Delta Annex Chapter 2 Brannan Andrus Levee Maintenance District; Reclamation Districts 317, 407, 2067

2.1 Introduction

This chapter of the Delta Annex details the hazard mitigation planning elements specific to the Brannan-Andrus Levee Maintenance District (BALMD) and Reclamation Districts (RD) 317, 407, and 2067, all new participating jurisdictions to the Sacramento County Local Hazard Mitigation Plan (LHMP) Update. This chapter of the Delta 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 the BALMD. This chapter of the Delta Annex provides additional information specific to BALMD and RDs 317, 407, and 2067, with a focus on providing additional details on the planning process, risk assessment, and mitigation strategy for these Districts.

2.2 Planning Process

As described above, the Districts followed the planning process detailed in Section 4 of the Base Plan. In addition to providing representation on the Sacramento County Hazard Mitigation Planning Committee (HMPC), BALMD and RDs 317, 407, and 2067 formulated their own internal planning team to support the broader planning process requirements. Internal planning participants, their positions, and how they participated in the planning process are shown in Table 2-1. Additional details on plan participation and representatives from each District are included in Appendix A.

Table 2-1 BALMD and RDs 317, 407, and 2067 Planning Team

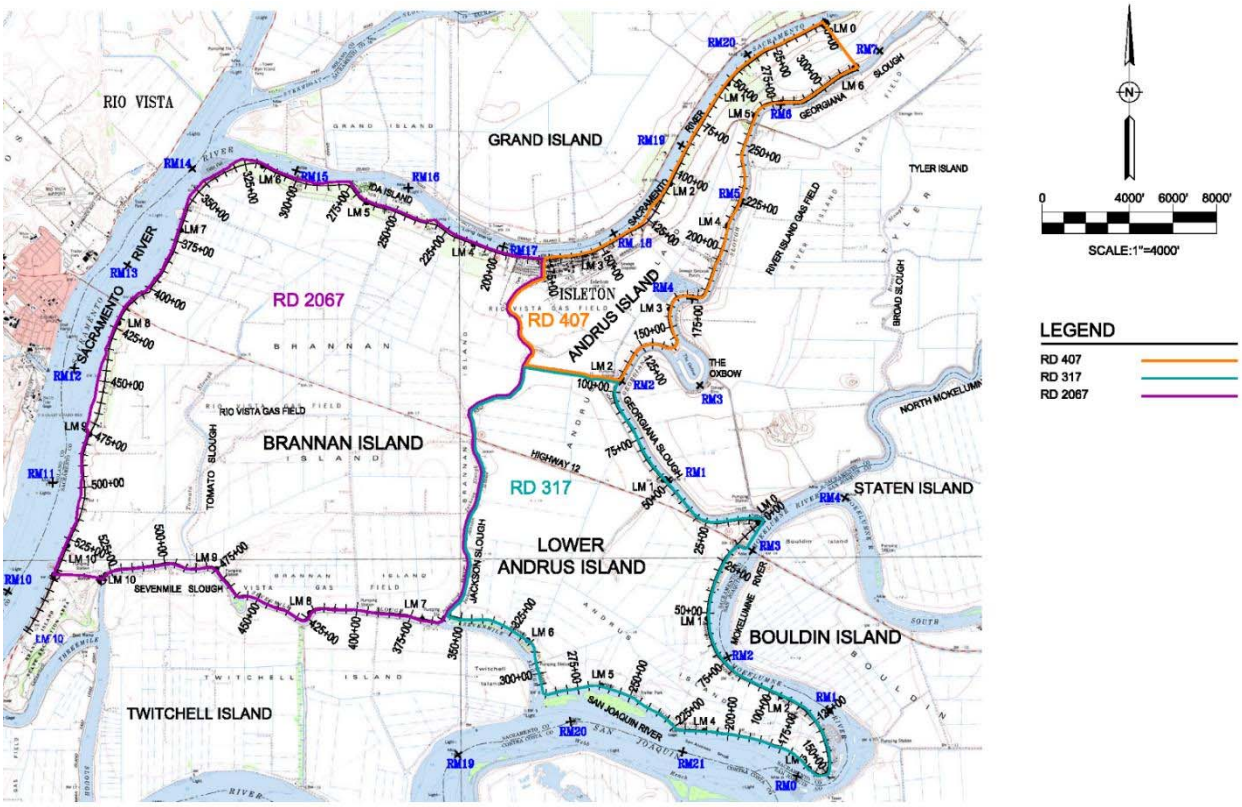
Name	Position/Title	How Participated
Emily Pappalardo	Project Manager	Attended meetings, collected data, drafted text, reviewed draft docs
Gilbert Labrie	District Engineer	Collected data, reviewed draft docs

Source: BALMD

2.3 Community Profile

The community profile for BALMD and RDs 317, 407, and 2067 is detailed in the following sections. Figure 2-1 displays a map and the location of BALMD boundaries within Sacramento County.

Figure 2-1 BALMD and RDs 307, 407, and 2067 Map



Source: BALMD

2.3.1. BALMD and RDs 317, 407, and 2067 Overview, Background, and History

Brannan-Andrus Island is surrounded by 26.2 miles of levee, excluding the Brannan Island State Park, that protects about 13,000 acres of land, which is primarily in agricultural/rural use. It is bordered by the Sacramento River, Georgiana Slough, Mokelumne River, San Joaquin River, and Sevenmile Slough. The levees along the Sacramento River and Georgiana Slough are designated as project levees (16.2 miles). The remaining levees along the Mokelumne River, San Joaquin River and Sevenmile Slough are considered non-project levees (10.0 miles). Out of the 10 miles of non-project levee, 3.3 miles border the non-tidal, controlled section of Sevenmile Slough.

The BALMD monitors and maintains the levees on the island. Reclamation Districts 317, 407, and 2067 and maintain and control the operations of the seven pumping stations to keep the island dry. Five pumping stations are located along Sevenmile Slough, another is on Georgiana Slough, and a lift station is located on the main drainage canal in the northern part of the island.

The BALMD levee system protects an island population of approximately 1,837. This figure includes a major recreation contingent and the City of Isleton, with close to 900 residents. Approximately 379 acres are urbanized, with about 187 acres incorporated by the City of Isleton.

2.4 Hazard Identification

BALMD and RDs 317, 407, and 2067's planning team identified the hazards that affect the Districts and summarized their geographic extent, probability of future occurrences, potential magnitude/severity, and significance specific to BALMD and RDs 317, 407, and 2067 (see Table 2-2).

