections of levees on multiple islands at the same time. As a result, many islands could be flooded simultaneously. For example, the DRMS report indicated that there is a 40 percent probability of a major earthquake causing 27 or more islands to flood at the same time in the 25-year period from 2005 to 2030. It is not specified which islands in Sacramento County would be included in this flooding.

The duration and cost of levee repairs increases with the number of islands that are flooded due to an earthquake, as shown in Table S-5. This is not only due to the extensive amount of repairs required, but also to the availability of labor and materials to make the repairs. These numbers from the DRMS report are applicable to Sacramento County.

Table S-5 Duration and Cost of Repairs for Earthquake-Induced Levee Failures

Number of flooded islands	Estimated range of cost of repair and dewatering	Estimated range of time to repair breaches and dewater [days]
1	$43,000,000 – $240,000,000	136 – 276
3	$204,000,000 – $490,000,000	270 – 466
10	$620,000,000 – $1,260,000,000	460 – 700
20	$1,400,000,000 – $2,300,000,000	750 – 1,020
30	$3,000,000,000 – $4,200,000,000	1,240 – 1,660

Source: DRMS Risk Report 2009

In addition to dewatering costs, the Delta contains improved parcels at risk to flooding.

Water Quality Risk

Earthquake damage to levees and to the islands they protect could take years to repair following a major earthquake. One significant impact of levee failures would be to the state's water supply. For example, if 20 islands were flooded as a result of a major earthquake, the export of fresh water from the Delta could be interrupted for about a year and a half. Water supply losses of up to 8 million acre-feet would be incurred by State and federal water contractors and local water districts.

If subsided Delta islands are flooded due to levee breaches, significant amounts of dissolved organic carbon [DOC] would be released into Delta waters from the highly organic peat soils on these islands. Disinfectants used during the drinking water treatment process react with DOC to produce disinfection byproducts in treated water. Many of these chemical byproducts can increase cancer risks or cause other health effects.

Other water quality problems resulting from island flooding include increased algae blooms. Algae blooms can complicate drinking water treatment processes and can adversely affect some aquatic species.

Some soils in the Delta Region contain moderate levels of mercury due, among other things, to historical gold mining activities that occurred upstream of the Delta during the Gold Rush. Mercury in soils can, under certain circumstances, be converted to the highly toxic methylated form when islands are flooded. Methylated mercury can accumulate in the food chain potentially affecting fish. Humans and animals that consume fish contaminated with methylated mercury are at risk of poisoning.

Natural Resources at Risk

In all seismic levee failure scenarios, the area of vegetation impacted increases with the area flooded. The degree of impact depends on the type of vegetation flooded. Results of the DRMS Project indicate potential losses of up to 39 percent of herbaceous wetland, seasonal grasses and low-lying vegetation, 29 percent of non-native trees, and 24 percent of shrub wetland due to an event where multiple islands are flooded. In addition, in Sacramento County, the Delta Area at risk to liquefaction contains highly productive farmland. Should a levee fail, loss of crops would have a large economic impact. Information specific to the losses in Sacramento County were not available.

Population at Risk

The Delta levees most likely to fail due to earthquakes and earthquake liquefaction are generally located in the central-west area of the Delta, some of which is likely to be in the Sacramento County portion of the Delta. Their failure will cause rapid flooding and leave little time for evacuation.

The greatest immediate public safety concern is for the people working and living on Delta islands, and for people traveling through the Delta on various roads and highways. According to the DRMS report, there is a 40 percent probability of 90 or more fatalities in the Delta from levee failures due to a seismic event in the 25-year period from 2005 through 2030. The expected fatalities from earthquake-related island flooding are high due to the lack of warning for earthquakes and because of the rapid rate of flooding likely to occur after an earthquake. It should be noted that these fatality figures are for the Delta as a whole, and not limited to those areas of the Delta lying within Sacramento County.

Future Development

The consequences of a major earthquake in the Delta Region will also increase with time. Because of increasing water demand and the state's growing population and economy, the economic consequences of an interruption in Delta water supply operations due to an earthquake will increase. Consequences to the Delta Region will also increase due to additional development. According to the DRMS report, total expected economic losses are anticipated to increase by about 200 percent by 2050 and by about 500 percent

by 2100. The risk of fatalities is expected to increase, on average, by about 250 percent from 2005 to 2050. It should be noted that these economic figures are for the Delta as a whole, and not limited to those areas of the Delta lying within Sacramento County.

Flood: 1%/0.2% Annual Chance

Likelihood of Future Occurrence–Occasional/Unlikely
Vulnerability–Extremely High

Hazard Profile and Problem Description

This hazard analyzes the FEMA DFIRM 1% and 0.2% annual chance floods. These tend to be the larger floods that can occur in the County or in the Delta, and have caused damages in the past. Flooding is a significant problem in Sacramento County and the Delta. Historically, the Delta has been at risk to flooding primarily during the winter and spring months when river systems in the County swell with heavy rainfall and snowmelt runoff. Normally, storm floodwaters are kept within defined limits by a variety of storm drainage and flood control measures. Occasionally, extended heavy rains result in floodwaters that exceed normal high-water boundaries and cause damage. Flooding has occurred both within the 1% and 0.2% annual chance floodplains and in other localized areas.

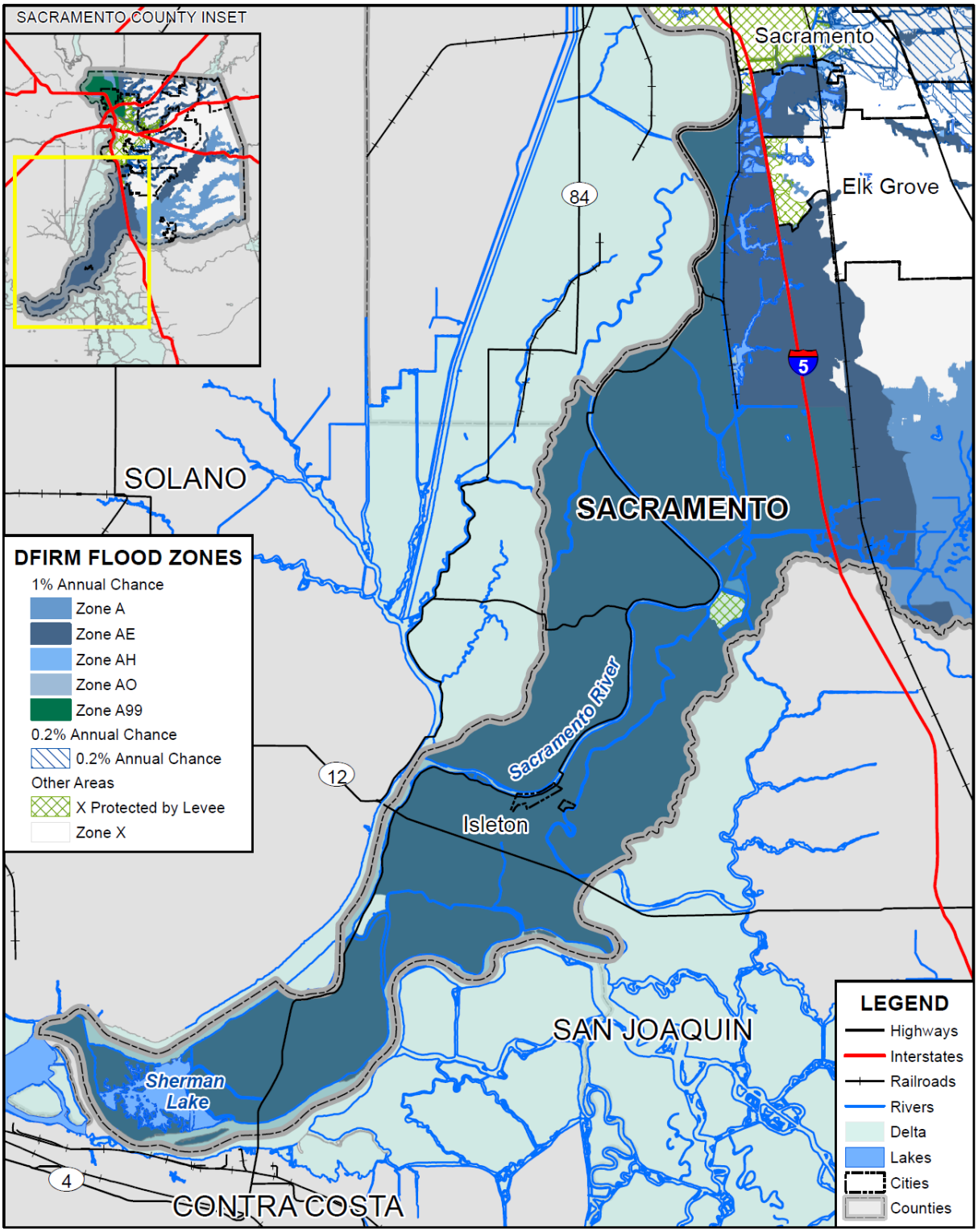
As previously described in Section 4.3.11 of the Base Plan, the Sacramento County Planning Area and the Delta have been subject to historical flooding.

Location and Extent

The Delta Region lies within a floodplain and is faced with a major flooding problem because of an aging levee system and issues associated with subsidence, seepage, erosion and seismicity. Flooding has occurred in some parts of the Delta on the average of once every three and one-half to four years. While construction of upstream reservoirs has reduced the threat of overtopping, Delta levee failures continue to be a serious problem. Since 1950, levee failures have been twice as likely to be caused by foundation or levee instability than by overtopping. The condition of Delta levees has been deteriorating over time and flooding frequency increasing. Although there are currently efforts to improve, flood protection is generally inadequate except for those areas protected by federally built or "project" levees.

The Delta has areas located in the 1% and 0.2% annual chance flood zones. This is seen in Figure S-7.

Figure S-7 Sacramento County Delta – FEMA DFIRM Flood Zones



Data Source: FEMA NFHL 07/19/2018, Sacramento County GIS, Cal-Atlas; Map Date: 09/2020.

Table S-6 details the DFIRM mapped flood zones located within the Delta.

Table S-6 Sacramento County Delta– DFIRM Flood Hazard Zones

Flood Zone	Description	Flood Zone Present in the Delta
A	1% annual chance flooding: No base flood elevations provided. Mandatory flood insurance purchase requirements and floodplain management standards apply.	X
AE	1% annual chance flooding: Base flood elevations provided. Mandatory flood insurance purchase requirements and floodplain management standards apply.	X
AH	Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between one and three feet. Base Flood Elevations (BFEs) derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply.	
AO	Areas subject to inundation by 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply.	
A99	Areas subject to inundation by the 1-percent-annual-chance flood event, but which will ultimately be protected upon completion of an under-construction Federal flood protection system. These are areas of special flood hazard where enough progress has been made on the construction of a protection system, such as dikes, dams, and levees, to consider it complete for insurance rating purposes. Zone A99 may only be used when the flood protection system has reached specified statutory progress toward completion. No Base Flood Elevations (BFEs) or depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.	
Shaded X	0.2% annual chance flooding: The areas between the limits of the 1% annual chance flood and the 0.2-percent-annual-chance (or 500-year) flood. Flood insurance is not mandatory but is available.	X
X Protected by Levee	Areas protected by levees from 1% annual chance flood event. Levee protection places these areas in the 0.2% annual chance flood zone. Flood insurance is not mandatory but is available.	X
X (unshaded)	No flood hazard	X

Source: FEMA

Additionally, flood extents can generally be measured in volume, velocity, and depths of flooding. Expected flood depths in the Delta vary, depending on the nature and extent of a flood event; specific depths are unknown. Flood durations in the Delta tend to be short to medium term, or until either the storm drainage system can catch up or flood waters move downstream. Flooding in the Delta tends to have a shorter speed of onset, due to the amount of water that flows through the Delta.

Geographical flood extents for the Delta from the FEMA DFIRMs are shown in Table S-7.