Table 2-2 BALMD, RDs 317, 407, and 2067—Hazard Identification

Hazard	Geographic Extent	Probability of Future Occurrences	Magnitude/ Severity	Significance
Agricultural Hazards	Significant	Occasional	Critical	Low
Bird Strike	Limited	Unlikely	Negligible	Low
Climate Change	Limited	Occasional	Negligible	Low
Dam Failure	Extensive	Unlikely	Catastrophic	Medium
Drought and Water Shortage	Significant	Likely	Critical	Medium
Earthquake	Limited	Occasional	Limited	Low
Earthquake: Liquefaction	Significant	Occasional	Limited	Medium
Flood: 100/200/500-year	Extensive	Occasional	Catastrophic	High
Flood: Localized Stormwater Flooding	Limited	Highly Likely	Limited	High
Landslides	Limited	Unlikely	Limited	Low
Levee Failure	Limited	Occasional	Critical	High
River/Stream/Creek Bank Erosion	Limited	Highly Likely	Negligible	Medium
Severe Weather: Extreme Temperatures – Cold/Freeze	Extensive	Likely	Limited	Low
Severe Weather: Extreme Temperatures – Heat	Extensive	Highly Likely	Limited	Low
Severe Weather: Fog	Extensive	Highly Likely	Limited	Medium
Severe Weather: Heavy Rains and Storms (Thunderstorms, Hail, and Lightning)	Extensive	Highly Likely	Critical	Medium
Severe Weather: Wind and Tornadoes	Extensive	Highly Likely	Limited	Medium
Subsidence	Significant	Likely	Negligible	Low
Volcano	Limited	Unlikely	Negligible	Low
Wildfire:(Burn Area/Smoke)	Limited	Likely	Limited	Medium

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

Probability 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 5540 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

2.5 Hazard Profile and Vulnerability Assessment

The intent of this section is to profile BALMD and RDs 317, 407, and 2067's hazards and assess the Districts' vulnerability separate from that of the Planning Area as a whole, which has already been assessed in Sections 4.2 and 4.554 Vulnerability Assessment in the main plan. The hazard profiles in the main plan discuss overall impacts to the Planning Area and describes the hazard problem description, hazard extent, magnitude/severity, previous occurrences of hazard events and the likelihood of future occurrences. Hazard profile information specific to BALMD 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 District. For more information about how hazards affect the County as a whole, see Chapter 4 Risk Assessment in the main plan.

2.5.1. Hazard Profiles

Each hazard vulnerability assessment in Section 2.5.3, includes a description as to how the hazard affects the BALMD and RDs 317, 407, and 2067 and information on past occurrences. The intent of this section is to provide jurisdictional specific information on hazards and further describe how the hazards and risks differ across the Planning Area.

2.5.2. Vulnerability Assessment

This section identifies BALMD, RD 317, RD 407, and RD 2067's assets at risk, including values at risk, critical facilities and infrastructure, economic assets, natural resources, historic and cultural resources, and growth and development trends.

Assets at Risk and Critical Facilities

This section considers the Districts' assets at risk, with a focus on key District assets such as critical facilities, infrastructure, and other District assets and their values. With respect to District assets, the majority of these assets are considered critical facilities as defined for this plan:

> *Any facility (a structure, infrastructure, equipment or service), that is adversely affected during a hazardous event may result in interruption of services and operations for the District 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, and (3) Hazardous Materials Facilities.*

Table 2-3 lists critical facilities and other District assets identified by the BALMD and RDs 317, 407, and 2067's planning team as important to protect in the event of a disaster. BALMD, RD 317, RD 407, and RD 2067's physical assets, valued at over $244 million, consist of the buildings and infrastructure to support the BALMD, RD 317, RD 407, and RD 2067 operations.

Table 2-3 BALMD's Critical Facilities, Infrastructure, and Other District Assets

Name of Asset	Facility Type	Address	Replacement Value	Hazard Info
District Levees	Infrastructure	n/a	$235,000,000	
Cross Levee	Infrastructure	n/a	$5,000,000	

Source: BALMD

Table 2-4 RD 317's Critical Facilities, Infrastructure, and Other District Assets

Name of Asset	Facility Type	Address (coordinates)	Replacement Value	Hazard Info
150 HP Pump	Infrastructure	38.111931, -121.613444	$500,000	
50 HP Pump	Infrastructure	38.111931, -121.613444	$250,000	
75 HP Pump	Infrastructure	38.111931, -121.613444	$250,000	

Source: RD 317

Table 2-5 RD 407's Critical Facilities, Infrastructure, and Other District Assets

Name of Asset	Facility Type	Address (coordinates)	Replacement Value	Hazard Info
60 HP Pump Station	Infrastructure	38.14775, -121.600867	$250,000	
60 HP Pump Station	Infrastructure	38.14775, -121.600883	$250,000	

Source: RD 407

Table 2-6 RD 2067's Critical Facilities, Infrastructure, and Other District Assets

Name of Asset	Facility Type	Address (coordinates)	Replacement Value	Hazard Info
100 HP Pump	Infrastructure	38.123272, -121.663794	$500,000	
60 HP Pump	Infrastructure	38.123272, -121.663794	$250,000	
60 HP Pump	Infrastructure	38.123272, -121.663794	$250,000	
60 HP Pump	Infrastructure	38.119219, -121.646192	$250,000	
60 HP Pump	Infrastructure	38.119219, -121.646192	$250,000	
100 HP Pump	Infrastructure	38.11825, -121.629306	$500,000	

Name of Asset	Facility Type	Address (coordinates)	Replacement Value	Hazard Info
75 HP Pump	Infrastructure	38.122444, -121.682978	$250,000	
75 HP Pump	Infrastructure	38.122444, -121.682978	$250,000	

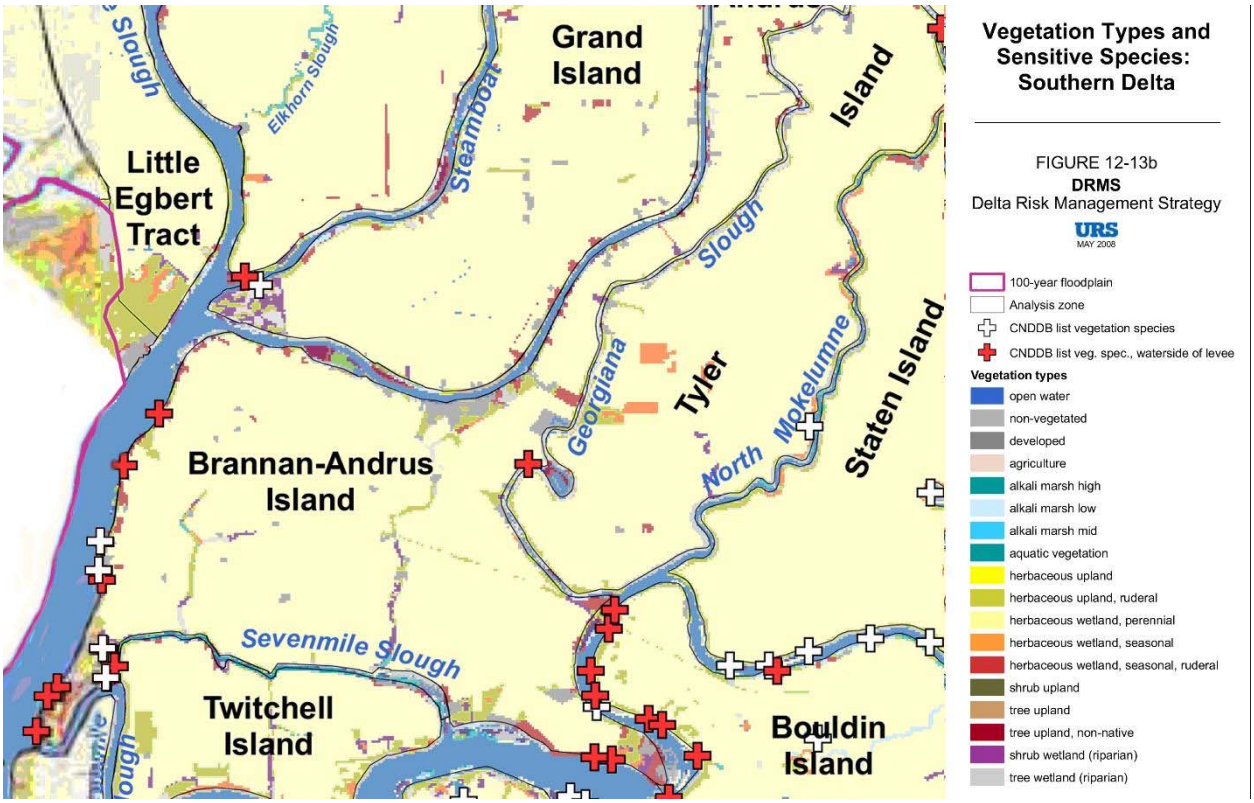
Source: RD 2067

Natural Resources

The 5-Year Plan noted that in terms of natural resources, Brannan-Andrus Island has freshwater wetland, upland, and riparian habitats. Within the freshwater wetland category, there are 12.36 acres of herbaceous perennial wetland and 26.63 acres of herbaceous seasonal/ruderal wetland. Upland habitat consists of 724.74 acres of herbaceous ruderal, 10.13 acres of shrub, 47.61 acres of tree, and 292.56 of non-native tree upland. There is also approximately 142.31 acres of riparian habitat, with 96.88 acres of shrub wetland, and 45.43 acres of tree wetland.

Two small sloughs, Tomato Slough and Jackson Slough, in the interior of the island provide some riparian habitat. Refer to Figure 2-2 for specific habitat areas. According to the California Natural Diversity Database the sensitive species found on Brannan-Andrus Island are: Northern California Black Walnut, Swainson Hawk, Northwestern Pond Turtle, Delta Tule Pea, Suisun Marsh Aster, Mason Lilaeopsis, and Delta Mudwort.

Figure 2-2 BALMD and RDs 317, 407, and 2067 Vegetation Types and Sensitive Species



Source: BALMD 2012 5-Year Plan

Historic and Cultural Resources

The 5-Year Plan noted that BALMD, RD 317, RD 407, and RD 2067 protect the City of Isleton. The City has two nationally registered historic districts, the Isleton Chinese and the Japanese Commercial Districts.

Growth and Development Trends

The BALMD 2012 5-Year Plan noted that the standard island elevation is about -14' with a minimum elevation of -22' and a maximum of +9' per the 2007-2008 DWR Lidar Survey. With the adoption of the Delta Protection Act in 1992, about 40% of Brannan-Andrus Island was designated as a Secondary Zone of the legal Delta, extending from the northern edge of Highway 12 to Tyler Island Bridge Road, east of Isleton. The remainder of the island is in the Primary Zone, which was established to protect the area for agriculture, wildlife habitat, and recreation uses within the Delta. The BALMD levee system protects an island population of approximately 1,837. This figure includes a major recreation contingent and the City of Isleton, with close to 900 residents. Approximately 379 acres are urbanized, with about 187 acres incorporated by the City of Isleton.

Beyond the city limits of Isleton, Sacramento County zoning designates approximately 1,200 acres to recreational use along the southeast corner of Andrus Island. Scattered around Brannan-Andrus Island are a large contingent of the Delta resorts, including RV parks, boat launches, and marinas for local and public use. A majority of these recreational uses are located along the Delta Loop, a 7.2-mile drive with 40

recreational attractions bordering the Mokelumne and San Joaquin Rivers, and Sevenmile Slough. Overall, there are 5 large marinas (over 200 berths), 5 medium marinas (50 to 200 berths), and 8 small marinas (less than 50 berths) that account for a total of 2400 berths and 6 boat launching facilities. Twelve of the resorts also have RV/camping grounds totaling about 800 sites overall. Five of the resorts have cabins (approx. 300 total). About 40 acres total of dry storage is provided at eleven resorts. Four resorts are on their own island that bridges to Brannan-Andrus and may not be inundated by a flood but access could be compromised. Including marinas and resorts, there are approximately 148 businesses on the island.

There was a development of approximately 650 homes that failed in the housing crash of 2008. It is still developable land but many projects to revive the development have also failed. Development of that size is possible in the future given Isleton is in the Secondary Zone of the Delta which allows for some development. One hindrance is the levees are not certified by FEMA to protect against the 100-year flood. Thus homes will have to be elevated to protect from flooding. The failed development had accounted for that and designed the homes to be elevated with garages on the first story.

2.5.3. Vulnerability to Specific Hazards

This section provides the vulnerability assessment, including any quantifiable loss estimates, for those hazards identified above in Table 2-2 as high or medium significance hazards. Impacts of past events and vulnerability of the BALMD, RD 317, RD 407, and RD 2067 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 calculating loss estimates are similar to those described in Section 4.3.1 of the Base Plan and are based on data provided by the District as described further below. In general, the most vulnerable District assets include the levees and pumping stations that the District owns. There are approximately 10.3 levee miles along the Sacramento River, 5.9 levee miles along Georgiana Slough, 3 levee miles along the Mokelumne River, 2.6 levee miles along the San Joaquin River and 4.6 levee miles along Sevenmile Slough. The levee system is subject to riverine flooding. The most vulnerable levees are those along Georgiana Slough, the San Joaquin River and the tidal areas along Sevenmile Slough due to low landside elevations and waterside bank erosion. However, it is unlikely the levee system will fail due to overtopping. A high water situation could increase the hydraulic gradient within the levee that could result in under or through seepage. Seepage, if left unchecked, can result in levee failure and subsequent flooding. Reclamation Districts 407, 2067 and 317 own numerous pumping stations that are critical for island drainage. If the drainage system becomes compromised the District could experience localized flooding. If the system becomes compromised in a flood situation, damages could be worse than anticipated.

An estimate of the vulnerability of BALMD and RDs 317, 407, and 2067 to each identified priority hazard, in addition to the estimate of probability 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.

Dam Failure

Likelihood of Future Occurrence–Unlikely
Vulnerability–Medium

Hazard Profile and Problem Description

While unlikely, it is possible that dam failure can create a high water situation in the adjacent channels that could put the levee system at risk of failure from overtopping, under seepage, through seepage or debris impact. Given the distance from the dam system, a dam surge could dissipate prior to reaching this point in the Delta and result in a minor change in water elevation.

Past Occurrences

There are no past occurrences of dam failure.

Vulnerability to Dam Failure

Assets/Critical Facilities at Risk

The levees are at the highest risk to this hazard.

Natural Resources at Risk

Riparian habitats that border the channel can be lost due to erosive forces of high flows from dam failure.

Historic and Cultural Resources at Risk

The City has two nationally registered historic districts, the Isleton Chinese and the Japanese Commercial Districts that could be lost in the event of a flood due to dam failure.

Future Development

While future development may occur in the areas protected by levee, the Districts do not control this development. The Districts only can control whether the levees meet certification standards and the ongoing maintenance of these levees.