Table S-7 Sacramento County Delta – Geographical DFIRM Flood Zone Extents

Delta Area/ Flood Zone	Total Acres	% of Total Acres	Improved Acres	% of Total Improved Acres	Unimproved Acres	% of Total Unimproved Acres
Delta (City of Isleton)						
1% Annual Chance Flood Hazard	224	96.24%	61	93.26%	163	97.41%
0.2% Annual Chance Flood Hazard	0	0.00%	0	0.00%	0	0.00%
Other Areas	9	3.76%	4	6.74%	4	2.59%
Delta (City of Isleton) Total	**233**	**100.00%**	**66**	**100.00%**	**168**	**100.00%**
Delta (Unincorporated Sacramento County)						
1% Annual Chance Flood Hazard	85,415	99.01%	45,710	99.19%	39,705	98.81%
0.2% Annual Chance Flood Hazard	465	0.54%	373	0.81%	93	0.23%
Other Areas	387	0.45%	2	0.00%	385	0.96%
Delta (Unincorporated Sacramento County) Total	**86,267**	**100.00%**	**46,085**	**100.00%**	**40,183**	**100.00%**
Grand Total	**86,500**	**100.00%**	**46,150**	**100.00%**	**40,350**	**100.00%**

Source: FEMA DFIRM 11/2/2018

Past Occurrences

A list of state and federal disaster declarations for Sacramento County from flooding is shown on Table S-8. These events also likely affected the Delta to some degree.

Table S-8 Sacramento County – State and Federal Disaster Declarations from Flood 1950-2020

Disaster Type	Federal Declarations		State Declarations	
	Count	Years	Count	Years
Flood (including heavy rains and storms)	19	1950, 1955, 1958 (twice), 1963, 1969, 1982 (twice), 1983, 1986, 1995 (twice), 1996, 1997, 1998, 2008, 2017 (three times)	14	1955, 1958, 1964, 1969, 1983, 1986, 1995 (twice), 1997, 1998, 2006, 2017 (three times)

Source: Cal OES, FEMA

Due to the levees in the Delta Area, flooding past occurrences are discussed in the Past Occurrence section in Levee Failure section below.

Vulnerability to and Impacts from Flood

Floods have been a part of the Delta's historical past and will continue to be so in the future. During winter months, long periods of precipitation and the timing of that precipitation are critical in determining the threat of flood, and these characteristics further dictate the potential for widespread structural and property damages. Predominantly, the effects of flooding are generally confined to areas near the waterways of the County. As waterways grow in size from local drainages, so grows the threat of flood and dimensions of the threat. This threatens structures in the floodplain. Structures can also be damaged from trees falling as a result of water-saturated soils. Electrical power outages happen, and the interruption of power causes major problems. Loss of power is usually a precursor to closure of governmental offices and community businesses. Public schools may also be required to close or be placed on a delayed start schedule. Roads can be damaged and closed, causing safety and evacuation issues. People may be swept away in floodwaters, causing injuries or deaths.

Floods are among the costliest natural disasters in terms of human hardship and economic loss nationwide. Floods can cause substantial damage to structures, landscapes, and utilities as well as life safety issues. Floods can be extremely dangerous, and even six inches of moving water can knock over a person given a strong current. During a flood, people can also suffer heart attacks or electrocution due to electrical equipment short outs. Floodwaters can transport large objects downstream which can damage or remove stationary structures. Ground saturation can result in instability, collapse, or other damage. Objects can also be buried or destroyed through sediment deposition. Floodwaters can also break utility lines and interrupt services. Standing water can cause damage to crops, roads, foundations, and electrical circuits. Direct impacts, such as drowning, can be limited with adequate warning and public education about what to do during floods. Other problems connected with flooding and stormwater runoff include erosion, sedimentation, degradation of water quality, loss of environmental resources, and economic impacts.

The 2018 Flood Insurance Study (FIS) noted that the lower reaches/Delta of the Sacramento and San Joaquin Rivers are under the influence of the tides. The most severe flood conditions in the Delta would result when very high tides and large volume of stream outflow occur coincidentally, and strong onshore winds generate wave action. It should be noted that precipitation over the Delta does not materially affect local flood conditions.

Assets at Risk

Based on the vulnerability of the Delta to the flood hazard, the sections that follow describes significant assets at risk in the Delta. This section includes the values at risk, flooded acres, population at risk, and critical facilities at risk.

Values at Risk

GIS was used to determine the possible impacts of flooding within the Delta. The methodology described in Section 4.3.12 of the Base Plan was followed in determining structures and values at risk to the 1% (100-year) and 0.2% (500-year) annual chance flood event. Table S-9 is a summary table for the Delta. Parcel counts, values, estimated contents, and total values in the Delta are shown for the 1% and 0.2% annual chance flood zones, as well as for those properties that fall outside of the mapped FEMA DFIRM flood

zones. Table S-10 breaks down Table S-9 and shows the property use, improved parcel count, improved values, estimated contents, and total values that fall by datafile flood zones in the Delta.

Table S-9 Sacramento County Delta – Count and Value of Parcels at Risk in Summary DFIRM Flood Zones

Delta Area/ Flood Zone	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
Delta (City of Isleton)						
1% Annual Chance Flood Hazard	515	329	$21,145,419	$39,144,051	$24,482,767	$84,772,235
0.2% Annual Chance Flood Hazard	0	0	$0	$0	$0	$0
Other Areas	21	9	$1,571,792	$2,124,228	$1,570,789	$5,266,809
Delta (City of Isleton) Total	**536**	**338**	**$22,717,211**	**$41,268,279**	**$26,053,556**	**$90,039,044**
Delta (Unincorporated Sacramento County)						
1% Annual Chance Flood Hazard	2,418	1,550	$343,040,982	$395,607,129	$316,128,972	$1,054,777,092
0.2% Annual Chance Flood Hazard	258	183	$13,167,271	$22,153,220	$16,524,002	$51,844,499
Other Areas	5	2	$207,099	$183,749	$146,426	$537,274
Delta (Unincorporated Sacramento County) Total	**2,681**	**1,735**	**$356,415,352**	**$417,944,098**	**$332,799,400**	**$1,107,158,865**
Grand Total	**3,217**	**2,073**	**$379,132,563**	**$459,212,377**	**$358,852,956**	**$1,197,197,909**

Source: FEMA 11/2/2018 DFIRM, Sacramento County 2020 Parcel/Assessor's Data

*With respect to improve parcels within the floodplain, the actual structures on the parcels may not be located within the actual floodplain, may be elevated and or otherwise outside of the identified flood zone

**This parcel count only includes those parcels in the 0.2% annual chance flood zone, exclusive of the 1% annual chance flood zone. The 0.2% annual chance flood, in actuality, also includes all parcels in the 1% annual chance flood zone.

Table S-10 Sacramento County Delta – Count and Values of Parcels at Risk by Detailed Flood Zone and Property Use

Flood Zone / Property Use / Delta Area	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
Delta (City of Isleton)						
1% Annual Chance Flood Hazard						
Zone AE						

Flood Zone / Property Use / Delta Area	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
Agricultural	1	0	$32,472	$0	$0	$32,472
Care / Health	0	0	$0	$0	$0	$0
Church / Welfare	8	8	$208,114	$1,009,072	$1,009,072	$2,226,258
Industrial	5	5	$2,126,988	$1,224,909	$1,837,364	$5,189,260
Miscellaneous	17	0	$851,679	$0	$0	$851,679
Office	4	3	$188,095	$374,669	$374,669	$937,433
Public / Utilities	26	1	$43,974	$32,966	$32,966	$109,906
Recreational	0	0	$0	$0	$0	$0
Residential	257	254	$12,279,026	$30,529,882	$15,264,945	$58,073,852
Retail / Commercial	55	53	$2,190,276	$5,963,751	$5,963,751	$14,117,778
Unknown	0	0	$0	$0	$0	$0
Vacant	142	5	$3,224,795	$8,802	$0	$3,233,597
Zone AE Total	***515***	***329***	***$21,145,419***	***$39,144,051***	***$24,482,767***	***$84,772,235***
1% Annual Chance Flood Hazard Total	**515**	**329**	**$21,145,419**	**$39,144,051**	**$24,482,767**	**$84,772,235**
Other Areas						
Zone X						
Agricultural	0	0	$0	$0	$0	$0
Care / Health	0	0	$0	$0	$0	$0
Church / Welfare	0	0	$0	$0	$0	$0
Industrial	0	0	$0	$0	$0	$0
Miscellaneous	3	0	$32,459	$0	$0	$32,459
Office	1	1	$259,659	$318,675	$318,675	$897,009
Public / Utilities	2	0	$189	$0	$0	$189
Recreational	0	0	$0	$0	$0	$0
Residential	3	3	$776,692	$1,106,878	$553,439	$2,437,009
Retail / Commercial	5	5	$409,802	$698,675	$698,675	$1,807,152
Unknown	0	0	$0	$0	$0	$0
Vacant	7	0	$92,991	$0	$0	$92,991
Zone X Total	***21***	***9***	***$1,571,792***	***$2,124,228***	***$1,570,789***	***$5,266,809***
Other Areas Total	**21**	**9**	**$1,571,792**	**$2,124,228**	**$1,570,789**	**$5,266,809**
Delta (City of Isleton) Total	**536**	**338**	**$22,717,211**	**$41,268,279**	**$26,053,556**	**$90,039,044**
Delta (Unincorporated Sacramento County)						

Flood Zone / Property Use / Delta Area	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
1% Annual Chance Flood Hazard						
Zone A						
Agricultural	0	0	$0	$0	$0	$0
Care / Health	0	0	$0	$0	$0	$0
Church / Welfare	0	0	$0	$0	$0	$0
Industrial	0	0	$0	$0	$0	$0
Miscellaneous	9	0	$0	$0	$0	$0
Office	0	0	$0	$0	$0	$0
Public / Utilities	0	0	$0	$0	$0	$0
Recreational	0	0	$0	$0	$0	$0
Residential	0	0	$0	$0	$0	$0
Retail / Commercial	0	0	$0	$0	$0	$0
Unknown	0	0	$0	$0	$0	$0
Vacant	0	0	$0	$0	$0	$0
Zone A Total	***9***	***0***	***$0***	***$0***	***$0***	***$0***
Zone AE						
Agricultural	748	487	$197,732,742	$204,664,960	$204,664,960	$607,062,662
Care / Health	0	0	$0	$0	$0	$0
Church / Welfare	7	4	$57,949	$456,002	$456,002	$969,953
Industrial	34	23	$4,382,875	$6,831,692	$10,247,538	$21,462,105
Miscellaneous	189	5	$747,449	$13,642	$13,642	$774,733
Office	6	5	$639,776	$355,385	$355,385	$1,350,546
Public / Utilities	69	0	$27	$0	$0	$27
Recreational	66	43	$13,047,953	$16,714,813	$16,714,813	$46,477,579
Residential	969	910	$108,774,073	$154,124,012	$77,062,007	$339,960,101
Retail / Commercial	46	43	$3,520,666	$6,614,625	$6,614,625	$16,749,916
Unknown	1	1	$36,466	$131,696	$0	$168,162
Vacant	274	29	$14,101,006	$5,700,302	$0	$19,801,308
Zone AE Total	***2,409***	***1,550***	***$343,040,982***	***$395,607,129***	***$316,128,972***	***$1,054,777,092***
1% Annual Chance Flood Hazard Total	**2,418**	**1,550**	**$343,040,982**	**$395,607,129**	**$316,128,972**	**$1,054,777,092**
0.2% Annual Chance Flood Hazard						
X Protected by Levee						
Agricultural	6	6	$1,771,853	$1,846,175	$1,846,175	$5,464,203

Flood Zone / Property Use / Delta Area	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
Care / Health	3	0	$859	$0	$0	$859
Church / Welfare	3	2	$45,826	$19,420	$19,420	$84,666
Industrial	9	8	$730,435	$1,039,107	$1,558,659	$3,328,203
Miscellaneous	17	0	$14,598	$0	$0	$14,598
Office	12	10	$728,197	$1,699,371	$1,699,371	$4,126,939
Public / Utilities	2	0	$0	$0	$0	$0
Recreational	3	2	$147,470	$718,607	$718,607	$1,584,684
Residential	127	121	$5,694,650	$12,270,251	$6,135,125	$24,100,030
Retail / Commercial	32	30	$2,108,971	$4,546,645	$4,546,645	$11,202,261
Unknown	0	0	$0	$0	$0	$0
Vacant	44	4	$1,924,412	$13,644	$0	$1,938,056
X Protected by Levee Total	***258***	***183***	***$13,167,271***	***$22,153,220***	***$16,524,002***	***$51,844,499***
0.2% Annual Chance Flood Hazard Total	**258**	**183**	**$13,167,271**	**$22,153,220**	**$16,524,002**	**$51,844,499**
Other Areas						
Zone X						
Agricultural	0	0	$0	$0	$0	$0
Care / Health	0	0	$0	$0	$0	$0
Church / Welfare	0	0	$0	$0	$0	$0
Industrial	0	0	$0	$0	$0	$0
Miscellaneous	1	0	$0	$0	$0	$0
Office	1	1	$97,619	$109,104	$109,104	$315,827
Public / Utilities	1	0	$0	$0	$0	$0
Recreational	0	0	$0	$0	$0	$0
Residential	2	1	$109,480	$74,645	$37,322	$221,447
Retail / Commercial	0	0	$0	$0	$0	$0
Unknown	0	0	$0	$0	$0	$0
Vacant	0	0	$0	$0	$0	$0
Zone X Total	***5***	***2***	***$207,099***	***$183,749***	***$146,426***	***$537,274***
Other Areas Total	**5**	**2**	**$207,099**	**$183,749**	**$146,426**	**$537,274**
Delta (Unincorporated Sacramento County) Total	**2,681**	**1,735**	**$356,415,352**	**$417,944,098**	**$332,799,400**	**$1,107,158,865**

Flood Zone / Property Use / Delta Area	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
Grand Total	**3,217**	**2,073**	**$379,132,563**	**$459,212,377**	**$358,852,956**	**$1,197,197,909**

Source: FEMA 11/2/2018 DFIRM, Sacramento County 2020 Parcel/Assessor's Data

*With respect to improve parcels within the floodplain, the actual structures on the parcels may not be located within the actual floodplain, may be elevated and or otherwise outside of the identified flood zone

**This parcel count only includes those parcels in the 0.2% annual chance flood zone, exclusive of the 1% annual chance flood zone. The 0.2% annual chance flood, in actuality, also includes all parcels in the 1% annual chance flood zone.