Drought and Water Shortage

Likelihood of Future Occurrence–Likely
Vulnerability–Medium

Hazard Profile and Problem Description

This hazard could disrupt crop irrigation. Prolonged disruption could result in the loss of a crop that year. In the event that orchards or vineyards experience disruption in irrigation, they could be lost for multiple years until they are replanted and begin producing a crop between 3 to 5 years. Agriculture is the primary industry on the island. Agricultural users pay assessments for levee maintenance and improvements. If agriculture is lost the District will not be able to cover levee maintenance or make any necessary improvements.

Past Occurrences

Although California did recently experience an extended drought, agriculture in this District remained largely unaffected due to senior water rights and riparian water rights. Some farmers voluntarily cut water use by 25% in the Delta in response to the drought in the Summer of 2015.

Vulnerability to Drought and Water Shortage

Assets/Critical Facilities at Risk

The District Planning Team noted no facilities at risk to drought.

Future Development

Drought is not likely to affect future development in the area.

Earthquake: Liquefaction

Likelihood of Future Occurrence–Occasional
Vulnerability–Medium

Hazard Profile and Problem Description

In the event an earthquake is intense enough to result in shaking that could cause the sandy soils to liquefy, the levees could resettle, move off their foundations and possibly fail. Failure could compromise the levee system and result in flooding.

Past Occurrences

According to the Delta Risk Management Strategy, Brannan-Andrus Island levees have an estimated annual frequency of failure rating of 3% from flood risk and 5% from seismic risk. The annual frequency failure for a 100-year levee is 1%. However, there is no record of a levee failure caused by a seismic event in the entire Delta region.

Vulnerability to Liquefaction

Assets/Critical Facilities at Risk

The District Planning Team noted that the levees are at the highest risk to this hazard.

Future Development

While future development may occur in the areas protected by levee, the Districts do not control this development. The Districts only can control whether the levees meet certification standards and the ongoing maintenance of these levees.

Flood: 100/200/500-year

Likelihood of Future Occurrence–Occasional
Vulnerability–High

Hazard Profile and Problem Description

A 100/200/500-year flood event could cause flooding within the District. A high water event, depending on the water elevation, could cause failure due to overtopping but more realistically could increase hydraulic gradients within the levee section resulting in landside seepage or boils. Continued seepage, if left unaddressed, could erode the levee and result in failure. Heavy flows could also cause erosion and scour on the waterside bank that could undermine the levee and cause failure.

Past Occurrences

1986 was the closest the District came to experiencing a 100-year flood. The District has not experienced a 200 or 500-yr flood.

Vulnerability to Flood: 100/200/500-year

Assets/Critical Facilities at Risk

The levee system and pumping stations are vulnerable to a 100/200/500-year flood. Higher flows from such events could exceed the capacity of both the levee system and the pumping stations that are needed to drain the island.

Natural Resources at Risk

Riparian habitats that border the channel can be lost due to erosive forces of high flows from 100/200/500-year flows.

Historic and Cultural Resources at Risk

The District's two nationally registered historic districts, the Isleton Chinese and the Japanese Commercial Districts could be negatively impacted from inundation due to a 100/200/500-year flood. The marinas along the Delta Loop along Georgiana Slough, Mokelumne River and the San Joaquin River could also be damaged and possibly lost as a result of high flows from a 100/200/500 year flood event.

Future Development

While future development may occur in the areas protected by levee, that if failed, would cause flooding of the area, the Districts do not control this development. The Districts only can control whether the levees meet certification standards and the ongoing maintenance of these levees.

Flood: Localized Stormwater Flooding

Likelihood of Future Occurrence–Highly Likely
Vulnerability–High

Hazard Profile and Problem Description

Localized stormwater flooding can occur during heavy rains or seepage events that exceed the District's drainage capabilities. Lower areas around the island may be subject to minor flooding.

Past Occurrences

Some form of localized stormwater flooding occurs during most heavy rains. The most likely time this could have occurred in the past was during the wet year in 2006.

Vulnerability to Flood: Localized Stormwater Flooding

Assets/Critical Facilities at Risk

Localized flooding can overtax the Districts pumping system and create a more hazardous situation involving the levee system by limiting the ability for inspection.

Future Development

Future development should not be affected by local drainage issues.

Levee Failure

Likelihood of Future Occurrence–Occasional
Vulnerability–High

Hazard Profile and Problem Description

Levee failure could result in inundation of the Districts and could also result in the flooding of Brannan and lower Andrus islands.

Past Occurrences

The 2012 5-Year Plan reported that since the creation of the BALMD in 1967, Brannan-Andrus Island has experienced one flood event on June 22, 1972. The levee failed on the southern end of the island along the San Joaquin River. The levee breach occurred after hours during a construction effort to raise the levee and address an instability problem. The elevation of the levee crown at the time was 10.8 feet. The subsequent water level on the inundated island reached 6.2 feet. To protect the town of Isleton, a bow levee was constructed by the US Army Corps of Engineers and volunteers. The bow levee only held for 36 hours. When it failed, 35% of the Isleton community was inundated.

The flood resulted in a "big gulp" effect, where the salt water from Suisun Bay moved into the central and southern Delta, decreasing the Delta's freshwater outflow. The salt water intrusion degraded water quality for central Delta farms and forced pumping to be cut back at the Central Valley Project pumping plant in Tracy. In order to push back the salinity gradient, a hydraulic barrier was created by increasing water releases from Folsom, Oroville, and Shasta reservoirs. Still, it took those releases several days to reach the affected Delta areas. After releasing over 150,000 acre feet of water, salinity levels were eventually restored to pre-flood levels. It took eight weeks of pumping to dewater the Brannan-Andrus Island.

The USACE spent $1.4 million to repair the breach with another $1.0 million used in federal disaster assistance totaling $2.4 million. In addition, numerous marinas and restaurants suffered from a loss of business and the flood's negative publicity. Crops were lost and intrastate commerce was disrupted. When adding up all of the flood's indirect costs, including the diversion of fresh water destined for CVP customers, it was estimated that the total economic impact of the 1972 Brannan-Andrus flood was approximately $40 million.

The BALMD became concerned about another levee failure during a high water event in 1997, when a section of the landside slope sloughed into a toe ditch along the Georgiana Slough levee. The USACE spent over $1.1 million to stabilize approximately 6,700 lineal feet of levee.

Vulnerability to Levee Failure

As previously stated, BALMD monitors and maintains the levees on the island. Reclamation Districts 407, 2067, and 317 maintain and control the operations of the seven pumping stations to keep the island dry. Five pumping stations are located along Sevenmile Slough, another is on Georgiana Slough, and a lift station is located on the main drainage canal in the northern part of the island.

The 5-Year Plan noted that to repair a levee breach the average cost has been estimated to be approximately $25 million. But the total cost truly depends on the accessibility, size and severity of the breach, the size of the island, volume of water to be pumped out, weather conditions, etc. The $25 million figure assumes costs of $5/yd^3 of on-island replacement fill, $15/yd^3 of off-island fill, 6% per foot of engineering costs, and $5/foot for rip rap. A summer levee breach occurred on Brannan-Andrus in 1972 (discussed above). The Jones Tract failure in 2004, the most recent levee failure, provides insight into determining what a levee breach could cost today. It has been publicized that this 500 foot breach cost approximately $90 million for repair, recovery, and associated damage. However, many knowledgeable locals consider that figure inflated by as much as a factor of two.

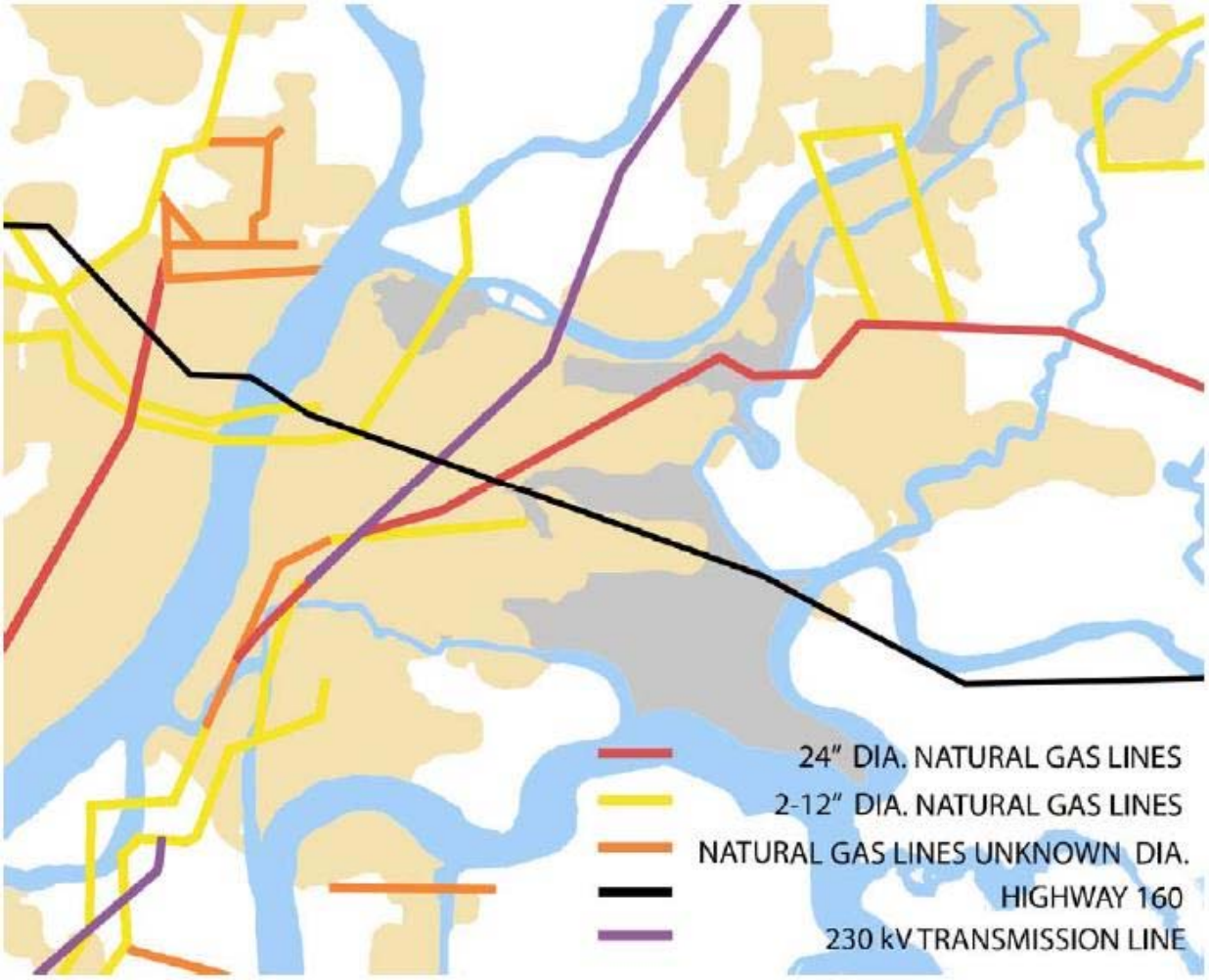
The 5-Year Plan broke down costs by land use type.

- **Residential –** The costs associated with inundation are taken from FEMA's method for estimating displacement. This includes a one-time cost of $500 per flooded household, a cost of $500 per month of inundation per household, and a monthly rental cost of $747. For Brannan-Andrus, it is estimated that there could be a one-time displacement cost of $182,400 for all occupied households along with an additional $15,600 per day to house these residents elsewhere. In addition to the residents, the various resorts on the island generate a transient population. To house this population in emergency shelters it could cost an estimated $85 per person per day. There are no reliable statistics covering that element of the population to determine a total cost per day for emergency housing, since the population fluctuates with the seasons. Flooding threats usually allow sufficient time to evacuate, so the costs to accommodate this unique group of part-time residents may not be significant.
- **Commercial –** Commercial structures will be adversely impacted from the time they are inundated through the time it takes to repair such damage and damage to surrounding infrastructure. For any business that is flooded FEMA assumes a one-time displacement cost of $1000, for a total of $148,000. Upon inundation, the businesses are assumed to have $77,500 of lost output value, $3,900 of lost profit, and $44,000 of lost value added per day on average. "Value added" is the sum of wages and salaries, proprietor's incomes, other property income, and indirect business taxes (URS 67). When a flood occurs, the island businesses could lose $140 million in sales for that year. Four-hundred seventy-one jobs could be lost per day over the duration of inundation. Overall, a flood could cost Brannan-Andrus Island businesses about $125,400 per day. Some businesses may be unable to recover from a flood and could possibly be lost as a result of such an event.
- **Agricultural –** Main crops grown on Brannan-Andrus Island are alfalfa, corn, wheat, pears, apples, cherries, and wine grapes. Brannan-Andrus Island has 10,517 acres of crops. Average cost for rehabilitation and field clean up is $235 per acre. This involves the removal of debris and sediment deposits after floodwaters have receded. Silt and debris can also clog drainage and irrigation ditches adding a variable cost to rehabilitation. The estimated total one-time cost for clean-up and rehabilitation is estimated to be $2.0 million. If inundation lasts longer than 14 days, it is assumed that the crops will be permanently lost. In 1972, it took eight weeks to pump out the island. Using that estimate, essentially all crops could be lost in a similar flood event. Any flood event that occurs between planting and harvest, could completely destroy the crops. Reestablishment of a lost crop dramatically increases economic losses. The inundation period is assumed to be five weeks on lower Tyler Island, meaning all crops on the lower end could potentially be lost in a flood event. However, due to the smaller size of RD 554 and an assumed inundation period of five days, not all crops may be lost. Not including clean-up costs, reestablishment of all crops on the island could total an estimated $23.9 million. In addition to reestablishment costs, a flood could also result in annual crop production losses. Annual crop production losses are incurred from the time of the flood and depend on how long inundation occurs, cleanup and the time required for the crops to produce a harvestable yield. If a flood occurs between planting and harvest, the crop will be lost for the year. Planting on Brannan-Andrus begins in

April and harvest ends by October. This report adds two months onto the planting season since it is estimated to take two months before the soils are dry enough for planting. As a result, the critical flood season for crops really occurs between February and October. If planting cannot occur within the same year as the flood event, annual production losses from orchards and vineyards could amount to about $17 million. If an event occurs between February and October, pushing planting to the following year, annual production losses will be about $26.8 million. Degraded water quality from salinity intrusion can also reduce crop yields.