Table S-11 summarizes Table S-10 above and shows Sacramento County Delta loss estimates and improved values at risk by FEMA 1% and 0.2% annual chance flood zones.

Table S-11 Sacramento County Delta – Flood Loss Estimates

Flood Zone / Delta Area	Total Parcel Count	Improved Parcel Count	Improved Structure Value	Estimated Contents Value	Total Value	Loss Estimate	Loss Ratio
Delta (City of Isleton)							
1% Annual Chance Flood Hazard	515	329	$39,144,051	$24,482,767	$63,626,818	$12,725,364	1.52%
0.2% Annual Chance Flood Hazard	0	0	$0	$0	$0	$0	0.00%
Delta (City of Isleton) Total	**515**	**329**	**$39,144,051**	**$24,482,767**	**$63,626,818**	**$12,725,364**	**1.61%**
Delta (Unincorporated Sacramento County)							
1% Annual Chance Flood Hazard	2,418	1,550	$395,607,129	$316,128,972	$711,736,101	$142,347,220	16.98%
0.2% Annual Chance Flood Hazard	258	183	$22,153,220	$16,524,002	$38,677,222	$7,735,444	0.92%
Delta (Unincorporated Sacramento County) Total	**2,676**	**1,733**	**$417,760,349**	**$332,652,974**	**$750,413,323**	**$150,082,664**	**17.90%**

Source: FEMA 11/2/2018 DFIRM, Sacramento County 2020 Parcel/Assessor's Data

*With respect to improve parcels within the floodplain, the actual structures on the parcels may not be located within the actual floodplain, may be elevated and or otherwise outside of the identified flood zone

**This parcel count only includes those parcels in the 0.2% annual chance flood zone, exclusive of the 1% annual chance flood zone. The 0.2% annual chance flood, in actuality, also includes all parcels in the 1% annual chance flood zone.

According to Table S-10 and Table S-11, the Sacramento County Delta area has 1,879 improved parcels and $774 million of structure and contents values or values in the 1% annual chance flood zone, and 183 improved parcels and $38.7 million of structure and contents values in the 0.2% annual chance flood zone. These values can be refined a step further. Applying the 20 percent damage factor as previously described

in Section 4.3.11 of the Base Plan, there is a 1% chance in any given year of a flood event causing $155 million in damage and a 0.2% chance in any given year of a flood event causing $7.7million in damage in the Sacramento County Delta. The loss ratio of 18.50% and 0.92% indicates that flood losses for 1% and 0.2% annual chance flooding, respectively, may be overwhelming and difficult to recover from.

Flooded Acres

Also of interest is the land area affected by the various flood zones. The following is an analysis of flooded acres in the Delta in comparison to total area within the Delta limits. The same methodology, as discussed in Section 4.3.12 of the Base Plan, was used for the Sacramento County Delta as well as for the County as a whole. Table S-12 represents a detailed and summary analysis of total acres for each FEMA DFIRM flood zone in the Delta.

Table S-12 Sacramento County Delta – Flooded Acres by Flood Zone

Flood Zone / Delta Area	Total Acres	% of Total Acres	Improved Acres	% of Total Improved Acres	Unimproved Acres	% of Total Unimproved Acres
Delta (City of Isleton)						
1% Annual Chance Flood Hazard	224	96.24%	61	93.26%	163	97.41%
0.2% Annual Chance Flood Hazard	0	0.00%	0	0.00%	0	0.00%
Other Areas	9	3.76%	4	6.74%	4	2.59%
Delta (City of Isleton) Total	**233**	**100.00%**	**66**	**100.00%**	**168**	**100.00%**
Delta (Unincorporated Sacramento County)						
1% Annual Chance Flood Hazard	85,415	99.01%	45,710	99.19%	39,705	98.81%
0.2% Annual Chance Flood Hazard	465	0.54%	373	0.81%	93	0.23%
Other Areas	387	0.45%	2	0.00%	385	0.96%
Delta (Unincorporated Sacramento County) Total	**86,267**	**100.00%**	**46,085**	**100.00%**	**40,183**	**100.00%**
Grand Total	**86,500**	**100.00%**	**46,150**	**100.00%**	**40,350**	**100.00%**

Source: FEMA 11/2/2018 DFIRM

Population at Risk

The DFIRM flood zones were overlayed on the parcel layer. Those residential parcel centroids that intersect the flood zones were counted and multiplied by the 2010 Census Bureau average household factors for Isleton and the unincorporated County. According to this analysis, there is a total population of 2,292 and 334 residents of the Delta at risk to flooding in the 1% and 0.2% annual chance floodplains, respectively. This is shown in Table S-13.

Table S-13 Sacramento County Delta – Count of Improved Residential Parcels and Population by Flood Zone

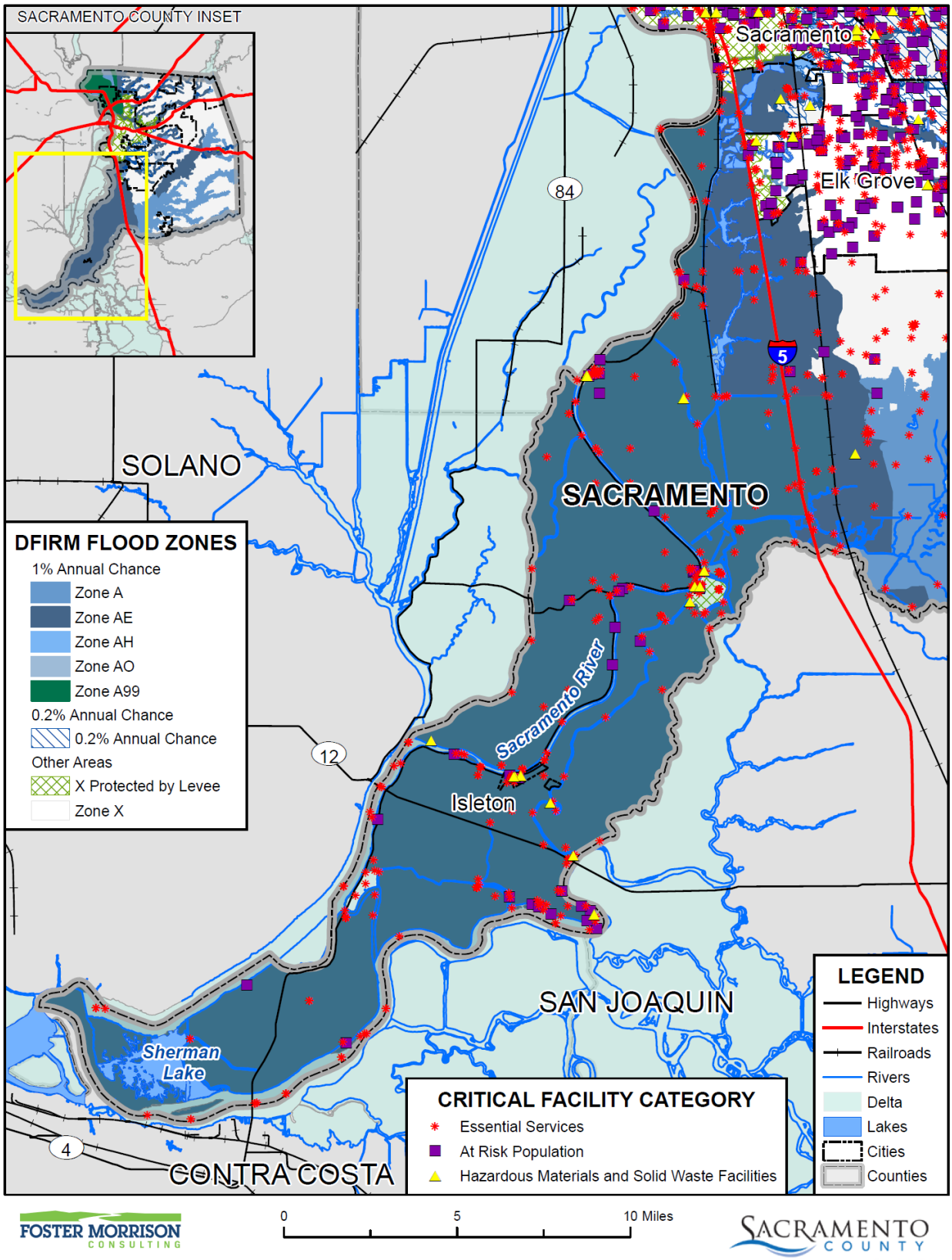
Jurisdiction	1% Annual Chance		0.2% Annual Chance	
	Improved Residential Parcels	Population at Risk	Improved Residential Parcels	Population at Risk
Isleton	254	686	0	0
Unincorporated Delta	810	2,236	121	334
Total	**1,064**	**2,922**	**121**	**334**

Source: FEMA DFIRM 11/2/2018, Sacramento County 2020 Parcel/Assessor's Data, US Census Bureau Average Household Sizes: Isleton (2.7), and unincorporated Sacramento County (2.76)

Critical Facilities at Risk

An analysis was performed on the critical facility inventory in Citrus Heights in DFIRM flood zones. GIS was used to determine whether the critical facility locations intersect a DFIRM flood zone. Details of critical facilities in mapped dam inundation areas in the Delta are shown in Figure A 8. Details of critical facility definition, type, name and address and jurisdiction by dam inundation area are listed in Appendix F.

Figure S-8 Sacramento Delta – Critical Facilities in DFIRM Flood Zones



Data Source: FEMA NFHL 07/19/2018, Sacramento County GIS, Cal-Atlas; Map Date: 08/2021.

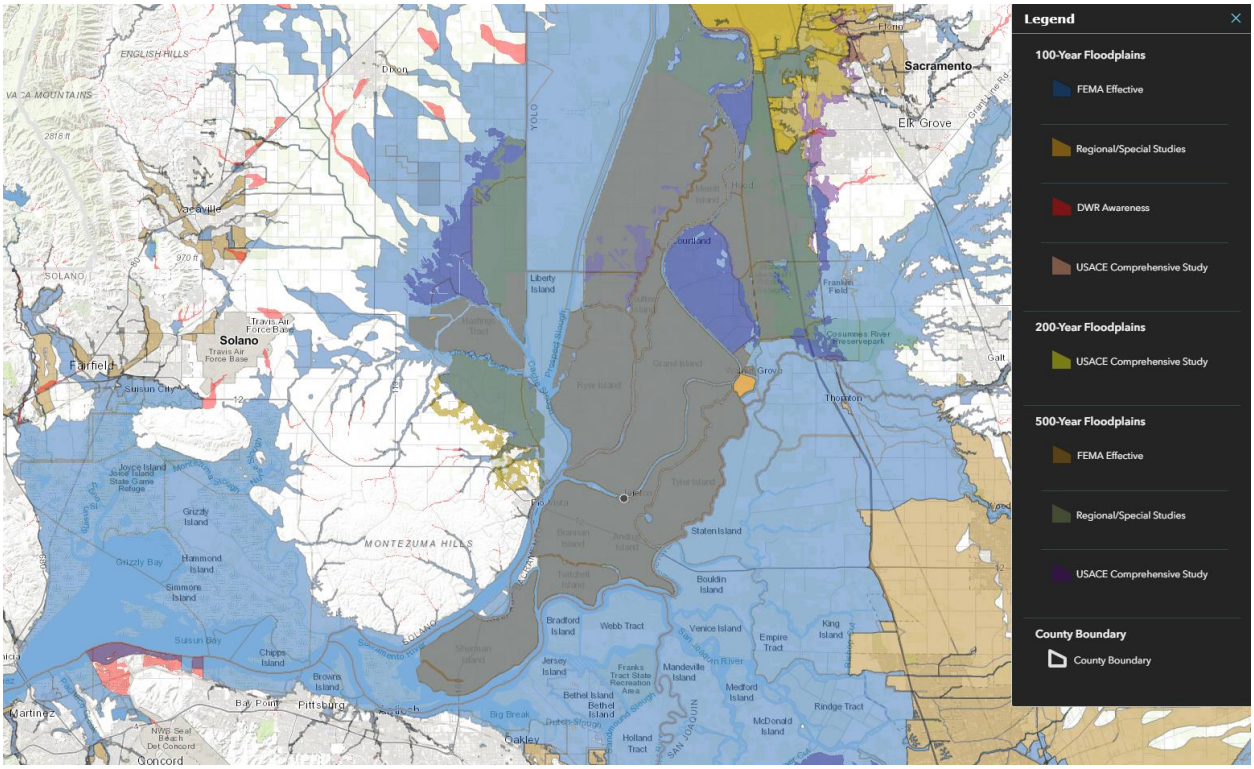
California Department of Water Resources Best Available Maps (BAM)

The FEMA regulatory maps provide just one perspective on flood risks in Sacramento County. Senate Bill 5 (SB 5), enacted in 2007, authorized the California DWR to develop the Best Available Maps (BAM) displaying 100- and 200-year floodplains for areas located within the Nevada-San Joaquin (SAC-SJ) Valley watershed. This effort was completed by DWR in 2008. DWR has expanded the BAM to cover all counties in the State and to include 500-year floodplains.

Different than the FEMA DFIRMs which have been prepared to support the NFIP and reflect only the 100-year event risk, the BAMs are provided for informational purposes and are intended to reflect current 100-, 200-(as applicable), and 500-year event risks using the best available data. The 100-year floodplain limits on the BAM are a composite of multiple 100-year floodplain mapping sources. It is intended to show all currently identified areas at risk for a 100-year flood event, including FEMA's 100-year floodplains. The BAM are comprised of different engineering studies performed by FEMA, Corps, and DWR for assessment of potential 100-, 200-, and 500-year floodplain areas. These studies are used for different planning and/or regulatory applications, and for each flood frequency may use varied analytical and quality control criteria depending on the study type requirements.

The value in the BAMs is that they provide a bigger picture view of potential flood risk to the Delta than that provided in the FEMA DFIRMs. The BAM map for the Delta is shown in Figure S-9.

Figure S-9 Sacramento County Delta – Best Available Map



Source: California DWR, retrieve 5/19/2021

Legend explanation: Blue - FEMA 1%, Orange – Local 1% (developed from local agencies), Red – DWR 1%r (Awareness floodplains identify the 1% annual chance flood hazard areas using approximate assessment procedures.), Pink – USACE 1% (2002 Sac and San Joaquin River Basins Comp Study), Yellow – USACE 0.5% (2002 Sac and San Joaquin River Basins Comp Study), Tan

– FEMA 0.2%, Grey – Local 0.2% (developed from local agencies), Purple – USACE 0.2% (2002 Sac and San Joaquin River Basins Comp Study).

Future Development

The potential for flooding may increase as floodwaters are channeled due to land development. Such changes can exacerbate flooding problems inside and outside of natural floodplains by altering or confining natural drainage channels. Floodplain modeling and master planning for future development should be based on build out property use to ensure that all new development remains safe from future flooding. While local floodplain management, stormwater management, and water quality regulations and policies address these changes on a site-by-site basis, their cumulative effects can have a negative impact on the overall floodplain.

Flood: Localized Stormwater Flooding

Likelihood of Future Occurrence–Highly Likely
Vulnerability–Medium

Hazard Profile and Problem Description

Flooding occurs in areas other than the FEMA mapped 1% and 0.2% annual chance floodplains. Flooding may be from drainages not studied by FEMA, lack of or inadequate drainage infrastructure, or inadequate maintenance. Localized, stormwater flooding occurs throughout the County during the rainy season from November through April. Prolonged heavy rainfall contributes to a large volume of runoff resulting in high peak flows of moderate duration.

Location and Extent

The Sacramento County Delta is subject to localized flooding throughout the area. Flood extents are usually measured in areas affected, velocity of flooding, and depths of flooding. Expected flood depths in the Delta vary by location. Flood durations in the Delta tend to be short to medium term, or until either the storm drainage system can catch up or flood waters move downstream. Localized flooding in the Delta tends to have a shorter speed of onset, especially when antecedent rainfall has soaked the ground and reduced its capacity to absorb additional moisture.

Past Occurrences

Past occurrences to localized flooding varies by area. Specific past occurrences for Isleton and the reclamation districts can be found in their Chapters to this annex.

Vulnerability to and Impacts from Localized Flooding

Historically, much of the growth in the Delta and County has occurred adjacent to streams, resulting in significant damages to property, and losses from disruption of community activities when the streams overflow. Additional development in the watersheds of these streams affects both the frequency and duration of damaging floods through an increase in stormwater runoff.

Primary concerns associated with stormwater flooding include impacts to infrastructure that provides a means of ingress and egress throughout the community. Ground saturation can result in instability, collapse, or other damage to trees, structures, roadways and other critical infrastructure. Objects can also be buried or destroyed through sediment deposition. Floodwaters can break utility lines and interrupt services. Standing water can cause damage to crops, roads, and foundations. Other problems connected with flooding and stormwater runoff include erosion, sedimentation, degradation of water quality, losses of environmental resources, and certain health hazards.

Future Development

The risk of localized flooding to future development can also be minimized by accurate recordkeeping of repetitive localized flooding. Mitigating the causes of the localized stormwater flooding will reduce future risks of losses.

Levee Failure

Likelihood of Future Occurrence–Occasional
Vulnerability–Extremely High

Hazard Profile and Problem Description

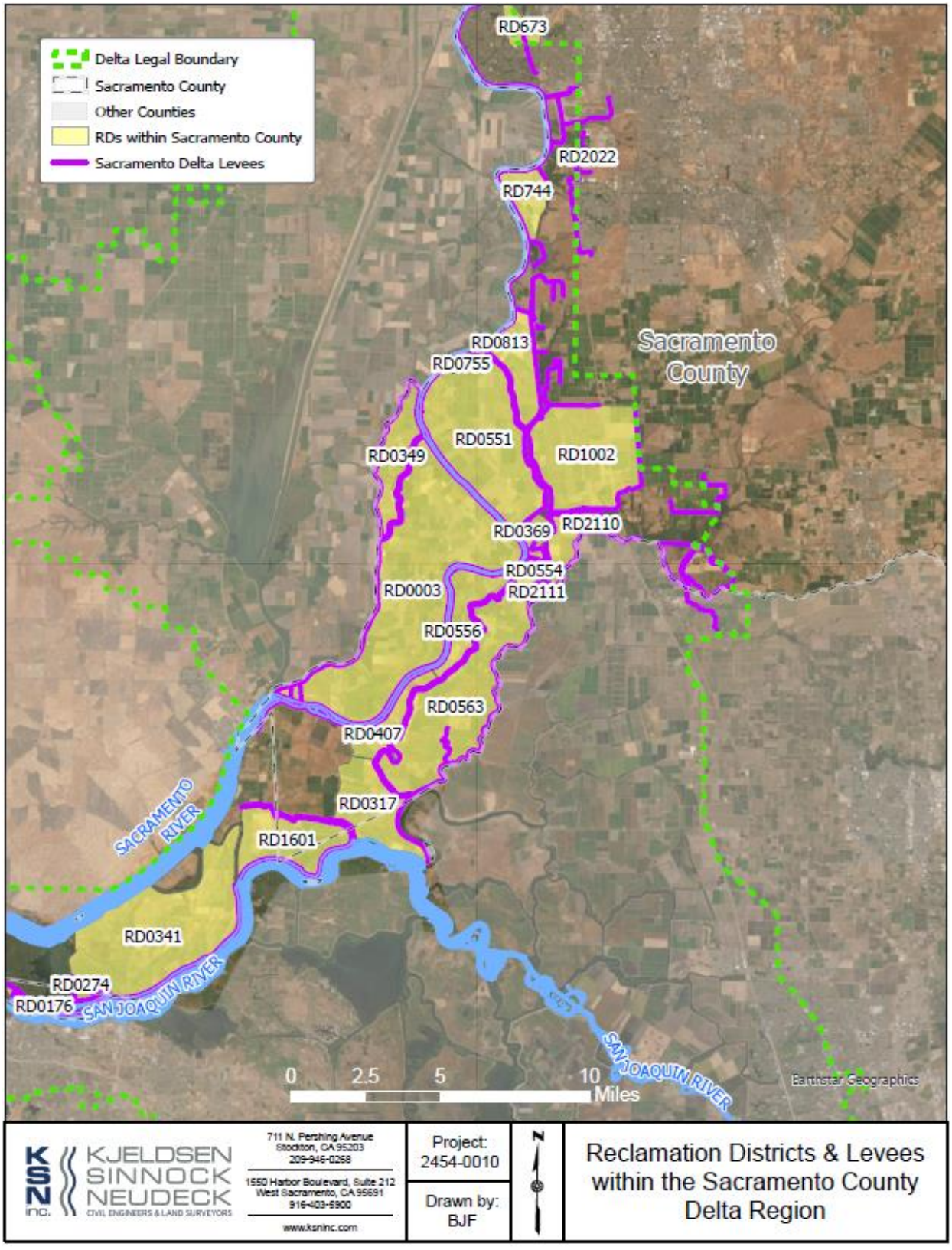
A levee is a raised area that runs along the banks of a stream or canal. Levees reinforce the banks and help prevent flooding by containing higher flow events to the main channel of a stream. By confining the flow to a narrower steam channel, levees can also increase the speed of the water. Levees can be natural or man-made.

Levees provide strong flood protection, but they are not failsafe. Levees are designed to protect against a specific flood level and could be overtopped during severe weather events or dam failure. For example, levees can be certified to provide protection against the 1% annual chance flood. Levees reduce, not eliminate, the risk to individuals and structures located behind them. A levee system failure or overtopping can create severe flooding and high water velocities. Levee failure can occur through overtopping or from seepage issues resulting from burrowing rodents, general erosion, excessive vegetation and root systems and other factors that compromise the integrity of the levee. No levee provides protection from events for which it was not designed, and proper operation and maintenance are necessary to reduce the probability of failure.

Location and Extent

There is not a scientific scale or measurement system in place for levee failure. Expected flood depths from a levee failure in the Delta are not known. The speed of onset is slow as the river rises, but if a levee fails the warning times are generally short for those in the inundation area. The duration of levee failure risk times can be hours to weeks, depending on the river flows that the levee holds back. The HMPC noted that when northern California reservoirs are nearing maximum capacity, they release water through the river systems, causing additional burdens on County levees. Levees in the Delta are shown on Figure S-10.