The Brannan-Andrus Island levee system also protects several critical infrastructure components. There is an approximately 18-mile network of roads that include State Highway 12 (4.21 mi.) and Highway 160 (8 mi.) which provide east-west and north-south links with interstate corridors. A power transmission line, sized at about 230kV runs about 3.6 miles down the center of the island to the south end, through Brannan Island State Park. There are approximately 9,088 acres of underground gas fields and storage areas with a total of 33 natural gas wells and 157 gas/oil wells. The areas in beige represent the natural gas fields. A Lodi Gas' natural gas pipeline (24" diameter) runs west to east across the island feeding two 2-12" diameter pipelines. In total there are about 14.3 miles of PG&E pipeline with natural gas production at about 5,117,858 mcf. These are all shown on Figure 2-3.

Figure 2-3 PG&E Natural Gas Pipelines, Gas Fields, Storage Areas, and Transmission Lines



Source: 2012 5-Year Plan

Assets/Critical Facilities at Risk

Levees and district pumping plant. On island inundation can create an open water situation where a large fetch could develop and erode the interior of other levees within the District. Inundation of the drainage pumps and system can make them inoperable and require replacement. Other critical facilities at risk include two fire departments, Isleton city offices and an elementary school.

Natural Resources at Risk

The 5-Year Plan noted that many western Delta islands (Brannan-Andrus included) are vital for maintaining Delta water quality. If Brannan-Andrus was to flood, it would lower outflows and draw saline water from Suisun Bay into the Delta. The salinity gradient would migrate up to the southwest and southern Delta as it did in the summer flood of 1972. Also similar to 1972, the saline water would force the State Water Project pumps to shut down due to degraded water quality. This would compromise the water supply for the central and southern parts of the state until the salinity barrier is pushed back west. If the event were to

occur between August and December, when there is less fresh water run-off, drinking water treatment costs would increase significantly for jurisdictions that draw water out of the Delta.

According to the PPIC report, intentional permanent flooding of an island or a levee failure would create a "big gulp," bringing salt water in from the bay. This would have long-term effects on Delta water quality and factors in heavily when attempting to determine which islands should be reclaimed after failure.

Historic and Cultural Resources at Risk

The City of Isleton and its historic Chinese and the Japanese Commercial Districts could be devastated if it became flooded. In 1972, part of the town was inundated but due to its higher elevation, areas adjacent to the levees stayed relatively dry. The greatest risk of inundation from a levee break would be from a break along the Sacramento River, which is the strongest levee in the District with the least likelihood of failure.

The marinas along the Delta Loop along Georgiana Slough, Mokelumne River and the San Joaquin River could also be damaged and possibly lost as a result of a levee break.

Future Development

While future development may occur in the areas protected by levee, the Districts do not control this development. The Districts only can control whether the levees meet certification standards and the ongoing maintenance of these levees.

River/Stream/Creek Bank Erosion

Likelihood of Future Occurrence–Highly Likely
Vulnerability–Medium

Hazard Profile and Problem Description

River/stream/creek bank erosion could destabilize the levee slope and, if left unaddressed, cause levee failure through undercutting.

Past Occurrences

Bank erosion is currently occurring on the District levees, particularly Georgiana Slough and Sacramento River and must be remedied.

Vulnerability to Erosion

Assets/Critical Facilities at Risk

The District Planning Team noted that the District's levees are at risk of erosion.

Future Development

While future development may occur in the areas protected by levee, which may be compromised by significant erosion issues, the Districts do not control this development. The Districts only can control whether the levees meet certification standards and the ongoing maintenance of these levees.

Severe Weather: Fog

Likelihood of Future Occurrence–Highly Likely
Vulnerability–Medium

Hazard Profile and Problem Description

Fog can make it difficult to perform levee inspections during high water due to lack of visibility.

Past Occurrences

Fog occurs annually but it has not occurred during high water events that require monitoring.

Vulnerability to Fog

Assets/Critical Facilities at Risk

The levees are at risk due to the inability to perform inspections.

Future Development

While future development may occur in the areas protected by levee, the Districts do not control this development. The Districts only can control whether the levees meet certification standards and the ongoing maintenance of these levees. However, fog is unlikely to affect future development of the area.

Severe Weather: Heavy Rains and Storms (Thunderstorms, Hail, Lightning)

Likelihood of Future Occurrence–Highly Likely
Vulnerability–Medium

Hazard Profile and Problem Description

Heavy rains and storms can result in higher flood flows that could increase the hydraulic gradients within the levee section and result in seepage or if great enough, possibly overtopping. They can also increase flows and result in erosion of the waterside bank.

Past Occurrences

There are heavy storms that occur every year. The last heavy rain and storm event that raised river levels the District experienced was in 2006, 1997 and 1986. No significant damages occurred due to these high water events.

Vulnerability to Heavy Rain and Storms

Assets/Critical Facilities at Risk

The Planning Team for the District noted that the District levees and pumping plant are at risk of damage from heavy rains and storms.

Future Development

While future development may occur in the areas protected by levee, which may be compromised by severe storms, the Districts do not control this development. The Districts only can control whether the levees meet certification standards and the ongoing maintenance of these levees.

Severe Weather: Wind and Tornadoes

Likelihood of Future Occurrence–Highly Likely
Vulnerability–Medium

Hazard Profile and Problem Description

In the event of high water, wind can create wave action that could cause erosion at the waterside bank of the District's levees.

Past Occurrences

Wind occurs on a regular basis. The hazard comes when high winds are coupled with high water, which happened in the winter of 2006. The District went on levee patrols during this time to monitor waves washing over the levee along the Mokelumne and San Joaquin River from the high winds coupled with high winter flows and high tide. No damages occurred as a result of the event.

Vulnerability to Wind and Tornadoes

Assets/Critical Facilities at Risk

The Planning Team for the District noted that the District levees and pumping plant are at risk of damage from winds and tornadoes.

Future Development

While future development may occur in the areas protected by levee, which may be compromised by high wind events, the Districts do not control this development. The Districts only can control whether the levees meet certification standards and the ongoing maintenance of these levees.

Wildfire

Likelihood of Future Occurrence–Likely
Vulnerability–Medium

Hazard Profile and Problem Description

A wildfire could destroy private property and other such structures on the island.

Past Occurrences

The District Planning Team noted no past occurrences.

Vulnerability to Wildfire

Assets/Critical Facilities at Risk

The District's pumping stations could be damaged in a fire. Furthermore the vegetation on the District levees could be burned leaving bare soil that could be subject to erosion.

Natural Resources at Risk

Riparian and shrub scrub vegetation could be lost in a wildfire.

Historic and Cultural Resources at Risk

Wildfire has the potential to irreparably destroy the historic Chinese and the Japanese Commercial Districts.

Future Development

It is unlikely that future development in the Districts will be affected by wildfire.

2.6 Capability Assessment

Capabilities are the programs and policies currently in use to reduce hazard impacts or that could be used to implement hazard mitigation activities. This capabilities assessment is divided into five sections: regulatory mitigation capabilities, administrative and technical mitigation capabilities, fiscal mitigation capabilities, mitigation education, outreach, and partnerships, and other mitigation efforts.

2.6.1. Regulatory Mitigation Capabilities

Table 2-7 lists regulatory mitigation capabilities, including planning and land management tools, typically used by local jurisdictions to implement hazard mitigation activities and indicates those that are in place in the BALMD and RDs 317, 407, and 2067.