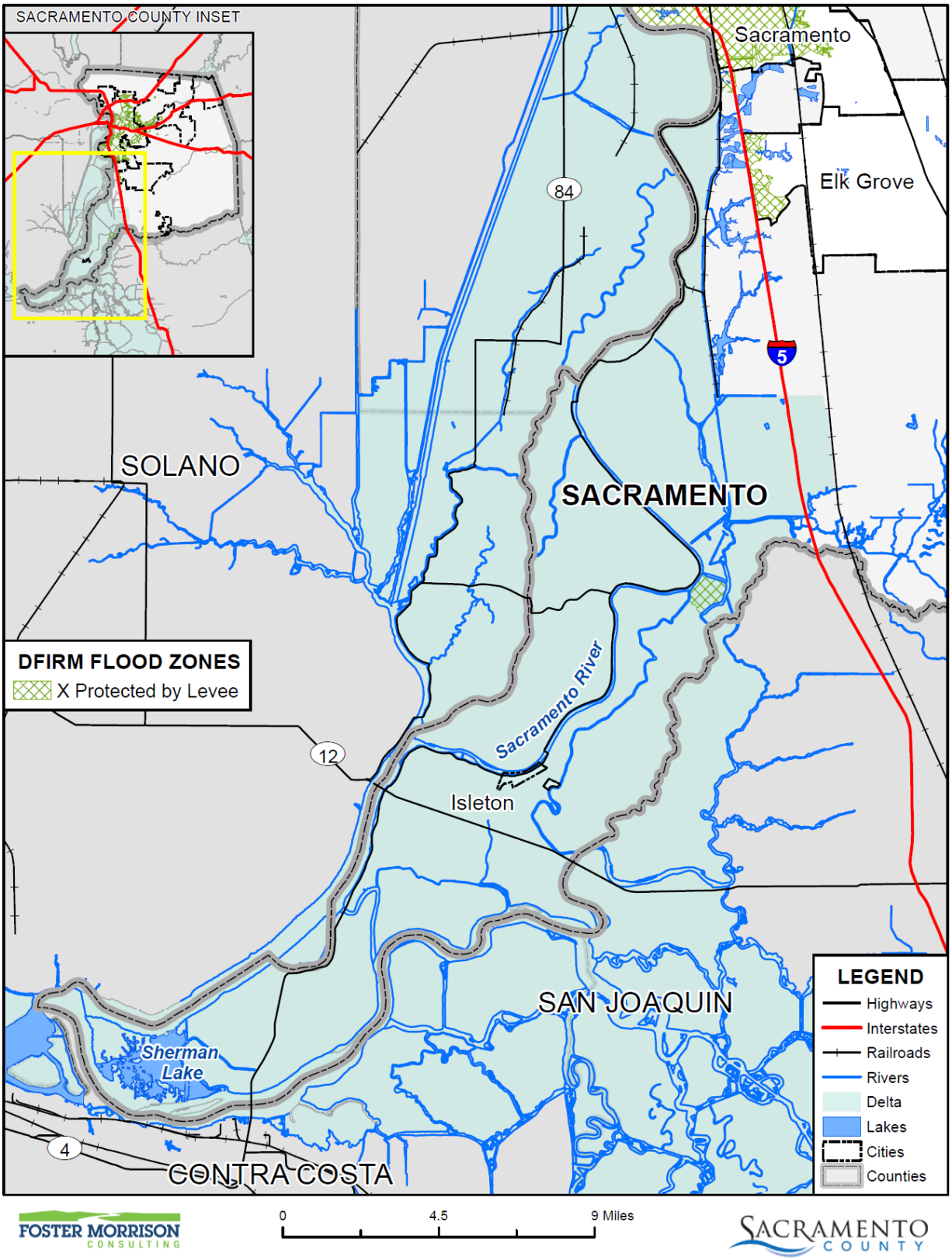
Figure S-10 Delta Levees



Source: KSN

Figure S-11 shows the FEMA DFIRM X Protected by Levee areas in the Delta. X Protected by Levee areas are those which FEMA has determined (in 2018) that the levee meets the standards for providing protection from the 1% Annual Chance Flood. Other levees exist that are not yet certified as providing protection against the 1% annual chance flood. Geographical levee failure flood extent for the Delta from the FEMA DFIRM X Protected by Levee Zone is shown in Table S-14. It should be noted that this flood extent is that which is protected, as defined by FEMA, from the 1% annual chance flood. Much of the rest of the Delta falls in the area not protected from the 1% annual chance flood.

Figure S-11 Sacramento County Delta – DFIRM X Protected by Levee Areas



Data Source: FEMA NFHL 07/19/2018, Sacramento County GIS, Cal-Atlas; Map Date: 09/2020.

Table S-14 Sacramento County Delta – Geographical Levee Failure Extents

X Protected by Levee/ Jurisdiction	Total Acres	% of Total Acres*	Improved Acres	% of Total Improved Acres*	Unimproved Acres	% of Total Unimproved Acres*
City of Isleton	0	0.00%	0	0.00%	0	0.00%
Unincorporated Delta	465	0.54%	373	0.81%	93	0.23%

Source: FEMA DFIRM 7/19/2018

*Percentage of total acres is the percent of total acres of the entire County Planning Area, not the total acres of the jurisdiction

Approximately 1,115 miles of levees in the Delta and 230 miles of levees in Suisun Marsh define the configuration of the waterways and landforms of the area. Most of these levees hold back water (i.e., prevent water from flowing onto the adjacent land) for 365 days per year, not just during floods. Over the years, many state and federal agencies and stakeholders have voiced concern over the condition of the Delta and Suisun Marsh levees and the consequences should they fail.

Past Occurrences

There have been two state and two federal disaster declaration from levee failure. This can be seen in Table S-15.

Table S-15 Sacramento County – State and Federal Levee Failure Disaster Declarations 1950-2020

Disaster Type	State Declarations		Federal Declarations	
	Count	Years	Count	Years
Levee Break	2	1972, 1980	2	1972, 1980

Source: Cal OES, FEMA

The two failures resulting in disaster declarations were:

- 1980 Delta Levee Break (Disaster EM-3078 declared on 1/23/1980)
- 1972 Andrus Island Levee Break (Disaster DR-342 declared on 6/21/1972)

Due to the numerous levee systems located throughout the Delta area, the flood and levee failure issues are intertwined; levee failures lead to extensive flooding. Thus, the following sections discuss both the levee failure events and major historic flooding within the Delta region.

The 2018 FIS noted that the Sacramento-San Joaquin Delta area has a long history of flooding. Since construction of levees started in the early 1860s, every island has been flooded at least once due to levee overtopping or failure. Prior to 1950, most of the failures were due to levee overtopping. However, since the construction of many upstream dams, that flood factor has been reduced and now the major cause of flooding is levee instability. Approximately 12 levee failures have occurred since 1980. Andrus, Brannan and Twitchell Islands, have all experienced historical floods. Large areas of the Delta were inundated during floods, and it is probable that the City of Isleton was damaged or seriously threatened.

Past flooding in the City of Isleton area has been due to levee failures caused by the separate or coincidental occurrence of very high tides and high stream outflow through the Delta region, or from unexplained levee failures apparently not related from high tides and/or high stream outflow can reasonably be expected, such failures cannot be reliably predicted. A detailed field inspection of levees protecting Andrus, Brannan and Twitchell Islands, was made to determine levee conditions insofar as it is possible to do so without subsurface exploration. The report on the inspection identifies problem areas susceptible to failure and requires exploratory borings and testing of core materials to definitively determine levee stability (USACE, 1976). Because 2-percent annual chance flooding would overtop levees, stability analysis was deemed unnecessary, and this study is concerned only with levee overtopping and disintegration of levee sections subsequent to overtoppings.

The 1950 and 1955 floods were outstanding in peak outflows through the Delta and several islands were flooded. The City of Isleton, however, was not affected. In December 1965 and January 1965, the coincidental occurrence of very high tides and heavy inflow resulted in unusually high stages on all Delta waterways. Concurrent strong onshore winds generated high waves that created very perilous conditions for many islands. Levees protecting Twitchell Island were seriously threatened by erosion and overtopping, but a massive flood fighting effort prevented overflow, destruction of levees and inundation of the City of Isleton. Several hundred acres were flooded and damages, mainly flood fighting and repair of levees and levee roads, were a little less than $1 million. In January and February 1969, high tides and adverse wave action in the Delta, combined with large river inflow and rain-soaked levees, caused the flooding of several islands and the endangerment of many other islands. Approximately 11,400 acres were inundated and flood damages amounted to about $9.2 million. The levee separating Andrus Island and the San Joaquin River failed from unknown causes in June 1972, resulting in the flooding of Andrus and Brannan Islands (including the City of Isleton). High winds had occurred prior to the break, but there had been no antecedent rainfall and the tidal cycle was not on the higher side. About 15,000 acres were inundated and flood damages for the event approximated $30 million.

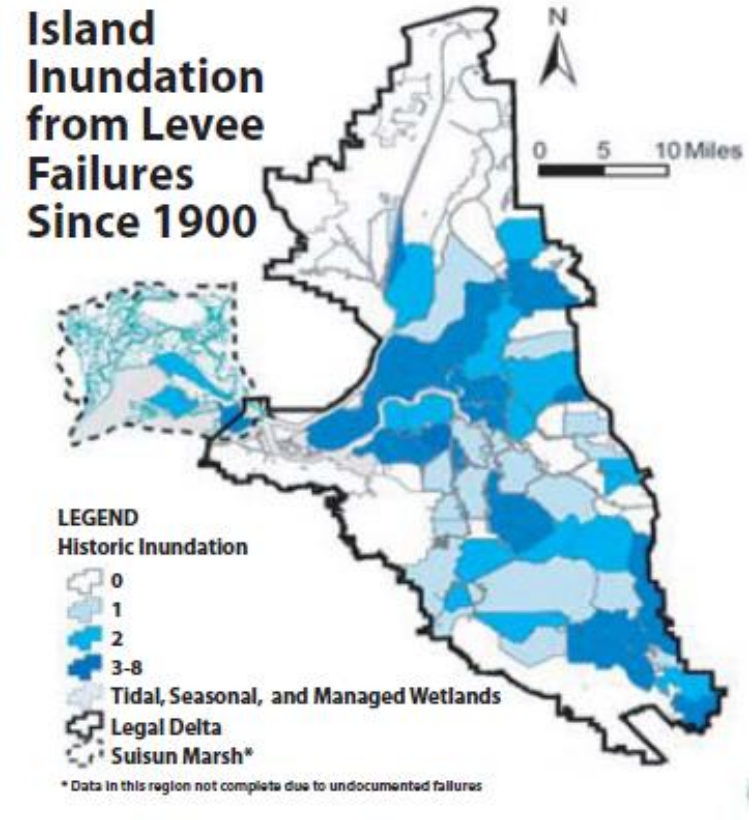
The most devastating flooding of the City of Isleton resulted from failure of a levee at the southern end of Andrus Island. The levee failed from unknown causes during the night of June 21, 1972. There had not been any antecedent rainfall and the tidal cycle was not on the higher side, but high winds had been occurring prior to the break. Approximately 200,000 acre-feet of water from the San Joaquin River inundated Andrus and Brannan Islands. Activities to fight floods to protect the City of Isleton proved to be a losing battle, and almost all of the city was flooded. The entire population was evacuated, with some residents not being able to return to their homes for 4 months. Approximately one-half of the housing units in the city were damaged or destroyed. Damage from the flood event on the islands and in the City of Isleton totaled approximately $30 million.

Due to the size of the Delta region, and the complexity of its stream and tidal regimen, flood frequency varies from location to location. In general, the 1950, 1955 and 1964 tidal stages in the central Delta, had frequencies of 10, 30 and 5 years, respectively. Stage during the 1955 and 1964 flood periods was strongly influenced by onshore winds. The 1972 flood event cannot be assigned a frequency because the levee failure that caused the flooding cannot be attributed to tidal stage or streamflow conditions.

There have been about 100 levee failures and 163 levee breaches since the early 1900. However, most of these failures occurred in the Delta Area and are not specific to portions of the Delta located inside of

Sacramento County. Due to overall improvements in the levee systems throughout the Delta, only 17 failures and 20 breaches occurred since 1990. These historic numbers are not representative of future occurrences within the County. Figure S-12 shows the levee failures since 1900.

Figure S-12 Island Inundation from Levee Failures from 1900-Present



Source: DRMS

Some islands have been flooded and recovered multiple times. A few islands, such as Franks Tract in San Joaquin County, have never been recovered. Some of the more major levee breaks in Sacramento County are further detailed below.

June 21, 1972 – A levee in the Brannan-Andrus Levee Maintenance District broke. 35% of the City of Isleton was inundated. A national disaster was declared June 27, and the breach was closed on July 26. Estimated damages in 2011 dollars were $234 million. The USACE repaired the break.

In **mid-January 1980**, severe rainstorms over central California precipitated high river outflow through the Delta, which, coinciding with gale force winds over the Delta and high tides, resulted in the levee failure and flooding of two tracts (placing approximately 9,600 acres under water). Continued high inflow to the Delta and wind-generated waves increased erosion on all Delta levees, necessitating intensive flood fighting and the temporary curtailment of boat traffic.

In late **February 1980**, three islands at the lower end of the Yolo Bypass and one additional tract were inundated.

1982/1983 – Heavy inflow and strong winds caused by a major storm over California in late November 1982, in combination with high tides, resulted in widespread levee erosion and overtopping in the Delta and the flooding of an island and a tract. A succession of intense storms continued to batter the State until March 1983, establishing rainfall records for the Delta and tributary regions. Upstream reservoir releases were larger and sooner than anticipated due to the heavy rainfall and a deep snowpack, worsening an already critical levee situation. Concurrently, extremely high tides prevailed in the Delta along with wind-driven waves. Several levee failures occurred and eight islands/tracts were under water by late March 1983. More than 16,000 acres were flooded and the estimated associated damages amounted to more than $20 million.

February 19, 1986 – Heavy rains and flooding affected Sacramento County and the surrounding area. 6 months of precipitation fell in 10 days in mid-February. High water content caused multiple levee failures. Two levee breaks in the same general area occurred on the 8,800 acre Tyler Island in Sacramento County. These two levee breaks were approximately 300 feet in length (see Figure S-13). A FEMA disaster declaration was declared on February 21. The approximate cost to repair the breaks was $6 million in 2011 dollars. Details on damages to structures and crops on the islands was not available.

Figure S-13 1986 Tyler Island Levee Breach

Source: California Department of Water Resources

December 1996 was one of the wettest Decembers on Record. Watersheds in the Sierra Nevada were already saturated by the time three subtropical storms added more than 30 inches of rain in late December 1996 and Early January 1997. The third and most severe of these storms lasted from December 31, 1996, through January 2, 1997. Rain in the Sierra Nevada caused record flows that stressed the flood management system to capacity in the Sacramento River Basin and overwhelmed the system in the San Joaquin River Basin. Levee failures due to breaks or overtopping in the Sacramento River Basin resulted in extensive damages. In the San Joaquin River Basin, dozens of levees failed throughout the river system and produced widespread flooding. The Sacramento-San Joaquin River Delta also experienced several levee breaks and levee overtopping. Affected Delta islands within Sacramento County included McCormack-Williamson Tract, Dead Horse Island and Glanville Tract.

January 11, 2017 – After atmospheric river rains struck Sacramento County and the surrounding area, flooding occurred. Independent reports from San Joaquin and Sacramento County Sheriff Deputies identified a breach in the Mokelumne River. A private levee failure within San Joaquin County continued to cause flooding to New Hope Road (in Sacramento County) through March 2017.

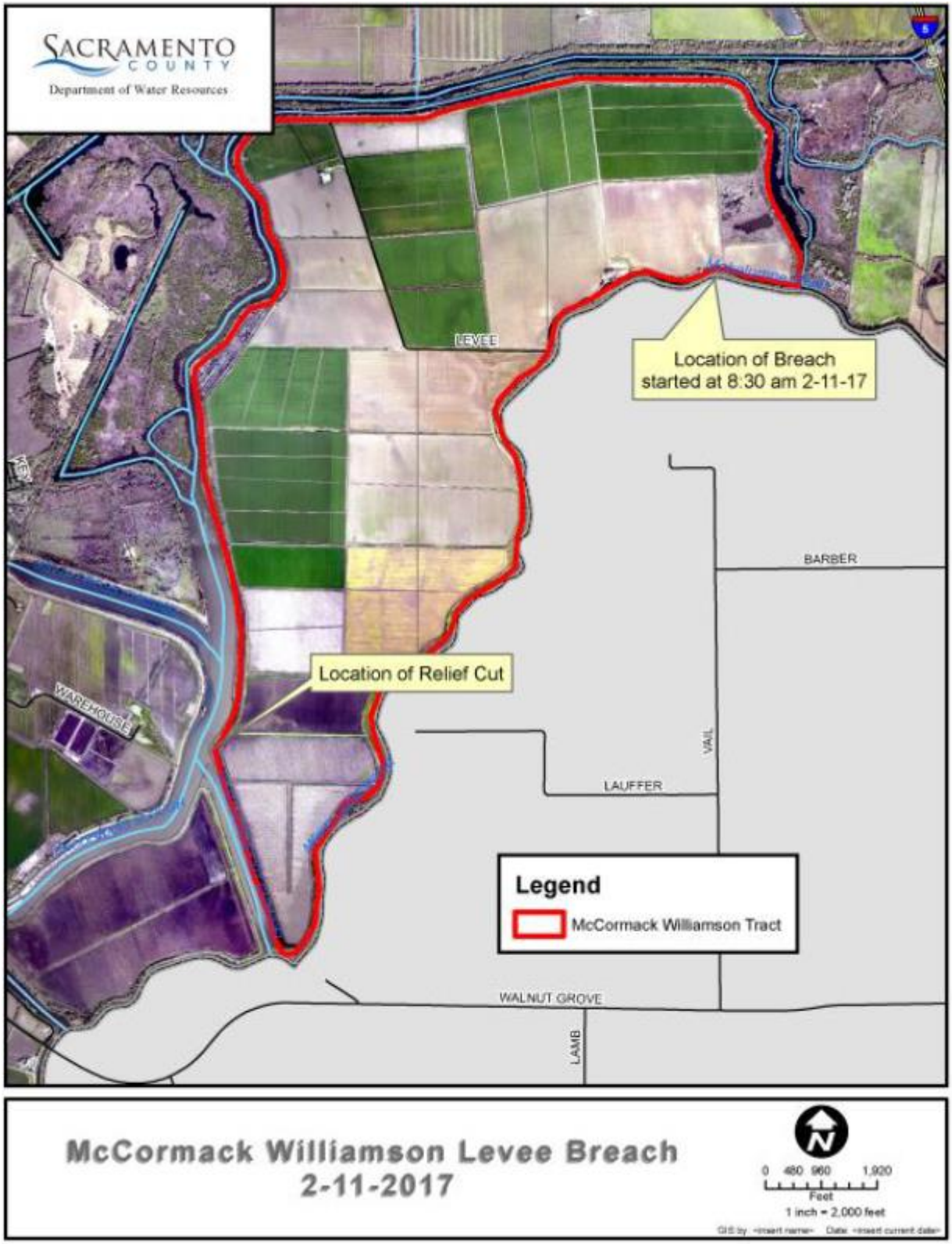
Figure S-14 New Hope Levee Break

Source: 2017 January Winter Storms After Action Report

February 11, 2017 – The McCormack Williamson Tract levee overtopped and failed starting at 8:30 am. The levee failed at River Mile 28 near the northeast section of the tract (see Figure S-15). According to the RD, at the time, it could have taken at least 9 hours for the Island to fill. The RD was planning to helicopter in equipment to construct a relief cut at the southwest end of the Island. The relief cut was intended to mitigate a surge of water into the Mokelumne River/ Snodgrass Slough that would result when the downstream levee breaks. A surge had the potential to impact several of the levees in the area that protect Tyler Island, Dead Horse Island and East Walnut Grove. The RDs had staged equipment and supplies in the event of a flood fight. Tyler Island RD monitored a small levee seepage problem along the North Fork of the Mokelumne at Sta 46000. The RD had planned to work on the repair starting that Monday when the

tides were lower and all repair equipment/ material was in place. Beyond that, Tyler Island was experiencing higher waters due to the McCormack Williamson relief cut and had continuous levee patrols.

Figure S-15 Sacramento County – McCormack Williamson Levee Breach



Source: 2017 February Winter Storm After Action Report from Sacramento County OES

February 12, 2017 – Road closures included 21 distinct areas throughout the southern portion of the county. RD800 reported significant damage to their levees and were able to conduct damage assessments. Results of those assessments were provided to the EOC along with any other resource requests. SMUD also reported that they had 6 homes without power in Point Pleasant area. Power was de-energized to those homes due to flooding. The Snodgrass Slough Levee was inspected for seepage and water continued to overtop Lambert Road flowing north toward Point Pleasant.

February 13, 2017 – Mandatory evacuations were ordered due to a compromised levee at Tyler Island Bridge Road. Land between Mokelumne and Georgiana Slough had been evacuated; 645 contacts within the Sacramento Alert system. Walnut Grove was under an advisory for the possibility of an evacuation and rock was brought in by barge crane to begin repairs on the levee. Advance plans for a relief cut were identified should the levee have failed.

February 18, 2017 – The United States Coast Guard Auxiliary provided photos of a levee with scouring in the Pearson Tract. Contacts to MBK Engineers were made regarding identifying the issue and making the necessary repair.

Vulnerability to and Impacts from Levee Failure

A levee failure can range from a small, uncontrolled release to a catastrophic failure. Levee failure flooding can occur as the result of prolonged rainfall and flooding. The primary danger associated with levee failure is the high velocity flooding of those properties outside and downstream of the breach.

Should a levee fail, some or all of the area protected by the levees would be at risk to flooding. Impacts from a levee failure include property damage, critical facility damage, and life safety issues. Business and economic losses could be large as facilities could be flooded and services interrupted. School and road closures could occur. Road closures would impede both evacuation routes and ability of first responders to quickly respond to calls for aid. Other problems connected with levee failure flooding include erosion, sedimentation, degradation of water quality, losses of environmental resources, and certain health hazards.

Generally, overtopping can be predicted based on river stages and the warning given depending on the source of the flood waters. On the Sacramento River system, depending on which dams are releasing the flows, advance warning of river stages may be as much as 24 hours.

The 2018 FIS noted that a fundamental flood problem in the Delta results from the fact that for every square mile of land reclaimed, there is one square mile less of floodplain to contain the volume of the rising tide and outflow from the rivers of the Central Valley. Furthermore, the substructure of much of the Delta is overlain by a 20- to 50-foot thick layer of peat soil, which is ideal for agriculture but very poor as foundation or building material for levees. Peat soil dried out and exposed to air constantly oxidizes and subsides. As islands subside, water pressure in adjoining channels may become too great for levees to withstand and a section may fail. Also, levees are continually being eroded by stream outflow, tidal flow, and wave wash from winds and boat wakes. Increasing levee fill creates compression that may force underlying materials to rupture into the adjoining waterway or toward the land side of the levee. If one island is flooded and its levees are lost, the levees protecting an adjacent island becomes more vulnerable to the forces of waves and wind.

Assets at Risk

Based on the vulnerability of the Delta to the levee failure hazard, the sections that follow describes significant assets at risk in the Sacramento County Delta. This section includes the values at risk, population at risk, and critical facilities at risk. It should be noted that the X Protected by Levee Zone shows only those areas protected by levees from the 1% annual chance flood. There are large areas of the Delta at risk to flooding outside of the X Protected by Levee areas.

Values at Risk

GIS was used to determine the possible impacts of levee failure flooding within the Sacramento County Delta. The methodology described in Section 4.3.14 of the Base Plan was followed in determining structures and values at risk to the levee failure flooding. Table S-16 shows the property use, improved parcel count, improved values, estimated contents, and total values that fall in FEMA X Protected by Levee flood zones in the Delta. As shown, no X Protected by Levee areas fall in the City of Isleton.

Table S-16 Sacramento County Delta – Count and Values of Parcels at Risk in X Protected by Levee Flood Zone and Property Use

Flood Zone / Property Use	Total Parcel Count	Improved Parcel Count	Total Land Value	Improved Structure Value	Estimated Contents Value	Total Value
Unincorporated Sacramento Delta						
X Protected by Levee						
Agricultural	6	6	$1,771,853	$1,846,175	$1,846,175	$5,464,203
Care / Health	3	0	$859			$859
Church / Welfare	3	2	$45,826	$19,420	$19,420	$84,666
Industrial	9	8	$730,435	$1,039,107	$1,558,659	$3,328,203
Miscellaneous	17	0	$14,598			$14,598
Office	12	10	$728,197	$1,699,371	$1,699,371	$4,126,939
Public / Utilities	2	0				
Recreational	3	2	$147,470	$718,607	$718,607	$1,584,684
Residential	127	121	$5,694,650	$12,270,251	$6,135,125	$24,100,030
Retail / Commercial	32	30	$2,108,971	$4,546,645	$4,546,645	$11,202,261
Unknown	0	0	$0	$0	$0	$0
Vacant	44	4	$1,924,412	$13,644	$0	$1,938,056
X Protected by Levee Total	**258**	**183**	**$13,167,271**	**$22,153,220**	**$16,524,002**	**$51,844,499**

Source: FEMA 11/2/2018 DFIRM, Sacramento County 2020 Parcel/Assessor's Data

*With respect to improve parcels within the floodplain, the actual structures on the parcels may not be located within the actual floodplain, may be elevated and or otherwise outside of the identified flood zone

**This parcel count only includes those parcels in the 0.2% annual chance flood zone, exclusive of the 1% annual chance flood zone. The 0.2% annual chance flood, in actuality, also includes all parcels in the 1% annual chance flood zone.

Table S-17 shows Sacramento County Delta levee failure flood loss estimates and improved values at risk by FEMA X Protected by Levee flood zones. As shown in the table above, these flood loss estimates from X Protected by Levee areas are for the unincorporated Delta only, as no X Protected by Levee areas currently exist in the City of Isleton.