Table 2-7 BALMD, RD 317, RD 407, and RD 2067's Regulatory Mitigation Capabilities

Plans	Y/N Year	Does the plan/program address hazards? Does the plan identify projects to include in the mitigation strategy? Can the plan be used to implement mitigation actions?
Comprehensive/Master Plan	N	
Capital Improvements Plan	N	
Economic Development Plan	N	
Local Emergency Operations Plan	Y	The plan addresses flooding hazards and can be used to implement mitigation actions
Continuity of Operations Plan	Y	
Transportation Plan	N	
Stormwater Management Plan/Program	N	
Engineering Studies for Streams	N	
Community Wildfire Protection Plan	N	
Other special plans (e.g., brownfields redevelopment, disaster recovery, coastal zone management, climate change adaptation)	N	
Building Code, Permitting, and Inspections	**Y/N**	**Are codes adequately enforced?**
Building Code	Y	Version/Year: CBC 2013
Building Code Effectiveness Grading Schedule (BCEGS) Score	N	Score:
Fire department ISO rating:	N	Rating:
Site plan review requirements	N	
Land Use Planning and Ordinances	**Y/N**	**Is the ordinance an effective measure for reducing hazard impacts? Is the ordinance adequately administered and enforced?**
Zoning ordinance	Y	Sacramento County Zoning Code
Subdivision ordinance	N	
Floodplain ordinance	Y	Yes, Sacramento County Floodplain Ordinance restricts development in the floodplain
Natural hazard specific ordinance (stormwater, steep slope, wildfire)	N	
Flood insurance rate maps	Y	AE Zone
Elevation Certificates	Y	
Acquisition of land for open space and public recreation uses	N	
Erosion or sediment control program	Y	5-YEAR PLAN
Other	N	
How can these capabilities be expanded and improved to reduce risk?		

Source: BALMD

2.6.2. Administrative/Technical Mitigation Capabilities

Table 2-8 identifies the department(s) responsible for activities related to mitigation and loss prevention for BALMD and RDs 317, 407, and 2067.

Table 2-8 BALMD, RD 317, RD 407, and RD 2067's Administrative and Technical Mitigation Capabilities

Administration	Y/N	Describe capability Is coordination effective?
Planning Commission	N	
Mitigation Planning Committee	N	
Maintenance programs to reduce risk (e.g., tree trimming, clearing drainage systems)	Y	Annual vegetation management
Mutual aid agreements	N	
Other	N	
Staff	**Y/N FT/PT**	**Is staffing adequate to enforce regulations? Is staff trained on hazards and mitigation? Is coordination between agencies and staff effective?**
Chief Building Official	N	
Floodplain Administrator	Y	Determined via the Emergency Operations Plan
Emergency Manager	Y	Determined via the Emergency Operations Plan
Community Planner	N	
Civil Engineer	Y, FT	Staff is trained to coordinate with agencies and perform tasks in an emergency situation
GIS Coordinator	N	
Other	N	
Technical		
Warning systems/services (Reverse 911, outdoor warning signals)	Y	Phone tree, Reverse 911
Hazard data and information	Y	
Grant writing	N	
Hazus analysis	N	
Other	N	
How can these capabilities be expanded and improved to reduce risk?		
BALMD can develop an improved warning system among trustees, public and staff.		

Source: BALMD

2.6.3. Fiscal Mitigation Capabilities

Table 2-9 identifies financial tools or resources that the BALMD and RDs 317, 407, and 2067 could potentially use to help fund mitigation activities.

Table 2-9 BALMD, RD 317, RD 407, and RD 2067's Fiscal Mitigation Capabilities

Funding Resource	Access/ Eligibility (Y/N)	Has the funding resource been used in past and for what type of activities? Could the resource be used to fund future mitigation actions?
Capital improvements project funding	Y	Delta Levees Subventions program to maintain levee system.
Authority to levy taxes for specific purposes	Y	Proposition 218 provides the District with the ability to raise assessments through a vote
Fees for water, sewer, gas, or electric services	N	
Impact fees for new development		Unknown, would be dictated by Sacramento County
Storm water utility fee	Y	Assessments are developed for drainage
Incur debt through general obligation bonds and/or special tax bonds	N	
Incur debt through private activities	Y	Bonds are obtained from the Bank of Rio Vista
Community Development Block Grant	N	
Other federal funding programs	N	
State funding programs	Y	Delta Levee Subventions Program and Delta Levee Special Projects, Proposition 84 and 1E
Other	N	
How can these capabilities be expanded and improved to reduce risk?		
The involvement of Federal agencies funds would help in reducing risk as well as the removal of the sunset clause on the Delta Levees Subventions Program.		

Source: BALMD

2.6.4. Mitigation Education, Outreach, and Partnerships

Table 2-10 identifies education and outreach programs and methods already in place that could be/or are used to implement mitigation activities and communicate hazard-related information.

Table 2-10 BALMD, RD 317, RD 407, and RD 2067's Mitigation Education, Outreach, and Partnerships

Program/Organization	Yes/No	Describe program/organization and how relates to disaster resilience and mitigation. Could the program/organization help implement future mitigation activities?
Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.	N	
Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	N	
Natural disaster or safety related school programs	N	
StormReady certification	N	
Firewise Communities certification	N	
Public-private partnership initiatives addressing disaster-related issues	N	
Other	N	
How can these capabilities be expanded and improved to reduce risk?		

2.6.5. Other Mitigation Efforts

The Districts do annual erosion repair and seepage abatement projects. There are currently two large projects in the planning stages that will address critical erosion sites on the Sacramento River and Georgiana Slough. The Districts are also updating their Five Year Plan with levee repair and enhancement projects to continue to maintain and improve the levee system.

2.7 Mitigation Strategy

2.7.1. Mitigation Goals and Objectives

BALMD and RDs 317, 407, and 2067 adopts the hazard mitigation goals and objectives developed by the HMPC and described in Chapter 5 Mitigation Strategy.

2.7.2. Mitigation Actions

The planning team for BALMD and RDs 317, 407, and 2067 identified and prioritized the following mitigation actions based on the risk assessment. Background information and information on how each action will be implemented and administered, such as ideas for implementation, responsible office, potential funding, estimated cost, and timeline are also included.

Action 1. Implement Bioengineered Bank Stabilization techniques

Hazards Addressed: Levee Failure, Earthquake: Liquefaction, River Bank Erosion, Flood 100/200/500-year, Severe Weather: Heavy Rains, Severe Weather: Wind

Goals Addressed: 1, 2, 3, 4

Issue/Background: Scour due to high flows and channel meander has eroded and undercut the waterside bank. Rip rap is just one way to combat erosion but provides no habitat benefits. The use of bioengineered bank stabilization techniques will provide plantable media to provide riparian and Shaded Riverine Aquatic Habitat.

Project Description: The designs include using plantable geotextile bags in the place of rip rap within the tidal zone to protect against erosion and provide habitat.

Other Alternatives: None

Existing Planning Mechanism(s) through which Action Will Be Implemented: None

Responsible Office/Partners: Reclamation District Board of Directors and District Engineer Gilbert Labrie

Project Priority: Medium

Cost Estimate: Adapted to different projects, difficult to estimate

Benefits (Losses Avoided): Reduction in flood risk from levee failure, bank erosion, 100/200/500 year flood and heavy rains.