Table S-17 Sacramento County Delta – X Protected by Levee Flood Loss Estimates

Flood Zone	Total Parcel Count	Improved Parcel Count	Improved Structure Value	Estimated Contents Value	Total Value	Loss Estimate	Loss Ratio
X Protected by Levee	258	183	$22,153,220	$16,524,002	$38,677,222	$7,735,444	0.92%

Source: FEMA 11/2/2018 DFIRM, Sacramento County 2020 Parcel/Assessor's Data

*With respect to improve parcels within the floodplain, the actual structures on the parcels may not be located within the actual floodplain, may be elevated and or otherwise outside of the identified flood zone

**This parcel count only includes those parcels in the 0.2% annual chance flood zone, exclusive of the 1% annual chance flood zone. The 0.2% annual chance flood, in actuality, also includes all parcels in the 1% annual chance flood zone.

According to Table S-17, the Sacramento County Delta area has 183 parcels and $38.7 million of structure and contents values or values in the X Protected by Levee flood zone. These values can be refined a step further. Applying the 20 percent damage factor as previously described in Section 4.3.11 of the Base Plan, two feet of flooding would cause $7.7 million in flood damages in the Delta.

Structures protected by levees that fail are often total losses. The analysis above assumes all levees in the Delta break at one time, which is unlikely. The extent and depth of actual flooding and associated damage will vary depending on the location, nature, depth, and extent of any levee break.

Population at Risk

The DFIRM flood zones were overlayed on the parcel layer. Those residential parcel centroids that intersect the levee failure flood zones were counted and multiplied by the 2010 Census Bureau average household factors for Isleton and the unincorporated County. According to this analysis, there is a total population of 334 residents of the Delta at risk to levee failure flooding. This is shown in Table S-13.

Table S-18 Sacramento County Delta – Count of Improved Residential Parcels and Population by Flood Zone

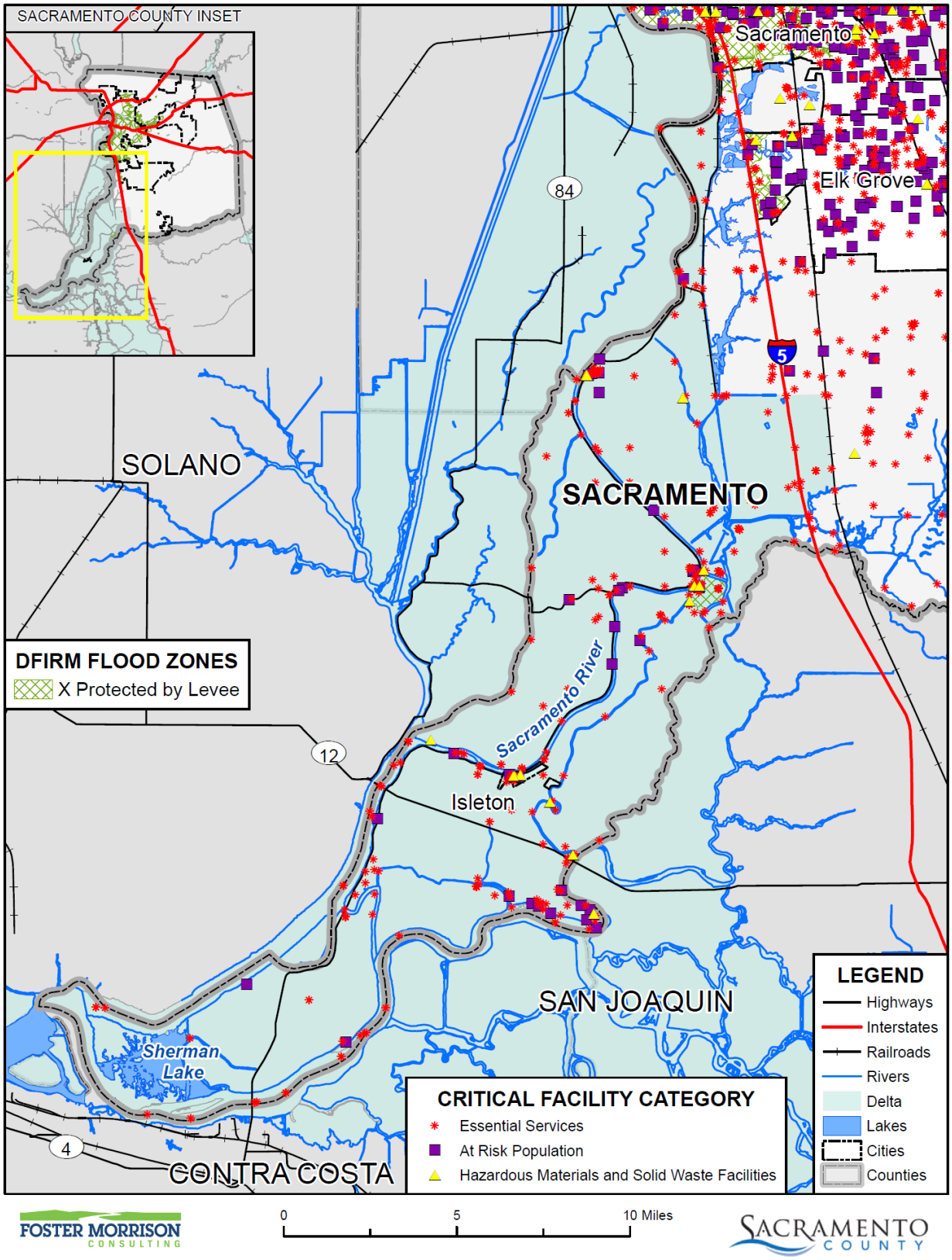
Jurisdiction	X Protected by Levee	
	Improved Residential Parcels	Population at Risk
Isleton	0	0
Unincorporated Delta	121	334
Total	**121**	**334**

Source: FEMA DFIRM 11/2/2018, Sacramento County 2020 Parcel/Assessor's Data, US Census Bureau Average Household Sizes: Isleton (2.7), and unincorporated Sacramento County (2.76)

Critical Facilities at Risk

An analysis was performed on the critical facility inventory in the Delta in DFIRM X Protected by Levee flood zones. GIS was used to determine whether the critical facility locations intersect an X Protected by Levee Zone. Details of critical facilities in mapped dam inundation areas in the Delta are shown in Figure S-16. Details of critical facility definition, type, name and address and jurisdiction by dam inundation area are listed in Appendix F.

Figure S-16 Sacramento Delta – Critical Facilities in DFIRM X Protected by Levee Zones



Data Source: FEMA NFHL 07/19/2018, Sacramento County GIS, Cal-Atlas; Map Date: 08/2021.

Future Development

The Delta serves as a saltwater barrier to maintain the State's drinking water supply, provides for rich agricultural production, natural gas fields, recreational facilities, legacy Delta Communities, all provide an economic base from which the public benefits in the form of jobs, tax revenues, and other economic benefits.

According to the Delta Protection Commission's "Economic Sustainability Plan for the Sacramento-San Joaquin Delta," nearly eighty percent of the Delta is classified as Prime Farmland, the California Farmland Mapping and Monitoring Program's highest designated tier, meaning that it meets the most stringent requirements for good farmland, including various water measurements, soil temperature, soil acid-alkali balance, erodibility, and more. The remainder of farmland in the Delta is classified as Farmland of Statewide Importance, Unique Farmland, or Farmland of Local Importance, and is divided nearly evenly between those classifications. These are the top four tiers available for agricultural land classification, out of nine possible land classifications. This indicates that every reclamation district in the Delta with any agricultural production protects a portion of the most valuable farmland in the State of California, regardless of the crops planted at any given time. While the cost of land might be less than that of urban lands, the continued usability of the land for agricultural production is critical to agricultural output of the State, regardless of the amount of land protected by any given Delta island.

New development should take levee failure areas into account during the construction of new homes and commercial properties. The County will continue to enforce the zoning, subdivision, and development ordinances in the unincorporated Delta Area. The City of Isleton will also enforce the development ordinances that exist in the City.

Severe Weather: Heavy Rains and Storms

Likelihood of Future Occurrence–Likely
Vulnerability–Medium

Hazard Profile and Problem Description

Storms in the Delta occur annually and are generally characterized by heavy rain often accompanied by strong winds and sometimes lightning and hail. Approximately 10 percent of the thunderstorms that occur each year in the United States are classified as severe. A thunderstorm is classified as severe when it contains one or more of the following phenomena: hail that is three-quarters of an inch or greater, winds in excess of 50 knots (57.5 mph), or a tornado. Heavy precipitation in the Delta falls mainly in the fall, winter, and spring months. Wind often accompanies these storms; hail and lightning are rare in the Delta.

Location and Extent

Heavy rain events occur on a regional basis. Rains and storms can occur in any location of the Delta. All portions of the Delta are at risk to heavy rains. Most of the severe rains occur during the fall, winter, and spring months. There is no scale by which heavy rains and severe storms are measured. Magnitude of storms is measured often in rainfall and damages. The speed of onset of heavy rains can be short, but accurate weather prediction mechanisms often let the public know of upcoming events. Hail and lightning

are rare in the Delta and Sacramento County. Duration of severe storms in California, Sacramento County, and the Delta can range from minutes to hours to days. Information on precipitation extremes can be found in Section 4.3.4 of the Base Plan.

Past Occurrences

According to historical hazard data, severe weather, including heavy rains and storms, is an annual occurrence in the Delta. This is the cause of many of the federal disaster declarations related to flooding. Past occurrences for the County were discussed in Section 4.3.4 of the Base Plan and in the Levee Failure section above. Events that had larger effects on individual Delta Reclamation Districts can be found in their respective Chapters of this Delta Annex.

Vulnerability to and Impacts from Heavy Rain and Storms

Heavy rain and severe storms are the most frequent type of severe weather occurrences in the Delta. These events can cause significant and localized flooding. Elongated events, or events that occur during times where the ground is already saturated can cause 1% and 0.2% annual chance flooding. Wind often accompanies these storms and has caused damage in the past. Hail and lightning are rare in the Delta, but also can cause damage, with lightning occasionally igniting wildfires.

Actual damage associated with the effects of severe weather include impacts to property, critical facilities (such as utilities), and life safety. Power outages may also occur. Heavy rains and storms often result in flooding creating significant issues. Roads can become impassable and ground saturation can result in instability, collapse, or other damage to trees, structures, roadways and other critical infrastructure. Floodwaters and downed trees can break utilities and interrupt services.

Future Development

Building codes in the Delta ensure that new development is built to current building standards, which should reduce the risk to future development in the Delta from heavy rains and storms. New critical facilities such as communications towers and others should be built to withstand hail damage, lightning, and thunderstorm winds. With adherence to development standards, future losses to new development should be minimal.

Severe Weather: High Winds and Tornadoes

Likelihood of Future Occurrence–Occasional
Vulnerability–Medium

Hazard Profile and Problem Description

High winds, as defined by the NWS glossary, are sustained wind speeds of 40 mph or greater lasting for 1 hour or longer, or winds of 58 mph or greater for any duration. High winds can cause significant property and crop damage, threaten public safety, and have adverse economic impacts from business closures and power loss.

Tornadoes are rotating columns of air marked by a funnel-shaped downward extension of a cumulonimbus cloud whirling at destructive speeds of up to 300 mph, usually accompanying a thunderstorm. Tornadoes form when cool, dry air sits on top of warm, moist air. Tornadoes are the most powerful storms that exist. Tornadoes, though rare, are another severe weather hazard that can affect areas of the Sacramento County Planning Area, primarily during the rainy season in the late fall, winter, and early spring.

Location and Extent

The entire Delta is subject to significant, non-tornadic (straight-line), winds. Each area of the County is at risk to high winds. Magnitude of winds is measured often in speed and damages. These events are often part of a heavy rain and storm event, but can occur outside of storms. The speed of onset of winds can be short, but accurate weather prediction mechanisms often let the public know of upcoming events. Duration of winds in California is often short, ranging from minutes to hours. The Beaufort scale is an empirical 12 category scale that relates wind speed to observed conditions at sea or on land. Its full name is the Beaufort Wind Force Scale. The Beaufort Scale was shown in Section 4.3.5 of the Base Plan.

The Delta Breeze is the local name for a wind coming from the southwest, off of the Delta of the Sacramento River and San Joaquin River. This wind carries with it cooler, more humid air from off of the Pacific Ocean. The effects of this wind are very noticeable during the summer, as this sea breeze can cool the air by more than 10°F. According to the National Weather Service, the wind is primarily driven by a sea breeze circulation, which can often become coupled with a mountain breeze to form one large (mesoscale) circulation of air from the Farallon Islands up into the Sierra Nevada.