Potential Funding: District assessments and Delta Levees Subventions Program and 2016 Multi Benefit PSP

Timeline: Summer 2018 to Summer 2023

Action 2. Development of Dredge Stockpile Site

Hazards Addressed: Levee Failure, Earthquake: Liquefaction, River Bank Erosion, Flood 100/200/500-year, Severe Weather: Heavy Rains, Severe Weather: Wind

Goals Addressed: 1, 2, 3, 4

Issue/Background: This area is District owned and can provide an on-island mitigation site to offset impacts from levee improvement projects.

Project Description: Develop habitat for sensitive species such as freshwater marsh, riparian and shrub scrub.

Other Alternatives: None

Existing Planning Mechanism(s) through which Action Will Be Implemented: None

Responsible Office/Partners: Reclamation District Board of Directors and District Engineer Gilbert Labrie

Project Priority: Medium

Cost Estimate: $500,000

Benefits (Losses Avoided): Ancillary to projects that reduce flood risk from levee failure, bank erosion, 100/200/500 year flood and heavy rains.

Potential Funding: District assessments and Delta Levees Subventions Program and Special Projects funding

Timeline: Summer 2020 to Summer 2023

Action 3. Georgiana Slough Waterside Erosion Repair

Hazards Addressed: Dam Failure Levee Failure, Earthquake: Liquefaction, River Bank Erosion, Flood 100/200/500-year, Severe Weather: Heavy Rains, Severe Weather: Wind

Goals Addressed: 1, 2, 3, 4

Issue/Background: Scour due to high flows and channel meander has eroded and undercut the waterside bank. If left unaddressed, the slope may fail or result in underseepage that could ultimately cause levee failure and flood.

Project Description: The designs include filling voids at the waterside toe with rip rap and riparian bench will be enhanced with added fill. The levee slopes will be regraded and fill added to accommodate a Bulletin 192-82 critical levee section. Levee slopes will be a minimum of 2:1 landside and 3:1 water side where applicable.

Other Alternatives: None

Existing Planning Mechanism(s) through which Action Will Be Implemented: None

Responsible Office/Partners: Reclamation District Board of Directors and District Engineer Gilbert Labrie

Project Priority: High

Cost Estimate: Multi-Year effort, not available (current project in planning progress is 2 million for 0.3 miles)

Benefits (Losses Avoided): Reduction in flood risk from levee failure, bank erosion, 100/200/500 year flood and heavy rains.

Potential Funding: District assessments and Delta Levees Subventions Program and 2016 Multi Benefit PSP

Timeline: Summer 2018 to Summer 2023

Action 4. Hydrographic surveys and data collection

Hazards Addressed: Levee Failure, Earthquake: Liquefaction, River Bank Erosion, Flood 100/200/500-year, Severe Weather: Heavy Rains, Severe Weather: Wind

Goals Addressed: 1, 2, 3, 4

Issue/Background: In order to reveal heavily eroded areas, hydrographic survey data must be obtained to inform repair and maintenance activities. It can also be used to develop designs and estimate costs to repair the levee system.

Project Description: Hydrographic surveys will be performed along Georgiana Slough, Mokelumne River, San Joaquin River, Sevenmile Slough, and potentially the Sacramento River to reveal deep waterside bank erosion.

Other Alternatives: None

Existing Planning Mechanism(s) through which Action Will Be Implemented: None

Responsible Office/Partners: Reclamation District Board of Directors and District Engineer Gilbert Labrie

Project Priority: High

Cost Estimate: $300,000

Benefits (Losses Avoided): Aides in providing information for projects that will reduce in flood risk from levee failure, bank erosion, 100/200/500 year flood and heavy rains.

Potential Funding: District assessments and Delta Levees Subventions Program

Timeline: 2018 to 2025

Action 5. Mokelumne River Crown Raising

Hazards Addressed: Dam Failure Levee Failure, Earthquake: Liquefaction, River Bank Erosion, Flood 100/200/500-year, Severe Weather: Heavy Rains, Severe Weather: Wind

Goals Addressed: 1, 2, 3, 4

Issue/Background: Crown deficiencies have reduced the levees freeboard above the 100-year flood and has increased the levees vulnerability to flooding during a high water event.

Project Description: Crown raising will occur from District stations 115+00 to 127+00 and 135+00 to 145+00 to repair Bulletin 192-82 deficiencies

Other Alternatives: None

Existing Planning Mechanism(s) through which Action Will Be Implemented: None

Responsible Office/Partners: Reclamation District Board of Directors and District Engineer Gilbert Labrie

Cost Estimate: $500,000

Benefits (Losses Avoided): Reduction in flood risk from levee failure, bank erosion, 100/200/500 year flood and heavy rains.

Potential Funding: District assessments and Delta Levees Subventions Program and Special Projects funding

Timeline: Summer 2020 to Summer 2023

Project Priority: High

Action 6. San Joaquin River Waterside Erosion Repair

Hazards Addressed: Dam Failure Levee Failure, Earthquake: Liquefaction, River Bank Erosion, Flood 100/200/500-year, Severe Weather: Heavy Rains, Severe Weather: Wind

Goals Addressed: 1, 2, 3, 4

Issue/Background: Scour due to high flows and channel meander has eroded and undercut the waterside bank. If left unaddressed, the slope may fail or result in underseepage that could ultimately cause levee failure and flood.

Project Description: The designs include filling voids at the waterside toe with rip rap and riparian bench will be enhanced with added fill. The levee slopes will be regraded and fill added to accommodate a Bulletin 192-82 critical levee section. Levee slopes will be a minimum of 2:1 landside and 3:1 water side where applicable.

Other Alternatives: None

Existing Planning Mechanism(s) through which Action Will Be Implemented: None

Responsible Office/Partners: Reclamation District Board of Directors and District Engineer Gilbert Labrie

Project Priority: High

Cost Estimate: Multi-year effort, not available

Benefits (Losses Avoided): Reduction in flood risk from levee failure, bank erosion, 100/200/500 year flood and heavy rains.

Potential Funding: District assessments and Delta Levees Subventions Program and Special Projects funding

Timeline: Summer 2020 to Summer 2023

Action 7. Sevenmile Slough French Drain and Seepage Berm

Hazards Addressed: Dam Failure Levee Failure, Earthquake: Liquefaction, River Bank Erosion, Flood 100/200/500-year, Severe Weather: Heavy Rains, Severe Weather: Wind

Goals Addressed: 1, 2, 3, 4

Issue/Background: Seepage has been an issue at this levee stretch along Sevenmile Slough. This issue must be resolved to improve the levee stability.

Project Description: Project will remove existing toe drain and install a seepage berm and French drain to resolve seepage issues and facilitate proper drainage through the levee

Other Alternatives: None

Existing Planning Mechanism(s) through which Action Will Be Implemented: None

Responsible Office/Partners: Reclamation District Board of Directors and District Engineer Gilbert Labrie

Project Priority: High

Cost Estimate: $1,200,000

Benefits (Losses Avoided): Reduction in flood risk from levee failure, bank erosion, 100/200/500 year flood and heavy rains.

Potential Funding: District assessments and Delta Levees Subventions Program and Special Projects funding

Timeline: Summer 2020 to Summer 2023