Tornadoes, while rare, can occur at any location in the County and Delta. Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale (EF) provides more damage indicators (28) and associated degrees of damage, allowing for more detailed analysis and better correlation between damage and wind speed. It is also more precise because it considers the materials affected and the construction of structures damaged by a tornado. The F Scale and EF Scale are shown in Section 4.3.5 of the Base Plan.

Past Occurrences

Winds events, especially those accompanying severe thunderstorms, are generally larger events. As such, events that affected the County have affected the Delta. Past occurrences for the County are detailed in Section 4.3.5 of the Base Plan. Often the more significant issue related to high winds within the Delta are related to increase wave action on the levees. Events that had larger effects on individual Delta Reclamation Districts and the City of Isleton can be found in their respective Chapters of this Delta Annex.

Vulnerability to and Impacts from Severe Weather: Wind and Tornado

High winds are common occurrences in the Delta throughout the entire year. Straight line winds are primarily a public safety and economic concern. Windstorm can cause damage to structures and power lines which in turn can create hazardous conditions for people. Debris flying from high wind events can shatter windows in structures and vehicles and can harm people that are not adequately sheltered. High

winds can impact critical facilities and infrastructure and can lead to power outages. Wind can also drive wildfire flames, spreading wildfires quickly. During periods of high winds and dry vegetation, wildfire risk increases. High winds that occur during periods of extreme heat can cause PSPS events to be declared in the County; although these are unlikely to occur in the Delta area where the wildfire risk is low. More information on power shortage and failure can be found in the Severe Weather: Extreme Heat Section above, as well as in Section 4.3.3 of the Base Plan.

Impacts from high winds in the Delta will vary. Future losses from straight line winds include:

- Downed trees
- Increased power outage events
- Power line impacts and economic losses from power outages
- Occasional building damage, primarily to roofs

In the Delta, levees are vulnerable to wave action from both thunderstorm winds and from the Delta Breeze that causes excess erosion, and can threaten the levee integrity in each Reclamation District. Wind action, especially when coupled with high water events, leads to scour and high bank erosion, which creates wave induced erosion at the levee toe.

Future Development

New critical facilities should be built to withstand thunderstorm winds. While minimal damages have occurred to critical facilities in the past due to high winds and tornadoes, there still remains future risk. With development occurring in the region, future losses to new development may occur. Reclamation Districts will need to continue to armor levees against wind induced wave action that causes excess erosion. New critical facilities should also consider adding generators for times of power outages.

Subsidence

Likelihood of Future Occurrence–Likely
Vulnerability–High

Hazard Profile and Problem Description

Subsidence is the gradual settling or sinking of the earth's surface over manmade or natural underground voids with little or no horizontal motion. Subsidence occurs naturally and also through man-driven or technologically exacerbated circumstances. Subsidence is worsened when groundwater drawdown exceeds the ability of the ground to naturally recharge. This is more common during periods of drought.

Location and Extent

There is no scientific scale to measure subsidence. Subsidence is measured in inches or feet of elevation change over time. Subsidence has a long speed of onset, as it occurs over many years. The duration of subsidence is long, as it is rare for subsidence to be reversed. In Sacramento County, the Delta in the southeast portion of the County is highly at risk to subsidence. In the Delta, subsidence affects the islands as well as the levees.

Past Occurrences

Subsidence has occurred over the years throughout the Delta area. Past occurrences for subsidence in Isleton or the reclamation districts are detailed in their respective Chapters to this Annex.

Vulnerability to and Impacts from Subsidence

Historically, the County has been at risk from subsidence. Vulnerability in the County from subsidence comes from several different causes:

- Compaction of Unconsolidated Soils by Earthquake Shaking (Liquefaction)
- Compaction by Heavy Structures
- The Erosion of Peat Soils
- Fluid Withdrawal

These were discussed in detail in Section 4.3.16 of the Base Plan.

As noted, subsidence has historically been a significant issue in the Delta; although more recently the rate of subsidence has been decreasing. Sacramento costs of levee construction and maintenance are generally borne by the State of California and the Federal government, as well as by local reclamation districts. These costs also increase as subsidence progresses, forcing levees to be built higher and stronger. In 1981 to 1986 the total amount spent on emergency levee repairs related to flooding was about $97 million, and in 1981 to 1991 the amount spent on routine levee maintenance was about $63 million. Thus the annual cost of repair and maintenance of Delta levees in the 1980s, from subsidence and other factors, averaged about $20 million per year. Note that these costs reflect the larger Delta Area. Repair and maintenance costs for the Delta Area located in Sacramento County would be proportionately less.

Much larger costs might be incurred if land subsidence indirectly affects the north-to-south water-transfer system, which is predicated on acceptable water quality in the southern Delta. The western Delta islands, in particular, are believed to effectively inhibit the inland migration of the salinity interface between Bay and Delta. If these are flooded, the water available to the massive pumping facilities near the Clifton Court Forebay might become too saline to use.

The statewide water-transfer system in California is so interdependent that decreased water quality in the Delta might lead to accelerated subsidence in areas discussed elsewhere in this document. Both the Santa Clara and San Joaquin Valleys rely, in part, on imported water from the Delta to augment local supplies and thereby reduce local ground-water pumpage and arrest or slow subsidence. Degradation of the Delta source water could well lead to increased ground-water use, and renewed subsidence, in these and other areas in California.

The management issues raised by land subsidence range in scale from those faced by individual farmers to the possible global-scale issue posed by the carbon-dioxide flux, with its possible link to climate change. At the most local level, individual farmers or reclamation districts must maintain drainage networks on the islands and pump the agricultural drainage back into waterways. These costs increase gradually as subsidence progresses.

Members of the HMPC did note that although tremendous subsidence of islands has occurred since their original reclamation, recent LiDAR survey data indicates that very few areas of the Delta are actively subsiding. In addition, surveys and geotechnical evaluations show that subsidence rarely occurs close enough to a levee to cause instability. In the few areas that this may be a problem, the "toe berm" design, used to meet the Federal PL 84-99 and State Bulletin 192-82, caps the peat and effectively stops subsidence.

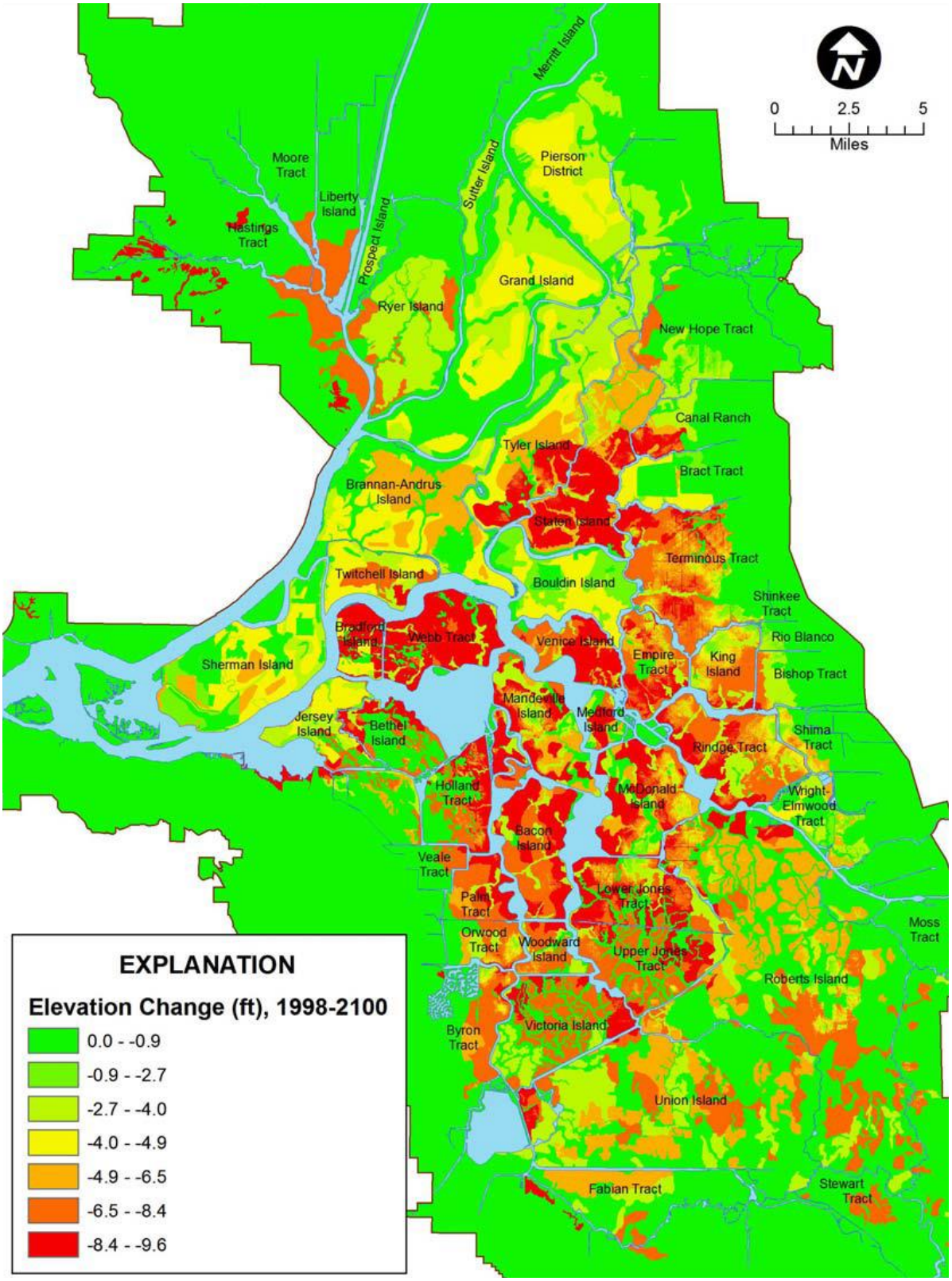
Local farmers have changed farming practices to help limit and mitigate the issues related to subsidence. This is especially true in the Delta Area.

Subsidence of Delta lands has been reported to be a major risk to Delta levees, however, subsidence is limited or non-existent under and adjacent to the levees as those areas have consolidated over the last fifty years and oxidation of the peat foundations is limited because it is not farmed.

Future Development

As subsidence progresses (see Figure S-17), the levee system will likely become increasingly vulnerable to catastrophic failure during floods and earthquakes. Areas for future development will become more limited. The interrelated issues of Delta land subsidence, water quality, and wildlife habitat will continue to pose a major dilemma for California water managers.

Figure S-17 Additional Expected Subsidence from 1998 to 2100



Source: Delta Risk Management Strategy, 2009

S.6 Delta Annex Chapters

S.6.1. Introduction

This Delta Annex contains separate Chapters that presents data specifically related to each Delta Area entity – the Delta of Isleton or each reclamation district that is a participating jurisdiction to this LHMP Update. Each Delta Annex Chapter is structured with the same format. The intent of the Chapters is to demonstrate how the risk varies across the Delta and specific to each participating jurisdiction, beyond that provided above in this umbrella Delta Annex. The following is an explanation of the format and what each data set represents.

Planning Team

This section begins with a list of each City/District Planning Team members that participated in the planning process. A table of names, positions, and how each person participated are included in each Chapter.

Community Profile

A general description, overview, background, and history for each Delta Area jurisdiction. Maps of each jurisdiction's location in the Delta are included, if available.

Hazard Identification and Summary

Each participating jurisdiction identified the hazards that affect their jurisdiction and summarized their geographic extent. frequency of occurrence, special extent, and significance specific to Isleton or the Reclamation District. This information is presented in a table in each Chapter.

Hazard Profile and Vulnerability Assessment

The intent of this section is to assess each entity's risk and vulnerability separate from that of the Planning Area as a whole, which has already been assessed in Section 4.3 of the Base Plan and also within this Delta Annex. This vulnerability assessment analyzes the population, property, and other assets at risk to hazards ranked of medium or high significance that may vary from other parts of the planning area. Each hazard contains the following items, to the extent data is available:

- Past Occurrences
- Assets at Risk
- Populations at Risk
- Critical Facilities at Risk

Capability Assessment

The purpose of this section of the planning process is to determine what policies, programs, regulations, and other mechanisms Isleton or the reclamation districts, already have in place that either contribute to, or hinder the ability to mitigate the effects of natural hazards.

Mitigation Strategy and Actions

The final section of each Chapter acknowledges concurrence with the overall 2021 LHMP Goals and Objectives and puts forth the recommended actions of all participating Delta jurisdictions: Isleton and Reclamation Districts.